User’s Guide

Pollutant Load Estimation Tool (PLET)

Version 2.0

Developed for U.S. Environmental Protection Agency

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Note: The Pollutant Load Estimation Tool (PLET) model may be accessed at the PLET website (https://epa.gov/nps/plet) or, for registered Grants Reporting and Tracking System (GRTS) users, by logging into GRTS and navigating to the Tools drop-down menu and selecting *PLET Models*. For more detailed information, refer to the Accessing PLET section of the User's Guide. Optionally, you may obtain the initial model input data from the PLET Input Data Server. However, it is the **user's responsibility** to check and refine the initial data for study areas. The Input Data Server can be accessed at the top of the model page from the "Download Input Data Server Data" button or from outside of the model at https://ofmpub.epa.gov/apex/grts/f?p=109:333.

Step 1. Access the PLET model interface and click on the *Create a New Model* button in the upper right-hand corner.

Step 2. Name the model and select the state where the modeled area is located. Additional data entry fields will appear.

- Follow the directions on the bottom of the screen to specify the area to be modeled (one or more 12-digit hydrologic unit code [HUC12] watersheds or a custom watershed) and to select a precipitation observation.
- Select *Create model* when finished.

Step 3. Add as many watersheds or modeled areas as needed for the scenario. Click on the *Add/Edit Watersheds* button near the top of the model interface to add new rows, each representing a different watershed area. The trash can icon located at the left of each row can be used to remove extra or erroneous rows. For additional watersheds added, the precipitation observation point closest to the centroid of the HUC12 is automatically selected.

Step 4. The *Input Module* is composed of 10 input tables. The first several tables require local data provided by the user or data from the Input Data Server. The remaining tables contain default values that users are encouraged to update based on the availability of local data.

- Manually enter land use in acres and specify the representative Soil Hydrologic Group (SHG) in the Watershed Land Use Area and Precipitation table (Table 1) or review the data provided by the PLET Input Data Server and update as appropriate.
- Enter the total number of agricultural animals by type and number of months per year that manure is applied to croplands and pastureland in the Agricultural Animals (Animal Count) table (Table 2). To calculate the average number of months manure is applied, click on the *Manure Application* button at the top of the PLET interface to open the calculator.
- Enter the values for septic system parameters in the Septic and Illegal Wastewater Discharge table (Table 3).
- If the percent nutrient content in the soil is known, adjust the default values in Table 4.
- If more local data are available, modify the Table 5 – Revised Universal Soil Loss Equation Version 2 (RUSLE2) parameters associated with the county selected when first creating a model.

Step 5. You may stop here and proceed to Step 7. If you have more detailed information on your watershed(s), proceed with adding data to the remaining input tables.

Step 6. Review parameter values for tables 6, 6a, 7, 7a, 8, 9, and 10 and update with more local data, if available:

- Modify the curve number table in Table 6 and Table 6a.
- Modify the nutrient concentrations (in milligrams per liter [mg/L]) in surface runoff in Table 7.

- Modify the nutrient concentrations (in mg/L) in shallow groundwater in Table 7a.
- Specify the detailed land use distribution in the urban area in Table 8.
- Specify the cropland irrigation information in Table 9.
- Specify the wildlife density on cropland by animal type in Table 10.

Step 7. Enter the representative dimensions and characteristics for gullies and streambanks, if desired. Click on the *Gullies and Streambanks* button at the top of the PLET interface to open the form. This form can also be used to represent gully and streambank restoration practice efficiencies.

Step 8. Add best management practices (BMPs) to the model scenario. Navigate to the BMP Module by clicking on the BMP tab towards the top of the PLET model.

- Click the *Add BMP* button on the right side to open the BMP entry form.
- Select the appropriate watershed and land use and click Add BMP.
- Double-click on the resulting BMP cell and select the desired BMP from the drop-down list.
- Enter the proportion of the land use for which the BMP will be applied.

To represent more than one BMP per land use type, click the *BMP Calculator* button to open the calculator and create a combined BMP efficiency for multiple BMPs. Refer to the complete User's Guide for instructions on how to use the BMP Calculator.

For urban land uses, BMPs are entered using the Urban BMP Tool, which can be accessed by clicking on the *Urban BMP Tool* button near the top of the PLET model interface. Enter BMP information for each urban land use and click *Apply LID/BMP* to add the BMP to the model.

Step 9. Add the protected acres of forest to the model scenario. Navigate to the Protected Lands module by clicking the *Protected Lands* button near the top of the PLET interface.

- Confirm the correct watershed is selected under the *Watershed(s)* drop-down list.
- Click *Add row* at the top of the table.
- Select a land use from the *Avoided Future Land Use* drop-down list.
- Enter the number of protected acres and click *Apply to Watershed*.

Step 10. View the estimated loads and load reductions in the Total Loads Module. Loads and load reductions are automatically generated and appear in the Total Loads Module.

When land protection is included in the model scenario, click the box next to *Show forest prevented loads and prevented runoff by subwatershed* to generate Table 6 – Total prevented loads/runoff from land protection. These loads are presented independently from the total loads calculations in other tables in the Total Loads Module.

To generate the groundwater load information, click the box next to *Groundwater load calculation* to turn on that feature.

The *Treat All Subwatersheds as Part of a Single Watershed* check-box changes the sediment delivery ratio. This box is only relevant if there is more than one watershed in the model. Checking the box allows the sediment delivery ratio to be calculated using the total watershed area of all watersheds included in the model. **Important:** This feature does not represent routing through the watersheds in a particular order. Unchecking the box allows the sediment delivery ratio to be calculated independently for each watershed in the model.

Results can be downloaded as an Excel spreadsheet by clicking on *Download* in the upper right corner of the Total Loads Module.

1 Introduction

1.1 Overview of PLET

This document is a user's guide to the Pollutant Load Estimation Tool (PLET). PLET provides a user-friendly web interface to create a customized model. It employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs), including low impact development practices (LIDs) for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD); and sediment delivery based on various land uses and management practices. The land uses considered are urban, cropland, pastureland, feedlot, forest, and a user-defined type. The pollutant sources include major nonpoint sources such as cropland, pastureland, farm animals, feedlots, urban runoff and failing septic systems. The types of animals considered in the calculation are beef cattle, dairy cattle, swine, horses, sheep, chickens, turkeys and ducks. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the Revised Universal Soil Loss Equation Version 2 (RUSLE2) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the default BMP efficiencies provided under the Additional Reference Tab.

PLET is utilized at the user's own direction. Neither the U.S. Environmental Protection Agency nor any of its contractors assumes responsibility for the operation, output, interpretation or use of this tool.

1.2 PLET Structure

Figure 1-1 shows the overall model structure of PLET. It is composed of interactive modules for input and BMPs based on user data, an output module that presents the results of the modeled scenario, and hidden processes to handle intermediate calculations. The input data include state name, county name, precipitation observation point, land use areas, agricultural animal numbers, manure application months, population using septic tanks, septic tank failure rate, direct wastewater discharges, irrigation amount/frequency and BMPs for simulated watersheds. When local data are available, users may choose and are encouraged to modify the default values for RUSLE2 parameters, soil hydrologic group, nutrient concentrations in soil and runoff, runoff curve numbers, and detailed urban land use distribution. Pollutant loads and load reductions are automatically calculated for total nitrogen, total phosphorus, BOD and sediment.

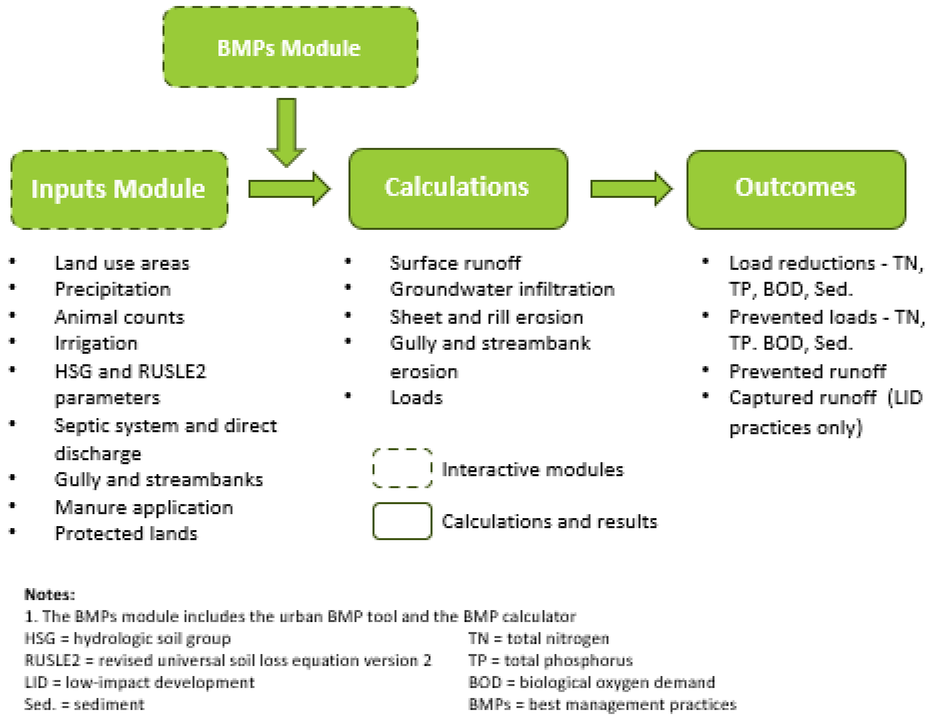


Figure 1-1. PLET model structure.

2 Getting Set Up

2.1 Technical Requirements

To use PLET, the user must have an internet-connected computer. PLET is compatible with all available internet browsers except for Internet Explorer.

2.2 Accessing PLET

The PLET modeling component can be accessed in two ways:

(1) Registered users of the EPA's Grants Reporting and Tracking System (GRTS) can log into GRTS with their account info (username/password) and then navigate to PLET using the *Tools* drop-down menu within the GRTS application, as shown in Figure 2-1.

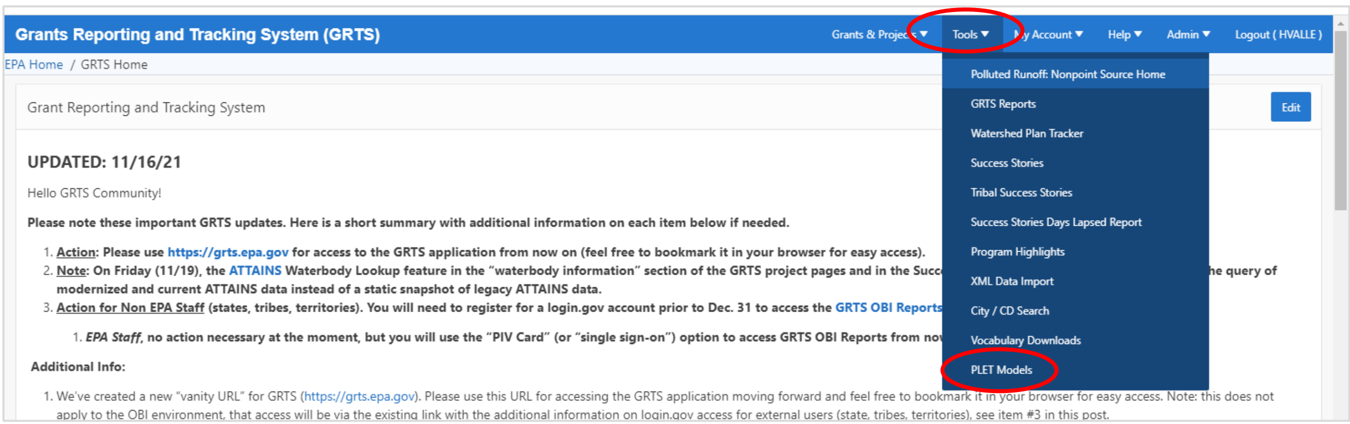


Figure 2-1. Location of the PLET model in the GRTS program.

(2) Registered users of GRTS, as well as non-GRTS "guest" users, can access PLET via the [PLET Login Page link] (Figure 2-2), which is also linked from the main PLET webpage at https://epa.gov/nps/plet. Then, the user may enter either their email or their GRTS user account info. First-time users will be sent a link via email to confirm their identity and set up a password for access to PLET.

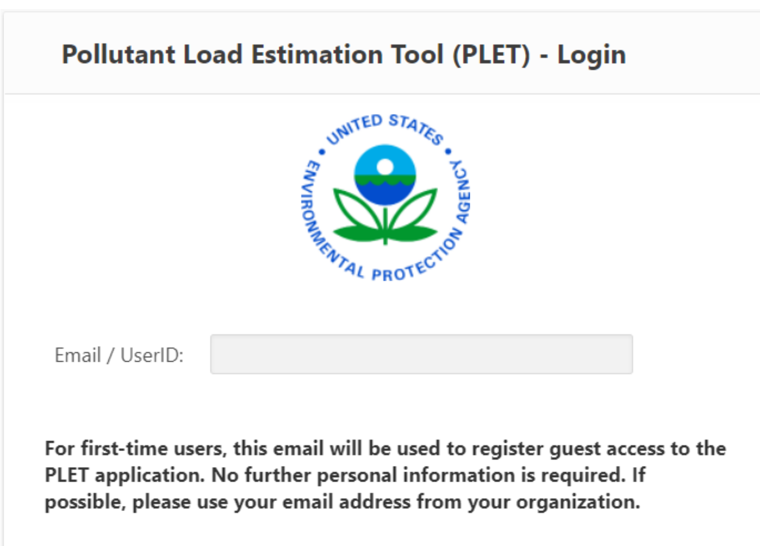


Figure 2-2. PLET access page.

3 Using the Model – Creating a Model

3.1 Overview of Input Modules and Data Entry

PLET is primarily composed of four modules—Inputs, BMPs, Total Loads, and Additional Reference Tables—all designed for user interaction. PLET also includes several other interactive data entry forms. Data entries in the modules and forms are in different colors.

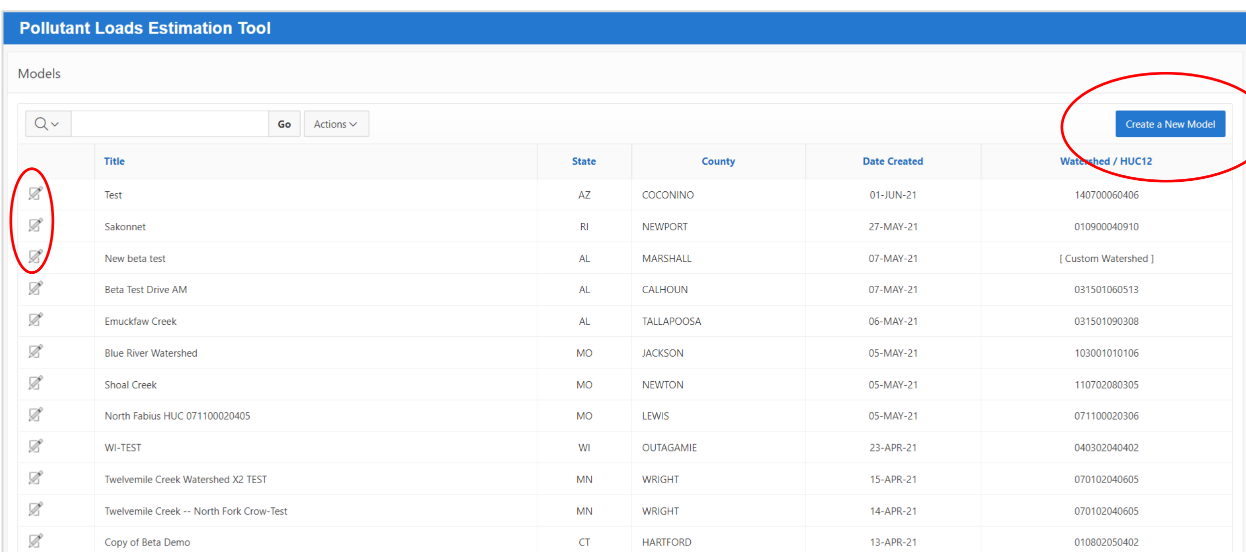
- Orange entries designate the values or controls that the user should specify (e.g., cropland area in acres).
- Black entries on the Inputs, BMPs and Additional Reference Tables modules provide useful information and assumptions to help users understand the spreadsheet tool. The user can adjust these if more accurate local data are available.
- Black entries on the Total Loads module are information calculated by the spreadsheet and cannot be changed.

Data fields can be edited by double-clicking within the cell to be edited. Once a cell is edited, the upper right corner will have a blue icon. Edits will only be marked during the current session of the tool. If the user exits and returns to the tool, edits from previous sessions will be saved but not marked.

All model changes are automatically saved. There is no save button in the tool.

3.2 Create a New Model

Upon logging into the PLET tool, the home page provides a list of models created by the user (or an empty list if no models have been created yet). To create a new model, the user clicks on the *Create a New Model* button in the upper right-hand corner. To access an existing model, the user clicks on the edit symbol to the left of the desired model in the table (as shown in Figure 3-1). Once a model is created, it is shown in the list, including the name of the model, the state, county and 12-digit hydrologic unit code (HUC12) of the model domain and the date the model was created.



Title	State	County	Date Created	Watershed / HUC12
Test	AZ	COCONINO	01-JUN-21	140700060406
Sakonnet	RI	NEWPORT	27-MAY-21	010900040910
New beta test	AL	MARSHALL	07-MAY-21	[Custom Watershed]
Beta Test Drive AM	AL	CALHOUN	07-MAY-21	031501060513
Emuckfaw Creek	AL	TALLAPOOSA	06-MAY-21	031501090308
Blue River Watershed	MO	JACKSON	05-MAY-21	103001010106
Shoal Creek	MO	NEWTON	05-MAY-21	110702080305
North Fabius HUC 071100020405	MO	LEWIS	05-MAY-21	071100020306
WI-TEST	WI	OUTAGAMIE	23-APR-21	040302040402
Twelvemile Creek Watershed X2 TEST	MN	WRIGHT	15-APR-21	070102040605
Twelvemile Creek -- North Fork Crow-Test	MN	WRIGHT	14-APR-21	070102040605
Copy of Beta Demo	CT	HARTFORD	13-APR-21	010802050402

Figure 3-1. PLET modeling home page.

3.3 Selecting the Modeled Area

After clicking on *Create a Model*, a model set-up screen will open, and the user will be prompted to name the model run and select the state in which the area to be modeled is located (Figure 3-2). Upon selecting the state, other data entry fields will automatically appear, including the Primary Watershed HUC drop-down list and the county drop-down list (Figure 3-3). Primary Watershed refers to the watershed selected on the "Create a New Model" page; it is used to determine the project county, which influences RUSLE2 factor values. Instructions will appear describing the options for creating a model for one or more HUC12s and for creating a model for a custom watershed. There are three ways to specify the area to be modeled:

1. Select a HUC12 watershed from a drop-down list.
2. Manually select a watershed from the mapper.
3. Select custom watershed from the drop-down list.

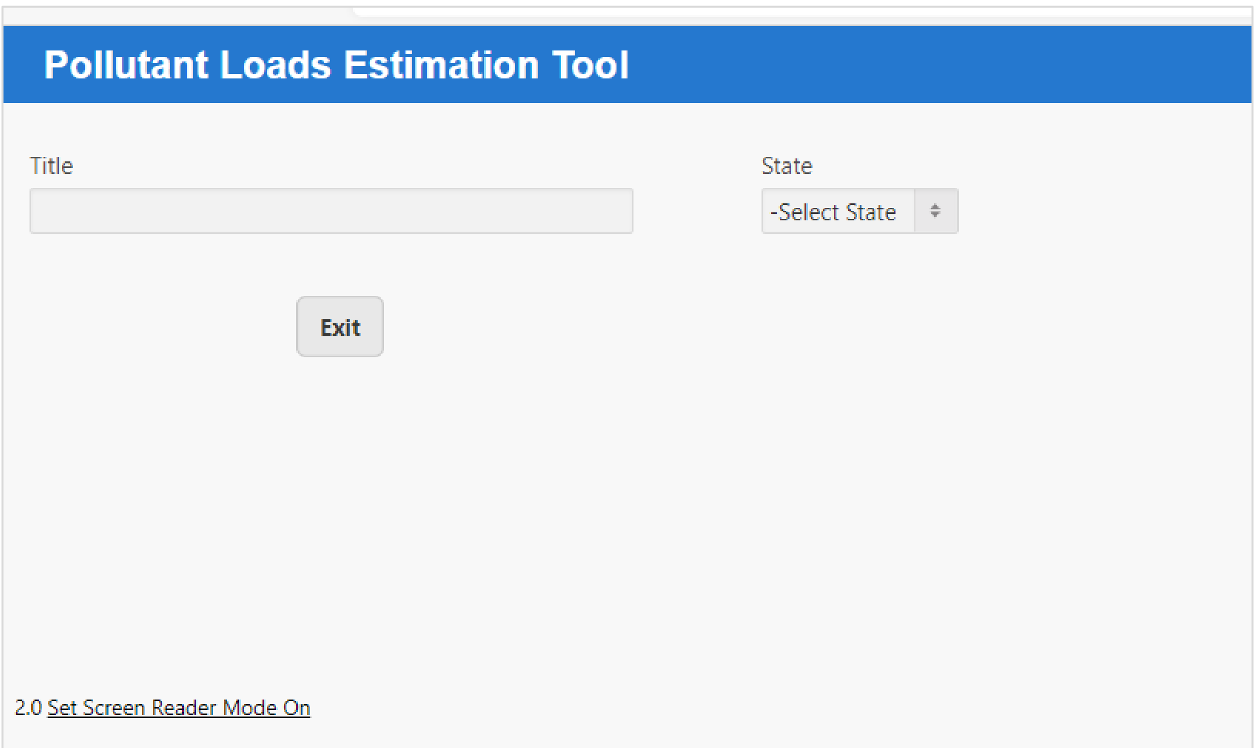


Figure 3-2. Initial set up page.

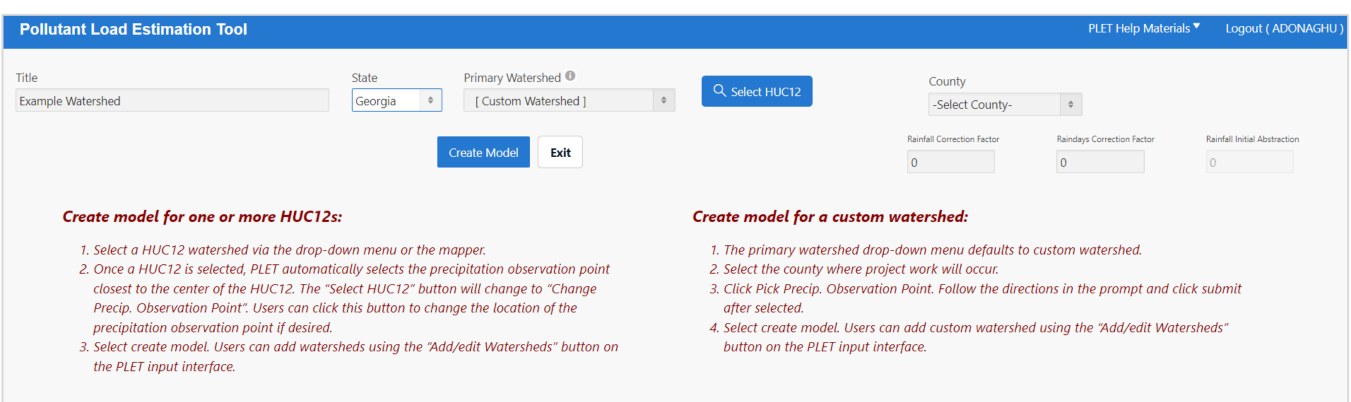


Figure 3-3. Initial set up page once the Title and State are selected.

