

Model My Watershed BMP Spreadsheet Tool

User Manual

Manual by Barry Evans, Drexel University & Penn State University

Manual version: 2020-1-09 at 11:00am ET

- Repository & Archives: <https://github.com/WikiWatershed/MMW-BMP-spreadsheet-tool>
- Latest Version of Tool: https://raw.githubusercontent.com/WikiWatershed/MMW-BMP-spreadsheet-tool/master/MMW_BMP_Spreadsheet_Tool.xlsx
- Latest Version of Manual: https://raw.githubusercontent.com/WikiWatershed/MMW-BMP-spreadsheet-tool/master/docs/MMW_BMP_Spreadsheet_Tool_UserManual.docx

Overview

This tool was developed to support the evaluation of potential pollutant load reductions that might result from the implementation of various Best Management Practices (BMPs) and similar mitigation measures in a watershed where loads from a wide range of rural and urban sources have been quantified. Although it was designed to readily accept simulated output from the multi-year model in Model My Watershed, load estimates from other models and load estimation tools could theoretically be used as well to evaluate potential reductions.

The tool was initially developed to assist municipalities in Pennsylvania in meeting their obligations with respect to achieving load reductions specified by the Pennsylvania Department of Environmental Protection as part of the NPDES permit renewal process. However, the tool is generic enough that it can be used for similar evaluations undertaken by a much wider range of users. Once model output results have been entered into the appropriate tab within the spreadsheet tool, other tabs are automatically populated with data in a way that facilitates the analysis of various load reduction strategies that deal with sediment, nitrogen and phosphorus loads from both urban and rural upland sources, as well as from streambanks that might be eroded due to grazing animals and excess runoff from impervious surfaces in urbanized areas.

In this document, instructions are provided for doing load/BMP analyses for two basic situations:

- 1) Analysis of pollutant loads and potential BMP scenarios for a given watershed. In this case, the Multi-Year Model in MMW (i.e., the GWLF-E model) is used to estimate mean annual nutrient and sediment loads (kg/yr) and loading rates (kg/ha) from a variety of sources within the area of interest (AOI). The resulting model output is then entered into the customized Excel-based tool

to estimate potential load reductions that might result from the implementation of BMPs and other remedial measures in both rural and urban areas throughout the watershed.

- 2) Analysis of pollutant loads and potential BMP scenarios for specific “targeted” areas within a larger watershed. In this case, specific functionality has been built into the tool to assist municipalities in Pennsylvania meet pollutant load reduction requirements mandated as part of their cyclical NPDES permit review process. In utilizing the tool, MMW model output is used to estimate pollutant loads and loading rates for the larger watershed area as described above. Then, portions of the watershed loads are subsequently “assigned” to one or more municipalities or “urban areas” located within that watershed based on the landscape characteristics of those areas (e.g., size, land cover type, and extent of impervious surface). Once the load assignments have been made, user of the tool can then simulate various BMP scenarios to evaluate potential load reductions. (Note: although this tool was initially developed for use in Pennsylvania, it could easily be used in other geographic regions for similar applications as well).

The following two sections briefly describe the steps for conducting analyses associated with the two basic situations outlined above.

Analysis of Pollutant Loads and Potential BMP Scenarios for a Single Watershed

Step 1: Load Output Data from Model My Watershed

Upon using the multi-year model in Model My Watershed, the user is presented with tabular results to the left of the “area of interest” map as shown in the example in Figure 1 below. (Note: see the Appendix to this document if you are unsure of how to use Model My Watershed to simulate pollutants loads for any given area of interest).

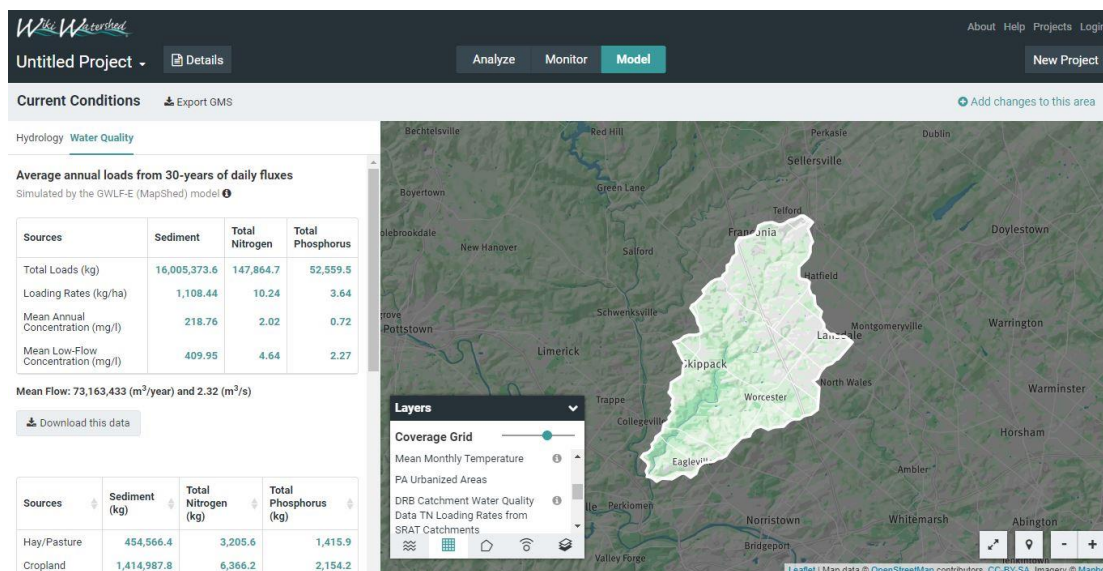


Figure 1

The data required by the spreadsheet tool is included in an additional table which provides more detailed load information by source category (e.g., land cover type, point sources, streambank erosion, etc.). As shown in Figure 2, this data can be downloaded in csv format by clicking on the “Download this data” button. *(Note: the spreadsheet tool itself can be downloaded via the link provided below the results table as also highlighted in Figure 2. In using this tool, it is recommended that the original Excel file be left un-altered, and that copies of it be used for individual projects).*

Once downloaded, these data can be copied and pasted into the appropriate places in the “MMW Output” tab in the tool. *(Note: As shown in Figure 2, make sure you download the csv file from the “Water Quality” section and not the “Hydrology” section).* Similarly, information on the areal extent of the different source areas also needs to be copied and pasted from the “csv” file that can be downloaded from the “Analyze” results for the particular area of interest as shown in Figure 3. Figure 4 illustrates the specific locations within the “MMW Output” tab (high-lighted in green) where these model results should be inserted.

Once these data are inserted as shown, the table in the upper left-hand corner of this tab (shown in blue in Figure 4) is automatically populated with the correct model results required to populate other tabs in the spreadsheet and to support the various functions built into the tool. Note also in Figure 5 that there is a spot in the “MMW Output” tab where the user can insert information on the length of streams in a given watershed that can be used for implementing various stream protection activities such as streambank fencing and streambank stabilization. In this case, the values for length of streams in agricultural areas (typically a combination of cropland and pasture land), non-agricultural areas, and total length of streams in the watershed can be entered by the user manually or obtained from the “Streams” section of the “Analyze” tab as shown in Figure 6.

