Quantitative Microbial Risk Assessment Tutorial Land-applied Microbial Loadings within a 12-Digit HUC

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Summary

This tutorial reviews screens, icons, and basic functions of the SDMProjectBuilder (SDMPB). It demonstrates how one chooses a 12-digit HUC for analysis, performs an assessment of land-applied microbes by simulating microbial fate and transport using HSPF, and analyzes and visualizes the results at multiple locations in the watershed using BASINS. It shows how to

- Initiate the execution of SDMPB.
- Navigate the SDMPB.
- Identify and label a 12-digit HUC.
- Develop the necessary input files to execute HSPF successfully.
- Develop the necessary input file to view results from the SDMPB and HSPF.
- Register the HSPF simulation with BASINS.
- Use HSPF to simulate SDMPB's problem statement.
- View simulation results for flows and microbial densities with BASINS.

Land-applied Microbial Loadings within a 12-Digit HUC

PURPOSE

Automate the data acquisition process for input data requirements of a confederation of models

OBJECTIVE

Preform an assessment of microbial fate and transport within a 12-digit HUC by capturing contextual data for the watershed model WinHSPF (a.k.a. HSPF) and pre-populate its input data files to account for

- Overland runoff;
- Snow accumulation/melt;
- Hourly simulations;
- NLDAS meteorological data;
- Land-applied microbial loadings; and
- Microbial fate and transport.

DEMONSTRATION

This tutorial reviews screens, icons, and basic functions of how one takes the output from the SDMProjectBuilder (SDMPB) and performs a microbial fate and transport analysis within a 12-digit Hydrologic Unit Code (HUC-12). A HUC-12 is a subwatershed between 16 and 63 mi². Application of the watershed model HSPF is demonstrated, as well as visualization of results at multiple locations in the watershed using BASINS. The application demonstrates how to

- Initiate the execution of SDMPB.
- Navigate the SDMPB.
- Identify and label a 12-digit HUC.
- Develop the necessary input files to execute HSPF successfully.
- Develop the necessary input file to view results from the SDMPB and HSPF.
- Register the HSPF simulation with BASINS.
- Use HSPF to simulate SDMPB's problem statement.
- View simulation results for flows and microbial densities with BASINS.

SOFTWARE ACCESS, RETRIEVAL, AND DOWNLOAD

Instructions for access, retrieval, and download of the SDMProjectBuilder, HSPF, and BASINS software products are provided by Whelan et al. (2015a). When installed, three shortcut icons should be on your desktop:



TUTORIAL – TABLE OF CONTENTS

NAVIGATING THE SDMPB AND IDENTIFYING THE HUC-8 OF INTEREST

CHOOSE A 12-DIGIT HUC WITHIN A WATERSHED AND COLLECT ENVIRONMENTAL AND SOURCE-TERM DATA

- Choose a HUC-12
- Identify and Modify Local Source-term Data
 - *MonthlyFirstOrderDieOffRateConstants.csv*
 - WildlifeDensities.csv
 - PointSourceLL.csv and PointSourceData.csv
- Import Local Data Files
- Run Project Builder and Collect Map Layers Describing Environmental Characteristics

USE HSPF TO SIMULATE THE SDMPB PROBLEM STATEMENT BY PERFORMING AN ASSESSMENT ON A 12-DIGIT HUC

- Execute the Assessment with HSPF
- Register the HSPF Simulation with BASINS

LABEL SUBWATERSHEDS, RIVER REACHES, MET STATIONS

- Increase the NLDAS Symbol Size
- Label and Color-code MET Stations
- Correlate MET Stations with Subwatersheds
- Label Stream Reaches

VIEW SIMULATION RESULTS FOR FLOWS AND MICROBIAL DENSITIES USING BASINS

- Register HSPF Simulation and Data Files
- View Graphical Simulation Results for Hourly Discharges at Multiple Locations
- Modify the Look and Feel of the Graphical Plots
- View Simulation Results for Hourly and Daily Discharges at the Same Location
- View Microbial Simulations: Time Series of Microbial Densities at Multiple Locations
- View Tabular Results Associated with Hourly Discharge and Microbial Density Simulations

NAVIGATING THE SDMPB AND IDENTIFYING THE HUC-8 OF INTEREST

1. Execute the SDMProjectBuilder (SDMPB) by clicking on the shortcut icon displayed on the computer screen:



- 2. A detailed and more comprehensive tutorial describing the procedure for identifying an 8-digit HUC is provided in Whelan et al. (2015b). An abbreviated version follows.
- 3. Create a folder where you have administrative rights. In the example below, "TESTA" was created. Click "Save".



4. From the Menu Bar, select "SDMProjectBuilder>New SDM Project".



Specify the name and location of the	e new project file	X
SDMPB + TESTA	✓ 4y Search TESTA	٩
Organize 🔻 New folder		!≕ ▼ 🔞
SDMPB bin ctc TESTA TESTA_OLD SDMPB_061215 SDMPB_090315 SDMPB_090415 SDMPB_091115	Name No items match your search.	Date modified
File <u>n</u> ame: TESTA Save as <u>type</u> : Project files (*.d.	spx) Save	▼ ▼ Cancel

5. Create a new file named "TESTA" in the folder "TESTA". Click "Save".

6. A map of the Unites States including Alaska, Hawaii, and Puerto Rico should appear.



7. Under "SDMProjectBuilder", select "Nav Helper".



- 8. Whelan et al. (2015b) explains how a user can find a HUC-8 within the United States by zooming in on the State and County or directly inputting the HUC-8 identifying Catalog Unit (CU) code. In this case, catchments in the Manitowoc, Wisconsin County basin will be analyzed, within the HUC-8 04030101 near Manitowoc, Wisconsin. Do not close "Navigation Helper" until instructed.
 - Check the "NHD+" and "HUC-12" boxes
 - Type "04030101" as the "HUC 8"
 - Click "Zoom" to the right of "HUC 8".

Whelan et al. (2015b) explains how one labels the HUC-8s with CU codes.

Navigation Help	er	
Base Layers		
State:	Wisconsin 🗸	Zoom
County:	Manitowoc County -	Zoom
HUC 8:	04030101 ▼ ▼ NHD+ ▼ HUC 12s	Zoom Get Data
Layers:	•	Show Attributes
	Close	

9. The appropriate HUC-8 will be highlighted (in blue below) on the screen:



10. Click "Get Data".

Navigation Help	ber	
Base Layers		
State:	Wisconsin 🗸	Zoom
County:	Manitowoc County -	Zoom
HUC 8:	04030101 ▼ ▼ NHD+ ▼ HUC 12s	Zoom Get Data
Layers:	•	Show Attributes
	Close	

11. A screen similar to the following will appear.







13. Choose "Close".

Navigation Help	er	
Base Layers		
State:	Wisconsin	Zoom
County:	Manitowoc County	Zoom
HUC 8:	04030101	Zoom Get Data
Layers:	•	Show Attributes
	Close	

CHOOSE A 12-DIGIT HUC WITHIN A WATERSHED AND COLLECT ENVIRONMENTAL AND SOURCE-TERM DATA

Choose a HUC-12

14. Choose the "Select" button (red circle), then the appropriate HUC-12 (i.e., headwaters Killsnake River) as illustrated below. In this example, you are identifying a single HUC-12 (i.e., headwaters Killsnake River) in the Manitowoc Watershed, as highlighted in the figure below; highlight the single HUC-12 shown. The SDMPB allows the user to choose any HUC-12. Because it does not account for any upstream inflow to the HUC, it is advisable to choose only headwater HUCs when defining a single HUC-12. It should be noted that overland flow simulations are not a function of instream flow simulations, so these computations are not compromised if a non-headwater HUC is chosen. A future plan will allow the user to specify an upstream boundary condition to address this issue.



15. Using the Zoom In button 15. Joom to this area.

Check the "nhdflowline" Map Layer. If it is not at the top of the listing, move it there to ensure it is the outermost projection, and it will appear on the map. To see where the ponded waters are located, check the Map Layer titled "nhdwaterbody for 04030101". This provides a full picture of water sources and their locations.



Identify and Modify Local Source-term Data

Descriptions of the local source-term data are described in Whelan et al. (2015c). There are 12 default files located in the "LocalData" directory, as illustrated below:

<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>T</u> ools <u>H</u> elp				
Organize 👻 Include in library 👻 Share wit	h ▼ Burn New folder			
iii testa	Date modified	Туре	Size	
HSPF-PEST	AnimalLL.csv	10/5/2015 5:27 PM	Microsoft Excel C	25 KB
	BoundaryPointsLL.CSV	10/5/2015 5:27 PM	Microsoft Excel C	1 KB
LocalData	FCProdRates.csv	10/5/2015 5:26 PM	Microsoft Excel C	1 KB
	GrazingDays.csv	10/5/2015 5:27 PM	Microsoft Excel C	1 KB
	ManureApplication.csv	10/5/2015 5:28 PM	Microsoft Excel C	1 KB
	MonthlyFirstOrderDieOffRateConstants.c	10/5/2015 3:07 PM	Microsoft Excel C	1 KB
	OutputPointsLL.csv	10/5/2015 3:07 PM	Microsoft Excel C	1 KB
	PointSourceData.csv	10/5/2015 3:06 PM	Microsoft Excel C	1 KB
SDMPB_090415	PointSourceLL.csv	10/5/2015 3:05 PM	Microsoft Excel C	1 KB
	SepticsDataWatershed.csv	10/5/2015 5:27 PM	Microsoft Excel C	1 KB
SDMPB_093013	SepticsLL.csv	10/5/2015 5:27 PM	Microsoft Excel C	16 KB
SDMProjectBuilder_100214	🗟 WildlifeDensities.csv	10/5/2015 3:08 PM	Microsoft Excel C	1 KB

Table 1 summarizes the metadata associated with the parameters contained within each file, including definitions and units.

These files must be reviewed by the user to ensure they are applicable to the watershed of interest. For this example problem, the following modifications will be made:

- Domestic Animals and Wildlife
 - Farm locations with domestic animal numbers and types, their production rates along with production rates in built-up areas, number of animal grazing days, and fraction of animal-generated manure applied to the soil will remain unchanged, as documented in the AnimalLL.csv, FCProdRates.csv, GrazingDays.csv, and ManureApplication.csv example templates, respectively. The farm locations reflect actual farm locations within the Manitowoc Basin. No changes to any of these files are necessary.
 - Different first order die-off rates will be used for land-applied microbes, so modifications to the MonthlyFirstOrderDieOffRateConstants.csv example template are necessary.
 - Wildlife densities will be changed to reflect the actual number of deer in this area, so the WildlifeDensities.csv example template will be modified.
- Point Sources
 - There will be no point sources. Whelan et al (2015c) describe several ways to exclude point sources. The two default point source locations defined in PointSourceLL.csv just happen to randomly fall within our watershed. The user can do any of three things to remove the use or impacts of a point source: (1) change Latitude-Longitude coordinates to locations outside of the watershed, (2) reduce the point source loadings to *de minimus* levels in PointSourceData.csv, or (3) within HSPF, remove the point source from the simulation (see Whelan et al., 2015c). In this example, Latitude-Longitude pairs will be changed to a location outside of the watershed. Because only microbes are associated with this assessment, the reference to chemicals in PointSourceData.csv will be removed.