3.3.1 Selecting a HUC12 watershed from a drop-down list

If the user is working at the HUC12 scale, knows the HUC12 number of the watershed of interest, and would like to start building the model with default watershed characteristics provided by the Input Data Server, the HUC12 can be selected directly from the Watershed drop-down list. Find the desired HUC12 in the drop-down list and then click on the *Select HUC12* button. The button will then change to read *Change Precip. Observation Point*. PLET will automatically select a precipitation observation point closest to the centroid of the selected HUC12. To use a different precipitation observation point, click on the *Change Precip Observation Point* button to open the mapper. The selected precipitation observation point is shown in green, with other points shown in yellow (Figure 3-4). Select the preferred precipitation observation point from those on the mapper and then click *Select* at the top left of the mapper to return to the model creation page. This will populate the rainfall and raindays correction factors. Click on *Create Model* once the desired HUC12 and precipitation observation point have been selected. The watershed data in tables 1–5 (land use, animal counts, etc.) will be pre-populated for the selected watershed. The values provided should be used as a starting point and replaced with local data when available.

3.3.2 Manually selecting a watershed from the mapper

If the area to be modeled is known, but the specific HUC12 is unknown, the user may generate location-specific data by clicking on the *Select HUC12* button, which opens the mapper. Zoom to the area of interest on the mapper and click within the area. The associated HUC12 will be selected; click *Submit* to select the HUC12. The mapper will close, and the precipitation observation point closest to the centroid of the selected HUC12 will populate the precipitation fields (rainfall correction factor, raindays correction factor, and rainfall initial abstraction). To change the selected precipitation observation point, click on the *Change Precip. Observation Point* button, which will reopen the mapper. While on the mapper, different precipitation observation points can be clicked to identify the specific precipitation data for each point (Figure 3-4). Once the preferred precipitation observation point is selected, Click on *Submit* to return to the model creation page. This will update the rainfall and raindays correction factors. Click on *Create Model* once the desired HUC12 and precipitation observation point have been selected. The watershed data in tables 1–5 (land use, animal counts, etc.) will be pre-populated for the selected watershed. The values provided should be used as a starting point and replaced with local data when available.

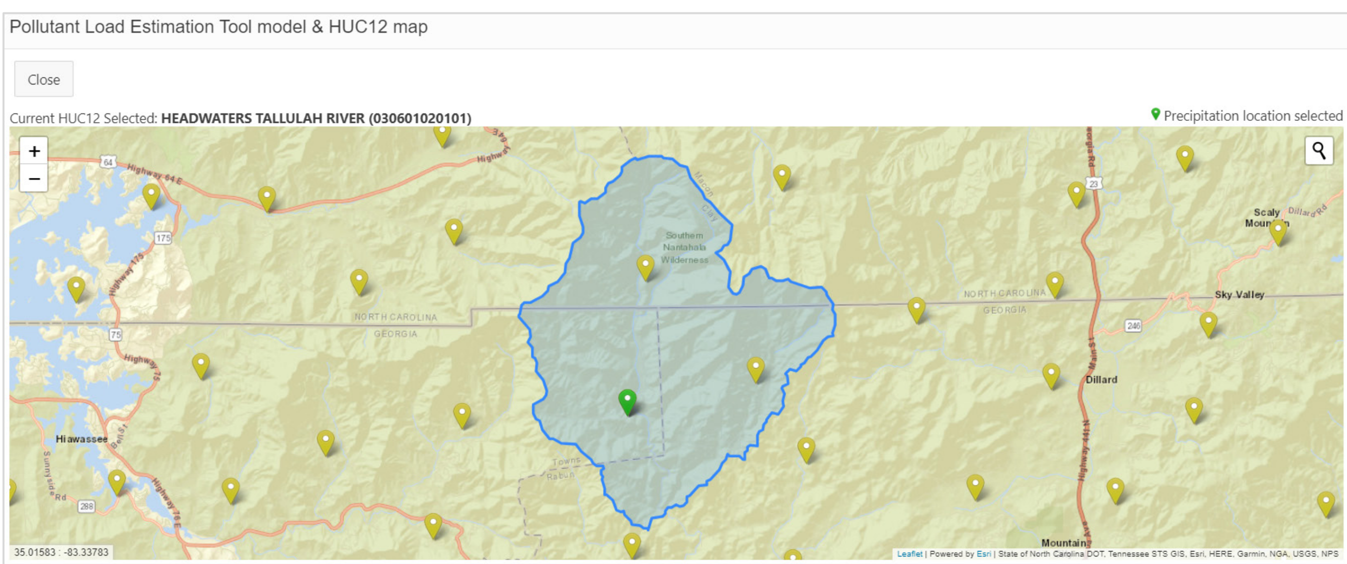


Figure 3-4. Mapper view watershed selection with an example watershed selected, along with the selected (green) precipitation observation point and other optional precipitation observation points (yellow).

3.3.3 Selecting a custom watershed

If the area to be modeled is not a HUC12 watershed, “Custom Watershed” can be selected from the Watershed drop-down list after selecting the state. The Custom Watershed allows the user to fill in all information about the watershed manually. Select the county that contains the area of interest via the drop-down list. The *Select HUC12* button will change to a *Pick Precip. Observation Point* button. Click the button to open the mapper and click on the mapper at a point within the area of interest. The nearest precipitation observation point will appear in green. Clicking on different points on the mapper will result in different precipitation observation points being selected. Watershed boundaries are not displayed when selecting a custom watershed, as this option may be more relevant when using PLET for field-scale models. Select the relevant precipitation observation point and click on *Submit* to return to the model creation page. To change the precipitation observation point, click on the *Change Precip. Observation Point* and repeat the process of selecting a precipitation observation point. Click on *Create Model* once the desired precipitation observation point has been selected. This will populate the rainfall and raindays correction factors, the hydrologic soil group (HSG) in Table 1, and the RUSLE2 values in Table 5 based on the location information specified by the user. All other user-specified data fields in tables 1–3 will remain set to 0. The user should evaluate the pre-populated values and update them if more specific local data are available. The user must also populate tables 1–3 with land use acreages, agricultural animal counts, and information about septics and illegal wastewater discharges.

3.4 Using the Navigation Dashboard

Once the model is set up, the action buttons and summary information at the top of the model page remain visible in any of the submodules in the model. Moving across from left to right and top to bottom, these buttons include (Figure 3-5):

- *Share Model* – allows the user to share the current version of the model with another user. When clicked, it opens a pop-up window with an input field to enter the email address or username of the intended recipient of the model. Enter an email address or username and click Submit. To leave this pop-up without sharing the model, click cancel.
- *Copy Model* – creates a new version of the existing model. When clicked, the user will be brought into a new copy of the model that is named “Copy of…” as part of the model’s title. Changes to this version will not impact the settings and inputs to the original version.
- *Delete Model* – deletes the version of the model. Once deleted, the model cannot be recovered. Prior to deleting, a pop-up will ask the user to confirm the model should be deleted. To delete, click ok. To keep the model, click cancel.
- *Download Input Data Server Data* – provides a screen with the Input Server Data for the selected watershed(s) that have been added to the model. These data are specific to the initial data provided by the Input Data Server; these data do not include any edits that may have been made since populating the model initially.
- *Exit* – brings the user back to the home page with the list of existing models.
- *Rainfall Correction Factor* – is automatically populated based on the selected precipitation observation point. Provides the percentage of rainfall events that exceed 5 millimeters (mm) per event.
- *Raindays Correction Factor* – is automatically populated based on the selected precipitation observation point. Provides the percentage of rain days (events) that generate runoff.
- *Rainfall Initial Abstraction* – determines initial rainfall retention on the land surface, ranges from 0 to 0.2. Default is set to zero.

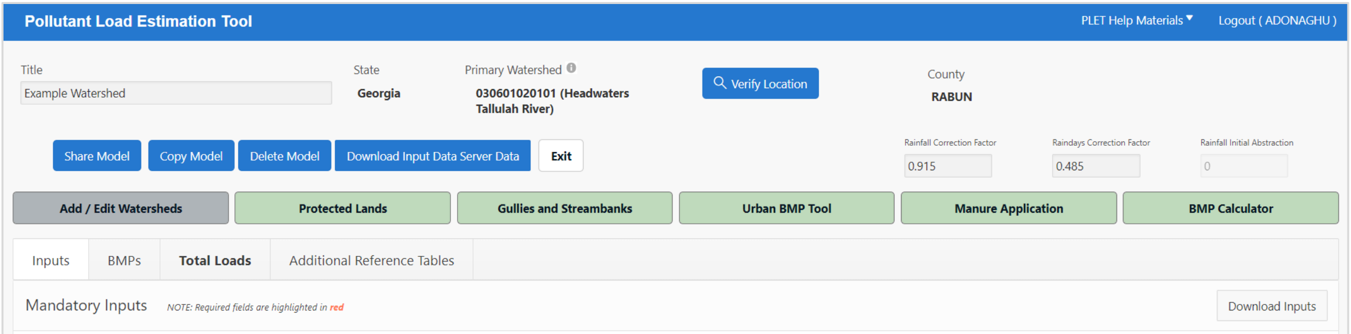


Figure 3-5. PLET Model Navigation Dashboard.

The *Add/Edit Watersheds* button brings up a pop-up that will display a Watershed row that is populated with the watershed name and acreages from the initial watershed that was added (Figure 3-6). This is known as the Primary Watershed. To add additional watersheds, select the HUC12(s) from the drop-down list and click the *Add* button to add each new one (Figure 3-7). Note that the precipitation observation point for watersheds other than the Primary Watershed will automatically have the point closest to the HUC12 centroid selected. This cannot be changed. Once the watersheds have been added, click the *Save/Close* button to return to the Inputs module. If Custom Watershed is selected from the drop-down watershed list, the user will need to populate the land use acreages as well as the precipitation fields.

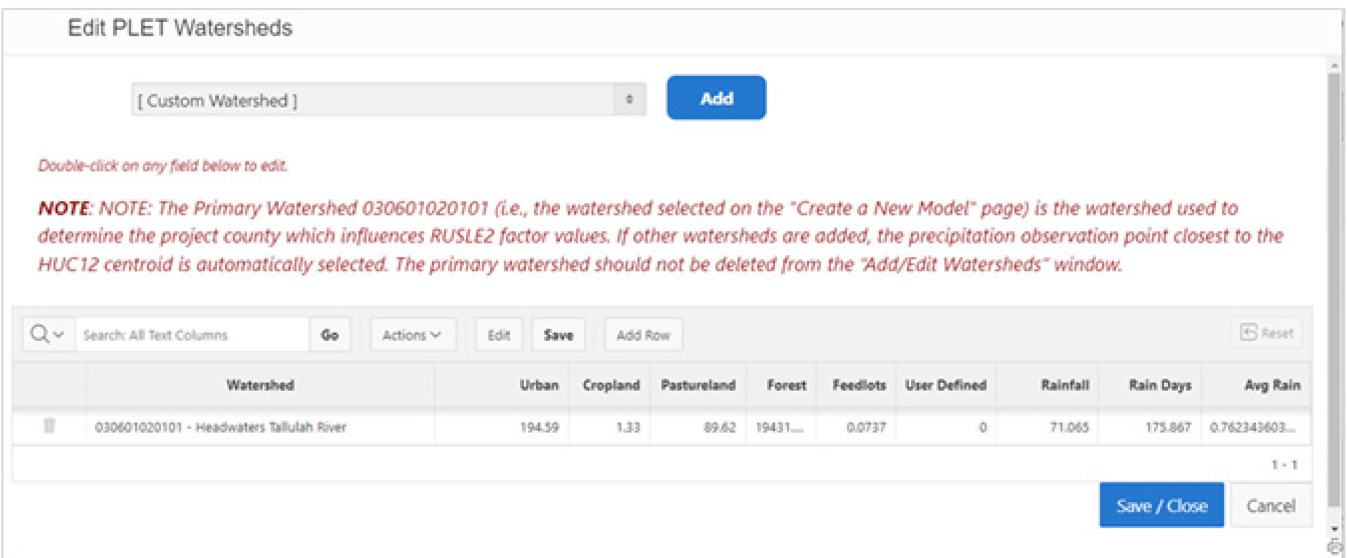


Figure 3-6. View of the Add Watershed pop-up used to input additional watersheds and their land use acreages.

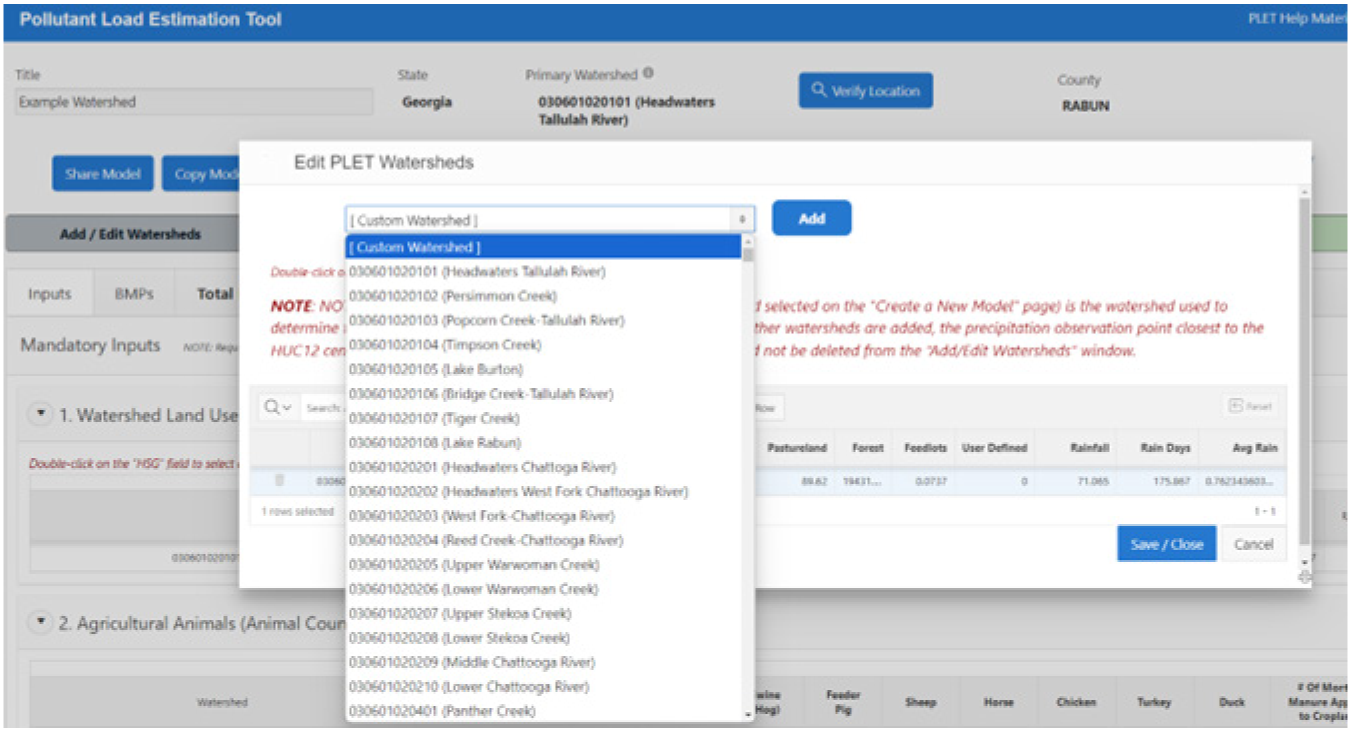


Figure 3-7. Drop-down list in the Add Watershed pop-up used to create additional rows for more watersheds.

To delete a watershed, click the trash can icon next to the watershed to be deleted; another pop-up will ask the user to confirm deletion of the watershed from the model (Figure 3-8). Click *OK* to delete the watershed and click *Cancel* to return to the list of watersheds. If Cancel is selected, to exit the Delete pop-up, hit the "Esc" key on the keyboard.

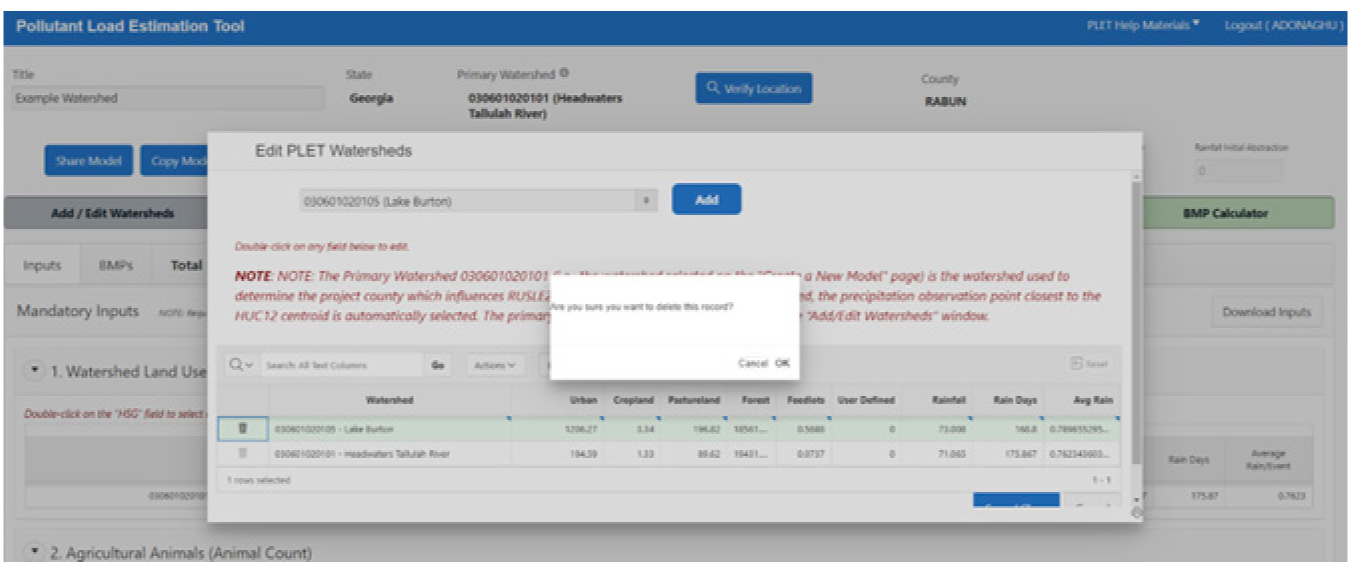


Figure 3-8. Delete watershed pop-up window, shown with delete confirmation message.

The previously described Navigation Dashboard buttons are used to set up the modeled watersheds. The remaining Navigation Dashboard buttons, which are green, are used to provide inputs to the model (Figure 3-5). These input buttons, briefly described below, are discussed in more detail in the appropriate section of this User's Guide:

- *Protected Lands* opens a pop-up window with a form for adding acres of protected lands and avoided future land uses to the model.
- *Gullies and Streambanks* opens a pop-up window with a form for adding gullies and streambanks to the model.
- *Urban BMP Tool* opens a pop-up to the Urban BMP and LID input form. BMPs applied to urban land uses are added using this form.
- *Manure Application* opens the manure application calculator, which allows the user to calculate a land-use-wide average manure application period for both pasture and cropland.
- *BMP Calculator* opens the BMP Calculator tool, which provides a workspace to configure multiple BMPs on a given land use to determine that combined efficiency value.

4 Using the Model – Input Data Server and Inputs Module

4.1 Input Data Server

For users interested in gathering initial input data for a watershed of interest, the Input Data Server is available. The Input Data Server provides initial model input data that can be used as a starting point in populating the PLET model. It provides HUC12-level land use acreages, agricultural animals, septic system information, and HSG information. These data can be downloaded for use in other applications, or the data can be applied automatically to a PLET model as it is developed. **Note:** for users downloading data for HUC12 watersheds that cross county lines, the data provided is at the HUC12 scale and is not subdivided by county; therefore, requesting the data for more than one county produces duplicate data. The Input Data Server can be accessed from outside of the model at https://ofmpub.epa.gov/apex/grts/f?p=109:333.

The Input Data Server allows the user to select the state and county of interest; then, it generates a list of 8-digit HUC (HUC8) watersheds. Once a HUC8 is selected, the list of HUC12 watersheds within the selected HUC8 watershed appears. From here, one or more HUC12 watersheds can be selected (Figure 4-1). To select more than one watershed, hold down the Shift button while clicking on the desired HUC12 watersheds. After selecting watersheds, click on *Generate* and the Input Data Server will provide data tables that can be downloaded individually by data type or all together in one Excel spreadsheet (Figure 4-2).

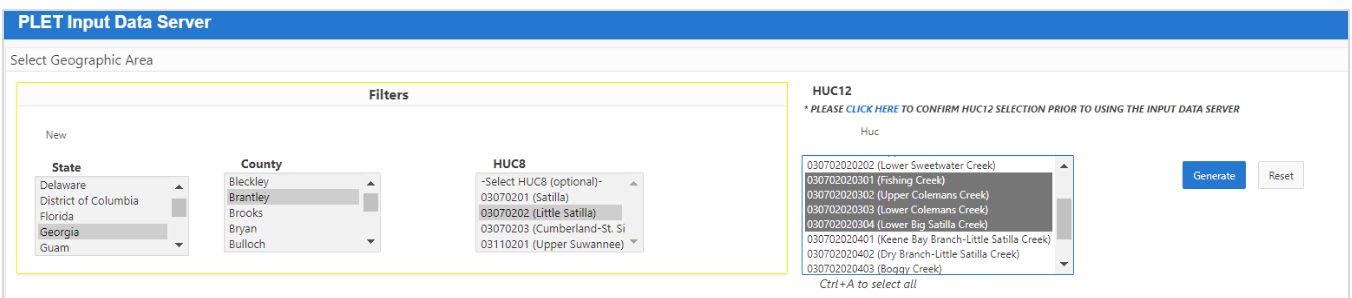


Figure 4-1. Input Data Server watershed selection fields.

Landuse Area Download

Watershed Name	HUC12	Urban	Forest	Pastureland	Cropland	Feedlots	Water	Other Landuse
Upper Colemans Creek	030702020302	1623.7	21998.38	1356.6	3763.14	4.8669	16.9	6.89
Lower Big Satilla Creek	030702020304	908.26	16555.04	1717.77	9595.88	2.8867	55.6	28.47
Fishing Creek	030702020301	1452.01	17903.64	2447.46	8229.49	2.607	105.86	1.78
Lower Colemans Creek	030702020303	1174.02	9491.14	1440	9077.92	4.2489	91.63	36.7

Agricultural Animals Count Download

Watershed Name	HUC12	Beef Cattle	Dairy Cattle	Swine	Sheep	Horse	Turkey	Chicken	Duck
Upper Colemans Creek	030702020302	337	161	3	0	15	0	196417	0
Lower Big Satilla Creek	030702020304	230	90	3	5	21	0	115366	0
Fishing Creek	030702020301	233	86	3	8	27	0	102971	0
Lower Colemans Creek	030702020303	300	131	2	1	18	0	171495	0

Septic Systems Download

Watershed Name	HUC12	Septic Systems	Population per Septic System	% Septic Failure Rate
Upper Colemans Creek	030702020302	292	2	0.57
Lower Big Satilla Creek	030702020304	208	2	0.57
Fishing Creek	030702020301	345	3	0.57
Lower Colemans Creek	030702020303	318	2	0.57

Hydrological Soil Group Download

Figure 4-2. Example partial outputs from the Input Data Server.

4.2 Inputs Module

The Input module has 10 tables (shown on the following pages in Figure 4-3 and Figure 4-4), with a combination of optional and required data inputs. Although some tables do not require data to run the model, it is up to the user to decide whether these optional data tables should be excluded depending on the purpose of the model run and the characteristics of the watershed. The tables include:

1. Watershed Land Use Area and Precipitation
2. Agricultural Animals (Animal Count)
3. Septic and Illegal Wastewater Discharge
4. Percent Nutrient in Soil
5. Revised Universal Soil Loss Equation Version 2 Factor Values
6. Reference Runoff Curve Number
    a. Detailed Urban Reference Runoff Curve Number
7. Nutrient Concentration in Runoff
    a. Nutrient Concentration in Shallow Groundwater
8. Urban Land Use Distribution
9. Input Irrigation Area and Irrigation Amount (optional)
10. Wildlife Density in Cropland (optional)

For most HUC12 watersheds, if they were selected from the drop-down list during model setup, tables 1–8 will be automatically populated with initial model input data specific to the watershed and/or county derived from the Input Data Server and pre-set default values. It is the user's responsibility to verify and refine the initial data, and EPA highly encourages users to replace initial values with more locally specific and relevant data whenever it is available.