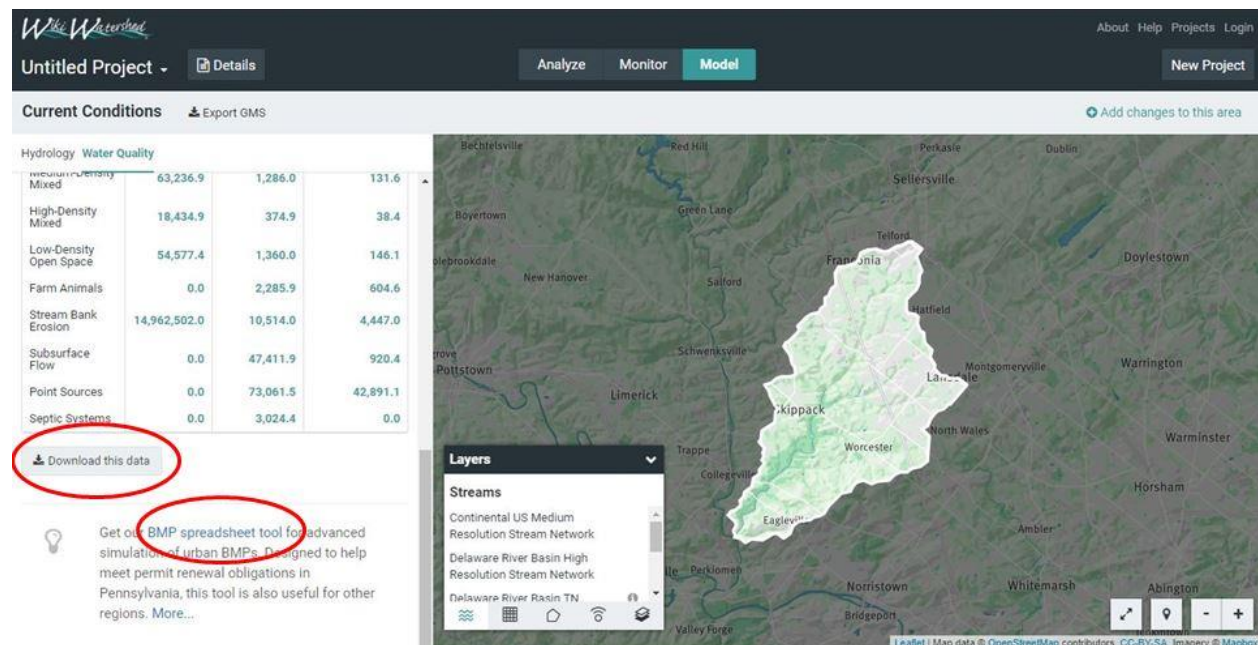


Figure 2

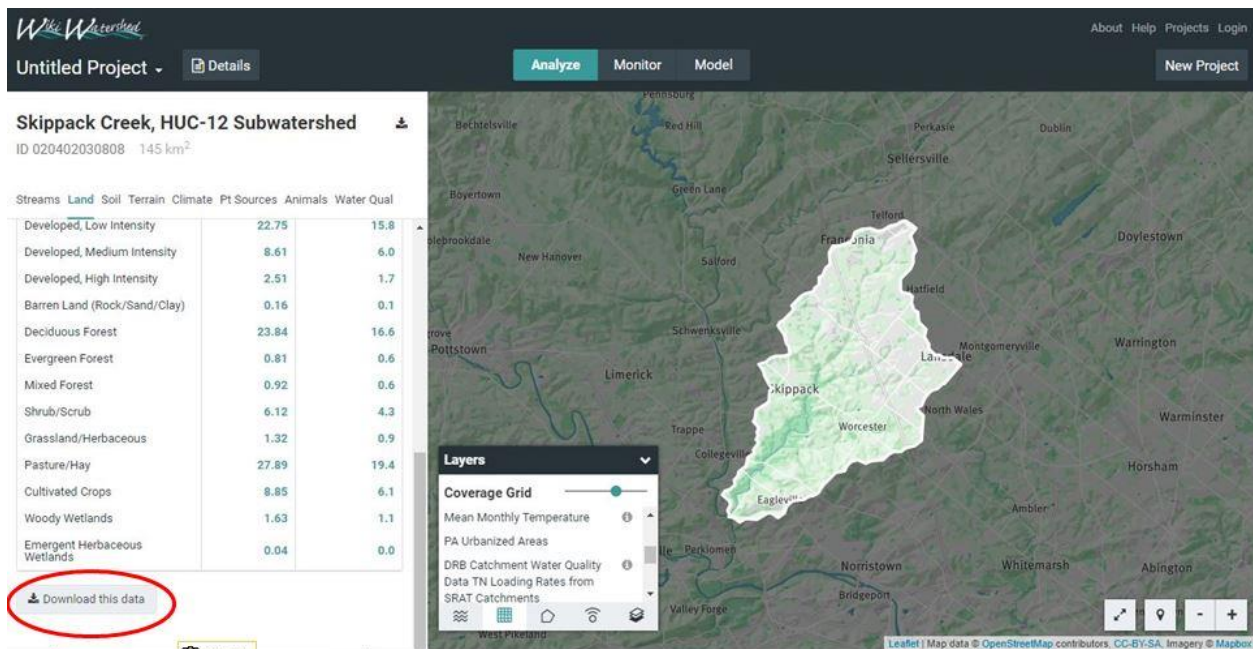


Figure 3



Figure 4

One of the more important tabs populated with the MMW model results is the "Land Use Loading Rate Look-Up Table" shown in Figure 7. In this case, model results drawn from the "MMW Output" tab are used to calculate "upland" pollutant loading rates as well as "streambank" loading rates that are attributed to the different land use areas. As described later, various BMPs can be simulated to evaluate potential load reductions from "upland" areas and streambanks. In the case of developed (urban) areas, various BMPs are simulated that have an effect on both "upland" loads as well as "downstream" loads caused by streambank erosion. Additionally, with urban stormwater BMPs, "composite" loading rates

that combine loads from both upland and streambank sources are used in the simulation of potential load reductions as described in a later section.

To support loading rate calculations in the “Land Use Loading Rate Look-Up Table” tab, information is drawn from the “MMW Output” tab as well as other intermediate locations such as the “Streambank Sediment Loading”, “Streambank Nitrogen Loading”, and “Streambank Phosphorus Loading” tabs. While users of this BMP spreadsheet tool are not required to add or modify data in these latter three tabs (which are automatically populated from other tabs), some users may find them informative with regard to how streambank-eroded loads are assigned to various upland sources as a result of runoff emanating from these areas.

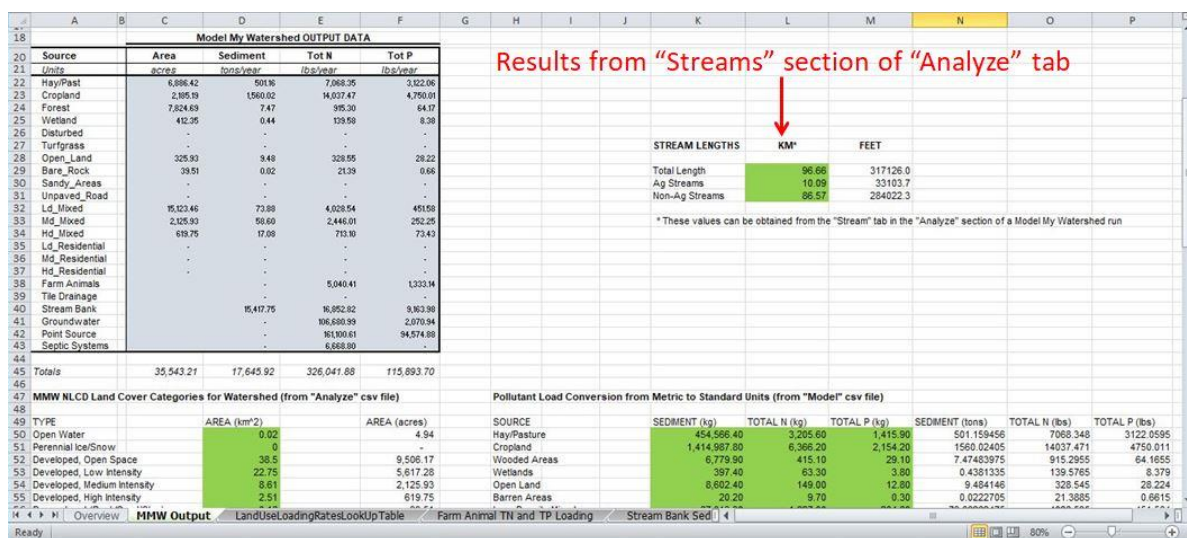


Figure 5

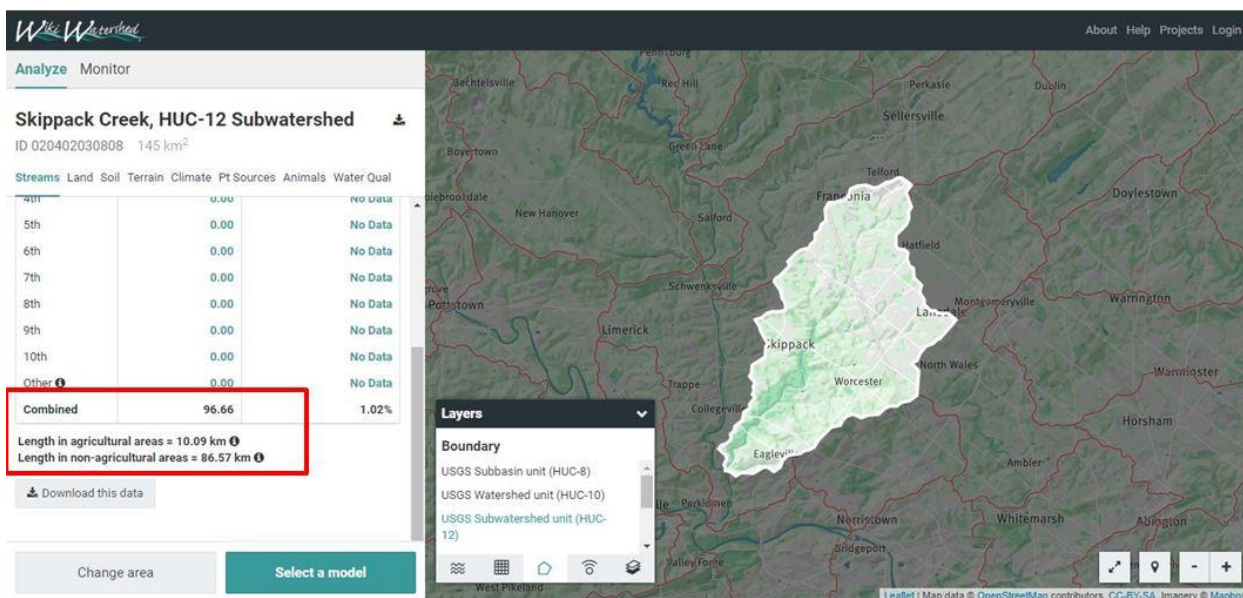


Figure 6

3	A	B	C	G	J	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
4		Watershed: Skippack																			
5		Year: 2018																			
6		Source File: User Specified																			
7		Section 2: Land Use Loading Rates Look-Up Table																			
10		TOTAL WATERSHED ANNUAL LOADS										ANNUAL LAND USE LOADING RATES (lbs/acre)									
12																					
13																					
14		Source	Area	Sediment	Total Nitrogen	Total Phosphorus						From Land Use	From Stream Bank	From Farm Animal				From Land Use	From Stream Bank	From Farm Animal	
15		Units	Acres	Tons	Pounds	Pounds						Bt/acre	Bt/acre	Bt/acre				Bt/acre	Bt/acre	Bt/acre	
16		Source	Area	Sediment	Total Nitrogen	Total Phosphorus						Bt/acre	Bt/acre	Bt/acre				Bt/acre	Bt/acre	Bt/acre	
17		HayPast	6,886.42	591.16	1,063.35	3,122.06	445.55	650.66	796.21	1.03	0.36	0.56	1.35	0.45	0.13	0.15	0.73	HayPast			
18		Cropland	2,185.13	1,560.02	14,037.47	4,150.01	1,427.82	650.66	2,018.48	6.42	0.36	0.56	1.34	2.17	0.13	0.15	2.51	Cropland			
19		Forest	7,342.63	7.47	985.50	64.18	1.91	650.66	652.57	0.12	0.36	n/a	0.46	0.01	0.13	n/a	0.20	Forest			
20		Wetland	412.35	0.44	133.55	8.58	2.13	650.66	652.73	0.34	0.36	n/a	0.19	0.02	0.13	n/a	0.21	Wetland			
21		Disturbed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Disturbed			
22		Turfgrass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Turfgrass			
23		Open_Land	325.93	9.48	328.55	28.22	55.20	650.66	100.86	1.01	0.36	n/a	1.51	0.03	0.13	n/a	0.23	Open_Land			
24		Barw_Rock	53.51	0.02	21.23	0.66	113	650.66	651.73	0.54	0.36	n/a	0.39	0.02	0.13	n/a	0.21	Barw_Rock			
25		Sandy_Areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Sandy_Areas			
26		Upworn_Road	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Upworn_Road			
27		Ld_Mixed	15,502.44	73.38	4,026.54	451.59	3.17	346.95	955.33	0.27	0.40	n/a	0.15	0.03	0.28	n/a	0.31	Ld_Mixed			
28		Md_Mixed	2,125.93	58.60	2,446.01	252.25	55.13	1,615.05	1,730.18	1.15	1.08	n/a	2.23	0.12	0.50	n/a	0.62	Md_Mixed			
29		Hd_Mixed	613.75	17.08	733.30	73.43	55.13	2,264.54	2,419.67	1.15	1.65	n/a	2.80	0.12	0.70	n/a	0.82	Hd_Mixed			
30		Ld_Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Ld_Residential			
31		Md_Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Md_Residential			
32		Hd_Residential	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	n/a	0.00	0.00	0.00	n/a	0.00	Hd_Residential			
33																					
34		Source		Sediment	Total Nitrogen	Total Phosphorus															
35		Units		Tons	Pounds	Pounds															
36		Farm Animal		0.00	5,040.41	1,333.34															
37		TN Drainage		0.00	0.00	0.00															
38		Stream Bank		15,417.75	16,852.62	3,363.30															
39		Groundwater		0.00	106,660.33	2,070.34															
40		Point Source		0.00	161,100.61	34,574.88															
41		Septic Systems		0.00	6,660.00	0.00															
42																					
43																					
44		Overview	MMW Output	LandUseLoadingRatesLookUpTable	Farm Animal TN and TP Loading	Stream Bank Sediment															