FILE NAME	INPUT DATA AND DEFINITION	UNITS	
Domestic Animals and Wildlife			
	Domestic animal locations by Latitude and	Degree (by	
Animall Losv	Longitude	fraction)	
AnnalLe.csv	Domestic animal numbers by type and	Number	
	location	Number	
	Production or shedding rate of microbes		
	from the domestic animal, which equals		
	the multiple of the 1) Domestic animal		
	shedding rate in mass of waste (wet	Counts/d/animal	
FCProdRates.csv	weight) per time and 2) Microbial		
	by the domestic animal		
	Typical microbial production or shedding	Counts/d/ac	
	rate per wildlife per area		
	Number of grazing days per domestic	Number	
	animal per month	Number	
GrazingDays.csv			
	Fraction of the number of grazing days that	fraction	
	Beef Cattle spend in a stream per month		
	Fraction of manure applied to soil each		
	month per domestic animal	traction	
ManureApplication.csv	Fraction of amount of manure shed by the	c	
	domestic animal incorporated into soil	fraction	
Monthly Eirst Order Die Off Pate Constants cov	First-order microbial inactivation/die-off	1/d	
	rate on the land surface per month	1/u	
WildlifeDensities csv	Typical number of wildlife per unit area by	Number/mi ²	
	land use type		
Point Sources			
PointSourceLL.csv	Point source locations by Latitude and	Degree (by	
	Longitude	fraction)	
	Annual-average flow for each point source	ft ³ /s	
Deint Course Data and	Annual-average microbial loading rate for	Counts/yr	
PointSourceData.csv	Annual average chemical leading rate for		
	Annual-average chemical loading fate for	Lbs/yr	
Sentic Systems			
	Septic system locations by Latitude and	Degree (by	
SepticsLL.csv	Longitude	fraction)	
	Number of people per septic unit	Number	
	Average fraction of septic systems that fail	fraction	
SepticsDataWatershed.csv	Average septic overcharge rate per person	gal/d/person	
	Typical microbial density of septic	Counte/I	
	overcharge reaching the stream	Counts/L	
Intermediate Points			
BoundaryPoints csy	Boundary point locations by Latitude and	Degree (by	
	Longitude	fraction)	
OutputPoints.csv	Output point locations by Latitude and	Degree (by	
	Longitude	fraction)	

Table 1.	Names o	f default	support fil	les and inp	ut types fo	or which the	e user has a	ccess for mo	difications

- Septic Systems
 - Septic locations and their metadata, represented by SepticsLL.csv and SepticsDataWatershed.csv, respectively, will remain unchanged and used as is, since these locations reflect actual locations within the Manitowoc Basin.
- Intermediate Points
 - The intermediate Latitude-Longitude locations listed in BoundaryPoints.csv and OutputPoints.csv randomly fall within the HUC-12 boundaries. Because they do not impact the simulations, their contents will remain unchanged.

MonthlyFirstOrderDieOffRateConstants.csv

16. Open MonthlyFirstOrderDieOffRateConstants.csv using TextPad, Notepad, WordPad, Excel, or other pertinent editor. Using WordPad, the original file includes die-off rate constants by month with units of d⁻¹:

M	onthly	FirstOr			
<u>F</u> ile	<u>E</u> dit	F <u>o</u> rmat	<u>V</u> iew	<u>H</u> elp	
Mont Janu Febr Maro Apri May, Juny Augu Sept Octo Nove Dece	:h,Di Jary, 'uary :h,O. il,O. j,O. 51 2,O. 55 (,O. 55 (,O. 55 (,O. 50 2,O. 50 2,O. 50 2,O. 50 2,O. 50 2,O. 50 2,O. 50 2,O. 510 2,O. 51 2,O. 51 2,O. 51 2,O. 51 2,O. 51 2,O. 51 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	eoffRat 0.36 36 51 1 .51 r,0.51 0.36 ,0.36 ,0.36	teCon	tant	*
				Þ	зđ

17. Change the rate constants to 0.064 d^{-1} , so the file becomes:

MonthlyFirstOr	×
<u>File E</u> dit F <u>o</u> rmat <u>V</u> iew <u>H</u>	lelp
Month,DieOffRateConta January,0.064 February,0.064 March,0.064 April,0.064 June,0.064 June,0.064 July,0.064 August,0.064 September,0.064 October,0.064 November,0.064	nt 🔺
•	▶

These reflect lower-end values by Martinez et al. (2013) (see Kim et al., 2015).

18. Save as a csv file and exit.

WildlifeDensities.csv

The wildlife densities associated with this region of Wisconsin tend to be dominated by deer, with typical fall and winter densities of 29 and 21 deer/mi², respectively (WDNR, 2015). 29 deer/mi² will be

assumed to be associated with agricultural (pasture and cropland) and forest land types. No deer will be associated with Built areas. Because recreational activities with beaches typically occur during summer and fall, fall numbers will be used in this analysis.

19. Open WildlifeDensities.csv using TextPad, WordPad, Notepad, Excel, or other pertinent editor. Using Notepad, the original file includes the flowing locations:



20. Update the file by changing the "5" to "29", so the file looks like the following:



21. Save as a csv file, and exit.

PointSourceLL.csv and PointSourceData.csv

22. Open PointSourceLL.csv using Notepad, TextPad, WordPad, Excel, or other pertinent editor. Using Notepad, the original file includes the flowing point source locations PT001 and PT002:

PointSourceLL.csv - No	X	
<u>F</u> ile <u>E</u> dit F <u>o</u> rmat <u>V</u> iew <u>H</u> elp		
Latitude,Longitude, PtSrcId 44.112,-88.256,PT001 44.06,-88.191,PT002		^
		Ŧ
<	Þ	t

23. Remove the second Latitude-Longitude pair, and change the coordinates for PT001 to <33.899, -83.346>, which happens to be somewhere in Georgia.



24. Save as a csv file, and exit.

25. Open PointSourceData.csv using Notepad, TextPad, WordPad, Excel, or other pertinent editor. Using Notepad, the original file includes the flowing point source locations PT001 and PT002:

ſ	PointSourceData.csv - Notepad
	<u>File Edit Format View H</u> elp
	PtSrCId, FacName, Load, Parm PT001, PointSource1,1, FLOW PT001, PointSource1,1000, Microbes PT001, PointSource1,5, Diazinon PT002, PointSource2,2, FLOW PT002, PointSource2,2000, Microbes PT002, PointSource2,4, Diazinon

26. Remove the three lines referencing PT002 and the line referencing the Diazinon loading for PT001. The resulting file will look like the following:

	PointSourceData.csv - Notepad						
E	ile	<u>E</u> dit	F <u>o</u> rmat	<u>V</u> iew	<u>H</u> elp		
P P P	t Sr T00 T00	cId, 1, P 1, P	FacNa ointSo ointSo	me, L urce1 urce1	oad, I ,1, FI ,1000	Parm LOW , Microbe	s

27. Save as a csv file, and exit.

Ensure that all revised files replaced the original files contained in the "LocalData" folder under the working directory.

Import Local Data Files

After replacing the files in the "LocalData" folder within the working folder, these data can be registered with the SDMProjecBuilder (SDMPB).

28. From the Menu Bar, choose "SDMProjectBuilder", then "Import Local Data Files".



A screen will appear to allow the user to import 12 "Local Data Files," of which the five files listed in the screen below identify specific Latitude-Longitude locations for locations of domestic animals (e.g., farms), intermediate points (i.e., boundary conditions, output points), point sources (e.g., POTWs), and septic systems:

🔡 Edit Local Data	
Local Data Files	
AnimalLL	
BoundaryPointsLL	
PointSourceLL	
SepticsLL	
Orașe Din	
Open File	
Edit File	
Start Adding Points	
Delete Selected Point(s) on Map Close File	
Close	

We will register, as map layers, the following Local Data Files: animal locations (AnimalLL) and Septic locations (SepticsLL) which happen to be the same (i.e., farms use septic systems).

🖳 Edit Local Data	
Local Data Files	
AnimalLL	
OutputPointsLL PointSourceLL	
September	
Open File	
Edit File	
Start Adding Points	
Delete Selected Point(s) on Map	Close File
Close	

29. To register "AnimalLL", highlight "AnimalLL", and choose "Open File".

30. Wait until the screen changes, then "Close File."

🖳 Edit Local Data	
Local Data Files	
AnimalLL	^
BoundaryPointsLL OutputPointsLL	E
PointSourceLL Sentics I	+
oopilooee	
Open File	
Edit File	
Cost Addas Drive	
Start Adding Points	
Delete Selected Point(s) on Map	Close File
Close	

31. The map layer for animal locations (typically farms) will appear on the map, similar to that below: SDM Project Builder



32. To register "SepticsLL", highlight "SepticsLL", and choose "Open File".

🖳 Edit Local Data	
Local Data Files AnimalLL BoundaryPointsLL OutputPointsLL PointSourceLL SepticsLL Copen File Edit File	
Start Adding Points Delete Selected Point(s) on Map Close Fi	e

33. When the screen changes, choose "Close File."

🖳 Edit Local Data	
Local Data Files	
AnimaILL BoundaryPointsLL OutputPointsLL PointSourceLL	E
SepticsLL	T
Open File	
Edit File	
Start Adding Points	
Delete Selected Point(s) on Map	Close File
Close	

34. The following screen, which includes the Animal (I.e., farm) (dark blue square dots) and septic locations (light blue smaller dots) overlaid on each other, will appear.





Zoom in and view the HUC-12 of interest with animal farm and septic locations:

35. When complete, "Close" the screen:

🖳 Edit Local Data	
Local Data Files AnimalLL BoundaryPointsLL OutputPointsLL PointSourceLL SepticsLL	•
Open File Edit File	
Start Adding Points Delete Selected Point(s) on Map	Close File
Close	>

Run Project Builder and Collect Map Layers Describing Environmental Characteristics



36. A HUC-12 was previously selected. If it was unselected in the meantime, re-select the HUC-12.

37. From the Menu Bar, choose "SDMProjectBuilder", then "Run Project Builder".



The screen below appears.

