

1. Introduction

This tutorial explains how to use some of the basic functionality of WAM. The user will learn how to enable the WAM extensions and show the WAM Toolbar, load scenarios, make changes to land use, and run the altered scenario. The user will then run WAM on the modified scenario and use tools to compare results between two scenarios.

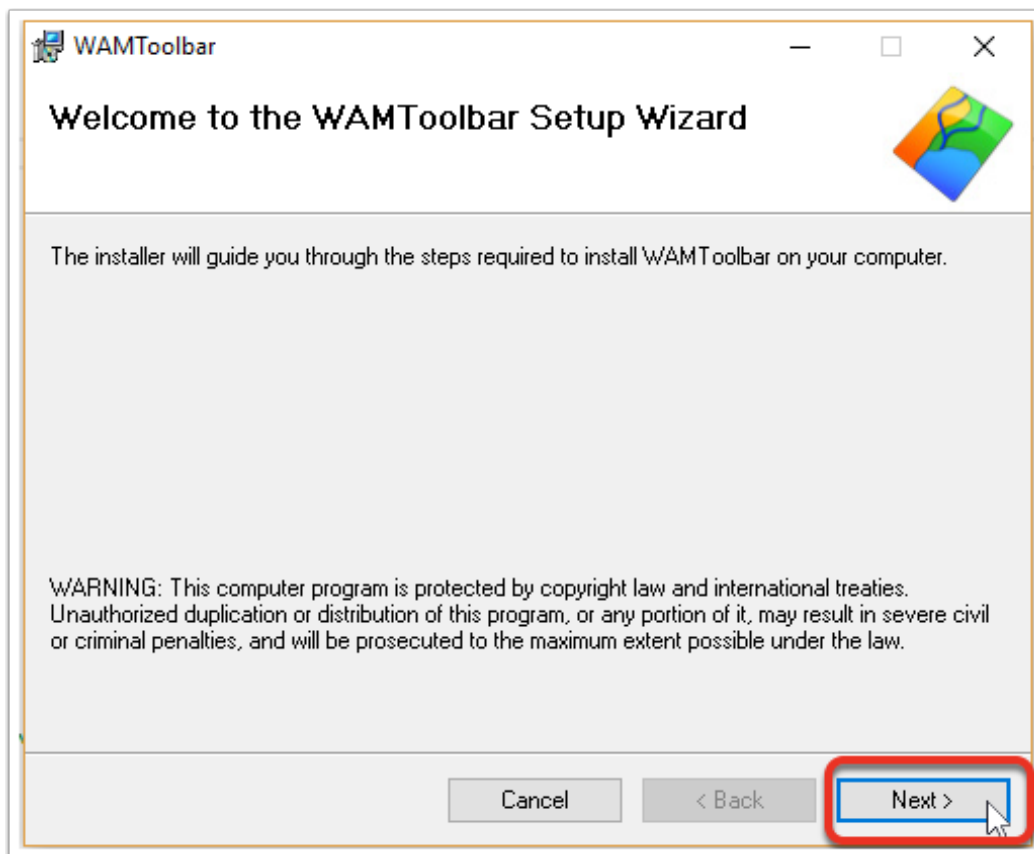
2. The Example Basin

The basin we will use for the examples is the L-48 basin within the Indian Prairie sub-watershed. This is a small basin in the south-east portion of the Indian Prairie sub-watershed that is drained by the S-127 pump, which discharges into Lake Okeechobee. This basin was incorporated into the larger Indian Prairie WAM setup to simulate the entire sub-watershed. Large basins, however, take more resources to work with, and take longer to simulate in WAM. In the interest of working with a manageable tutorial the L-48 basin was excised from the larger sub-watershed to function as a stand-alone simulation.



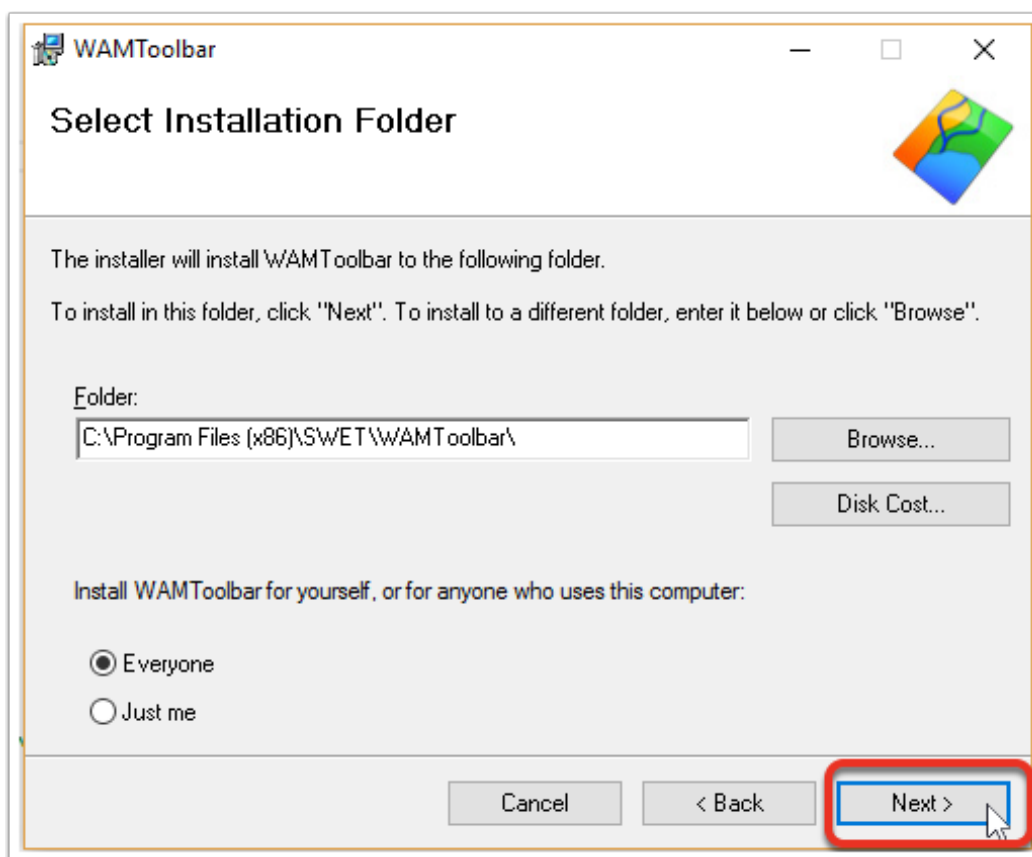
3. Installing the WAM Toolbar

The latest version of the WAM Toolbar is always available from our website at www.swet.com, under Software -> Download WAM for ArcGIS. Currently, the WAM Toolbar supports ArcGIS 10.3.1 and requires the Microsoft .NET framework 4.0. Your systems/GIS administrator may have already downloaded and installed the latest version of the toolbar. **If this is the case, skip to step 7.** If this is **not** the case, and you have to install it yourself, download it and unzip the installer. Then, double click the installer file "setup.exe". A welcome screen should appear. Click on "Next >" when ready.



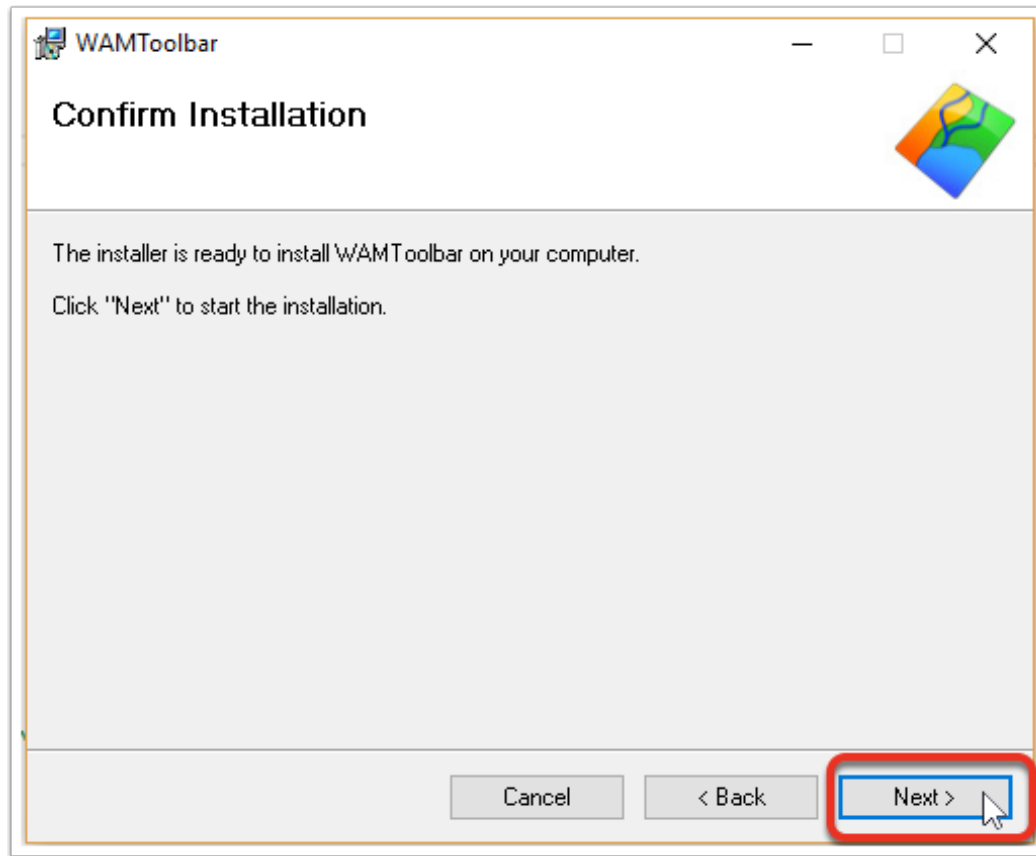
4. Installation Folder

It is best to use the default folder, but if this is not allowed on your system, navigate to an appropriate folder using the "Browse..." button. When finished, click "Next >".



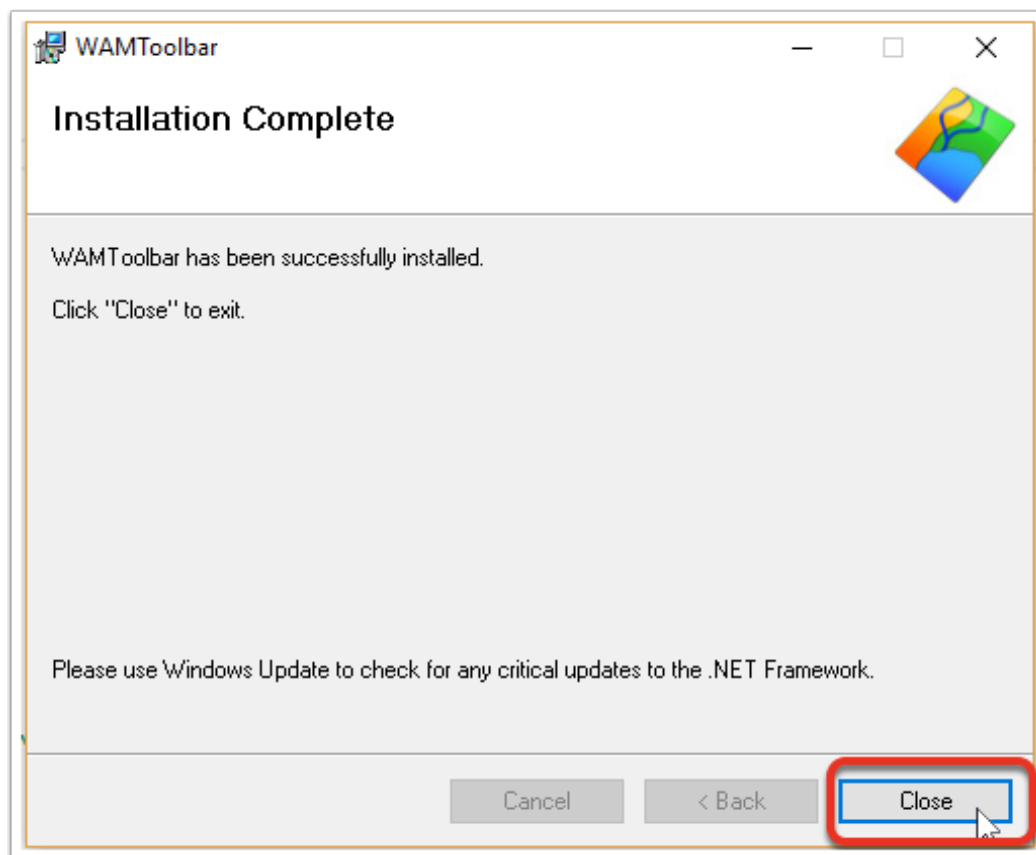
5. Confirm

Click "Next >" when ready to install.



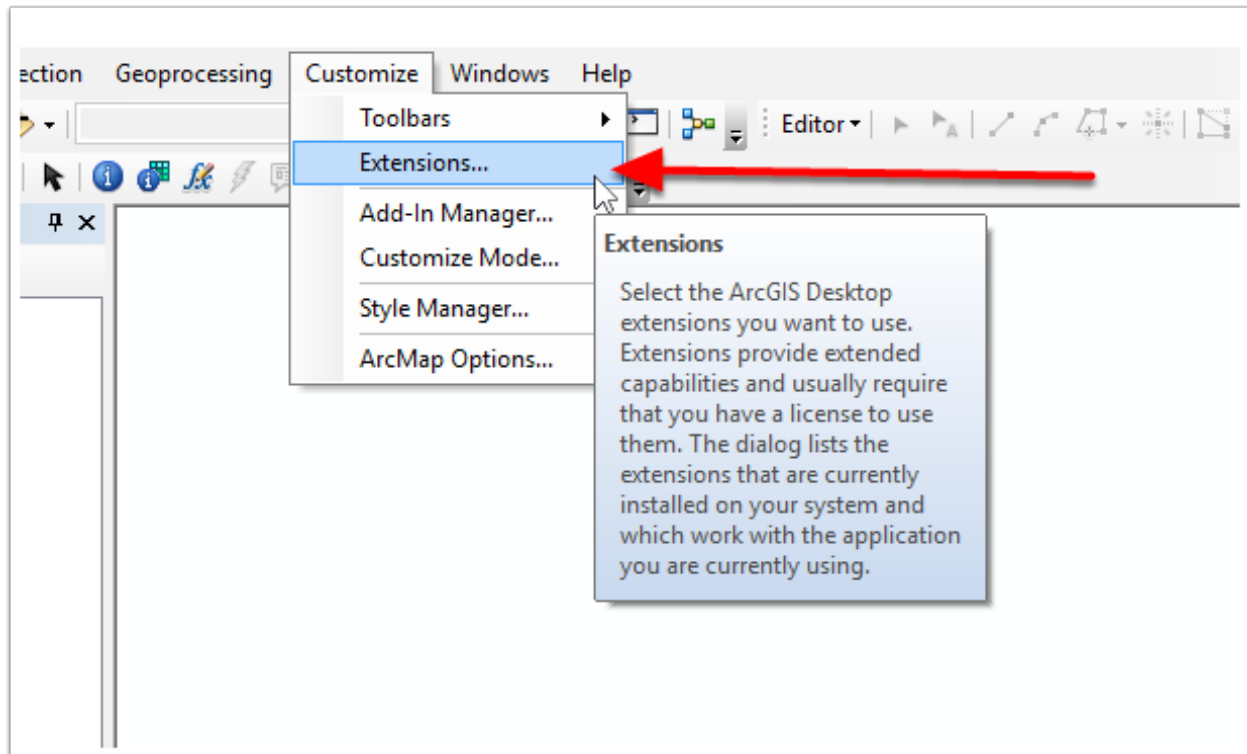
6. Installation Complete

An installation progress bar will appear. When the installation is complete, click "Close". The toolbar is now installed.



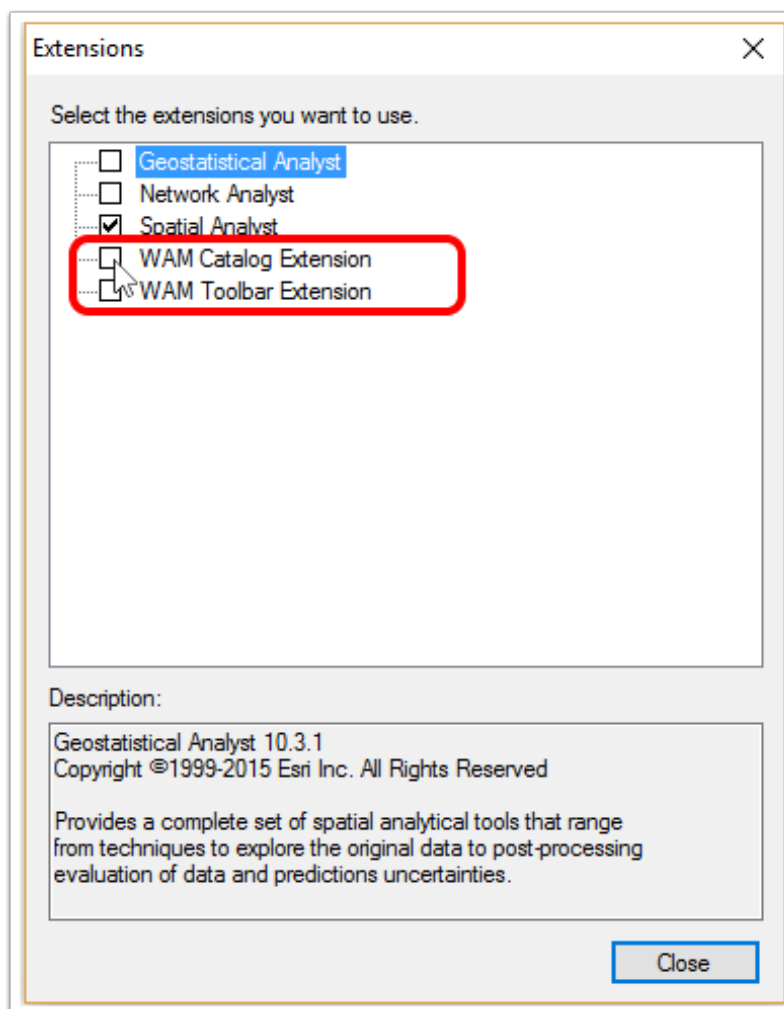
7. Enabling the WAM Extensions

The first step after installation is to enable the WAM extensions. **Start ArcMap.** There are two WAM extensions: the WAM Toolbar (which provides a toolbar), and the WAM Catalog extensions, which provides a set of context menus for the Catalog tab in ArcMap. To enable the extensions, click on the ArcMap Customize menu, and select "Extensions..."



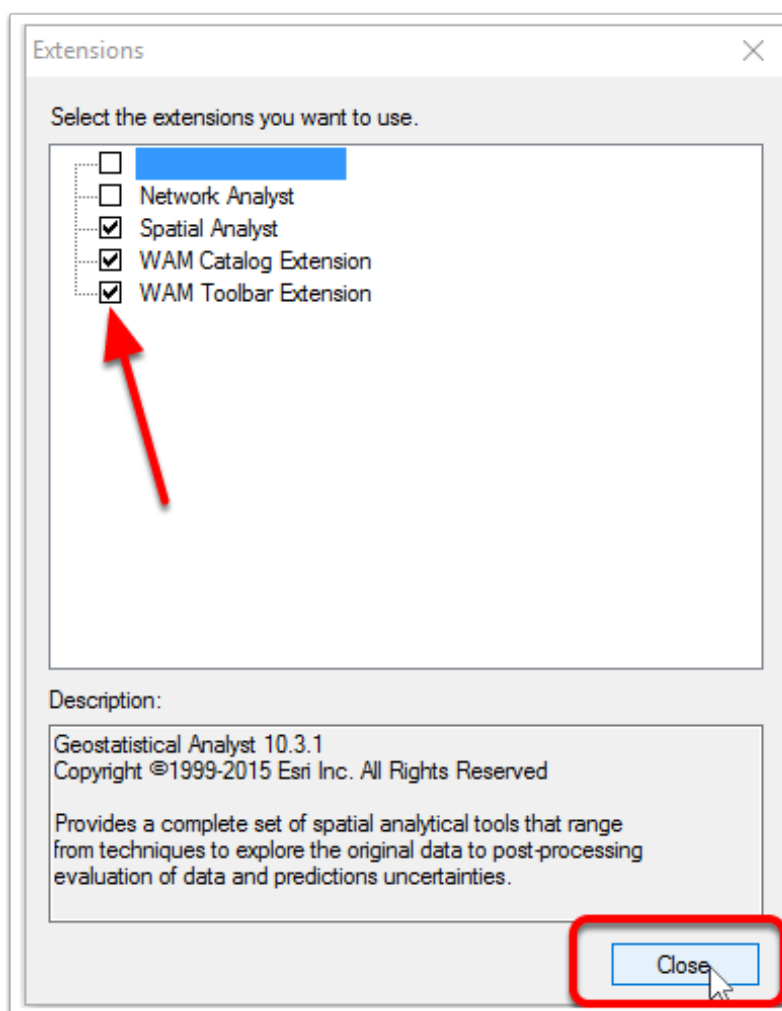
8. The Extensions Window

This will open up the ArcGIS extensions window. The WAM extensions should appear towards (or at) the end of the list.



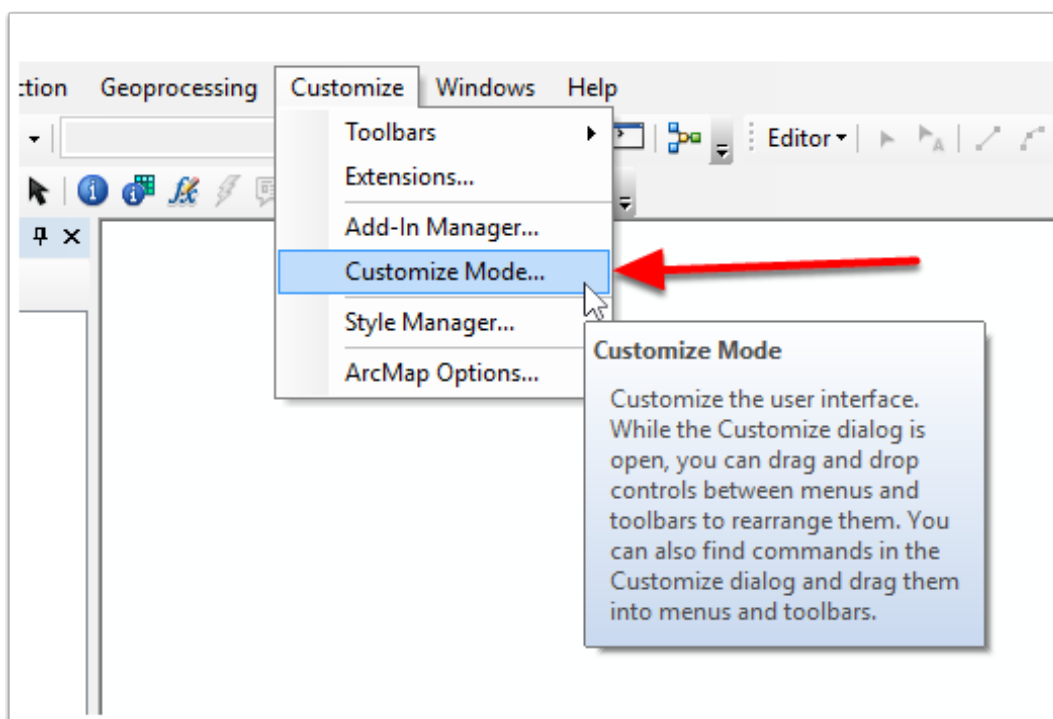
9. Enable the Extensions

Enable the two extensions by clicking in the check box by the extension names. In addition, make sure the Spatial Analyst extension is checked as well. Click the close button.



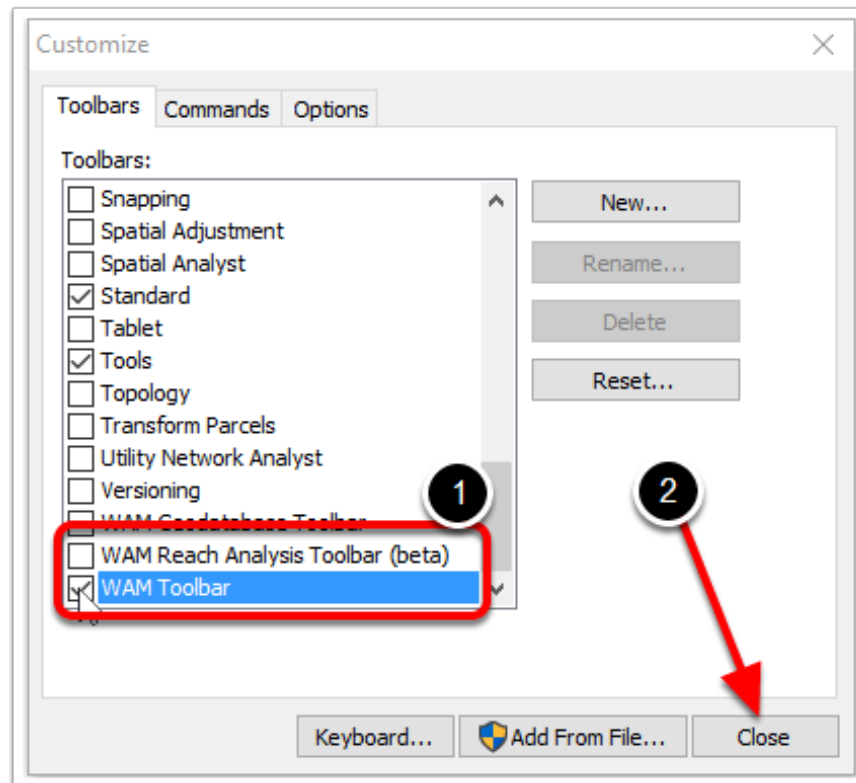
10. Open the Customize Window

The toolbars now need to be displayed in ArcMap. Click again on the Customize menu, and then on "Customize Mode".



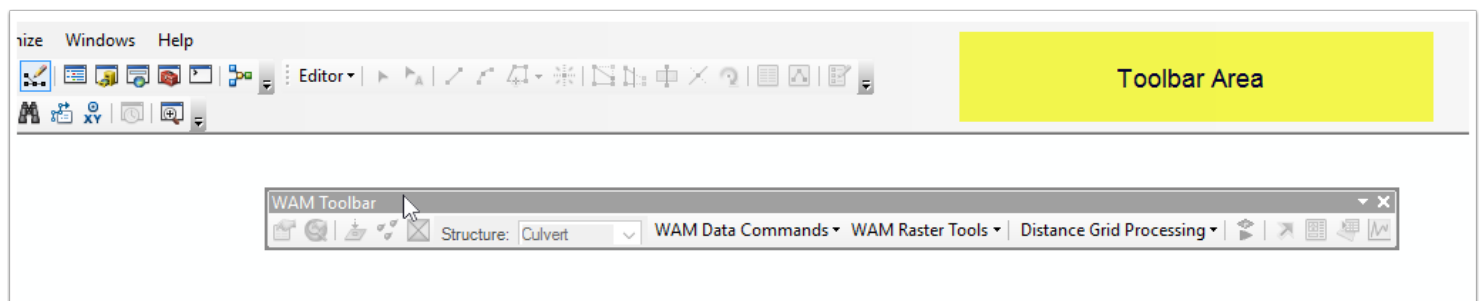
11. Enable the Toolbar(s)

Click on the check box by the WAM Toolbar to display it. If desired, also enable the WAM Reach Analysis Toolbar (beta). Do NOT enable the WAM Geodatabase Toolbar. Click the Close button



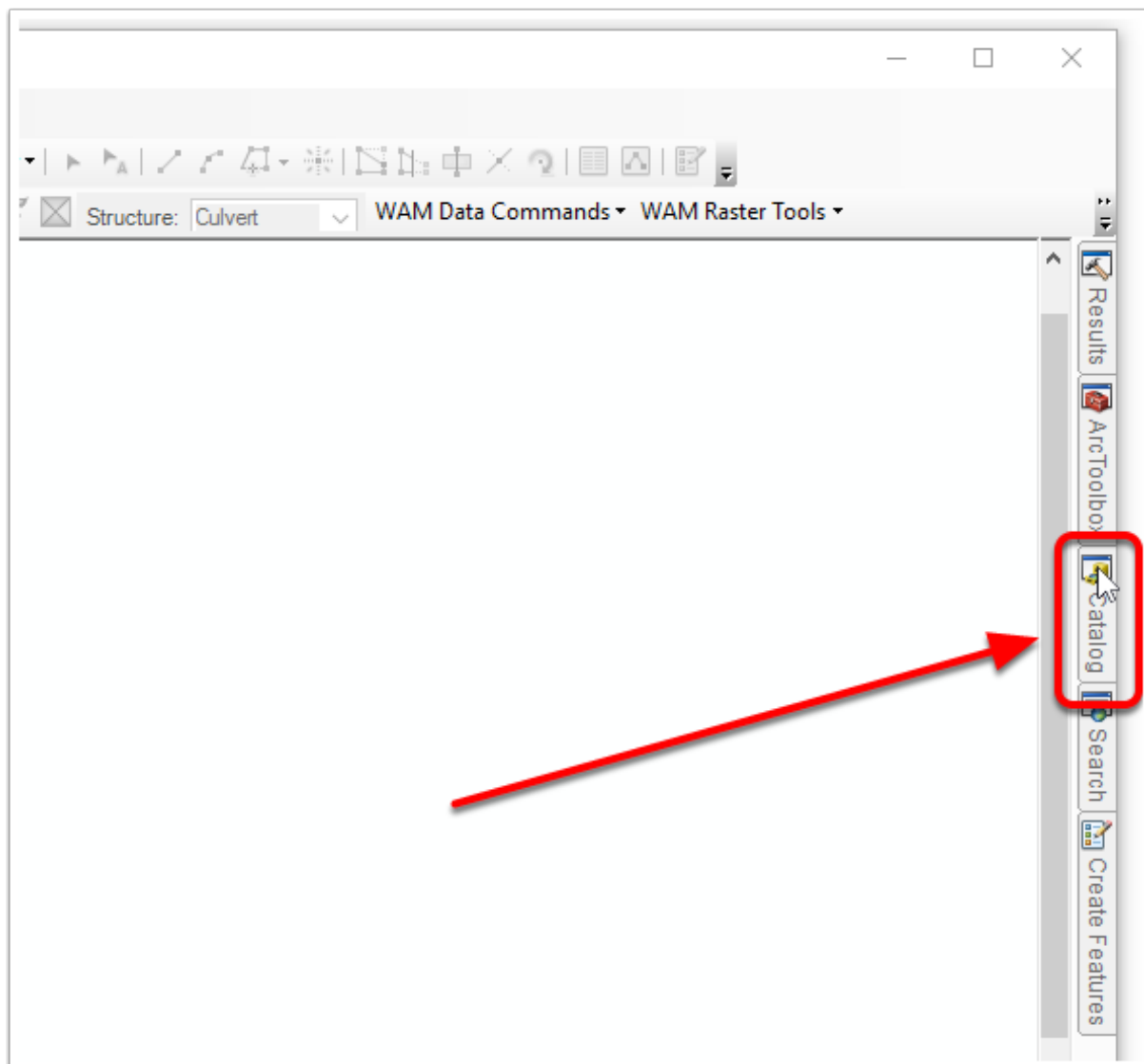
12. The WAM Toolbar

The Toolbar should appear. It can be docked into the toolbar area with the default ArcMap toolbars, or left to float above the current document. All buttons are disabled until a WAM map is loaded



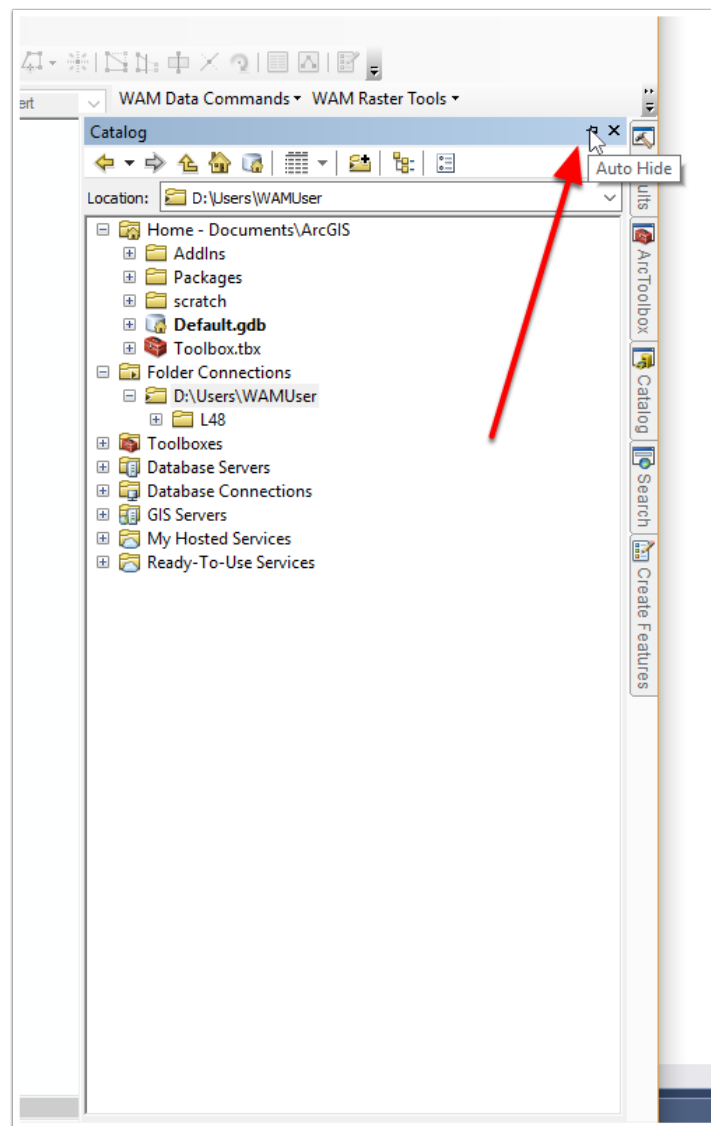
13. The ArcMap Catalog

Click on the catalog tab to open it.