Figure 7

Step 2: Evaluate Potential Load Reductions from BMPs in Rural Areas

Using the “Agricultural BMPs” tab, various mitigation measures (both existing and proposed) can be simulated to evaluate potential load reductions in both upland areas (primarily agricultural) and in streams due to streambank erosion. To facilitate this activity, information from other tabs is extracted and used to populate key cells in this tab. More specifically, information is drawn from other tabs (primarily the “MMW Output” tab) to assign values to cells pertaining to watershed loads and the extent of available land on which various BMPs might be applied. For example, the cells highlighted in blue in Figure 8 provide available land areas or stream lengths to which measures such as conservation tillage, cover crops, riparian buffers, streambank stabilization, etc. might be applied. (Note: these cells are highlighted for illustration purposes only, and do not appear this way in the actual BMP spreadsheet tool). In the same figure, the cells highlighted in yellow are used to specify the existing and/or proposed extent of such measures. (Note that with this tab, as “existing” BMPs are applied, the availability of land area and/or loads for future BMPs are subsequently reduced). Based on user input, the potential load reductions are summed for all existing and proposed measures and provided at the bottom of this tab as illustrated in Figure 9.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																		
2	Average Annual Loads from Watershed								Existing BMPs	Sediment	Total N	Total P		Proposed BMPs	Sediment	Total N	Total P	Comments
3	Source	Area (acres)	Sediment (tons)	Tot N (pounds)	Tot P (pounds)				Cover Crops					Cover Crops				
4	Hay/Past	6,886.4	501.2	7,068.3	3,122.1				Available Acres	2,185.2				Available Acres	2,185.2			Note: Do not double
5	Cropland	2,185.2	150.0	14,037.5	4,760.0				Acres Treated	50.0				Acres Treated	150.0	0.29	0.50	
6	Forest	7,024.7	7.5	995.3	64.2				Reduction Coefficient	0.35	0.29	0.50		Reduction Coefficient	0.35	0.29	0.50	
7	Wetland	412.3	0.4	139.6	8.4				Lbs/yr Reduced	24,886.8	93.1	94.3		Lbs/yr Reduced	648,697.5	2,421.62	1,412.9	
8	Disturbed	0.0	0.0	0.0	0.0													
9	Turfgrass	0.0	0.0	0.0	0.0				Conservation Till					Conservation Till				
10	Open Land	325.9	9.5	328.5	28.2				Available Acres	2,185.2				Available Acres	2,060.2			Note: Do not double
11	Bare Rock	39.5	0.0	214.7	0.7				Acres Treated	125.0				Acres Treated	975.0			
12	Sandy Areas	0.0	0.0	0.0	0.0				Reduction Coefficient	0.30	0.08	0.22		Reduction Coefficient	0.30	0.08	0.22	
13	Ungrazed Flood	0.0	0.0	0.0	0.0				Lbs/yr Reduced	53,143.2	64.2	59.8		Lbs/yr Reduced	417,636.9	501.1	466.3	
14	L4_Mixed	15,125.5	73.9	4,028.5	451.6													
15	Md_Mixed	2,125.9	58.6	2,446.0	252.3				Forested Buffers Crops					Forested Buffers Crops				Note: 1 acre of buffer This also accounts for Note: Assumes but
16	Hd_Mixed	619.8	17.1	713.1	73.4				Available Acres	2,185.18				Available Acres	2,185			
17	L4_Residential	0.0	0.0	0.0	0.0				Stream feet buffered	900.00				Stream feet buffered	1,200.00			
18	Md_Residential	0.0	0.0	0.0	0.0				Buffer acres created	0.23				Buffer acres created	2.75			
19	Hd_Residential	0.0	0.0	0.0	0.0				Acres Treated	0.46				Acres Treated	5.51			
20	Farm Animals								Reduction Coefficient	0.54	0.41	0.40		Reduction Coefficient	0.54	0.41	0.40	
21	Tile Drainage								Lbs/yr Reduced	681.3	2.86	0.90		Lbs/yr Reduced	6,176.2	31.69	10.76	
22	Stream Bank	15,417.8		16,852.8	9,864.0				Floodplain Restoration					Floodplain Restoration				
23	Groundwater	0.0		106,681.0	2,070.9				Part 1: Streambank Load					Part 1: Streambank Load				
24	Point Source	0.0		91,189.6	54,574.9				Available Stream Feet	33,003.68				Available Stream Feet	32,503.68			
25	Septic Systems								Stream Feet Stabilized	500.00				Stream Feet Stabilized	4500.00			
26	TOTAL	35,543.2	17,645.9	325,041.9	115,893.7				Sed Reduction per foot	15.00	0.192	0.174		Sed Reduction per foot	15.00	0.192	0.174	
27	Tons of Sediment x 2,000 = conversion to pounds								Lbs Streambank Load Reduced	690,000.0	115.20	104.40		Lbs Streambank Load Reduced	517,500.00	864.00	783.00	
28	Stream Bank (pounds rounded to 1 decimal)																	
29	LAND USES								Part 2: Upland Load					Part 2: Upland Load				
30	Total Undeveloped	17,674.07							Additional % Reduction	0.10				Additional % Reduction	0.10			
31	Land	6,886.42							Lbs upland load reduced	6,900.00	11.52	10.44		Lbs upland load reduced	51,750.00	86.40	78.30	
32	Hay/Past	6,886.42							Total Floodplain Lbs Reduced	75,900.00	126.72	114.84		Total Floodplain Lbs Reduced	56,250.00	950.40	861.30	
33	Cropland	2,185.18							Grazing Land					Grazing Land				
34	Forest	7,024.68							Available Acres	6886.42				Available Acres	6886.42			
35	Wetland	412.36							Acres Treated	0.00				Acres Treated	0.00			
36	Disturbed	0.00							Sed Reduction Coeff	0.30	0.30	0.30		Sed Reduction Coeff	0.30	0.30	0.30	
37	Turfgrass	0.00																
38	Open Land	325.93																
39	Bare Rock	39.51																
40	Sandy Areas	0.00																
41	Ungrazed Flood	0.00																

Figure 8

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																		
2									Existing BMPs	Sediment	Total N	Total P		Proposed BMPs	Sediment	Total N	Total P	Comments
3									Stream Feet Stabilized	0.00				Stream Feet Stabilized	0.00			
4									Sediment Reduction (lb/ft)	15.00	0.19	0.17		Sediment Reduction (lb/ft)	15.00	0.19	0.17	
5									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
6									Ag E&S					Ag E&S				
7									Available Acres	2185.19				Available Acres	2185.19			
8									Acres Treated	0.00				Acres Treated	0.00			
9									Reduction Coefficient	0.16	0.05	0.10		Reduction Coefficient	0.16	0.05	0.10	
10									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
11									Streambank Fencing					Streambank Fencing				
12									Available Stream Feet	33003.68				Available Stream Feet	33003.68			
13									Stream Feet Fenced	0.00				Stream Feet Fenced	0.00			
14									Reduction (lb/ft)	2.55	0.02	0.0075		Reduction (lb/ft)	2.55	0.02	0.0075	
15									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
16									Nutrient Management					Nutrient Management				
17									Part 1: Surface Runoff					Part 1: Surface Runoff				
18									Available Acres	2185.19				Available Acres	2185.19			
19									Acres Treated	0.00				Acres Treated	0.00			
20									Reduction Coefficient	0.00	0.29	0.44		Reduction Coefficient	0.00	0.29	0.44	
21									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
22									Part 2: Subsurface Flow					Part 2: Subsurface Flow				
23									Reduction Coefficient	0.15	0.10	0.10		Reduction Coefficient	0.00	0.15	0.10	
24									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
25									AVMS					AVMS				
26									Available Load	0.00	5040.41	1233.14		Available Load	0.00	5040.41	1233.14	
27									Port of Total Animals Covered	0.00	0.00	0.00		Port of Total Animals Covered	0.00	0.00	0.00	
28									Reduction Coefficient	0.00	0.75	0.75		Reduction Coefficient	0.00	0.75	0.75	
29									Lbs/yr Reduced	0.00	0.00	0.00		Lbs/yr Reduced	0.00	0.00	0.00	
30									TOTAL LBS REDUCED	15511.37	286.76	229.86		TOTAL LBS REDUCED	1644726.69	3908.17	2751.25	
31									Percent of Original Load	0.44	0.09	0.20		Percent of Original Load	4.60	0.20	0.20	

Figure 9

Step 3: Evaluate Potential Load Reductions from BMPs in Urban Areas

In the case of rural landscapes, various agricultural BMPs and stream restoration measures are simulated to predict potential pollutant load reductions from either upland areas or in streams due to eroded streambanks. With urban areas, similar reductions are also considered with this spreadsheet tool (as is the case with streambank stabilization and street sweeping). However, most of the load reductions in urban areas are simulated by considering the combined load reduction effects of urban BMPs on both upland and streambank loads. As has been shown in numerous studies, stormwater

runoff from impervious surfaces in developed areas not only transports pollutants that have accumulated on such surface in between precipitation events, but the increased runoff (relative to more pervious surfaces) also significantly contributes to downstream streambank erosion.

Accordingly, with this spreadsheet tool, the application of most urban BMPs that result in reduced overland and sub-surface flows to streams is assumed to result in reduced upland and streambank loads as well. To estimate such load reductions, the initial “treated” loads are calculated by multiplying the extent of the urban area treated by a given BMP by the “composite” loading rate discussed previously that considers both the upland and streambank loads attributed to that particular land use type (e.g., in this case, higher-density land use types result in higher composite loads due to greater amounts of impervious surface). As described below, a reduction coefficient that represents the removal rate of sediment and nutrients for the BMP is then applied to estimate the reduced load.