🔜 Build Frames SDM Project			
Select Area Of Interest On Map Or Enter Key(s) Below			
Select By: 🔿 HUC-8 💿 HUC-12 🔿 Catchment 🔿 County 🔿 Current Map Layer 🔿 Pour Point	🔘 Box		
1 Selected: 040301010406 : Headwaters Killsnake River			
Circle Defines O One Defines Des Celevier			
Single Project O Une Project Per Selection			
Cancel	Next		

Because a HUC-12 was previously selected, the "040301010406: Headwaters Killsnake River" automatically appears. The software only has been tested for "HUC-12" and "Pour Point" assessments, although it should work for HUC-8 assessments since the only essential difference between a HUC-12 and HUC-8 is size. If the HUC-12 has not already been selected, select it.

38. Choose "Next", and the screen below appears.

🖳 Build Fr	rames SDM Project		
Parameter	rs For Model Generation		
1	Minimum Catchment Size (square kilometers)		
5	Minimum Flowline Length (kilometers)		
0.07	Ignore Landuse Areas Below Fraction		
1990	Simulation Start Year		
2000	Simulation End Year		
HSPF	Output Interval: Hourly - Microbes		
	Snow: No Snow - Land-Applied Chemical Chemical Properties		
SWAT	SWAT 2005 Database c:\users\gwhelan\iemtechnologies\sdmpb\bin\models\SWAT\Databases\swat2005.mdb		
Cancel	Previous Next		

- 39. Use the choices and values included in this figure:
 - "3" for the "Minimum Catchment Size". During delineation, an attempt will be made to delineate subwatersheds to at least this sizewhich ensures that modeling very small subwatersheds is kept to a minimum.
 - "3" for the "Minimum Flowline Length". During delineation, an attempt will be made to delineate subwatersheds so that river segments have at least this length. This ensures that modeling very small river segments is kept to a minimum.
 - "0.1" for the "Ignore Landuse Areas Below Fraction". During delineation, land use types below this fraction of total land use will be combined. This ensures that modeling *de minimus* land use types is minimized.
 - "1990" for the "Simulation Start Year" which is the year in which the simulation begins.
 - "2000" for the Simulation End Year" which is the year in which the simulation ends.
 - "HSPF" for the watershed model.
 - "Hourly" for the "Output Interval". Simulations are hourly within HSPF, but the output can be presented in a number of units such as hourly, daily, weekly, monthly, annually, etc..
 - "Degree Day" for the "Snow" calculation. This option determines if snow accumulation and melt calculations are included. Choices are No Snow, Energy Balance method, or Degree Day method.
 - "Microbes" determines if microbes will be simulated. If not chosen, all microbial data will be ignored.
 - "Land-Applied Chemical" indicates there is a chemical application equally applied to all agricultural lands within the watershed.
 - "Chemical Properties" indicates that if a chemical is applied, this button allows the user to modify its physicochemical properties.

- Build Fr	ames SDM Project		
Parameter	rs For Model Generation		
3	Minimum Catchment Size (square kilometers)		
3	Minimum Flowline Length (kilometers)		
0.1	Ignore Landuse Areas Below Fraction		
1990	Simulation Start Year		
2000	Simulation End Year		
V HSPF	Output Interval: Hourly - Microbes		
SWAT	Snow: Degree Day Chemical Chemical Properties No Snow Energy Balance Degree Day SWAT Degree Day SWAT		
Cancel	Previous Next		

40. Pick "Next", and the following screen will appear.

Build Frames S	DM Project
Data Options	
Soil STATSGO SSURGO	Meteorologic BASINS NCDC Enter NCDC Token Here NDAG Data and the
	INLUAS Precipitation
Elevation	NHDPlus Elevation
Delineation	NHDPlus 👻
Save Project As	C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\TESTA.mwprj
Cancel	Add Layers To Map During Project Creation Build

41. Use the choices and values included in this figure:

- Choose STATSGO which is less detailed than SSURGO for soil options.
- Choose "NLDAS Precipitation". NLDAS is the North American Land Data Assimilation System and contains automatic quality control (QC), uses hourly gauge station data and modeled precipitation, provides estimates at hourly intervals with a 1/8th-degree resolution, and provides precipitation time series at specified locations (Kim et al., 2014). This is used in conjunction with NCDC NOAA meteorological data which supplies information for regional data, such as air temperature. BASINS uses cached NCDC data up to 2009. For direct access to hourly NCDC data, choose "NCDC, but the user must obtain a Token ID. Subwatersheds default to the nearest MET station.
- Choose the "NHDPlus Elevation" for Elevation and "NHDPlus" for Delineation.
- The name of the file should already be identified, but a different name or location can be selected by choosing the name of the file (e.g., *.mwprj) and where it is saved. The .mwprj file is a MapWindow (mw) Project (prj) file directly consumed by BASINS. The program will automatically identify the working folder structure the user originally created. If a special location and name is chosen, the user may identify a special folder using "Save Project As".
- To allow data retrieval, check "Add Layers To Map During Project Creation".

🖳 Build Frames S	DM Project
Data Options Soil STATSGO SSURGO	Meteorologic BASINS NCDC Enter NCDC Token Here V NLDAS Precipitation
Elevation Delineation	NHDPlus Elevation NHDPlus
Save Project As	C:\Users\awhelan\iemTechnologies\SDMPB\TESTA\TESTA.mwprj
Save Hoject As	
Cancel	Add Layers To Map During Project Creation Previous Build

42. Now choose "Build" which may take several minutes to complete, depending on the computer.

43. Processing takes several minutes for a HUC-12.

🚰 FramesSDM Status	-OX		
Step 7 of 7: Creating HSPF input sequence			
11,961 of 149,669			
Cancel Pause Log			

44. Some computers may ask several times if the re-project map layer should match the map coordinate system; choose "Yes" each time.

Projection Mismatch	\times
Reproject map layer to match the map coordinate system? This will not affect the source fil	e.
<u>Y</u> es <u>N</u> o	

- 45. When the SDMPB has finished running, you will see the message below. If the user chooses
 - "Ok", SDMPB will exit and close down.
 - "Open Folder", the user will be redirected to the working folder location.
 - "Open in BASINS", BASINS will automatically open with the SDMPB map layers for this assessment.

When exiting the SDMPB, the following files are created:

- a. BASINS File: *.mwprj, the MapWindow Project file that contains the conceptual layout and map layers of the assessment.
- b. HSPF-related Files pertinent to these examples include the:
 - i. *.uci file, which is the User Control Input file. It is a flat file containing all non-time series data. The UCI file is the controlling input file for HSPF. Based on choices of the user, the SDMPB automatically constructs the HSPF UCI file. Appendix A reviews some of the contents of the UCI file related to this tutorial to show where data were captured in this file. It is presented for the more advanced user who is familiar with HSPF and its UCI file and is not required reading for this tutorial.
 - ii. *.wdm files, which is the Watershed Data Management files. These binary files contain time series data (i.e., weather, input, output, calibration, etc.).
 - iii. *.hbn file, which is the HSPF Binary output file that contains binary output.

Although not recommended at this time due to a potential error in DotSpatial, ways that a user can view the typical map layers generated by SDMPB are reviewed in Appendix B.

Frames SDM
Finished Building Project C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\TESTA.mwprj
Ok Open Folder Open in BASINS



46. Choose "Open in BASINS", and the following screen appears:

💟 unnamed 🔻 X: 631,785.020 Y: 2,371,217.467 Meters 🛛 Lat: 44.094 Long: -88.074

1:52604

USE HSPF TO SIMULATE THE SDMPB PROBLEM STATEMENT BY PERFORMING AN ASSESSMENT ON A 12-DIGIT HUC

Execute the Assessment with HSPF

47. After clicking "Build" within SDMPB and subsequent processing, the user has a project folder containing GIS layers and other project-related files. An example folder structure is developed:



Files relevant for HSPF simulation are located in the "HSPF" subfolder.



48. The user can open HSPF in one of two ways:

a. Use the WinHPSF3.0 icon on the Windows desktop. Pick the appropriate UCI file or



b. From the BASINS menu bar, choose "Models", "HSPF", then "Open Existing". Pick the appropriate UCI file.

BAS	INS 4.	1 - TES	A*																					
File		atershe	d Deline	eation	🔣 Model	s	Compute	e 🔣 La	unch	🔣 Analys	s Lay	er Viev	v Boo	kmarks	Plug-ins	Shapefil	e Editor	Conv	erters Help					
	-	- 📥		-			X			1	N					• ‡ ?	0	•	.					
New	Oper	n Save	Print	Settings	Add	Remove	e Clear	Symbo	logy	Categories	Query I	Properties	Table	Sel	ect Deselect	Measure	e Identify	/ Labe	l Mover					
4	€	P	Û	<u>ال</u>				ن ك	at :	ship ship			\bigcirc	0	Ø	爵	5	2	- 1		- 1 C	\checkmark	5	1
Pan	In	Out E	tent S	elected	Previous	Next	Layer	New Ir	isert .	Add Remov	e Copy	Paste	Merge	Erase	Erase beneath	Move	Rotate	Resize	Move vertex	Add vertex	Remove vertex	Cleanup	Undo	

We will use the WinHSPF3.0 icon.

49. To open the HSPF project, activate the WinHSPF3.0 icon on the Windows desktop



which opens the main HSPF window:

🕌 Hydrological Simulation Pr	ogram - Fortran (HSPF)	
File Edit Functions Help soet over ces Wet Seals Met Seals Point Sour ces		

Select UCI	
Image: Solution of the second state Image: Sol	Search HSPF
Organize 🔻 New folder	:= - 🔟 🔞
Let TESTA Name	Date modified
HSPF 040301010406.uci	10/7/2015 10:24 AM
HSPF-PEST	
huc12	
LocalData	
Multipplus	
pcs	
BDMPB_061215	
B SDMPB_090315	
BDMPB_090415 + < □ □ □	+
File name: 040201010406 usi	UCI files (* uci)
	<u>Open</u> Cancel

50. From the "File" menu, choose "Open", navigate to the UCI file, and click "Open".

51. The new HSPF project will appear in the HSPF GUI, with the watershed workflow schematic shown below.



The user may navigate through the HSPF controls to interact with the HSPF project.

52. The simulation period is set by the user in SDMProjectBuilder, and output is set at an hourly time step. The simulation period can be checked or modified by clicking on the "Simulation Time and Meteorologic Data" toolbar button in the HSPF menu bar:



53. The window below will appear for setting simulation start and end dates.

WinHSPF - Si	mulation Time and Meteorologic Data
Start: 19 End: 20	Year Month Day Hour Minute 90 1 1 0 0 100 12 31 24 0
Met Segment	
Add	Edit Apply
Connections	
Met Seg ID	Operation 🔺
X294Y152	PERLND 101
X294Y152	PERLND 102
X294Y152	PERLND 103
X294Y152	PERLND 104
X294Y152	PERLND 105
X294Y152	PERLND 106 -
X294Y152	PERLND 107
X294Y152	PERLND 108
X294Y152	IMPLND 102
X293Y152	PERLND 201
X293Y152	PERLND 202
X293Y152	PERLND 204
¥293¥152	PERIND 206
	QK <u>C</u> ancel

- 54. The date can be changed, but we will leave the starting and ending dates unchanged for this assessment. Click "OK".
- 55. Save the HSPF project by clicking "File", then "Save" on the main menu bar.
- 56. To run the HSPF simulation, click the "Run Simulation" icon.