14. Pin the Catalog Tab

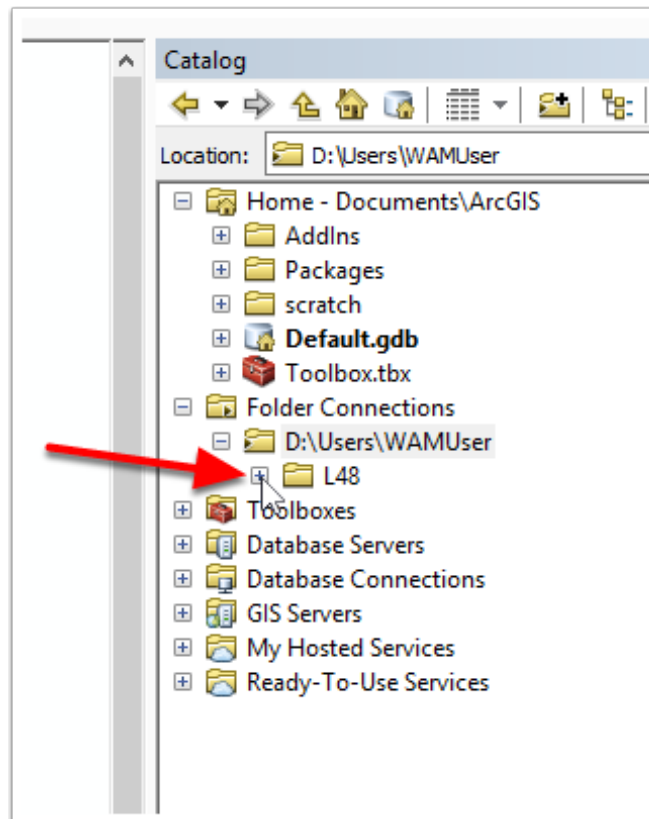
Click on the small pin to keep the Catalog tab open, since we will be using it quite a bit.



15. Expand the WAM Project

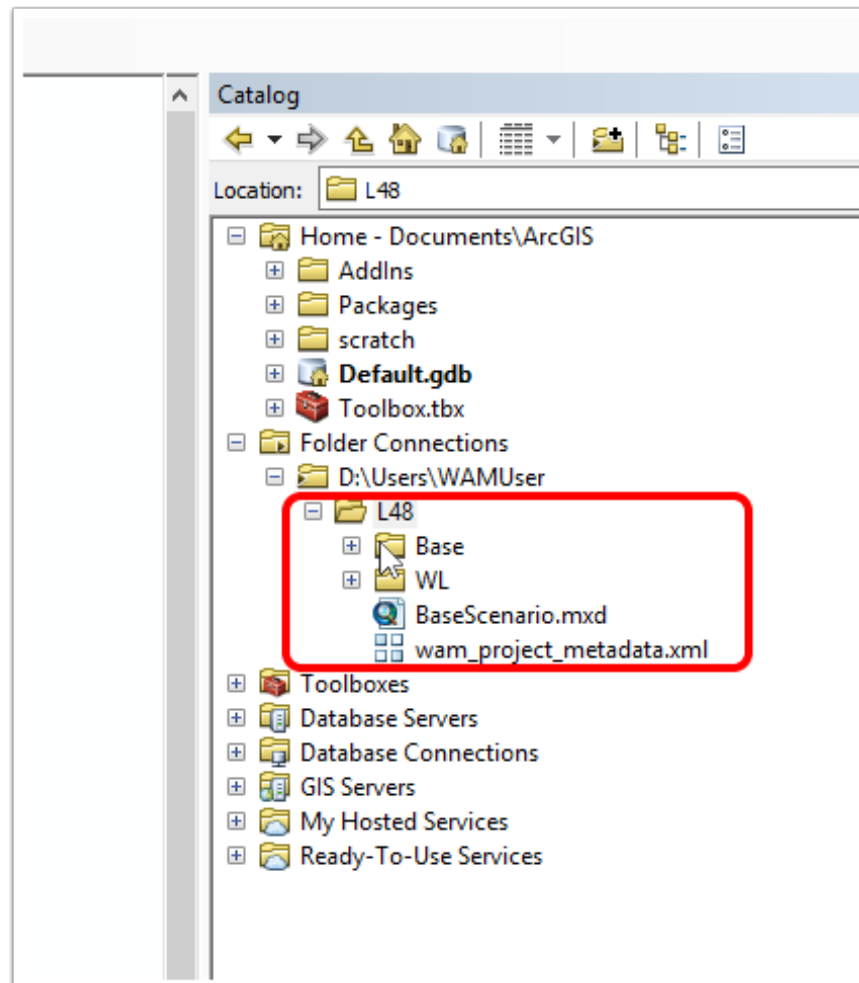
WAM projects and scenarios are kept in Windows as regular folders, and they appear in the ArcMap catalog.

Here, the project **L48** has been copied into the directory **D:\Users\WAMUser** on the local disk. This will most likely be different on your computer, so navigate to where the project is located. To expand the view, click on the small "+" icon just to the left of "L48".



16. The WAM Scenarios

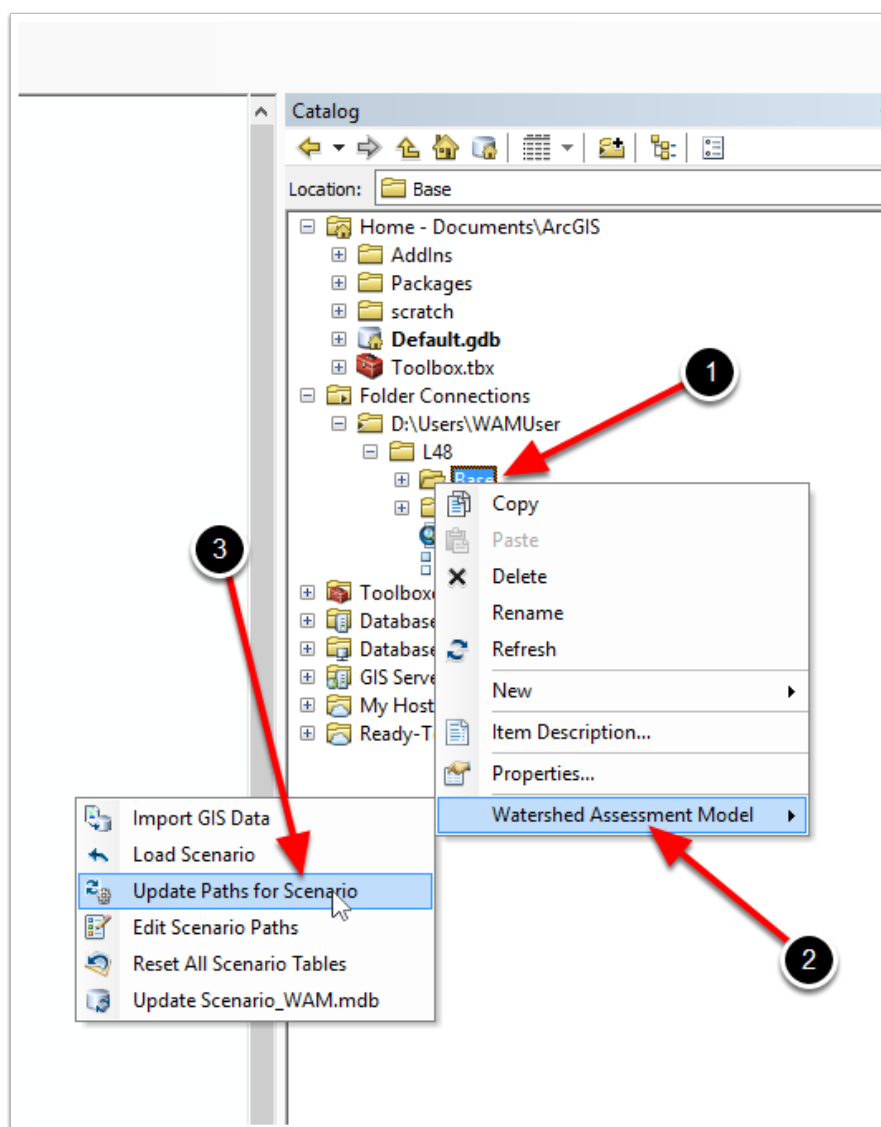
There are two WAM Scenarios associated with this project. Right now they are identical copies of each other, but we will make some changes to the WL scenario and re-run WAM so that we can compare the effects of making land use changes. "Base" is the base scenario, "WL" (for "wetlands") is a scenario where we will change some land uses to wetlands to see how that may affect nutrient loading.



17. Update Paths

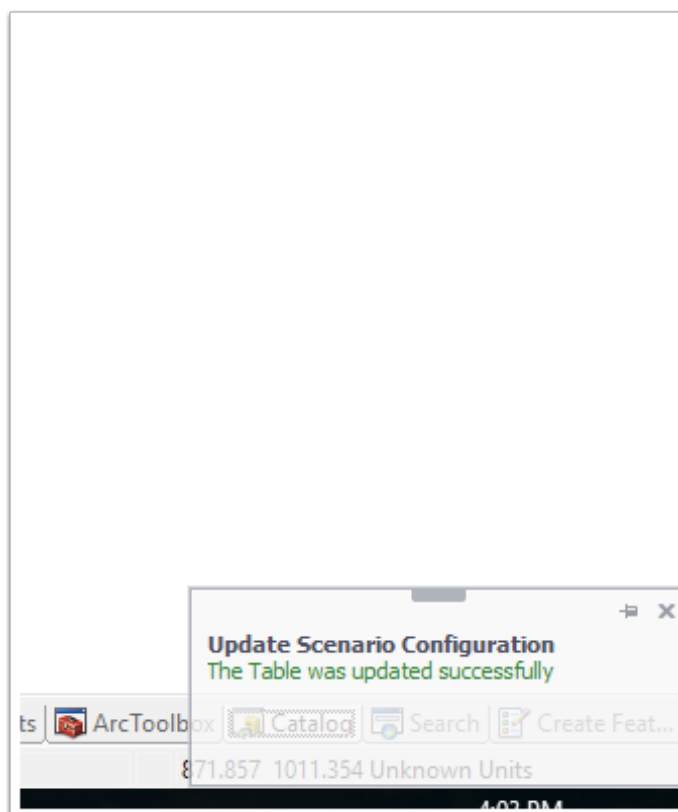
Because these scenarios have been moved from their original location, the first thing that needs to be done is to update some of the data contained in the scenarios. Every WAM scenario has a database of tabular information containing input parameters for WAM associated with it. This database is named "Scenario_WAM.mdb" and it is a regular Microsoft Access database. In addition to WAM parameter data, it contains some information about the location of the WAM scenario on the disk - this is what needs to be updated. To perform this update, (1) right

click on the "base" folder, and (2) click on the "Watershed Assessment Model" sub-menu item, and then (3) click on "Update Paths for Scenario". Do this for both the Base and the WL scenarios.



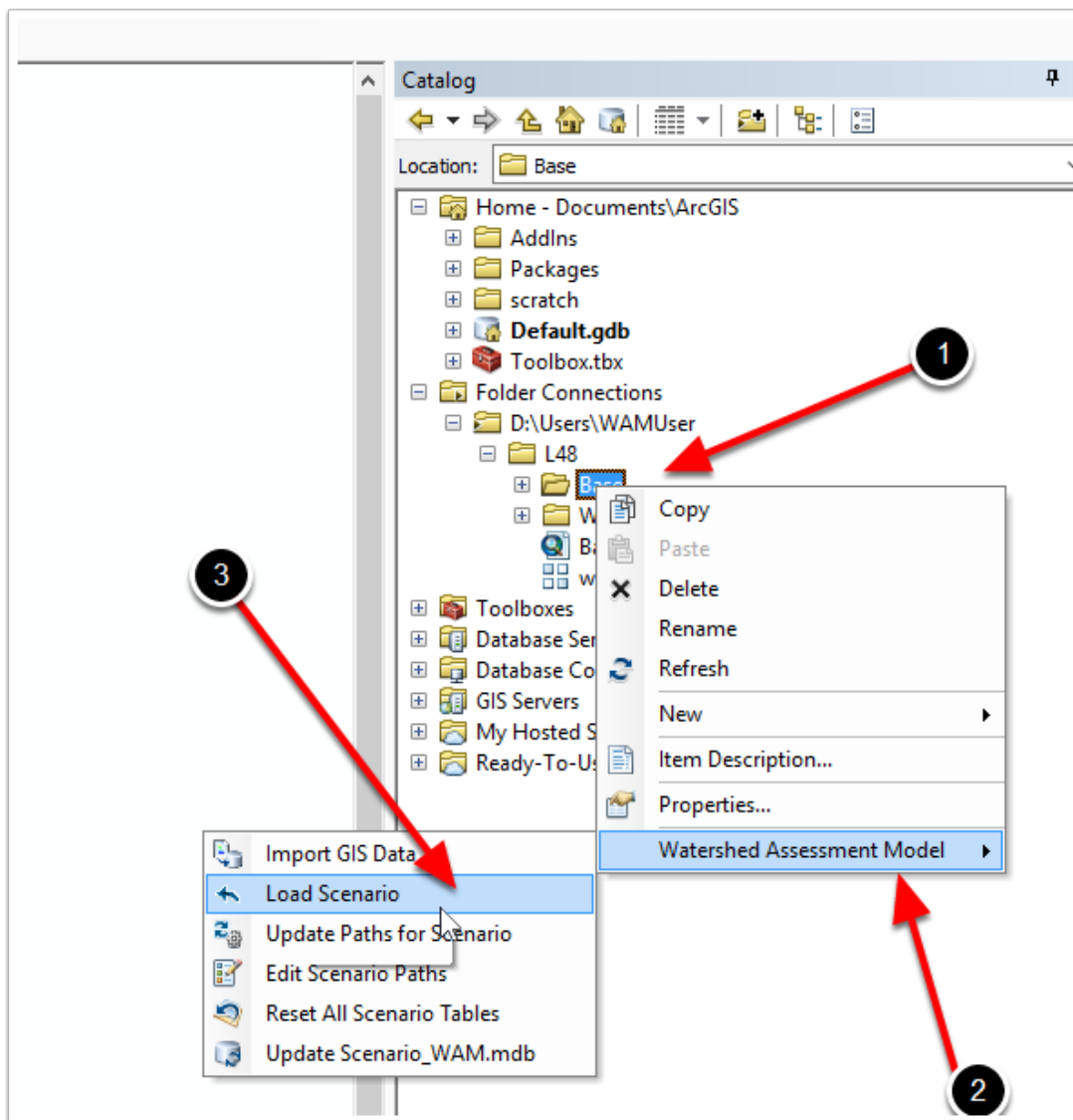
18. Message about the Update

In the bottom right corner of the screen the following message should appear after each update. If this does not work, contact SWET at wam@swet.com.



19. Loading Scenarios

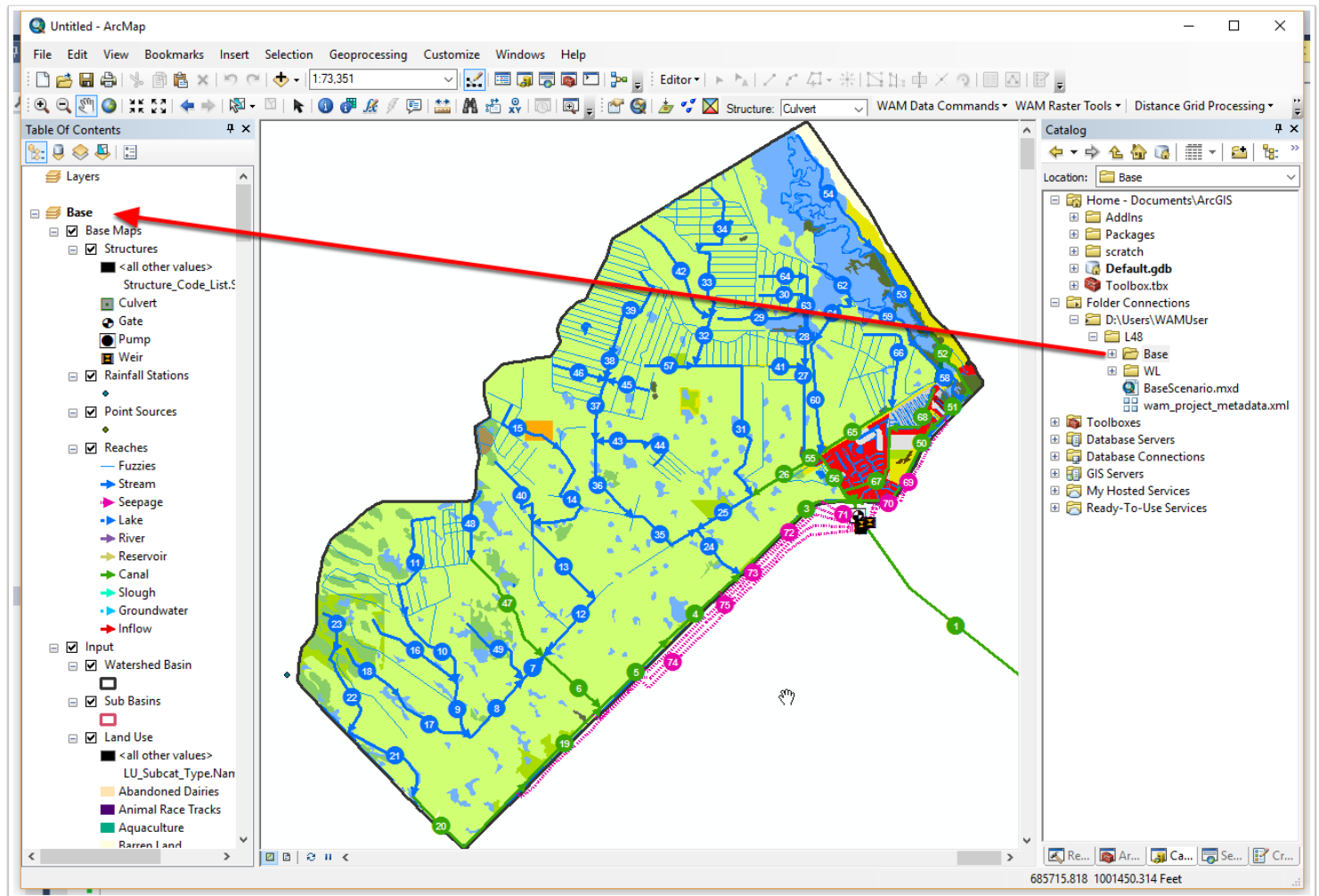
Now we will load the Base and WL scenarios. Again, right click on the Base scenario, select "Watershed Assessment Model" > "Load Scenario" and wait a few moments.



20. The Base Scenario

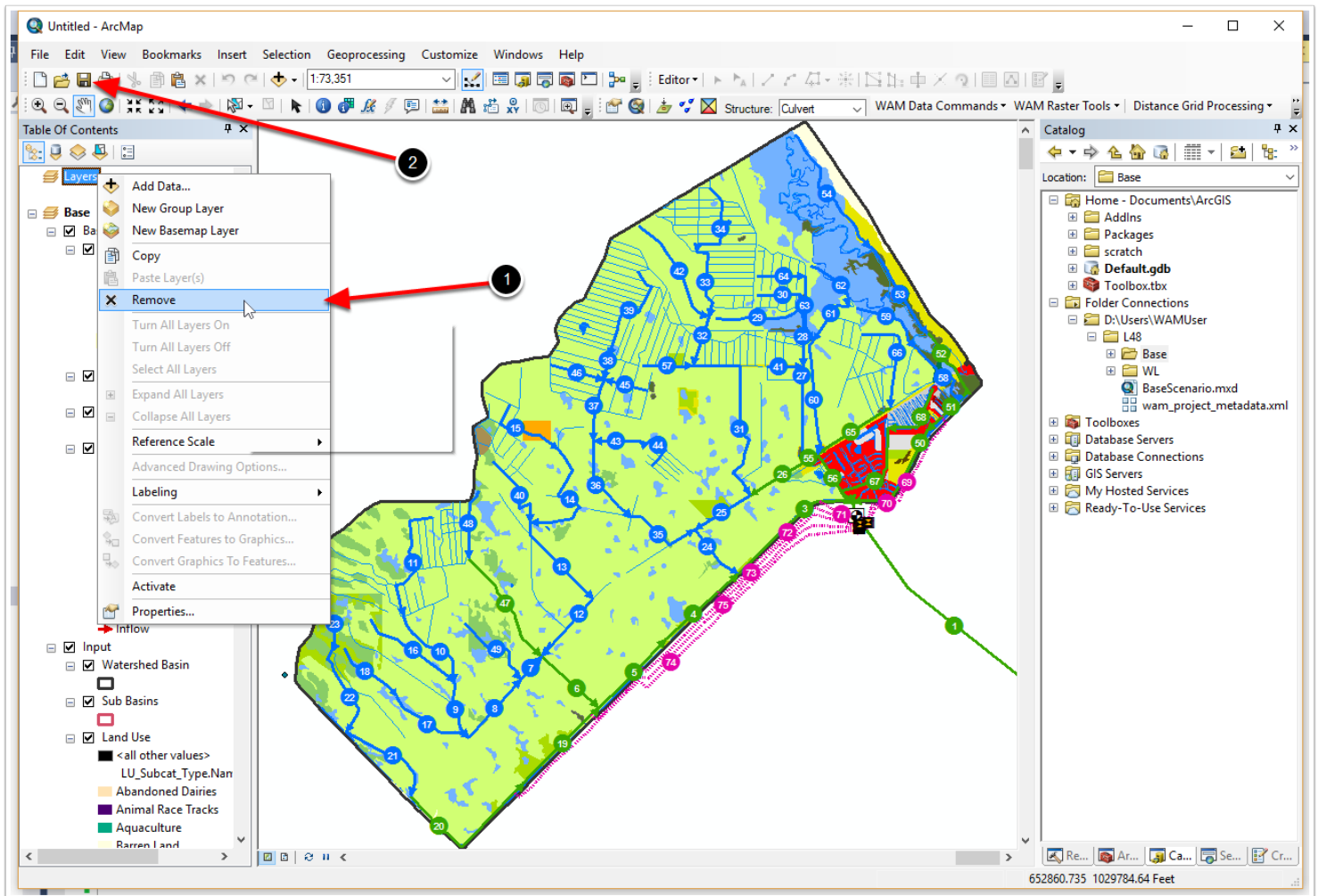
The base scenario should appear in ArcMap. On the right the ArcMap Table of Contents (or TOC) shows two Data Frames - the default frame "Layers" and the newly loaded scenario "Base", which has the same name as the scenario shown in the Catalog. The various geodatasets used by WAM appear in the scenario. Point and line feature layers are shown in the "Base Maps" group layer, while the basin outline, sub-basins, land use, soils,

etc., show up under the "Input" group layer. Other group layers include "Output" for output grids, and "Distance Processing Grids" used to determine routing from source cells to reaches.



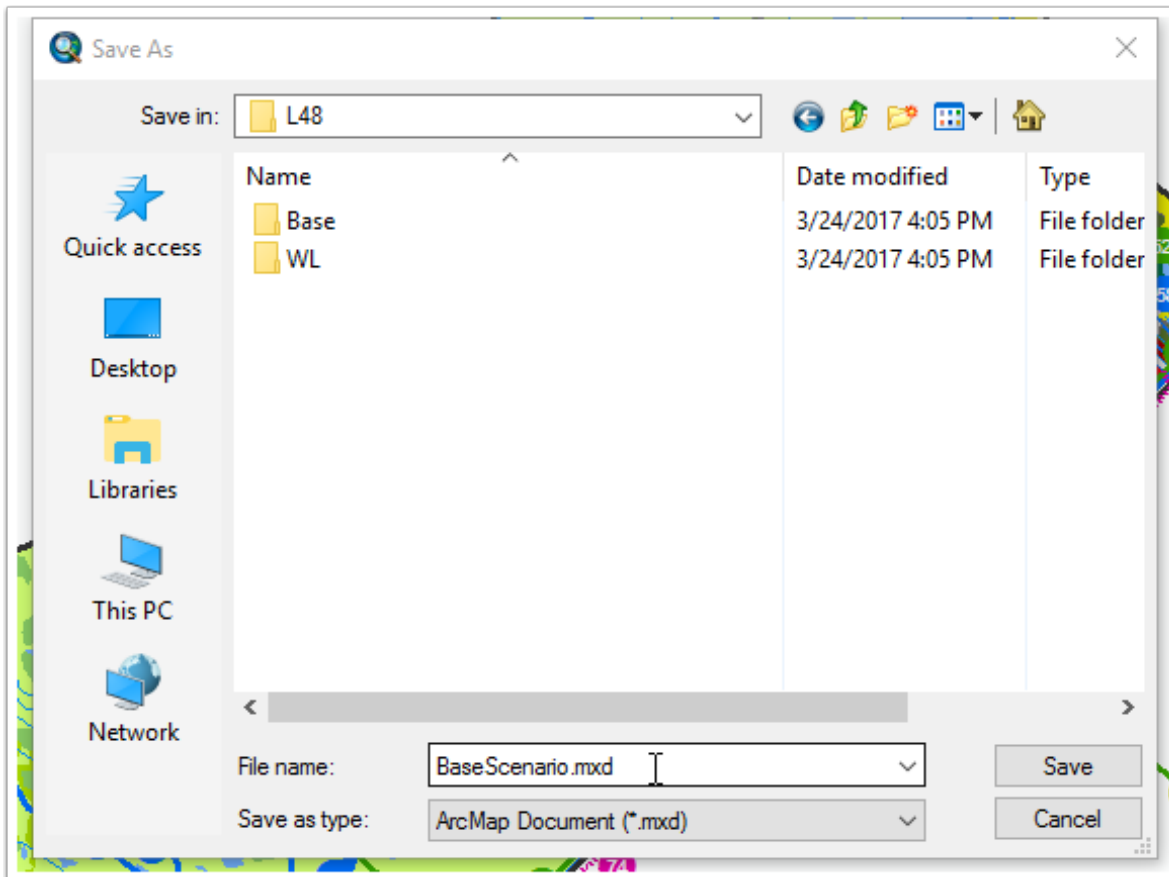
21. Prepare the Map for Saving

Before saving, the default "Layers" Data Frame should be removed. Right-click on the Data Frame and select (1) Remove. Then (2) click on the File menu and "Save", or click on the small disk icon.



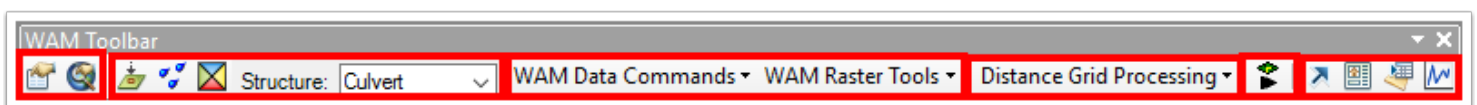
22. Save the Map

If there is an existing map named "BaseScenario.mxd", you can overwrite it or save it under a different name.



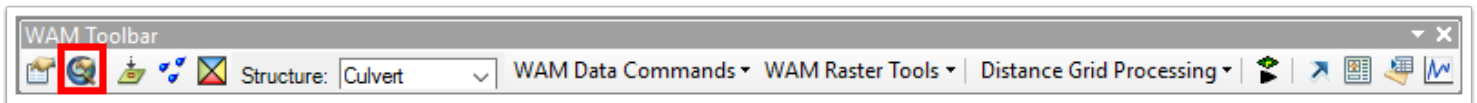
23. A Quick Note on the WAM Toolbar

The WAM Toolbar contains many of the commands used by WAM to set up and modify scenarios. The Reach Analysis Toolbar (not discussed here) is used to create stream networks. The toolbar can be roughly divided into six sections as shown. From left to right, these are 1) Tools to modify features and global properties, 2) Add or modify point information such as rain stations and hydraulic structures, 3) import files and create various raster types, 4) create distance grids which determine source cell to stream distances, 5) create the input files necessary to run WAM, and 6) view results from running WAM.



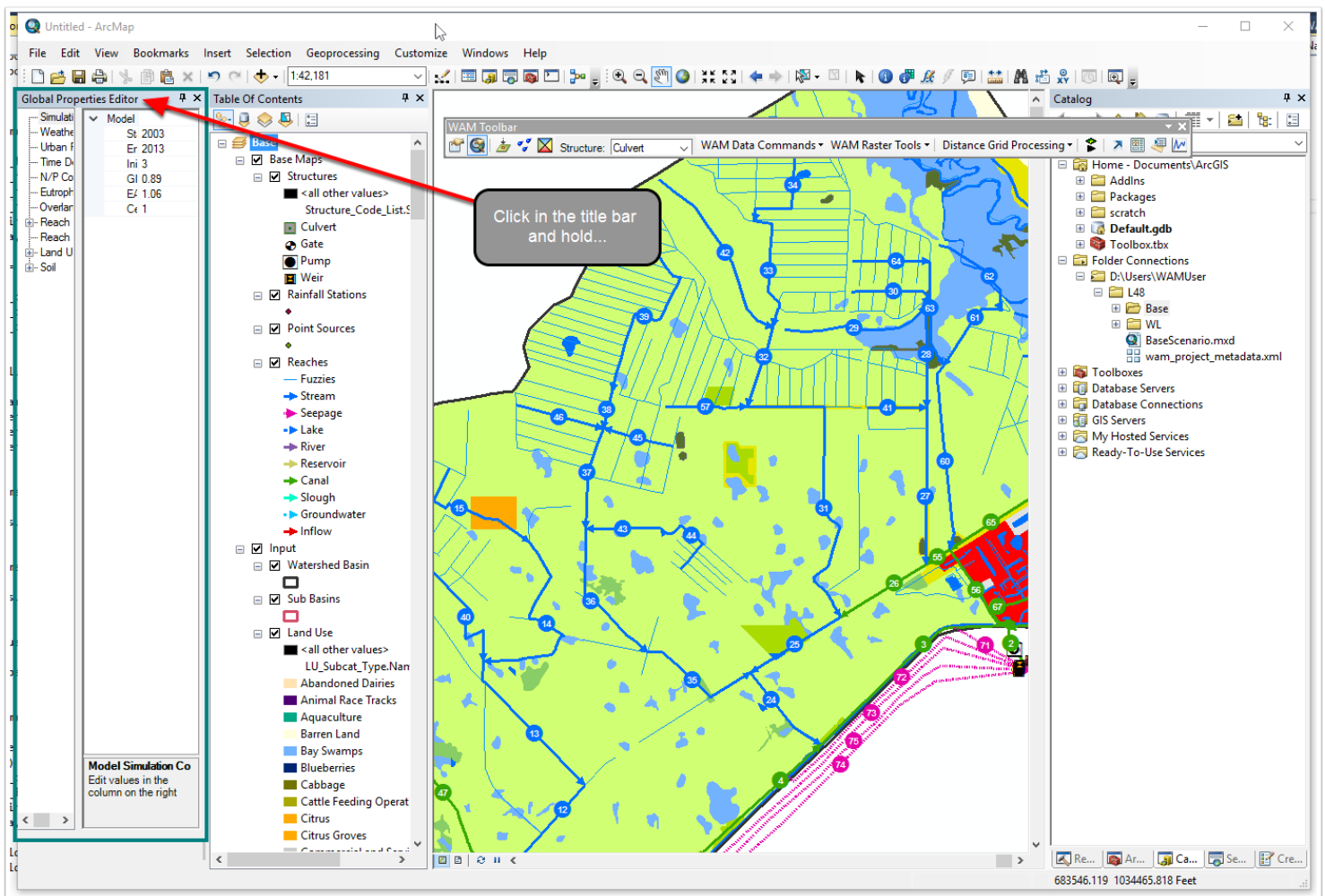
24. The Global Properties Window

For example, the second button from the left opens a dockable window to view and change global properties for WAM. Clicking on it will open a dockable window.