In this spreadsheet tool, a “Performance Standard” approach is used to dynamically set the removal efficiency rates based on the type of BMP used and the runoff volume captured. This approach was originally developed for use within the Chesapeake Bay watershed model, and has been adopted by the states within the Chesapeake Bay watershed. With this approach, regression curves have been developed for two basic types of BMPs (RR – runoff reduction, and ST – stormwater treatment). Most urban BMP types used within the Bay watershed have been assigned to either of these two categories, and the value of sediment and/or nutrient removal efficiency varies as a function of runoff volume that is captured via detention and/or infiltration (see Figures 10-12). For example, as shown in Figure 11, if a water volume equivalent to 0.5 inches of runoff per acre of impervious surface is captured by an “RR-type” BMP, a sediment removal rate of 53% would be calculated

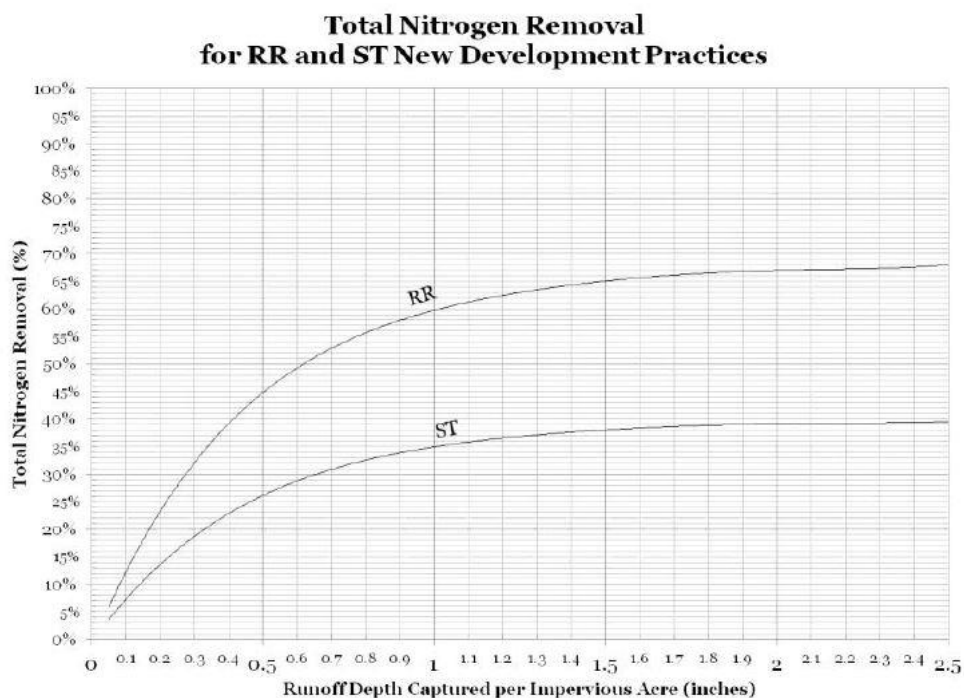


Figure 10

Total Phosphorus Removal for RR and ST New Development Practices

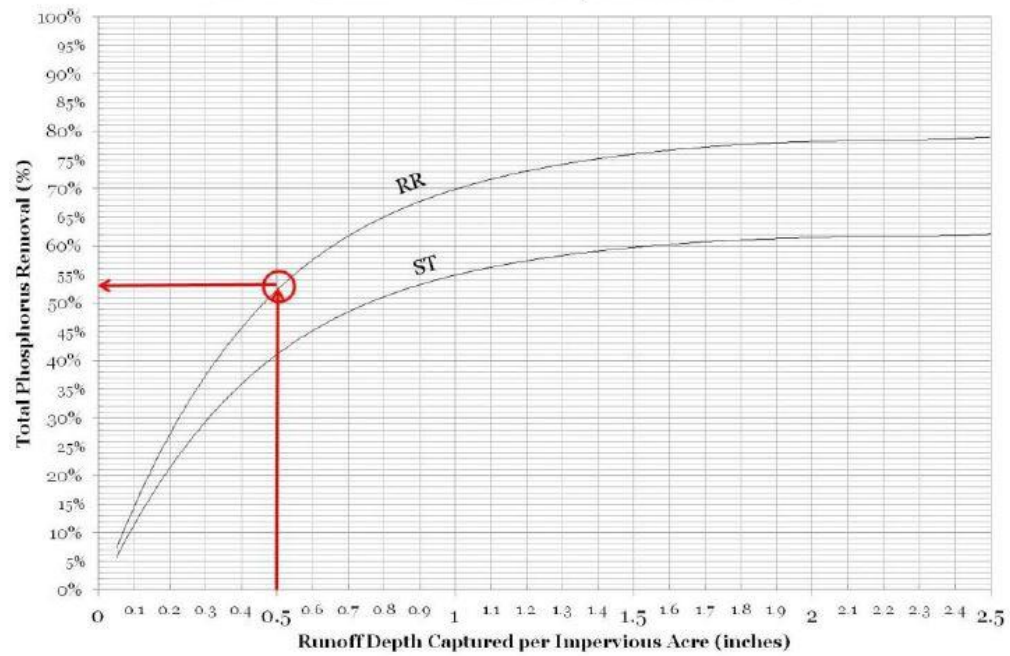


Figure 11

Sediment Removal for RR and ST Stormwater Retrofit Practices

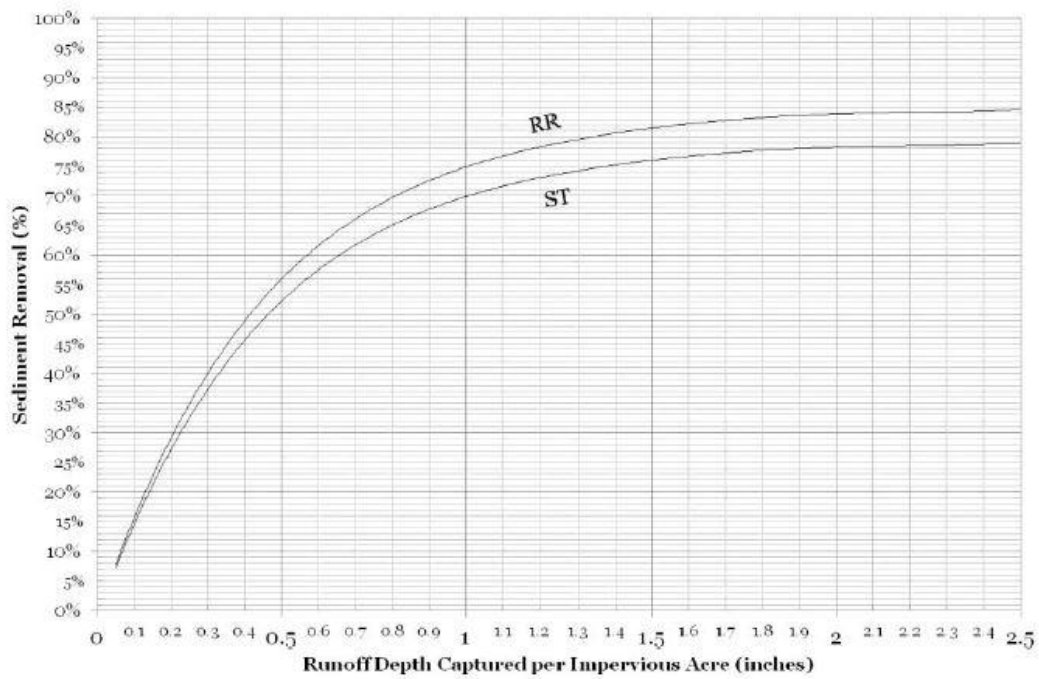


Figure 12

With the MMW BMP spreadsheet tool, data about urban BMPs are entered using the “Urban BMPs” tab. First, the user must enter general information such as Project Name (any name), a BMP Name (which can be a single BMP or collection of BMPs that drains a single area), the BMP type (RR or ST), and whether it is “Existing” or “Proposed” as shown by the red arrows in Figure 13. (For reference purposes, Figure 14 shows a table of the different BMPs that have been assigned to either category for Chesapeake Bay modeling purposes). Then, as shown in Figure 15, the user must enter information on: 1) the types of land uses treated by a BMP or collection of BMPs, 2) the extent to which different land use types are treated by the BMP or BMP system (i.e., number of acres), and 3) the quantity (runoff depth) captured by the BMP. Upon entering this information, the removal efficiency values for sediment, nitrogen and phosphorus, as well as potential load reductions, are automatically calculated as shown in Figure 16.

Within this tab, a “pull-down” window is provided so that load reductions for different parts of an urban area, or for sub-areas treated by different BMP/collection systems, can be estimated as shown in Figure 17. With this function, the load reductions for multiple “Project Name” entries with the same name can be aggregated. Although this tab currently only allows for up to four different “Project Names” to be aggregated, additional names can be added by simply copying the cells in the last row of the calculated cells under the “Project Name” heading and pasting them into the next line below .

	A	B	C	D	E	F
1	Urban BMP Load Reduction Calculation Table					
2	INSTRUCTIONS TO MUNICIPALITY: Each row in the table below should represent a different BMP drainage area. Choose the dominant land use draining to the					
3	If a BMP has multiple land uses in the drainage area, these drainage areas should be represented on a subsequent row with the same BMP name. The treatment					
4	If one of the drainage areas to the same BMP has NO impervious cover, use the Manual Override column to type in the treatment depth (in/imp. ac) of the primary					
5	The examples below show the various options and should be deleted before tallying reductions. Notice one example demonstrates when a drainage area covers					
6						
7						
8	Project Name	BMP Name	BMP Type	Existing or Proposed	Year Installed	MapShed Land Cover of Drainage Area
9						
10	Project_name	BMP_name	BMP_type	Existing?	YearInstalled	drainageLandCoverClass
11	Pine Creek	Stream Stabilization	Stream Restoration	Proposed	2020	
12	Existing	Mall	ST	Existing	Existing	Hd_Mixed
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25	NOTE: the above table is an Excel Table, which has special features. For more information, see https://support.office.com/en-us/article/overview-of-excel-tables-7ab0bb7d-3a9e-4b56-a1c1-39d177105006					
26	ADD ROWS by right-clicking a row number inside the Table, and choosing “Insert”. This will automatically copy formulas and update links throughout this workbook					
27						

