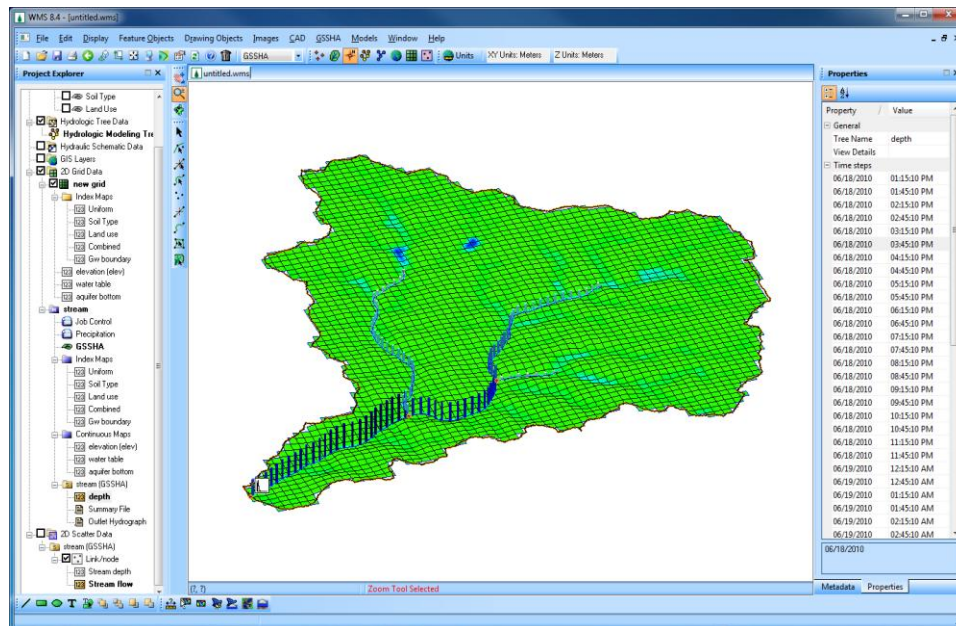


WMS 9.1 Tutorial

GSSHA – Applications – Simulating Constituent Transport

Model constituent transport in GSSHA



Objectives

Develop input parameters for and run a long-term model that simulates constituent transport both with and without sediment transport.

Prerequisite Tutorials

- GSSHA – Applications – Long Term Simulations in GSSHA

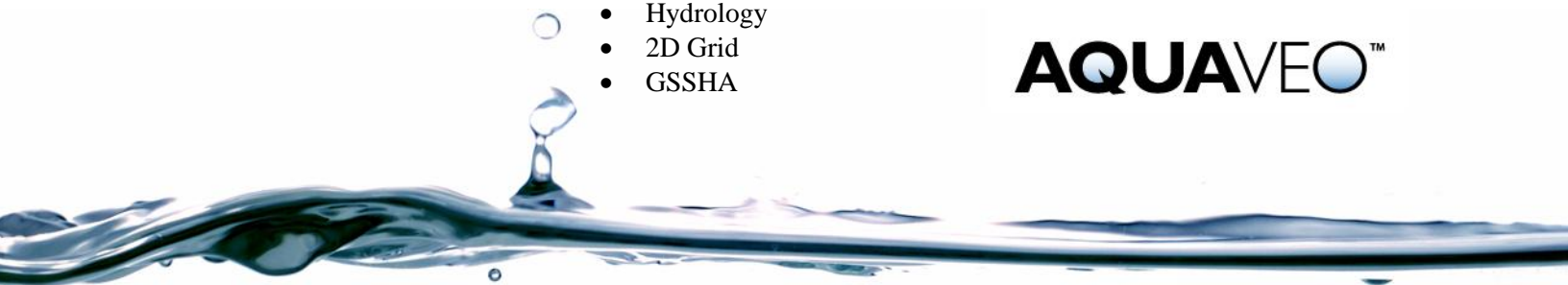
Required Components

- Data
- Drainage
- Map
- Hydrology
- 2D Grid
- GSSHA

Time

- 30-45 minutes

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2 Introduction

Two types of reactive constituent transport are available in GSSHA. Any constituent can be simulated as a simple first order reactant. The nutrient cycle can also be simulated with the Nutrient Simulation Model (NSM). In either case, the overall simulation methods within the GSSHA model are the same.

