Quantitative Microbial Risk Assessment Tutorial

Pour Point Analysis of Land-applied Microbial Loadings and Comparison of Simulated and Gaging Station Results

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Summary

This tutorial demonstrates a pour point analysis

- Initiates execution of the SDMPB.
- Navigates the SDMPB.
- Chooses a pour point within a watershed, delineates the sub-area that contributes to that pour point, and collects data for it.
- Considers land application of microbes.
- Develops necessary input files to execute HSPF.
- Develops necessary input file to view results from the SDMPB and HSPF.
- Views simulation results for flows and microbial densities with BASINS.
- Retrieves observed daily USGS flows and compares to simulated daily flows at the pour point.

Pour Point Analysis of Land-applied Microbial Loadings and Comparison of Simulated and Gaging Station Results

PURPOSE

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

OBJECTIVE

Pre-populate input data files of models automatically. Importation of point source data will be performed in the context of an assessment of microbial fate and transport, within a pour-point delineated watershed, by capturing contextual data for the watershed model WinHSPF (a.k.a. HSPF) and pre-populating its input data files to account for:

- Overland runoff;
- Snow accumulation/melt;
- Hourly simulations;
- Remote-sensing NLDAS, coupled with monitoring, meteorological data;
- Land-applied microbial loadings;
- Instream point source microbial loadings; and
- Microbial fate and transport.

DEMONSTRATION

This tutorial reviews screens, icons, and basic functions of the SDMProjectBuilder (SDMPB), performs a Pour Point simulation for Microbial Fate and Transport using HSPF, and analyzes and visualizes results at multiple locations in the watershed using BASINS. It demonstrates how to

- Initiate execution of the SDMPB.
- Navigate the SDMPB.
- Choose a pour point within a watershed, delineate the sub-area that contributes to it, and collect data for it.
- Consider land application of microbes.
- Develop necessary input files to execute HSPF.
- Develop necessary input files to view results from the SDMPB and HSPF.
- View simulation results for flows and microbial densities with BASINS.
- Retrieve observed daily USGS flows and compare to simulated daily flows at the pour point.

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 desktop icons appear.



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EXECUTE THE SDMProjectBuilder

Identify a Project

Whelan et al. (2015b) provide a detailed tutorial for identifying an 8-digit HUC. Whelan et al. (2015c) extend this tutorial and review screens, icons, and basic functions of how to take output from the SDMProjectBuilder (SDMPB) and perform a fate and transport analysis of land application of microbes within a HUC-12. This section follows the instructions of Whelan et al. (2015b, 2015c) without going into similar detail, describes creation of a working folder, and briefly identifies the HUC-8 and a watershed based on a pour point.

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



- 2. Create a folder where you have administrative rights.
- 3. From the Menu Bar, select "SDMProjectBuilder", then "New SDM Project".



4. Create a new file within the working folder. A map of the Unites States including Alaska, Hawaii, and Puerto Rico should appear.



Identify a HUC-8 and Watershed of Interest

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

🕘 SD	M Project Builder
File	SDMProjectBuilder Extensions
1 🔜 🛛	New SDM Project 🛁 👒
Leger	Nav Helper
⊡ 🥩	Import Local Data Files
E	Run Project Builder
	Options /

6. Fill out the screen as below, choose "Zoom", then "Get Data".

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

7. A screen similar to the following will appear.



8. Choose "Close".

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

9. In this example, we assess only the four uppermost 12-digit HUCs in the Manitowoc watershed (highlighted in the following figure). The pour point does not have to coincide with any particular location or HUC, although in this case it will match four 12-digit HUCs.





10. Using Zoom In, *zoom 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 will appear on the map.*



11. To see where all ponded waters are located, check the Map Layer titled "nhdwaterbody for 04030101". This provides a picture of all water sources and their locations.



12. For this example, you will identify the pour point that includes only the four uppermost HUC-12s, as designated by the red circle on this map projection.



MODIFY AND IMPORT LOCAL DATA FILES

This section identifies and modifies local data files, imports local data files to the SDMPB, executes the project builder, and collects map layers describing environmental characteristics.