Figure 13

Table 4 Classification of BMPs based on Runoff reduction capability¹	
<i>Runoff Reduction (RR) Practices</i>	<i>Stormwater Treatment (ST) Practices ²</i>
<i>Non-Structural Practices</i>	
Landscape Restoration/Reforestation	Constructed Wetlands
Riparian Buffer Restoration	Filtering Practices (aka Constructed Filters, Sand Filters, Stormwater Filtering Systems)
Rooftop Disconnection (aka Simple Disconnection to Amended Soils, to a Conservation Area, to a Pervious Area, Non-Rooftop Disconnection)	Proprietary Practices (aka Manufactured BMPs)
Sheetflow to Filter/Open Space* (aka Sheetflow to Conservation Area, Vegetated Filter Strip)	Wet Ponds (aka Retention Basin)
Non-Structural BMPs, PA 2006 BMP Manual, Chapter 5	Wet Swale
<i>Practices</i>	
All ESD practices in MD 2007	
Bioretention or Rain Garden (Standard or Enhanced)	
Dry Channel Regenerative Stormwater Conveyance (aka Step Pool Storm Conveyance)	
Dry Swale	
Expanded Tree Pits	
Grass Channels (w/ Soil Amendments, aka Bioswale, Vegetated Swale)	
Green Roof (aka Vegetated Roof)	
Green Streets	
Infiltration (aka Infiltration Basin, Infiltration Bed, Infiltration Trench, Dry Well/Seepage Pit, Landscape Infiltration)	
Permeable Pavement (aka Porous Pavement)	
Rainwater Harvesting (aka Capture and Re-use)	
*May include a berm or a level spreader ¹ Refer to DC, MD, PA, VA or WV State Stormwater Manuals for more information ² Dry ED ponds have limited removal capability , their efficiency is calculated using rates in Table B-4, Appendix B	

Source:

Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards, Stewart Comstock, Scott Crafton, Randy Greer, Peter Hill, Dave Hirschman, Shoreh Karimpour, Ken Murin, Jennifer Orr, Fred Rose, Sherry Wilkins. Revised: January 20, 2015, Prepared by: Tom Schueler and Cecilia Lane, Chesapeake Stormwater Network

Figure 14

simulated results against, additional simulations may need to be conducted before any final results are achieved with the spreadsheet tool. Also, as described earlier, multiple “project areas” are provided in the urban tab in case individual sub-areas need to be considered within a larger urban area. Additionally, if multiple areas or scenarios need to be addressed, the user can make as many copies of the tool as needed.

	A	B	C	D	E	F	G	H	I
1						Entire Watershed			
2						Sediment (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)	
3									
4						35291849	326042	115894	← Total “No-BMP” Loads
5									
6						35025	20	9	} “Existing” and “Proposed” BMP Loads
7									
8						17250	29	26	
9									
10						155111	287	230	} Total Load Reductions from “Existing” and “Proposed” BMP s
11									
12						1644721	3905	2751	
13									
14									
15						1852107	4241	3017	} Total Load Reductions from Baseline
16						33439742	321801	112877	
17						5.2	1.3	2.6	
18									
19									
20						35101712	325735	115655	} Total Load Reductions from Baseline
21						1661971	3934	2777	
22						4.7	1.2	2.4	
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									
51									
52									
53									
54									
55									
56									
57									
58									
59									
60									
61									
62									
63									
64									
65									
66									
67									
68									
69									
70									
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									
81									
82									
83									
84									
85									
86									
87									
88									
89									
90									
91									
92									
93									
94									
95									
96									
97									
98									
99									
100									

Figure 18

Analysis of Pollutant Loads and Potential BMP Scenarios for Specific Subareas or “Targeted” Areas within a Larger HUC12 Watershed

SPECIAL NOTE:

As of January 2020, a new routine has been implemented within Model My Watershed that provides for automated entry of land cover and pollutant load information to the Excel-formatted BMP Spreadsheet tool (see Section 7.3 of the Technical Documentation for MMW). When this option is used, “auto-populated” spreadsheets are automatically provided for download by the user, thereby negating the need for manual “copying and pasting” of data as described in Steps 1-3 below.

Basically, the steps associated with this type of analysis are the same as those given above with the exception of two additional steps (Step 2 and Step 3) as described below.

Step 1: Load Output Data from Model My Watershed for the Larger Watershed

(Same as Step 1 in the previous section)

Step2: Define the Boundary of the Target Area

The process for estimating the land cover distribution for a smaller target area (e.g., municipality or other user-defined urban area or BMP area) is essentially the same as when a boundary is selected or created for any watershed or area of interest (AOI) in Model My Watershed. In this case, instead of using either the “Select boundary” or “Delineate watershed” options to define an AOI, either the “**Draw area**” or “**Upload file**” options as shown in Figure 19 are used to define the AOI. (See the Appendix for more details on how to use these two options for defining an AOI for this particular purpose). Note that for this particular type of analysis, the boundary of the target area must not extend beyond the boundary of the larger watershed as no clipping is performed as part of this operation.

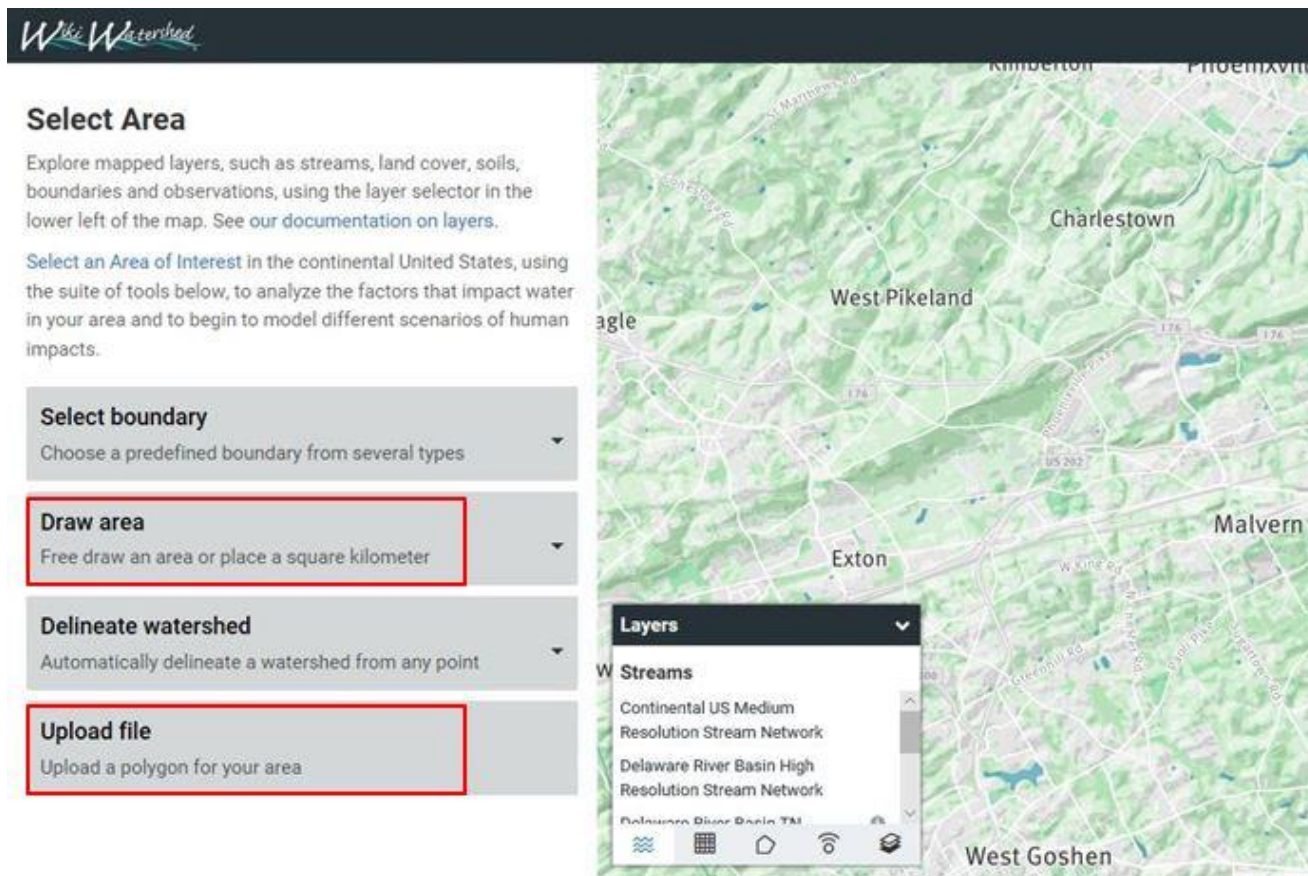


Figure 19

Step 3: Enter Land Cover Distribution Data for the “Target” Area within the Larger Watershed

After a boundary for the “target area” is defined using one of the two methods described above, Model My Watershed will summarize various characteristics of the AOI just as it does for any other area selected. As shown in Figure 3 in the previous section, the land cover distribution for the new AOI can be downloaded in a csv-formatted file. However, in this case, the data in this csv file are to be copied and pasted into a different location in the BMP spreadsheet tool. More specifically, data on the type and areal extent of the different land cover categories for the smaller, target area are to be pasted into the location shown in Figure 20. As also shown in this figure (see the smaller red box to the right), data on stream lengths are also entered for the target area similar to the way they are entered for the larger watershed as shown previously in Figure 5.

Once these data are pasted into this location in the spreadsheet, information on land cover for the target area is then carried over to the “Urban BMPs” tab to help the user determine the load reductions that might be obtained by applying different BMP scenarios in this specific area. (Note: in addition to using either the “Draw area” or “Upload file” options, it is also possible to just manually enter information on the areal extent of different land cover types in the target [urban] area if these are already known).

Note: The information below is only used for allocation of “urban” loads within a larger watershed boundary					
MMW NLCD Land Cover Categories for Urban Area (from second, smaller “Analyze” csv file)					
TYPE	AREA (km ²)	AREA (acres)	TN (lb/yr)	TP (lb/yr)	Sediment (lb/yr)
Open Water	0	-			
Perennial Ice/Snow	0	-			
Developed, Open Space	5.27	1,301.23	975.93	403.38	1,243,887.93
Developed, Low Intensity	2.79	688.89	516.67	213.56	658,528.90
Developed, Medium Intensity	0.84	207.41	462.52	128.59	358,852.33
Developed, High Intensity	0.2	49.38	138.27	40.49	119,488.98
Barren Land (Rock/Sand/Clay)	0	-	0.00	0.00	0.00
Deciduous Forest	1.49	367.90	176.59	73.58	240,082.35
Evergreen Forest	0.02	4.94	2.37	0.99	3,222.58
Mixed Forest	0.06	14.81	7.11	2.96	9,667.75
Shrub/Scrub	0.7	172.84	82.96	34.57	112,790.37
Grassland/Herbaceous	0.15	37.04	17.78	7.41	24,169.36
Pasture/Hay	4.66	1,150.62	2,243.70	968.99	916,135.67
Cultivated Crops	1.2	296.30	2,174.81	743.70	615,946.15
Woody Wetlands	0.06	14.81	10.37	3.11	9,670.92
Emergent Herbaceous Wetlands	0.01	2.47	1.73	0.52	1,611.82
Totals	17.45	4,308.64	6,810.81	2,561.85	4,313,956.14

(Note: The values below only pertain to the smaller target area)

STREAM LENGTH	KM ²	FEET
Total Length	21.6	70866.1
Ag Streams	4.27	14009.2
Non-Ag Streams	17.33	56857.0

* These values can be obtained from the “Stream” tab in the “Analyze” sector

Figure 20

Subsequent Steps

After entering information for the smaller target area of interest as described in the two previous steps, an assessment of potential load reduction scenarios using various BMPs can be conducted by following Steps 2 through 4 outlined in the previous section (see an example of this in Figure 21). After any given scenario, the potential load reductions are then shown in the “Total Load Reductions” tab as shown earlier in Figure 18. In this case, however, the load reduction results are displayed in the “Urban Area” portion of this tab as shown in Figure 22, and any BMPs simulated are assumed to be applied in the target (urban) area first until available rural and urban land areas within that particular area are exhausted. Therefore, the percent load reduction values for the target area are usually higher than those for the larger watershed within which it is located.