To manually enter data:

1. Enter the land use areas in acres, the dominant hydrologic soil group (HSG[1]), and the percent imperviousness of feedlots in Table 1.
2. Enter the total number of agricultural animals by type and number of months per year that manure is applied to croplands in Table 2; refer to the Manure Calculator section below for more information on calculating the average number of months of manure application for the watershed.
3. Enter the values for septic system parameters, population counts that discharge wastewater directly, and reduction percentages on direct wastewater discharge in Table 3.
4. Optionally modify the percent nutrient concentrations and RUSLE2 parameters associated with the selected county in Table 4 and Table 5, respectively.

The user may stop here and proceed to the BMP module unless there is more detailed information on the watersheds that can be updated in the remaining input tables. The remaining input tables are already populated with default values or are set to zero (0) and should be updated with local data, if available.

The reference curve number default values in tables 6 and 6a are derived using the land use and soil group inputs from Table 1. If watershed-specific pollutant concentrations in runoff or groundwater are known, these can be updated in tables 7 and 7a. In Table 8, the model will also automatically subdivide the urban land use acreage into preset proportions of urban land uses, such as residential, industrial and institutional. However, these distributions can be adjusted to better reflect the actual urban land use distribution in the project area. The land use proportions in Table 8 must add up to 100. If they are edited and do not add up to 100, a warning will appear below the table (“ERROR – Total % must equal 100”).

If the user wishes to represent irrigation or changes to irrigation, this information should be included in Table 9. The total cropland acres are automatically populated from Table 1. If there are significant wildlife populations on cropland that should be represented, these can be included in Table 10.

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[1] HSG A: Low runoff potential and high infiltration rates even when thoroughly wetted. Chiefly deep, well to excessively drained sands or gravels. High rate of water transmission (< 75 centimeters per hour [cm/hr]).

HSG B: Moderate infiltration rates when thoroughly wetted. Chiefly moderately deep to deep, moderately well to well-drained soils with moderately fine to moderately coarse textures. Moderate rate of water transmission (0.4 to 0.75 cm/hr).

HSG C: Low infiltration rates when thoroughly wetted. Chiefly soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. Low rate of water transmission (0.15 to 0.40 cm/hr).

HSG D: High runoff potential. Very low infiltration rates when thoroughly wetted. Chiefly clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay pan or clay layer at or near the surface, or shallow soils over nearly impervious material. Very low rate of water transmission (0 to 0.15 cm/hr).

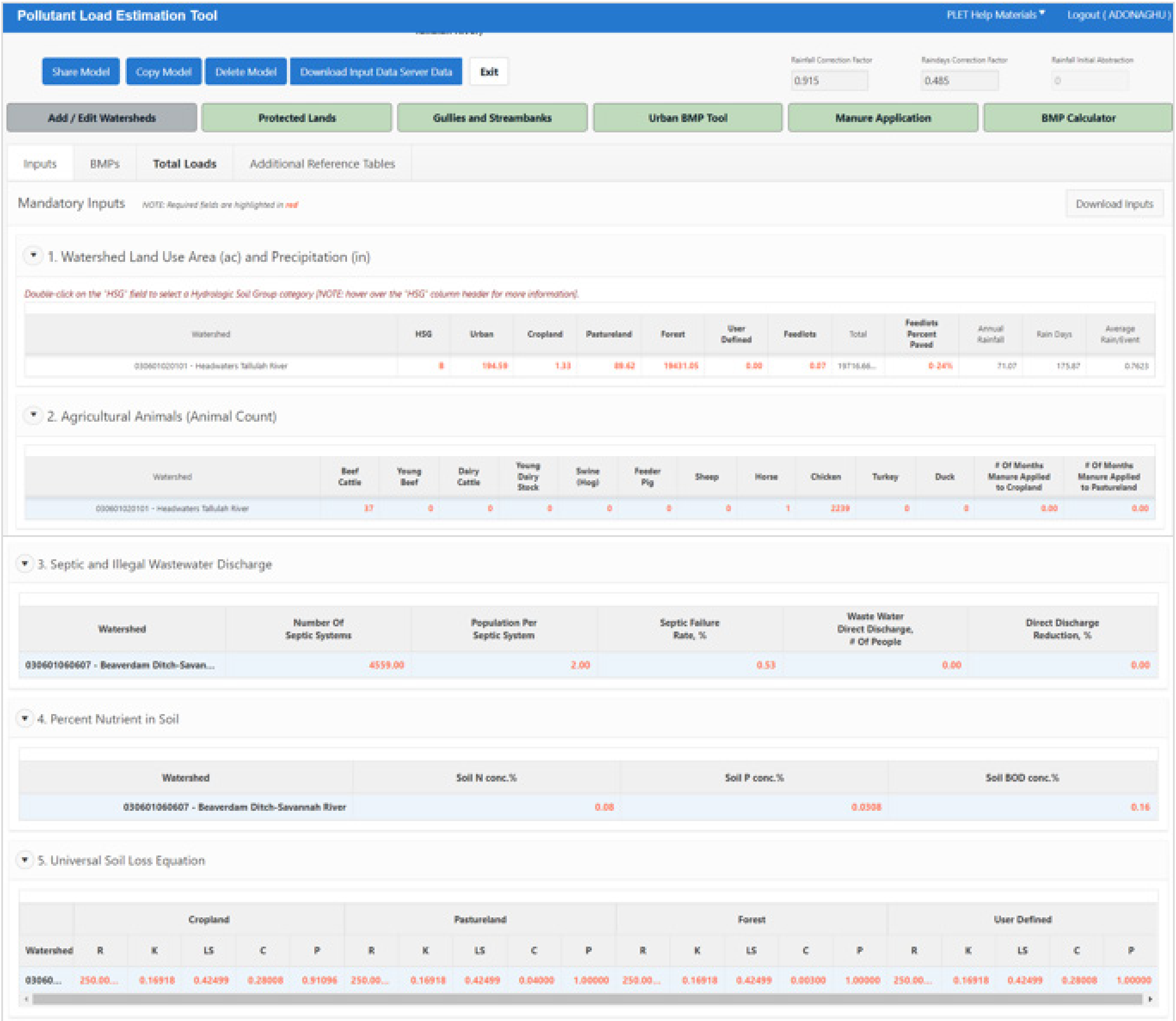

Figure 4-3. View of the Input Module tables 1–5.

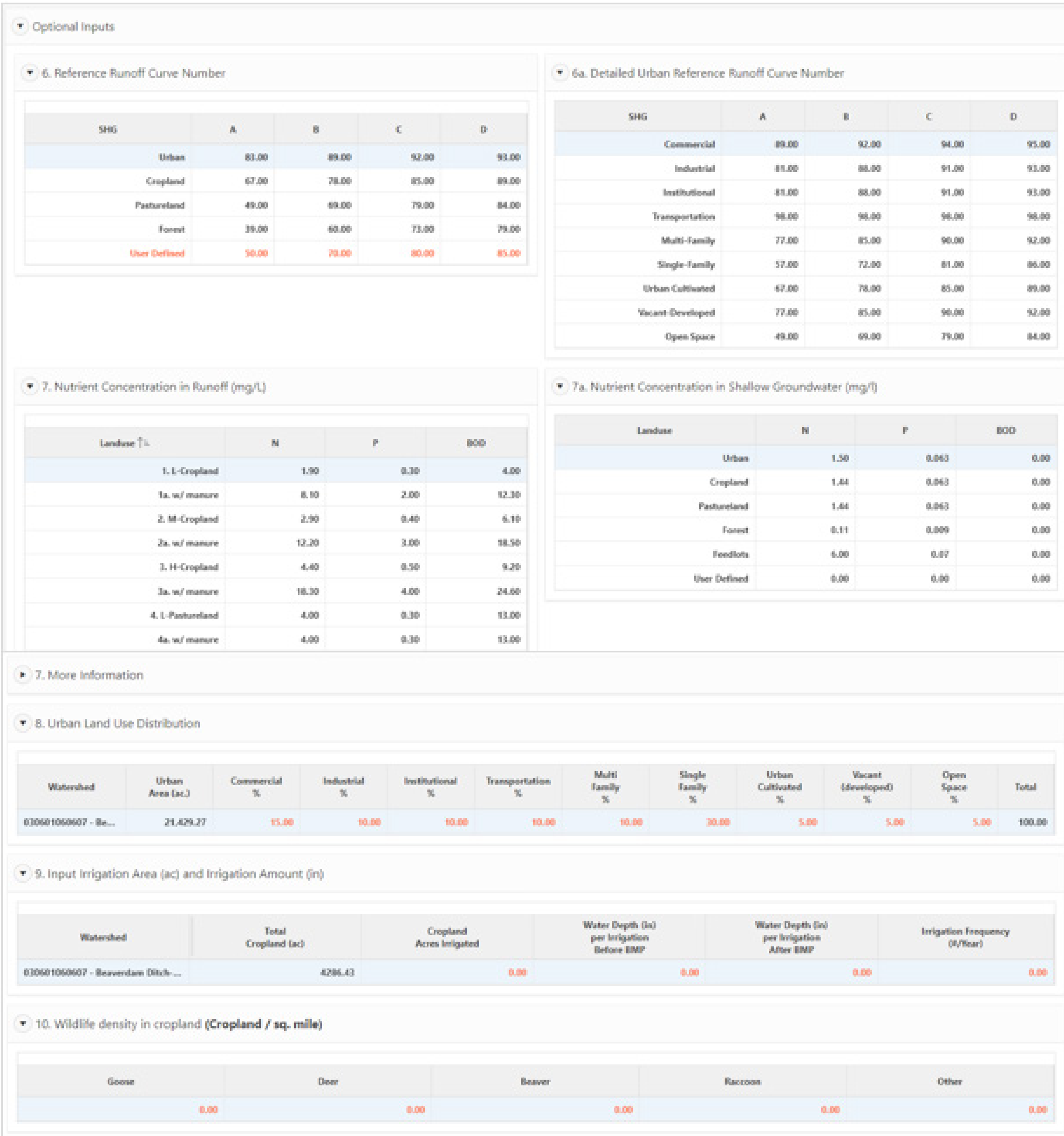

Figure 4-4. View of the Inputs Module tables 6–10.

4.2.1 User-Defined Land Use

The tool can accommodate one user-defined land use, which is added in Table 1. When creating a user-defined land use, the user should update the RUSLE2 values (Table 5), runoff curve number (Table 6), and nutrient concentration in runoff (Table 7) to represent the land use. As a default, the user-defined land use nutrient concentrations in runoff are set to zero. As a result, no pollutant loading is generated from this land use until the user adds the concentrations.

4.2.1.1 Replacing initial and default values with local data

EPA strongly encourages the use of local data, when available, to replace default values as well as the initial inputs that are provided in the Input Data Server. In cases where no other information is available, these values are useful but can be improved upon with more specific information at the local level. After considering the other available data and the purposes for running the model, the user must decide whether the default values and initial input data are adequate to represent the watershed being modeled.

4.2.2 Updating RUSLE2 Values

The model calculates annual erosion using RUSLE2. The RUSLE2 is a model containing both empirical and process-based science that estimates long-term, average-annual rates of rill and inter-rill (sheet) soil erosion caused by rainfall and runoff. The default RUSLE2 parameter values (R, the rainfall erosivity index; K, the soil erodibility factor; LS, the topographic factor; C, the cropping factor; and P, the conservation practice factor) for different types of rural land uses are included within PLET based on the county of the Primary Watershed. The RUSLE2 parameters provided in the model are based on the 2015 and 2017 National Resources Inventory (NRI) database, except in cases where county-specific data were not available for these years. In these cases, PLET's original Universal Soil Loss Equation values based on the 1992 NRI database are used. Additional details on the derivation of RUSLE2 values can be found in the PLET support document, *Revised Universal Soil Loss Equation Version 2 (RUSLE2) Factor Updates* (2024), under the PLET help materials menu. The user can also obtain more recent soil erosion parameter values from their local Natural Resources Conservation Service office or calculate them using NRCS's most recent RUSLE2 tool (https://www.ars.usda.gov/southeast-area/oxford-ms/national-sedimentation-laboratory/watershed-physical-processes-research/research/rusle2/revised-universal-soil-loss-equation-2-overview-of-rusle2/). The RUSLE2 program requires the user to enter site-specific values or describe site-specific information using different entries from the RUSLE2 database. This information is used as the inputs to determine erosion.

4.2.3 Using PLET for other pollutants

If the user has adequate information on pollutant soil concentrations, concentrations in runoff and BMP reduction efficiencies, PLET may be used to calculate the loads of pollutants other than nitrogen, phosphorus and BOD by replacing the pollutant data for nitrogen, phosphorus or BOD with data for another pollutant. **However, the user should ensure that mg/L is the appropriate unit of expression for the pollutant in question** and should consider the appropriateness of a runoff model when opting to use it for other pollutants. If the pollutant is not expressed in mg/L, the calculations will be incorrect. PLET cannot account for impacts on pollutants related to pH or growth and decay functions. It is the user's responsibility to ensure the model is being used appropriately for the pollutant of interest.

4.2.4 Manure Application

The Manure Calculator supports data entry in Table 2. It calculates the average number of months for manure application per year with varying application frequencies across the watershed. It can be applied separately for cropland and pastureland. All acres of the land use need to be included, even those that do not receive manure, to accurately calculate the average number of months of manure application across the land use. Acres that do not receive manure should be entered with the number of months set to zero.

After clicking the *Manure Application* button, a pop-up Manure Calculator form will appear (Figure 4-5). Enter the total land use acres in the watershed, then enter each set of acres with the number of months during which manure is applied. Double-click to activate the field for data entry. Click *Add Row* to create additional rows for data entry. Once all acres are accounted for, click *Calculate.* Below the table, the average number of months will appear, along with a land use acreage validation. If the total land use acres do not match the total acres in the table, a warning will appear: "Check to ensure total treatment area matches the total land use area." Edit the acreages and click Calculate again. The Total Landuse Area Check should now read "OK." Select the watershed and land use where the months of manure will be included from the respective drop-down lists and click *Apply* *to Selected Watershed*. A notice will confirm that the data were applied successfully. Click “Esc” on the keyboard to return to the Input module.

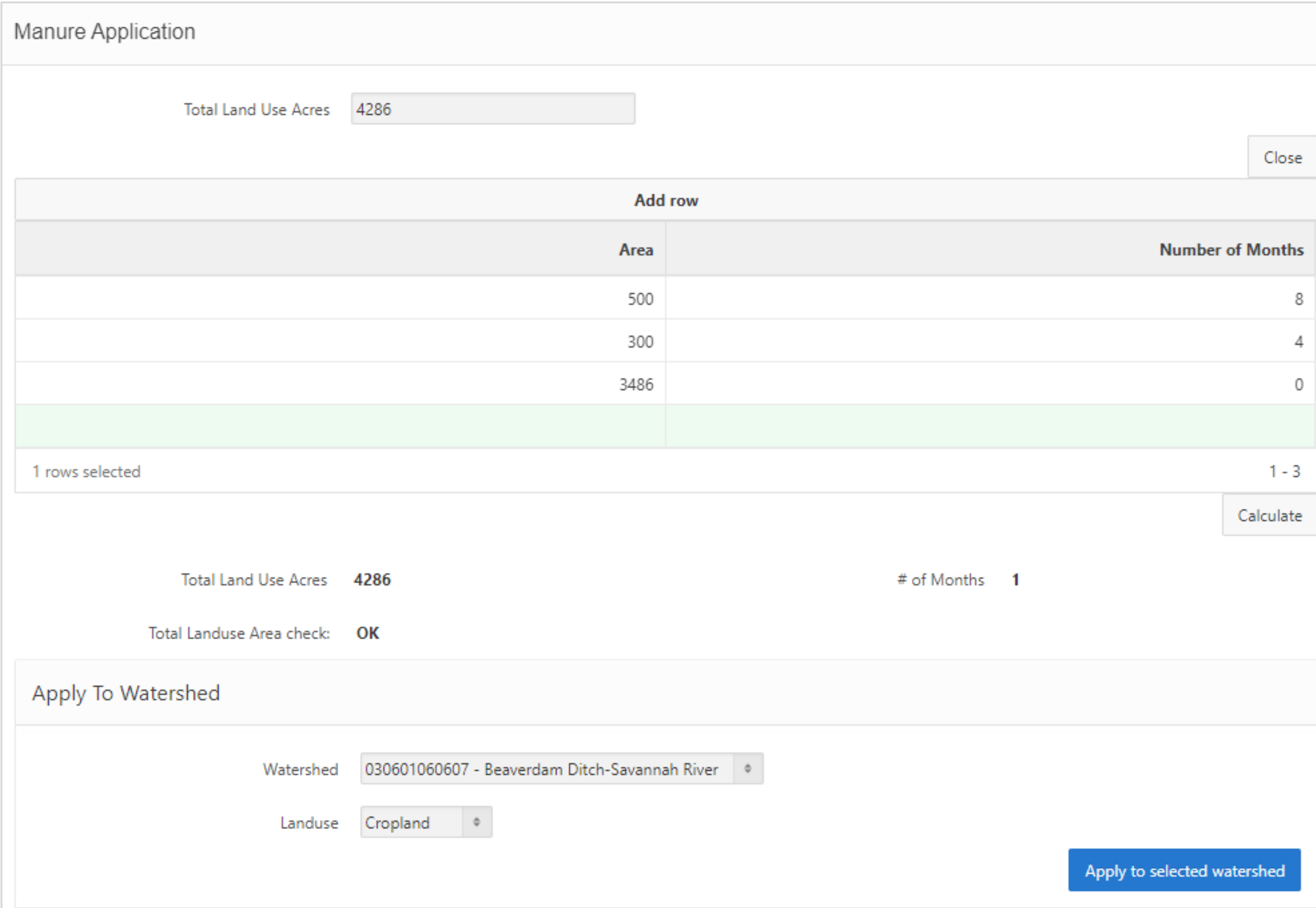

Figure 4-5. View of the Manure Calculator.

4.2.5 Gullies and Streambanks

The *Gullies and Streambanks* button takes the user to the Gullies and Streambanks Form (Figure 4-6), where the dimensions of the user-specified gully formations and impaired streambanks can be defined. This form contains two tables: the first table will show the gully formations, and the second table will show the impaired streambanks. To add new a gully or streambank to the form, select *gully* or *streambank* and click *Submit* to generate a blank form. For each new gully or streambank, the required information can be defined in following steps:

Gully:

1. Select the watershed to apply the gully.
2. Name the gully.
3. Specify the gully dimensions (length, top width, bottom width, and depth).
4. Specify the time (number of years) the gully has taken to form the current size.
5. Specify the gully stabilization (BMP) efficiency (0–1) and the gully soil textural class.

Streambank:

1. Select the watershed to apply the streambank.
2. Name the streambank.
3. Specify the streambank dimensions (length, height).
4. Specify the eroding streambank's lateral recession rate (foot/year).
5. Specify the streambank stabilization (BMP) efficiency (0–1) and the streambank soil textural class.

The form calculates the initial loading from gullies and streambanks and the reductions from stabilization and restoration BMPs. Gully loads are based on annual erosion rates, which are determined by the volume of the gully and the soil weight times the soil nutrient concentration. Stream calculations are similar, except they also include a lateral recession rate. The streambank form requires separate entries for each side of a streambank, while the gully form represents the entire gully in one entry.

Once the soil textural class is selected, the soil dry weight (density) and nutrient correction factor will automatically populate. For streambanks, a lateral recession factor is also required. The user can select from categories ranging from slight to severe, corresponding to estimated lateral recession rates, which will populate automatically. For more information about the soil texture classes and associated density and nutrient correction factors and the lateral recession rates, click on the *More Info* drop-down on the right-hand side of the Gullies and Streambanks Form. If local or project-specific data are available for the soil density, nutrient correction factor, or lateral recession rate, the user can edit these data user to better reflect local conditions.

The annual load and load reduction will automatically be calculated based on the inputs provided. If the model represents a gully or streambank under current unimproved conditions (i.e., without a restoration BMP), the BMP efficiency field should be set to zero (0), and the load reduction will be calculated as 0. If the model represents a restoration BMP, the BMP efficiency value should be set to a non-zero value, where 1 equals 100% removal of the gully or streambank load.

Click *Submit* for the gully or streambank entry to appear in the Report rows on the Gullies and Streambanks Form. A pop-up in the upper-right corner will confirm that the gully or streambank has been submitted. To delete a previously entered gully or streambank, click on the trash can icon on the left side of the row to be deleted, and a pop-up window will ask for confirmation before deleting the row (Figure 4-7). To add another gully or streambank, select the gully or streambank radio button and enter another gully or streambank. When all entries are complete, click the *Close* button to exit the Gullies and Streambanks Form and return to the main model view.

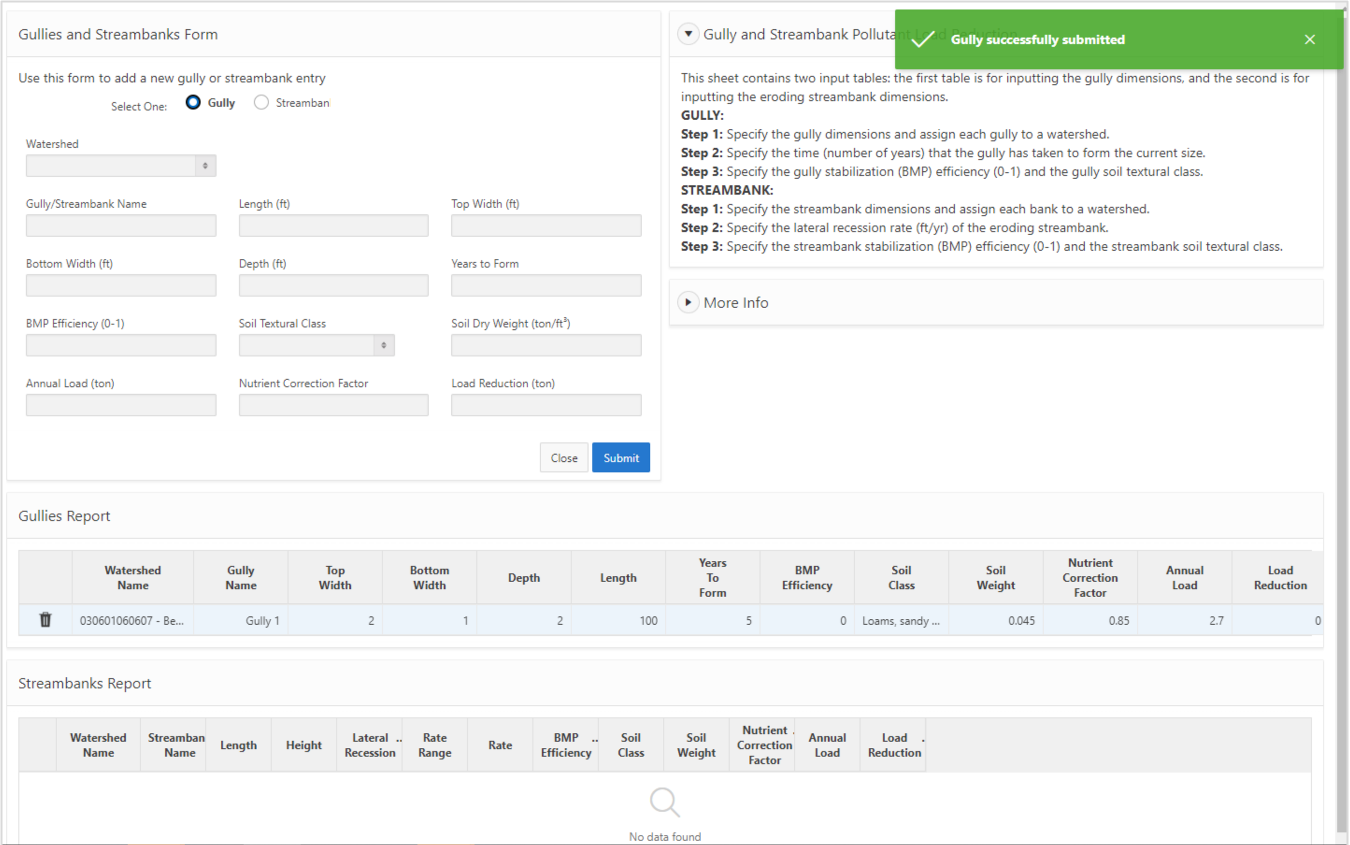

Figure 4-6. View of the Gullies and Streambanks Form.