In this tutorial we will simulate total nitrogen and total phosphorous as simple first order reactants. First, we will create a constituent transport model without soil erosion and later add sediment transport to the model. This will allow us to look at the differences between only dissolved as well as coupled dissolved and sorbed transport.

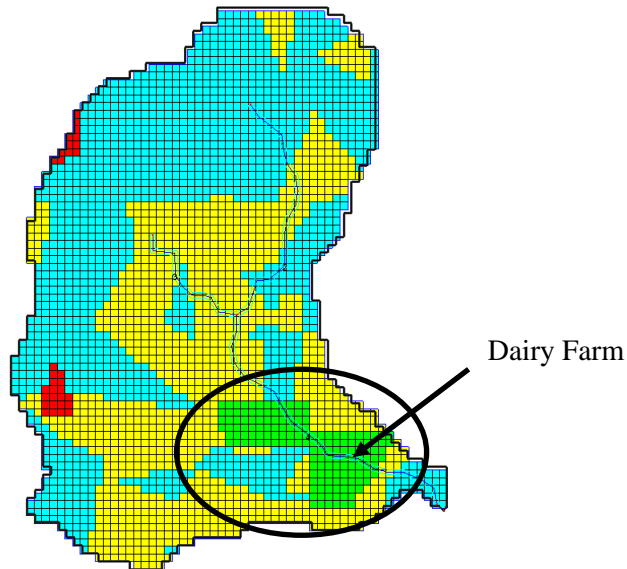
3 Open an Existing GSSHA Project

1. In the 2D Grid Module  select **GSSHA | Open Project File**.
2. Locate the ***GSSHA Distributed Hydrologic modeling*** folder in your tutorial files. If you have used default installation settings in WMS, the tutorial files will be located in ***|My documents|WMS 9.1|Tutorials|***.
3. Browse and open the project ***|GSSHA Distributed Hydrologic modeling|Contaminants|base.prj***.
4. Save the project with a different name as ***|GSSHA Distributed Hydrologic modeling|Personal|Contaminants|contaminant.prj*** so that the original project remains unchanged.
5. Turn off the display of all other coverages except the GSSHA coverage.

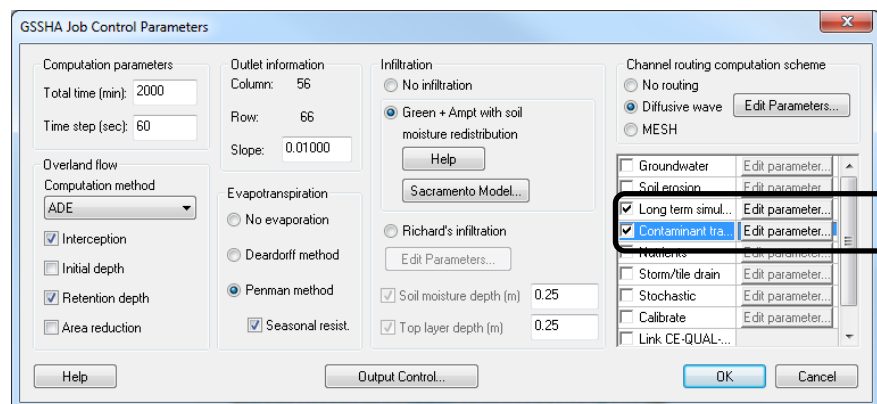
4 Adding Contaminants

In this exercise we will assume that there is a dairy farm as shown in the following index map which acts as a contaminant source in the watershed.