As the simulation is executed, the status monitor will appear.

HspfEngineNet Status Monitor
12%
Cancel Pause Log

57. When the simulation is complete, the status monitor disappears. The HSPF subfolder will contain additional files such as the .ech, .out, and .hbn files shown below.

					- • ×
	TEST	A ▶ HSPF	- 4 ∳	Search HSPF	Q
<u>File E</u> dit <u>V</u> iew <u>T</u> ools <u>H</u> elp					
Organize 🔻 Include in library 👻 Share wit	th 🔻	Burn New folder			• 🔳 🔞
Kim_Test_Results	*	Name	Size	Date modified	Туре
▷ 🎍 pest13		o40301010406.uci	45 KB	10/7/2015 11:18 AM	UCI File
SARATimeSeriesUtility		ERROR.FIL	69 KB	10/7/2015 11:18 AM	FIL File
A DALA		HSPF.log	100 KB	10/7/2015 11:18 AM	Text Document
Þ 📁 bin		a 040301010406.ech	89 KB	10/7/2015 11:18 AM	ECH File
P etc		040301010406.hbn	1,588 KB	10/7/2015 11:18 AM	HBN File
		🖻 040301010406.out	3,383 KB	10/7/2015 11:18 AM	OUT File
		🖻 040301010406.wdm	13,200 KB	10/7/2015 11:18 AM	WDM File
	=	040301010406.psr	1 KB	10/7/2015 10:24 AM	PSR File
		040301010406.seg	1 KB	10/7/2015 10:24 AM	SEG File
		040301010406.ptf	2 KB	10/7/2015 10:24 AM	PTF File
		040301010406.rch	2 KB	10/7/2015 10:24 AM	RCH File
		040301010406.wsd	5 KB	10/7/2015 10:24 AM	WSD File
		📧 met.wdm	10,560 KB	10/7/2015 10:23 AM	WDM File
SDMPB 061215		4			
13 items					
13 items				Cor	nputer 🔡

Note that the HSPF binary output file (.hbn) in this example is roughly 1.6 Mb in size. The file size could be an issue for long simulation periods, as the size may approach a limit of 2.0 GB.

58. Save the HSPF project by clicking "File", then "Save" on the main menu bar.

Leave the HSPF workflow schematic screen open, as you may want to refer to it when operating in the BASINS interface.

Register the HSPF Simulation with BASINS

59. If BASINS is not already open, start BASINS with the BASINS 4.1 icon on the desktop in order to view results of the simulation:



60. At the "Welcome" window, choose "Open Existing Project".

Welcome to BASINS 4.1		×
	<u>Build New Project</u> View Documentation	
	Open Existing Project 02060006	
Close	up	

61. Navigate to the project folder (e.g., TESTA), and select the *.mwprj file. Note that the name of the file reflects your selection. Be certain the file name you assigned to your assessment matches the *.mwprj extension. An example:

🌉 Open	Section 1		
	🖟 « SDMPB ⊧ TESTA ⊧	✓ 4y Search TESTA	S
Organize 🔻	 New folder 	≡ - □ 0	
D	Install_SDMP8_101714 Install_SDMP8_102314 Install_SDMP8_111214 Install_SDMP8_111214 Install_SDMP8_111214 SKm_Test_Results Install_SDMP8 SDMP8 SDMP8 Install_SDMP8 Install_SDMP8 </td <td>Name Name Name NBSPF NSPF-PEST Nucl2 LocalData MHDPlus NLCD DCS ETESTA.mwpr</td> <td>C 1 1 1 1 1 1 1 1</td>	Name Name Name NBSPF NSPF-PEST Nucl2 LocalData MHDPlus NLCD DCS ETESTA.mwpr	C 1 1 1 1 1 1 1 1
	File <u>n</u> ame:	MapWindow Project Files (*.mv Open Cancel	

62. Click "Open" so the SDMPB project will open in BASINS 4.1. Although all SDMPB map layers may not be displayed within the SDMPB interface, they are visible as BASINS map layers, and data are available in BASINS for HSPF simulations. The following screen including domestic animal and septic locations, which overlay each other and NLDAS stations will appear:



LABEL SUBWATERSHEDS, RIVER REACHES, MET STATIONS

To plot results effectively, the user must identify subwatersheds (i.e., subbasins), stream reaches, and MET stations, etc. with aunique identifier. This section reviews labeling protocols for subwatersheds, river reaches, and MET stations.

Increase the NLDAS Symbol Size

63. It is hard to differentiate NLDAS MET stations from the domestic animal/septic locations, so

- uncheck the other map layers since NLDAS symbols may actually be hidden behind other symbols and
- increase the size of the NLDAS symbol by double-clicking on the NLDAS Grid Center symbol (see blue arrow):





64. The screen below appears; change the "Size" to 20, and click "Ok".





65. By clicking "File," then "Manage Data" on the menu bar, we can see that the MET data are loaded into the project and there are 14 MET time series in the file.



66. Choose "File", then "Exit" to return to the main screen.

Label and Color-code MET Stations

67. To Color-code the MET stations, double-click "NLDAS Grid Center" label (see blue arrow in screen below)



68. Choose "Categories" tab, and

- 1. check "Unique values"
- 2. select "LOCATION"
- 3. check "Gradient"
- 4. choose "Color scheme"
- 5. click "Generate"
- 6. check the boxes with non-zero counts
- 7. choose "Apply"



69. Choose "Labels", then "Setup."

ι	ayer prop	erties: N	LDAS Grid	Center						×
ſ	General	Mode	Appearance	e Categories	Labels	Charts	Visibility]
	Labe	ls previev	N			Set	up ear			
	Арр	earance -								
	1	/ Labels	visible	Frame visib	le					
	1	0	Size	•						
L							Apply	/	Ok	Cancel

70. Double click on "Location", then "Ok."

Label style							
Preview	Expression	Font	Frame	Position	Visibility	Styles]
•X294Y152	Express [LOCAT) Fields	ion ON]					Clear
Labels visible	LUCATI	UN				+ Example	" " NewLine
10 Font size					[/ [/	Area] + "h Populatio	ha" + n]/1000 + "thsnd."
Transparency 255						Descriptic Area] -th ha''-strir	on ne name of field ng constant
Expression is correct			A	pply		Ok	Cancel

71. Choose the Position, then click "Ok."

abel generation		
Position		
	Ok	Cancel

72. Click "Ok."

Layer prop	erties: N	ILDAS Grid C	enter						×
General	Mode	Appearance	Categories	Labels	Charts	Visibility			
Labe	ils previer	√	94Y152		Sel C	lup			
App	earance Z Labels	visible Size	Frame visib	le					
						App	ły	Ok	Cancel

The two MET stations that influence the seven subwatersheds are now labeled and color-coded (one light red and one purple).



Correlate MET Stations with Subwatersheds

73. To see which subwatersheds (i.e., subbasins) are associated with which MET stations, double-click on "Simplified Catchment" (see blue arrow in figure below):



74. The following screen will appear:



- 75. To color code subwatersheds to match the color-coded MET stations, choose the "Categories" tab, and
 - 1. check "Unique values"
 - 2. select "ModelSeg"
 - 3. check "Gradient"
 - 4. choose "Color scheme"
 - 5. click "Generate"
 - 6. check the boxes with non-zero counts
 - 7. choose "OK"

Laye	er properties: Si	implified Cat	chment				×
G	ieneral Mode	Appearance	Categories	Labels Cha	rts Visibility		5
	Fields NLCD_51 NLCD_61 NLCD_71 NLCD_81	1	Classification Categories	7 🗼	Color scheme	Random colo	Generate Clear
	NLCD_82 NLCD_83 NLCD_84 NLCD_85		Categories Style	Name	3	Count	
	NLCD_91 NLCD_92 PCT_CN PCT_MX			Unclassified X293Y152 X294Y152		0 2 5	
2	PRECIP TEMP ModelSeg	E	6			-	
	SUBBASIN SLO1 AREAACRES AREAMI2 BNAME	-					
	·				Apply	7] Ok	Cancel

76. From the resulting image, you can see that the subwatersheds have been color-coded with the nearest NLDAS locations.



Appendix C illustrates how the HSPF UCI file captures and assigns the two NLDAS stations to the subwatersheds.

Label Stream Reaches

77. To label the stream reaches so they match the number scheme in the HSPF workflow, double-click on the map layer "Simplified flowline" (the blue arrow in the screen capture below):



🔟 unnamed 👻 X: 630,264.992 Y: 2,367,501.722 Meters | Lat: 44.062 Long: -88.097 |

78. Choose the "Labels" tab, then "Setup":

General	Mode	Appearan	ce Categor	ies Labels	Charts	Visibility		
Labe	ls preview				Set	ID		
					a	ear		
- 400								
, opp								
3	Labels	visible	- Frame	visible				
1	0	Size	-					
						Apply	Ok	Cancel

79. Under "Expression",

- choose "SUBBASIN" under "Fields"
- change the Font size to 20.
- click "Ok"

Label style						×
Preview	Expression	Font	Frame	Position	Visibility	Styles
6	Express [SUBBAS	ion SIN]				
Labels visible 20 Font size	Fields AREAW AREAW CUMLEN LOCDRA Boundar SUBBAS	TMAP TMAT NKM AINA Y			• 	Clear + "" NewLine Example Area] + "ha" + Population]/1000 + "thsnd."
Transparency 255	LEN2 LAREA TAREA TAREA	CRES				Description Area] - the name of field ha'' - string constant
Expression is correct			A	pply		Ok Cancel

80. Choose "middle segment" for the location of the label and click "Ok".

Label generation
Position
First segment
Last segment
Middle segment
Congest segment
Orientation realtive to line Parallel
Label every part of shape
Ok Cancel



💹 unnamed 🔻 X: 627,442.200 Y: 2,365,210.279 Meters | Lat: 44.044 Long: -88.135 |

VIEW SIMULATION RESULTS FOR FLOWS AND MICROBIAL DENSITIES USING BASINS

There are two ways to view HSPF simulation results: create a graph of the output time series or view the time series in tabular form. The following related topics will be covered:

- Register HSPF Simulation and Data Files
- View Graphical Simulation Results for Hourly Discharges at Multiple Locations
- Modify the Look and Feel of the Graphical Plots
- View Simulation Results for Hourly and Daily Discharges at the Same Location
- View Microbial Simulations: Time Series of Microbial Densities at Multiple Locations
- View Tabular Results Associated with Hourly Discharge and Microbial Density Simulations

Register HSPF Simulation and Data Files

82. Go to the "File", then "Manage Data" menu. The user may see a pre-loaded met.wdm file, as illustrated below. Time series data sources from the HSPF simulation are needed for viewing simulation results, so they will be added.