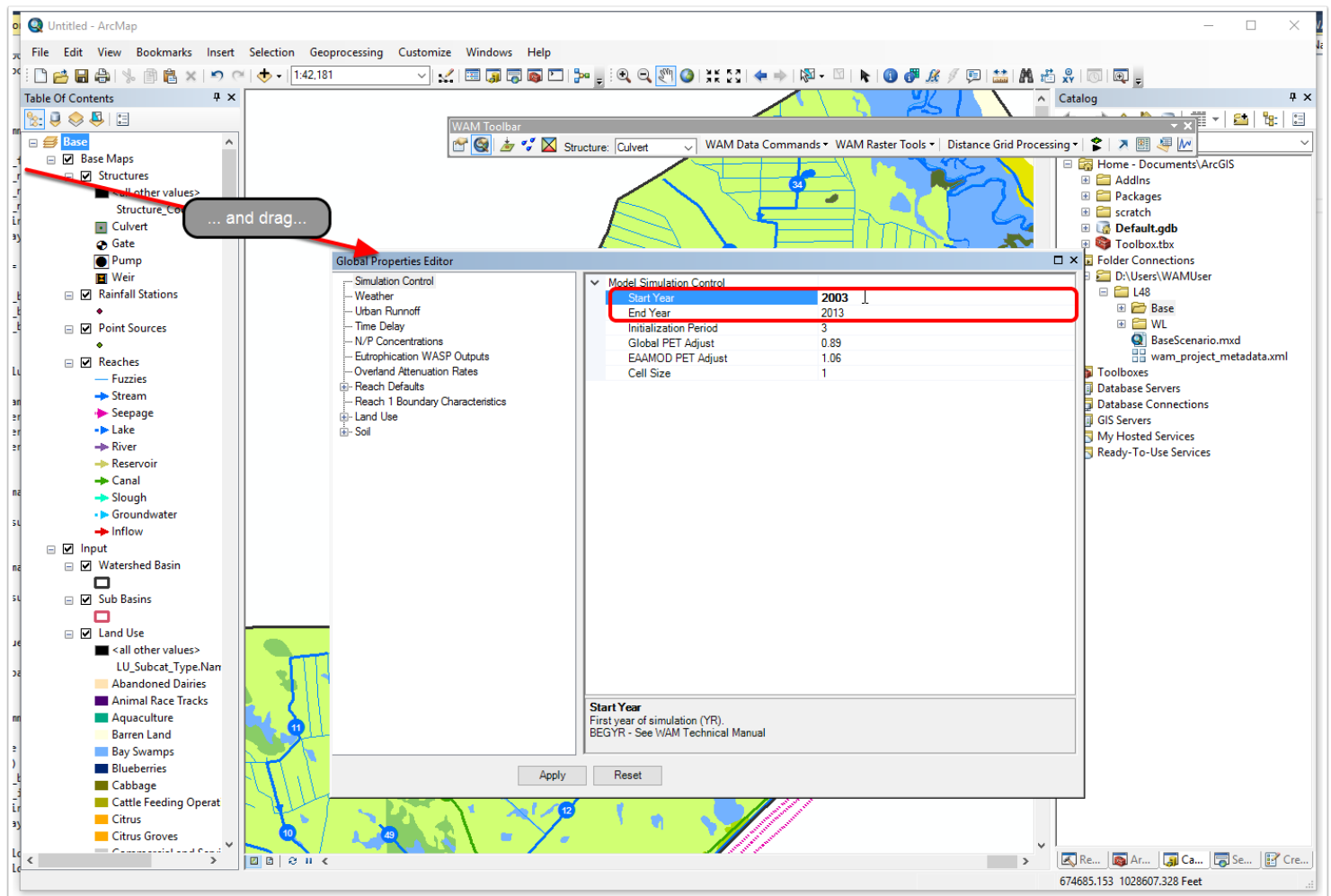
25. The Docked Window

Here, the Global Properties editor has appeared docked to the far left side of the ArcMap document. It is usually easier for the user if it floats freely above the document. By clicking in the title bar and holding the mouse button down, the window can be dragged so that it "undocks" and it can be moved around.



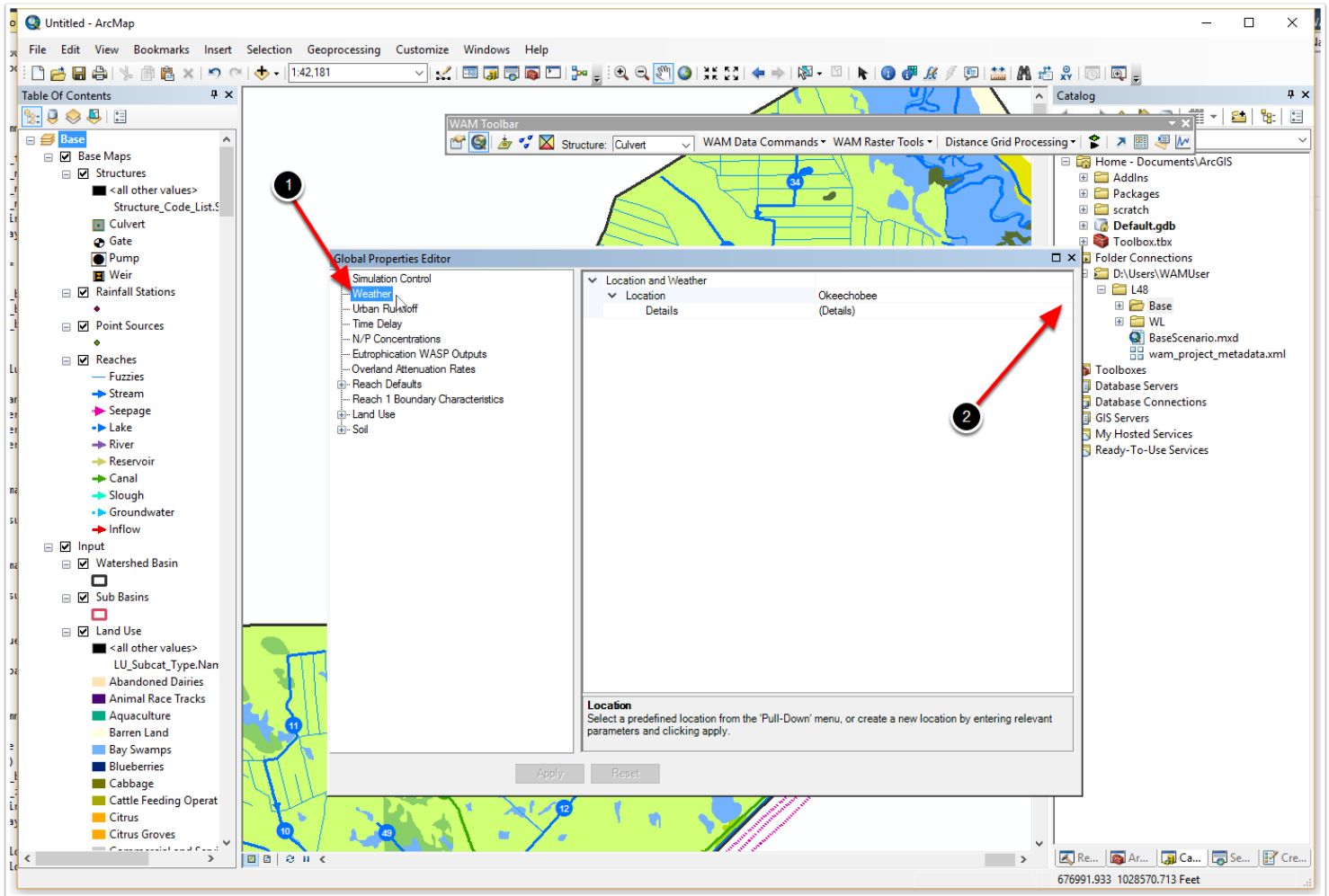
26. Undocking the Global Properties Editor

This is the result of dragging the window out to the middle of the ArcMap document. Here, the user can, for example, change the start or end year of the simulation by editing the value in the right column and clicking "Apply". Values that have been edited will appear in **bold**. Different sets of properties can be viewed by clicking on one of the categories on the left pane of the window, e.g., "Weather".



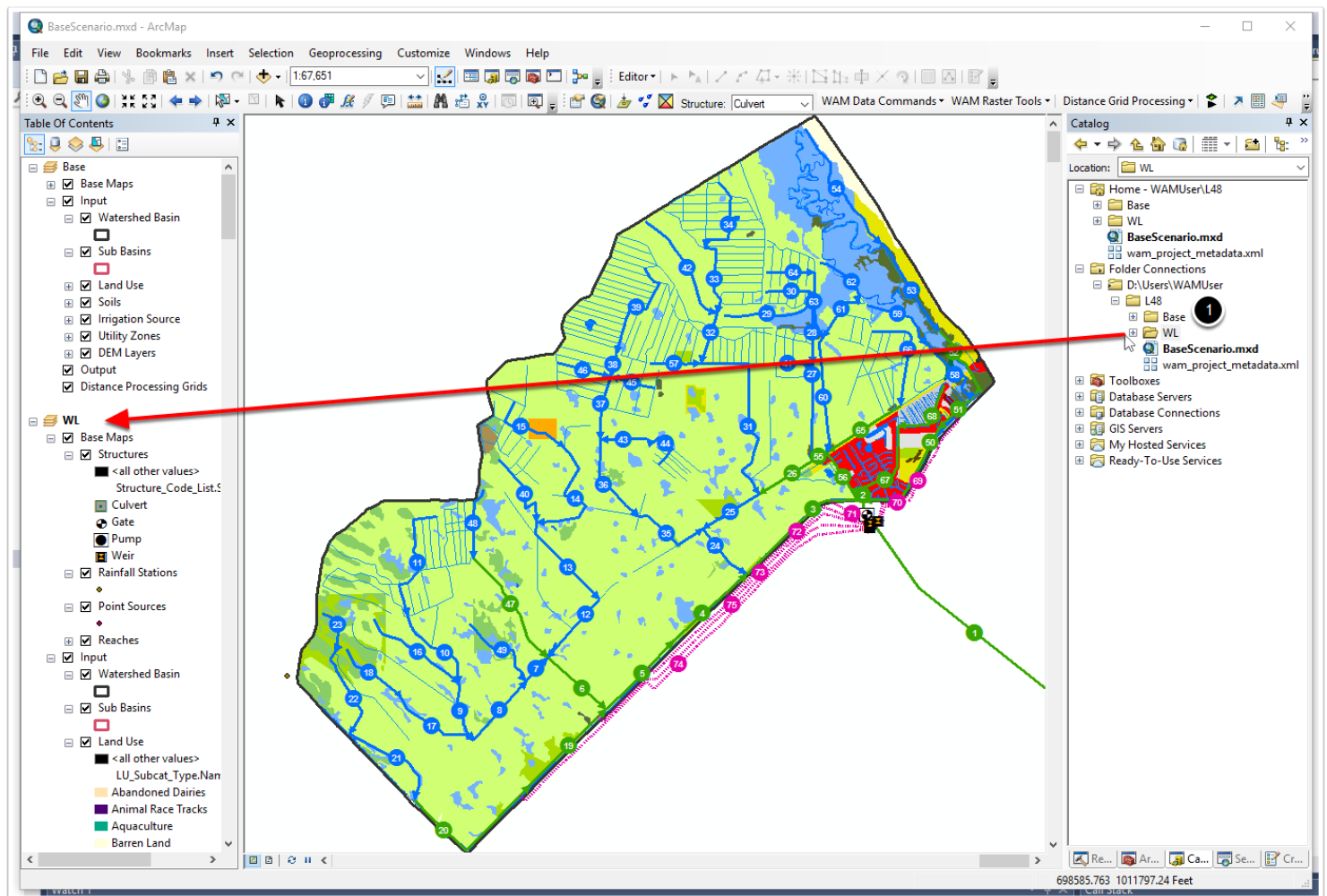
27. Selecting a Different Global Property

Here, "Weather" has been (1) clicked, and information about the weather parameters can be viewed by clicking on the (2) "(Details)" row. The window can be closed after exploring. Use the "Apply" button to save any changes, or "Reset" to discard them.



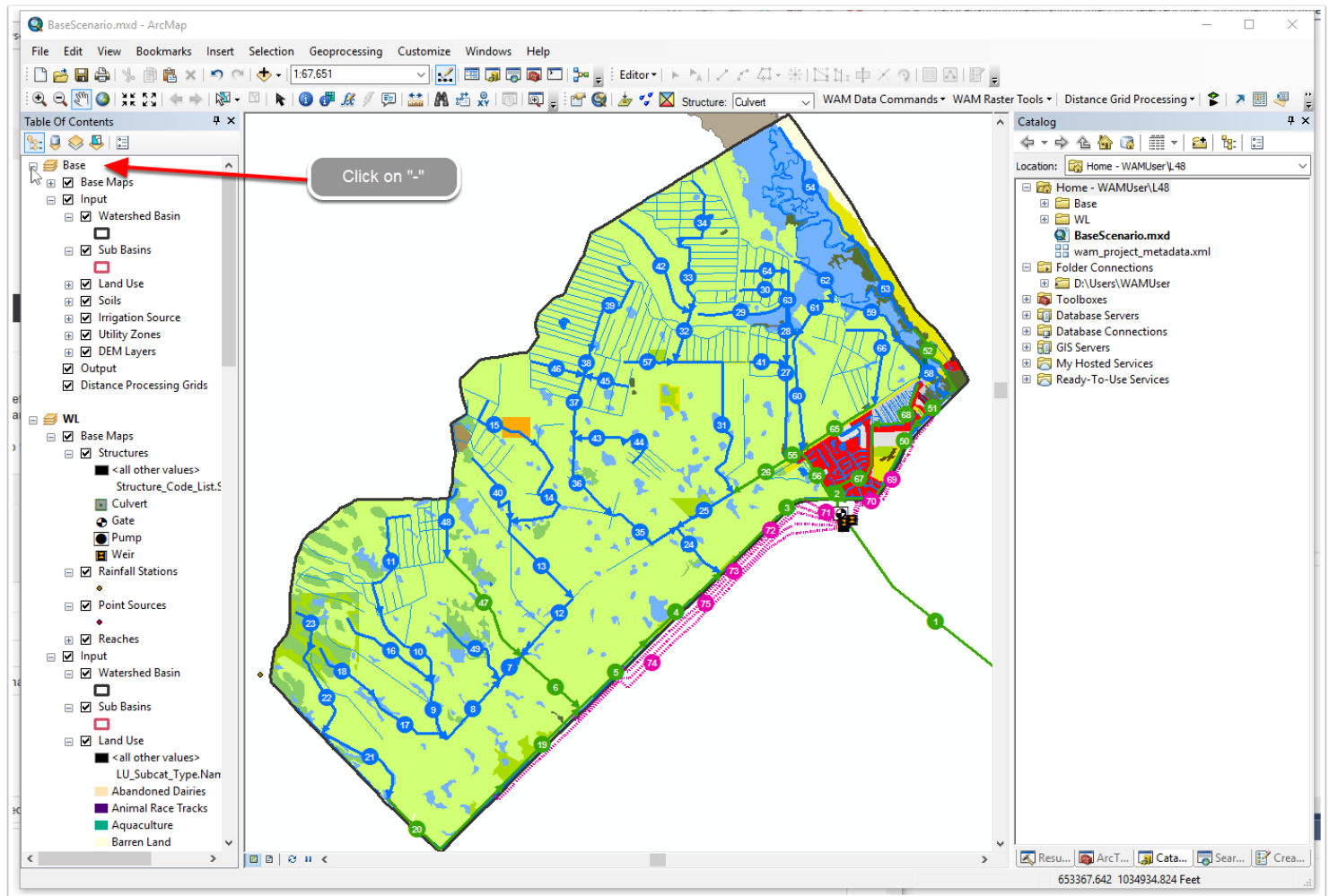
28. Load the WL Scenario

As mentioned above, WL stands for wetland. We want to load the WL scenario into the map so we can do comparisons between the two. Right click on the WL folder (1) in the Catalog and click on "Watershed Assessment Model" and "Load Scenario". It will load into the map below the Base scenario after a few moments. Note that the Data Frame "WL" is in **bold**, this means that it is the currently active layer. We're going to make some changes to this scenario and re-run it.



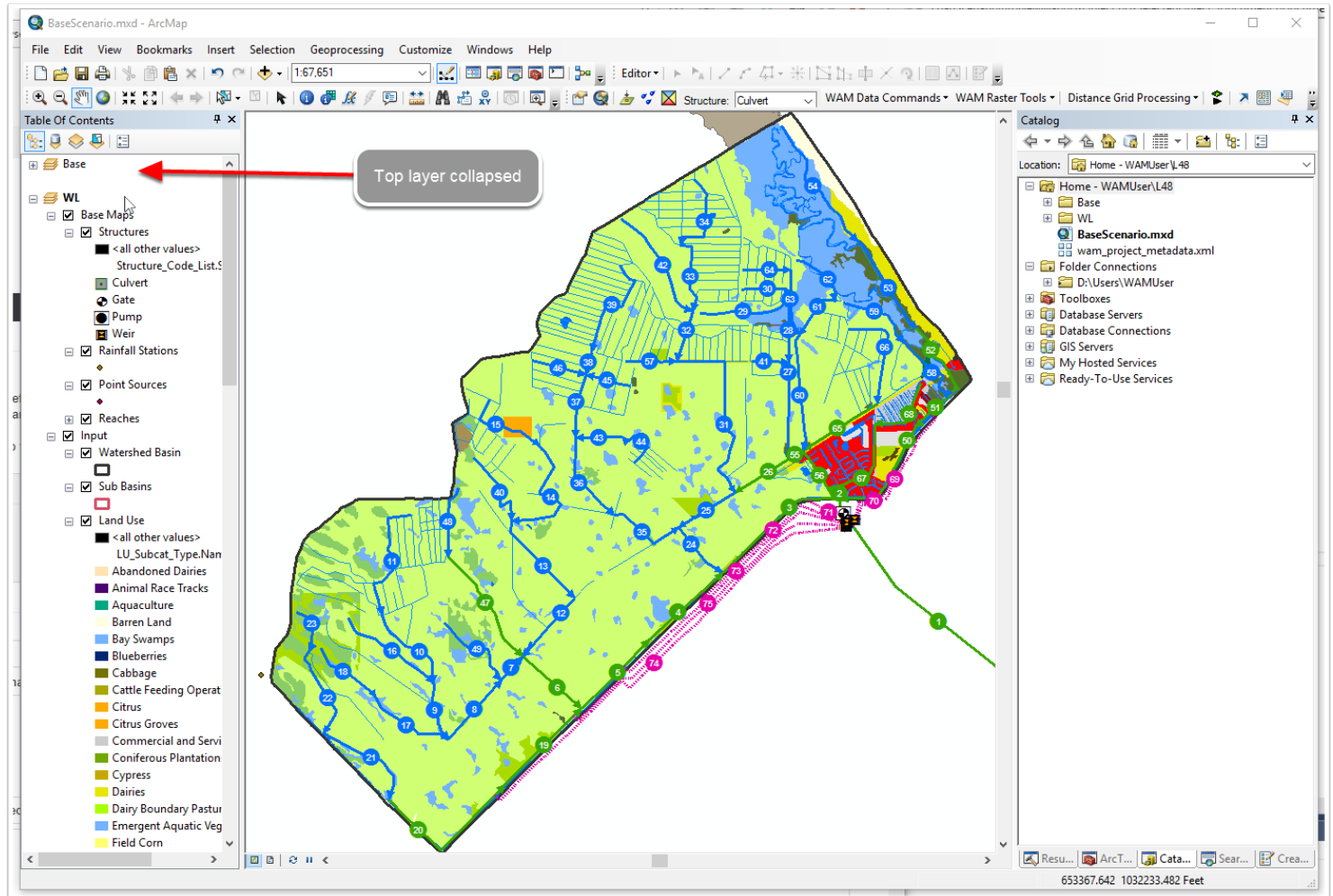
29. Collapse the "Base" Scenario Layers

To make things a bit simpler visually, we will collapse the layers in the (non-active) Base scenario. To do this, click on the "-" by the "Base" at the top of the TOC to collapse the layers. This also helps to avoid confusion since both scenarios have identically named layers.

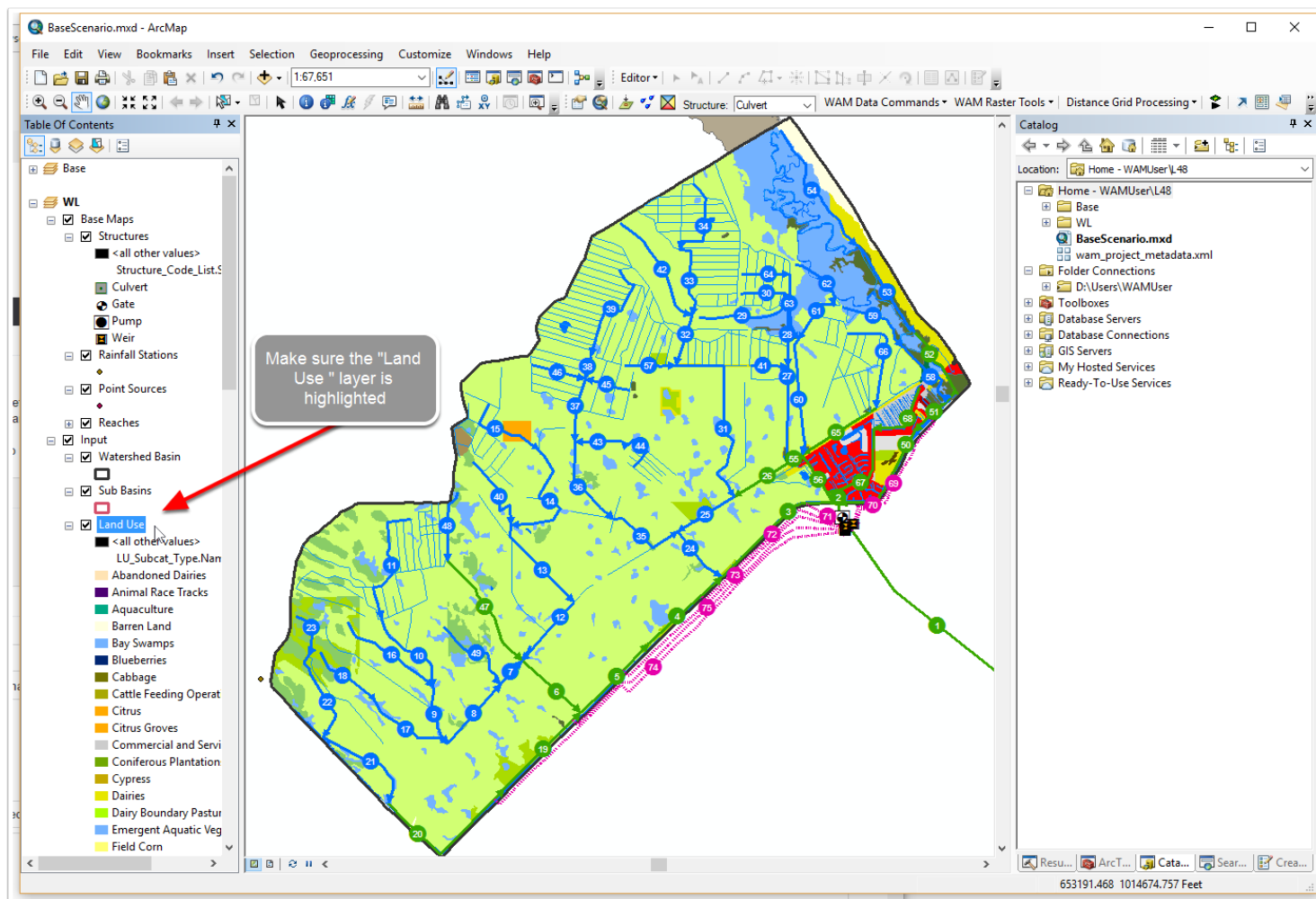


30. Just the WL Scenario Showing

This will prevent us from inadvertently selecting layers from the wrong scenario.

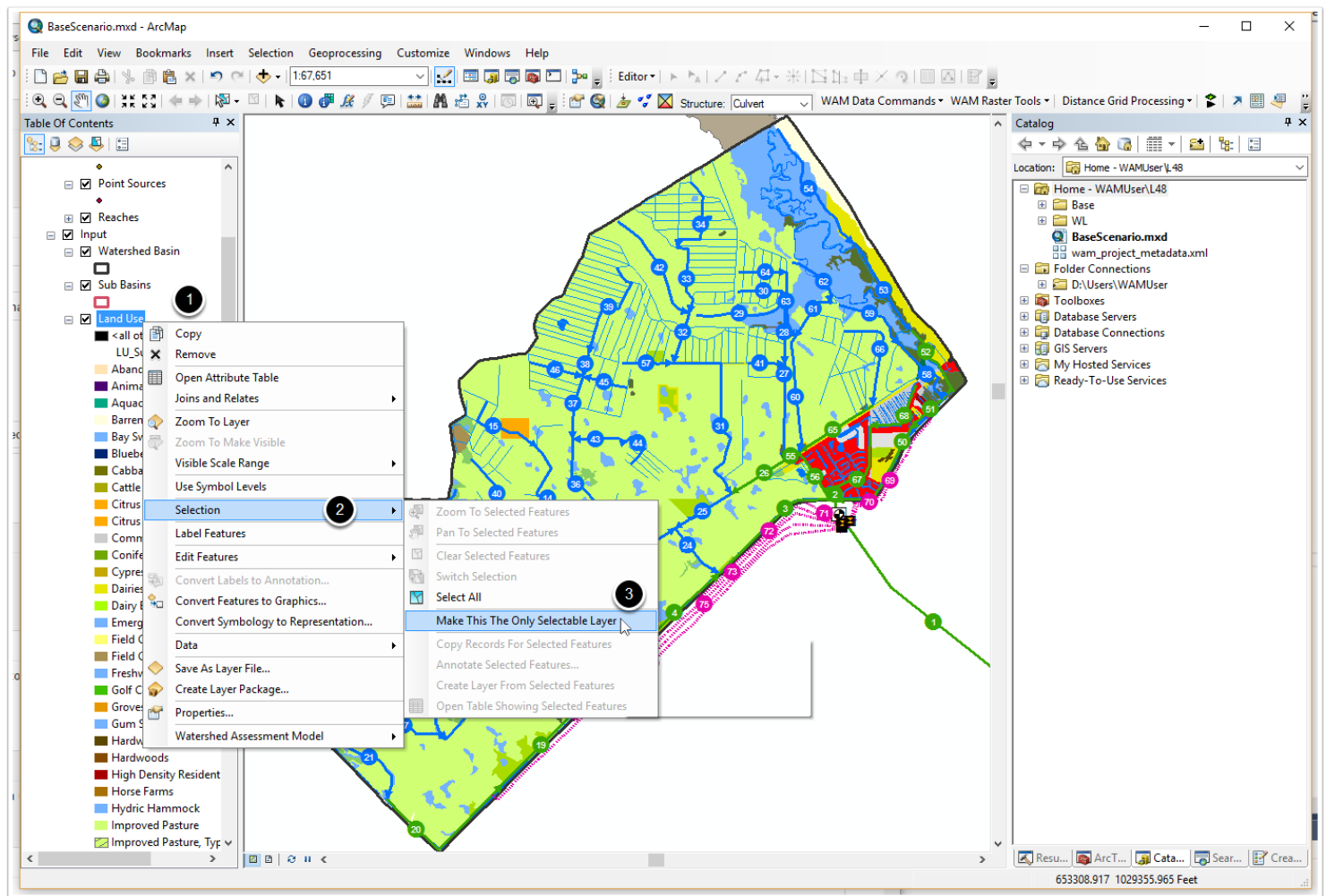


31. Select the WL Land Use Layer in the Table of Contents



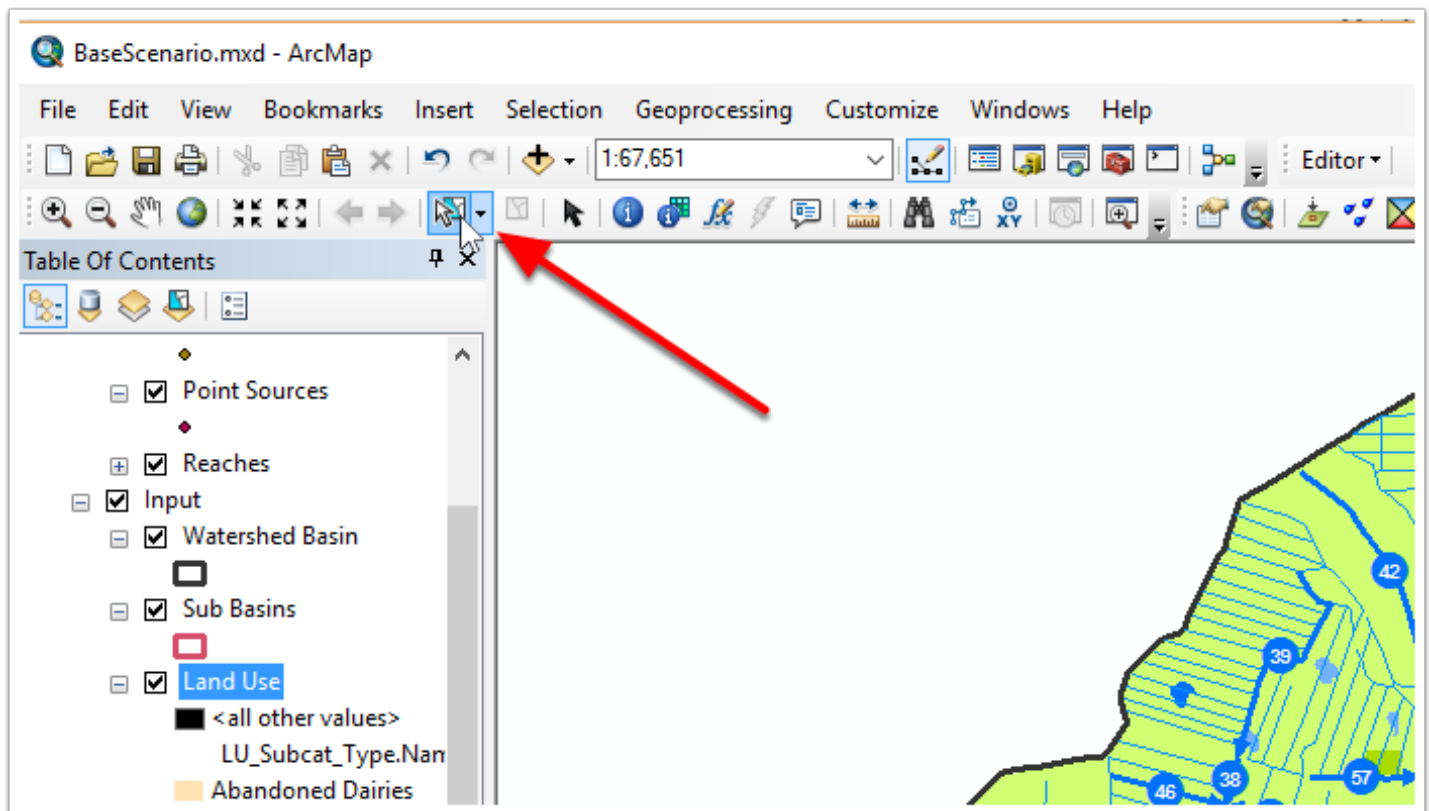
32. Make Land Use the Only Selectable Layer

Right click on (1) "Land Use" in the TOC to get the popup menu, then (2) "Selection", then (3) "Make This The Only Selectable Layer". This means that only features in the Land Use layer can be selected.



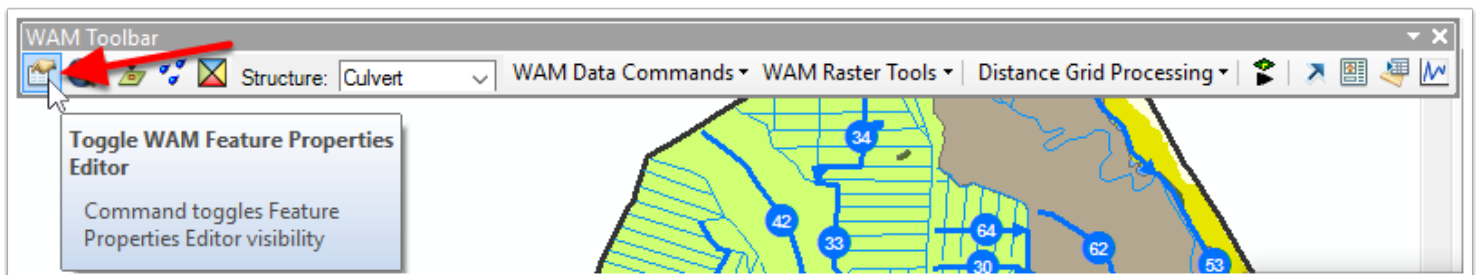
33. Choose the Selection Tool

We are going to be selecting features from the Land Use layer, and we don't want to be selecting features from other layers. Make sure the tool is highlighted.