Identify and Modify Local Source-term Data

The user can modify certain source-term parameters and influence the degree of resolution of the watershed through 12 local-data files that are installed when a user begins a new project. They are located in the "LocalData" folder within the working folder. Descriptions of the local source-term data are in Whelan et al. (2015d). Whelan et al. (2015c, 2015e) provide additional examples identifying and modifying the local source-term data example default files. Metadata associated with the parameters contained within each file, including definitions and units, are summarized in Table 1. Five of the 12 files denote locations such as the location of point sources, animal locations, septic systems, etc. For this example problem:

- **MonthlyFirstOrderDieOffRateConstants.csv** Different first order die-off rates will be used for land-applied microbes. They will be changed from 0.36 and 0.51 d⁻¹ to 0.064⁻¹.
- WildlifeDensities.csv Wildlife densities will be updated to 29 deer/mi² from 5 deer/mi² to more accurately reflect densities in this area (WDNR, 2015).
- AnimalLL.csv, FCProdRates.csv, GrazingDays.csv, ManureApplication.csv, SepticsLL.csv, SepticsDataWatershed.csv – Animal numbers and locations and septic-system locations will use default values, since they are applicable to the Manitowoc River basin; no change to these files is required.
- **PointSourceLL.csv, PointSourceData.csv, BoundaryPoints.csv, OutputPoints.csv** There are no point sources or intermediate points. Since these default locations are outside the watershed, no modifications to these files are necessary.

The only files that will be modified will be MonthlyFirstOrderDieOffRateConstants.csv and WildlifeDensities.csv.

MonthlyFirstOrderDieOffRateConstants.csv

13. Using Notepad, the original file includes die-off rate constants by month with units of d⁻¹:

MonthlyFirstOr	
<u>File Edit Format View H</u> elp	
Month, DieOffRateContant January, 0.36 February, 0.36 March, 0.36 April, 0.51 June, 0.51 June, 0.51 July, 0.51 August, 0.51 September, 0.51 October, 0.36 November, 0.36	*
+	

FILE NAME	INPUT DATA AND DEFINITION	UNITS				
Domestic Animals and Wildlife						
	Domestic animal locations by Latitude and	Degree (by				
Animall Losv	Longitude	fraction)				
AnimalL.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					
	concentration based on mass of waste shed					
	by the domestic animal					
	Typical microbial production or shedding	Counts/d/ac				
	rate per wildlife per area	counts, a, ac				
	Number of grazing days per domestic					
	animal per month	Number				
GrazingDays.csv						
	Fraction of the number of grazing days that	fraction				
	beef cattle spend in a stream per month	inaction				
	Fraction of manuro applied to soil each					
	month per domestic animal	fraction				
ManureApplication.csv	Fraction of amount of manure shed by the					
	domestic animal incorporated into soil	fraction				
	First-order microbial inactivation/die-off					
MonthlyFirstOrderDieOffRateConstants.csv	rate on the land surface per month	1/d				
Wildlife Develting and	Typical number of wildlife per unit area by	Number (m. ?				
WildlifeDensities.csv	land use type	Number/mi-				
Point Sources						
PointSourcell csv	Point source locations by Latitude and	Degree (by				
	Longitude	fraction)				
	Annual-average flow for each point source	ft³/s				
	Annual-average microbial loading rate for	Counts/vr				
PointSourceData.csv	each point source					
	Annual-average chemical loading rate for	Lbs/vr				
	each point source	//				
Septic Systems		Degree /bu				
SepticsLL.csv	Septic system locations by Latitude and	Degree (by				
	Number of people per ceptic unit	Number				
	Average fraction of centic systems that fail	fraction				
SenticsDataWatershed cov	Average induction of septic systems that fall	al/d/parson				
SepticsData water sileu.csv	Typical microbial density of contic	Bailatherson				
	overcharge reaching the stream	Counts/L				
Intermediate Points						
	Boundary point locations by Latitude and	Degree (by				
BoundaryPoints.csv	Longitude	fraction)				
	Output point locations by Latitude and	Degree (bv				
OutputPoints.csv	Longitude	fraction)				