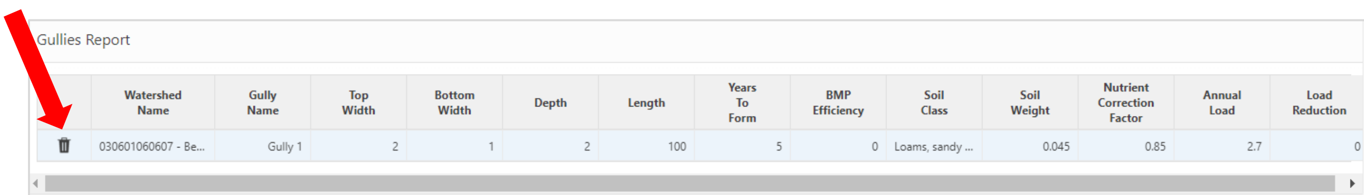

Figure 4-7. View of the trash can icon to delete a row.

4.2.6 Protected Lands Tool

The Protected Lands Tool allows users to document acres of land protected from a land use change through acquisition, easements or other protection measures. The tool estimates the annual pollutant loads and runoff volume prevented by maintaining an existing land use (forest). For example, when protecting forest areas from future development to urban land use, prevented annual loads equal the annual load generated from the parcel of the urban land use minus the annual load generated from the forest parcel. Similarly, prevented annual runoff equals the runoff generated from the urban parcel minus the runoff generated from the forest parcel. Refer to Appendix C for more details on the calculations.

The *Protected Lands* button takes the user to the Protected Lands Form (Figure 4-8). In the form, select the watershed where the land protection will occur using the drop-down menu, and click on the *Add row* button. Double-click on the avoided future land use drop down menu and select the avoided future land use (Figure 4-9); then, click in the Protect Acres field to enter the number of acres that will be protected from a land use change. Click *Apply to Watershed* to apply the changes, and a confirmation pop-up will appear (Figure 4-10). If additional avoided future land uses need to be added, click on the *Add row* button to create another row and repeat the process of adding avoided future land use and acres. The sum of protected acres cannot exceed the total acreage of existing forest acres displayed on the input tab. Click the *Close* button to return the user to the Inputs module.

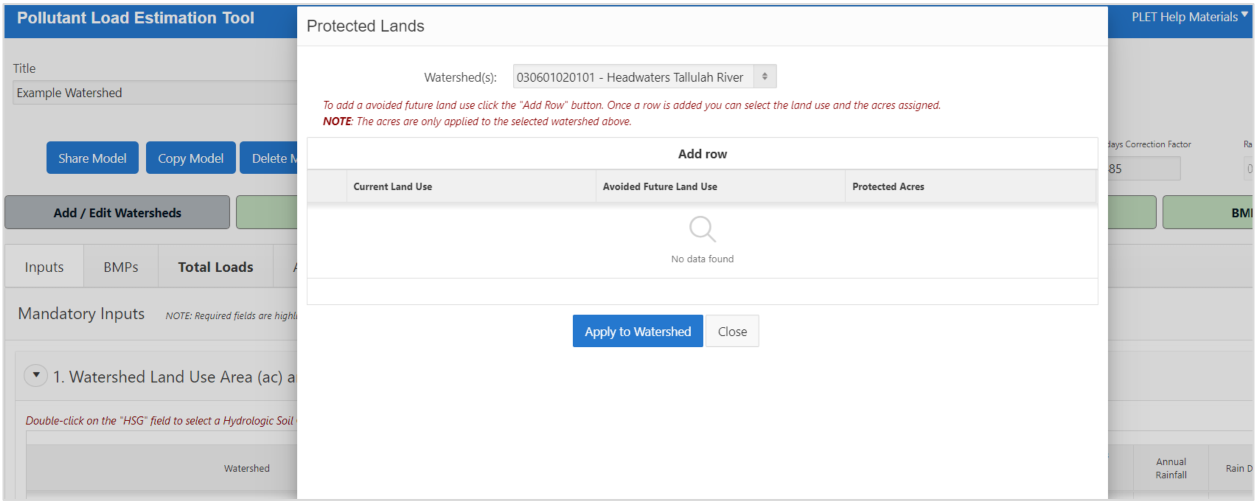

Figure 4-8. View of the Protected Lands form.

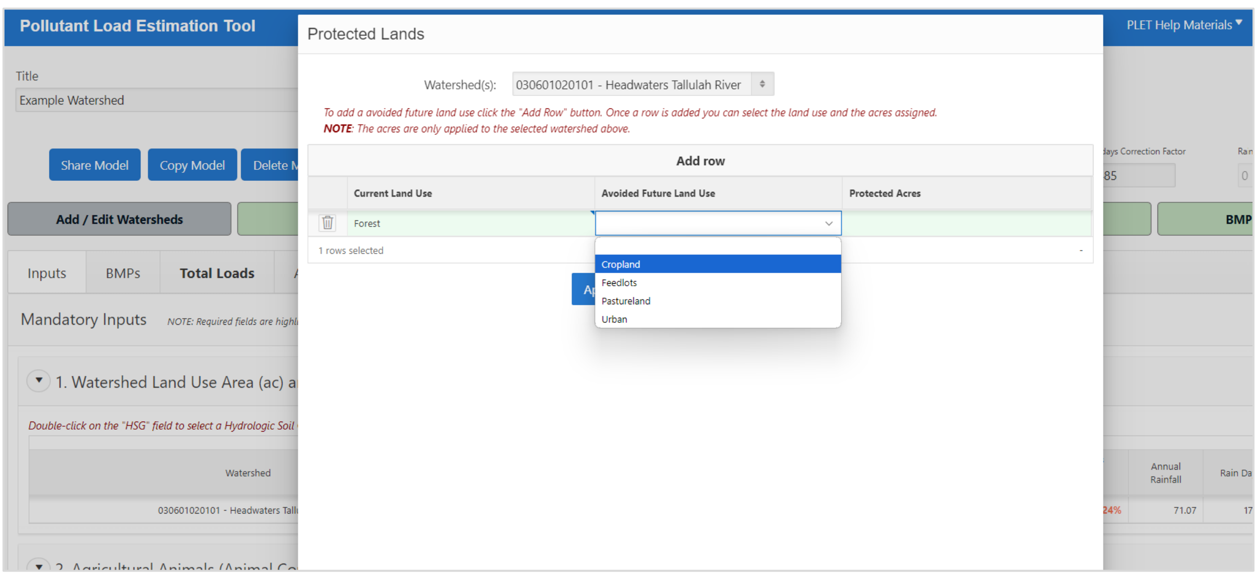

Figure 4-9. View of the avoided future land use drop-down menu.

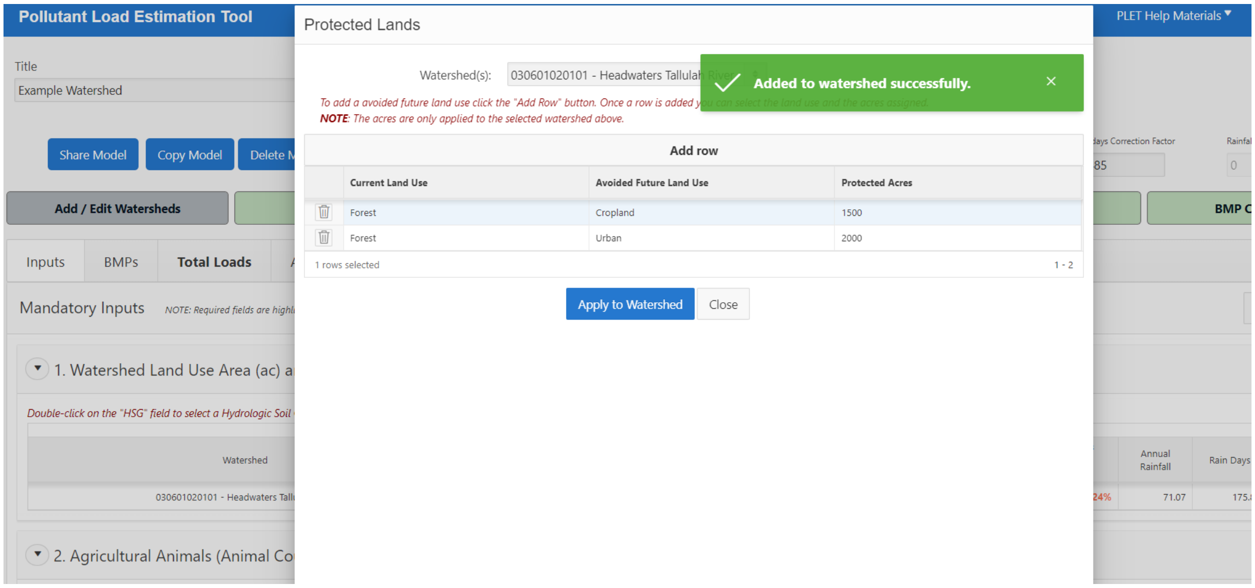

Figure 4-10. View of the confirmation pop-up that the avoided future land use has been applied in the model.

5 Using the Model – BMPs Module

The BMPs module provides a single table where the BMPs can be entered for all watersheds and all non-urban land uses. The land uses included in the BMPs module are cropland, feedlots, pasture, forest and user-defined. To populate BMPs, users select the BMP and the percent area of the land use the BMP is applied. The effective efficiency will be calculated automatically.

The BMP worksheet is set up to accept one BMP per land use per watershed. If only BMP per land use is being applied in each watershed, this is the only table needed for adding non-urban BMPs. Alternatively, combined BMP efficiencies can be created to account for multiple BMPs on a single land use using the BMP Calculator, which is discussed later in this guide.

To add a BMP to the BMP table, click *Add BMP* on the right side of the table, a pop-up window will open, where the watershed and land use should be specified for the BMP that is being added (Figure 5-1). After clicking *Add BMP* in the pop-up window, a new line is created in the BMP table. From here, double-click on the BMPs cell to activate a drop-down list of BMPs that can be applied. Once a BMP is selected, the pollutant efficiencies will automatically populate in the table. For BMPs with no default efficiency value data, "ND" will be displayed in corresponding efficiency field in the table.

The next step is to add the percentage of the land use on which the BMP is applied to the "% Area BMP Applied" field. Adding a single BMP to a land use means that only one type of BMP is present, but there may be several locations throughout the watershed with this BMP. The user should add up the total acreage of the BMP type in the watershed and determine what percentage of the land use is covered by this BMP.

For example, if Contour Farming is the only cropland BMP in a watershed, add up all the acres of contour farming throughout all the cropland and divide this by the total acres of cropland in the watershed to determine the percent area of the BMP.

The list of BMPs in the BMPs drop-down menu will include those specific to the selected land use and any custom BMPs the user created previously.

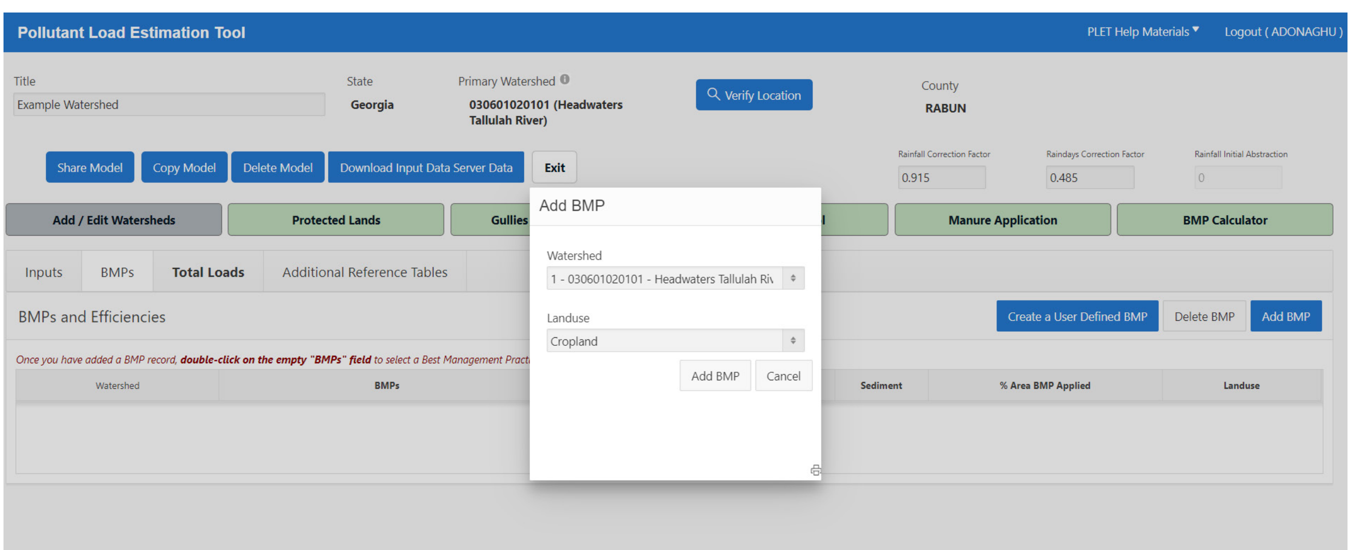

Figure 5-1. BMP Module layout and pop-up window to specify the watershed and land use where a BMP will be applied.

To delete a BMP from a scenario, click on *Delete BMP* on the right side of the BMP table. A pop-up window will list the BMPs in the scenario. Click the trash can icon next to the BMP that will be deleted. A second pop-up will ask, “Are you sure?” Click *OK* to delete the BMP or *Cancel* to keep it.

5.1 User-Defined BMPs (Custom BMPs)

PLET allows the user to create custom BMPs that include BMPs not represented in the model or BMPs with efficiencies that differ from the default values included in the model. Creating user-defined BMPs allows the user to add BMPs that reflect local data that might not otherwise be captured with the default values. Custom BMPs can also represent a suite of practices with a combined BMP efficiency. User-defined BMPs are saved and can be accessed for future use in other modeling scenarios.

To create a user-defined BMP, click on *Create a User Defined BMP* in the BMPs module. This opens a dialog box where the user can enter the BMP name and pollutant reduction efficiency values (Figure 5-2). Efficiencies are values between 0 and 1.00, where 1.00 equals 100% pollutant removal (e.g., 0.4 is 40% removal). After clicking *Save and Close*, the BMP will be saved. To add the new BMP to the scenario, click *Add BMP* and select the watershed and land use where the practice will be applied. Then, select the practice from the drop-down list in the BMPs column. Custom BMPs are distinguished from default BMPs with the naming convention “User Defined/Custom BMP (Custom BMP Name),” where the Custom BMP Name is the name entered in the Custom BMP creation dialog box.

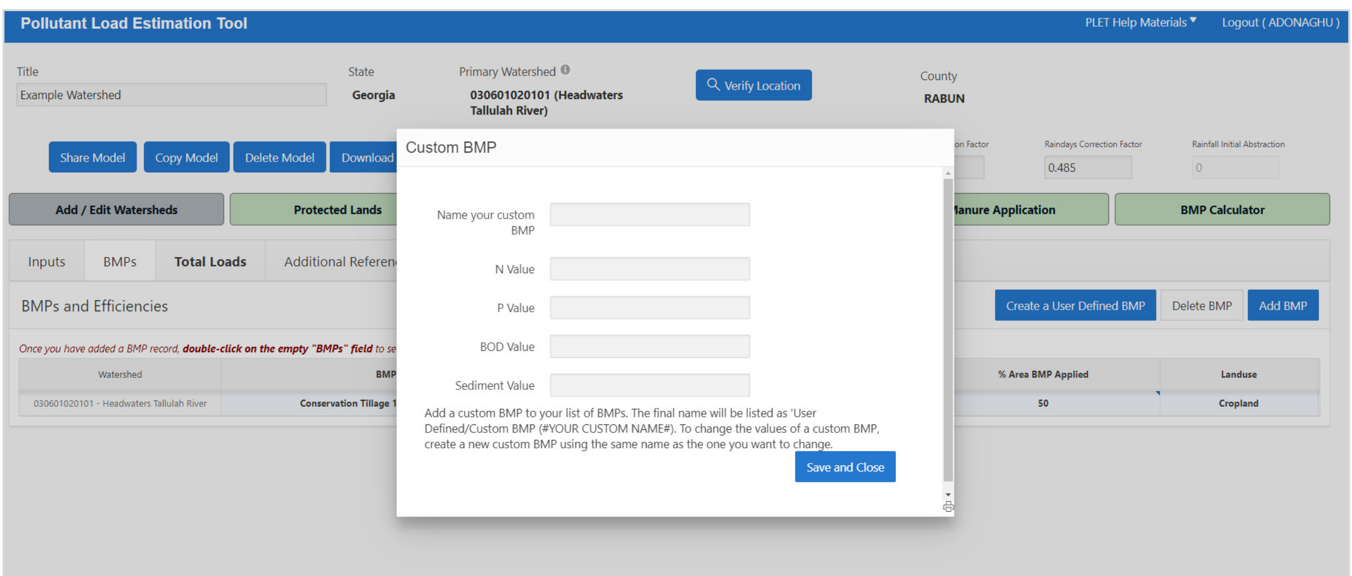

Figure 5-2. View of the Custom BMP pop-up where the BMP name and pollutant removal efficiencies are specified.

5.1.1 Editing Default Efficiency Values

While the user can manually adjust the efficiency values of the default BMPs, EPA strongly recommends creating a custom BMP with the desired efficiency values. This is advised because any manual adjustment to the default values will not be carried over to other models and may result in incorrect values being applied to areas of less than 100%.

5.2 Urban BMP Tool

The Urban BMP Tool supports the input of BMPs on urban land uses. All urban BMPs are entered here rather than on the BMPs module. The Urban BMP Tool uses event mean concentrations (EMCs) in runoff for each of the nine urban land use types.

Table 8 in the Input module provides a default distribution for urban land uses. Before working in the Urban BMP Tool, the user should modify this table to match the desired urban land use distribution in the watershed. The Urban BMP Tool provides default values for urban pollutant concentrations, and the user can modify/refine these values if local data are available.

To use the Urban BMP Tool, select the watershed from the drop-down and then select the urban land use where BMPs will be applied (Figure 5-3). Select the BMP from the Available LID/BMP drop-down list and enter the total acres treated by that type of BMP. The total available acreage for the land use selected will be shown for reference; the BMP drainage area cannot exceed the amount of total available acres. Click on *Apply LID/BMP* and a pop-up will indicate that the BMP has been applied. As BMPs are entered, they will appear in the Selected Urban BMPs table, showing the type of practice on each urban land use. Further down, the Effective BMP Application Area table will indicate the number of acres where BMPs have been applied on each land use. There is also a Percentage of BMP Effective Area table that will show the proportion of each land use with BMPs.

There are generally three types of urban BMP/LID practices: standard efficiency-based reduction BMP practices, BMP and LID practices with runoff capture depths, and LID practices with volume reductions. LID practices with volume reductions are denoted with an asterisk in the Available LID/BMP drop-down list.

Practices that include a runoff capture depth and volume reductions will have additional required inputs. When a runoff capture depth practice is selected, another input window (Runoff) will appear with fields for the percent impervious and the runoff capture depth. The default values are set at 100% impervious and 0.5 inch capture depth. The user should modify these values to reflect the local conditions. Based on the BMP drainage area, the percent impervious area, and the runoff capture depth, the tool will calculate the percent of captured runoff volume from the total area of the selected land use and the BMP storage capacity in gallons. An estimated BMP sizing (required BMP area) is also calculated. The BMP storage volume will be displayed in the Captured Flow Volume table, and the required BMP area will be shown in the BMP Surface Area or Number of Units table.

Similarly, if a runoff volume reduction practice is selected, the Runoff input window will appear, as will a second pop-up window called Runoff Volume Reduction. The Runoff input window will now include a third calculated value – the required number of cisterns/rain barrels to treat the BMP drainage area at the runoff capture depth specified. The Runoff Volume Reduction pop-up will provide the runoff volume reduced by the selected practice based on the user-specified inputs. This information will be presented in the Captured Flow Volume and BMP Surface Area or Number of Units tables.

Like the BMP module, only one BMP type can be entered for each land use. For example, if there are 12 bioretention systems on the commercial land use area, add up the total drainage area for all 12 systems and apply that as the BMP drainage area.

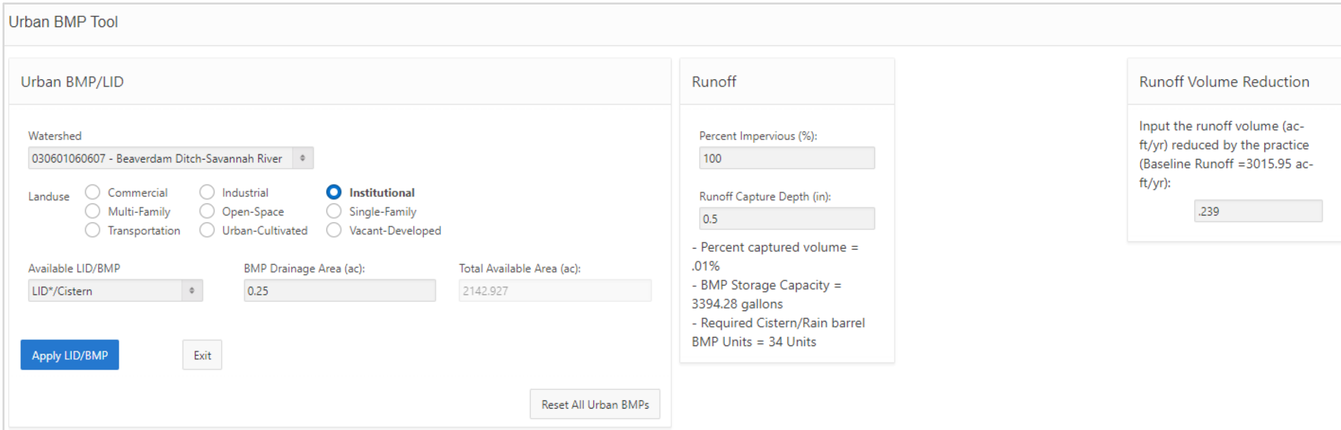

Figure 5-3. View of the Urban BMP Tool input screen.

5.2.1 Combined Urban BMPs and Custom Urban BMPs

The Combined BMPs-calculated selection from the Available LID/BMP drop-down list provides options for entering either a custom BMP efficiency for a single BMP or a combined BMP efficiency for multiple BMP types. Upon selecting the Combined BMPs-Calculated, an Efficiencies pop-up window will appear where the user can enter the pollutant removal efficiencies directly and access the BMP Calculator (Figure 5-4). If the custom BMP efficiency is known, the user should enter the pollutant removal efficiencies; then, click *Apply LID/BMP*.

If there are multiple types of BMP on a given urban land use, the user can click on the BMP Calculator button in the pop-up. This will open the BMP Calculator, which can be used to calculate a combined BMP efficiency for all the BMPs on a given land use. Refer to the BMP Calculator section of this guide for details on its use. Once the BMP configuration is submitted from the BMP Calculator, the user will be returned to the Urban BMP Tool, where the BMP will automatically be submitted to the scenario. There is no need to click *Apply LID/BMP*. The combined BMP efficiency will also be displayed in the Efficiencies pop-up. Note that with combined BMPs, volume reduction calculations are not provided.

Click *Exit* to leave the Urban BMP Tool and return to the main tool modules.