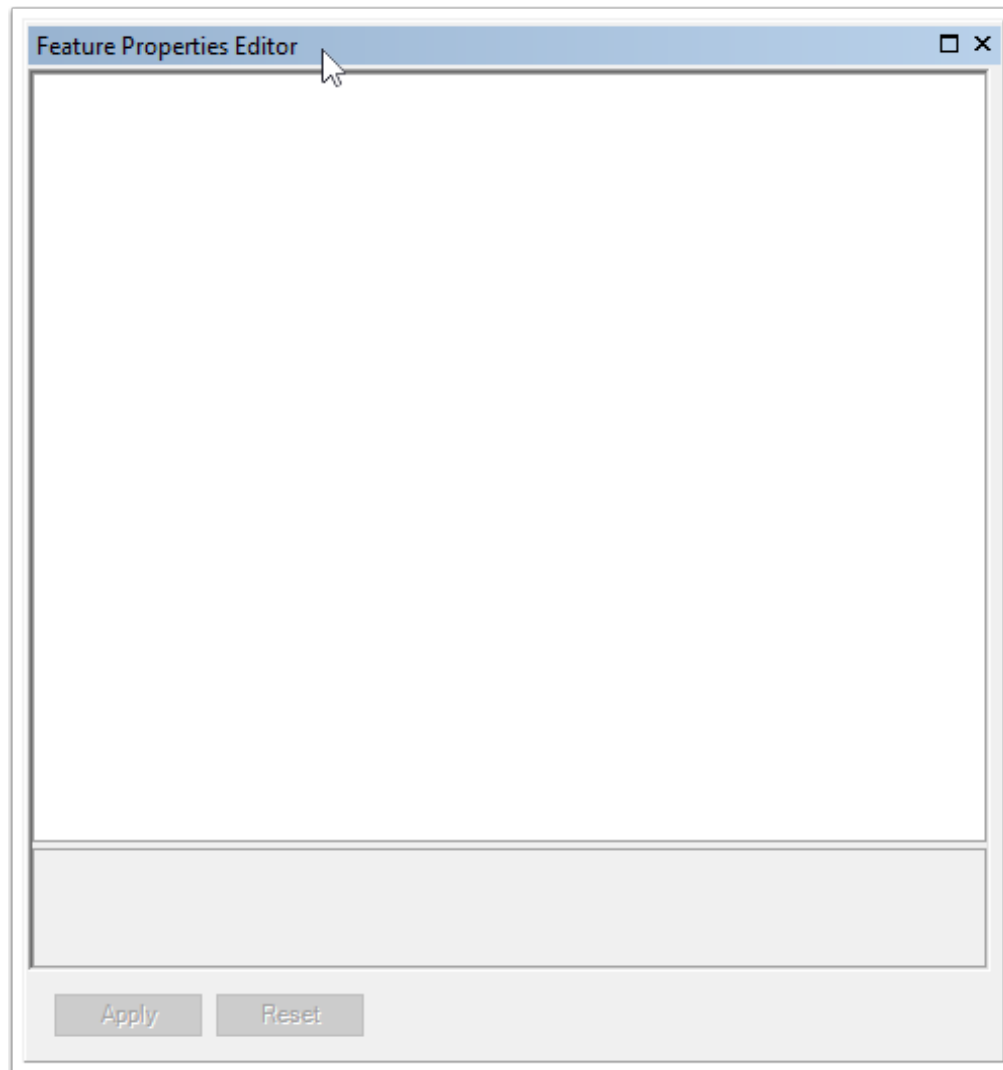
34. The WAM Feature Properties Editor

The WAM Feature Properties Editor is used to make changes to the data associated with a particular feature or group of features. It will make changes to the underlying Scenario_WAM.mdb database so that we don't have to use Microsoft Access. To open it, press the left-most button on the WAM Toolbar, "Toggle WAM Feature Properties Editor"



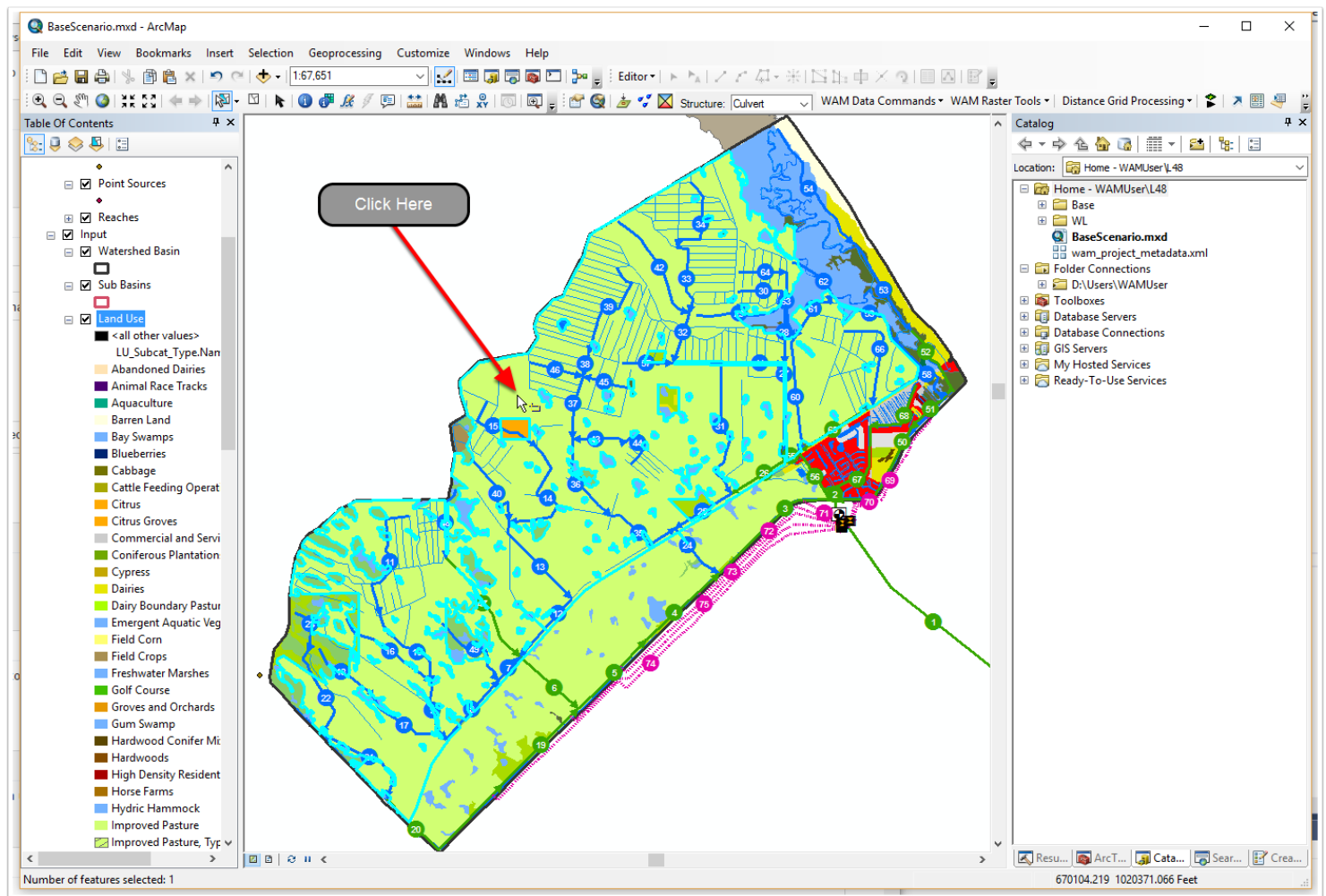
35. Feature Properties Editor

The Feature Properties Editor will appear. It should be blank, since it only displays information about selected features. If nothing is selected, it will be blank. A few more additional tips - it will only display information from the layer that is highlighted in the ArcMap Table of Contents. In this case, the "Land Use" layer should be the one highlighted, and the Feature Properties Editor will only show information about land use features.



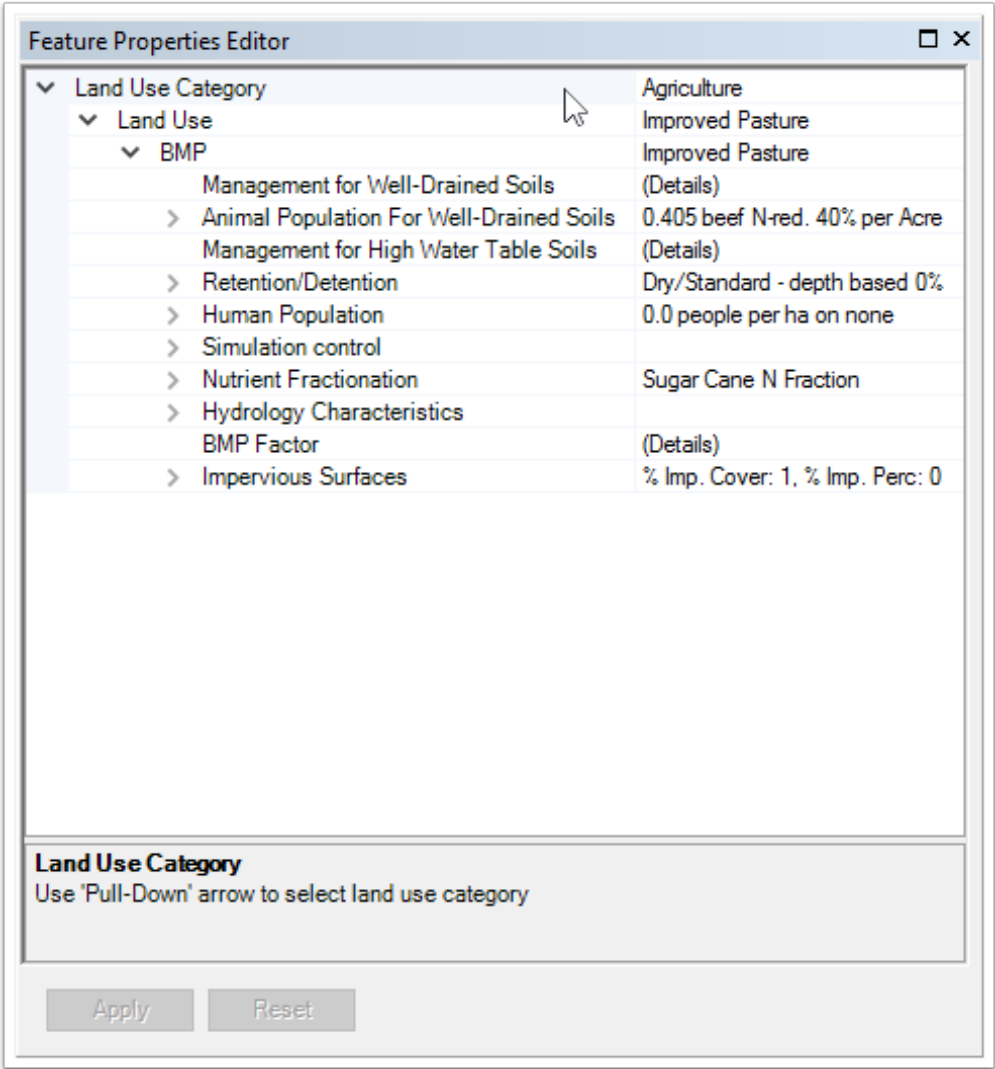
36. Select a Land Use Feature

In ArcMap, a selected feature will show outlined in cyan. In this case a sizeable polygon has been selected by clicking within the boundary.



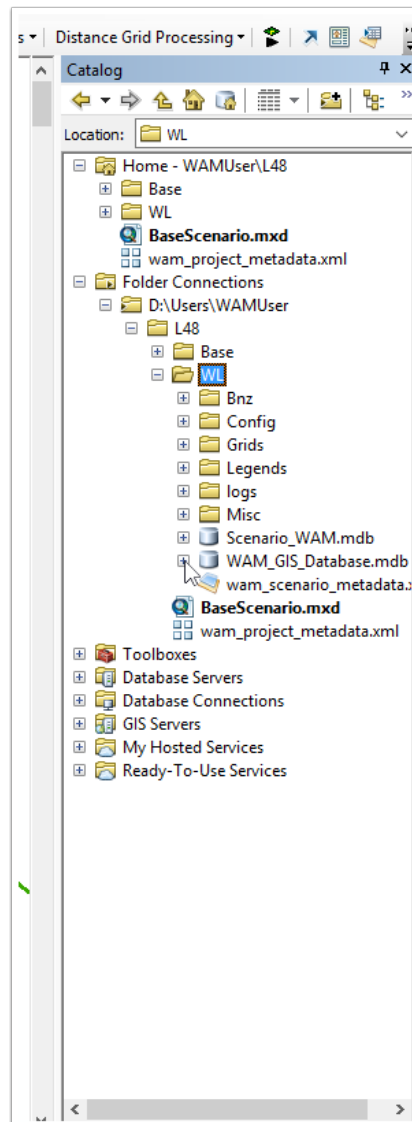
37. Data in the Feature Properties Editor

Data from the selected land use will show in the feature properties editor. Feel free to explore and make changes but **DON'T** apply any changes now (press the "Reset" button, not "Apply"), since we will be making changes later. The feature properties editor is split into two sides. In the columns on the left, the various data categories are shown, while the specific data associated with the feature are shown in the right column.



38. Open the WL folder

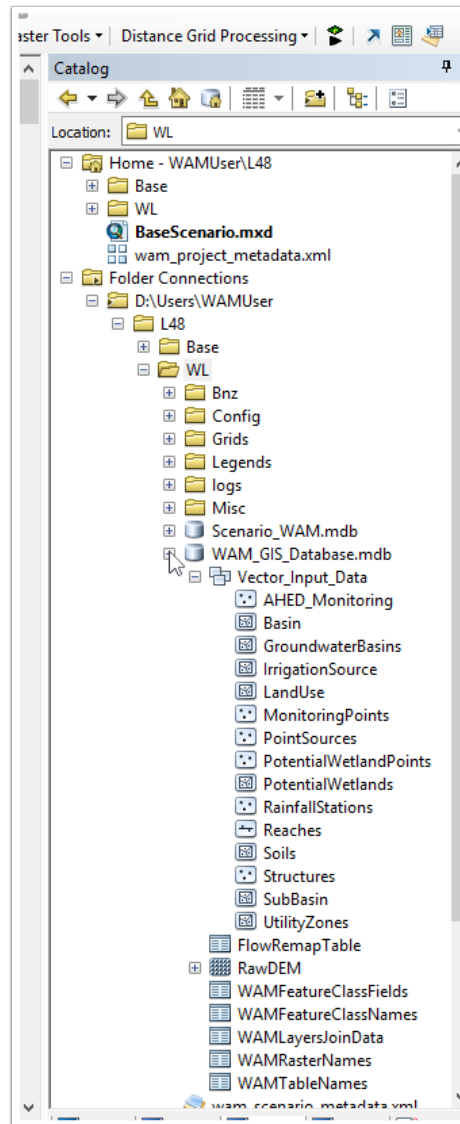
We are going to be making changes based on a geodataset within the WAM_GIS_Database.mdb that's not part of the standard WAM distribution. The database "WAM_GIS_Database.mdb" contains all of the layers needed for WAM, together with additional layers specific to a particular project or scenario.



39. Open the Database

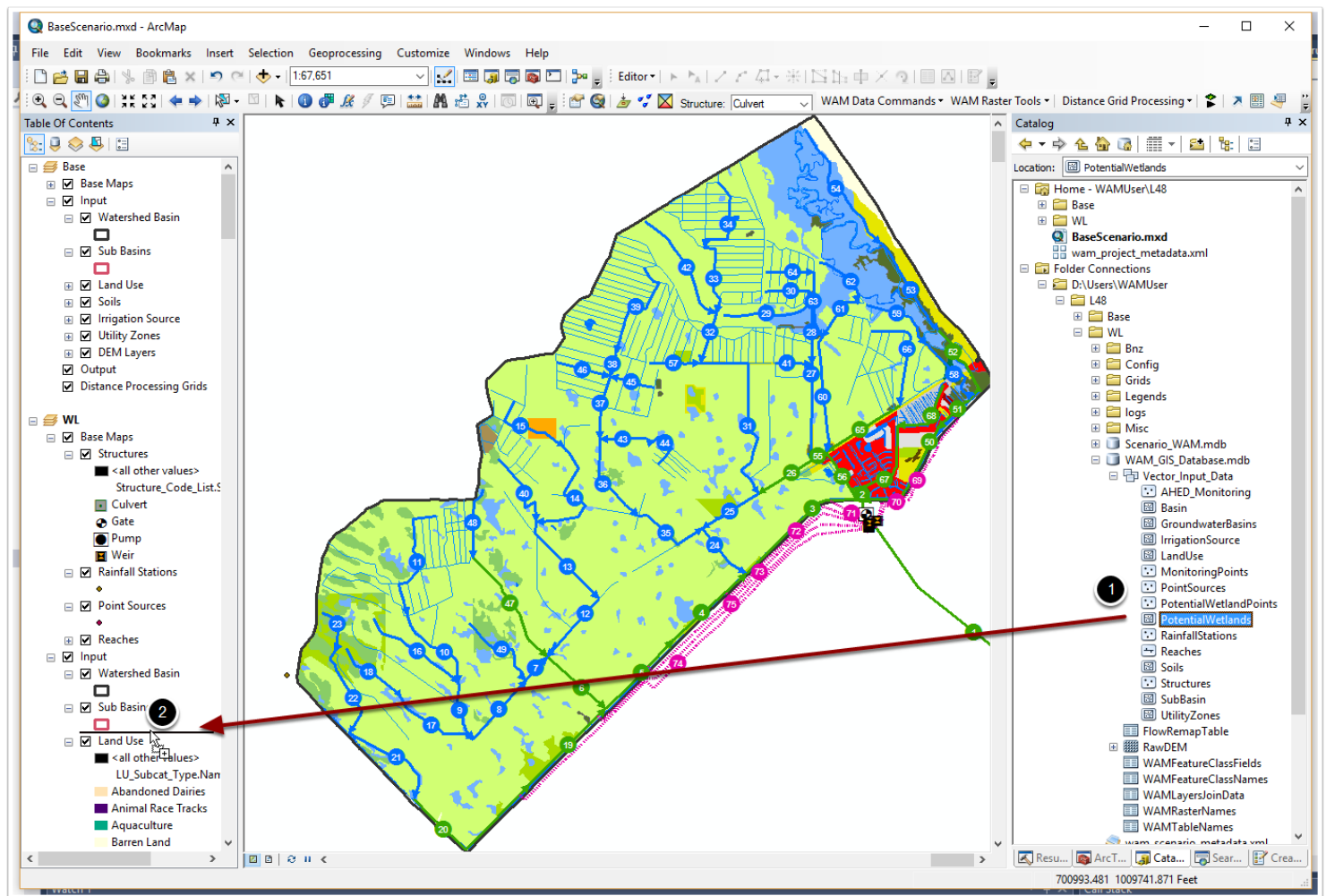
Open by clicking on the plus to the left of WAM_GIS_Database.mdb, then open the "Vector_Input_Data" feature dataset in the same way. We're going to add the "PotentialWetlands" feature class to the map. This is a

geodataset that's specific to this project, it contains polygons that show the spatial extent of areas that may be used to create treatment wetlands for the L-48 basin.



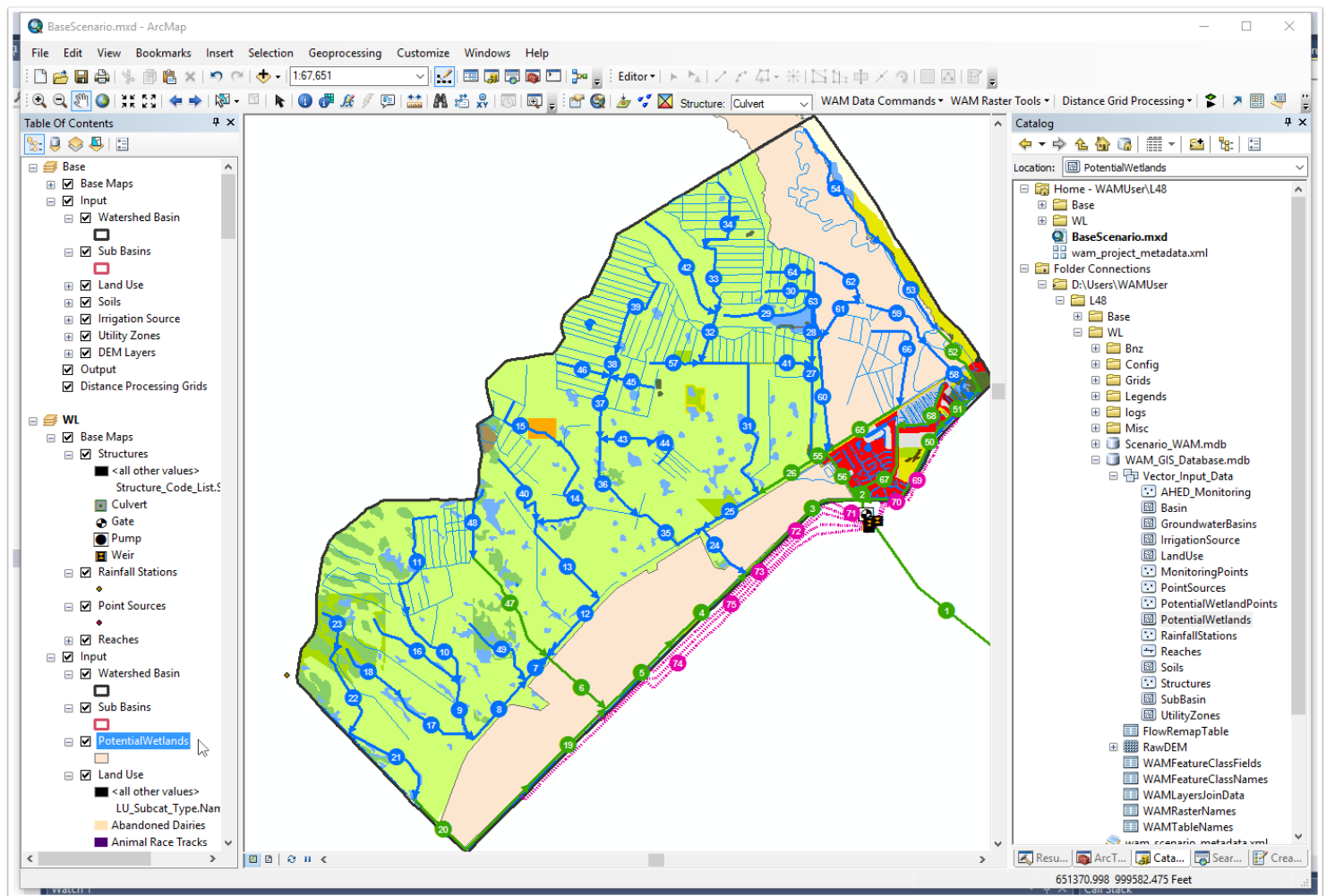
40. Adding a Feature Class

Click on the feature class (1) "PotentialWetlands" in the Catalog and drag it to the Table of Contents between "Sub Basin" and "Land Use"



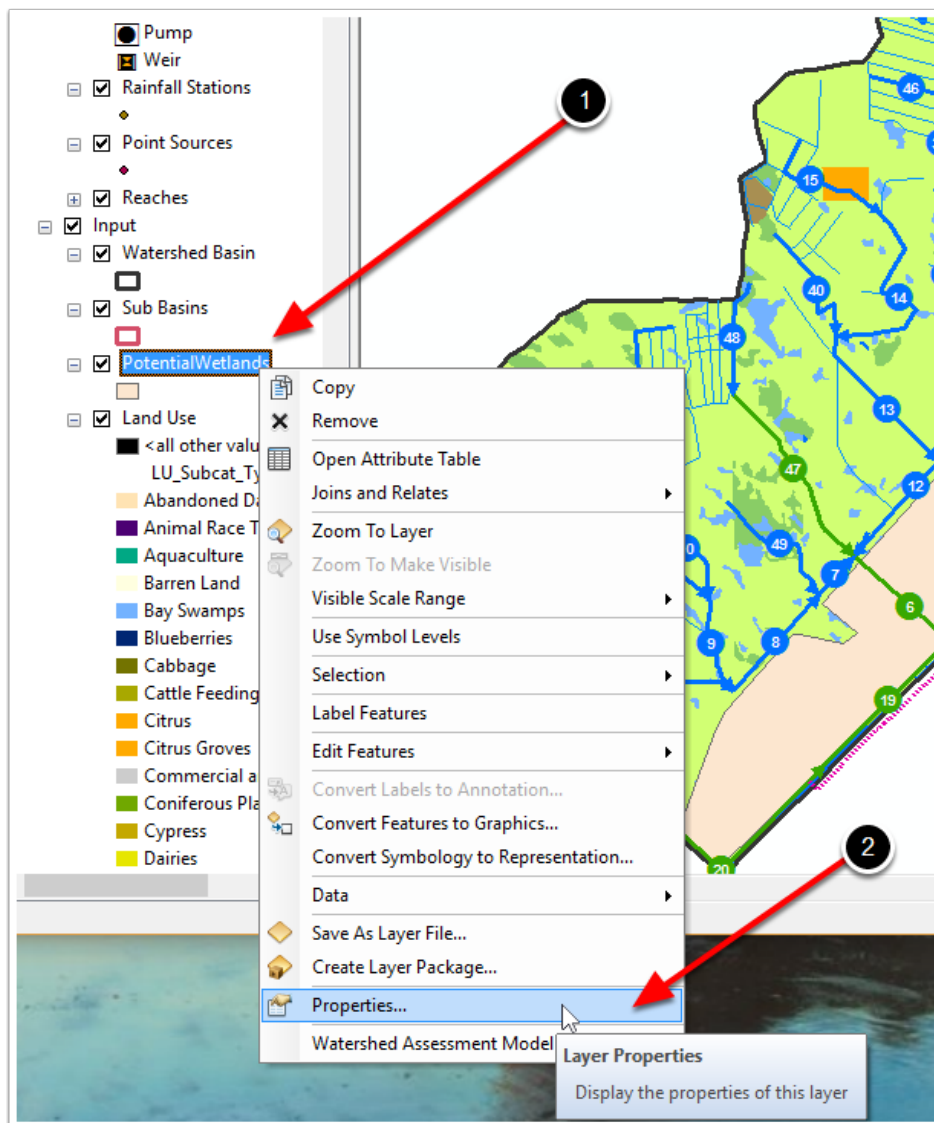
41. Potential Wetlands Added

This adds the polygons showing the potential treatment wetlands to the map. The potential wetlands are the beige polygons to the map.



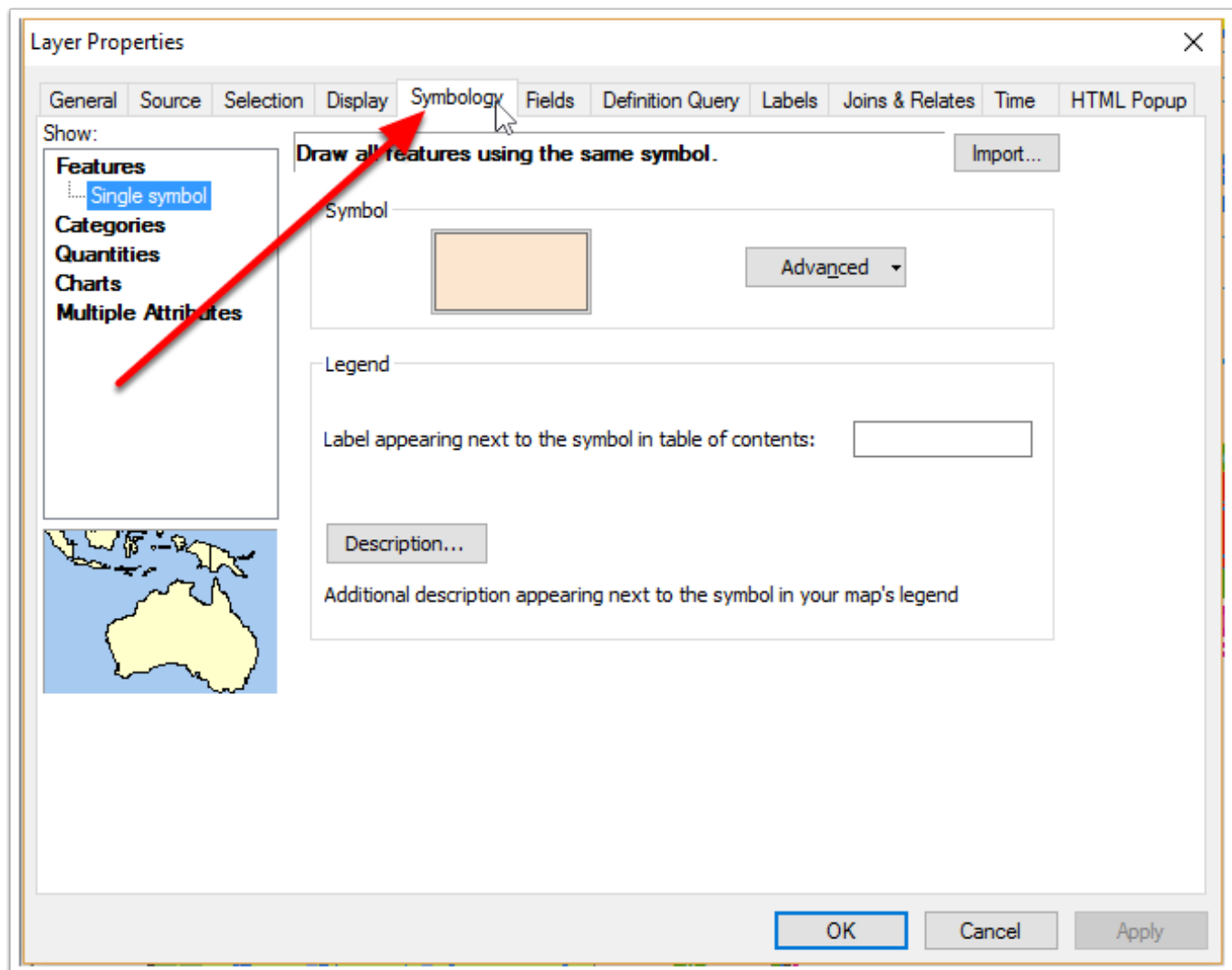
42. Symbolize

To symbolize the layer a bit better, right click (1) on "PotentialWetlands" and (2) click on "Properties..."