Table 1.	Names of	of def	aults	support	files an	d inpu	it tvi	pes to	which	the user	has access	for m	odifications
			aares							0000	1145 466655		oannoacionio

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



15. Save as a csv file, and exit.

WildlifeDensities.csv

16. Using Notepad, the original file includes the following locations:

WildlifeDensities.csv - Notepad		x	
<u>File Edit Format View H</u> elp			
Animal,DensityPerSqMile_Cropland,DensityPerSqMile_Pasture,DensityPerSqMile_Forest,DensityPerSqMile_E Duck,0,0,0,0 Goose,0,0,0,0 Deer,5,5,5,0 Beaver,0,0,0,0 Raccoon,0,0,0,0 OtherWildlife,0,0,0,0	uiltu	p.	*
4		•	зł.

17. Update the file by changing the "5" to "29" so it looks like the following:



- 18. Save as a csv file, and exit.
- 19. Ensure that all revised files have replaced the original files contained in the "LocalData" folder under the working directory.

Import Local Data Files

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

20. From the Menu Bar, choose "SDMProjectBuilder", then "Import Local Data Files". AnimalLL, SepticsLL, and PointSourceLL will be registered using the procedure outlined by Whelan et al. (2015c, 2015d).



21. To register "AnimalLL", highlight "AnimalLL" and choose "Open File". Wait until the screen changes, then "Close File."

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

22. The map layer for animal locations (typically farms) will appear on the map, like that below:



23. To register "SepticsLL", highlight "SepticsLL" and choose "Open File". When the screen changes, choose "Close File."

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

24. When complete, "Close" the screen.

🖳 Edit Local Data	
Local Data Dia	
BoundaryPointsLL	
Output PointsLL = PointSourceLL	
SepticsLL	
Open File	
Edit Hie	
Stat Adding Points	
State Floating Forms	
Delete Selected Point(s) on Map Close Fi	le
Close	

EXEUCUTE THE PROJECT BUILDER

The project builder delineates the watershed of interest and collects environmental map layers that support the microbial assessment.

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



26. Choose "Pour Point". For "Maximum Upstream", use an upstream distance that reflects the distance to the upstream divide. Because this HUC-8 is an upstream HUC and has a boundary that is not totally adjacent to another HUC, a large "Maximum Upstream" distance can be used, such as "200" km.







28. Click "Select Pour Point On Map".



29. On the map, click on the pour point location which should be just downstream of the junction (see arrow). The location is very sensitive, so zoom in accordingly.



30. Click "Next" on the "Build FRAMES SDM Project" interface.

💀 Build Frames SDM Project	
Select Area Of Interest On Map Or Enter Key(s) Below Select By: O HUC-8 O HUC-12 O Catchment O County O Current Map Layer O Pour Point (🔿 Вох
Pourpoint Watershed from NHDPlus COMID = 12175030 Press the button below to select a different pour point.	< >
Maximum Upstream: 200 km Select Pour Point On Map	
Cancel	Next

31. The aqua square is the pour point and the delineated area is blue in the figure below.



32. When you Zoom Out, wou see the red highlighted area associated with the assessment, corresponding to the four upstream HUC-12s that comprise the watershed draining through the pour point.



33. After choosing "Next", complete the "Build FRAMES SDM Project" as shown. Use values included in this figure. To ensure adequate sizes, define the "Minimum Catchment Size" and "Minimum Flowline Lengths" as "3" and "3", respectively. Land areas less than 10% of the total have been factored into other Map Layers, as noted by the "Ignore Landuse Areas Below Fraction" of "0.1". Check "HSPF"; the "Degree Day" method is chosen for snow accumulation and melt and "Microbes" for land applied simulation. Output is "Hourly".