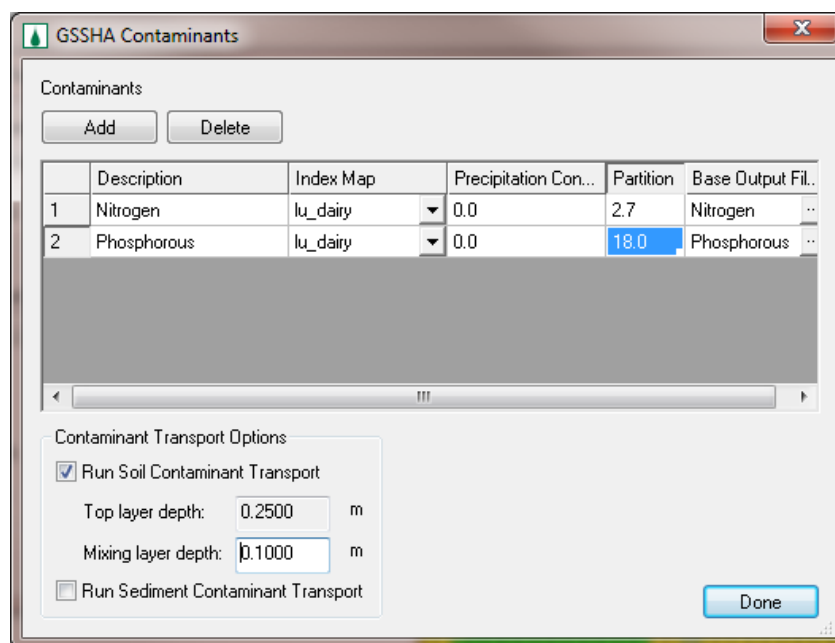
Constituent transport can be simulated on the overland flow plane, in the channel network including reservoirs, and in the soil column. These parameters are defined as shown below.



1. In *2D Grid Module*, select **GSSHA / Job Control**.
2. In the *Job Control* dialog, click on the check box next to *Contaminant Transport* to select it.

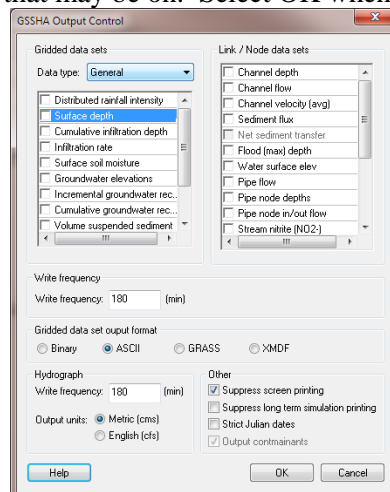


3. Click on the *Edit parameter* button for Contaminant Transport.
4. In the *GSSHA Contaminants* dialog that opens, click on the *Add* button twice to add two contaminants and enter the following information.



Note: The base output file column specifies the location of the output files that will be generated for each contaminant. These output files will be written in the same folder where your project files are located (in this case *GSSHA Distributed Hydrologic modelings\Personal\Contaminants*)

5. At the bottom of the dialog, check on *Run Soil Contaminant Transport* and click off *Run Sediment Contaminant Transport*.
6. Set the *Mixing layer depth* to 0.1 m
7. Click Done.
8. Still in the *Job Control* dialog, select output control.
9. Make sure that *Output Contaminants* in the lower right hand side of the dialogue under *Other* is selected (It may have been grayed out).
10. Select *Suppress screen printing*.
11. Check off any additional outputs under *Gridded Data Sets* and *Link/Node Data sets* that may be on. Select OK when finished.