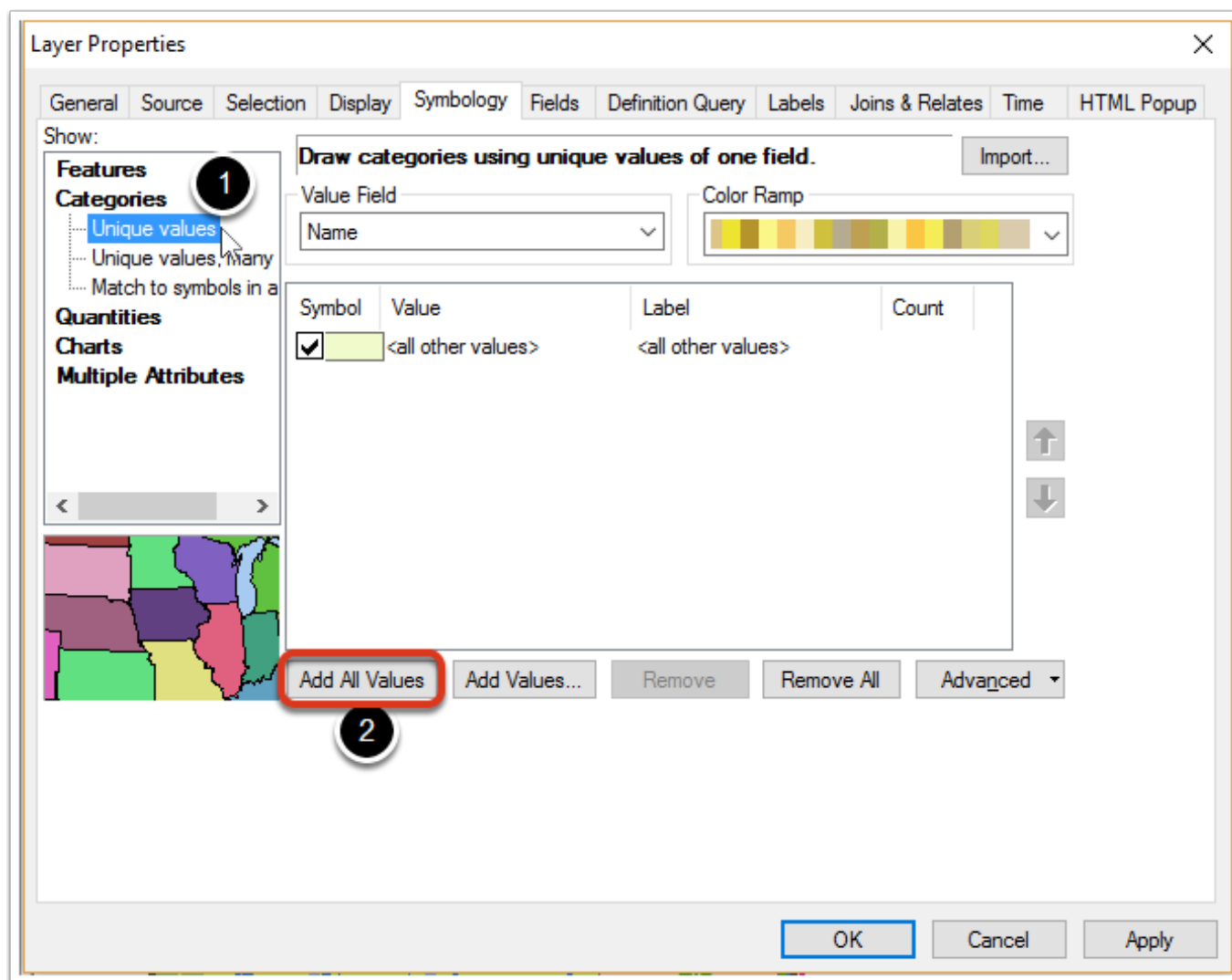
43. The Layer Properties Screen

This will bring up the properties window for the layer. We are going to change the symbology. If the tab has not already been selected, click on it now.



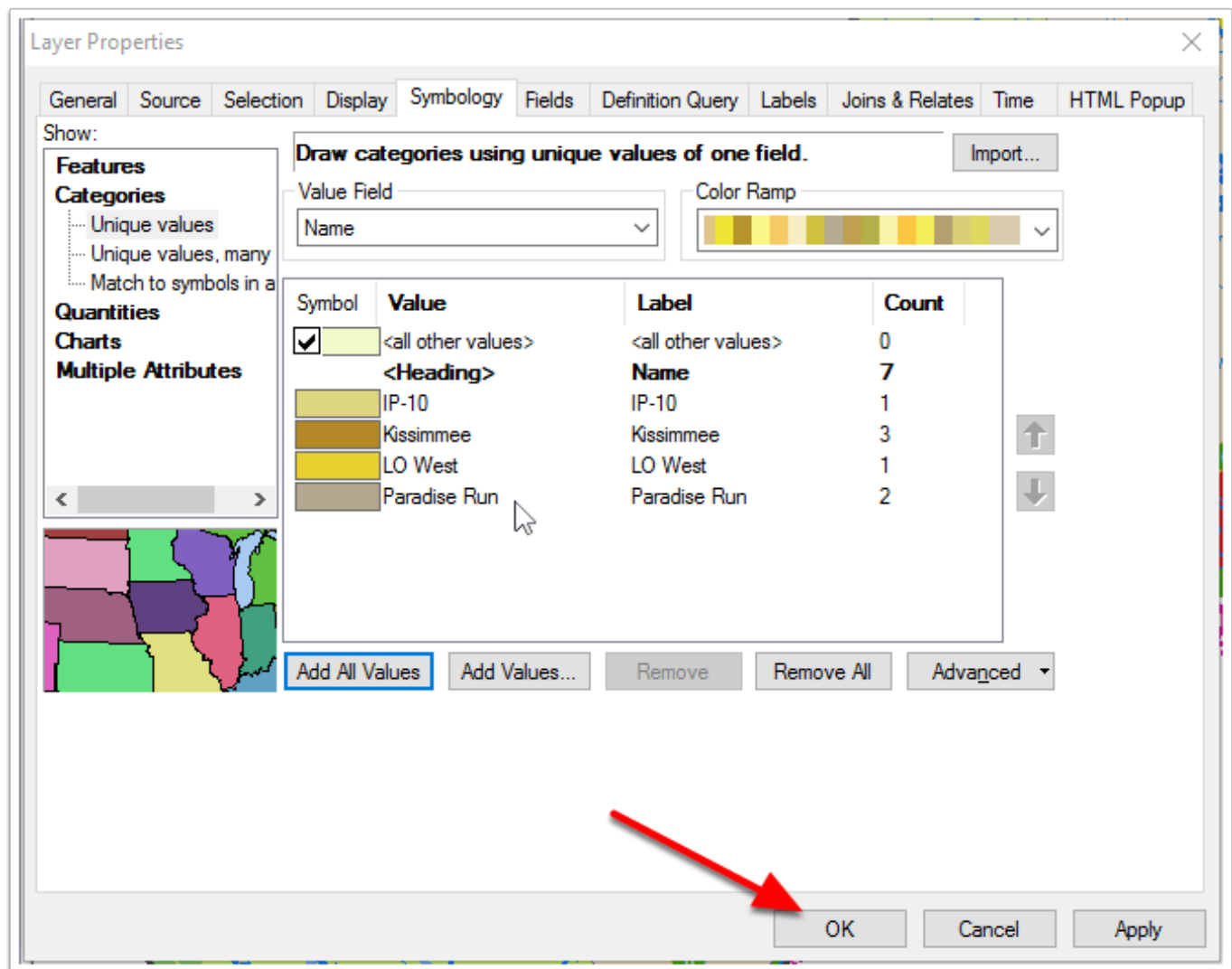
44. Symbolize by Categories

Click on "Categories", then "Unique Values" (1). The value field should stay as "name". Click Add All values (2).



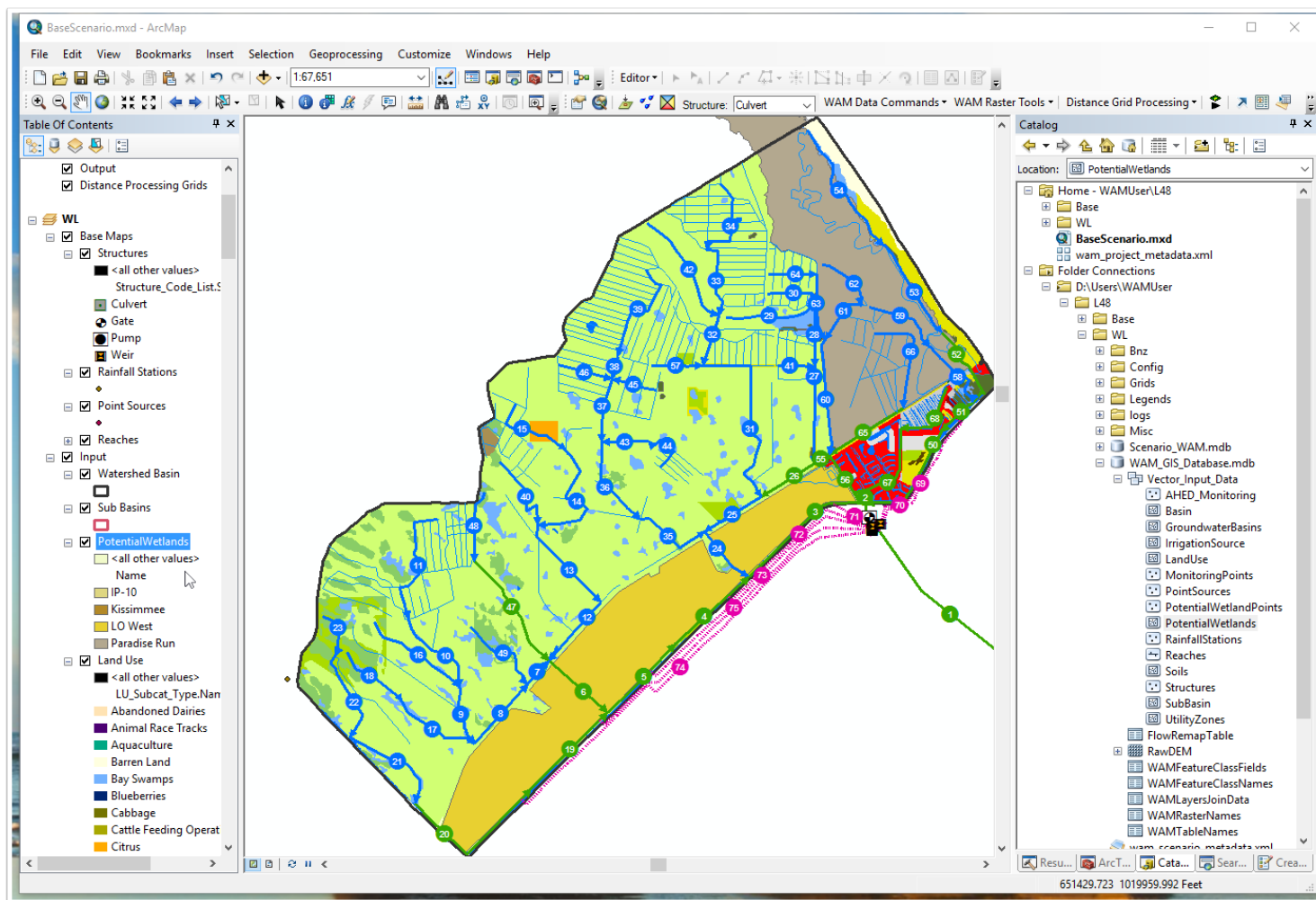
45. The New Symbology

The colors that show up for you to symbolize the different names may be different. Click OK



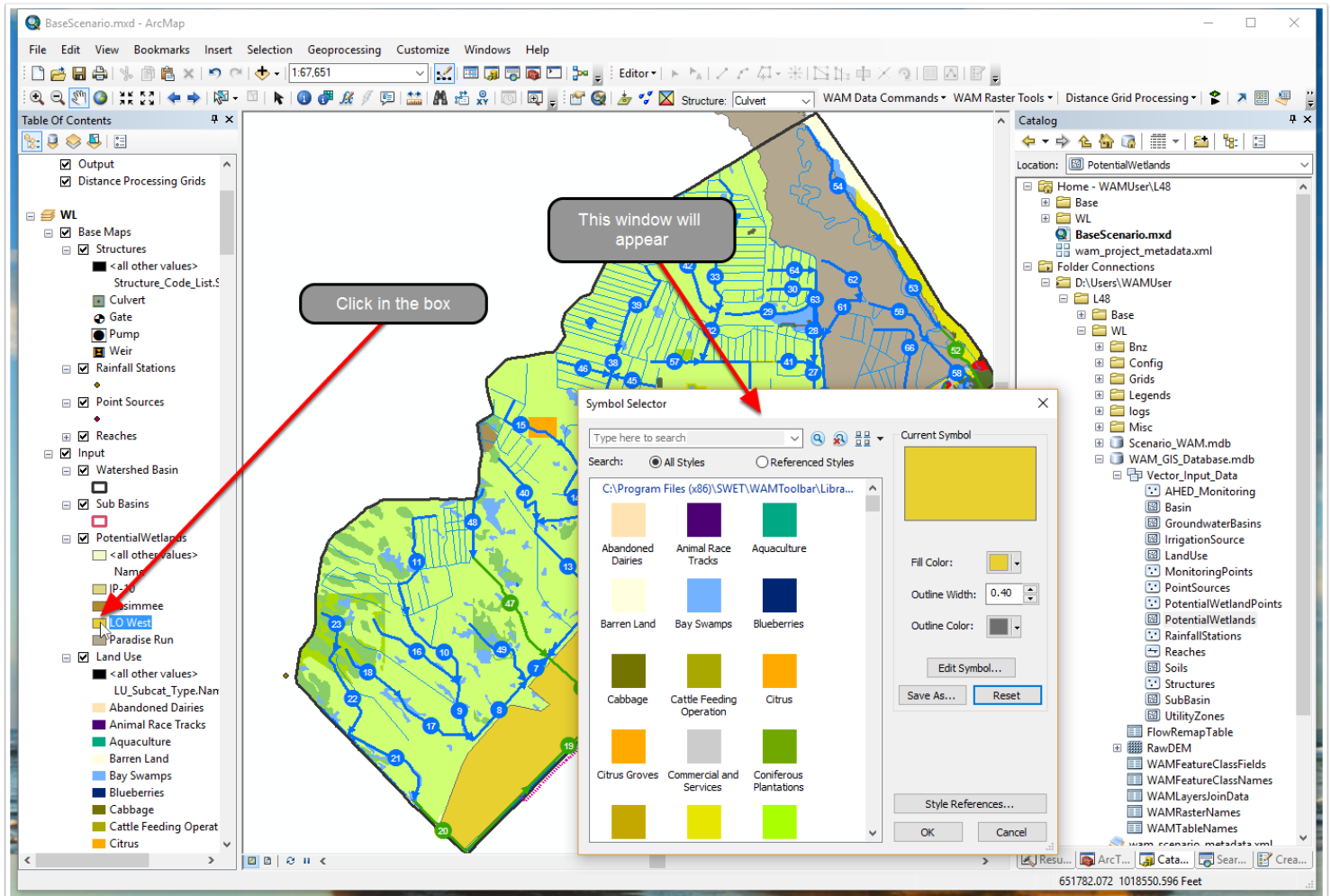
46. The Symbolized Layer

The PotentialWetlands layer has now been symbolized according to the name of the wetland.



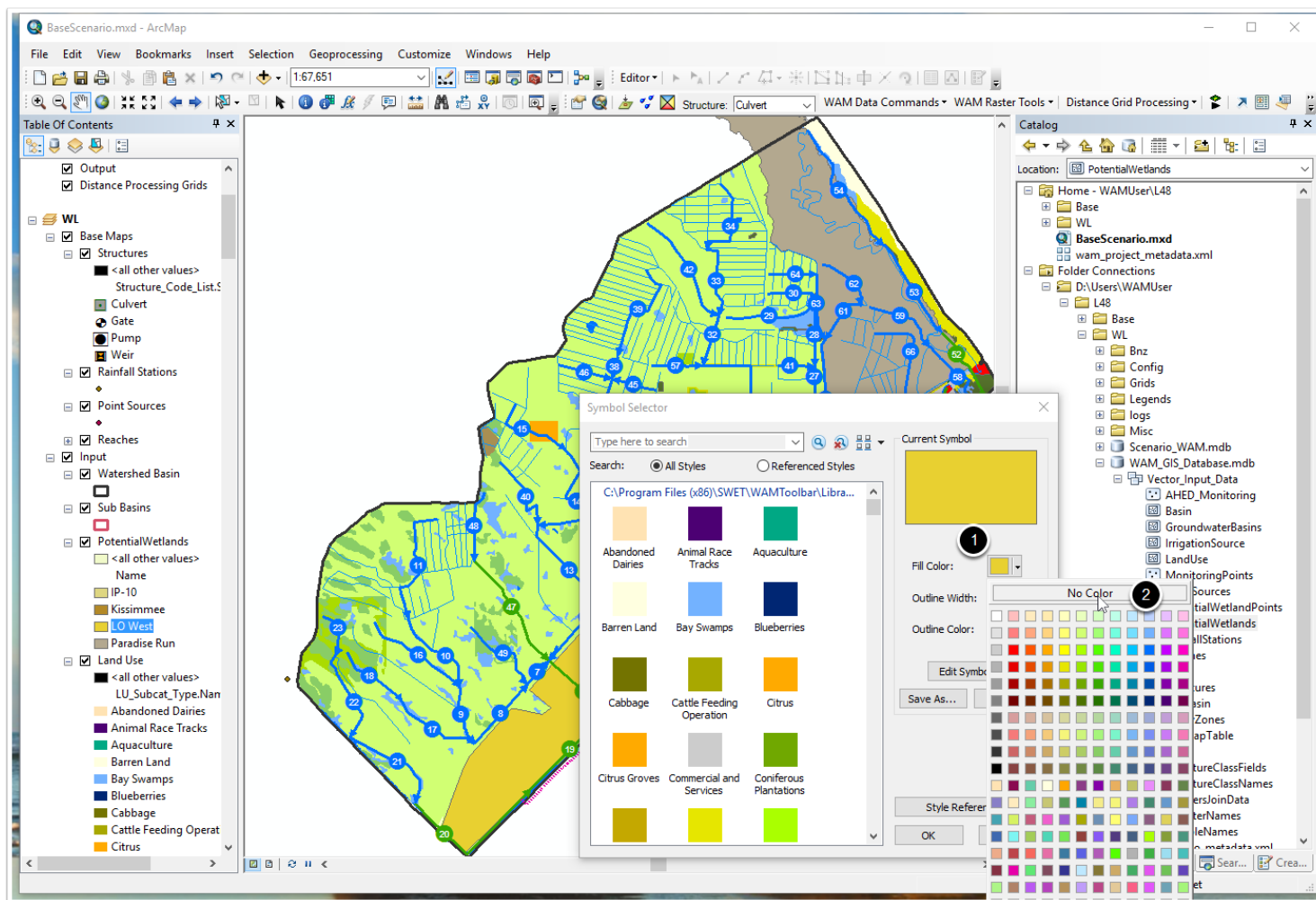
47. Make the LO West Polygon Hollow

In order to see the underlying land uses, we are going to make the polygon associated with the LO West polygon hollow, i.e., only an outline with no fill. To do this click in the small color box to the right of LO West and the "Symbol Selector" should appear



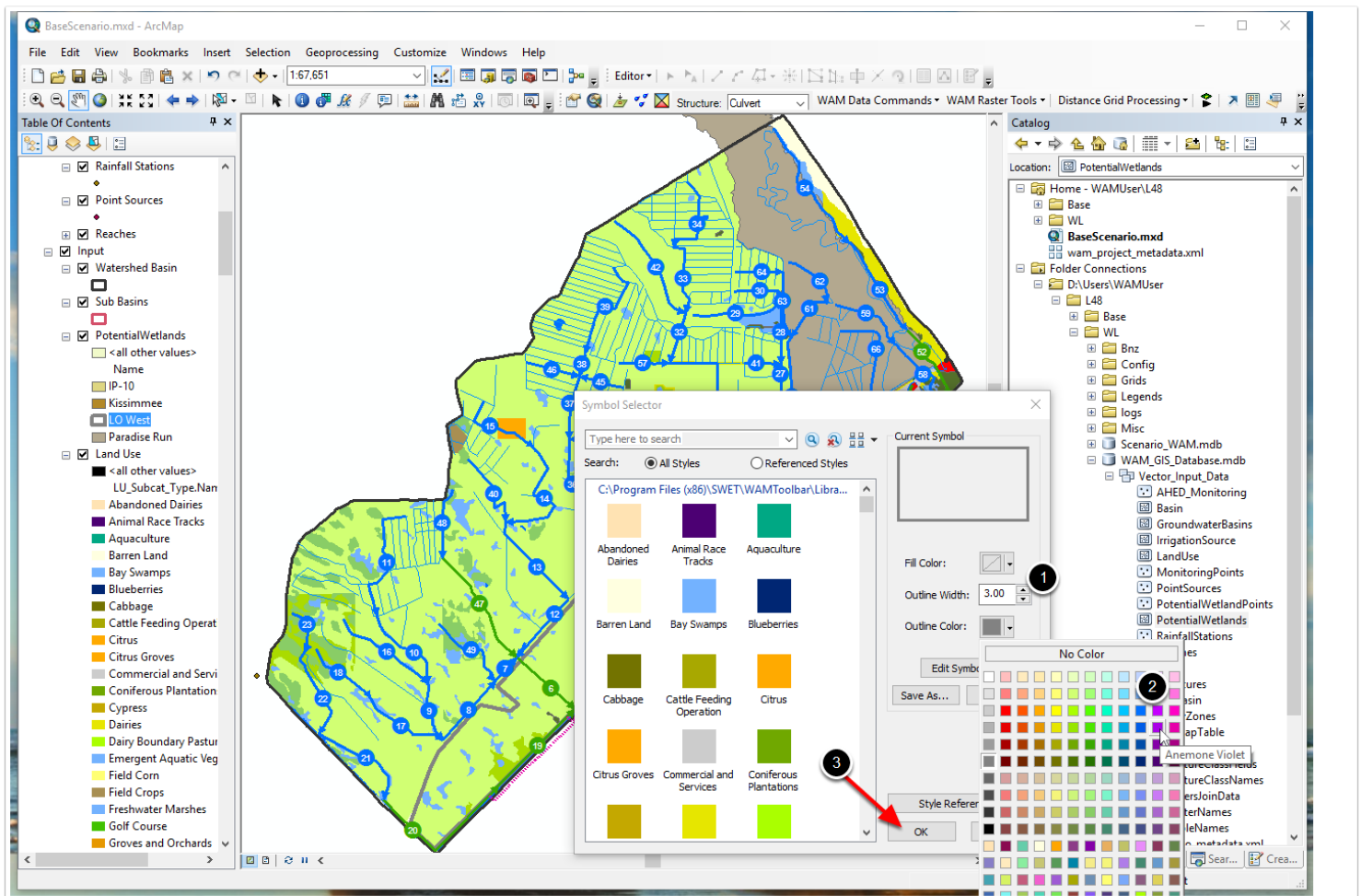
48. Get Rid of the Fill

Click on the small color box to the right (1) of "Fill Color" and then (2) click on "No Color"



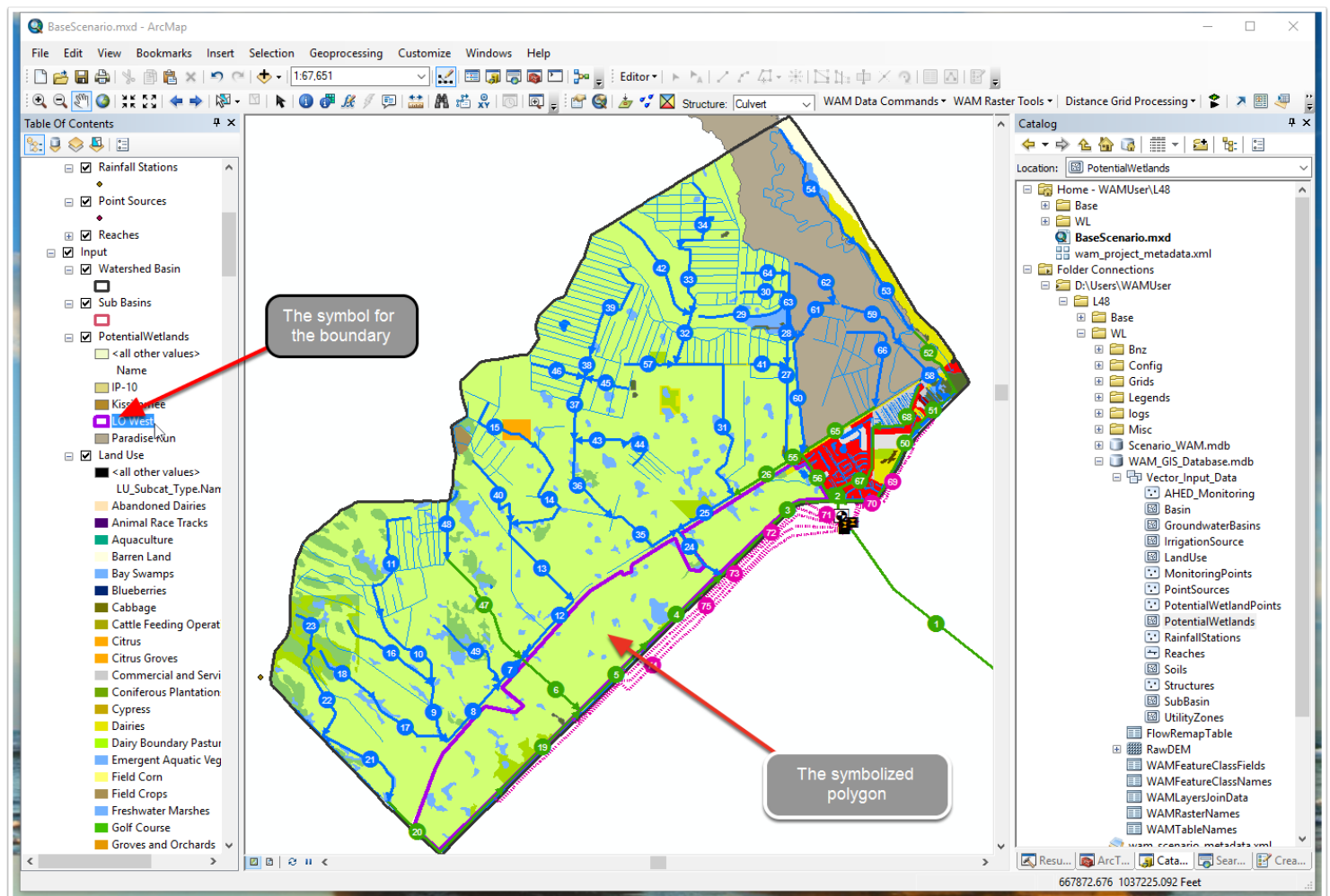
49. Make the Boundary Thicker

Make the outline width 2 or 3 by (1) clicking on the small up arrow, and make the color of the outline (2) somewhat garish so it is easily visible, and click OK.



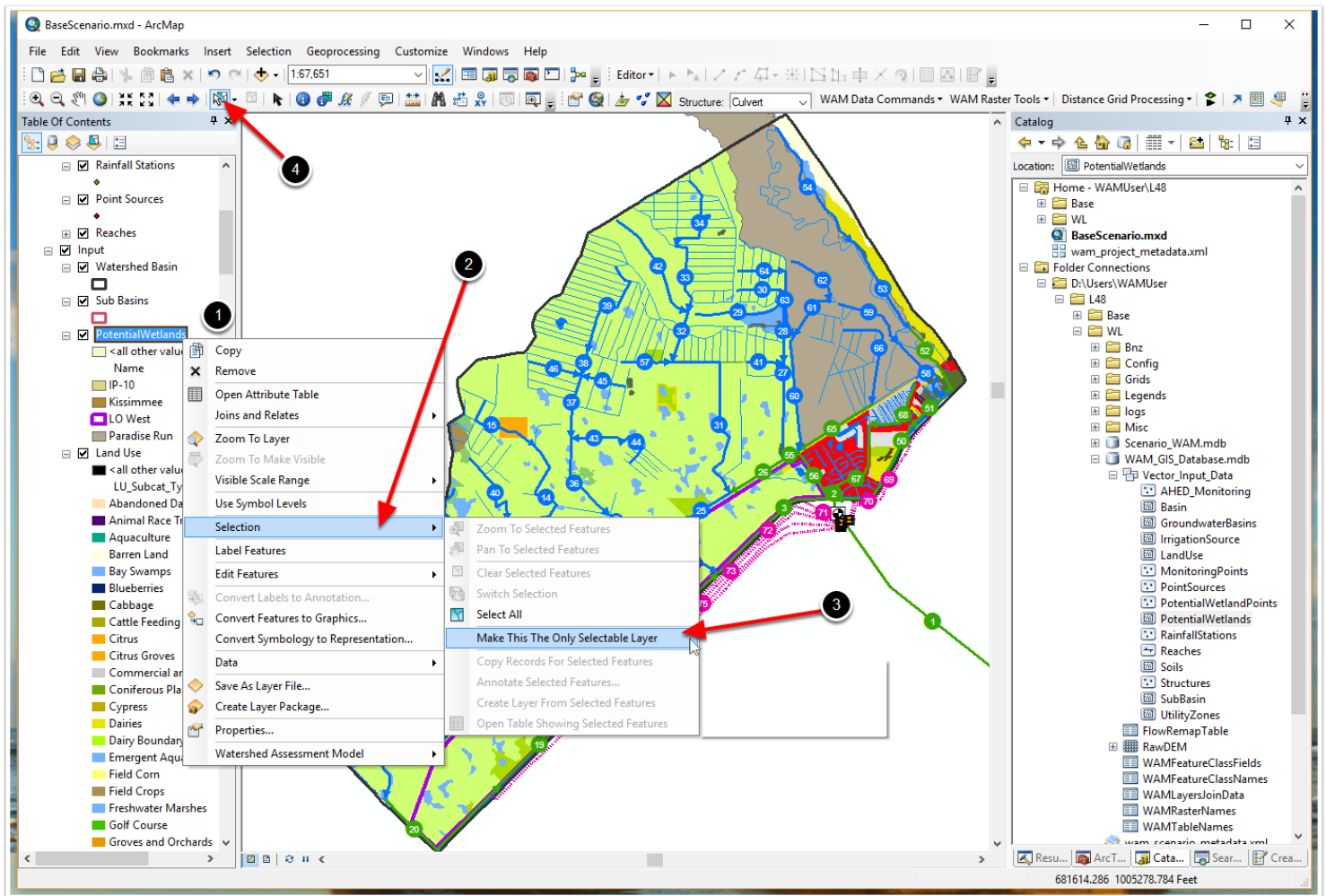
50. The Wetland Boundary

The wetland boundary is now shown by the purplish color. Your color may be different, depending on what you selected.



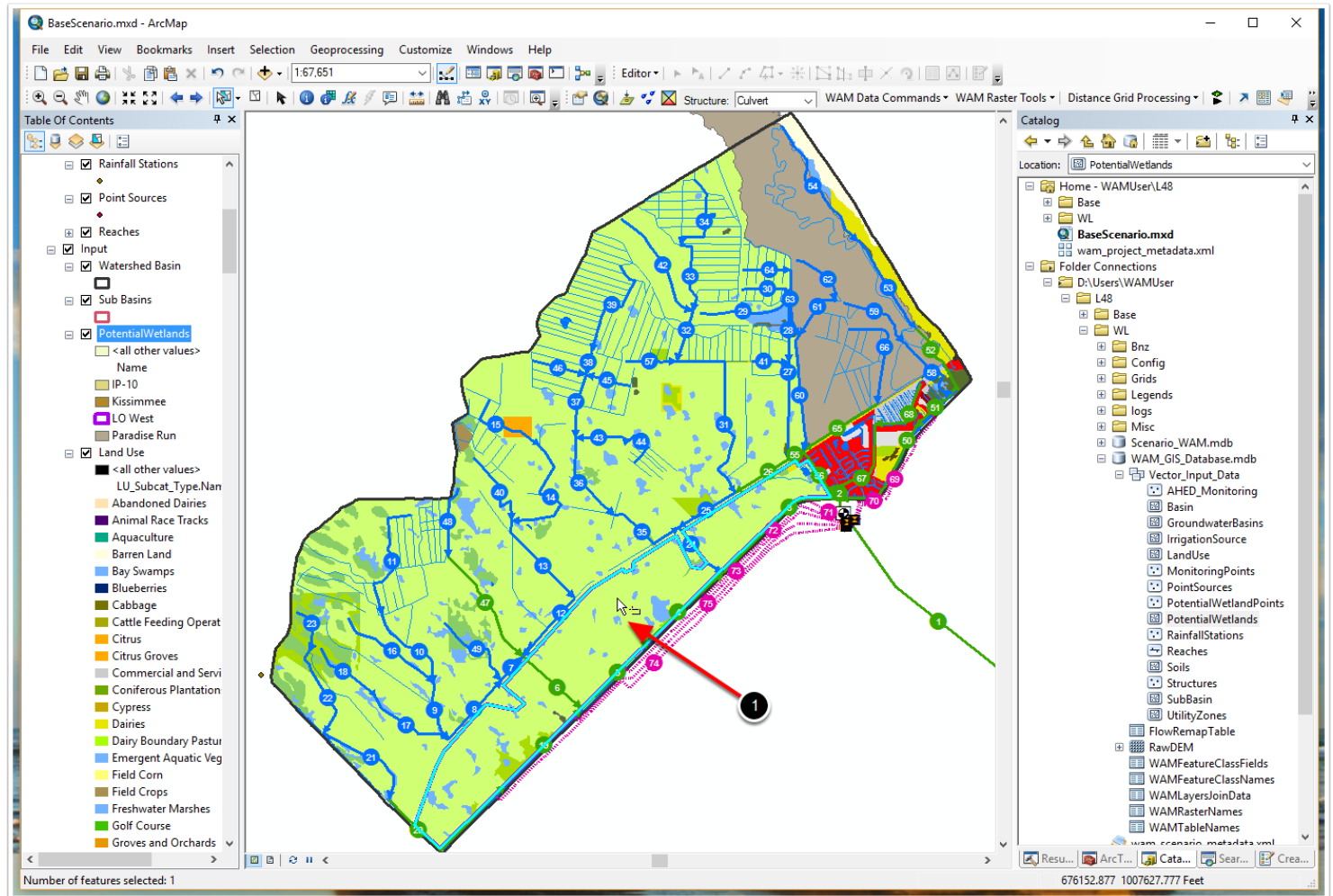
51. Make Potential Wetland the only selectable layer

Right click on (1) PotentialWetlands and then (2) Selection, then (3) Make this the Only Selectable Layer. Make sure the selection tool is active (4).