य Data Sources	
File Analysis Help	
	A\met\met.wdm (14)
<u>e</u>	

83. The WDM file associated with the watershed of interest contains time series data. From within the Data Sources window, select "File", then "Open". A selection window like the one below appears.



84. Select "WDM Time Series", then "Ok".

85. Navigate to the HSPF project folder, and select the *.wdm file (not met.wdm) associated with your assessment. Here, it is '040301010406.wdm'. This file contains the output time series written from HSPF to the WDM file.

Select WDM Tir	ne Series file to	open			? 🗙
Look <u>i</u> n:	C HSPF		 G 	ø 🖻 🖽	-
My Recent Documents Desktop	040301010406	.wdm			
My Documents					
My Computer					
	File <u>n</u> ame:	040301010406.wdm		~	<u>O</u> pen
My Network	Files of type:	WDM Files (*.wdm)		~	Cancel

86. With this data source open, the file name will appear in the Data Sources window. [Note: There may be other WDM files already registered in the list, but do not select met.wdm.]

🖉 Data Sources
File Analysis Help
⊡-WDM C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\met\met.wdm (14)
C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.wdm (49)
C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.wdm
49 Timesenes 13,516,800 bytes
Modified 10/7/2015 11:18:06 AM

- 87. The HSPF Binary file (*.hbn) only exists after execution of HSPF; hourly data associated with the "RO" designation (Reach Outflow) are associated with the *.hbn file. To view results of the Microbial simulation, the HSPF binary output file must be added to the current BASINS project.
- 88. From the "Data Sources" window, choose the "File", then "Open" again.

89. Select "HSPF Binary Output", then "Ok".



90. Navigate to the HSPF project folder and select the file with the HBN extension.

Select HSPF Bi	nary Output file	to open				? 🔀
Look jn:	C HSPF		~ (3 🦻	• 🖽 对	
My Recent Documents Desktop My Documents	040301010406	.hbn				
My Computer						
	File <u>n</u> ame:	040301010406.hbn			~	<u>O</u> pen
My Network	Files of type:	HSPF Binary Output Files (*.ht	bn)		~	Cancel

91. Click "Open". Because of its large size, the HBN file may take time to read.

92. Once the file has been read, it appears in the Data Sources window.

Uata Sources
File Analysis Help
-WDM C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\met\met.wdm (14) C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.wdm (49) HSPF Binary Output C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.hbn (1360)
Timeseries::HSPF Binary Output C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.hbn 1,360 Timeseries 1,625,282 bytes Modified 10/7/2015 11:18:06 AM

93. Close the Data sources window and save the BASINS project by clicking "File", then "Save". Exit the screen.

Appendix A showed that the EXT TARGETS block within the HSPF uci file specifies which time series are output. Instream hourly time series for flow (RO) in ft3/s and microbial densities (DQAL) in Cells/L are published for each reach (RCHRES).

View Graphical Simulation Results for Hourly Discharges at Multiple Locations



Previously, HSPF captured the modeling workflow within its graphical user interface as

These reaches (RCHRES) correspond to the BASINS schematic, reach number by reach number, as follows:



Hourly flow and microbial densities will be viewed at multiple locations; in this case, Reaches (i.e., RCHRES) 3 and 7. The reach ID numbering scheme correlates to the site layout in HSPF, as illustrated in the HSPF workflow below.



94. Within the BASINS user interface, choose "Analysis", then "Graph".



95. The screen below will appear.

Select Data To Graph			
File Attributes Select Help			
Select Attribute Values to Filter Available 0	Data		
Scenario 👻	Location	~	Constituent v
04030101	1:102	~	QTOTAL Z
040301010406	P:101		RDENPF
COMPUTED	P:102	1	RETS
OBSERVED	P:103		R0
	P:104		ROHEAT
	0.106	× .	n.n.n.
Matching Data (6 of 822)			
040301010406	R:5		RO
040301010406	R:6		RO
040301010406	R:8		RO
040301010406	R:1		RO
040301010406	R:7		RO
040301010406	R:9		RO
Selected Data (0)			
Dates to Include			
All Common			
start none none			
End none none			
Apply month/day sange to each year			
Change Time Step To: 1 Ho	ur 💌 Accumulate/Divide 💌		Ok Cancel

96. To know the time units associated with the plotted results,

- choose "Attributes",
- then "Add"
- then select "Time Unit"

🔣 Select Data To Graph					x
File Attributes Select Select Attribute Values to Filte	t Help r Available Data				
Scenario	Location	 Constituent 	T	ìme Unit	-
04030101 040301010406 COMPUTED E NLDAS 065887VED	I:102 I:202 IMP102 IMP202 P:101	AGWET AGWI AGWO AGWS AIRT		ttribute oundary Day oundary Month Intvl IiGen Out IiGen Parm onstituent tab Severe	
Matching Data (1429 of 1429) OBSERVED COMPUTED COMPUTED OBSERVED OBSERVED OBSERVED OBSERVED	VI471568 VI471568 VI471568 VI471568 VI471568 VI473269 VI473269 VI473269 VI473269	PREC ATEM PEVT PREC PREC ATEM WIND SOLR	UDDD DDE H H L L L L L L L L L L L L L L L L L	ata Jource ata Tolerance escription levation (story 1)) TAID Jude Hourly culde Hourly tv/ attude ocation ongtude Day Un Years	III
Selected Data (0)			O P R S S S S S S S S	peration RECIP oint etum Period TANAM cenario ection tart Year ummary File	
Dates to include All Con Start none none none End none none none Apply month/day range to Change Time Step To:	each year	Average/Same 🔻		GROUP SBYR SFILL SFORM STYPE Ime Unit IBC190 IBC200 Ok Cancel	-

97. The following screen appears.

\llbracket Select Data To Graph				• ×
File Attributes Se	lect Help			
Select Attribute Values to F	Filter Available Data			
Scenario	✓ Location	 Constituent 		•
04030101	 I:102 	 AGWET 	▲ Hour	
040301010406	1:202	AGWI	Day	
COMPUTED	■ IMP102	AGWO	Month	
NLDAS	IMP202	AGWS		
OBSERVED	P:101	AIRT		
DT ODC	T.100		*	
Matching Data (1429 of 14	29)			
OBSERVED	WI471568	PREC	Hour	
COMPUTED	WI471568	ATEM	Hour	
COMPUTED	WI471568	PEVT	Hour	
COMPUTED	WI471568	PREC	Hour	
OBSERVED	WI473269	PREC	Hour	
OBSERVED	WI473269	ATEM	Hour	
OBSERVED	WI473269	WIND	Hour	
OBSERVED	WI473269	SOLR	Hour	-
Selected Data (0)				
Dates to Include				
All C	Common			
Start none nor	ie			
End none nor	ne			
Apply month/day range	e to each year			
Change Time Step To	: 1 Day	▼ Average/Same ▼	Ok	Cancel

As noted earlier, the constituent name for the instream hourly time series for flow in ft³/s is "RO" and the constituent name for the instream hourly microbial densities in Cells/L is DQAL. Each is published for the subwatershed location RCHRES which corresponds to hourly time units.

98	Τo	nlot the	flow	information	scroll down	and select	"RO"	under '	'Constituent"
50.	10		110 00	million mation,		and sciect	NO.	unuci	constituent .

Scenario	 Location 	 Constituent 	Time U	nit .
04020101	A 1:102	A DETS	A Hour	
04030101	1.102		- Hour	
	E IMP102	ROHEAT	Month	
	IMP202	ROVOL	Month	
	P-101	SAREA		
	T D.100	CODOC MIL	-	
Astobiog Data (14 o	f 1/(29)			
4030101	RCH5	RO	Hour	
4030101	RCH1	RO	Hour	
4030101	RCH4	RO	Hour	
4030101	RCH6	RO	Hour	
4030101	RCH3	RO	Hour	
4030101	BCH2	BO	Hour	
14030101	RCH7	RO	Hour	
040301010406	R·5	RO	Month	
Selected Data (0)				
Dates to Include				
Dates to Include	Common			
Dates to Include	Common			

99. A list of reaches with flow data appears under 'Matching Data'. Choose RCH 3 and RCH7, whose selection will appear in "Selected Data":

🛃 Select Data To Graph			
File Attributes Select	Help		
Select Attribute Values to Filter	Available Data		
Scenario -	Location	▼ Constituent	▼ Time Unit ▼
04030101 ^	I:102	 RETS 	▲ Hour
040301010406	1:202	RO	Day
COMPUTED =	IMP102	ROHEAT	Month
NLDAS	IMP202	ROVOL	
OBSERVED	P:101	SAREA	
DT ODC	0.100	CODOC MI	·
Matching Data (14 of 1429)			
04030101	RCH5	RO	Hour
04030101	RCH1	RO	Hour
04030101	RCH4	RO	Hour 🗉
04030101	RCH6	RO	Hour
04030101	RCH3	RO	Hour
04030101	RCH2	RO	Hour
04030101	RCH7	RO	Hour
040301010406	R:5	RO	Month 🛫
Colored Data (2 of 1420)			
Selected Data (2 of 1423)	PCH2	80	Have
04030101	DCU7	RO	Hour
04030101	NCH/	NU	Hour
Dates to Include			
All Com	non		
Start 1990/01/01 1990/0	1/01 1990/01/01		
End 2000/12/31 2000/1	2/31 2000/12/31		
Apply month/day range to	each year		
Change Time Step To:	1 Day	ige/Same 👻	Ok Cancel

100. Click "OK" and the graph selection window will appear.



101. Select "Timeseries", then "Generate" to produce the graph below. The discharge was previously defined as cfs (ft³/s).



102. Both hydrographs are plotted together.

Modify the Look and Feel of the Graphical Plots

If the user wishes to have individual plots, reaches can be selected one at a time for plotting. In the meantime, we will modify the graph, one at a time, and plot them, so results are easier to view.

103. To better differentiate the plots, the y-scale can be changed and curves assigned different colors. Choose "Edit", then "Graph".



The screen below appears.

•

Edit Timeserie	es Graph	gend Tex	t interest contraction		<u> </u>
Axis	Bottom X	⊂ Left Y	∕ ⊚ Right Y	Auxiliary Y	
Type Title	Time HOURLY	Linea	r 🔘 Logarithmic	e 🔘 Probability	Font
Zoom Range	1989/12/31	to	2000/12/31	Reverse	
Major Units	✓ tics ✓	grid	Grid Color	Font	
Minor Units	V tics V	gnd	Grid Color		
				Apply Automatically	Apply

104. To change the ranges and titles of the x and y axes,

Choose "Bottom X", change the Title to "Year", and choose "Apply"

Axis	Both	om X 💿	Left '	Y 🔘 Right Y	Auxiliary Y	
Type	(i) Time	0	Lines	r 🔿 Logeth	vnic 💿 Probability	
Title	Year					Font
Zoom Range	1989/12	2/31	to	2000/12/31	Reverse	
Major Units	V tics	🕅 grid		Grid Color	Font	
Minor Units	V tics	Die 💟		Grid Color		

• Choose "Left Y" and "Linear", change the "Zoom Range" minimum to 0 and maximum to 100, change the Title "Hourly Discharge (ft^3/s), and choose "Apply".