34. Click "Next" and the following screen appears. Change the screen to that below; make no changes to the "Save Project As" text box unless there is a special folder location:

🖳 Build Frames S	DM Project	
Data Options Soil STATSGO SSURGO	Meteorologic BASINS NCDC Enter NCDC Token Here	
Elevation Delineation	NLDAS Precipitation NHDPlus Elevation NHDPlus	•
Save Project As	C:\Users\gwhelan\iemTechnologies\SDMPB\TESTC\TESTC.mwprj	Previous Build

- 35. Now choose "Build" which takes approximately 25 minutes to complete for a pour point with four HUC-12s, depending on the computer.
- 36. Some computers may ask several times if the re-project map layer should match the map coordinate system; choose "Yes" each time.

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

37. When the SDMPB has finished running, choose "Open in BASINS".

Frames SDM
Finished Building Project C\Program Files\iemTechnologies\SDMProjectBuilder\data\PourPoint12175050-3\PourPoint12175050-3.mwprj
Ok Open Folder Open in BASINS

38. BASINS will automatically open with the SDMPB map layers for this assessment:



39. Go to the BASINS menu, choose "File," then "Save". Choose "File", then "Exit" to close BASINS.

EXECUTE HSPF, SIMULATING FLOW AND MICROBIAL TRANSPORT

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



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

Locate UCI file to open	
SDMPB + TESTB + HSPF	← 4 Search HSPF P
Organize 🔻 New folder	1= - 🔟 🔞
etc TESTA TESTA HSPF HSPF-PEST LocalData met NHDPlus NHDPlus NLCD pcs	Name C
J SDMPB_061215	▼ (III) →
File <u>n</u> ame: 040301010406.uci	VCI files (*.uci) Open Cancel

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



43. To run the HSPF simulation, click the "Run Simulation" icon. Save the HSPF project by clicking "File", then "Save" on the main menu bar. Leave the HSPF workflow schematic screen open since you may want to refer to it when operating in the BASINS interface.



VIEW HSPF SIMULATION RESULTS WITH BASINS

Register Flow and Microbial Densities with BASINS

44. If BASINS is not already open, start BASINS with the BASINS 4.1 icon on the desktop. At the "Welcome" window, open your existing project.



45. Navigate to the project folder (e.g., TESTB) 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:



46. Click "Open" so the SDMPB project will open in BASINS 4.1. The following screen, showing domestic animal and septic locations, which overlay each other and NLDAS stations,, will appear:



47. Go to the "File", "Manage Data" menu in the BASINS menu bar. With the "Data Sources" window open, see that no times series data sources are pre-loaded except, possibly, a met.wdm file. Time series data sources from the HSPF simulation are needed to view the simulation results, so they will be added.

Z Data Sources	
File Analysis	Help
C:\Users\gv	vhelan\iemTechnologies\SDMPB\TESTC\met\met.wdm (21)

48. To add time series data source, select "File", then "Open" from the "Data Sources" window. A selection window appears:



49. Select "WDM Time Series", then "OK". Navigate to the HSPF project folder, and select the file "SDMProject.wdm". It contains the output time series written from HSPF to WDM. [Note: For the pour point simulation, the wdm name should be SDMProject. Although an equivalent *.wdm file name may be there, do not select met.wdm file.]

Locate UCI file to open	
G SDMPB → TESTC → HSPF	 ✓ 4 Search HSPF
Organize 🔻 New folder	1 🗸 🖬 💿
	Name C SDMProject.uci 1
🖟 pcs	۹ ا
File <u>n</u> ame: SDMProject.uci	✓ UCI files (*.uci) ✓ Open Cancel

50. With this data source open, the file name appears in the "Data Sources" window. [Note: Other WDM files may already be registered in the list.]



51. The HSPF Binary file (*.hbn) only exists after executing 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. From the "Data Sources" window, choose "File", then "Open". The window below will appear to select a data source. Select "HSPF Binary Output", then "OK".



52. Navigate to the HSPF project folder and select the file with the HBN extension. Click "Open". Because the HBN file may be large, the registration may take time to read.



53. After the file has been read, it appears in the "Data Sources" window. Click "File", then" Exit".



View the Discharge Time Series

This sections views discharge time series based on hourly data by graphing the results at multiple locations. The locations will be Reaches (RCHRES) 11, 19, and 25 since they represent junctions in the waterbody network. The ID numbering scheme correlates to the site layout in HSPF. Leave HSPF open with this diagram in the background to allow viewing of the reach locations, numbering scheme, and ID numbers if you are not using BASINS to number these locations. See Whelan et al. (2015c) for instructions on how to label the watershed using the BASINS interface.