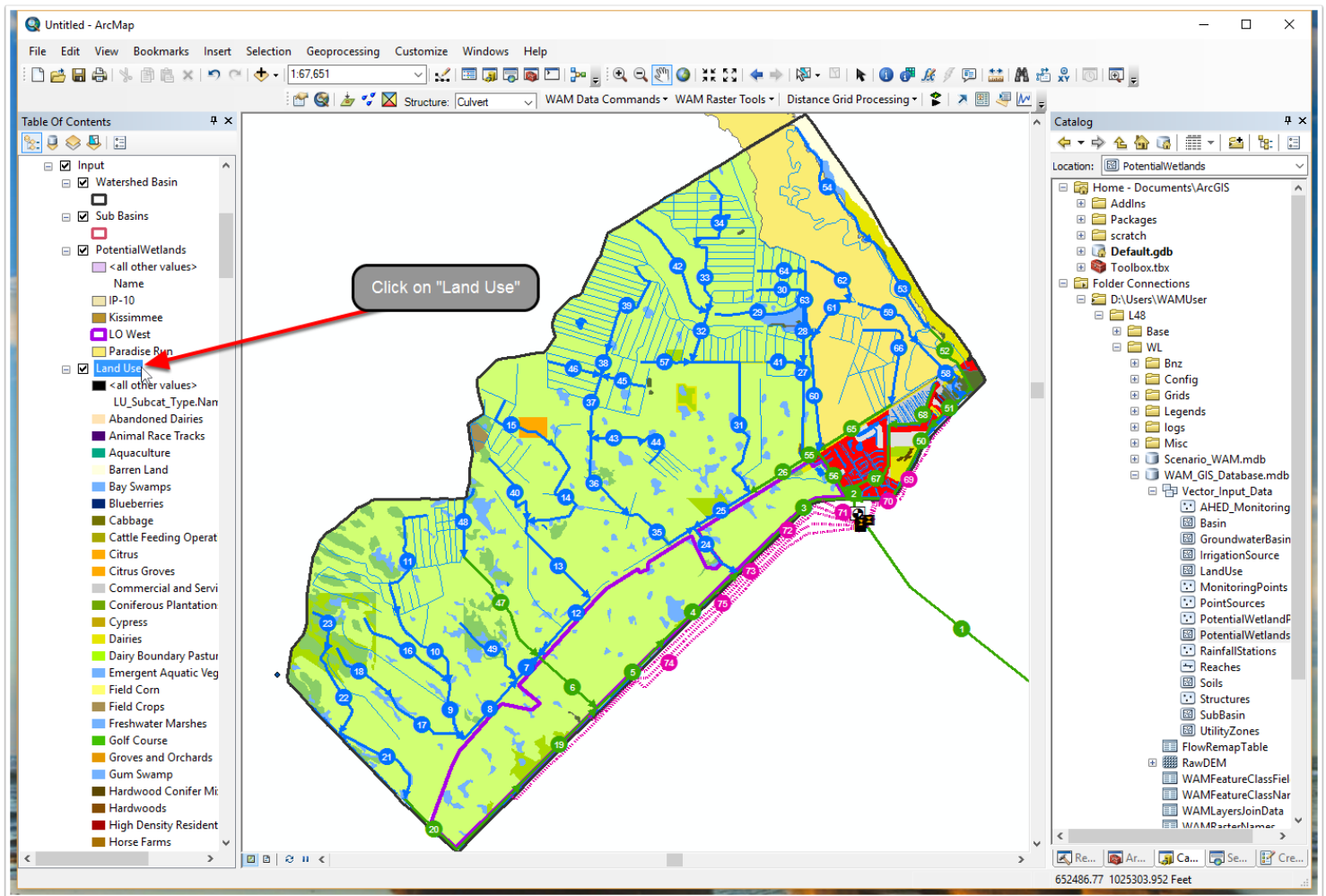
52. Select the LO West Polygon

Click inside the LO West polygon. The outline should change to a cyan color indicating that it has been selected.



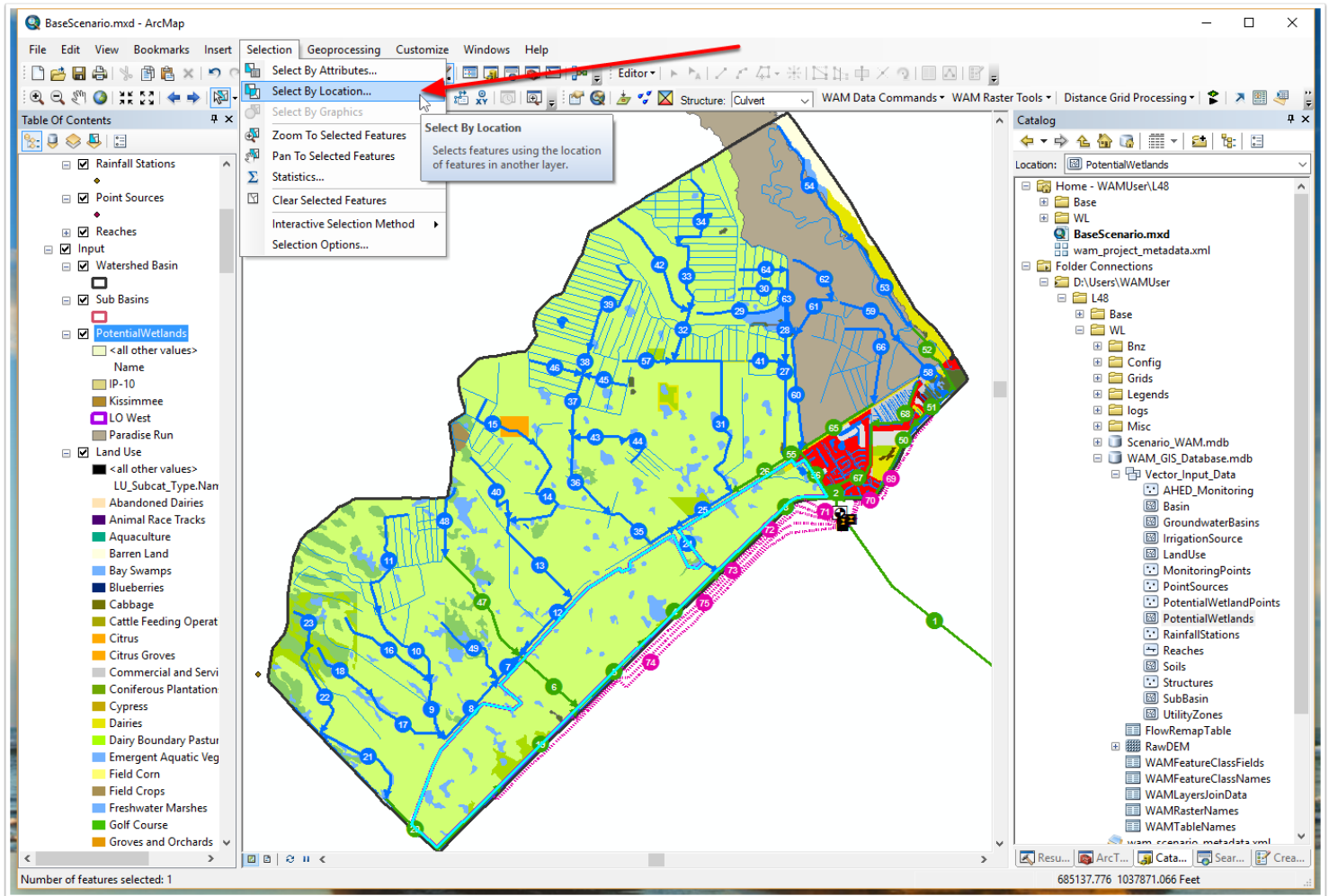
53. Highlight the Land Use Layer

In the ArcMap Table of Contents, make sure that the layer "Land Use" is highlighted, this way the Feature Properties Editor will show the selected land use features. Do this by clicking on the name "Land Use".



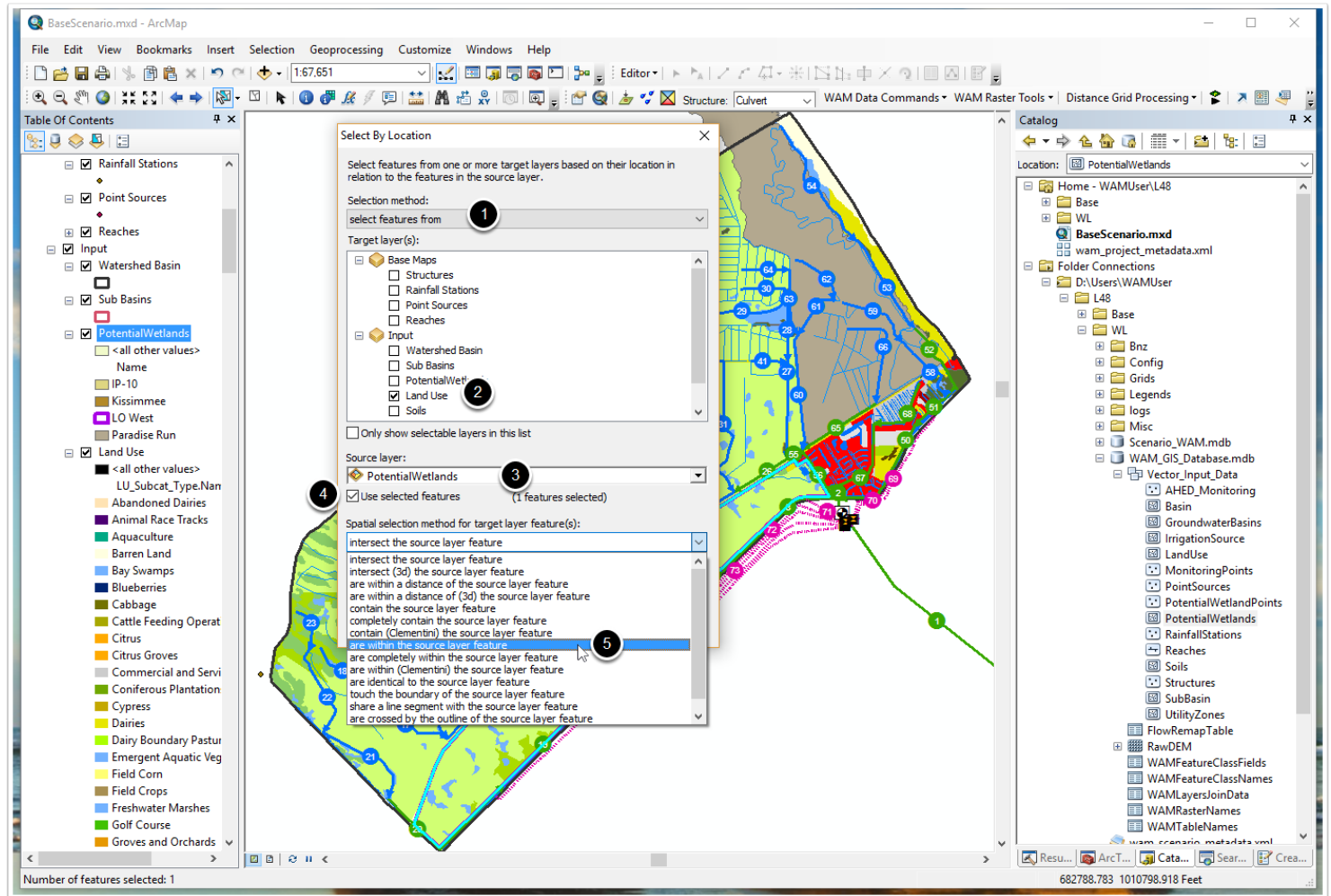
54. Select Land Uses by Location

We are now going to select the different land use polygons within the LO West polygon. We will do this so that we can make changes **only** to those land use polygons. To do this, we will use the "Select by Location..." tool. Click on the "Selection" menu, then choose "Select by Location".



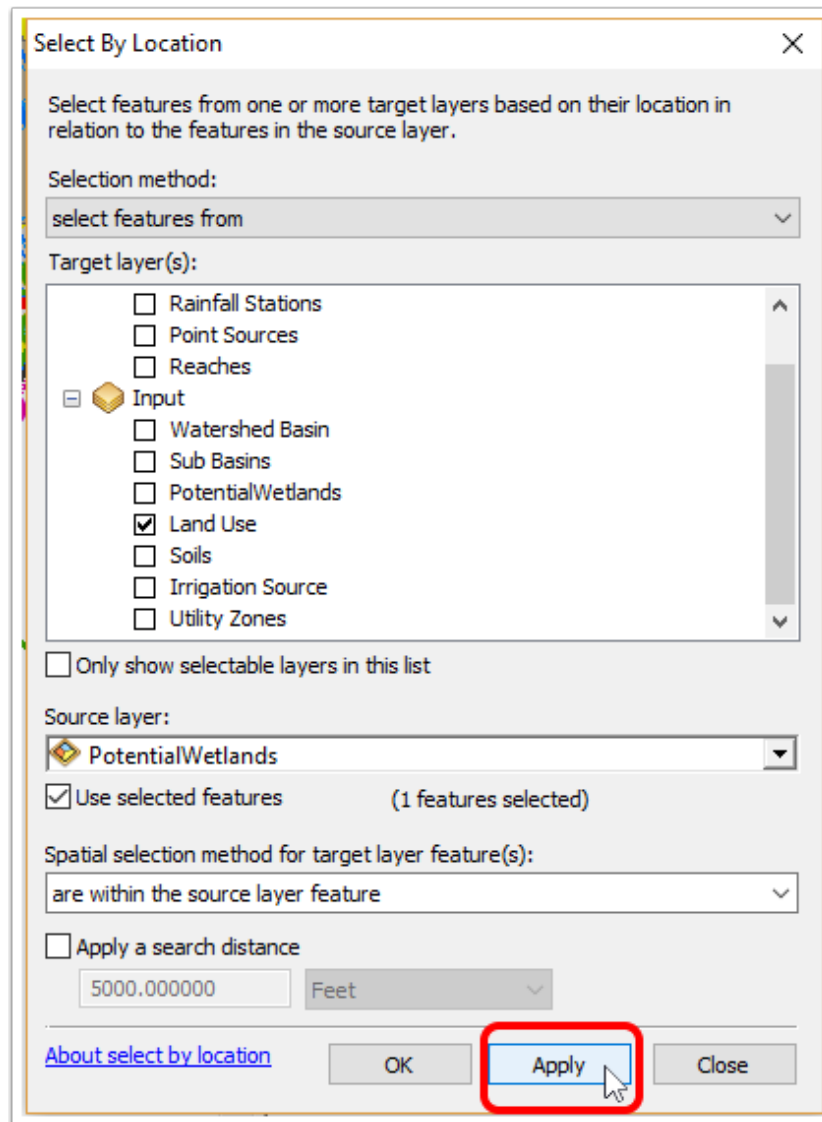
55. The Select by Location Window

The Select by Location window has many options. We want to (1) select features from (2) Land Use with the (3) source layer set to PotentialWetlands, using (4) Selected Features, and (5) are within the source layer featured. Click Apply (DO NOT CLICK "OK"! We want to keep the window open for now).



56. Select by Location

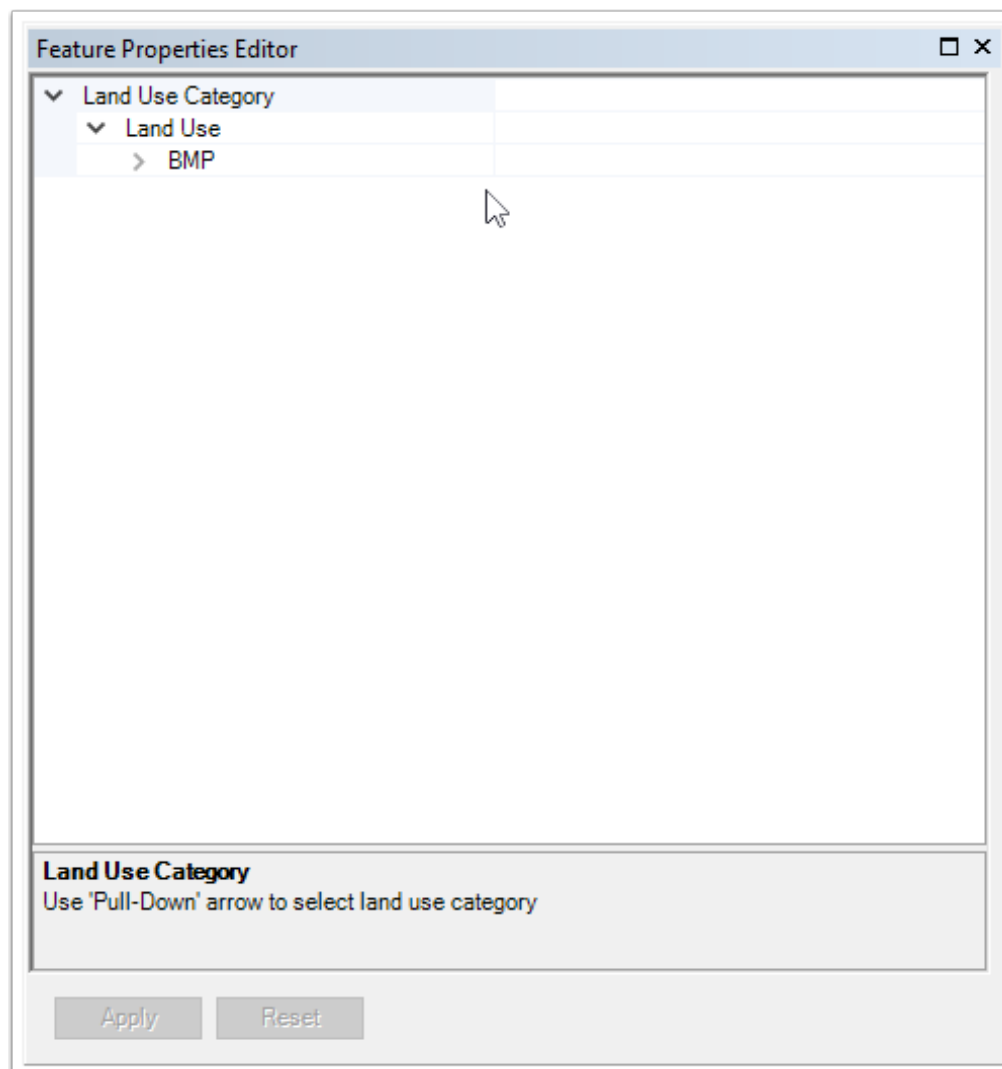
When we select features again from the Land Use layer they will be added to the feature properties editor. Nothing is added to the Feature Properties Editor unless its window is open. If you have not done so, click the "Apply" button.



57. The Feature Properties Editor

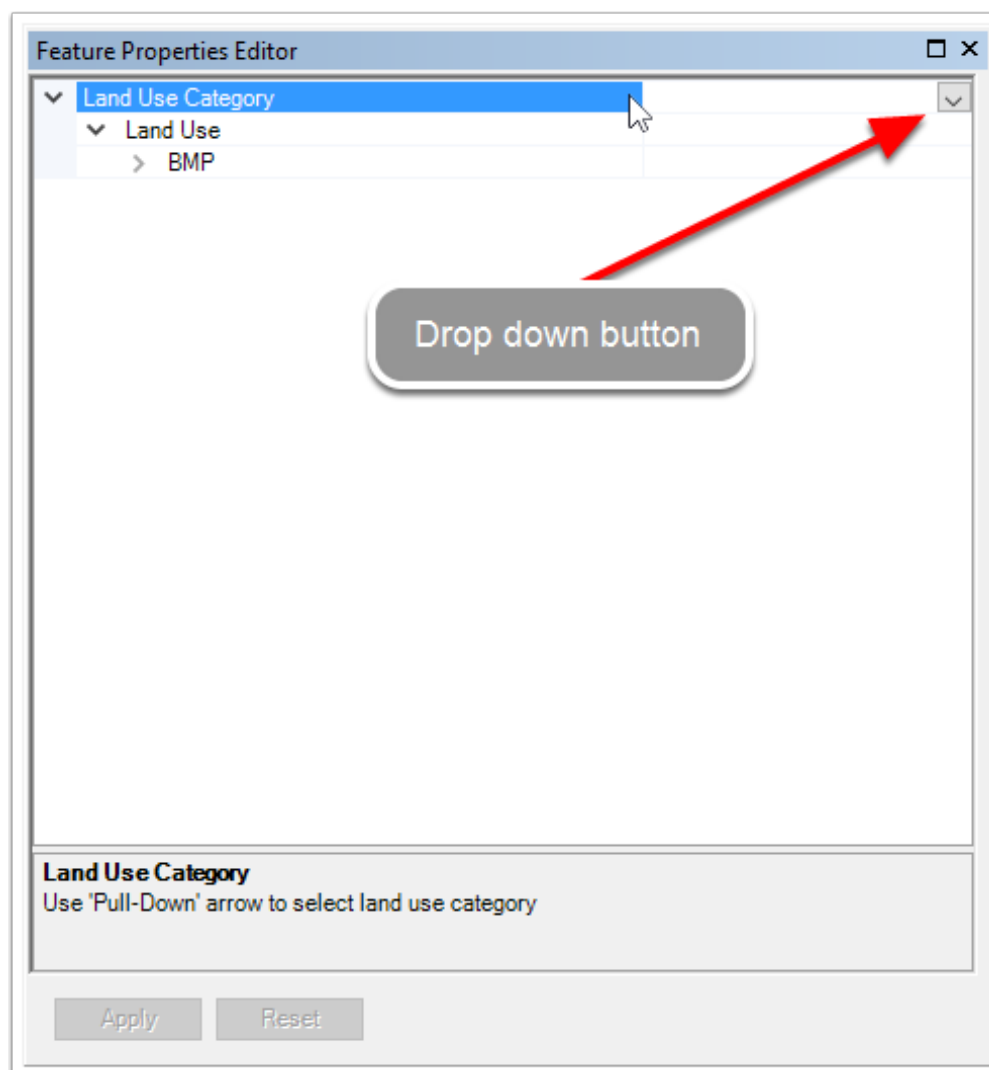
The Feature Properties Editor should appear different. The right side (now blank) will usually show data from the selected features, but if multiple features are selected (as they are here), only data that the features have in common are listed. Here, several different categories of land uses have been selected, including agriculture,

special case, etc., so there are no data in common. However, we can use this to change the Land Use Category and Land Use for **all** the selected features at once!



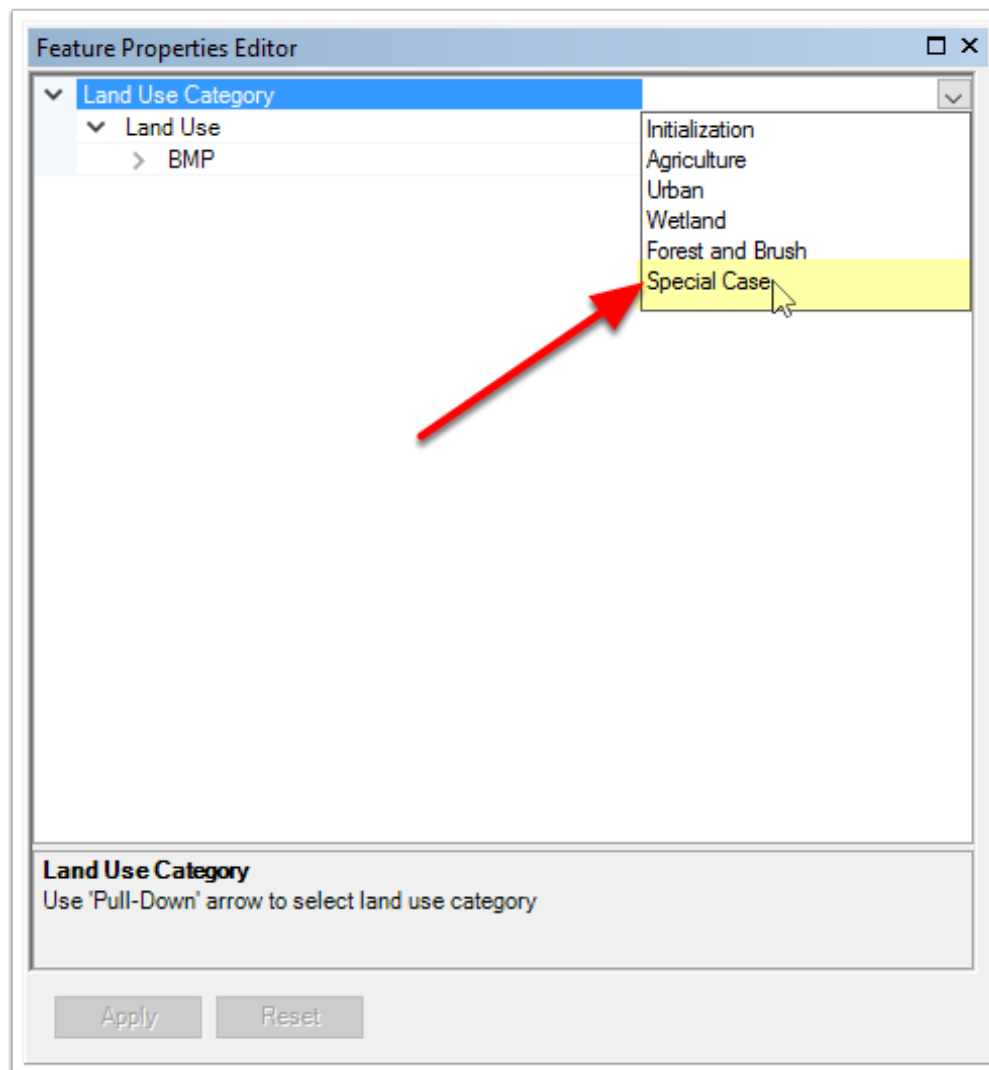
58. Changing the Selected Land Uses

Click on the left top-most row, "Land Use Category". A drop-down menu button should appear on the right side of the right column in the top row.



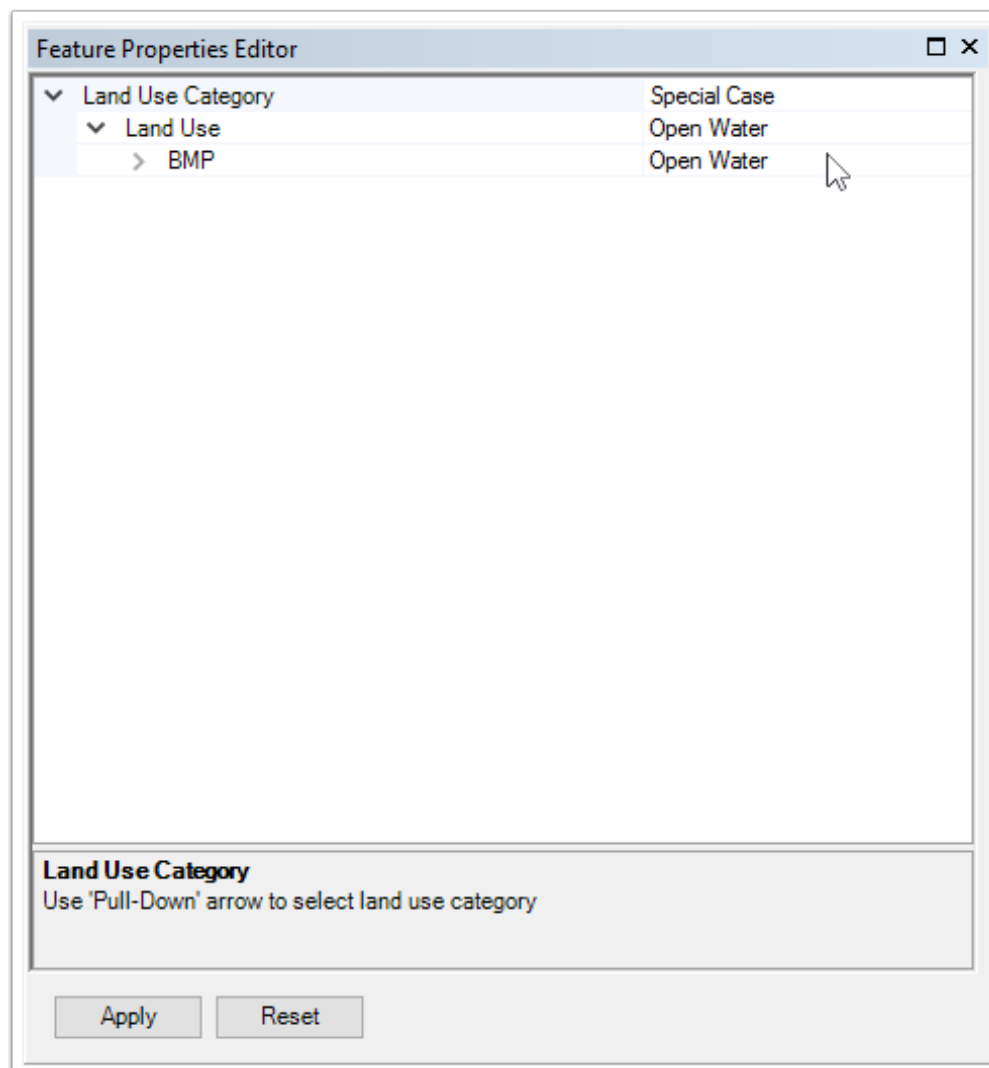
59. Select Special Case

Select Special Case for the Land Use Category. It should be the last item in the drop-down menu.