۲	Edit Timeseri	es Graph	-	-	-	
	Axes Curves	s Lines Leg	gend Text	t		
	Axis	Bottom X	Left Y	Y 🔘 Right Y	Auxiliary Y	
	Туре	Time	Linea	ır 🔘 Logarithmi	ic 🔘 Probability	
	Title	Hourly Disch	arge (ft^3/s	s)		Font
					_	
	Zoom Range	0	to	100	Reverse	
	Major Units	🗸 tics 🗸	grid	Grid Color	Font	
	Minor Units	🗸 tics 🗸	grid	Grid Color]	
					Apply Automatically	Apply

105. The screen becomes



106. To change color and label for the RCH3 curve,

- select "HOURLY 04030101 RO at RCH3" under "Curve".
- under "Color", select Blue, then "Ok".
- under Label, change the name to "Hourly Discharge Reach 3".
- click "Apply".

Edit Timeseries Graph	Color	Edit Timeseries Graph
Axes Curves Lines Legend Text	Basic colors:	Axes Curves Lines Legend Text
Curve HOURLY 04030101 RO at RCH3		Curve HOURLY 04030101 RO at RCH3
Label HOURLY 04030101 RO at RCH3 HOURLY 04030101 RO at RCH7		Label Hourly Dishcharge Reach 3
Y Axis 💿 Left 🔘 Right 🔘 Auxiliary		Y Axis 💿 Left 💿 Right 💿 Auxiliary
Color		Color
☑ Line Width 1 Solid ▼ RearwardStep ▼		✓ Line Width 1 Solid ▼ RearwardStep ▼
☑ Symbols Size 7 None ▼ 🔲 Fill	Custom colors:	✓ Symbols Size 7 None 👻 🔲 Fill
Apply Automatically Apply	Define Custom Colors >>	Apply Automatically Apply
	OK Cancel	

- 107. To change color and label for the RCH7 curve,
 - select "HOURLY 04030101 RO at RCH7" under "Curve".
 - Under "Color", select the Red, then "Ok".
 - Under Label, change the name to "Hourly Discharge Reach 7".
 - Click "Apply".
 - Click the upper right-hand corner "X".

Curve	Hourly	Discharg	e Reach 7				
Label	Hourly	Hourly Discharge Reach 7					
Y Axis	Left	0	Right 🔘 Auxilia	ary			
Color							
Line	Width	1	Solid	✓ RearwardStep	•		
Symbols	Size	7	None	▼ Fill			

108. Modifications to the plot are:



As one can see, discharges increase from Reach 3 to Reach 7 as the flow moves downstream.

View Simulation Results for Hourly and Daily Discharges at the Same Location

109. To overlay the discharge time series for daily average flows, which represent average flow for each day (sum of hourly flows divided by 24), from the BASINS user interface, choose "Analysis", then "Graph" from the menu.



- 110. Using a similar procedure as before,
 - Select "RO", then "RCH7" (RO and Hour) under Matching Data section
 - Select "FLOW", which is the daily flow, under the Constituent section, then "RCH7" (FLOW and Day) under the Matching Data section

Select Data To Graph			
File Attributes Select	t Help		
Select Attribute Values to Filter	Available Data		
Scenario 👻	Location 🔹	Constituent 💌	Time Unit 🔹
04030101	1:102	FLOW 🔺	Hour
040301010406	1:202	GAGE	Day
COMPUTED =	IMP102	GWVS	Month
NLDAS	IMP202	HRAD	
OBSERVED	P:101	HTEXCH	
DT ODC	n.101	1714/I	
Matching Data (17 of 1429)			
04030101	RCH7	FLOW	Day 🔺
04030101	RCH5	RO	Hour
04030101	RCH1	RO	Hour
04030101	RCH4	RO	Hour
04030101	RCH6	RO	Hour
04030101	RCH3	RO	Hour
04030101	RCH2	RO	Hour
04030101	RCH7	RO	Hour
Selected Data (2 of 1429)	Doug	22	
04030101	RCH/	RO	Hour
04030101	RCH7	FLOW	Day
Datas ta laskuda			
	200		
Start 1990/01/01 1990/0	11/01 1990/01/01		
End 2000/12/21 2000/1	2/21 2000/12/21		
Apply month/day range to	each year		
Change Time Step To:	1 Day	/Same 🔻	Ok Cancel

111. Click 'OK'. A graph selection window appears.



112. After "Timeseries" is selected, click "Generate" to produce the graph below. The discharge has been previously defined as cfs (ft³/s) even though the y-axis does not display the units. This figure can be modified in the same manner as hourly graphs. NOTE: One curve (HOURLY 04030101 RO) is plotted with the left y-axis (maximum of 1000) and the other curve (DAILY 04030101 FLOW) is plotted with the right y-axis (maximum of 500), making it appear that the daily average flows are higher than the hourly flows. To compare the curves, ensure that ranges associated with the two y-axes are the same.



113. By making y-axes consistent, changing curve colors, cleaning up labels, and interrogating the period June 1-30, 1995, the comparison between hourly and daily flows is illustrated below:



A similar example could be constructed for microbial densities, but density fluctuations would be on a log, not linear, scale. If individual storm events, which could vary hourly, impact exposure levels to sensitive receptors at recreational areas, then producing daily average values could miss critical peak exposure events, hence, the reason for using hourly simulations and capturing hourly results.

View Microbial Simulations: Time Series of Microbial Densities at Multiple Locations

Viewing a time series for microbial densities uses the same procedure as that used for discharges.

114. From the BASINS user interface, choose "Analysis", then "Graph" from the menu.



115. Under the Constituent section, choose "DQAL" to provides microbial densities in Counts/L at various reaches. Under Matching Data, choose the reaches corresponding to RCH3 and RCH7, and note they are in hourly outputs and will appear under Selected Data. Ensure that "Hour" is chosen under 'Change Time Step To', then click 'Ok'.

🔣 Select Data To G	raph				1	
File Attributes	Select	: Help				
Select Attribute value	s to Filter	Available Data		Canatituant		Time I la a
Scenario		Location	•	Constituent		
04030101		1:102		DQAL	^	Hour
040301010406	-	1:202		FLOW		Day
COMPUTED	=	IMP102		GAGE		Month
NLDAS		IMP202		GWVS		
OBSERVED	-	P:101		HRAD		
DT ODC		D.100		UTEVOU		
Matching Data (7 of 14	429)					
04030101		RCH5		DQAL		Hour
04030101		RCH1		DQAL		Hour
04030101		RCH4		DQAL		Hour
04030101		RCH6		DQAL		Hour
04030101		RCH3		DQAL		Hour
04030101		RCH2		DQAL		Hour
04030101		RCH7		DQAL		Hour
- Selected Data (2 of 1	429)					
04030101		RCH3		DQAL		Hour
04030101		RCH7		DQAL		Hour
Dates to Include						
All	Comr	mon				
Start 1990/01/01	1990/0	1/01 1990	/01/01			
End 2000/12/31	2000/1	2/31 2000	/12/31			
Apply month/day	range to	each year				
Change Time Ste	p To:	1 Day		/Same 🔹		Ok Cancel

The definitions of the microbial parameters are:

D	11-24-	HSPF-12.2 Manual				
Parameter	Units	(http://water.epa.gov/scitech/datait/models/basins/bsnsdocs.cfm)				
Microbe-DDQAL-BIODEG	counts/time interval	amount of parent material decayed by process BIODEG				
Microbe-DDQAL-GEN	counts/time interval	amount of parent material decayed by process GEN				
Microbe-DDQAL-HYDROL	counts/time interval	amount of parent material decayed by process HYDROL				
Microbe-DDQAL-OXID	counts/time interval	amount of parent material decayed by process OXID				
Microbe-DDQAL-PHOTOL	counts/time interval	amount of parent material decayed by process PHOTOL				
Microbe-DDQAL-TOT	counts/time interval	amount of parent material decayed by process TOT				
Microbe-DDQAL-VOLAT	counts/time interval	amount of parent material decayed by process K VOLAT				
Microbe-DQAL	counts/L	concentration of "dissolved" microbe (i.e., microbe in water)				
Microbe-IDQAL	counts/time interval	input of microbe in water column from upstream reach				
Microbe-RDQAL	counts	total storage of microbe in water column				
Microbe-RODQAL	counts	microbial outflow quantity				
Microbe-RRQAL	counts	microbial storage in reach				
Microbe-TIQAL	counts	total inflow of microbes				
Microbe-TROQAL	counts	total outflow of microbes				
Time interval' is hourly in t	his case.					

116. A graph selection window will appear. Choose "Timeseries".



117. With "Timeseries" selected, click "Generate". The following graph is produced with microbial densities of Counts/L.



118. By changing curve colors, cleaning up labels, changing the range on the y-axis, and converting it to log scale, microbial densities at reaches 3 and 7 can be compared. NOTE: These are uncalibrated simulations.



View Tabular Results Associated with Hourly Discharge and Microbial Density Simulations

119. To view tabular results of the time series for hourly discharges and corresponding microbial densities, using reach 7 (RCH7) as an example, choose "Analysis", then "List" from the BASINS menu.



120. Under the Constituent section, scroll down to "RO", and select RCH7 with the "Hour" Time Unit. The results will appear under the "Select Data To Graph" section. Under the Constituent section, scroll down to "DQAL", and select RCH7 with the "Hour" Time Unit. Results will appear under the "Select Data To Graph" section. Click 'Ok'.

Scenario	✓ Location	Constituent	▼ Time Unit	-
04030101	▲ I:102	▲ DEWTMP	A Hour	
040301010406	1:202	DIAZINON	Day	
COMPUTED	■ IMP102	DQAL	Month	
NLDAS	IMP202	FLOW		
DBSERVED	P:101	GAGE		
000	T.100	T C1440	•	
Matching Data (21 of 1429)	н. — — — — — — — — — — — — — — — — — — —			
04030101	RCH6	DQAL	Hour	^
04030101	RCH3	RO	Hour	
4030101	RCH3	DQAL	Hour	
4030101	RCH2	RO	Hour	
04030101	RCH2	DQAL	Hour	=
4030101	RCH7	RO	Hour	
4030101	RCH7	DQAL	Hour	
040301010406	R:5	RO	Month	-
Selected Data (2 of 1429)				
04030101	RCH7	RO	Hour	
4030101	RCH7	DQAL	Hour	
All C Start 1990/01/01 195	iommon 10/01/01 1990/0	1/01		
End 2000/12/31 200	0/12/31 2000/1	2/31		
End 2000/12/31 200	0/12/31 2000/1	2/31		

121. The following appears. Note that the first column (for time) reports in hourly increments, the second column presents discharges in ft³/s, and the third column presents corresponding microbial densities in Cells/L (or Counts/L).