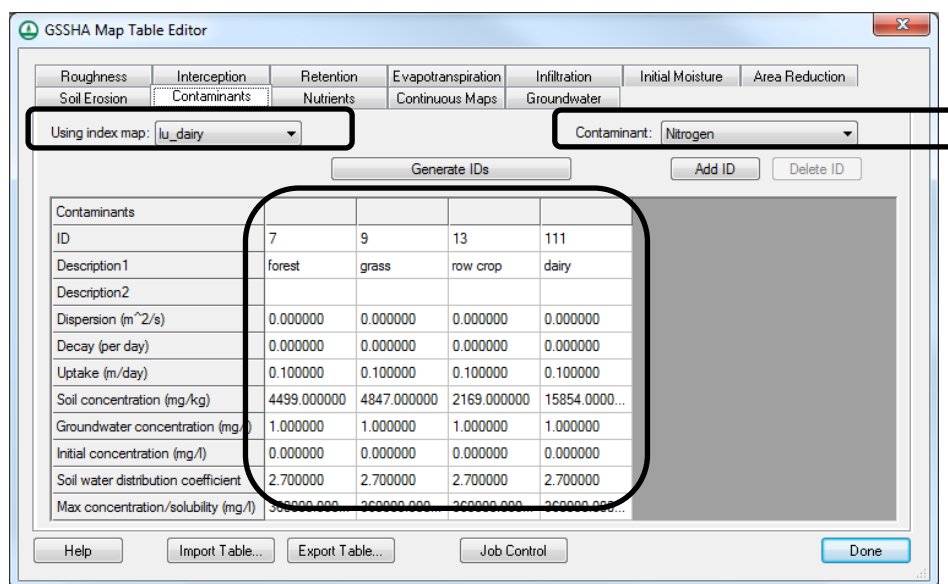
5 Defining Contaminants in the channels

1. In the *Job Control* dialog, click on Edit Parameters next to *Diffusive wave* channel Routing.
2. In *GSSHA Channel Routing Parameters* dialog that shows up, make sure that *Compute Contaminant Transport* is checked on and enter the following values:
 - Decay coefficient: 0.0
 - Dispersion coefficient: 0.0
 - Initial Concentration: 0.0
3. Click OK. This will define the conditions in the channel network.
4. Click OK to close the *Job control* dialog box.

6 Defining Contaminants parameters

1. Select *GSSHA / Map Tables*. Values for Roughness, Evapo-transpiration, Infiltration and Initial Moisture are already defined. Here we will define the parameters for the contaminants. If you recall, we had two contaminants Nitrogen and Phosphorous defined in previous step. We will have to define the parameters for both.
2. Select the *Contaminants Tab*. In *Using Index Map* drop down box, select “lu_dairy” and click *Generate IDs* button. This will generate 4 IDs.
3. The last column with ID 111 is the Dairy, you may rename the description field if you wish.
4. Enter the values in the spreadsheet for Nitrogen as shown in the following table.

ID	7	9	13	111
Description 1	forest	grass	row crop	dairy
Description 2				
Dispersion (m ² /s)	0.00	0.00	0.00	0.00
Decay (per day)	0.00	0.00	0.00	0.00
Uptake (m/day)	0.10	0.10	0.10	0.10
Soil concentration (mg/kg)	4499.00	4847.00	2169.00	15854.00
Groundwater concentration (mg/l)	1.00	1.00	1.00	1.00
Initial Concentration (mg/l)	0.00	0.00	0.00	0.00
Soil water distribution (L/kg)	2.70	2.70	2.70	2.70
Max concentration/solubility (mg/l)	360000.00	360000.00	360000.00	360000.00




5. From the *Contaminant* Drop down Menu select *Phosphorous* and select *lu_dairy* as the index map. Then click *Generate IDs*. Use the following table to fill the spreadsheet for Phosphorous.

ID	7	9	13	111
Description 1	forest	grass	row crop	dairy
Description 2				
Dispersion (m ² /s)	0.00	0.00	0.00	0.00
Decay (per day)	0.00	0.00	0.00	0.00
Uptake (m/day)	0.01	0.01	0.01	0.01
Soil concentration (mg/kg)	710.00	901.00	629.00	3115.00
Groundwater concentration (mg/l)	1.00	1.00	1.00	1.00
Initial Concentration (mg/l)	0.00	0.00	0.00	0.00
Soil water distribution (L/kg)	18.00	18.00	18.00	18.00
Max concentration/solubility (mg/l)	220000.00	220000.00	220000.00	220000.00

Note: More information about these parameters for the contaminants can be found on the GSSHA wiki

6. Note that phosphorous has a much greater affinity for soils, as indicated by the higher partition coefficient. It also has lower solubility and a lower uptake rate, so you would expect Nitrogen to be exported more from the watershed.
7. Click *Done* to close the *Mapping Table* dialog.