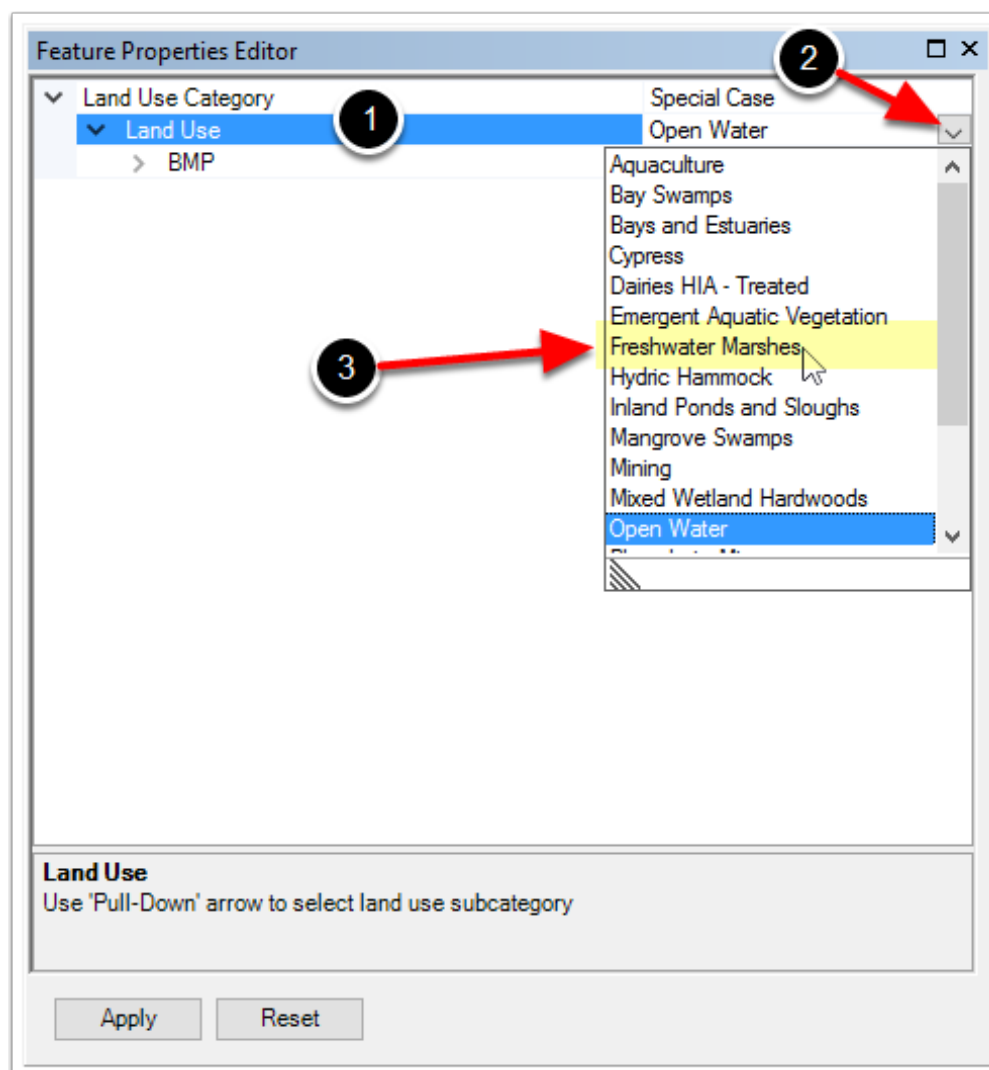
60. Default Land Use

The default land use for Special Case is Open Water - however, we don't want that, we want "Freshwater Marshes"



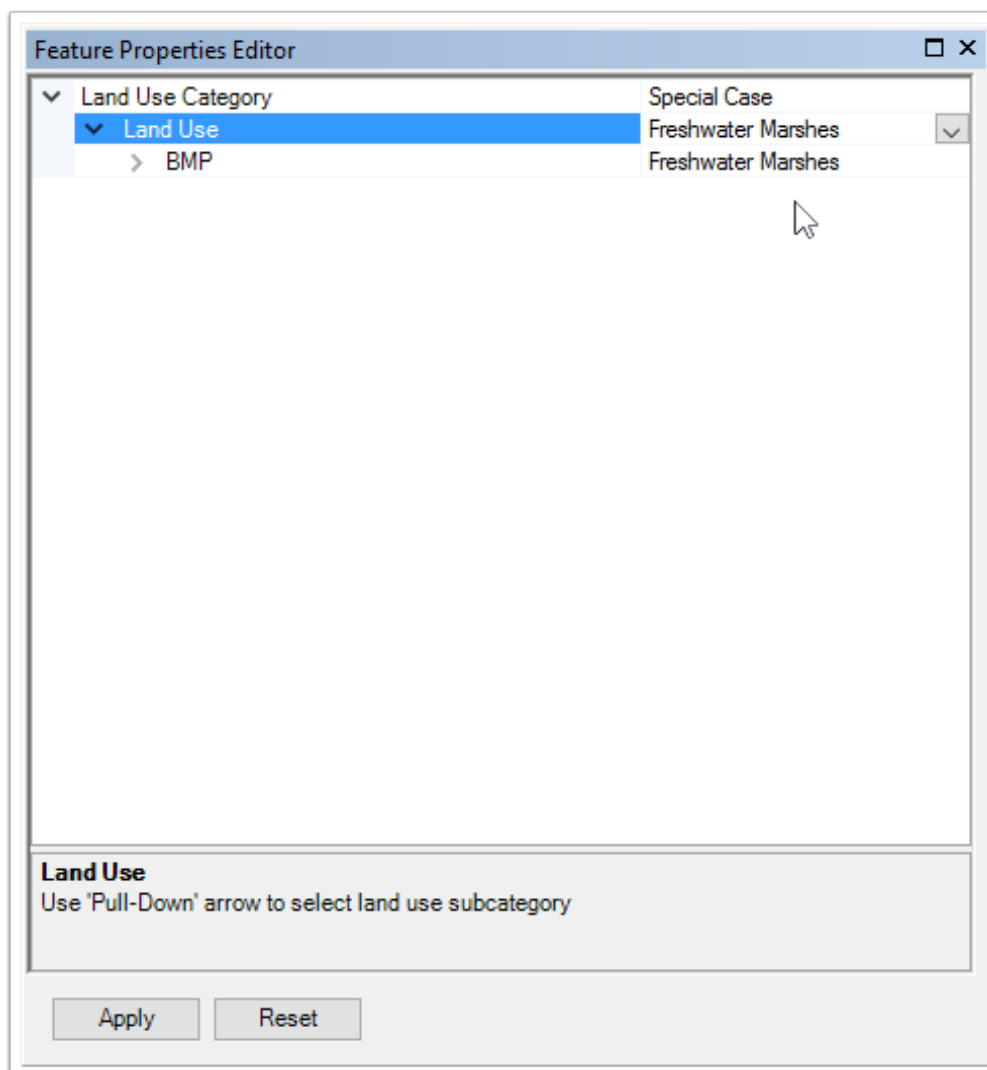
61. Change to Freshwater Marshes

Click In the (1) Land Use row in the left column, click on the (2) drop-down menu button in the right column, and select "Freshwater Marshes" from the list.



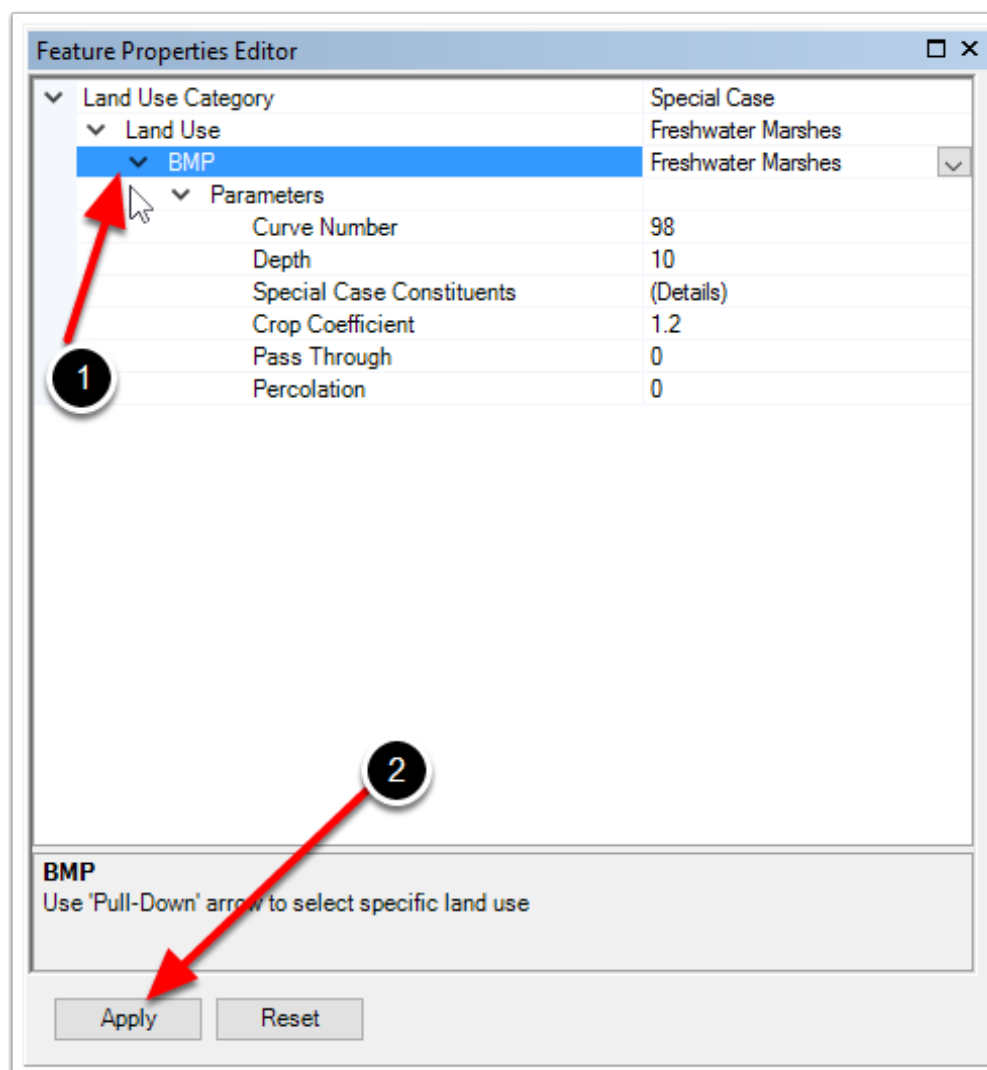
62. Freshwater Marshes Selected

Note there is no alternative BMP that can be applied to Freshwater Marshes, since it is a natural land use and there are no BMPs. For the "base" BMP, WAM uses the same name as the Land Use (in this case, "Freshwater Marshes" for both). As an aside, if you want to apply a specific BMP to a land use that *does* have BMPs associated with it, you would do that here.



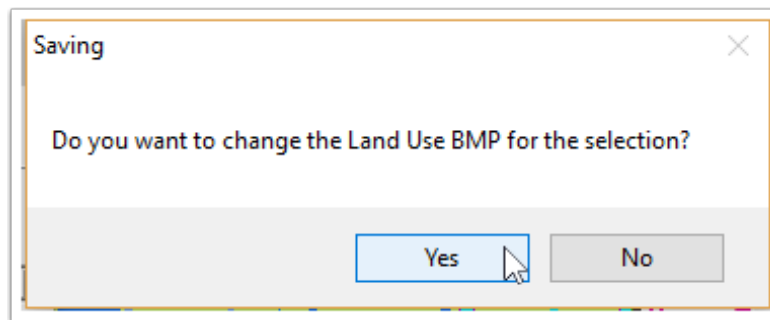
63. See properties for Freshwater Marshes

Click on the ">" by "BMP" if you want to see some of the underlying properties. Don't change anything for now, but after exploring, (2) click "Apply"



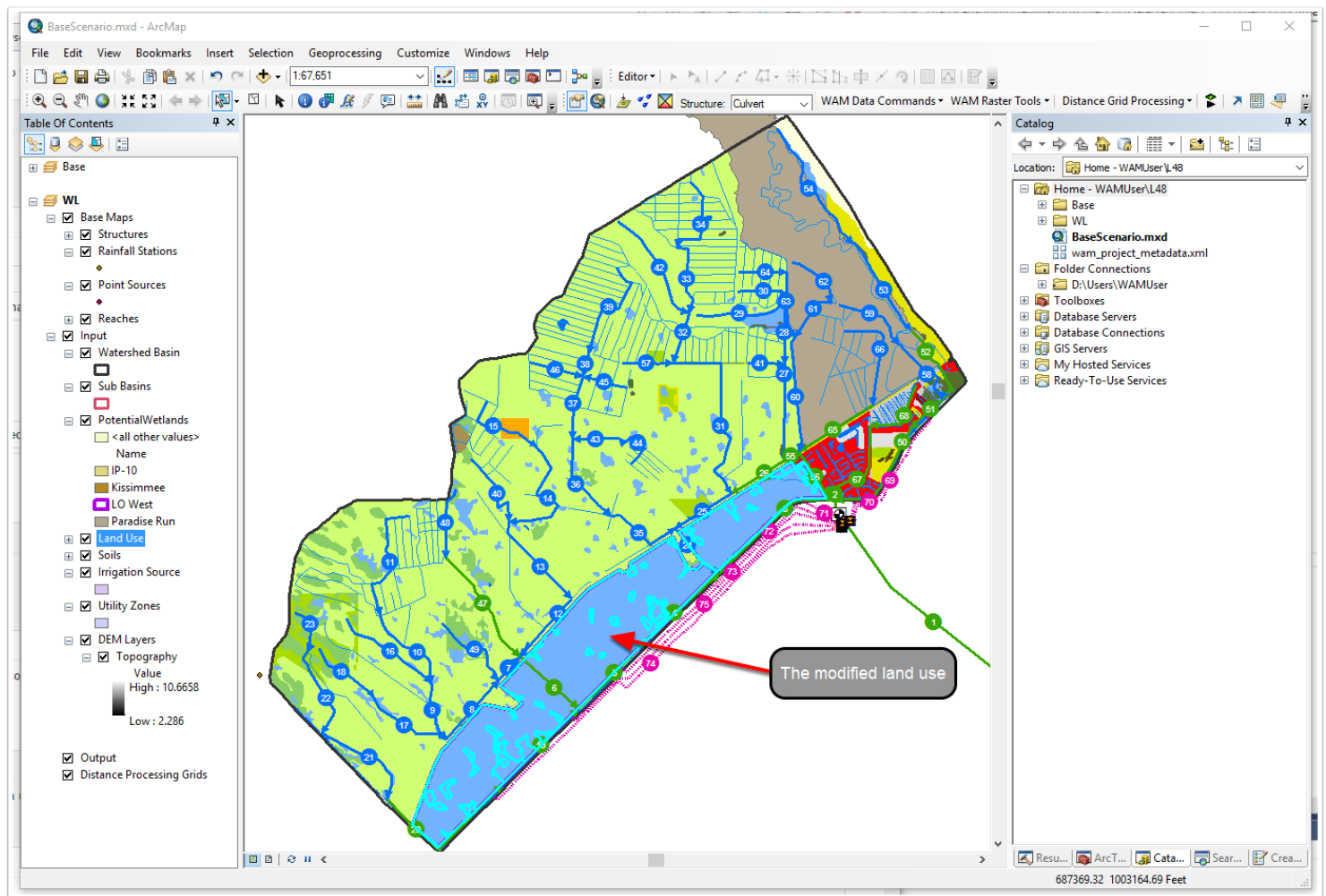
64. Agree to change the selection

Click on the "Yes" button to change the land use for the selected polygons. Also, close the Feature Properties Editor and the Select by Location windows if you have not already done so.



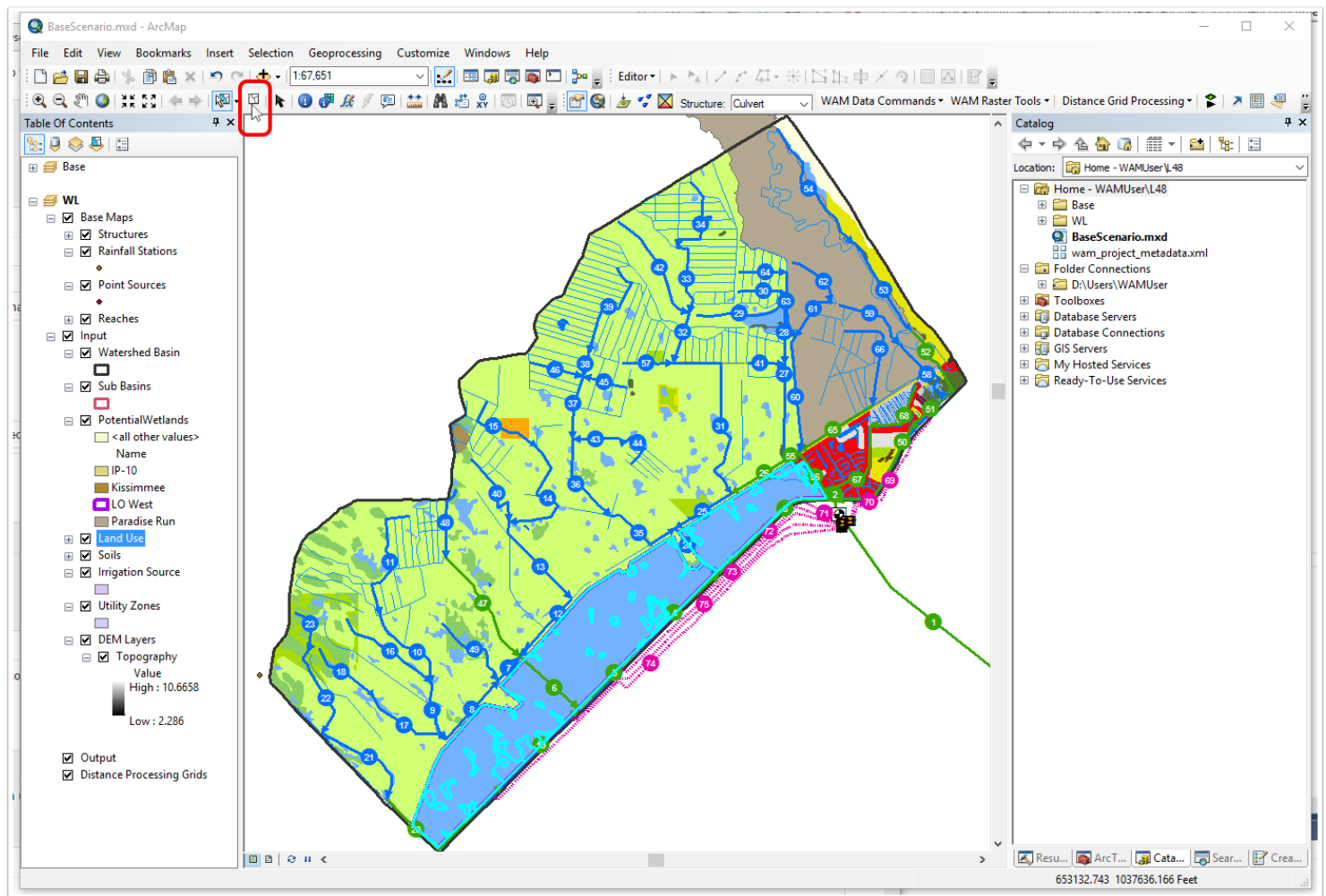
65. The Modified Map

This is how the map should look after the land use changes have been applied. The blue color indicates that it has been changed to "Freshwater Marshes", and the cyan outline indicates that the polygons are still selected.



66. Clear Selected Features

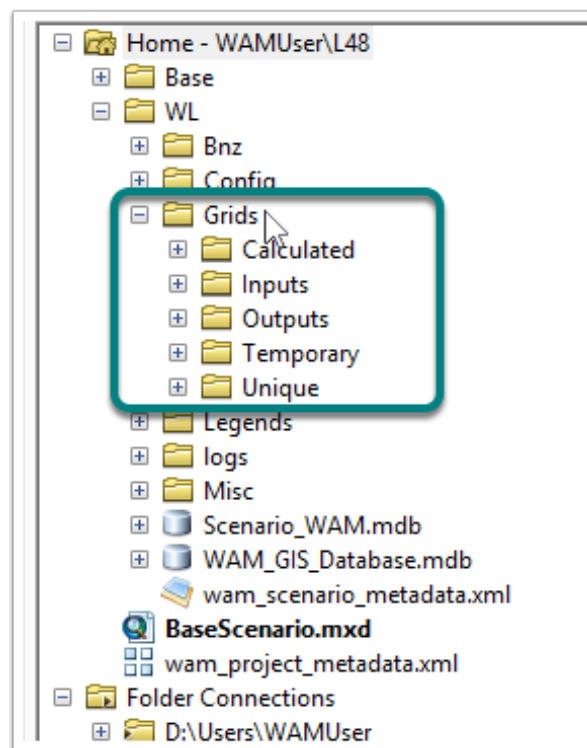
Note that clearing the selected features only de-selects features, it doesn't delete anything. The land uses have been changed, and we now prepare to run the changed scenario.



67. Aside: Structure for WAM rasters

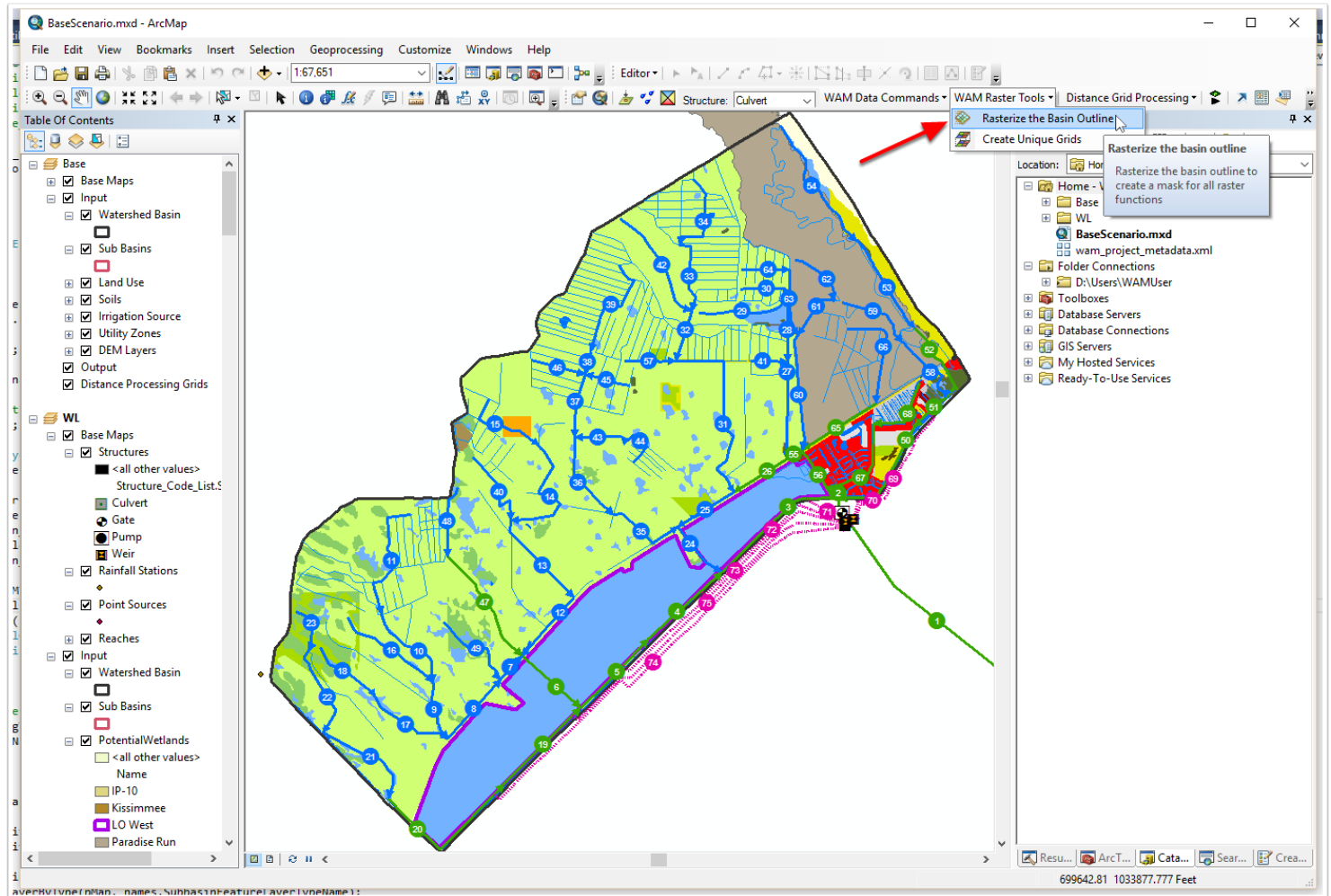
One of the steps that is now required is to re-create some of the grids used by WAM. A brief discussion of how these grids are organized on disk will come in helpful here. The various ESRI Grids (rasters) and WAM grids are stored in the "Grids" subdirectory under the scenario, here "WL". There are five subdirectories here, "Calculated", "Inputs", "Outputs", "Temporary", and "Unique". The last directory contains the unique grids.

These provide the unique combinations of land use, soil, rain zones, and utility zones of source cells within the model domain. Any time one of those four feature classes have been altered (as we have done here by altering the Land Use feature class), the unique grids must be regenerated. We will do that here.



68. Rasterize the Basin

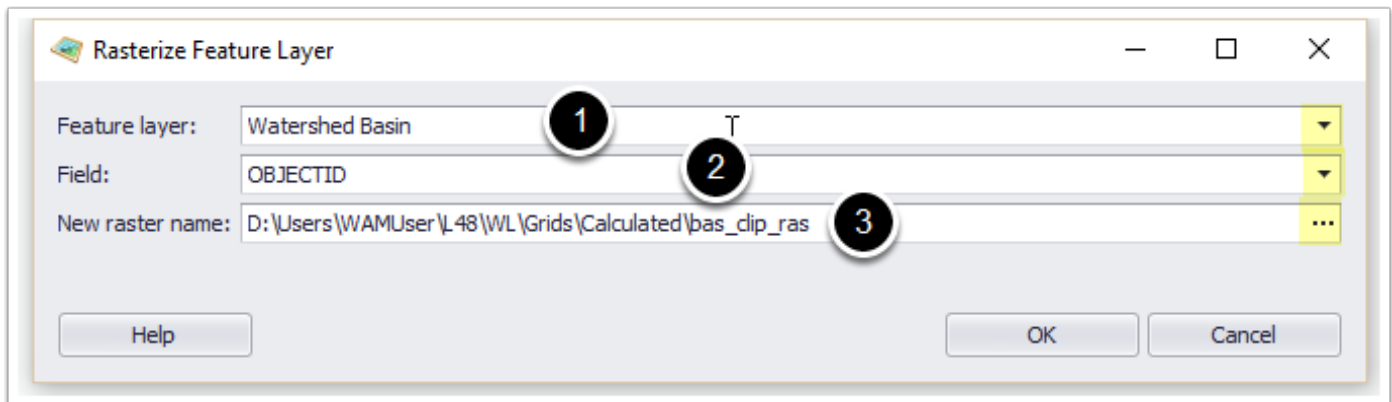
This is the first step when re-running the unique grids, although it only need to be done once **unless** the scenario directory has been moved or copied. It will not hurt to re-run this, so we do so here. Under the "WAM Raster Tools" menu, select "Rasterize the Basin Outline".



69. The Rasterize Feature Layer window

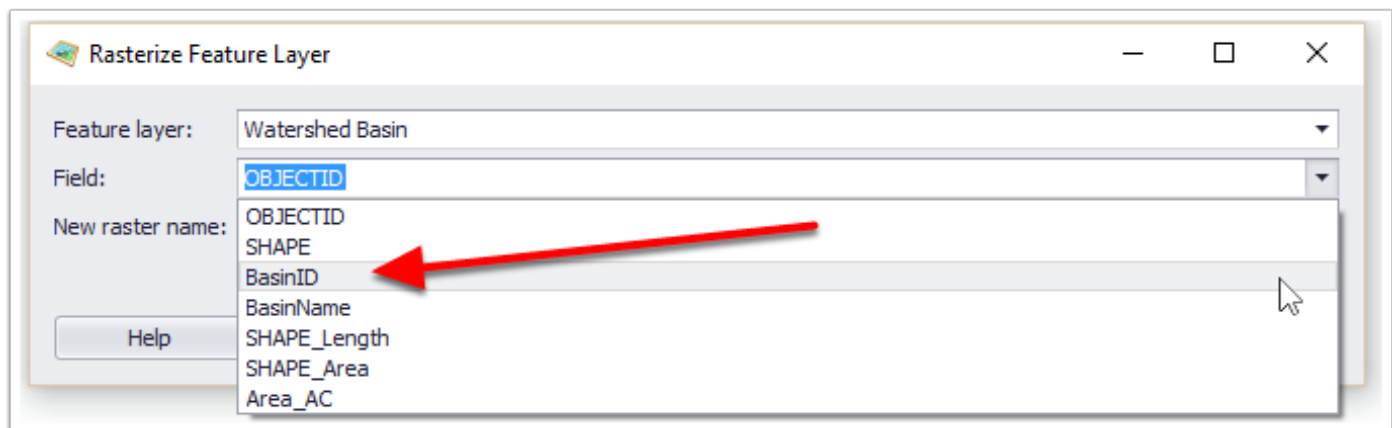
Make sure (1) the Feature Layer is set to "Watershed Basin", (2) the Field is currently "OBJECTID", but it must be changed to "BasinID" (see the next step), and (3) leave the name as it is but make sure the path is correct.

Highlighted in yellow are the arrows at the right side of the top two boxes that can be used to see the available options, while the "..." at the end of the bottom box will open a file chooser dialog.



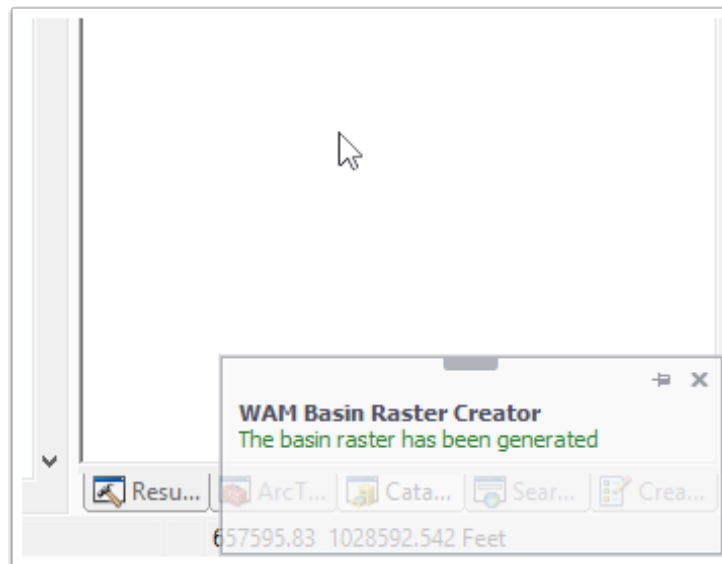
70. Select BasinID

From the drop-down menu for the Field, make sure the layer to be rasterized is "Watershed Basin" and click OK



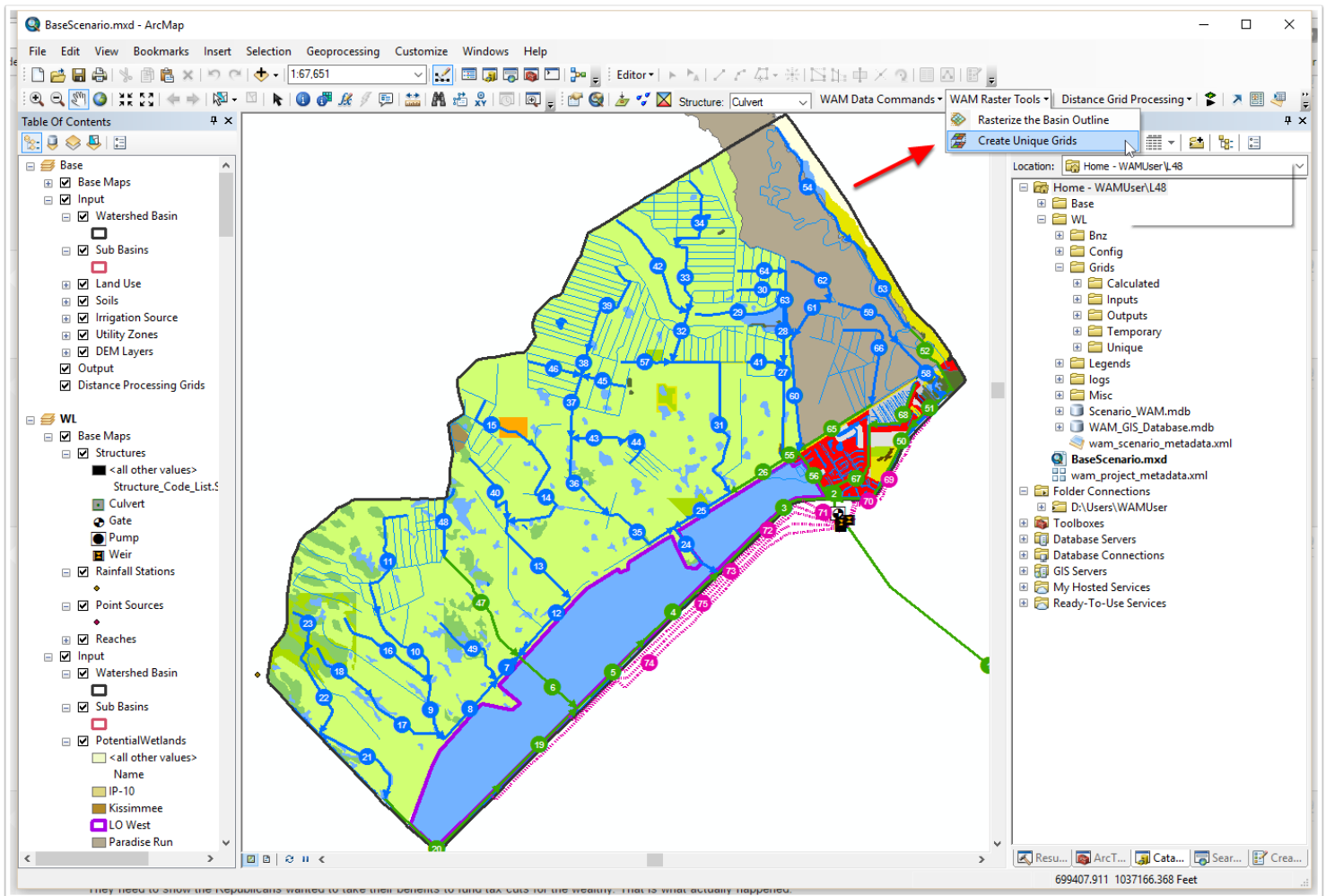
71. Rasterize Layer

When the process is complete (it should happen quickly), in the lower-right corner a success message should appear.



72. Create the Unique Grids

Under the WAM Raster Tools menu, the second item is used to create the unique grids. Click on that to start the process. A progress form should appear.