	A	B	C	D	E	F	G	H	I	
1	Urban BMP Load Reduction Calculation Table									
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										

NOTE: the above table is an Excel Table, which has special fea <https://support.office.com/en-us/article/overview-of-excel-tables-7ab0bb7d-3a9e-4b56-a3c9-6c94334e492c>.
 ADD ROWS by right-clicking a row number inside the Table, and chosing "Insert". This will automatically copy formulas and update links throughout this workbook.

Cells requiring user input for all BMPs
 Cells requiring user input for BMP efficiencies calculated using Performance Standard approach
 Cells requiring user input for non-Performance Standard BMPs (e.g., streambank stabilization and street sweeping)
 Cell values calculated based on user input
 Optional user input for treatment depth in non-developed areas (e.g., cropland)
 Optional user input

284022.3 Available stream length (ft) in Non-Ag Areas in the entire watershed (from MMW Output tab)
 56857.0 Available stream length (ft) in Non-Ag Areas in the smaller target area (from MMW Output tab)

Figure 21

	A	B	C	D	E	F	G	H	I	J	K	L	M
1						Entire Watershed					Urban Area*		
2						Sediment (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)			Sediment (lbs/yr)	TN (lbs/yr)	TP (lbs/yr)
3													
4						35291849	326042	115894			4313956	6811	2562
5													
6						37540	35	12			37540	35	12
7													
8						375456	307	216			375456	307	216
9													
10						0	0	0			0	0	0
11													
12						0	0	0			0	0	0
13													
14													
15						412996	342	228			412996	342	228
16						34878852	325700	115666			3900960	6469	2334
17						1.2	0.1	0.2			9.6	5.0	8.9
18													
19													
20						35254309	326007	115882			4276416	6776	2550
21						375456	307	216			375456	307	216
22						1.1	0.1	0.2			8.78	4.54	8.47
23													
24													
25													
26													
27													
28													

(1) After existing BMPs have been accounted for
 (2) After proposed BMPs have been accounted for

Figure 22

APPENDIX - Selecting/Defining an Area of Interest for use in Watershed Modeling

As shown in Figure A1 below, there are a number of tools available within Model My Watershed for selecting or defining an Area of Interest (AOI) for analysis or water quality simulation purposes, including **“Select boundary”**, **“Draw area”**, **“Delineate watershed”**, and **“Upload file”**. Some of the options included with these tools (e.g., “Square km” with the “Draw area” tool, and “County Lines” under the “Select boundary” tool) are not usually suitable since they do not necessarily represent watersheds or basins that are defined by topographic divides or stream networks. Brief descriptions of the most appropriate tools for use in hydrologic/water quality modeling are provided below.

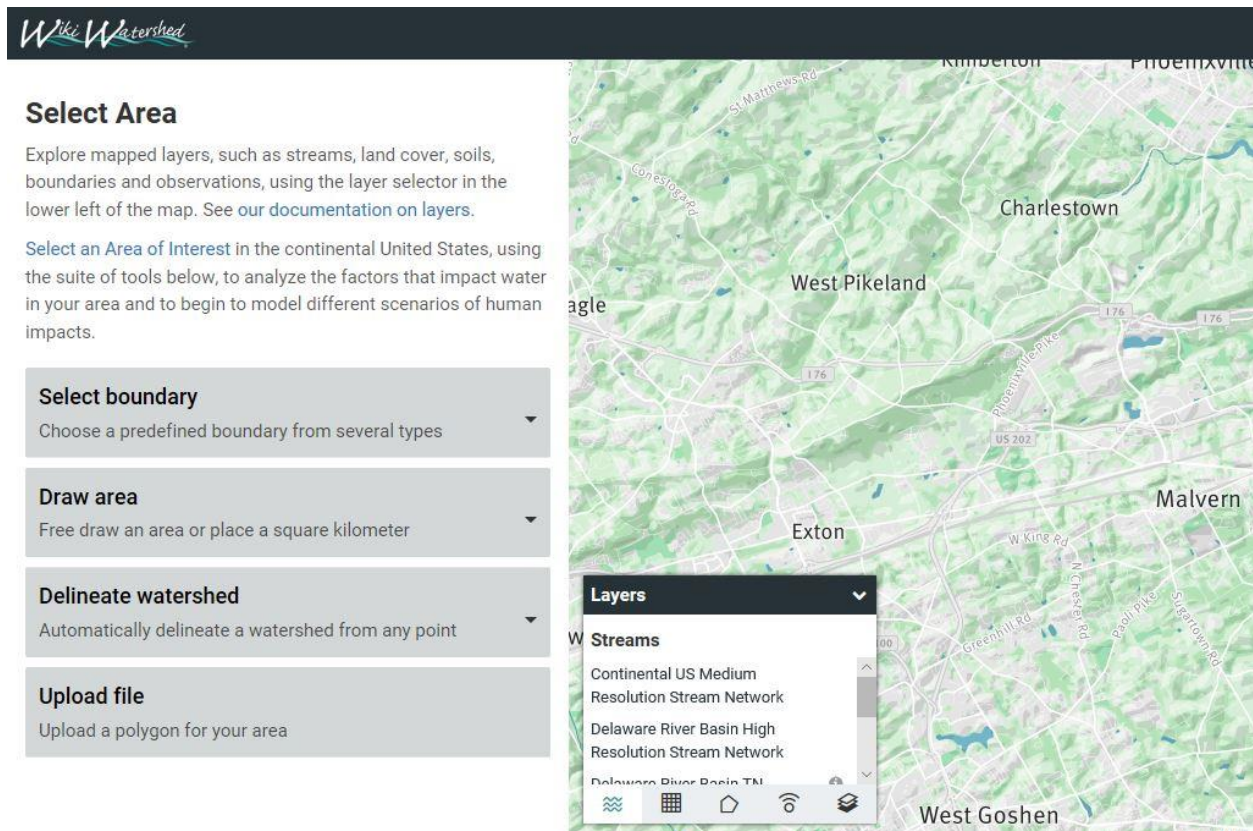


Figure A1.

Select Boundary

With this particular tool, the most suitable options for modeling include those which allow a user to depict and select pre-defined watershed/basin boundaries previously developed by the U.S. Geological Survey (i.e., the HUC12, HUC10 and HUC8 boundaries) as shown in Figures A2 and A3. Although all of these vary in average size depending upon where they are located geographically, across the country, HUC12 boundaries are typically on the order of 40 square miles in size, HUC10 boundaries are about 225 square miles in size, and HUC8 boundaries are about 700 square miles in size. Once a particular option is chosen, the user then moves the cursor over to the boundary of interest and clicks on it to begin the process of extracting the necessary data to begin the modelling process.