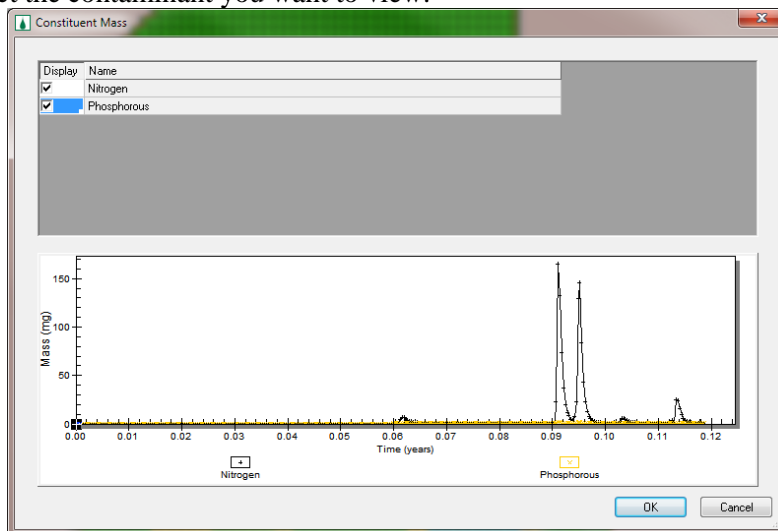
7 Save and Run

1. In the 2D Grid Module  select **GSSHA / Save Project File**.
2. Save the file as **|GSSHA Distributed Hydrologic modeling\Personal\Contaminants\contaminant.prj** and click yes to replace the existing file.
3. Select **GSSHA / Run GSSHA**.

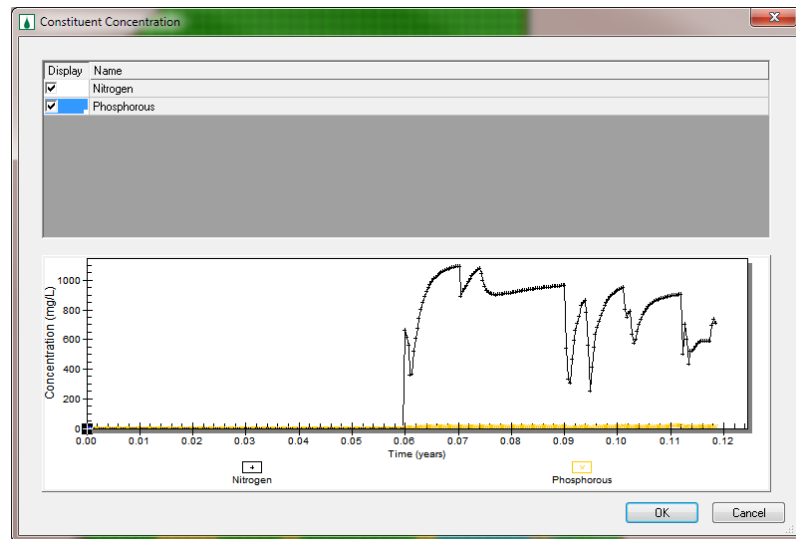
8 View Results

GSSHA generates contaminant maps for both the channel and the overland flow for all the constituents being modeled.

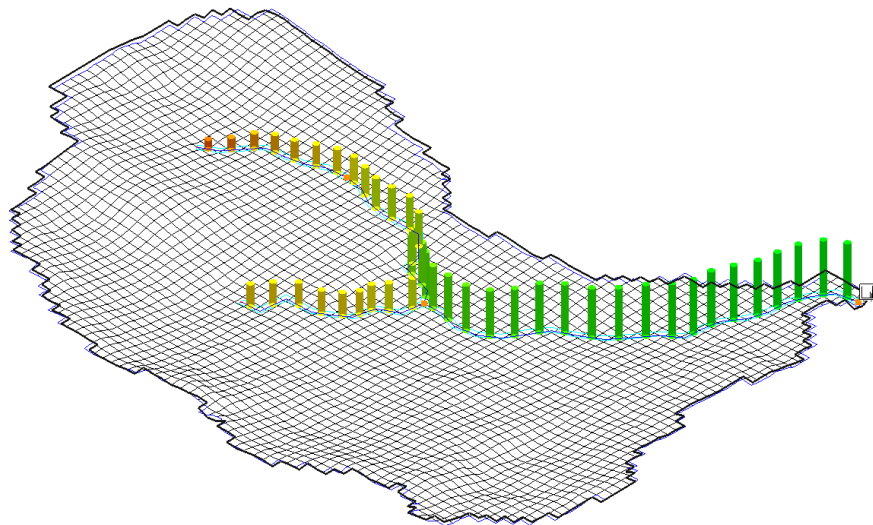
1. In the Project Explorer, right-click on the *Outlet Constituent Mass graph*, located below the GSSHA solution folder (the folder with the letter "S" on it) and select *View Graph*. In the window that opens, you have the option to select the contaminant you want to view.



2. Close the contaminant plot.
3. You can follow the same steps for the *Constituent Concentration graph*.



4. Visualize the Contaminant concentration and mass for both Nitrogen and Phosphorous by changing grid contour options.
5. Finally, from the display options, set the z-magnification and contour options for 2D scatter data and visualize the contaminant concentration and mass along the channel.