54. Choose "Analysis", then "Graph".



55. See Whelan et al. (2015c) for guidance on selecting data to graph. Under "Constituent", scroll down to "RO" and a list of reaches with flow data appears under "Matching Data". Choose reaches (i.e., RCHRES) 11, 19, and 25 which appear under "Select Data". Click "Ok".

Select Data To Grap	h			
File Attributes S Select Attribute Values to	ielect Help Filter Available Data			
Scenario	 Location 	 Constituent 	 Time Unit 	•
COMPUTED	E102	 RETS 	 Hour 	
NLDAS	1.202	RO	Day	
DBSERVED	1:302	ROHEAT	Month	
SOMPROJE	1:402	ROVOL		
5DMProject	1:502	SAREA		
	1000	* conce Manual		
Matching Data (25 of 465	2)			
DMPROJE	RCH6	RO	Hour	~
SDMPROJE	RCH13	RO	Hour	
SDMPROJE	RCH12	RO	Hour	_
SOMPROJE	RCH11	RO	Hour	
SDMPROJE	RCH16	RO	Hour	
SOMPROJE	RCH18	RO	Hour	
SDMPROJE	RCH7	RO	Hour	
SOMPROJE	RCH19	RO	Hour	
SOMPROJE	RCH20	RO	Hour	-
SDMPROJE	RCH21	RO	Hour	
SOMPROJE	RCH14	RO	Hour	
SOMPROJE	RCH25	RO	Hour	
Selected Data (3 of 4652	, ,			
OMPROJE	RCH11	RO	Hour	
SOMPROJE	RCH19	RO	Hour	
SDMPROJE	RCH25	RO	Hour	
Dates to include All Start 1990/01/01 11 End 2000/12/31 21 Apply month/day ran	Common 990/01/01 1990/01/0 000/12/31 2000/12/3 ge to each year	1		
Change Time Step T	pe to each year fo: 1 Day ● A	werage/Same 🔹	Ok	Cancel

56. Choose "Timeseries" and "Generate".

2	Choose Graphs to Create
	Timeseries Flow/Duration Frequency Running Sum Residual (TS2 - TS1) (two datasets needed but 1 datasets sele Cumulative Difference (two datasets needed but 1 datasets sele Scatter (TS2 vs TS1) (two datasets needed but 1 datasets sele
(Multiple WQ Plots All None Cancel Generate

57. The following graph appears. The discharge is defined as cfs (ft³/s). All three hydrographs are plotted together.



58. Using the editor, as described in Whelan et al. (2015c), the graph can be modified to provide a better view of the results. See how the discharge changes as one moves downstream to the pour point of the watershed. Exit by clicking the "X" in the upper right-hand corner.



View the Microbial Density Time Series

59. Select "Analysis", then "Graph" again. Under "Constituent", choose "DQAL" which provides microbial densities in Counts/L at various reaches. Under "Matching Data", choose reaches corresponding to 11, 19, and 25 (RCH11, RCH19, and RCH25, respectively). After they appear under "Selected Data", click 'Ok'.

Select Data To Graph	Same South	Grant Granter	
File Attributes Select	t Help		
Select Attribute Values to Filter	Available Data		
Scenario 👻	Location	Constituent -	Time Unit 🔹
COMPUTED	l:102 ^	DEWTMP ^	Hour
NLDAS	1:202	DQAL 🗖	Day
OBSERVED	1:302	FLOW	Month
SDMPROJE	1:402	GAGE	
SDMProject	1:502	GWVS	
	1.000	UPAT	
Matching Data (25 of 4652)			
SDMPROJE	RCH12	DQAL	Hour ^
SDMPROJE	RCH11	DQAL	Hour
SDMPROJE	RCH16	DQAL	Hour
SDMPROJE	RCH18	DQAL	Hour
SDMPROJE	RCH7	DQAL	Hour
SDMPROJE	RCH19	DQAL	Hour
SDMPROJE	RCH20	DQAL	Hour
SDMPROJE	RCH21	DQAL	Hour
SDMPROJE	RCH14	DQAL	Hour
SDMPROJE	RCH25	DQAL	Hour
			*
Selected Data (3 of 4652)			
SDMPROJE	RCH11	DQAL	Hour
SDMPROJE	RCH19	DQAL	Hour
SDMPROJE	RCH25	DQAL	Hour
Dates to Include			
All Com	mon		
Start 1990/01/01 1990/0	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	/Same 🔹	Ok Cancel