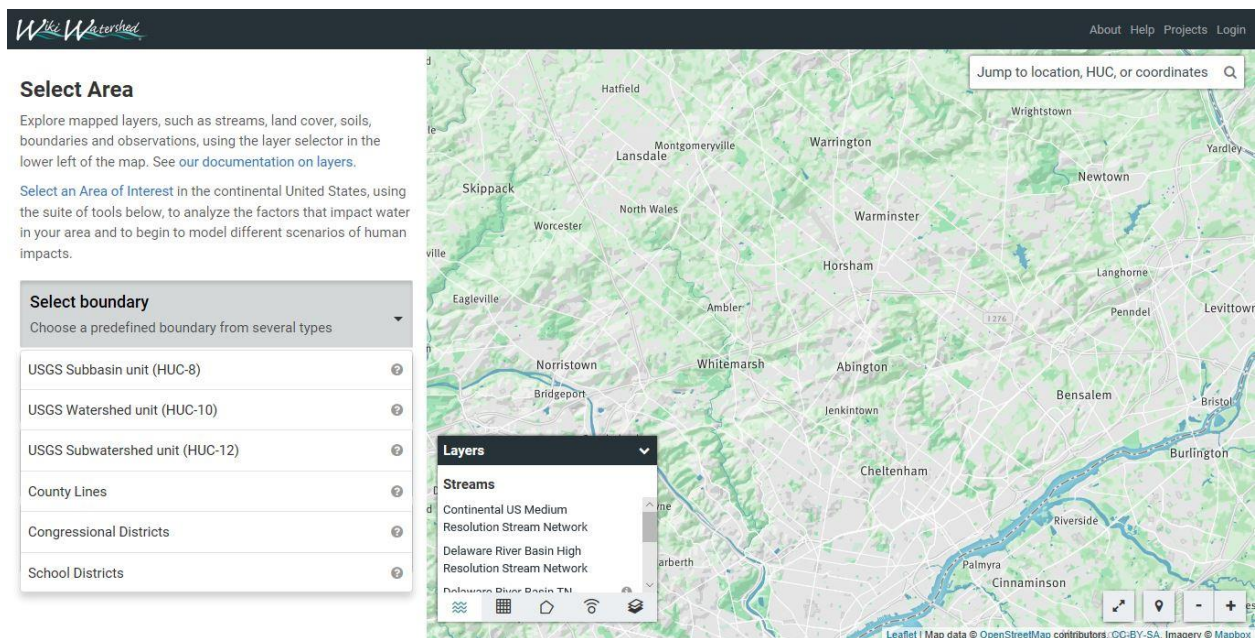


Figure A2

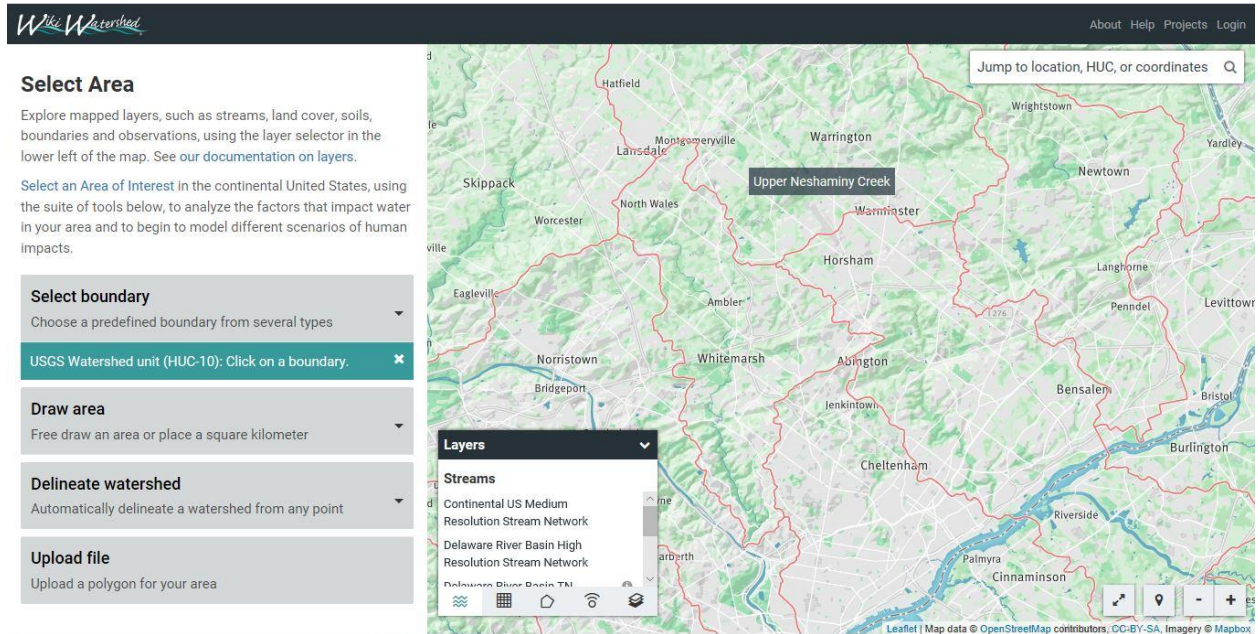


Figure A3

Draw Area

With this option, the user can manually draw a boundary of interest on their computer screen. In this case, the user begins by digitizing on-screen with the cursor by starting with a point and then finishing the polygon with that same point by clicking on it. Figure A4 shows a portion of such a polygon during the digitizing process. As soon as the polygon is finished, data will be extracted for that area as previously described. This procedure can be used for both defining a watershed boundary for subsequent analysis as well as the boundary for a smaller target (e.g., urban) area within the larger boundary. In drawing this boundary, the user may want to turn on other layers that can aid this process such as a satellite image (see Figure A5) or a layer that depicts a combination of municipal boundaries and “pre-defined” urban areas as shown in Figure A6. (Note: this latter option is only available in Pennsylvania).

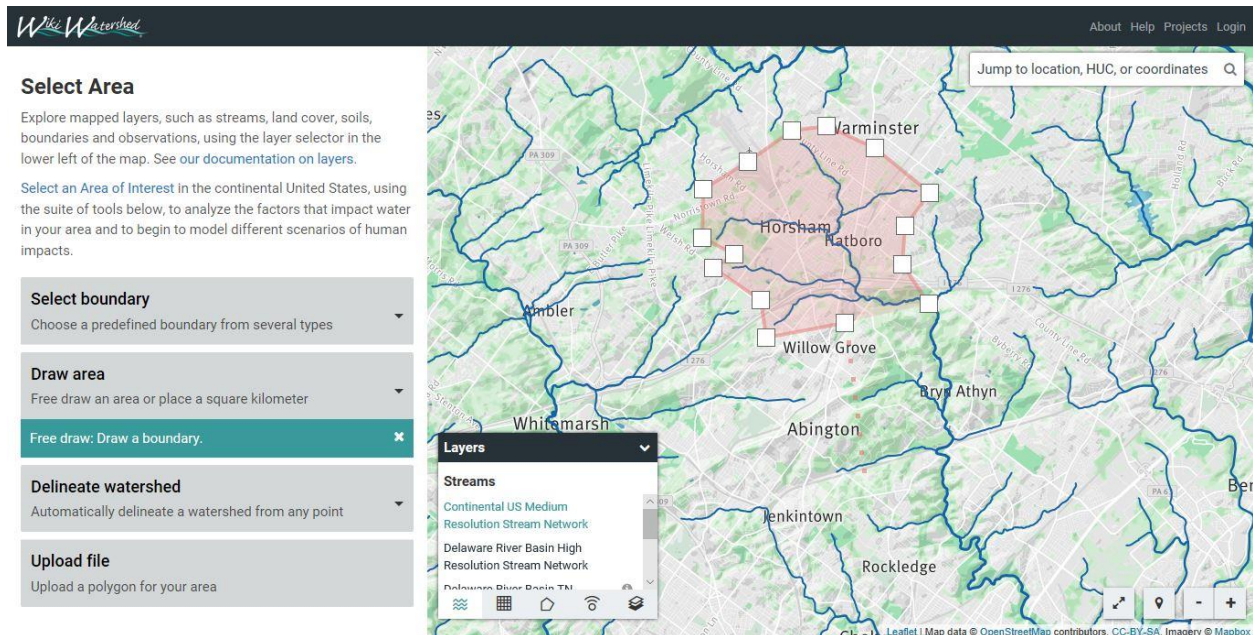


Figure A4.

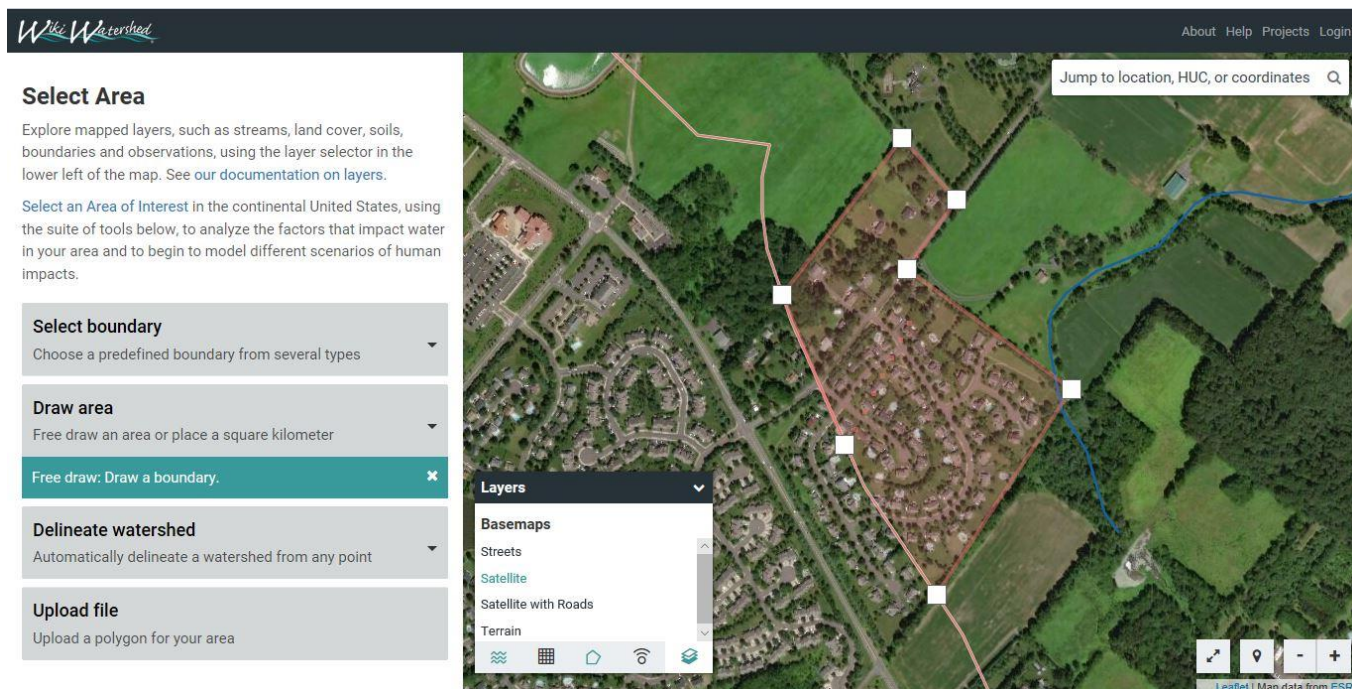


Figure A5

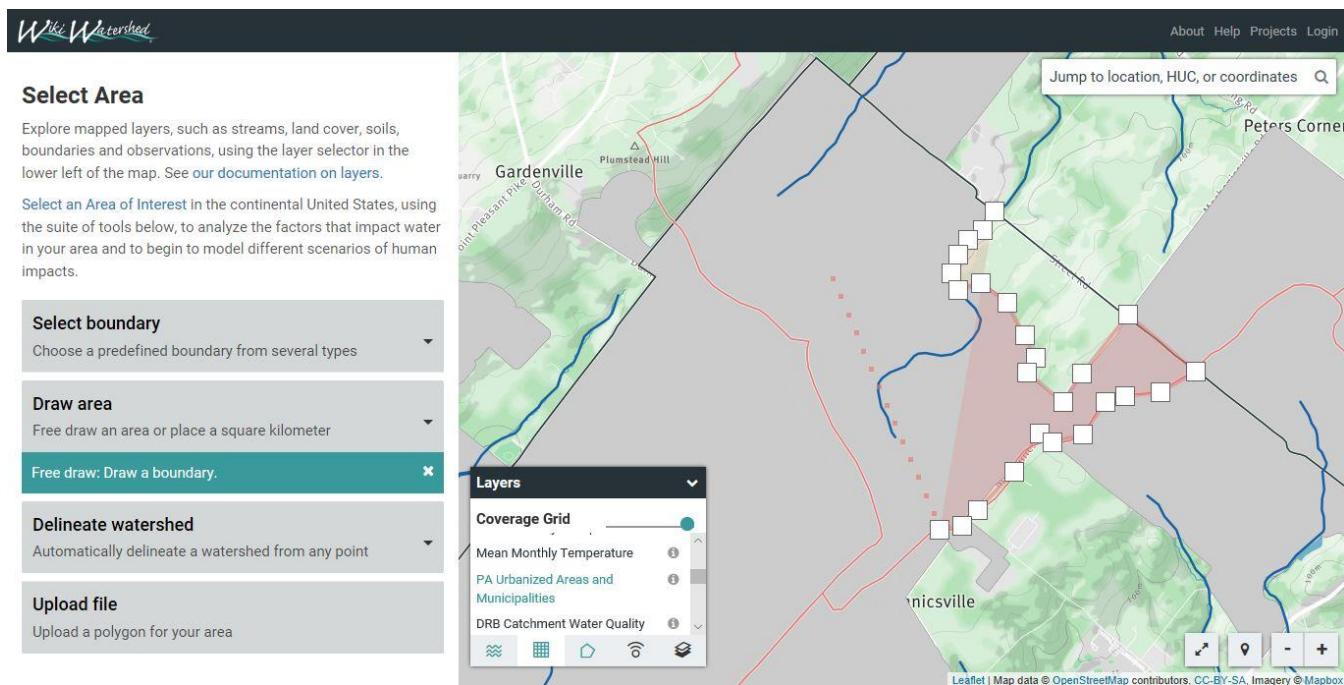


Figure A6

Delineate Watershed

With this option, a user can drop a point on a stream and have the boundary that defines the land area draining to that point (i.e., watershed boundary) automatically generated. Upon selecting a stream point, digital elevation data is used to find the topographic divides that separate adjacent drainage areas, and then delineate the appropriate boundary of interest. In utilizing this option, the user can select either of two stream networks for generating the polygon: 1) a high-resolution stream network that was specifically produced for the Delaware River Basin on the East Coast, or 2) a mid-resolution NHD stream network produced by the U.S. Geological Survey that is available for the entire country. A comparison between Figures A7 and A4 (which show the same geographic area) illustrates how much more accurate this approach is than manually digitizing such a boundary.