9 Adding Sediment Transport

Now, we will turn on the soil erosion and sediment transport in the constituent transport model that we developed in the previous step and see how it affects the constituent transport.

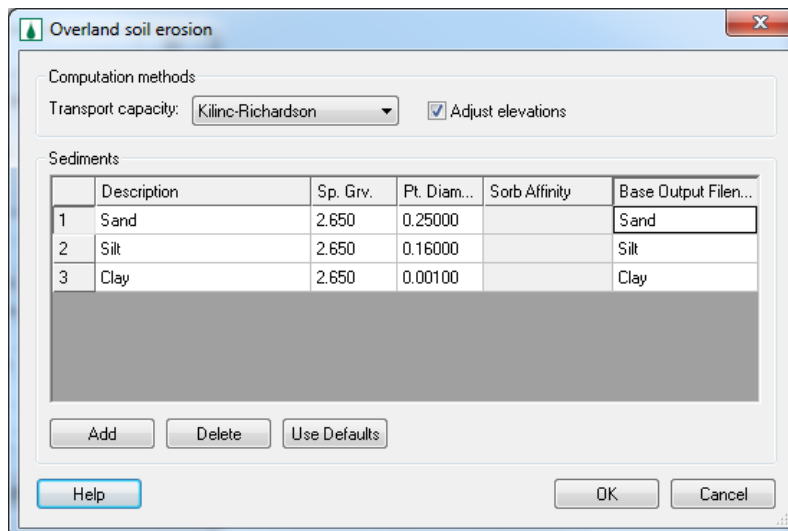
To save some time, a GSSHA project is already created that has sediments turned on and the constituents defined. You will modify this project and run it.

1. Open a new instance of WMS by clicking *New* button or select **File/New**.

2. Open GSSHA project |GSSHA Distributed Hydrologic modeling|Contaminants|ContaminantWSedBase.prj
3. Turn off the display of all other coverages except GSSHA coverage.
4. In the 2D Grid Module  select **GSSHA / Save Project File**.
5. Save the file as |GSSHA Distributed Hydrologic modeling|Personal|Contaminants|ContamWSed.prj

9.1 Sediment Parameters

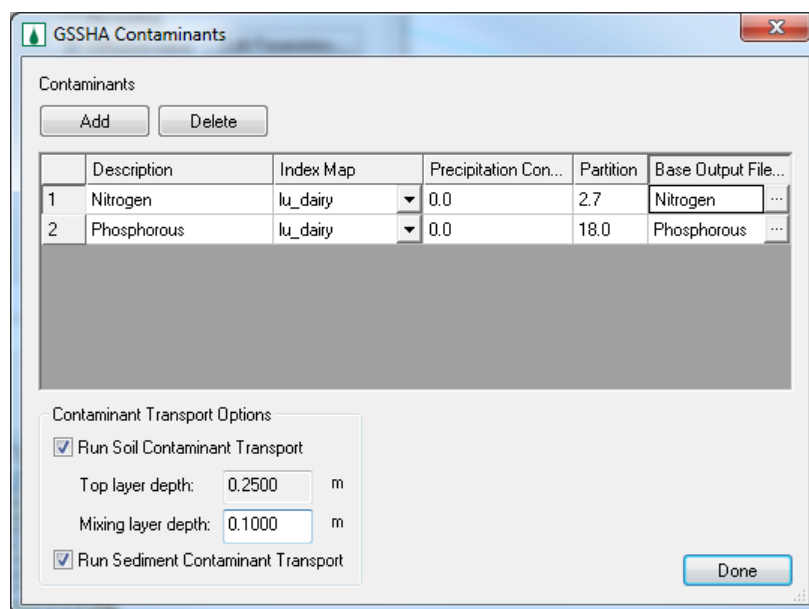
1. In the *GSSHA Job Control*, make sure that *Soil erosion* is turned on and click on *Edit Parameter*
2. Check and see if all the parameters are defined according to the following figure



3. Click OK.


9.2 Contaminant Parameters

1. Still in the *GSSHA Job Control* dialog, click on the *Edit Parameters* button next to the *Contaminant Transport* option.
2. Make sure that the parameters are defined as shown in the following figure.