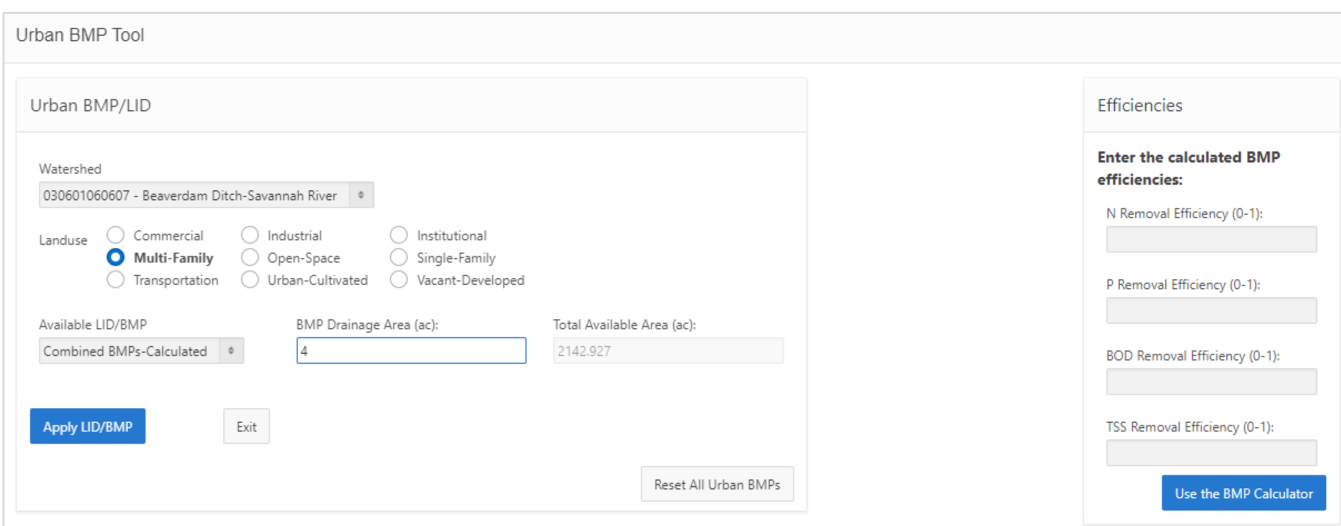

Figure 5-4. View of the additional input fields for custom and combined BMPs in the Urban BMP Tool.

5.3 BMP Calculator

The BMP Calculator calculates the combined BMP efficiency for combinations of multiple BMPs that can then be applied in the model. The calculator can be used to represent BMPs configured in series and parallel. For an explanation of BMPs in series and parallel, refer to Appendix A. To access the BMP calculator, click on the *BMP Calculator* button or select Combined BMPs-Calculated from the BMP drop-down list.

5.3.1 Navigating the BMP Calculator

As shown in Figure 5-5, when the BMP Calculator is opened, the main screen shows a gridded workspace. There are two modules in the BMP Calculator that can be found along the top of the window: BMP Editor, where BMP configurations can be created and modified, and Configuration List, where the user can review previously created BMP configurations and view the BMPs and efficiency value in each configuration.

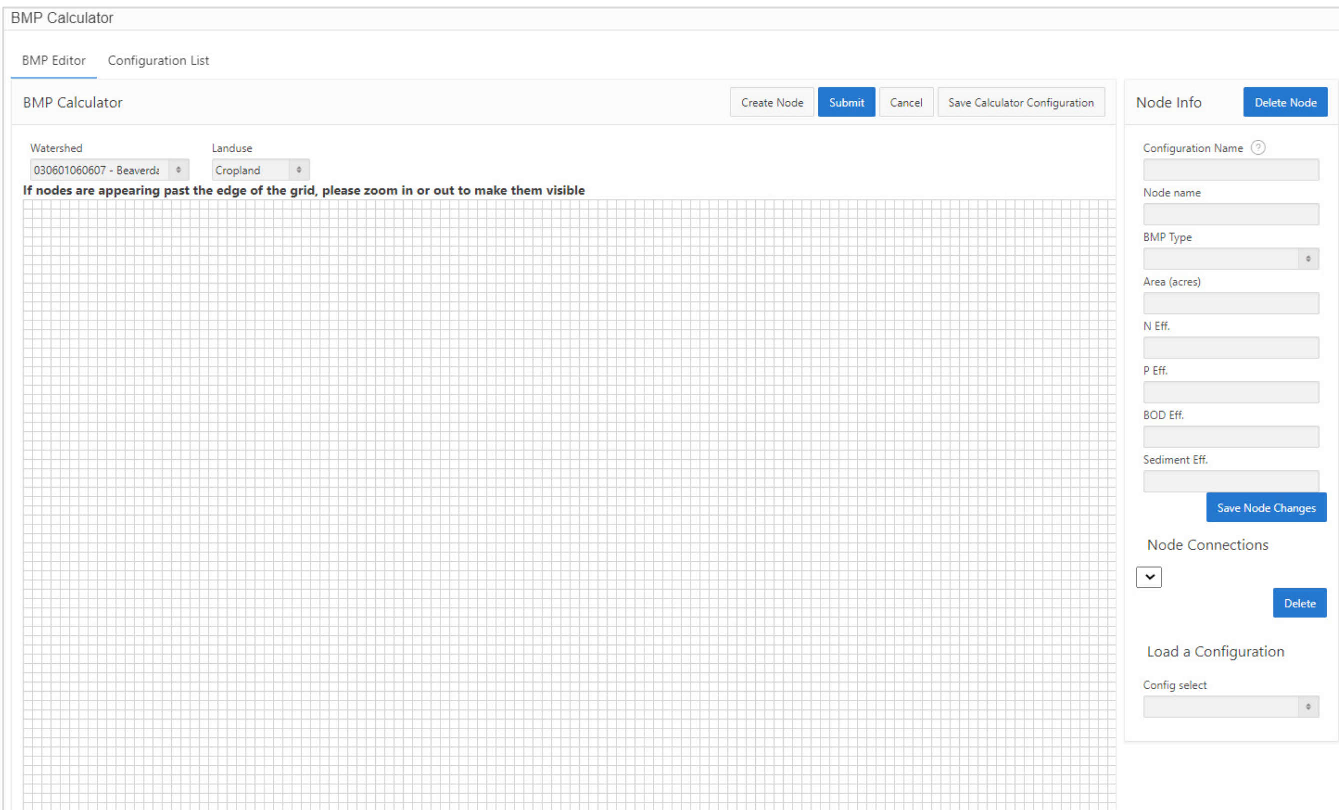

Figure 5-5. The BMP Calculator interface.

5.3.2 BMP Editor

In the BMP Editor's gridded workspace, each BMP is represented graphically by a node. Connecting a series of nodes creates a configuration representing multiple BMPs with a single set of combined BMP efficiency values. To build a BMP configuration, click on *Create Node*, and a New Node box will appear in the workspace. Click on the node box to activate data entry for the node. A panel on the right-hand side called Node Info provides input fields for the required information for each BMP in the configuration. In the Node Info pane, the user enters the Configuration Name, the name of the node, the BMP in the node, and the acres on which it will be applied; then, the efficiency values will automatically populate when a BMP is selected from the BMP Type drop-down list. Click on *Save Node Changes* to save and move on to the next node. If *Save Node Changes* is not clicked, the data entered will be lost. Continue building the nodes by clicking *Create Node* again and repeating the process as many times as necessary to represent all the BMPs. To create the configuration of the BMPs to represent how they are organized on the ground, click on the black half-circle on the right side of a node and drag it to the white half-circle on the left side of the node that it will drain to. A line will connect the two nodes. Multiple BMPs can connect to the same node if needed. The final node in the configuration will provide the resulting total area and combined BMP efficiencies. A more detailed explanation of BMP configurations is provided in Appendix A. Once the configuration is complete, click *Save Calculator Configuration*. This configuration is now available to use in any scenario and will appear in the BMP drop-down list in the BMPs module. Figure 5-6 shows the finished product of a parallel BMP configuration with three BMPs and a blank final node that connects all three BMPs together and provides the combined efficiency values. The final node, in this instance, represents the receiving water.

NOTE: When creating a BMP configuration, if *Save Calculator Configuration* is selected, the BMP workspace will be cleared prior to submitting the BMP to the selected land use. If this occurs, reload the BMP from the Configuration List and click *Submit*. If *Save Calculator Configuration* is not clicked, the combined BMP efficiency will be entered into the scenario, but the configuration will not be saved or reviewable at a later time.

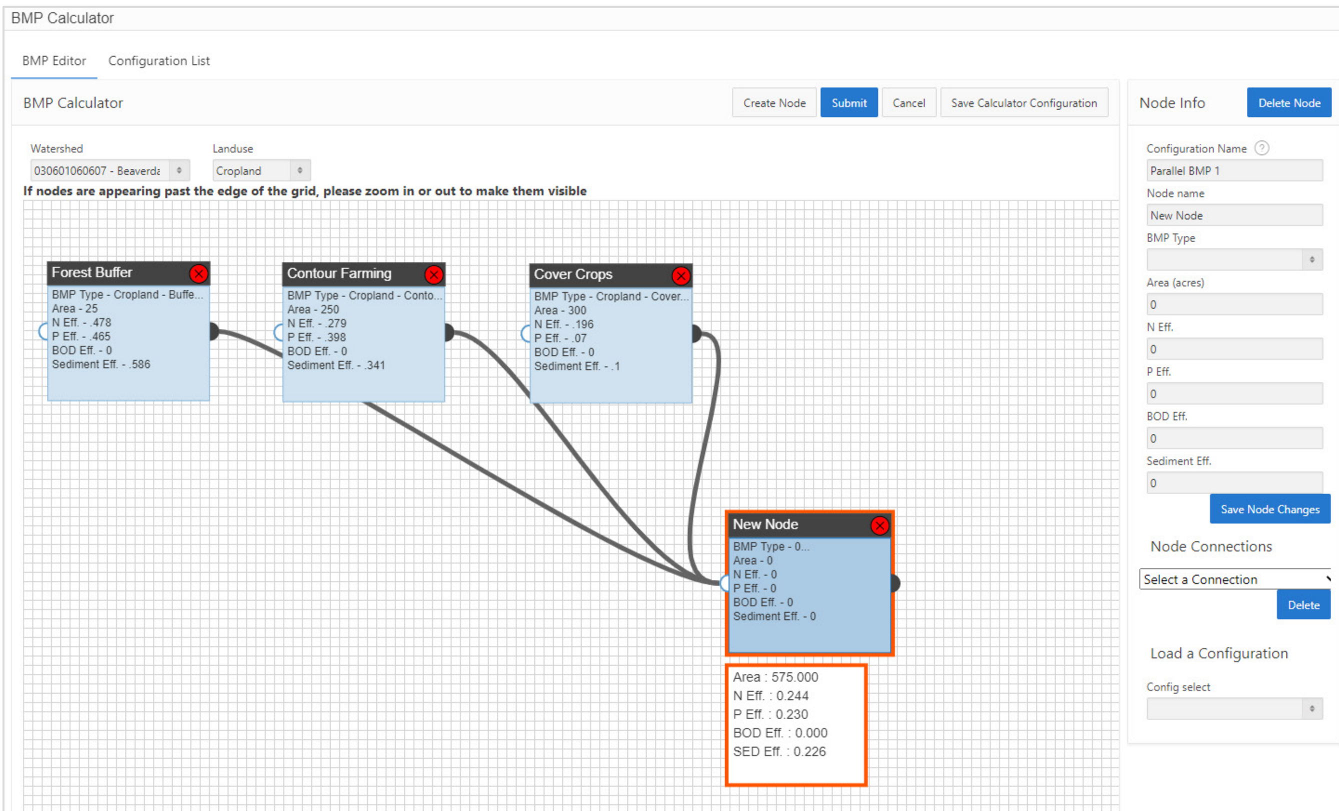

Figure 5-6. Example Combined BMP efficiency value configuration using the BMP Calculator BMP Editor.

5.3.3 Reviewing and Editing Previously Created Custom or Combined BMPs

To bring up a previously created configuration in the BMP Calculator, the bottom of the Node Info includes a "Load a Configuration" section with a drop-down list of all previously created BMP configurations. Select the BMP configuration of interest, and it will load in the workspace.

To change elements of a previously created configuration once it is loaded in the workspace, make the desired edits and click *Save Calculator Configuration*. To create a new BMP configuration based on a previous BMP configuration, load the initial configuration and then edit the configuration name. Once the name is changed, the changes to the configuration will be reflected in the new configuration while still maintaining the original configuration of the initial BMP configuration.

5.3.4 Configuration List

The Configuration List summarizes all the combined BMP configurations created by (or accessible to) the user. The list shows the combined efficiency value for each configuration. Click *View Configuration* to see an image of the BMP configuration below the list. This is intended as a reference for the user when reviewing and selecting the appropriate BMP configuration from those previously created.

6 Using the Model – Total Loads Module

The Total Loads module shows the final results of the modeled calculations in terms of watershed pollutant loads and load reduction from BMPs (Figure 6-1). There are several tables summarizing the results of the scenario:

- Table 1 – A summary of the total pollutant loads for each watershed in the scenario, both with and without pollutant reduction practices. Table 1 also provides the percent reduction in pollutants from load reduction practices.
- Table 2 – The total loads by land use for all watersheds cumulatively. The sources gullies, streambanks, septic and groundwater are each broken out separately from land uses.
- Table 3 – The pollutant loads by land use by watershed with pollutant reduction practices.
- Table 4 – The loads from groundwater by land use with BMPs included.
- Table 5 – The pollutant loads from just urban areas.
- Table 6 – The prevented loads and prevented runoff volume from land protection.

As shown in Figure 6-1, there is a *Download* button on the top right of the Total Loads module. This will generate an Excel file with the results from the six tables above, each in its own tab. In addition to the results tables, there are three check-boxes in the upper left of the Total Loads module: (1) *Groundwater Load Calculation*, (2) *Treat All Subwatersheds as Part of a Single Watershed, and* (3) *Show forest prevented loads and prevented runoff by subwatershed*, also visible in Figure 6-1.

Groundwater loads are optional; check the box to include groundwater loads. These values are based on the infiltration volume, using the selected HSG for each watershed in the scenario. Based on the infiltration rate, the annual infiltration volume is calculated for the different land uses. The annual infiltration volume is assumed to be equivalent to the annual groundwater output in the local hydrological cycle.

The groundwater load is not impacted by any of the BMPs entered into the scenario. Changes to groundwater loads can be manually adjusted by the user by editing the HSG applied and/or editing the nutrient concentrations in shallow groundwater to reflect the desired practices.

The *Treat All Subwatersheds as Part of a Single Watershed* check-box changes the sediment delivery ratio. This box is only relevant if there is more than one watershed in the model. Checking the box allows the sediment delivery ratio to be calculated using the total watershed area of all watersheds included in the model. **Important:** This feature does not represent routing through the watersheds in a particular order. Unchecking the box allows the sediment delivery ratio to be calculated independently for each watershed in the model.

The *Show Forest Prevented Loads and Prevented Runoff by Subwatershed* check-box toggles the visibility of Table 6 on and off. This check-box will only appear if the Protected Lands tool was used to apply protected land uses and will automatically be checked. Table 6 provides a summary of the current land use, the avoided future land use, the number of protected acres and the associated pollutant loads, and the runoff volume prevented.

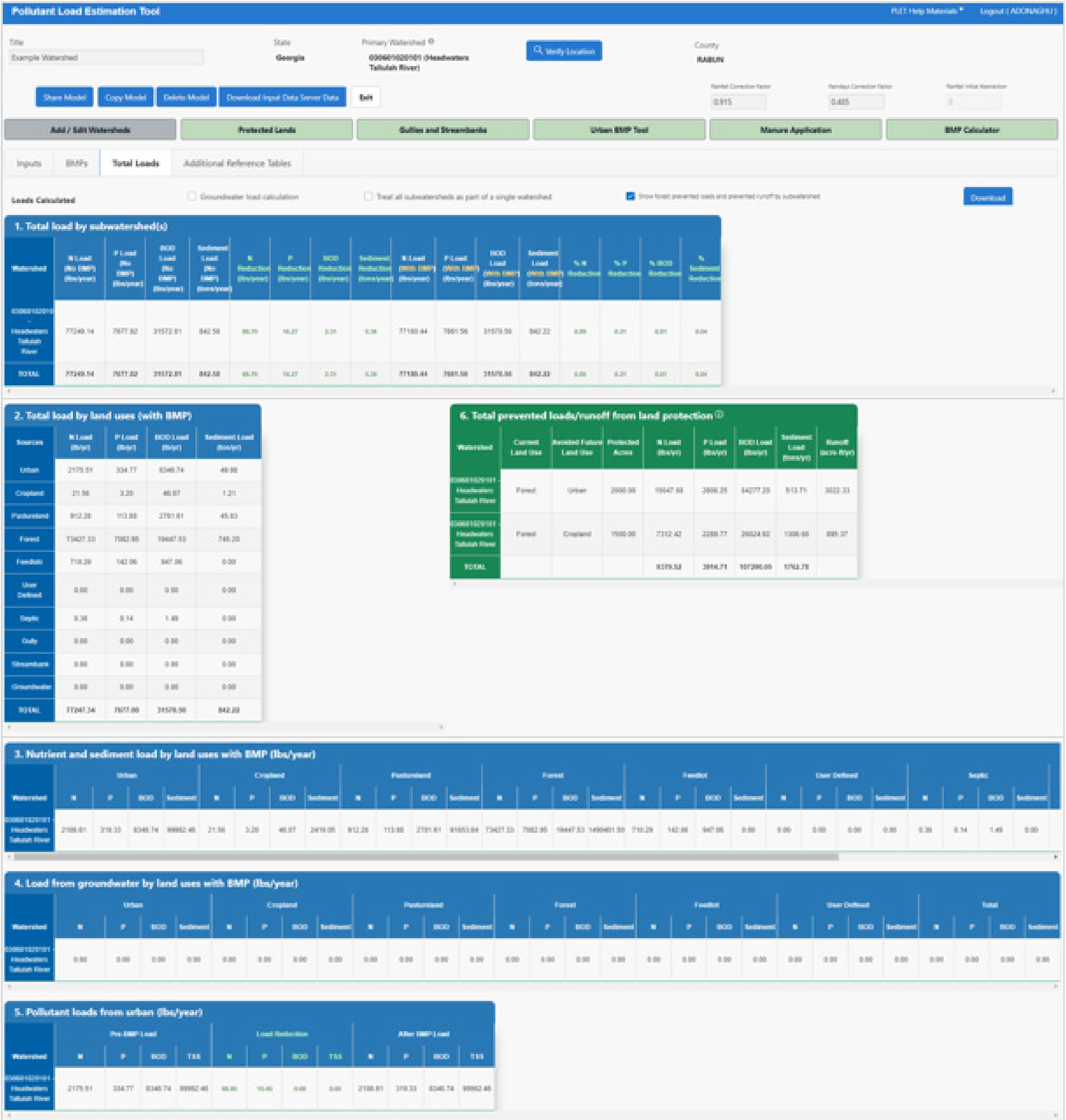

Figure 6-1. Total Loads Module. Note that full visibility of tables 3 and 4 may require scrolling to see all columns.

7 Using the Model – Additional Reference Tables Module

The Additional Reference Tables module provides default values for animal weights used to calculate animal equivalent units, soil infiltration rates, feedlot nutrient ratios, septic overcharge pollutant concentrations reaching streams, and wastewater nutrients and volume (Figure 7-1). These values are used in conjunction with the data entered on the Inputs module to generate the loading rates for the land uses and activities. The user can adjust the default values if more accurate local data are available.

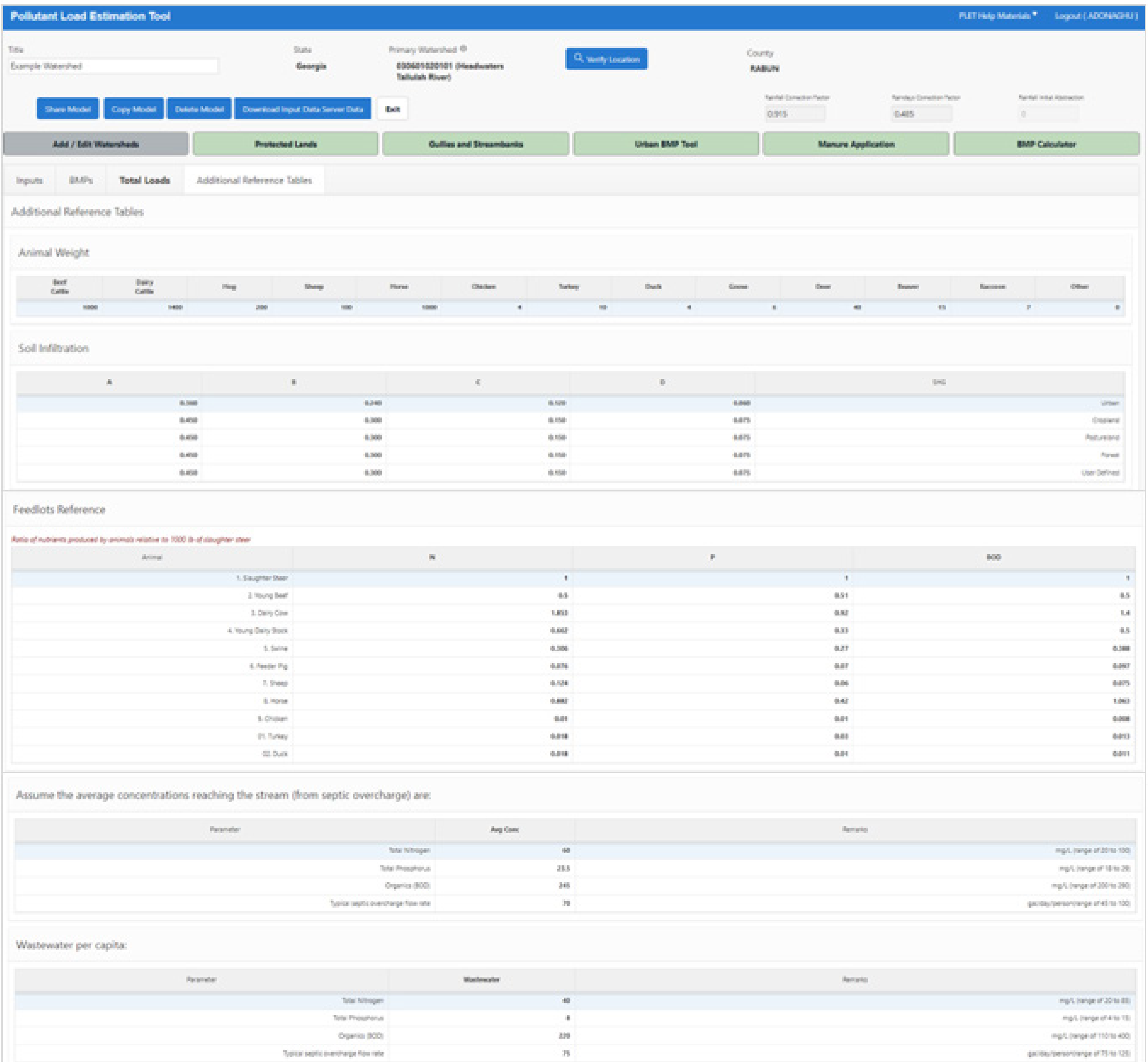

Figure 7-1. View of the Additional Reference Tables module.

APPENDIX A – BMPs in Series and Parallel

APPENDIX B – References Used in PLET

APPENDIX C – PLET Underlying Formulas Documentation

APPENDIX A – BMPs in Series and Parallel

Introduction

Series and parallel describe different configurations of BMP placement on the landscape. As shown in Figure A-1, parallel BMPs are BMPs that treat areas separately, and the individual loads drain into the same waterbody. In a series BMP configuration, more than one BMP treats the same watershed area. In other words, the same runoff flows through two or more different BMPs before reaching the waterbody. BMPs in series can also be thought of as a treatment train. Modelers can use the BMP calculator tool to develop a singular BMP for common treatment trains applied in their watershed.

There can also be combinations of parallel and series BMPs, where one portion of the watershed is treated by multiple BMPs, and another portion is treated by one or more different BMPs.