The definitions of the microbial parameters are:

Parameter	Units	HSPF-12.2 Manual	
Farameter	onita	(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 intervall is housing this same			

Time interval' is hourly in this case.

60. Choose "Timeseries", then "Generate".

V Timeseries	
Flow/Duration	
Frequency	
Running Sum	
Residual (TS2 - TS1) (two	datasets needed but 1 datasets sele
Residual (TS2 - TS1) (two Cumulative Difference (two	datasets needed but 1 datasets sele datasets needed but 1 datasets se
Residual (TS2 - TS1) (two Cumulative Difference (two Scatter (TS2 vs TS1) (two	datasets needed but 1 datasets sele datasets needed but 1 datasets se datasets needed but 1 datasets sele
Residual (TS2 - TS1) (two Cumulative Difference (two Scatter (TS2 vs TS1) (two	datasets needed but 1 datasets sele datasets needed but 1 datasets sel datasets needed but 1 datasets sele
 Residual (T52 - TS1) (two Cumulative Difference (two Scatter (TS2 vs TS1) (two 	datasets needed but 1 datasets sele datasets needed but 1 datasets sel datasets needed but 1 datasets sele Multiple WQ Plots



61. The following graph is produced with microbial densities of Counts/L:

62. Using the editor described in Whelan et al. (2015c), the graph can be modified to provide a better view of the results. See how the densities change as one moves downstream to the pour point of the watershed. As the uncalibrated results indicate, microbial densities are very low in this area, the headwaters of the Manitowoc River basin. Exit by clicking the "X" in the upper right-hand corner.



RETRIEVE OBSERVED DAILY USGS FLOWS AND COMPARE THEM WITH SIMULATED DAILY FLOWS AT THE POUR POINT

BASINS can also be used to add data to the project. The objective of this exercise is to retrieve the Observed Daily USGS Flows at the pour point and compare them to uncalibrated daily discharge simulations at the pour point, Reach 25.

63. From the main BASINS menu, select "File, then "Download Data".



64. Choose USGS Discharge stations as the data type, and click "Download".

🌉 Download Data				×
Region to Download	Hydrologic Units			•
DEM Shape	GIRAS Land Use	NED	Census	Met Stations
National Hydrograph	y Dataset Plus		303(d)	Met Data
AllElevation Grid		Catchments Hydrography	r	
Station Locations fro	n US Geological Survey I Water Quality 🔲 I	National Wa Measuremer	ter Information nts 🔲 Daily	y GW 🔲 Periodic
Data Values from US Station Locations m	Geological Survey Nation ust be selected on the ma	nal Water In p before dat	formation Syst a value downl	em Ioad
National Land Cover	Data 2001	Canopy	🔲 1992 Lar	nd Cover
EPA STORET Wate	Quality Results (available af	ter Stations	are selected o	n map)
North American Land	Data Assimilation System	n ole after grid	selection on m	nap)
Merge	Clip to Region	H	elp Car	Download

65. Click 'OK'.

Data Download 🛛 🛛 🗙
Downloaded Layer: NWIS Daily Discharge Stations
ОК

66. The NWIS Daily Discharge Stations layer will appear on the map. De-select "NHDPlus Catchment" (red circle in figure below) since these catchments are outside the simulation area; removing them from the screen will reduce confusion.



67. Highlight the "NWIS Daily Discharge Stations" (one click), then click on the symbol below this Map Layer.



68. The size of the symbol for the discharge stations to download data for the correct station is increased. Change "Size" to 24, "Fore color" to red, select "Apply", then "Ok".