3. Enter 0.1m for *Mixing Layer Depth*
4. Click *Done*.
5. Under *Job Control*, select *Output Control* ensure that output option for contaminants is turned on and it is off for all other outputs. Also select suppress printing to screen.
6. Click *OK* to close *Job Control* dialog.

9.3 Map Table Parameters

1. In the 2D Grid Module  select ***GSSHA/Map Tables***
2. Switch to the *Contaminants Tab* and make sure that the parameters for both *Nitrogen* and *Phosphorous* are defined.
3. Similarly, switch to the *Soil Erosion* tab, make sure the parameters are defined properly.
4. Click *Done*.

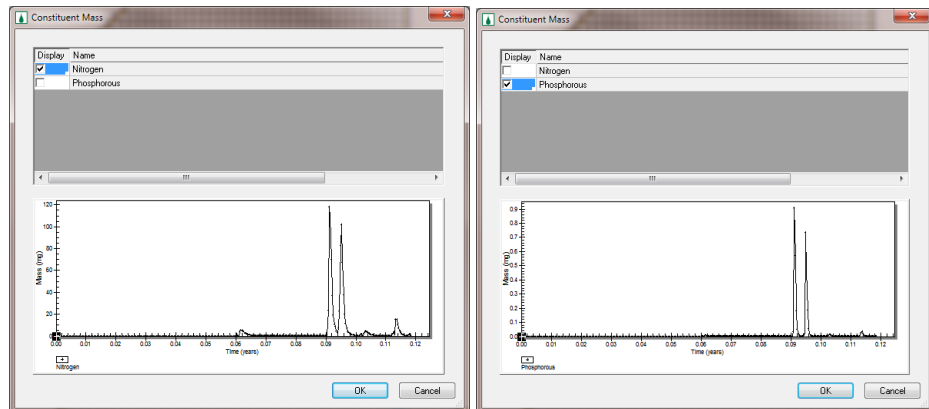
10 Save and Run

1. In the 2D Grid Module  select ***GSSHA / Save Project File***.
2. Save file as ***\\GSSHA Distributed Hydrologic modeling\\Personal\\Contaminants\\contamWSed.prj*** and click yes to replace the existing file.
3. Select ***GSSHA / Run GSSHA***.

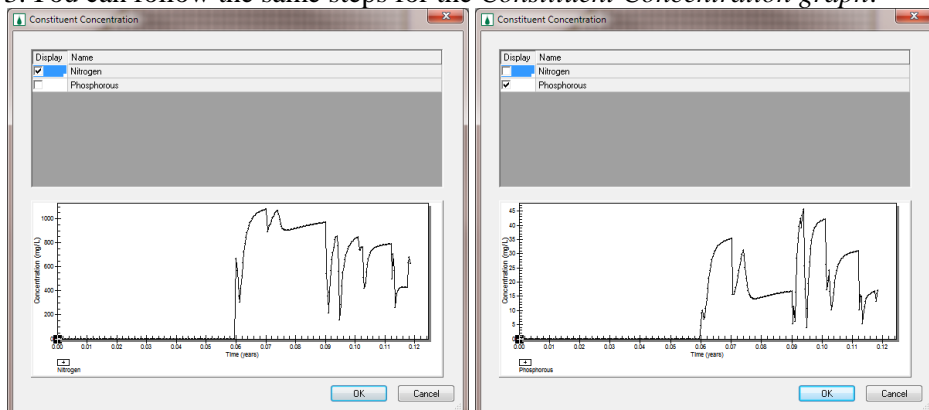
11 View Results

This will take little longer than the model with *Constituents only*. Once done running, GSSHA generates contaminant concentration and mass maps for both the channel and the overland flow for all the constituents being modeled.

1. In the Project Explorer, right-click on the *Outlet Constituent Mass* graph, located below the GSSHA solution folder (the folder with the letter "S" on it) and select *View Graph*. In the window that opens, you have the option to select the contaminant you want to view.



2. Close the contaminant plot.
3. You can follow the same steps for the *Constituent Concentration* graph.



4. Notice that while still smaller than nitrogen export, phosphorous export is increased when coupled with sediment transport, while nitrogen is little affected. This is due to differences between the constituents affinity for sediment particles.
5. View the sediment plots as well.