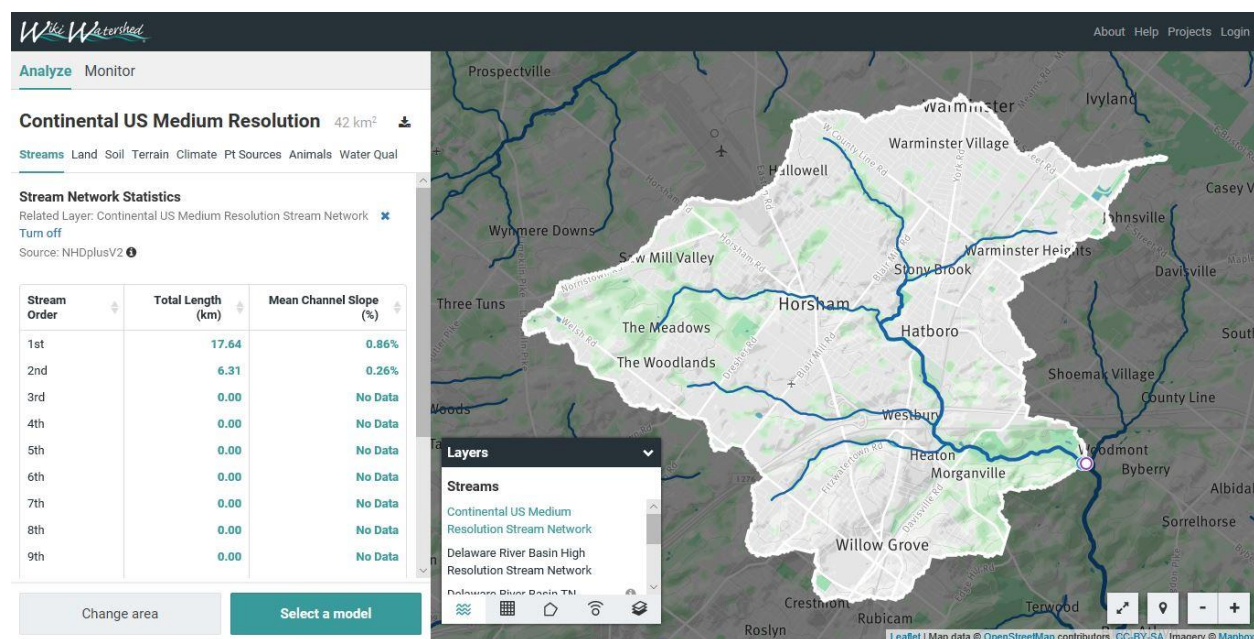


Figure A7

Upload File

With this option, a user can upload a digital boundary that has been previously created outside of MMW to define the area of interest. This can be used to define either a watershed boundary or a smaller target (urban) area within the larger watershed as described earlier in this document. Upon selecting this option, the user is presented with a screen as shown in Figure A8. Upon clicking on the “Select a file” button, the user is then asked to browse to the file to be uploaded. As noted in Figure A8, this can either be a zipped shapefile or a “geojson” file. Figure A9 shows an example of a boundary file uploaded for an area in eastern Pennsylvania.

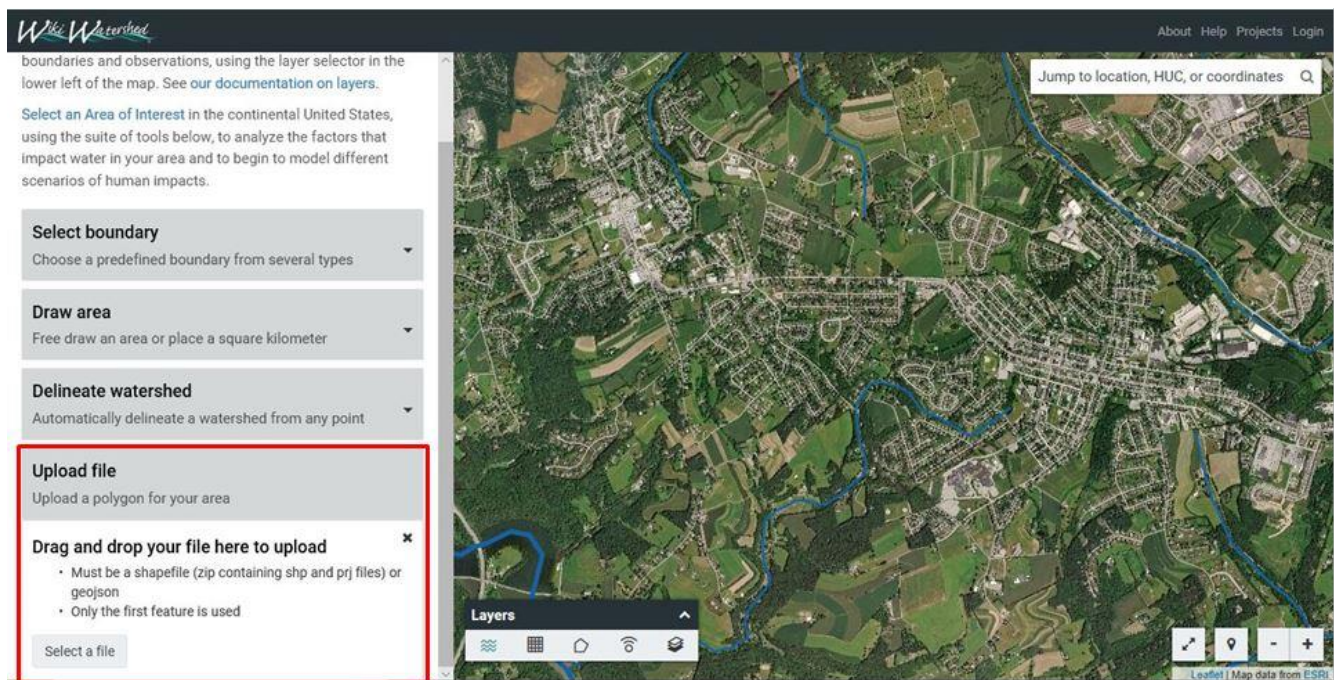


Figure A8

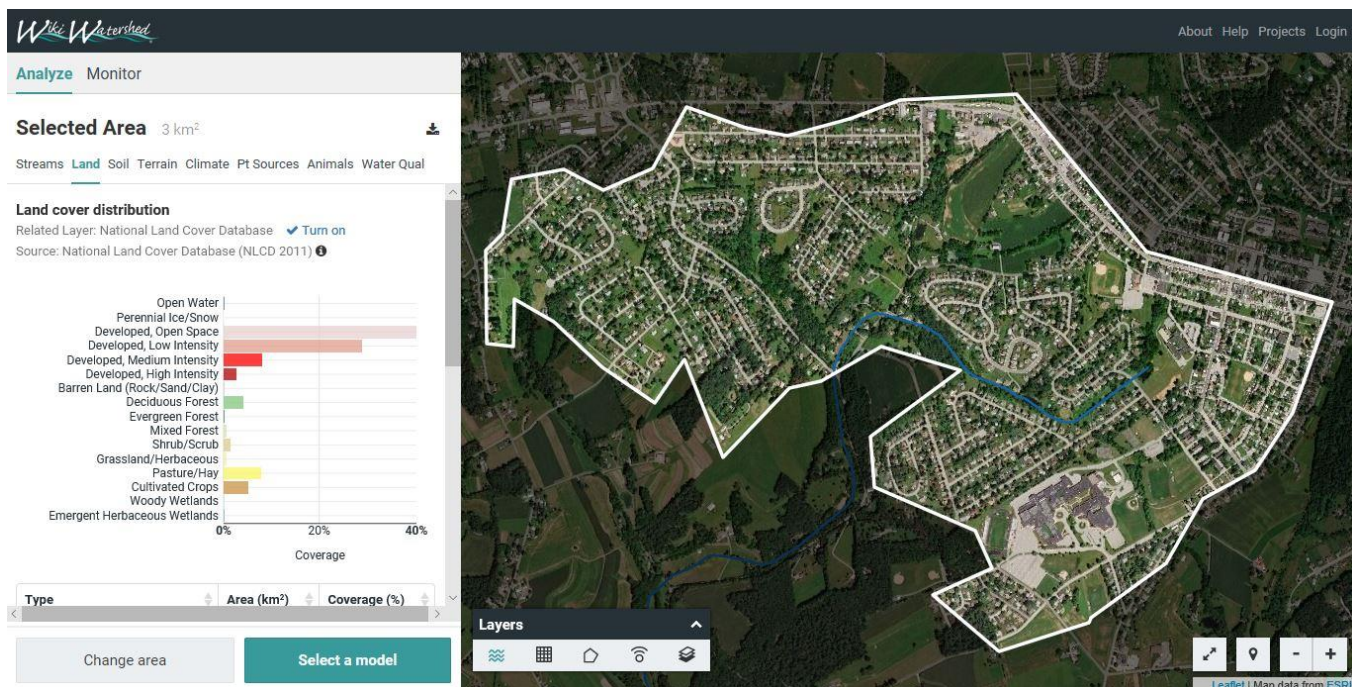


Figure A9.