Point style	La N	E COL	x
Preview		Symbols Characters Icons Options	
	•	Point shape 🔶 Regular 👻	
	•	Number of sides 4 Side ratio 5	
Size	24	∎●◆▼▲⋖ ▶ ╋¥★●↑→↓←₩ Ĕ	
Rotation	0	Transparency 255	
Fore color	-		
		Apply Ok Cancel	

If you can see stations on the map, there is no need to zoom in near the outlet of the study area to select the nearby USGS station. The USGS flow station nearest the outlet (Reach 25) is identified by the red circle below.



69. Highlight the "NWIS Daily Discharge Stations" map layer using the BASINS Select button on the tool



bar, **Select** then select the gaging station at the outlet. The symbol will change color (orange in this case), indicating its selection (see red circle in figure below).



70. Choose "File", then "Download Data" again, this time specifying download "Daily Discharge" data values.

💐 Download Data					
Region to Download	Hydrologic Units 🔹				
DEM Shape	GIRAS Land Use 🔲 NED 📄 Census 📄 Met Stations				
DEM Grid	Legacy STORET NHD 303(d) Met Data				
National Hydrography I Al Elevation Grid	Dataset Plus Catchments Hydrography				
Station Locations from Discharge	US Geological Survey National Water Information System Water Quality Measurements Daily GW Periodic				
Data Values from US G Daily Discharge	Ceological Survey National Water Information System Water Quality Measurements Daily GW Periodic harge Measurements Daily GW Periodic				
National Land Cover D	ata 2001 Impervious 🔲 Canopy 📄 1992 Land Cover				
EPA STORET Water Quality Stations Results (available after Stations are selected on map)					
North American Land D	Data Assimilation System Precipitation (available after grid selection on map)				
Merge	Clip to Region Help Cancel Download				

71. Click "Download". A prompt will ask where the data should be saved. Click "Ok".



72. When the download is complete, this message appears. Click "OK":



73. When the following screen appears, click "OK".

Data Download	x
Downloaded Data file: C:\Users\gwhelan\iemTechnologies\SDMPB\TESTC\nwis\flow.wdm	
ОК	

74. The "Data Sources" window appears, indicating NWIS data have been added to the project. Choose "file", then "Exit". In the main BASINS menu, choose "File", then "Save".

🛃 Data Sources								
File Analysis Help								

75. To generate a graph of the observed and simulated discharge time series, go to the main BASINS screen, select "Analysis", then "Graph" on the tool bar. Make the following choices [Note: The lower-case "observed", if available, refers to observed instantaneous discharge data that were added and that are not part of this tutorial.]:

🖉 Select Data To Graph 📃 📼 💻 🍽							
File Attributes Select Help Select Attribute Values to Filter Available Data							
Scenario -	Location •	Constituent -	Time Unit				
COMPUTED	04085395	DEWP	Hour				
NLDAS	l:102	DEWTMP	Day				
OBSERVED	1:202	DQAL	Month				
SDMPROJE	1:302	FLOW					
SDMProject	1:402	GAGE					
	LENN	CHAIC					
Matching Data (3 of 4653)							
SDMPROJE	RCH25	FLOW	Day				
SDMPROJE	RCH21	FLOW	Day				
OBSERVED	04085395	FLOW	Day				
Selected Data (2 of 4653)							
SDMPROJE	RCH25	FLOW	Day				
OBSERVED	04085395	FLOW	Day				
Dates to Include All Common Start 1990/01/01 1993/07/01 1990/01/01 End 2005/09/30 2000/12/31 2005/09/30 Apply month/day range to each year Image: Common with the second seco							
Change Time Step To: 1 Day V Average/Same V Ok Cancel							

76. Select "Timeseries", then "Generate".



77. The following graph appears.



78. Using the editor described in Whelan et al. (2015c), the graph can be modified to provide a better view of the results. The daily average observed discharge at Chilton (Reach 25) is in red and the daily average simulated discharge is in blue. The simulated results are uncalibrated and appear to overestimate base flow. The trends are captured well.



DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

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