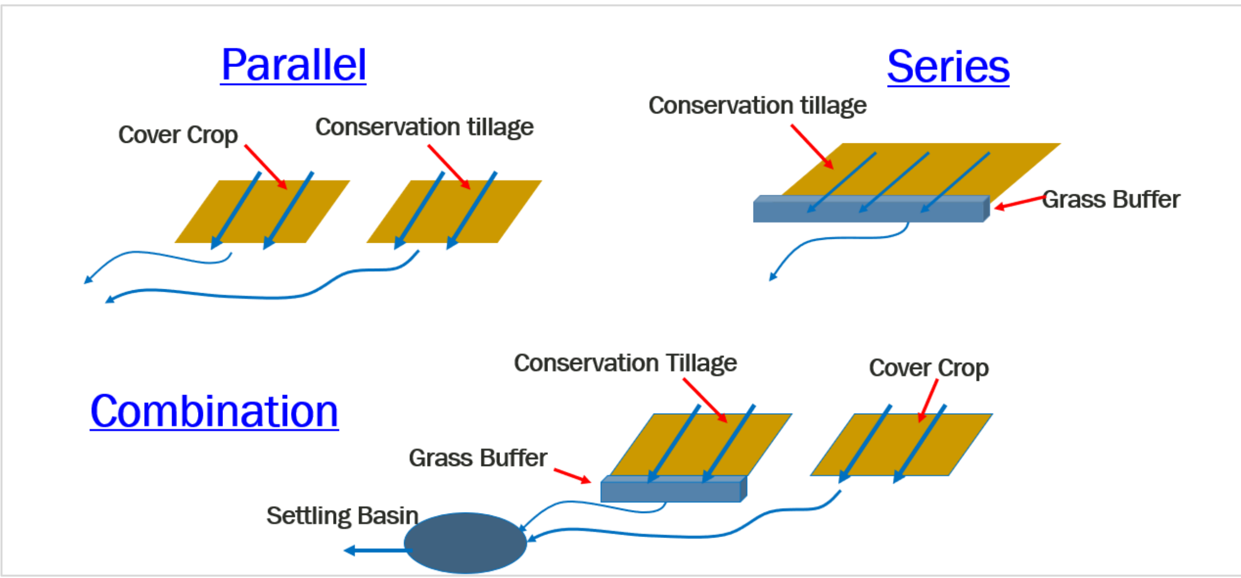

Figure A-1. Illustration of BMPs in parallel and series configurations and a combination of both.

Parallel BMPs Example

The first example is a watershed with parallel BMPs only (Figure A-2). In this example, there are 2,000 acres of cropland in the watershed. It has three BMPs: forest riparian buffer (25 acres), contour farming (250 acres) and cover crops (300 acres), leaving 1,425 acres of cropland untreated by BMPs. Each of these BMPs treats a separate area of the watershed. To build this configuration in the BMP calculator, create separate nodes for each BMP and connect them to a node representing the remaining acres in the watershed, as shown in Figure A-3. The results box below the final node in the configuration shows that there are 2,000 acres. In this configuration, 100% of the cropland is represented. The user can apply the resulting efficiency values to cropland and denote that the Percent Applied in the BMP module row for cropland is 100%. Alternatively, a scenario can be built that only represents the watershed areas treated by BMPs, as shown in Figure A-4. In this case, the node at the end of the configuration is left blank and the area reflected is only 575 acres, the sum of the BMP acreages. Notice that because all acreage in the calculator is treated by a BMP, the efficiencies are higher. However, if this configuration is to be added to the same scenario, the Percent Area Applied would be 28.75% (575/2000 acres). Both of these configurations will result in identical load reductions in this scenario. However, the first configuration representing all cropland may be most useful when building a single watershed scenario, whereas the second option could be used to build a BMP combination that is saved and frequently applied across many watersheds and different scenarios.

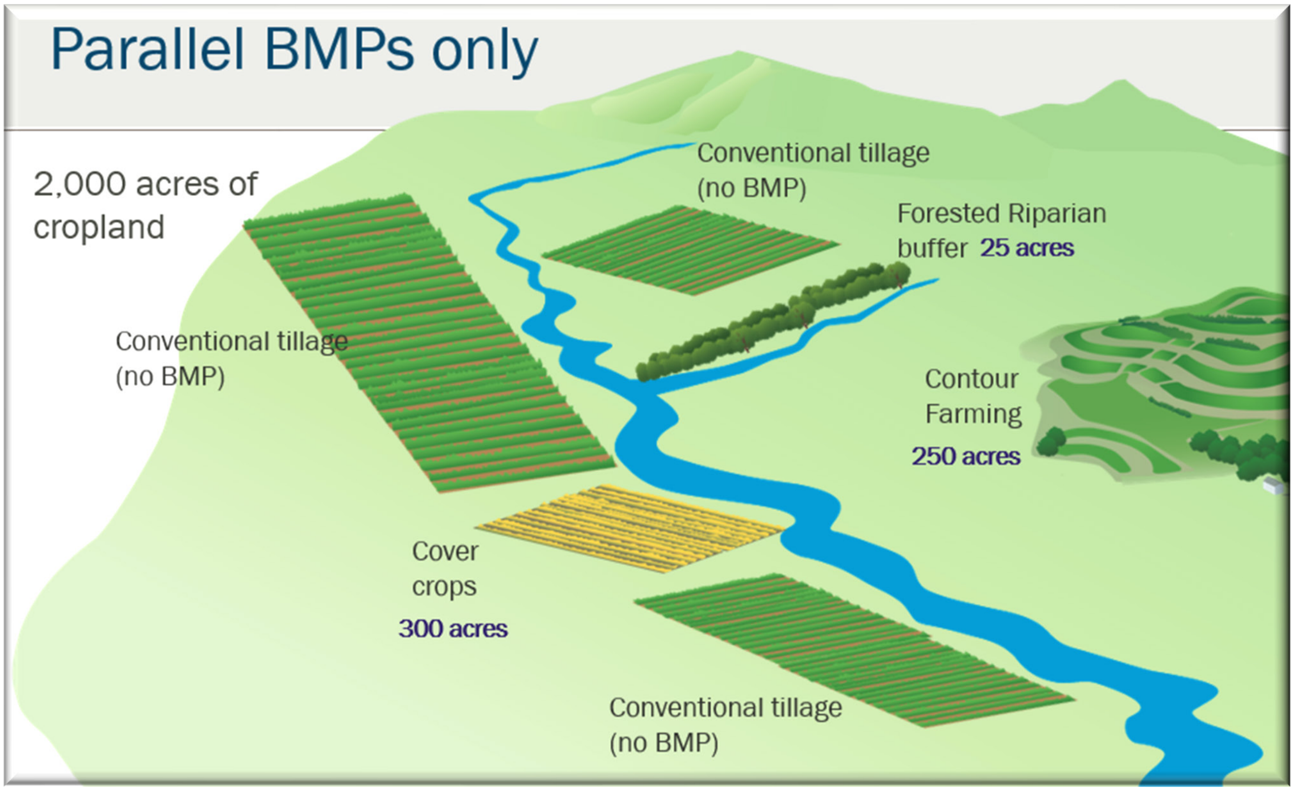

Figure A-2. Example of parallel BMPs on the landscape.

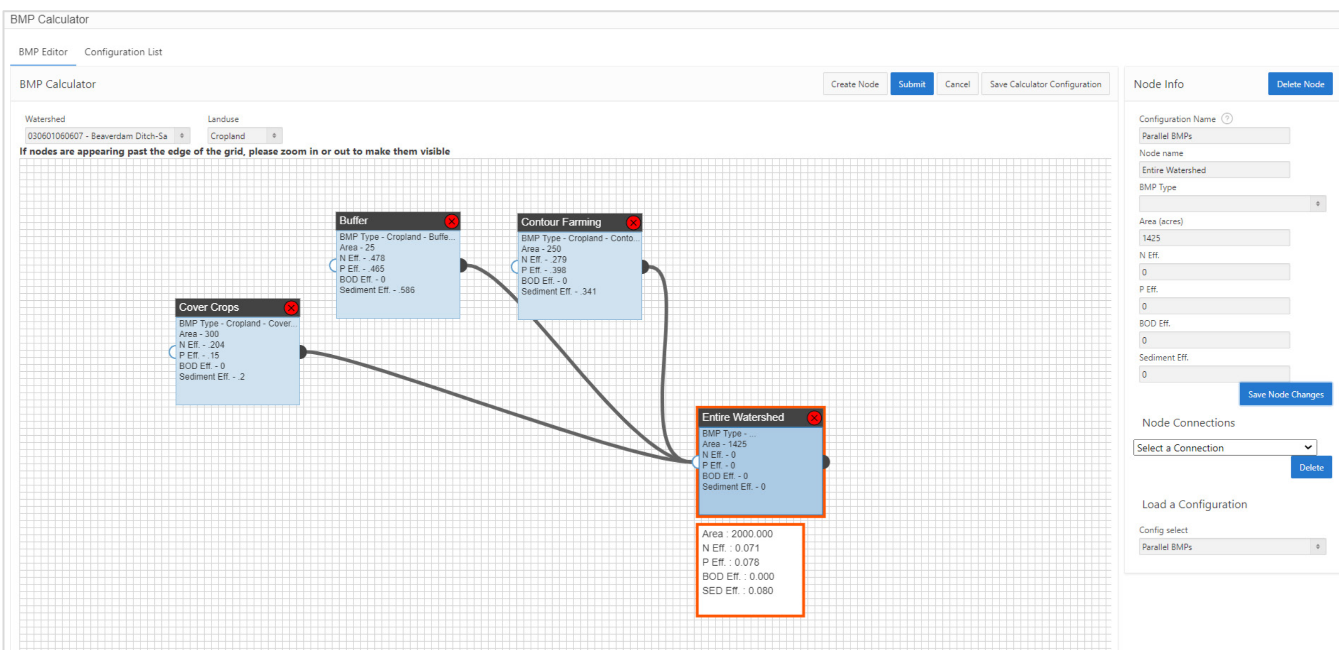

Figure A-3. Example configuration of parallel BMPs in the BMP Calculator representing all cropland.

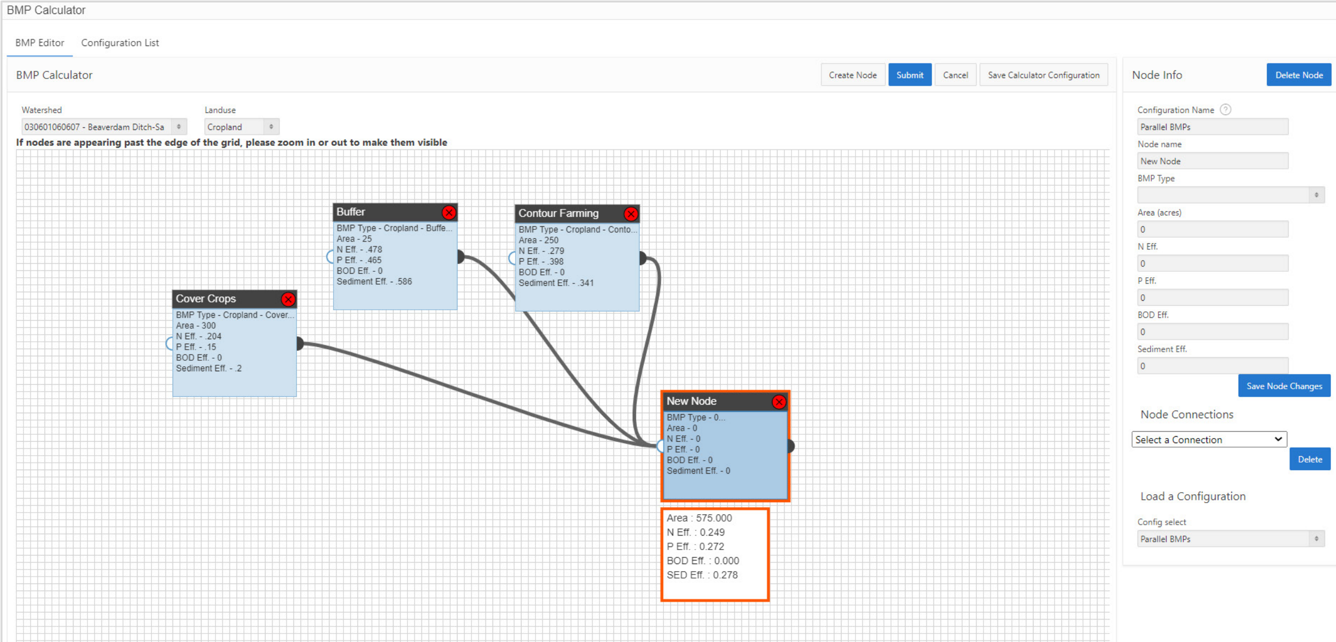

Figure A-4. Example configuration of parallel BMPs in the BMP Calculator representing only cropland with BMPs.

Series BMPs Example

This example demonstrates a watershed with series BMPs (Figure A-5). There are 625 acres of pasture in this watershed. All the pasture flows through a forested riparian buffer, but 525 acres also have livestock exclusion fencing. The practices are arranged so that runoff from the fenced pasture will also travel through the buffer, creating two practices in series. For this configuration, it is necessary to ensure the correct number of acres is represented in the BMP Calculator. The acres treated by fencing are routed to the riparian buffer, which treats an additional 100 acres of pasture. The configuration is shown in Figure A-6. The 525 fenced acres are routed to the riparian buffer, where those 525 acres plus an additional 100 acres only treated by the buffer are represented. The results box below the buffer node confirms that the total acreage in the scenario is 625 acres. A common mistake in this type of configuration would be to enter 525 acres treated by the fencing and then 625 acres treated by the buffer. However, the results box indicates this is incorrect because the total acreage would be shown as 1,150 acres rather than 625 acres.

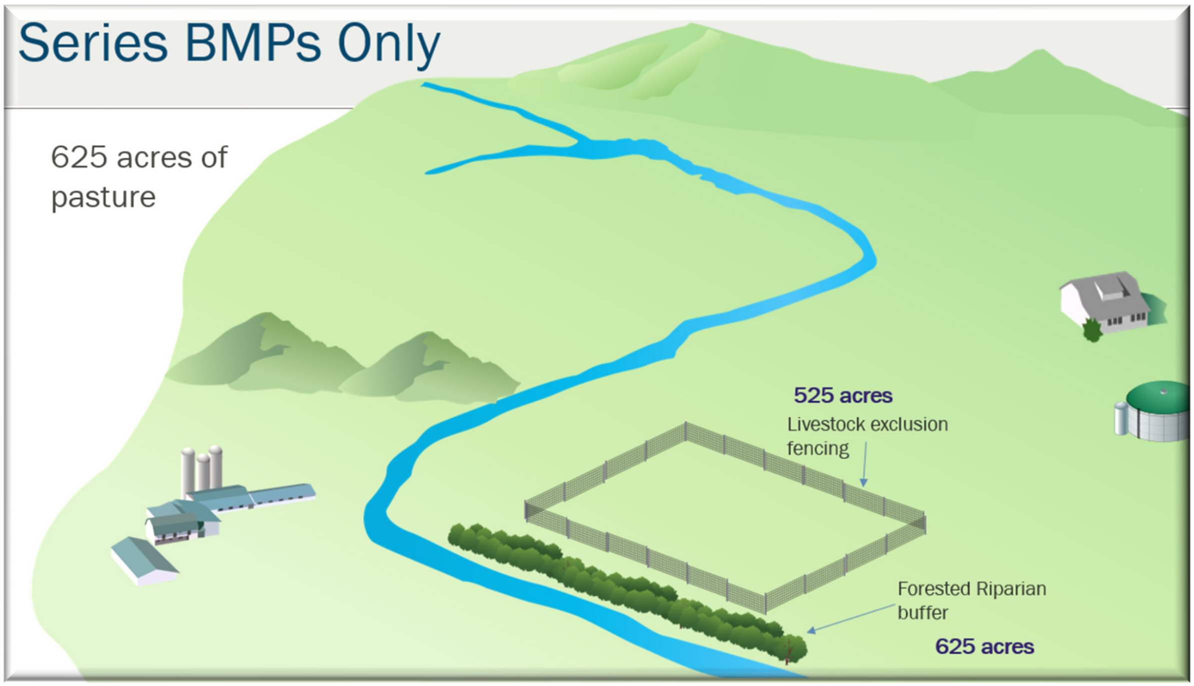

Figure A-5. Example of series BMPs on the landscape.

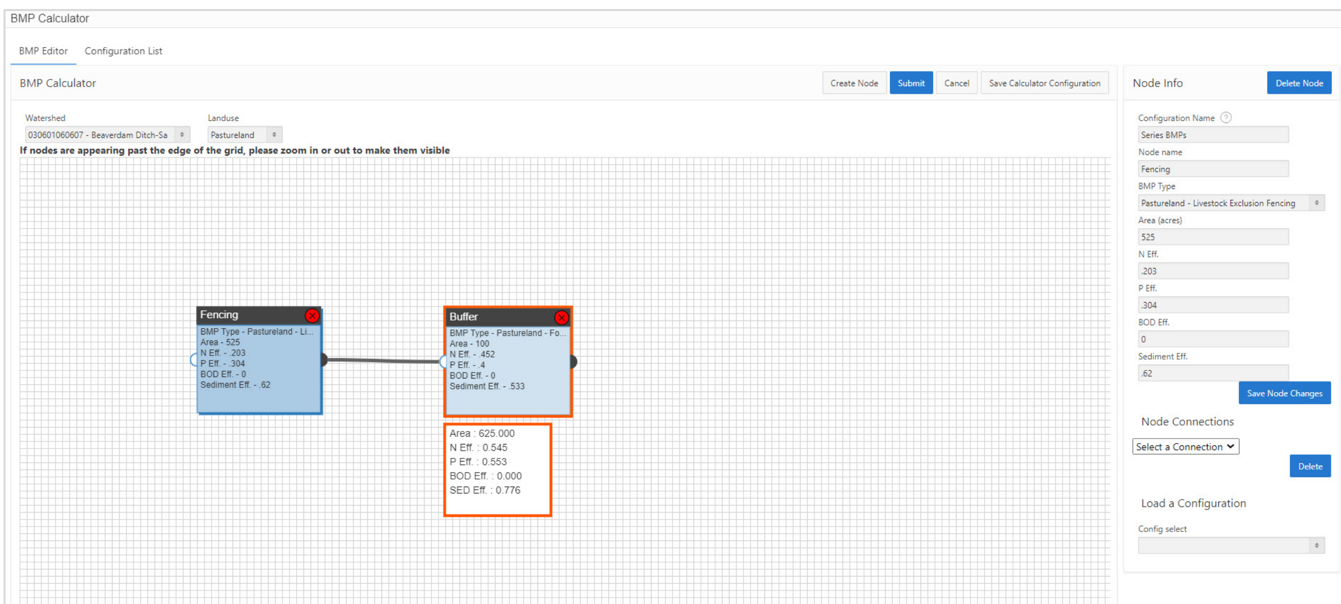

Figure A-6. Example of series BMP configuration in the BMP Calculator.

Parallel and Series BMPs Combined

Next is an example of parallel and series BMPs in the same configuration. In this scenario, there are 975 acres of pasture in the watershed. There are several BMPs across the pastureland: 100 acres of forage planting high in the watershed, 25 acres draining to forested riparian buffer on one side of the stream, and 750 acres of livestock exclusion fenced pasture draining through a forest buffer before reaching the stream. This leaves 100 acres of pasture untreated by BMPs (Figure A-7).

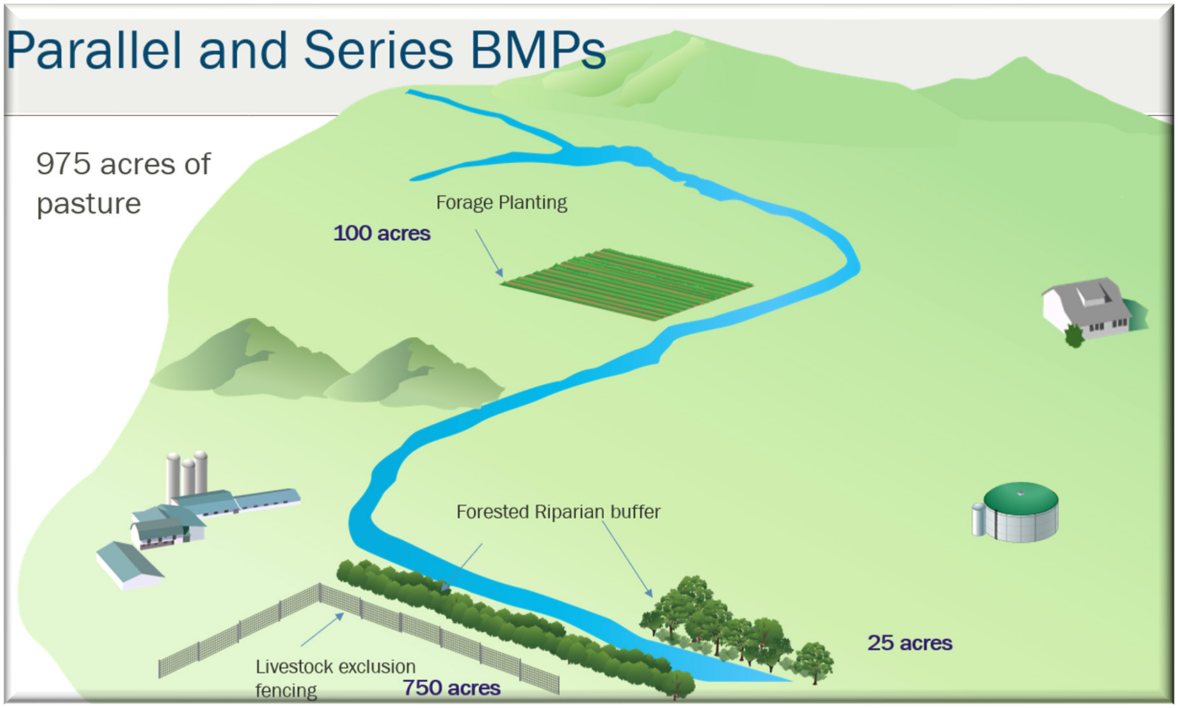

Figure A-7. Example of combined series and parallel BMPs.

In the BMP Calculator, the forage planting and 25 acres of forested riparian buffer are two parallel BMPs; therefore, they can be linked directly to a downstream node representing the entire watershed. The livestock exclusion fencing and the riparian buffer represent a BMP series, so these should be linked together, with 0 acres in the buffer node to denote that the buffer treats the same pasture acres as the fencing. This series BMP can also be connected to the node representing the entire watershed. This final downstream node represents all the upstream acreages and BMPs plus the 100 untreated acres, so the 100 untreated acres are entered, and the BMP type is left blank. The results box shows the combined efficiencies for this configuration on 975 acres. Figure A-8 illustrates the completed configuration for this scenario.

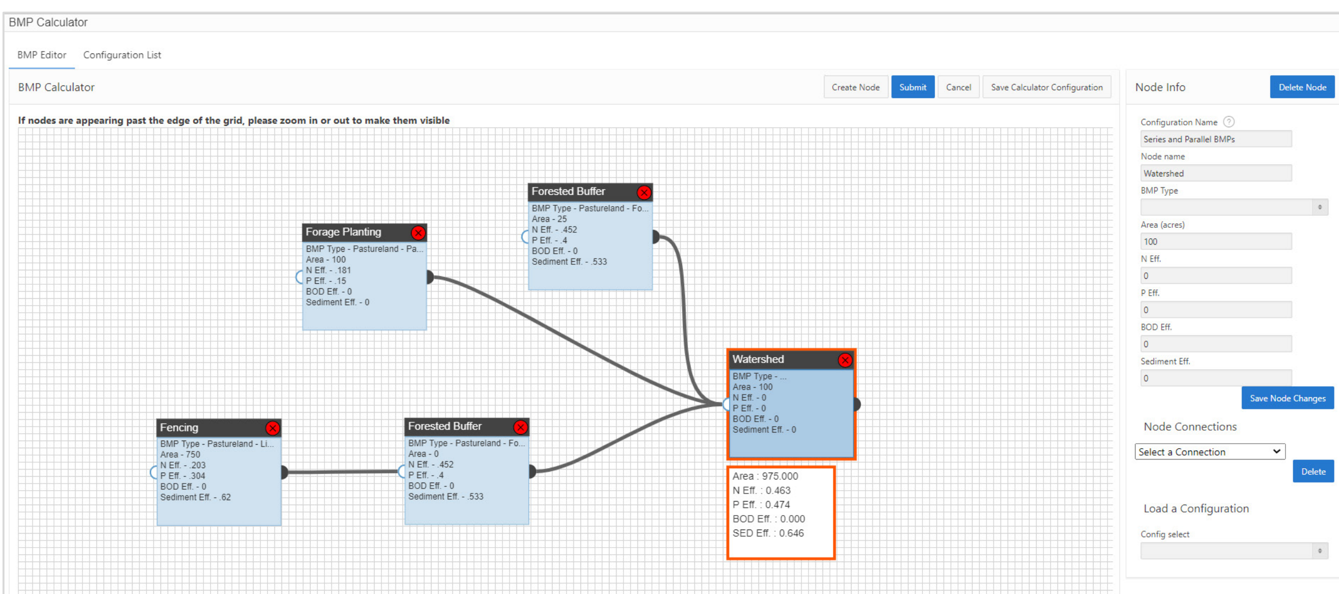

Figure A-8. BMP Calculator configuration for series and parallel BMPs on the same watershed.