\llbracket Timeseries Lis	t		
File Edit Viev	v Analysis Help		
History 1	from 040301010406.wdm	from 040301010406.wdm	
Constituent	RO	DQAL	
ld	148	149	
Min	0.062203	0.026511	
Max	842.97	6,392.2	
Mean	13.798	38.035	
1990/01/01 01:00	129.85	98.918	
1990/01/01 02:00	117.54	96.597	
1990/01/01 03:00	104.31	93.74	
1990/01/01 04:00	91.34	90.82	
1990/01/01 05:00	79.274	87.995	
1990/01/01 06:00	68.398	85.303	
1990/01/01 07:00	58.788	82.748	
1990/01/01 08:00	50.404	80.302	
1990/01/01 09:00	43.151	77.944	
1990/01/01 10:00	36.919	75.658	
1990/01/01 11:00	31.599	73.422	
1990/01/01 12:00	27.074	71.226	
1990/01/01 13:00	23.234	69.083	
1990/01/01 14:00	19.982	67.029	
1990/01/01 15:00	17.234	65.049	
1990/01/01 16:00	14.92	63.129	
1990/01/01 17:00	12.976	61.287	
1990/01/01 18:00	11.342	59.498	
1990/01/01 19:00	9.96/4	57.769	
1990/01/01 20:00	8.8091	56.104	
1990/01/01 21:00	7.8335	54.501	
1990/01/01 22:00	7.0116	52.968	
1000/01/01 23:00	6.31/6	51.482	
1990/01/01 24:00	5.7301	50.043	
1990/01/02 01:00	0.2313	40.042	
1990/01/02 02:00	4.0000	47.231	
1990/01/02 03:00	4.4451	40.302	
1990/01/02 05:00	2 9/52	44.72	
1990/01/02 05:00	3.8904	42.368	
1990/01/02 00:00	3,825	41.248	
1990/01/02 08:00	3 7781	40.161	
1990/01/02 09:00	3 7195	39.098	
1990/01/02 10:00	3 6597	38 032	
1990/01/02 11:00	3 5999	36.956	
1990/01/02 12:00	3 5401	35.91	
1990/01/02 13:00	3,4804	34.912	-

DISCLAIMER

The findings and conclusions in this presentation have not been formally disseminated by the EPA and should not be construed as representing any Agency determination or policy.

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APPENDIX A SDMPB-generated HSPF UCI File

1. Go the HSPF folder and open the UCI file with a text editor such as Notepad, WordPad, or TextPad. TextPad was used in Appendix A.

Solution → HSPF	✓ 4 Search HSPF
<u>File E</u> dit <u>V</u> iew <u>T</u> ools <u>H</u> elp	
Organize 🔻 Include in library 🔻	Share with 🔻 🚿 📰 🔹 🚺
 ▲ SDMP8 > ▲ bin > ▲ etc ▲ TESTA ▲ HSPF-PEST > ▲ hSPF-PEST > ▲ hccl2 ▲ LocalData ▲ met > ▲ NLCD ▲ NLCD ▲ pcs 	Name BECOL FI B 400301010405.uc B 400301010405.uc B 400301010405.ep 0 400301010405.ep 0 400301010405.ept 0 400301010405.ept 0 400301010405.ept 0 400301010405.ept 0 400301010405.ept 0 400301010405.ept 0 400301010405.wd B metwdm ▼ 4 mm
9 items	
9 items	Computer

2. Looking at the UCI, we see the "MONTH-DATA" blocks for Microbes, and that the HSPF "PERLND" (i.e., pervious land) sections SEDMNT, PSTEMP, and PQUAL have been activated.



TextPad - C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.u	ri
File Edit Search View Tools Macros Configure Window Help	
ACTIVITY	
*** RCHRES ACTIVE SECTIONS *** x - x HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PK	FG PHFG
1 7 1 1 0 1 0 1 0 0 END ACTIVITY	0 0
PRINT-INFO	
*** RCHRES Printout level flags	V PHCB PIVI PVP
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4 4 1 9
BINARY-INFO **** RCHRES Binary Output level flags	
*** x - x HYDR ADCA CONS HEAT SED GQL OXRX NUTR PL	VK PHCB PIVL PYR 4 4 1 9
END BINARY-INFO	
GEN-INFO	Davin t an
*** RCHRES Nexits Unit Systems In t-series Eng	gl Metr LKFG
1 Killsnake River 1 1 1	91 0 0 92 0
2 STREAM 2 1 1 1 3 STREAM 3 1 1 1	91 0 0 92 0 91 0 0 92 0
4 STREAM 4 1 1 1 5 STREAM 5 1 1 1	
6 STREAM 6 1 1 1	
END GEN-INFO	51 0 0 52 0
HYDR-PARM1_	
*** Flags for HYDR section ***RC HRES VC A1 A2 A3 ODFVFG for each *** ODGTFG for	or each FUNCT for each
*** x - x FG FG FG FG possible exit *** possible 1 7 0 1 1 1 4 0 0 0 0 0 0	exit possible exit
END HYDR-PARM1	
HYDR-PARM2 *** FCHRES FIBM FIBM IEN DEITH STOOP	
*** $\mathbf{x} - \mathbf{x}$ (miles) (ft) (ft)	(in)
	0.5 0.01
3 0 3 3.2 39 3.2 4 0 4 3.48 69 3.2	0.5 0.01 0.5 0.01
	0.5 0.01
7 0 7 7.04 49 3.2 END HYDE-PARM2	0.5 0.01
*** Initial conditions for HYDR section	
A A A A A A A A A A A A A A A A A A A	And the local sector of our port
*** x - x ac-ft for each possible exit for	initial value of OUTDGT or each possible_exit,ft3

3. HSPF RCHRES sections HTRCH and GQUAL have been activated.

4. The microbes are simulated as general quality constituents in the GQUAL section. TextPad - C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.uci File Edit Search View Tools Macros Configure Window Help 🗋 🖆 🔚 🗐 🚭 🖻 📓 🕼 🕼 🗇 오이 = 📰 = 📲 🏈 🏷 斜 🚱 👁 🖓 🔹 🐽 🕨 Find incrementally 🗍 🕆 🗌 Match case 🛓 × 040301010406.uci 0. GQ-GENDATA *** RCHRES NGQL TPFG PHFG ROFG CDFG SDFG PYFG LAT × 7 *** x deg õ END GQ-GENDATA GQ-AD-FLAGS *** Atmospheric Deposition Flags *** RCHRES GQUAL1 GQUAL2 GQUAL3 GQUAL4 GQUAL5 GQUAL6 GQUAL7 *** x - x <F><C> <F> <C> <F <C> <F <C> <F <C> <F <C> <F <C> <C> <F 0 0 Π. END GQ-AD-FLAGS GQ-QALDATA *** RCHRES DQAL CONCID GQID CONV QTYID *** x concid х 7Microbe OR/L 0.0353 #ORG END GQ-QALDATA GQ-QALFG *** RCHRES HDRL OXID PHOT VOLT BIOD GEN SDAS *** x - x END GQ-QALFG Search Results

5. The EXT TARGETS block specifies which time series are output. Instream hourly time series for flow (RO) in ft³/s and microbial densities (DQAL) in Cells/L are published for each reach (RCHRES).

式 Та	TextPad - C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\HSPF\040301010406.uci														
i <u>E</u> il	e <u>E</u> dit	<u>S</u> earch	<u>V</u> iew	<u>T</u> ools	<u>M</u> acro	os	<u>C</u> onfigure	<u>W</u> indo	w <u>H</u> el	р					
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	PERLI	ND 101	PWATER	PERO	1	1		-/Stig	WDM1	102	PERO	1	ENGL	AGGR	REPL
	PERLI	4D 101 4D 102	PQUAL PWATER	POQC	1	1 1			WDM1 WDM1	$103 \\ 104$	POQC	1 1	ENGL	AGGR	REPL REPL
	PERL	VD 102	PQUAL PWATER	POQC	1	1 1			WDM1 NDM1	105 106	POQC	1	ENGL ENGL	AGGR AGGR	REPL
	PERLI	VD 103	PQUAL	POQC	i	1			WDM1	107	POQC	1	ENGL	AGGR	REPL
	PERLI	4D 104 4D 104	PWATER	PERO	1	1 1			WDM1 WDM1	108 109	PERO	1	ENGL	AGGR	REPL REPL
	PERL	ND 105	PWATER	PERO	1	1			WDM1	110	PERO	1	ENGL	AGGR	REPL
	PERLI	VD 105	PWATER	PERO	1	1			WDM1	112	PERO	1	ENGL	AGGR	REPL
	PERL	ND 106 ND 107	PQUAL PVATER	POQC	1 1	1 1			WDM1 WDM1	$\frac{113}{114}$	POQC	1 1	ENGL ENGL	AGGR AGGR	REPL REPL
	PERLI	ID 107	PQUAL	POQC	1	1			WDM1	115	POQC	1	ENGL	AGGR	REPL
	PERLI	VD 108 VD 108	PQUAL	POQC	1	1			WDM1 WDM1	117	POQC	1	ENGL	AGGR	REPL
	IMPL)	VD 102 VD 102	IWATER Toliat	SURO	1	1 1			WDM1 WDM1	132	SURO	1	ENGL ENGL	AGGR AGGR	REPL REPL
	PERLI	ND 201	PWATER	PERO	ī	1			WDM1	118	PERO	1	ENGL	AGGR	REPL
	PERLI	ND 201 ND 202	PQUAL PWATER	POQC	1	1			WDM1 WDM1	119 120	POQC	1	ENGL	AGGR AGGR	REPL REPL
	PERL	ND 202	PQUAL PWATER	POQC	1	1			WDM1 WDM1	121	POQC	1	ENGL	AGGR	REPL
	PERLI	ID 204	PQUAL	POQC	1	1			WDM1	123	POQC	1	ENGL	AGGR	REPL
	PERL	ND 206 ND 206	PWATER POUAL	PERO	1	1 1			WDM1 WDM1	124 125	PERO	1	ENGL ENGL	AGGR	REPL REPL
	PERLI	ND 207	PWATER	PERO	ī	ĩ			WDM1	126	PERO	ī	ENGL	AGGR	REPL
	PERLI	4D 207 4D 208	PQUAL PWATER	PERO	1	1			WDM1 WDM1	127	POQU	1	ENGL	AGGR	REPL
	PERLI	ND 208	PQUAL	POQC	1	1			WDM1	129	POQC	1	ENGL	AGGR	REPL
	PERLI	ND 205 ND 205	PQUAL	POQC	1	1			WDM1 WDM1	130	POQC	1	ENGL	AGGR	REPL
	IMPL:	ND 202	IWATER	SURO	1	1			WDM1 WDM1	134	SURO	1	ENGL	AGGR	REPL
	RCHR	ES 5	HYDR	RO		1			WDM1	136	RO	1	ENGL	AGGR	REPL
	RCHR	IS 5 राज 1	GQUAL HYDR	DQAL RO	1	ī			WDM1 WDM1	137 138	DQAL RO	1	ENGL ENGL	AGGR	REPL REPL
	RCHRI	is i	GQUAL	DQAL	ī	ī			WDM1	139	DQAL	ī	ENGL	AGGR	REPL
	RCHRI	25 4 25 4	HYDR GQUAL	RO DQAL	1	1 1			WDM1 WDM1	$140 \\ 141$	RO DQAL	1	ENGL	AGGR	REPL
	RCHR	IS 6	HYDR	RÖ	1	1			WDM1	142	RÖ	1	ENGL	AGGR	REPL
	RCHR	10 6 IS 3	HYDR	RO	1	1			WDM1 WDM1	143	RO	1	ENGL	AGGR	REPL
	RCHR	IS 3	GQUAL HVDP	DQAL RO	1	1			WDM1 WDM1	$145 \\ 146$	DQAL RO	1	ENGL FNGI	AGGR	REPL
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	RCHR	\$S 7 \$S 7	HYDR HYDR	RO RO	1 1	1 1		AVER	WDM1 WDM1	$\begin{array}{c}101\\148\end{array}$	FLOW RO	1 1	ENGL ENGL	AGGR	REPL REPL
	RCHR	25 7	GOUAL	DQAL	ī	1			WDM1	149	DQAL	ī	ENGL	AGGR	REPL
	ENDI	SAI IA	RGEIS												