APPENDIX B – References Used in PLET

The following references describe where the default values and data assumptions are derived.

Data Type	***Source***	***Note***
HUC12	USEPA, n.d.	EPA ArcGIS Server https://watersgeo.epa.gov/ArcGIS/rest/services/OW/WBD_WMERC/MapServer
Precipitation observation points	Texas A&M University 2023	Based on long-term (30 years) average PRISM weather data from 4km x 4km grid cells, area-weighted at the HUC14 scale, using 1993–2022 data. Refer to 2024 PLET Precipitation Data Update memo under the PLET help menu for more information.
Land use	MRLC 2011	Multi-Resolution Land Characteristics Consortium, 2011 landcover
Agricultural animal counts	USDA NASS 2014; USDA 2012.	2014 animal count data. The agricultural animal data source is at the county level and is summarized at the HUC12 level based on the pastureland area weighted ratio.
Animal weights	ASAE 1998	Standard animal weights
Feedlot nutrient concentrations associated with animal weights	DEQ 1999	Nutrient ratios
Nutrient adjustment factor by animal density	Evans et al. 2001	Based on the density of agricultural animals in the study area (PLET calculates animal density automatically)
Number of septic systems	WVU 1992, 1998	The septic system data source is at the county level and is summarized at the HUC12 level based on the low-density residential area weighted ratio.
Population per septic system	WVU 1992, 1998	The septic system data source is at the county level and is summarized at the HUC12 level based on the low-density residential area weighted ratio.
Septic failure rate	WVU 1992, 1998	The septic system data source is at the county level and is summarized at the HUC12 level based on the low-density residential area weighted ratio.
Septic overcharge concentrations reaching stream	Horsley & Witten 1996; USEPA 1980	
Wastewater per capita concentrations	Metcalf and Eddy 2003	2nd Edition. Table: Typical composition of untreated domestic wastewater
RUSLE2 parameters: National Resources Inventory	USDA NRCS 1992, 2015, 2017	National Resource Inventory study 1992, 2015 and 2017 by county. Refer to RUSLE2 Factor Updates memo under the PLET help menu for more information.
Hydrologic soil group (HSG)	USDA NRCS 2002, SSURGO database	Area-weighted within each HUC12
Soil N, P, BOD concentrations	Haith et al. 1992	National average from general watershed loading functions manual.
Runoff curve numbers	USDA NRCS 1986	TR55 manual, Table 2-2b: • Cropland - Row Crops – Good condition • Pasture - Pasture – Fair condition • Forest - Woods – Fair condition

Data Type	*Source*	*Note*
Soil cover curve number for feedlot based on percent paved	DEQ 1999	Page 39, Figure 8 in DEQ 1999
Infiltration fraction by HSG for groundwater infiltration volume calculation	Caraco 2001	Taken from Page 7-16, Table 7.7 of Caraco 2021 (by HSG; same for all land use types). Urban land use infiltration fraction value was assumed to be 20% less for each HSG.
Sediment delivery ratio	USDA NRCS 1983; Vanoni 1975	Drainage area power function relationships
Urban runoff curve numbers	USDA NRCS 1986	TR55 manual, Table 2-2a
Urban land pollutant concentrations in runoff	Caraco 2001	Default suggested TN, TP and TSS concentrations taken from Tables 6.2, 6.3 and 6.4 for Commercial, Industrial, Transportation and Residential.
Nutrient concentration in runoff	Haith et al. 1992; Haith and Shoemaker 1987	Dissolved nutrients in agricultural runoff (Table 2 in Haith and Shoemaker [1987]) • Cropland-Low – N and P taken from Small Grains – N with manure estimated from ratios estimated from reported values of Cropland-Medium with and without manure (see Cropland-Medium) • Cropland-Medium – N with and without manure taken from Corn – P scaled based on ratio of Cropland Low and High since reported Corn P was less than small grain P, ratio of ~1.5 was used to scale Cropland Low to Cropland Medium for P) • Cropland-High – N and P estimated based on ratio of 1.5 from Cropland- Medium – Cropland-High N estimated based ratio of N with and without manure for Medium condition • Manured P concentrations taken based on best professional judgment using the range provided for Corn, Small Grains and Hay from manured lands (reported range: 1.9–8.7 mg/L). P concentration of 2, 3 and 4 mg/L were assigned for low, medium and high with manure condition. • BOD was taken as ~2 times N for without manure and ~1.5 times N for with manure applied. • Pasture values are currently same for all low, medium and high with and without manure. These should be updated as literature becomes available. Haith and Shoemaker (1987) report N and P as 3 mg/L and 0.25 mg/L—slightly lower than that in PLET, which has 4 mg/L and 0.3 mg/L. BOD was taken as 13 mg/L for which we do not have reference but is most likely based on best professional judgement. • Forest runoff concentration values are based on results from 2024 literature review. Refer to the PLET help menu for supporting information.

Data Type	Source	Note
Nutrient concentration in shallow groundwater	Haith et al. 1992; Haith and Shoemaker 1987	Taken as mean value of reported (inorganic forms of N and P) for central, eastern, and western US in Table 3 for mean dissolved concentration in streamflow. Forested~ 90% forested; Agriculture~ >=75%; Pasture taken same as that of Agriculture; Urban N from Caraco (2001), P taken same as Pasture.
Urban land use distribution		Percent urban land use distribution. Users should adjust these area placeholder values based on the distribution found in their watershed.
Gully and streambank soil dry density and correction factor	DEQ 1999	Figure 1: Lateral Recession Rate Exhibit 1: Dry Density Soil Weights; Exhibit 2: Soil Textural Class
BMP efficiency values	USEPA 2023	BMP percent efficiencies and associated references

Notes:

BOD = biological oxygen demand; HUC12 = 12-digit hydrologic unit code (HUC); HUC14 = 14-digit HUC; km = kilometers; mg/L = milligrams per liter; N = nitrogen; P = phosphorus; TN = total nitrogen; PT = total phosphorus; TSS = total suspended sediment

References and Resources

Agricultural animal counts:

- USDA NASS (U.S. Department of Agriculture National Agricultural Statistics Service). 2012 Census of Agriculture. https://agcensus.library.cornell.edu/census_year/2012-census/.

Animal equivalent units (animal weights):

- ASAE (American Society of Agricultural Engineers). 1998. *ASAE standards: Standards, engineering practice, and data*. 45th ed. American Society of Agricultural Engineers. St. Joseph, MI.

Animal nutrient concentrations by animal equivalent units:

- Evans, B.M., S.A. Sheeder, K.J. Corradini, and W.S. Brown. 2001. *AVGWLF version 3.2, users guide*. Software. Environmental Resources Research Institute, Pennsylvania State University, University Park, PA.
- DEQ (Michigan Department of Environmental Quality). 1999. *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual, June 1999 Revision*. DEQ Surface Water Quality Division, Nonpoint Source Unit. Lansing, MI. https://www.epa.gov/sites/default/files/2021-01/documents/region5manual.pdf.

Best Management Practice Efficiencies

- USEPA (U.S. Environmental Protection Agency). 2023. *Best Management Practice Efficiency References for the Pollutant Load Estimation Tool*. USEPA, Office of Wetlands, Oceans and Watersheds, Washington, DC.

Gully and streambank soil dry density and correction factor:

- DEQ (Michigan Department of Environmental Quality). 1999. *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual, June 1999 Revision*. DEQ Surface Water Quality Division, Nonpoint Source Unit. Lansing, MI.

HUC12 watershed boundaries:

- USEPA (U.S. Environmental Protection Agency). No date. USEPA/OW/WBD_WMERC (Map Server.) https://watersgeo.epa.gov/ArcGIS/rest/services/OW/WBD_WMERC/MapServer.

Hydrologic soil group:

- USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 2002. SSURGO database. USDA NRCS, Washington, DC. https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Infiltration rate by hydrologic soil group:

- Caraco, D. 2001. *The Watershed Treatment Model. Version 3.0.* Center for Watershed Protection, Ellicott City, MD.

Land use:

- MRLC (Multi-Resolution Land Characteristics Consortium). 2011. Crop Data Layer, 2011 CONUS Land Cover and AK Land Cover.
- NOAA (National Oceanic and Atmospheric Administration). No date. “Name of Data Set.” Coastal Change Analysis Program (C-CAP) High-Resolution Land Cover. NOAA Office for Coastal Management, Charleston, SC. https://coast.noaa.gov/digitalcoast/data/ccaphighres.html.

Nutrient concentration in runoff:

- Beaulac, M.N. and K.H. Reckhow. 1982. An examination of land use- nutrient export relationships. *Water Resources Bulletin* 18:1013–1024.
- Haith, D.A. and L.L. Shoemaker. 1987. Generalized watershed loading functions for stream flow nutrients. *Water Resources Bulletin* 23:471–478.
- Haith, D.A., R. Mandal, and R.S. Wu. 1992. *GWLF: General Watershed Loading Functions (User’s Manual, Version 2.0)*. Cornell University, Ithaca, NY, USA

- Horner, R.R. 1992. Water quality criteria/pollutant loading estimation/treatment effectiveness estimation. In R.W. Beck and Associates. *Covington Master Drainage Plan.* King County Surface Water Management Division, Seattle, WA.
- Maidment, D.R. 1993. *Handbook of Hydrology.* McGraw-Hill, New York, NY.
- Evans, B.M., S.A. Sheeder, K.J. Corradini, and W.S. Brown. 2001. *AVGWLF Version 3.2, Users Guide*. Environmental Resources Research Institute, Pennsylvania State University, University Park, PA.

Nutrient concentration in shallow groundwater

- Haith, D.A. and L.L. Shoemaker. 1987. Generalized watershed loading functions for stream flow nutrients. *Water Resources Bulletin* 23:471–478.
- Haith, D.A., R. Mandel, R., and R.S. Wu. 1992. GWLF: Generalized Watershed Loading Functions (User's Manual, Version 2.0). Cornell University, Ithaca, NY.

Precipitation observation points:

- Texas A&M University. 2023. *HAWQS 2.0, 2023, HAWQS System 2.0 and Data to model the lower 48 conterminous U.S using the SWAT model*. Texas Data Repository, V2. https://doi.org/10.18738/T8/GDOPBA.

Runoff curve numbers:

- USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 1986. *Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55)*. USDA NRCS, Washington, DC.

Sediment delivery ratio:

- USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 1983. Sediment sources, yields, and delivery ratios. In *National Engineering Handbook*, Chapter 6, Section 3, Sedimentation. USDA, Washington, DC.
- Vanoni, V.A., (ed). 1975. Sedimentation Engineering. ASCE Manuals and Reports on Engineering Practice No.54. American Society of Civil Engineers, New York, NY.

Septic systems – number of units, population per system, and failure rate:

- WVU (West Virginia University). 1992. National Small Flows Clearinghouse.[1] WVU, Morgantown, WV.
- WVU (West Virginia University). 1998. National Small Flows Clearinghouse. WVU, Morgantown, WV.

Septic overcharge concentrations reaching stream:

- Horsley & Witten, Inc. 1996. *Identification and Evaluation of Nutrient Bacterial Loadings to Maquiot Bay, Brunswick and Freeport, Maine*. Prepared for the Casco Bay Estuary Project by Horsley & Witten, Barnstable, MA. https://www.cascobayestuary.org/wp-content/uploads/2021/01/1996_nutrient_loading_maquiot_bay.pdf.
- USEPA (U.S. Environmental Protection Agency). 1980. Design Manual, Onsite Wastewater Treatment and Disposal Systems. EPA 625/1-80-012. USEPA, Office of Research and Development, Washington, DC. https://www.epa.gov/sites/default/files/2015-06/documents/septic_1980_osdm_all.pdf.

Soil nitrogen, phosphorus, and biological oxygen demand concentrations:

- Haith, D.A., R. Mandel, and R.S. Wu. 1992. GWLF: *Generalized Watershed Loading Functions (Version 2.0, User's Manual)*. Cornell University, Ithaca, NY.

Urban runoff curve numbers:

- USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service. 1986. U*rban Hydrology for Small Watersheds, Technical Release 55 (TR-55)*. USDA NRCS, Washington. DC.

[1] The National Small Flows Clearinghouse is now part of the National Environmental Services Center (www.nesc.wvu.edu).

Urban land pollutant concentrations in runoff:

- Caraco, D. 2001. *The Watershed Treatment Model. Version 3.0*. Center for Watershed Protection. Ellicott City, MD.

Universal Soil Loss Equation parameters:

- USDA NRCS (U.S. Department of Agriculture, Natural Resources Conservation Service). 1992. National Resources Inventory (NRI) database. USDA NRCS. Washington, DC.
- USDA NRCS. 2015. National Resources Inventory database. USDA NRCS. Washington, DC.
- USDA NRCS. 2017. National Resources Inventory database. USDA NRCS. Washington, DC. https://www.nrcs.usda.gov/nri.

Wastewater per capita concentrations:

- Metcalf and Eddy, Inc. 2003. *Wastewater Engineering: Treatment and Reuse*. 4th Edition. McGraw-Hill, New York, NY.

Weather data:

- USEPA (U.S. Environmental Protection Agency). 2019. *Better Assessment Science Integrating Point and Nonpoint Sources: BASINS Version 4.5 User's Manual*. USEPA, National Exposure Research Laboratory, Raleigh, NC. https://www.epa.gov/hydrowq/basins-core-manual.

APPENDIX C – PLET Underlying Formulas Documentation

1. Introduction

The purpose of this document is to provide all relevant equations and methods used in the PLET model. PLET employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various BMPs, including LID practices for urban areas. It computes surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day BOD; and sediment delivery based on various land uses and management practices. The land use types considered are urban, cropland, pastureland, feedlot, forest and user-defined. The pollutant sources include major nonpoint sources such as cropland, pastureland, farm animals, feedlots, urban runoff and failing septic systems. The types of animals considered in the calculation are beef cattle, dairy cattle, swine, horses, sheep, chickens, turkeys and ducks. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (from sheet and rill erosion only) is calculated based on the RUSLE and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

$$\begin{aligned}\text{Total Load from Various Sources}\\ &= \text{Urban} + \text{Cropland} + \text{Pastureland} + \text{Forest} + \text{Feedlots} + \text{User} - \text{Defined} + \text{Septic}\\ &+ \text{Gully} + \text{Streambank} + \text{Groundwater}\end{aligned} \qquad \textit{Equation 1}$$

2. Surface Runoff

The Runoff Curve Number (CN) method is used to estimate runoff from urban, cropland, pastureland, forest and a user-defined land use. The runoff equation used is:

$$Q = \frac{(P - Ia)^2}{(P - Ia) + S} \quad or \; Q = \frac{(P - \alpha \cdot S)^2}{P - \alpha \cdot S + S}$$ *Equation 2*

PLET calculates the average rainfall per event as follows:

$$P = (AR \cdot R_{cor})/(Rdays \cdot RD_{cor})$$ *Equation 3*

Where:

Q = Surface Runoff (in/day)

P = Rainfall (in) per event.

AR = average annual rainfall

Rdays = average rain days in a year

R_{cor} = rainfall correction factor refers to the percentage of rainfall events that exceed 5 millimeters (mm)/event

RD_{cor} = rain day correction factor refers to the percentage of rain day events that generate runoff

Ia = initial abstraction determines the initial rainfall retention on the land surface. Ia is given by αS (where α ranges from 0 to 0.2). Note that PLET uses zero initial abstraction factor as a default value. This is because rainfall and rainy days correction factors are already considering that runoff occurs when it rains more than 5mm in a day, a criterion used to calculate the correction factors. For example, for a value of α = 0, Equation 2 reduces to $P^2/(P+S)$

S = Potential maximum retention after runoff begins (in). S is related to the soil and cover conditions of the drainage area through the CN. CN has a range of 0 to 100, and S is related to CN by:

$$S = \left(\frac{1000}{CN}\right) - 10$$ *Equation 4*

The estimated average daily runoff volume is multiplied by the corrected number of average rain days in a year to calculate the annual runoff volume.

$$Annual\ Runoff\ Volume\ (ac - ft) = \frac{Q}{12} \times A\ \times (Rdays \cdot RD_{cor}) \qquad \text{Equation 5}$$

Where:

Q = surface runoff (in)

A = area of land use (acres [ac])

Rdays = average rain days in a year

RD_{cor} = rain day correction factor refers to the percentage of rain day events that generate runoff

PLET also includes the irrigation runoff contribution to croplands when irrigation is applied. The irrigation runoff depth (Q_{irr}) is calculated using Equation 2. The water depth per irrigation (inches) is used instead of the rainfall (P). The annual runoff volume for cropland is calculated as the sum of the surface runoff volume and irrigation volume.

$$\begin{aligned} Annual\ Runoff\ Volume\ Cropland\ (ac - ft) &= Runoff\ Volume\ of\ Cropland + Irrigated\ Runoff\ volume \\ &= \frac{Q}{12} \times A \times (Rdays \cdot RD_{cor}) + \frac{Q_{irr}}{12} \times A_{irr}\ \times IF \end{aligned} \qquad \text{Equation 6}$$

Where:

Q_{irr} = irrigation runoff (in)

A_{irr} = cropland acres irrigated

IF = irrigation frequency (#/year)

Urban load is calculated based on the loading from nine separate land use categories: commercial, industrial, institutional, transportation, multi-Family, single-Family, urban-Cultivated, vacant (developed) and open space. The surface runoff depth for each urban category is calculated using Equation 5.

3. Nutrient Load from Runoff

Urban

The following equations refers to the total load calculation for urban land. The loading is calculated using the calculated annual runoff volume and assumed nutrient EMC concentration in runoff for each of the nine urban land use categories:

$$W_N = [V \cdot C_N] \times 4{,}047 \cdot \frac{0.3048}{1000}$$ *Equation 7*

$$W_P = [V \cdot C_P] \times 4{,}047 \cdot \frac{0.3048}{1000}$$ *Equation 8*

$$W_{BOD} = [V \cdot C_{BOD}] \times 4{,}047 \cdot \frac{0.3048}{1000}$$ *Equation 9*

$$W_{TSS} = [V \cdot C_{TSS}] \times 4{,}047 \cdot \frac{0.3048}{1000}$$ *Equation 10*

Conversion factor: acre-feet and mg/L to kilograms (Kg) = 4,047 x (0.3048/1000) *Equation 11*

$$\frac{4{,}047 m^2}{1\ ac} \times \frac{0.3048\ m}{1\ ft} \times \frac{10^3\ L}{1\ m^3} \times \frac{1\ Kg}{10^6\ mg}$$

Where:

W_N, W_P, W_{BOD}, W_{TSS} = annual N, P, BOD, and TSS (sediment) loads from urban land (Kg)

V = the total calculated annual runoff volume from the various urban land use categories (acre-feet)

C_N, C_P, C_{BOD}, C_{TSS} = urban pollutant (N, P, BOD, and TSS) concentration in runoff in mg/L

Cropland and Pasture

The following equations refer to the total load calculation for cropland and pastureland. The loading is calculated using the calculated annual runoff and assumed nutrient concentration in runoff.

$$W_N = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_N + \left(\frac{N_m}{12}\right) \cdot C_{N_{mn}}\right] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 12*

$$W_P = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_P + \left(\frac{N_m}{12}\right) \cdot C_{P_{mn}}\right] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 13*

$$W_{BOD} = V \times \left[\left(1 - \frac{N_m}{12}\right) \cdot C_{BOD} + \left(\frac{N_m}{12}\right) \cdot C_{BOD_{mn}}\right] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 14*

Conversion factor: acre-feet and mg/L to pounds (lbs) = 4,047 x (0.3048/454)

$$\frac{4{,}047 m^2}{1\ ac} \times \frac{0.3048\ m}{1\ ft} \times \frac{1000\ L}{1\ m^3} \times \frac{1\ lb}{454{,}000\ mg}$$ *Equation 15*

Where:

W_N, W_P, W_{BOD} = annual N, P, and BOD loads from cropland and pastureland (lbs)

V = the calculated annual runoff volume (acre-feet)

N_m = number of months manure is applied

C_N, C_P, C_{BOD} = N, P or BOD nutrient concentration in agricultural area or pasture area in mg/L

C_{N_nm}, C_{P_mn}, C_{BOD_mn} = N, P or BOD nutrient concentration in manured agricultural area or manured pasture area in mg/L

Note that nutrient concentrations are calculated based on the input of the number of agricultural animals in the watershed. Animal Equivalent Counts (AEU; 1 AEU = 1000 lb/ac) are first calculated based on typical animal mass (lb) and counts of animals. The calculated AEU for each watershed is then used to estimate the nutrients in cropland and pastureland runoff based on literature values (for manured and non-manured areas).

Forested and User Defined

The forested and user-defined land use annual runoff loading is calculated using the annual runoff and assumed nutrient concentration in runoff for forested land use.

$$W_N = [V \cdot C_N] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 16*

$$W_P = [V \cdot C_P] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 17*

$$W_{BOD} = [V \cdot C_{BOD}] \times 4{,}047 \cdot \frac{0.3048}{454}$$ *Equation 18*

Conversion factor: acre-feet and mg/L to lbs = 4,047 x (0.3048/454)

$$\frac{4{,}047 m^2}{1\ ac} \times \frac{0.3048\ m}{1\ ft} \times \frac{1000\ L}{1\ m^3} \times \frac{1\ lb}{454{,}000\ mg}$$ *Equation 19*

Where:

W_N, W_P, W_{BOD} = annual N, P and BOD loads from forested or user-defined land use (lbs)

V = the calculated annual runoff volume (acre-feet)

C_N, C_P, C_{BOD} = N, P or BOD nutrient concentration in forested or user-defined land use area

4. Sediment Loading Calculations

Sediment loads (from cropland, pastureland, forest, and user-defined land uses) are calculated based on the RUSLE2 equation and sediment delivery ratio. Additional information on the derivation of updated RUSLE2 factor values can be found in the PLET supporting documentation titled *Revised Universal Soil Loss Equation Version 2 (RUSLE2) Factor Updated* (2024) on the PLET help materials menu. The RUSLE2 equation to calculate the mean annual soil loss is calculated as follows:

$$E = R \cdot K \cdot LS \cdot C \cdot P \cdot DA$$ *Equation 20*

Where:

E = the computed annual soil loss (sheet and rill erosion) in tons/year

R = the rainfall factor (unitless)

K = the soil erodibility factor (unitless)

LS = the topographic factor which combines the slope length and gradient (unitless)

C = the cropping management factor (unitless)

P = the erosion control practice factor (unitless)

A = area of land use (acres)

$$W_{sed} = E \cdot DR$$ *Equation 21*

Where:

DR = sediment delivery ratio (unitless)

W_{sed} = sediment load in tons/year

Sediment delivery ratio is calculated using:

$$DR = 0.42 \cdot A_W^{-0.125} \qquad if\ watershed\ area < 200\ acres$$ *Equation 22*

$$DR = 0.417662 \cdot A_W^{-0.134958} - 0.127097 \quad if\ watershed\ area > 200\ acres$$ *Equation 23*

Where:

A_W = watershed area (mi^2)

PLET calculates only the sheet and rill erosion using RUSLE2. Gully erosion and stream bank erosion are calculated separately.

5. Nutrient and Sediment Runoff Loads with BMP application

Pasture, Forested, and User-Defined

The nutrient, BOD, and sediment load calculations after BMP application for pasture, forest and user-defined land use are below:

$$W_{N1} = W_N - W_N \cdot e + SED_N \times 2{,}000 \qquad \textit{Equation 24}$$

$$W_{P1} = W_P - W_P \cdot e + SED_P \times 2{,}000 \qquad \textit{Equation 25}$$

$$W_{BOD1} = W_{BOD} - W_{BOD} \cdot e + SED_{BOD} \times 2{,}000 \qquad \textit{Equation 26}$$

$$SED = E \cdot DR\ (1 - e) \qquad \textit{Equation 27}$$

Conversion factor: tons to lbs

$$\frac{2{,}000\ lbs}{1\ ton} \qquad \textit{Equation 28}$$

Where:

W_N, W_P, W_{BOD} = annual N, P, or BOD loads (lbs)

SED = sediment load (lbs/year)

SED_N, SED_P, SED_{BOD}, are the nutrient loading (tons/year) from the sediment

SED_N, SED_P, and SED_{BOD} are calculated as follows:

$$SED_N = E \cdot DR\ (1 - e) \cdot \%soil\ N\ conc \cdot \frac{2}{100} \qquad \textit{Equation 29}$$

$$SED_P = E \cdot DR\ (1 - e) \cdot \%soil\ P\ conc \cdot \frac{2}{100} \qquad \textit{Equation 30}$$

$$SED_{BOD} = E \cdot DR\ (1 - e) \cdot \%soil\ BOD\ conc \cdot \frac{2}{100} \qquad \textit{Equation 31}$$

Where:

e = BMP efficiency (0 to 1)

Cropland

The nutrient, BOD and sediment load calculations after BMP application for cropland are:

$$W_{N1} = (W_N - (V_{irr} \cdot C_N) \times 4{,}047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_N) \times 4{,}047 \cdot 0.3048/454 + SED_N \times 2{,}000$$ *Equation 32*

$$W_{P1} = (W_N - (V_{irr} \cdot C_P) \times 4{,}047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_P) \times 4{,}047 \cdot 0.3048/454 + SED_P \times 2{,}000$$ *Equation 33*

$$W_{BOD1} = (W_{BOD} - (V_{irr} \cdot C_{BOD}) \times 4{,}047 \cdot 0.3048/454) \cdot e + (V_{irr} \cdot C_{BOD}) \times 4{,}047 \cdot 0.3048/454 + SED_{BOD} \times 2{,}000$$ *Equation 34*

Where:

C_N, C_P, C_{BOD} = N, P, or BOD nutrient concentration in the agricultural area

Urban

The nutrient, BOD, and sediment load calculations after BMP application for urban land uses are given below. A separate loading value is calculated for each of the urban land use categories depending on whether a BMP is applied to it or not. The resulting loading from each of the nine urban land use categories is then summed up to calculate the total urban load.

$$W_{N1} = W_N - W_N \cdot e \cdot \%A_{eff}$$ *Equation 35*

$$W_{P1} = W_P - W_P \cdot e \cdot \%A_{eff}$$ *Equation 36*

$$W_{BOD1} = W_{BOD} - W_{BOD} \cdot e \cdot \%A_{eff}$$ *Equation 37*

$$W_{TSS1} = W_{TSS} - W_{TSS} \cdot e \cdot \%A_{eff}$$ *Equation 38*

Where:

W_{N1}, W_{P1}, W_{BOD1}, W_{TSS1} = annual N, P, BOD and TSS (sediment) loads from urban land (Kg) after application of BMP

W_N, W_P, W_{BOD}, W_{TSS} = annual N, P, BOD and TSS (sediment) loads from urban land (Kg)

e = BMP efficiency application to the urban land use category

$\%A_{eff}$ = percentage of BMP effective area for each of the urban land use categories

$$\text{Total N Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2.2 \times \sum_{i=1}^{9} W_{N1}$$ *Equation 39*

$$\text{Total P Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2.2 \times \sum_{i=1}^{9} W_{P1}$$ *Equation 40*

$$\text{Total BOD Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2.2 \times \sum_{i=1}^{9} W_{BOD1}$$ *Equation 41*

$$\text{Total TSS Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2.2 \times \sum_{i=1}^{9} W_{TSS1}$$ *Equation 42*

Conversion factor: kilograms (Kg) to lb

$$\frac{2.2\ lb}{1\ kg}$$ *Equation 43*

Where:

i refers to each individual urban land use category

PLET also calculates the flow volume reductions for selected urban LID and infiltration BMP practices for each of the urban land use categories.

The approach involves calculating BMP storage capacity and the runoff volume per event. The computed BMP storage capacity is then compared with the runoff volume per event to determine the captured volume per event for the BMP (based on the minimum of both the computed volumes).

$$\text{BMP storage capacity (ac} - \text{ft)} = \text{DA} \cdot \text{PI} \cdot \frac{\text{RD}}{12}$$ *Equation 44*

$$\text{Runoff volume per event (ac} - \text{ft)} = \text{DA} \cdot \text{PI} \cdot \frac{\text{P}}{12}$$ *Equation 45*

$$\text{Captured volume per event} = \text{minimum}(\text{BMP storage capacity}, \text{Runoff volume})$$ *Equation 46*

$$\text{Captured volume per year (gal)} = \left(\text{Per}_{\text{captured}_{\text{Vol}_{\text{per}_{\text{Event}}}}} / 100 \cdot \text{DA}_{\text{Runoff}_{\text{volume}}}\right) \times 325{,}850.58$$ *Equation 47*

Conversion factor: acre-feet to gallons (gal)

$$\frac{325{,}850.58\ gal}{1\ ac - ft}$$ *Equation 48*

Where:

DA = BMP drainage area (acre)

PI = percent imperviousness within the drainage area, assuming 100% by default (%)

RD = impervious area runoff depth to be captured (in)

P = rainfall (in) per event

$$\text{Percent Captured Volume per Event} = \left(\text{BMP storage} \frac{\text{capacity}}{\text{Runoff}} \text{volume per event}\right) \text{x100}$$ *Equation 49*

Note that when the capture volume per event is equal to the runoff volume in Equation 46, then the percent captured volume is 100%.

$$\text{DA}_{\text{Runoff}_{\text{volume}}} = \text{LU}_{\text{Runoff}_{\text{volume}}} * \text{BMPDAAr} - \text{LUArea}$$ *Equation 50*

PLET also provides an estimate of the required BMP surface area or the required number of BMP units, depending on the type of BMP chosen.

$$\text{Required BMP surface area (acres)} = \frac{\text{BMP storage capacity(ac–ft)}}{\text{Typical design BMP storage depth(ft)}}$$ *Equation 51*

$$\text{Required BMP units} = \frac{\text{BMP storage capacity(ac–ft)} \cdot 325{,}850.58 \left(\frac{\text{gal}}{\text{acft}}\right)}{\text{Typical design unit volume (e.g., rain barrel) (gal)}}$$ *Equation 52*

6. Groundwater Infiltration

Groundwater infiltration is estimated as a fraction of the precipitation. PLET uses reference soil infiltration fractions for precipitation (P) for the various land uses based on hydrologic soil group to calculate the amount of infiltration to groundwater.

$$Infiltration\ (in) = Infiltration\ Fraction\ \times P\ (in) \qquad \text{Equation 53}$$

The volume of groundwater infiltration is then calculated as follows:

$$Infiltration\ Volume\ (ac\text{–}ft) = \frac{Infiltration\ (in)}{12} \times A\ (ac) \times (Rdays \cdot RD_{cor}) \qquad \text{Equation 54}$$

Note that to calculate the amount infiltrated for urban areas, the pervious areas are first calculated. The pervious area is calculated based on the difference between the total urban area and impervious area. The impervious area is calculated based on assumed percent imperviousness for the various urban land use categories.

$$\begin{aligned} Pervious\ Urban\ Area(ac) &= Total\ Urban\ Area \\ &- (\text{Commercial} \cdot 0.85 + \text{Industrial} \cdot 0.7 + \text{Institutional} \cdot 0.5 + \text{Transportation} \cdot 0.95 \\ &+ \text{Multi Family} \cdot 0.75 + \text{Single Family} \cdot 0.3 + \text{Urban Cultivated} \cdot 0.01 + \text{Vacant developed} \\ &\cdot 0.7 + \text{Open Space} \cdot 0.01) \end{aligned} \qquad \text{Equation 55}$$

Infiltrated groundwater volumes from feedlot areas are calculated using the calculated infiltration from urban areas and the feedlot pervious area. The feedlot pervious area is calculated based on the contribution from feedlot areas and a fraction based on feedlot percent paved area as shown below:

$$Feedlot\ Pervious\ Area(ac) = Feedlot\ Area\ pervious\ \times\ fraction\ based\ on\ feedlot\ \%\ paved \qquad \text{Equation 56}$$

Feedlot Percent Paved and associated fraction used in PLET:

Percent paved	Pervious fraction
0%–24%	0.875
25%–49%	0.625
50%–74%	0.375
75%–100%	0.125

7. Feedlot Calculations

Pollutant loads from feedlots in PLET are based on animal types, weight and average rainfall. Runoff volumes from the feedlots are calculated based on contributing area in acres, feedlot percent paved and the average event rainfall in inches.

$$V\ (ac-in) = Q\ (in) \cdot A(ac)$$ *Equation 57*

Where:

A = contributing feedlot area (acres)

Q = surface runoff (inches) and is calculated as

The surface runoff (Q) calculations are based on the Natural Resources Conservation Service runoff curve number method. Note that the CN used in the runoff calculations is estimated based on the selected range of percent imperviousness in the feedlot, based on the table below.

Impervious range	CN applied
0%–24%	91
25%–49%	92
50%–74%	93
75%–100%	94

Nutrient contributions in cropland from animals are used to derive load estimates for feedlots. The equivalent animal units (EAU) for N, P and BOD are first calculated using the equation below for each watershed.

$$EAU = No. \times Factor$$ *Equation 58*

Where:

No. = number of animals

Factor = ratio of nutrients produced by animals relative to 1,000 lb. of slaughter steer

The Animal Unit Density (AUD) and % manure pack are calculated using the following equation:

Equation 59

$$AUD = EAU — A$$

If AUD < 100, percent manure pack = AUD;

If AUD > 100, percent of manure pack = 100%

Finally, the pollutant concentration of in the feedlot runoff is calculated using the following equation:

$$C_{feedlot} = Fraction\ of\ manure\ pack \times Constant$$ *Equation 60*

Where:

$C_{feedlot}$ = runoff concentration from Feedlot (mg/L)

Fraction of manure pack = manure pack/100

The constant is pollutant-specific and based on 100% manure pack. N constant = 1,500 mg/L, P constant = 300 mg/L and BOD constant = 2,000 mg/L

The calculated runoff volume and concentration from feedlots (Equation 57 and Equation 60) are then used to calculate the feedlot loading.

$$W_{feedlot}\left(\frac{lb}{year}\right) = V\ (ac\text{–}\ in) \cdot\ (Rdays \cdot RD_{cor}) \cdot C_{feedlot}\left(\frac{mg}{L}\right) \cdot 0.227$$ *Equation 61*

Conversion factor: acre-inches (ac-in) and mg/L to lb/year = 0.227

$$\frac{4{,}047m^2}{1\ ac} \times \frac{0.0254\ m}{1\ in} \times \frac{1{,}000\ L}{1\ m^3} \times \frac{1\ lb}{454{,}000\ mg}$$ *Equation 62*

8. Septic Load

The septic load is calculated as the sum of the failing septic load and the direct wastewater loading (in lbs/hour [hr])

$$\text{Septic Load}\left(\frac{\text{lb}}{\text{year}}\right) = \left[\text{Failing Septic Load}\left(\frac{\text{lb}}{\text{hr}}\right) + \text{Direct Wastewater Load}\left(\frac{\text{lb}}{\text{hr}}\right)\right] \times 24\ (\text{hours}) \times 365(\text{days})$$ *Equation 63*

The failing septic load and direct wastewater load calculations are shown below.

Failing Septic Load

The failing septic load is calculated using the failing septic flow and an average concentration reaching the stream from septic overcharge. The failing septic flow is calculated using the number of septic systems (tanks), the failure rates (percentage) and the ratio of persons per septic system.

$$\text{Failing Septic Load}\left(\frac{\text{lb}}{\text{hr}}\right) = \frac{\left[\text{Failing Septic Flow}\left(\frac{\text{L}}{\text{hr}}\right) \times \text{Avg. concentration reaching stream from septic overcharge}\left(\frac{\text{mg}}{\text{L}}\right)\right]}{453{,}592}$$ *Equation 64*

Where:

$$\text{Failing Septic Flow}\left(\frac{\text{L}}{\text{hr}}\right) = \text{Population of Failing Septic (persons)} \times \text{Typical Septic Overcharge Flow Rate}\left(\frac{\frac{\text{gal}}{\text{day}}}{\text{person}}\right) \times \left(\frac{3.785}{24}\right)$$ *Equation 65*

Conversion factor: L/hr and mg/L to lb/hr *Equation 66*

$$\frac{1\ lb}{453{,}592\ mg}$$

Gallon (gal)/day to L/hr *Equation 67*

$$\frac{3.785\ L}{1\ gal} \times \frac{1\ day}{24\ hr}$$

The population of failing septic is calculated as follows:

$$\text{Population of Failing Septic (persons)} = \text{No. of Septic Systems} \times \text{Population per Septic System} \times \text{Septic Failure Rate\%}$$ *Equation 68*

The typical septic overcharge flow rate in PLET is 70 gal/day/person (range of 45–100).

The average concentrations reaching the stream from septic overcharge are determined based on ranges observed in literature for total nitrogen (TN), total phosphorous (TP), and organics (BOD) (as specified in the PLET model).

Direct Wastewater Load

$$\text{Direct Wastewater Load}\left(\frac{\text{lb}}{\text{hr}}\right) = \frac{\left[\text{Direct Wastewater Flow}\left(\frac{\text{L}}{\text{hr}}\right) \times \text{Avg. concentration}\left(\frac{\text{mg}}{\text{L}}\right)\right]}{453592}$$ *Equation 69*

Conversion factor: L/hr and mg/L to lb/hr

$$\frac{1\ lb}{453{,}592\ mg}$$ *Equation 70*

The direct wastewater flow is calculated based on per capita flow 75 gal/day/person (range of 75–125) and the specified direct discharge population as:

$$\text{Direct Wastewater Flow}\left(\frac{\text{L}}{\text{hr}}\right) = \text{per capita flow}\left(\frac{\frac{\text{gal}}{\text{day}}}{\text{person}}\right) \times \text{direct discharge population(persons)} \times \left(\frac{3.785412}{24}\right)$$ *Equation 71*

Conversion factor: gal/day to L/hr

$$\frac{3.785\ L}{1\ gal} \times \frac{1\ day}{24\ hr}$$ *Equation 72*

The average concentrations reaching the stream from wastewater load as specified in PLET for TN, TP and organics (BOD).

9. Gully Erosion Load

The annual load due to gully erosion (GE) for each watershed is calculated as the sum of all the impaired gully loading as follows:

$$\text{GE Sediment Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \sum_{i=1}^{n}\left[(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \frac{\frac{\text{Wt}}{\text{T}}}{2}\right]$$ *Equation 73*

$$\text{GE Nitrogen Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil N Conc} \times \sum_{i=1}^{n}\left[(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \frac{\frac{\text{NCF}}{\text{T}}}{2}\right]$$ *Equation 74*

$$\text{GE Phosphorous Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil P Conc} \times \sum_{i=1}^{n}\left[(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \frac{\frac{\text{NCF}}{\text{T}}}{2}\right]$$ *Equation 75*

$$\text{GE BOD Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil BOD Conc} \times \sum_{i=1}^{n}\left[(\text{TW} + \text{BW}) \cdot \text{D} \cdot \text{L} \cdot \text{Wt} \cdot \frac{\frac{\text{NCF}}{\text{T}}}{2}\right]$$ *Equation 76*

Conversion factor:

$$\frac{2{,}000\ lb}{1\ ton}$$ *Equation 77*

Where:

TW = top width (ft)

BW = bottom width (ft)

D = depth (ft)

L = length (ft)

Wt. = soil dry weight (ton/cubic foot [$ft^{3]}$) – based on soil textural class

NCF = nutrient correction factor – based on soil textural class

T = time (number of years) that the gully has taken to form the current size

PLET uses default 0.08, 0.031 and 0.160 percent soil nitrogen, phosphorous and BOD values, respectively, which can be updated.

The gully erosion load reduction is calculated using a specified BMP efficiency due to gully stabilization (0 to 1) as follows:

$$\text{GullyErosionLoad Reduction} = \text{GullyErosionLoad} \times \text{BMP Efficiency}$$ *Equation 78*

10. Impaired Streambank Load

The annual load due to Streambank (SB) Erosion for each watershed is calculated as the sum of the all the impaired stream bank loading as follows:

$$\text{SB Sediment Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \sum_{i=1}^{n} \text{L} \cdot \text{H} \cdot \text{LRR} \cdot \text{Wt}$$ *Equation 79*

$$\text{SB Nitrogen Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil N Conc} \times \sum_{i=1}^{n} \text{L} \cdot \text{H} \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF}$$ *Equation 80*

$$\text{SB Phosphorous Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil P Conc} \times \sum_{i=1}^{n} \text{L} \cdot \text{H} \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF}$$ *Equation 81*

$$\text{SB BOD Load}\left(\frac{\text{lb}}{\text{year}}\right) = 2{,}000 \times \%\ \text{Soil BOD Conc} \times \sum_{i=1}^{n} \text{L} \cdot \text{H} \cdot \text{LRR} \cdot \text{Wt} \cdot \text{NCF}$$ *Equation 82*

Conversion factor:

$$\frac{2{,}000\ lb}{1\ ton}$$ *Equation 83*

Where:

L = length (ft)

H = height (ft)

LRR = lateral recession rate (ft/year) – based on categorization of LRR (i.e., slight, moderate, severe or very severe)

Wt. = soil dry weight (ton/ft^3) – based on soil textural class

NCF = nutrient correction factor – based on soil textural class

PLET uses default 0.08, 0.031, and 0.160 percent soil nitrogen, phosphorous and BOD values, respectively.

The streambank load reduction is calculated using a specified BMP efficiency due to stream bank stabilization (0 to 1) as follows:

$$\text{StreamBankLoad Reduction} = \text{StreamBankErosionLoad} \times \text{BMP Efficiency}$$ *Equation 84*

11. Protected Lands Prevented Loads and Runoff Volume

The prevented loads are calculated as the difference between the loading if the land were to be converted to urban, cropland or pastureland (i.e., the avoided land uses) and the existing forest land use. Prevented runoff volume is calculated in the same manner as the difference in runoff volume from the avoided land use and the existing forest land use.

1.2 Nutrient and Sediment Pollutant Loads Prevented

Urban

$$W_{prevented\ N(U)} = (2.2 \times W_{N(U)}) - W_{N(F)}$$ *Equation 85*

$$W_{prevented\ P(U)} = (2.2 \times W_{P(U)}) - W_{P(F)}$$ *Equation 86*

$$W_{prevented\ BOD(U)} = (2.2 \times W_{BOD(U)}) - W_{BOD(F)}$$ *Equation 87*

$$W_{prevented\ TSS(U)} = (\frac{2.2}{2{,}000} \times W_{TSS(U)}) - (W_{SED(F)})$$ *Equation 88*

Conversion factor: Kg to lb

$$\frac{2.2\ lb}{1\ kg}$$ *Equation 89*

Conversion factor: Kg to tons

$$\frac{2.2\ lb}{1\ kg} \times \frac{1\ ton}{2{,}000\ lb}$$ *Equation 90*

Where:

$W_{N(U)}$, $W_{P(U)}$, $W_{BOD(U)}$, W_{TSS} = annual N, P, BOD and TSS (sediment) loads from urban land (Kg)

$W_{Sed(F)}$ = annual sediment load from forest (tons)

$W_{N(F)}$, $W_{P(F)}$, $W_{BOD(F)}$ = annual N, P and BOD loads from forest (lbs)

$W_{prevented\ N(U)}$, $W_{prevented\ P(U)}$, $W_{prevented\ BOD(U)}$ = annual N, P and BOD loads prevented by avoiding changing the forest land use to urban (lbs)

$W_{prevented\ TSS(U)}$ = sediment load prevented by avoiding changing the forest land uses to urban (tons)

Cropland and Pasture

$$W_{prevented\ N(C)} = W_{N(C)} - W_{N(F)}$$ *Equation 91*

$$W_{prevented\ P(C)} = W_{P(C)} - W_{P(F)}$$ *Equation 92*

$$W_{prevented\ BOD(C)} = W_{BOD(C)} - W_{BOD(F)}$$ *Equation 93*

$$W_{prevented\ sed(C)} = W_{sed(C)} - W_{sed(F)}$$ *Equation 94*

$$W_{prevented\ N(P)} = W_{N(P)} - W_{N(F)}$$ *Equation 95*

$$W_{prevented\ P(P)} = W_{P(P)} - W_{P(F)}$$ *Equation 96*

$$W_{prevented\ BOD(P)} = W_{BOD(P)} - W_{BOD(F)}$$ *Equation 97*

$$W_{prevented\ sed(P)} = W_{sed(P)} - W_{sed(F)}$$ *Equation 98*

Where:

$W_{N(C)}$, $W_{P(C)}$, $W_{BOD(C)}$ = annual N, P and BOD loads from cropland (lbs)

$W_{N(P)}$, $W_{P(P)}$, $W_{BOD(P)}$ = annual N, P and BOD loads from pastureland (lbs)

$W_{N(F)}$, $W_{P(F)}$, $W_{BOD(F)}$ = annual N, P and BOD loads from forest (lbs)

$W_{sed(C)}$ = annual sediment load from cropland (tons)

$W_{sed(P)}$ = annual sediment load from pastureland (tons)

$W_{sed(F)}$ = annual sediment load from forest (tons)

$W_{prevented\ N(C)}$, $W_{prevented\ P(C)}$, $W_{prevented\ BOD(C)}$ = annual N, P and BOD loads prevented by avoiding changing the forest land use to cropland (lbs)

$W_{prevented\ N(P)}$, $W_{prevented\ P(P)}$, $W_{prevented\ BOD(P)}$ = annual N, P and BOD loads prevented by avoiding changing the forest land use to pastureland (lbs)

$W_{prevented\ sed(C)}$ = annual sediment loads prevented by avoiding changing the forest land use to cropland (tons)

$W_{prevented\ sed(P)}$ = annual sediment loads prevented by avoiding changing the forest land use to pastureland (tons)

Refer to Sections 3 and 4 for complete load equations. Equations 7 through 20 are used to calculate the nutrient and sediment loads.

1.3 Volume Prevented

The volume prevented is the difference between the annual runoff volume from the avoided land use and the annual runoff volume from the forest land use.

$$V_{prevented\ (U)} = V_{(U)} - V_{(F)}$$ *Equation 99*

$$V_{prevented\ (C)} = V_{(C)} - V_{(F)}$$ *Equation 100*

$$V_{prevented\ (P)} = V_{(P)} - V_{(F)}$$ *Equation 101*

Where:

$V_{(U)}$, $V_{(C)}$, $V_{(P)}$, $V_{(F)}$ = annual runoff volume (acre-feet) for urban, cropland, pastureland and forest land uses.

$V_{prevented\ (U)}$, $V_{prevented\ (C)}$, $V_{prevented\ (P)}$ = annual runoff volume (acre-feet) prevented by avoiding changing the forest land use to urban, cropland or pastureland

The area of the land use (acres) change avoided is applied in Equation 5 to obtain $V_{(U)}$, $V_{(C)}$, $V_{(P)}$, $V_{(F)}$

Refer to Section 1 for complete volume calculations. Equations 2 through 5 are used to determine the annual runoff volume for a given land use.