APPENDIX B Typical Map Layers Generated by the SDMPB

This appendix briefly reviews typical map layers captured by the SDMPB. To view them, save the simulation prior to closing the "Finish Building Project Window". Regardless of whether SDMPB results are saved, the BASINS MapWindow project (*.mwprj) and HSPF UCI (*.uci) files will be created and saved for the watershed analysis. The various map layers can be viewed in BASINS. In this alpha version, it is not recommended to save the results since saving multiple use cases may result in some dotSpatial instability in later runs. This issue will be investigated.

Typical map layers generated by the SDMPB are as follows:

1. When finished running the SDMPB, you will see a message similar to the one below.



2. Prior to making a choice, go to the SDMPB menu bar, choose "File", then "Save".

SD SD	M Project Builder
File	S/ MProjectBuilder Extensions
	8 ● 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

3. After saving the file, return to the message window and choose "Ok".

Frames SDM
Finished Building Project C:\Users\gwhelan\iemTechnologies\SDMPB\TESTA\TESTA.mwprj
Ok Open Folder Open in BASINS

4. The SDMPB will automatically close. To inspect results of the data downloads, execute the SDMProjectBuilder (SDMPB) by clicking on the shortcut icon displayed on the computer screen.



5. Choose "File", then "Open".

SD SD	M Project Builder	·						
File	S ³ MProjectBuilder	Extensions						
1 6		🔁 🖲 🛄 🖸	19	-		20	+ B	

6. Select by double-clicking the *.dspx file in the working folder; here, it would be TESTA.dspx:

a 📗 SDMPB	🔳 statsgo.shx	10/6/2015 4:20 PM	SHX File	1 KB
Þ 퉲 bin	statsgoc.dbf	12/12/2003 12:50	DBF File	64 KB
🖻 퉲 etc	statsgol.dbf	12/12/2003 12:50	DBF File	168 KB
🛯 🍌 TESTA	TESTA.dspx	10/6/2015 4:23 PM	DSPX File	159 KB
HSPF	TESTA.mwprj	10/6/2015 4:23 PM	MWPRJ File	25 KB

7. The following screen will appear:



8. A summary of the Map Layers is documented in the Map Layer listing on the left side of the screen below. By checking certain map layers, we can zoom to the HUC-12 of interest.



The map displays only checked Map Layers, arranged in the following order:

- NHDPlus Flowline (nhdflowline.shp) Role: Hydrograhy (two of them)
- NHDPlus Waterbody (nhdwaterbody) (nhdwaterbody.shp) Role: Hydrography
- NHDPlus Catchment Polygons (catchment) (catchment.shp) role: SubBasin)

Layers can be interrogated individually by turning various Map Layers "on" and "off" and manipulating color and opaqueness. For example, the NHDPlus elevations (in cm) for the area can be viewed below (color gradation represents elevation gradation):



The NLCD Land cover which identifies impervious and pervious areas, and cropland, pastureland, forests, etc. can be presented as seen below. Note the watershed's opacity is less than unity:



where the meanings of the 2006 NLCD codes are:

NLCD Land Cover Classification Legend
11 Open Water
12 Perennial Ice/ Snow
21 Developed, Open Space
22 Developed, Low Intensity
23 Developed, Medium Intensity
24 Developed, High Intensity
31 Barren Land (Rock/Sand/Clay)
41 Deciduous Forest
42 Evergreen Forest
43 Mixed Forest
51 Dwarf Scrub*
52 Shrub/Scrub
71 Grassland/Herbaceous
72 Sedge/Herbaceous*
73 Lichens*
74 Moss*
81 Pasture/Hay
82 Cultivated Crops
90 Woody Wetlands
95 Emergent Herbaceous Wetlands
* Alaska only

The 12-digit HUC has been subdivided into much smaller subwatersheds which were automatically determined based on the minimum catchment size and flowline length.



APPENDIX C NLDAS Stations Recorded in the HSPF UCI File

Looking at the UCI, we see two sets of pervious and impervious land types (PERLND and IMPLND, respectively) corresponding to the two NLDAS locations in use.

RUN GLOBAL UCI Created by WinHSPF for 040301010406 START 1990/01/01 00:00 END 2000/12/31 24:00 RUN INTERP OUTPT LEVELS 1 0 RESUME 0 RUN 1 UNITS 1 END GLOBAL FILES ----> 24 040301010406.ech MESSU 91 040301010406.out 25 040301010406.wdm WDM1 WDM2 26 met.wdm BINO 92 040301010406.hbn END FILES OPN SEQUENCE INGRP INDELT 01:00 101 PERLND 102 PERLND PERLND 103 104 PERLND 1 PERLND 105 PERLND 106 PERLND 107 108 PERLND IMPLND 102 PERLND 201 202 PERLND 204 PERLND 206 PERLND 2 PERLND 207 208 PERLND 205 PERLND IMPLND 202 5 RCHRES RCHRES 1 4 RCHRES 6 RCHRES 3 RCHRES 2 RCHRES 7 RCHRES END INGRP END OPN SEQUENCE

The external sources (EXT SOURCES) block assigns MET data to each subwatershed (subbasin). Since we only pull precipitation data from NLDAS, the other met constituents are from a BASINS station that has the full suite of meteorological data (Green Bay).

EXT SOUR	RCE:	5	_						-		
<-Volume	<u>-></u>	<member></member>	SsysSqap <mult:< td=""><td>>Tran</td><td><-Targe</td><td>et 🛒</td><td>ols></td><td><-Grp></td><td><-Member</td><td>:-></td><td>***</td></mult:<>	>Tran	<-Targe	et 🛒	ols>	<-Grp>	<-Member	:->	***
<name></name>	х	<name> x</name>	tem strg<-factor-:	>strg	<name></name>	х	X.		<name> ></name>	۲. X	***
*** Met	Seg	g X294Y152	2								
WDM2	21	PREC	ENGLZERO	SAME	PERLND	101	108	EXTNL	PREC		
WDM2	6	PEVT	ENGL	SAME	PERLND	101	108	EXTNL	PETINP		
WDM2	3	ATEM	ENGL	SAME	PERLND	101	108	EXTNL	GATMP		
WDM2	14	WIND	ENGL	SAME	PERLND	101	108	EXTNL	WINMOV		
WDM2	15	SOLR	ENGL	SAME	PERLND	101	108	EXTNL	SOLRAD		
WDM2	17	DEWP	ENGL	SAME	PERLND	101	108	EXTNL	DTMPG		
WDM2	18	CLOU	ENGL	SAME	PERLND	101	108	EXTNL	CLOUD		
*** Met	Sec	g X293Y152	2								
WDM2	31	PREC	ENGLZERO	SAME	PERLND	201	208	EXTNL	PREC		
WDM2	6	PEVT	ENGL	SAME	PERLND	201	208	EXTNL	PETINP		
WDM2	3	ATEM	ENGL	SAME	PERLND	201	208	EXTNL	GATMP		
WDM2	14	WIND	ENGL	SAME	PERLND	201	208	EXTNL	WINMOV		
WDM2	15	SOLR	ENGL	SAME	PERLND	201	208	EXTNL	SOLRAD		
WDM2	17	DEWP	ENGL	SAME	PERLND	201	208	EXTNL	DTMPG		
WDM2	18	CLOU	ENGL	SAME	PERLND	201	208	EXTNL	CLOUD		
*** Met	Sec	g X294Y152	2								
WDM2	21	PREC	ENGLZERO	SAME	IMPLND	102		EXTNL	PREC		
WDM2	6	PEVT	ENGL	SAME	IMPLND	102		EXTNL	PETINP		
WDM2	3	ATEM	ENGL	SAME	IMPLND	102		EXTNL	GATMP		
WDM2	14	WIND	ENGL	SAME	IMPLND	102		EXTNL	WINMOV		
WDM2	15	SOLR	ENGL	SAME	IMPLND	102		EXTNL	SOLRAD		
WDM2	17	DEWP	ENGL	SAME	IMPLND	102		EXTNL	DTMPG		
WDM2	18	CLOU	ENGL	SAME	IMPLND	102		EXTNL	CLOUD		
*** Met	Sec	g X293Y152	2								
WDM2	31	PREC	ENGLZERO	SAME	IMPLND	202		EXTNL	PREC		
WDM2	6	PEVT	ENGL	SAME	IMPLND	202		EXTNL	PETINP		
WDM2	3	ATEM	ENGL	SAME	IMPLND	202		EXTNL	GATMP		
WDM2	14	WIND	ENGL	SAME	IMPLND	202		EXTNL	WINMOV		
WDM2	15	SOLR	ENGL	SAME	IMPLND	202		EXTNL	SOLRAD		
WDM2	17	DEWP	ENGL	SAME	IMPLND	202		EXTNL	DTMPG		
WDM2	18	CLOU	ENGL	SAME	IMPLND	202		EXTNL	CLOUD		