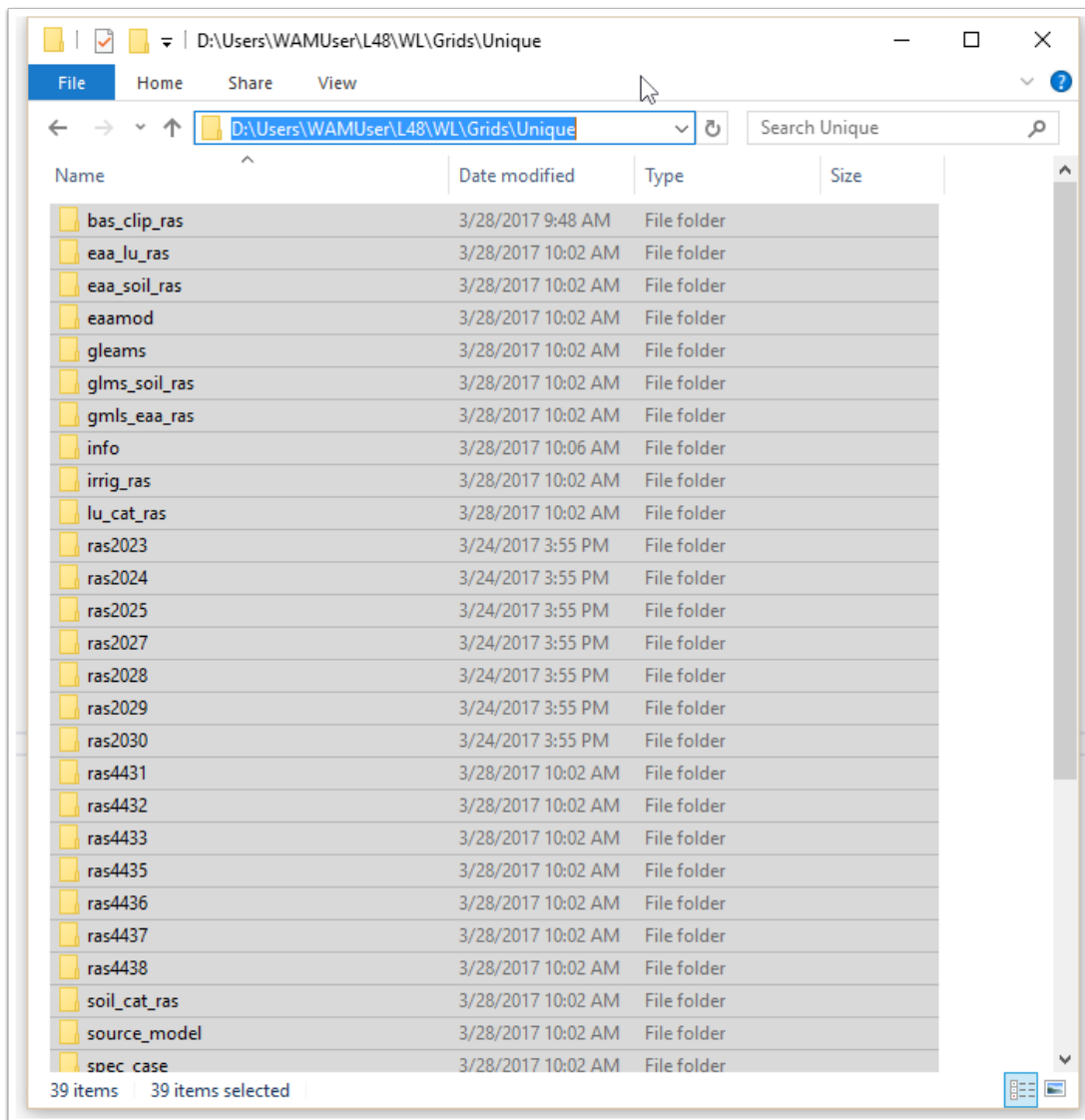
73. The Progress Form

This may take anywhere from a few seconds to several minutes, depending on the size of the basin and the speed of the computer.



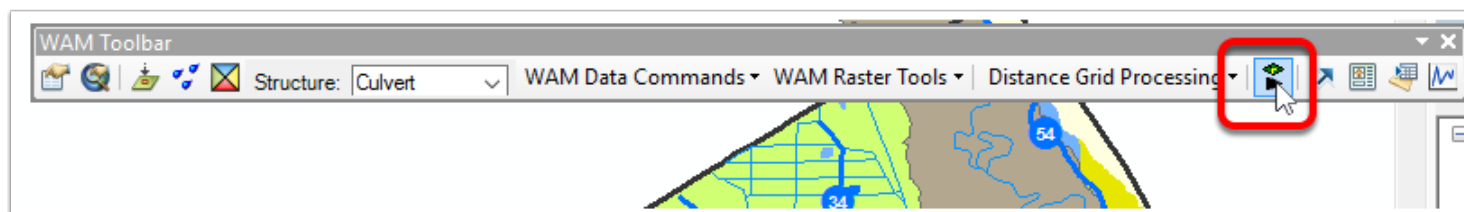
74. If things go wrong...

Sometimes things can go wrong and the unique grids will not be created. If this happens, first try running the command again. If that does not work, **SAVE** the map (**important!**) and then quit ArcMap, and then restart it again and open the map you just saved. Try running the command again. If it still doesn't work, the grids in the "Unique" directory (and *only* the unique directory) need to be deleted. Quit ArcMap, since you can't delete everything in the directory unless ArcMap is closed. Open a Windows Explorer Window, and navigate to the "Unique" directory. Once there, select all of the files and delete ALL of them. Once this is done, restart ArcMap and open the map you were working on. **Remember:** First, you have to re-run the "Rasterize the Basin Outline", then re-run the distance grids command.



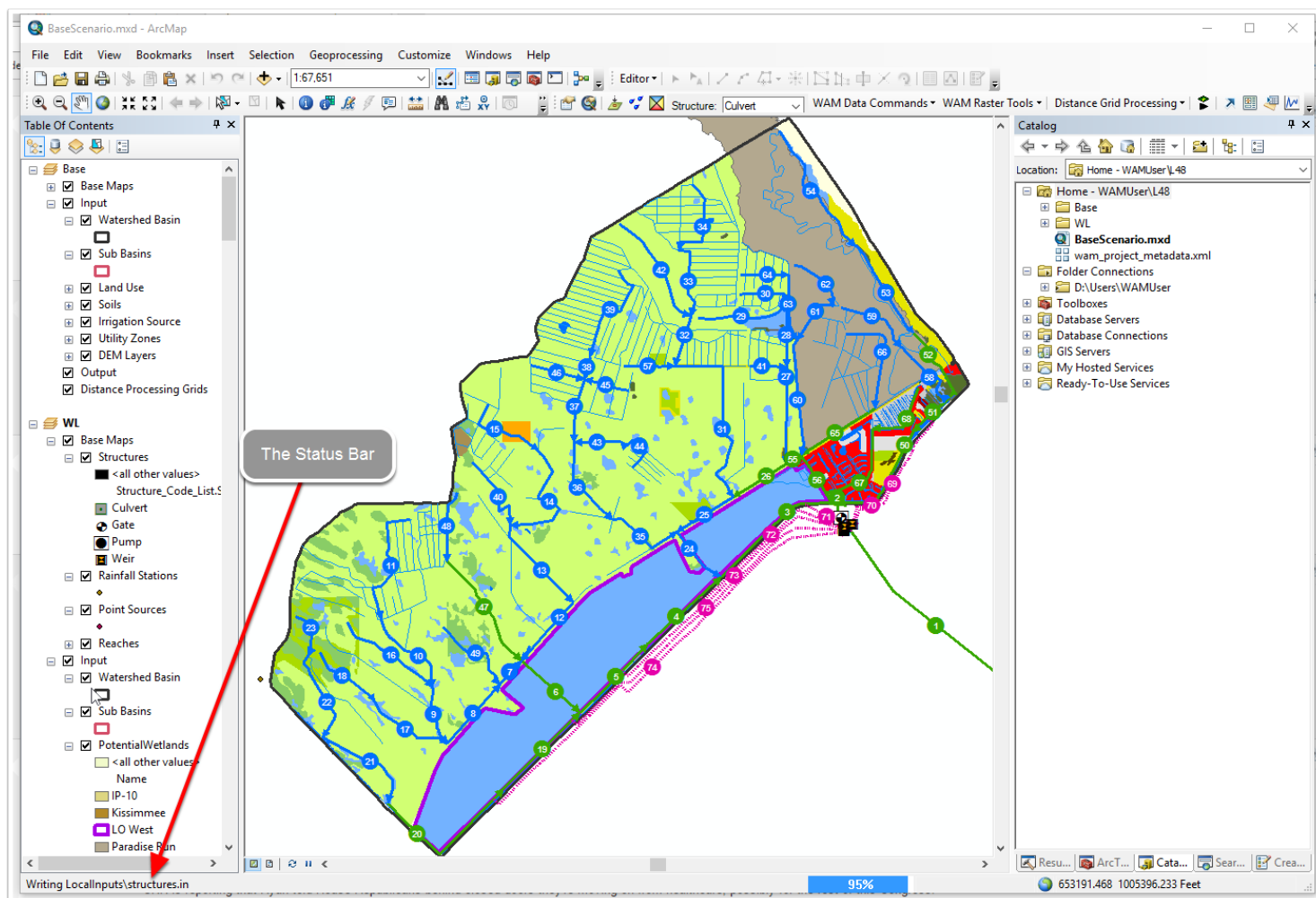
75. Create the Input Files

Click on the "Write WAM Input Files..." button shown highlighted in red. The status bar in the lower left part of the ArcMap window will indicate which files are being written. When it is finished, an information window will appear in the lower-right corner indicating if the process was successful.



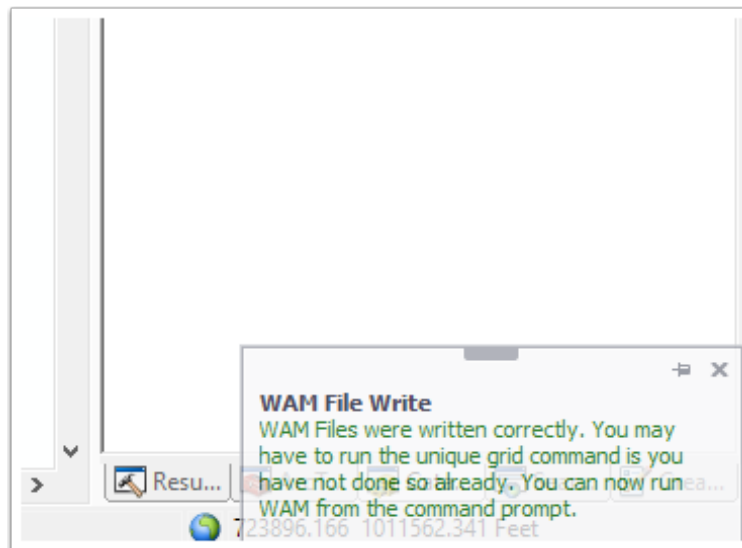
76. The Status Bar

The status bar is shown below, here it indicates that it is writing the file "structures.in" to the "LocalInputs" directory.



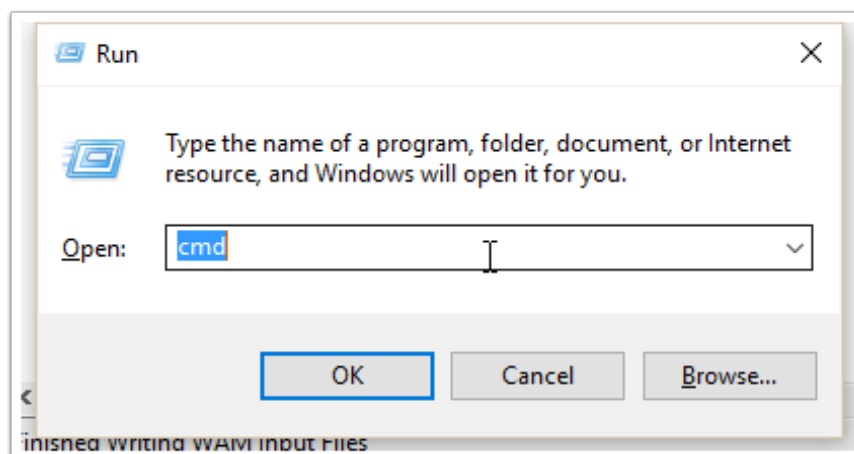
77. The Files were Successfully Written

Note that since the distance grids were created in a previous step that they do NOT need to be re-run again. BUCShell can now be re-run from the command line.



78. Open a command prompt - AKA "DOS Prompt"

There are a number of ways to open a command prompt. If you are not familiar with this program, the easiest way is to press the windows key + "R" and then in the "Run" box that opens, type "cmd":

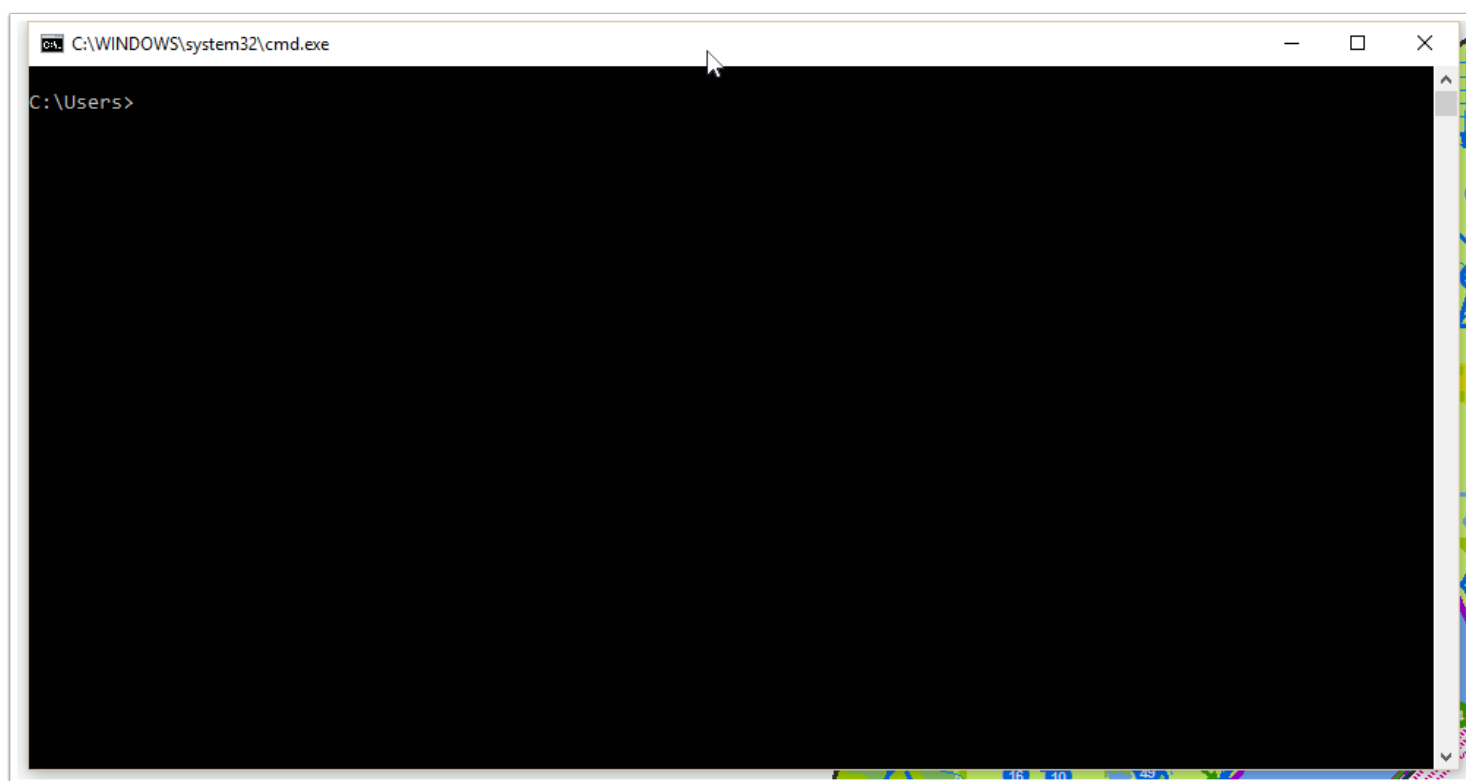


79. An Alternate Method

If you have windows 7 or 10, you can also type "Command Prompt" in the search box in the lower-left hand corner of the Windows task bar.

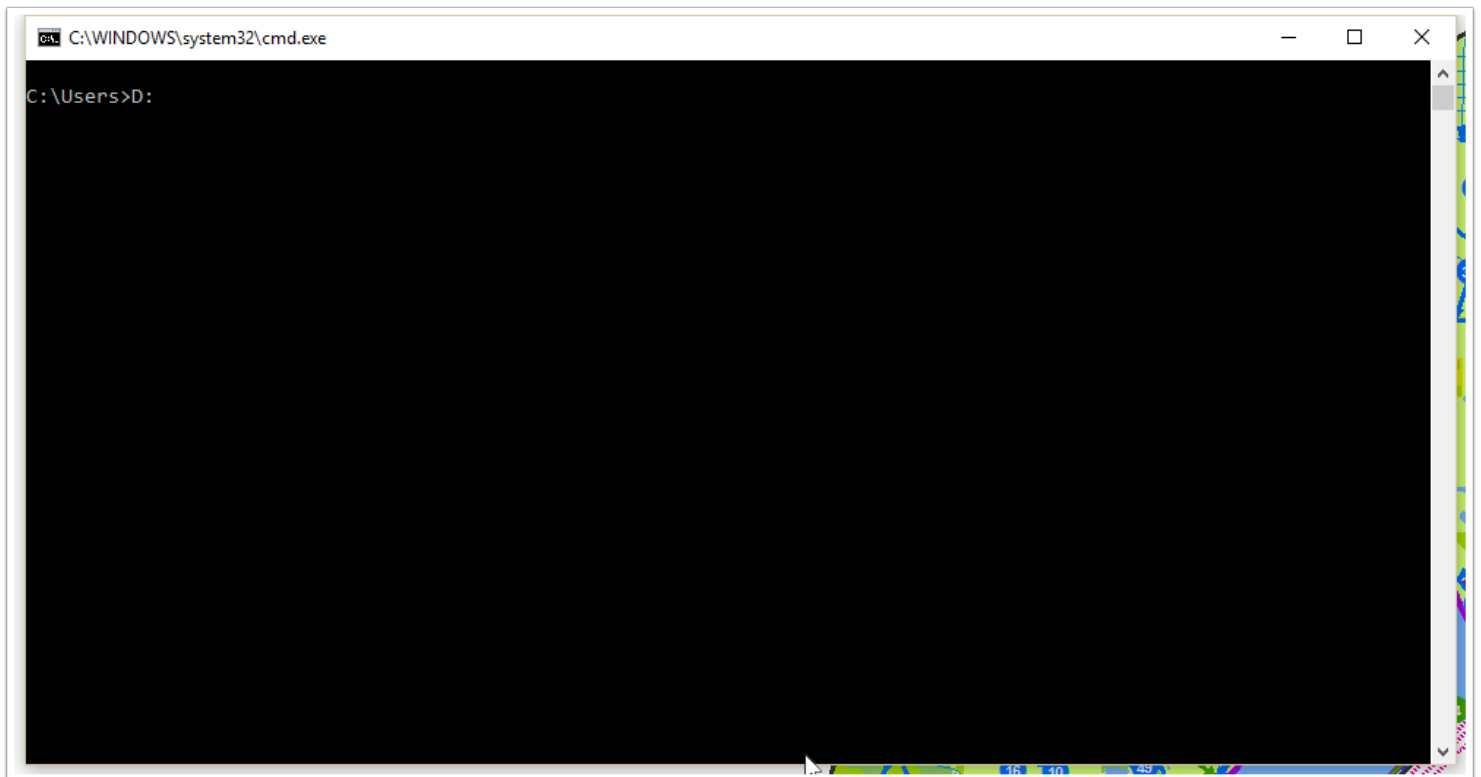
80. The Command Prompt

First, we need to navigate to where the scenario is located. In this example, it's on the "D:" drive. If yours is on the "C:" drive, ignore the next step. If it's on the "E:" drive (or "F:" or "H:") substitute that letter as appropriate.



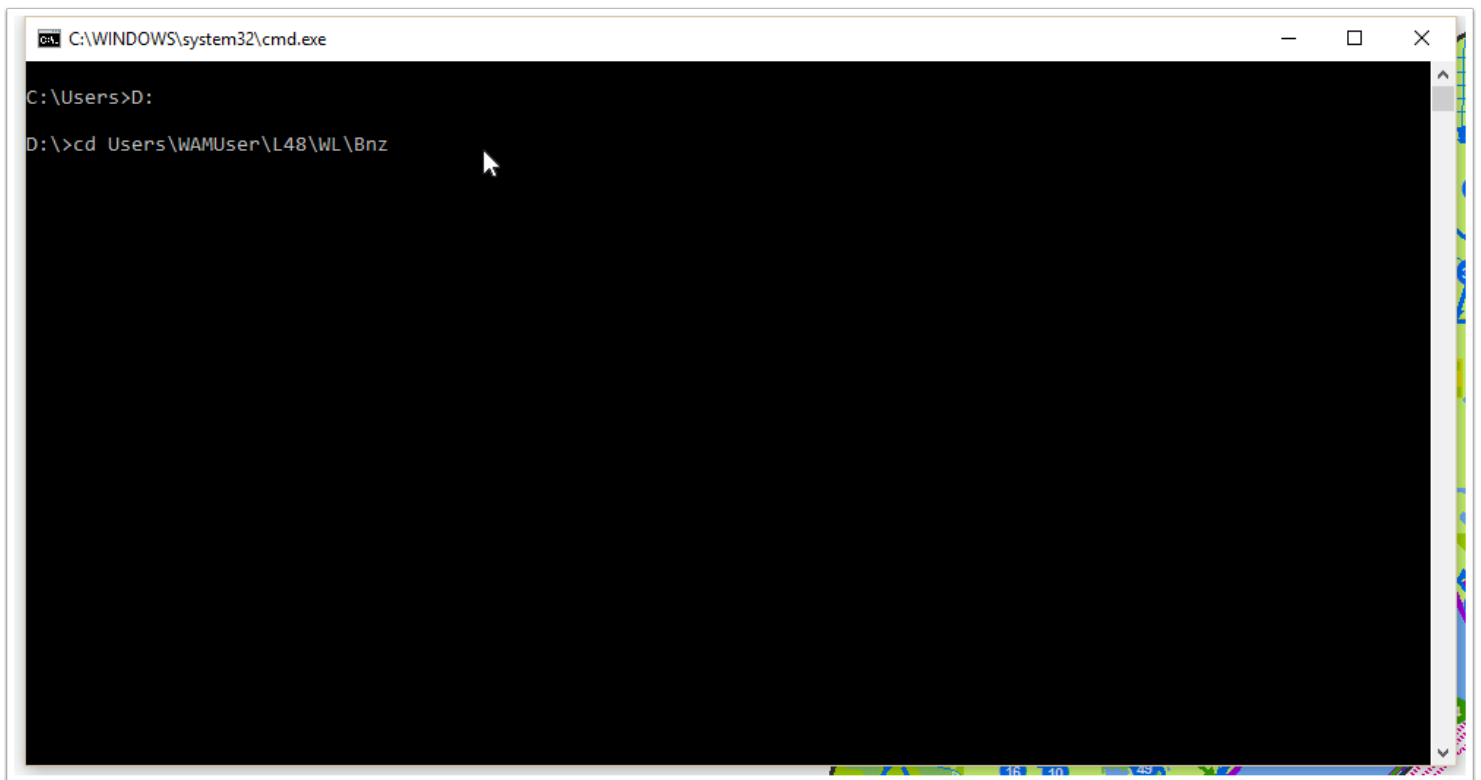
81. Change to D

Type D and a colon, i.e., "D:" (without the quotes) and press Return. If your setup is different, and, for example, your project is on the F: drive, type "F:" and hit return.



82. On D

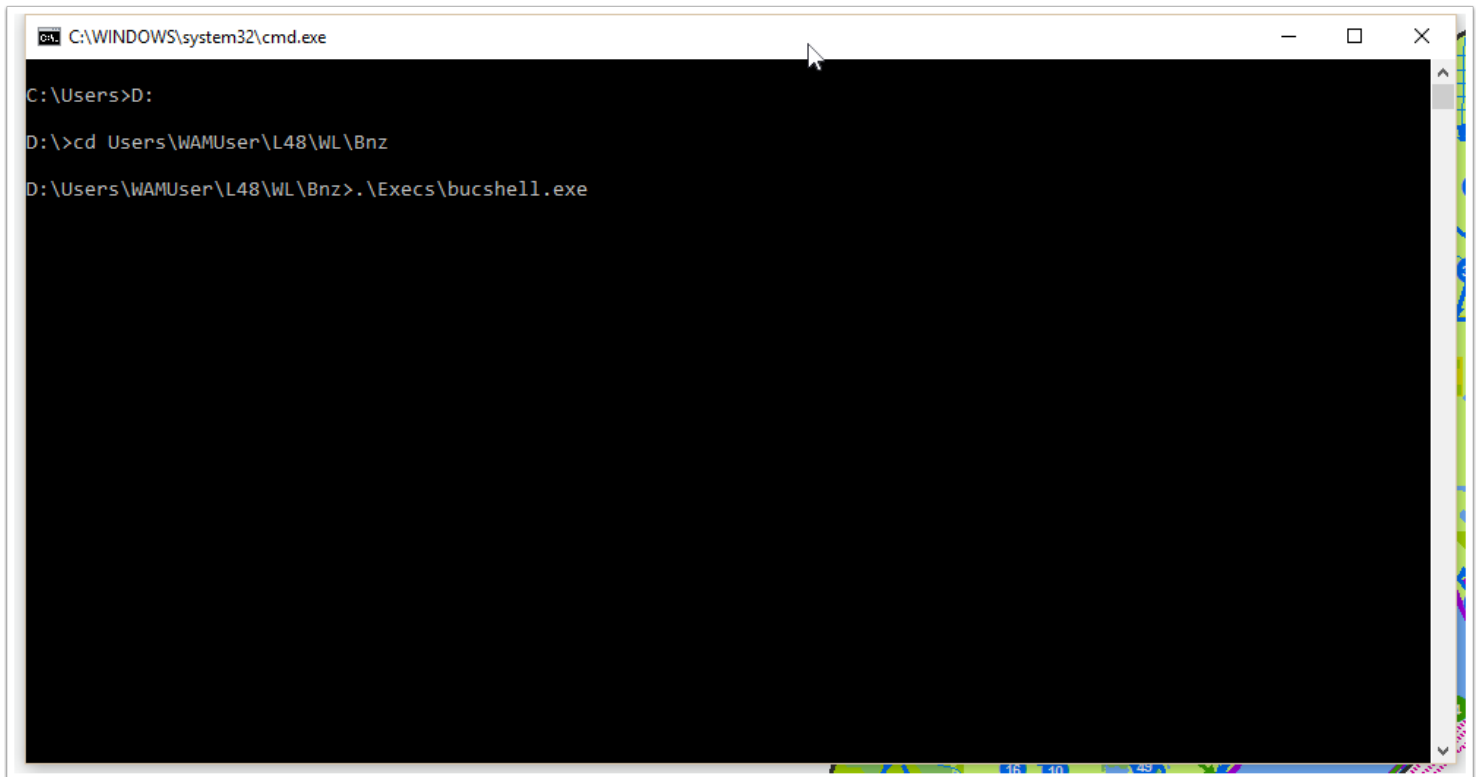
For this example, the WAM scenario is in the D:\Users\WAMUser\L48\WL directory. You must substitute in the directories where the project and scenarios are located on your computer as appropriate. For our example, type (without the quotes) "cd Users\WAMUser\L48\WL\Bnz" and press Return. **HANDY TIP:** The Windows command prompt has what is called an "autocomplete" feature. If you type in the first few letters of a directory and press the Tab key, it will fill in the rest of the directory name. If those few letters are common to several directories or files, it will cycle through them each time you press Tab. For example, if you typed "cd Users\WA" and then pressed Tab, it would complete to "cd Users\WAMUser". This can be extremely helpful when typing in long names.



```
C:\WINDOWS\system32\cmd.exe
C:\Users>D:
D:\>cd Users\WAMUser\L48\WL\Bnz
```

83. In the Bnz Directory

Type (without the quotes) ".\Execs\bucshell.exe" (Note that there is a period and a backslash ":" before the "Execs". Again, you only have to type ".\Ex" -> tab -> completes to ".\Execs" -> then add "buc", like ".\Execs\buc" -> tab -> completes to ".\Execs\bucshell.exe".) Press Return and BUCShell will run. Most of the files (called "Dayfiles") it creates should already be present and only a few have to be run.

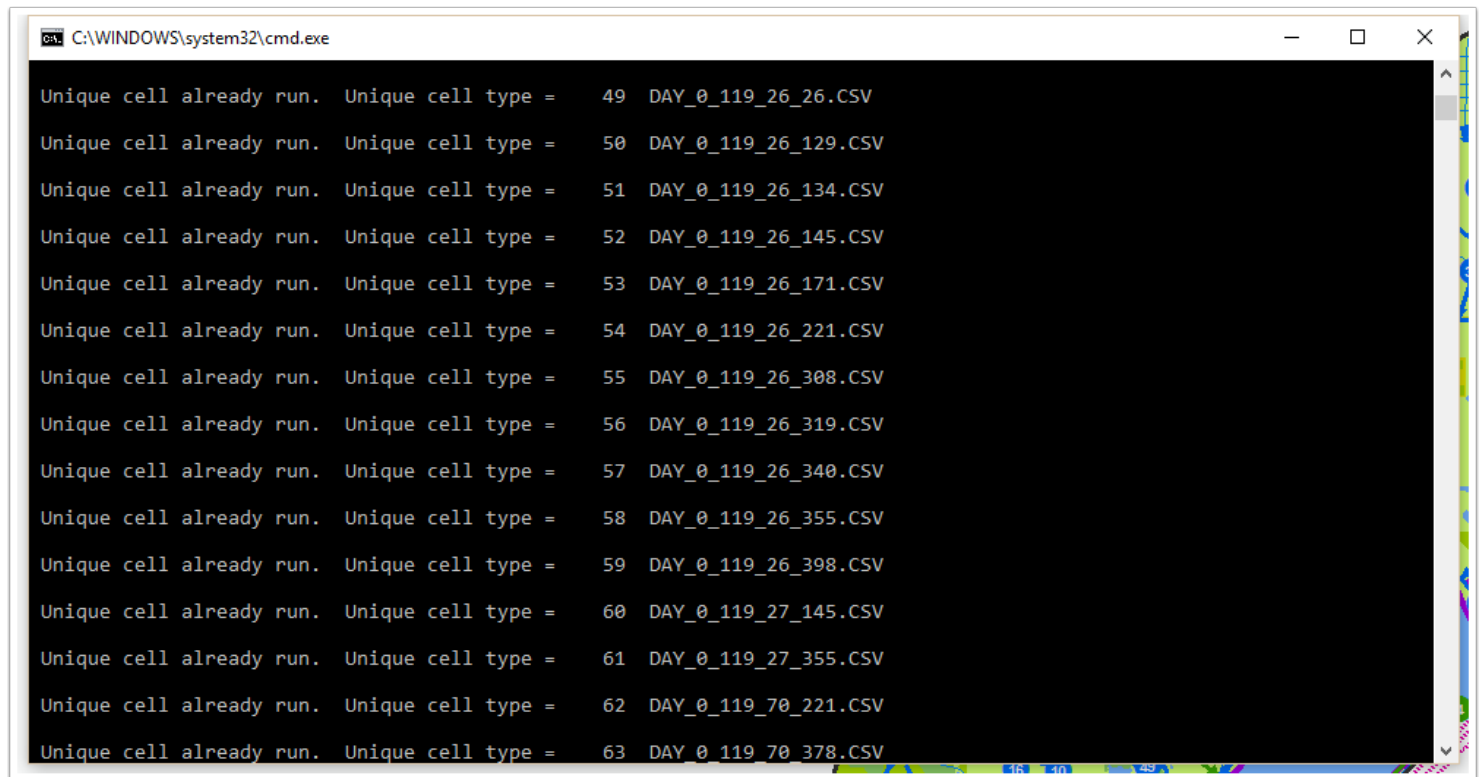


```
C:\WINDOWS\system32\cmd.exe
C:\Users>D:
D:\>cd Users\WAMUser\L48\WL\Bnz
D:\Users\WAMUser\L48\WL\Bnz>.\Execs\bucshell.exe
```

84. Running BUCShell

Note the several lines of text indicating that a cell has been run. The text "Unique cell already run. Unique cell type = 49 DAY_0_119_26_26.csv" indicates that the cell already has a Dayfile for that particular combination.

The rather cryptic notation indicates that (for the top line) the 49th unique combination is represented by Dayfile: DAY_0_119_26_26.CSV, where the first number 0 is the utility zone, the second number 119 is the rain zone, the third number 26 is the WAM land use ID (Improved Pasture in this case), and the last number is (coincidentally) also 26, which represents the WAM Soil ID (Basinger).



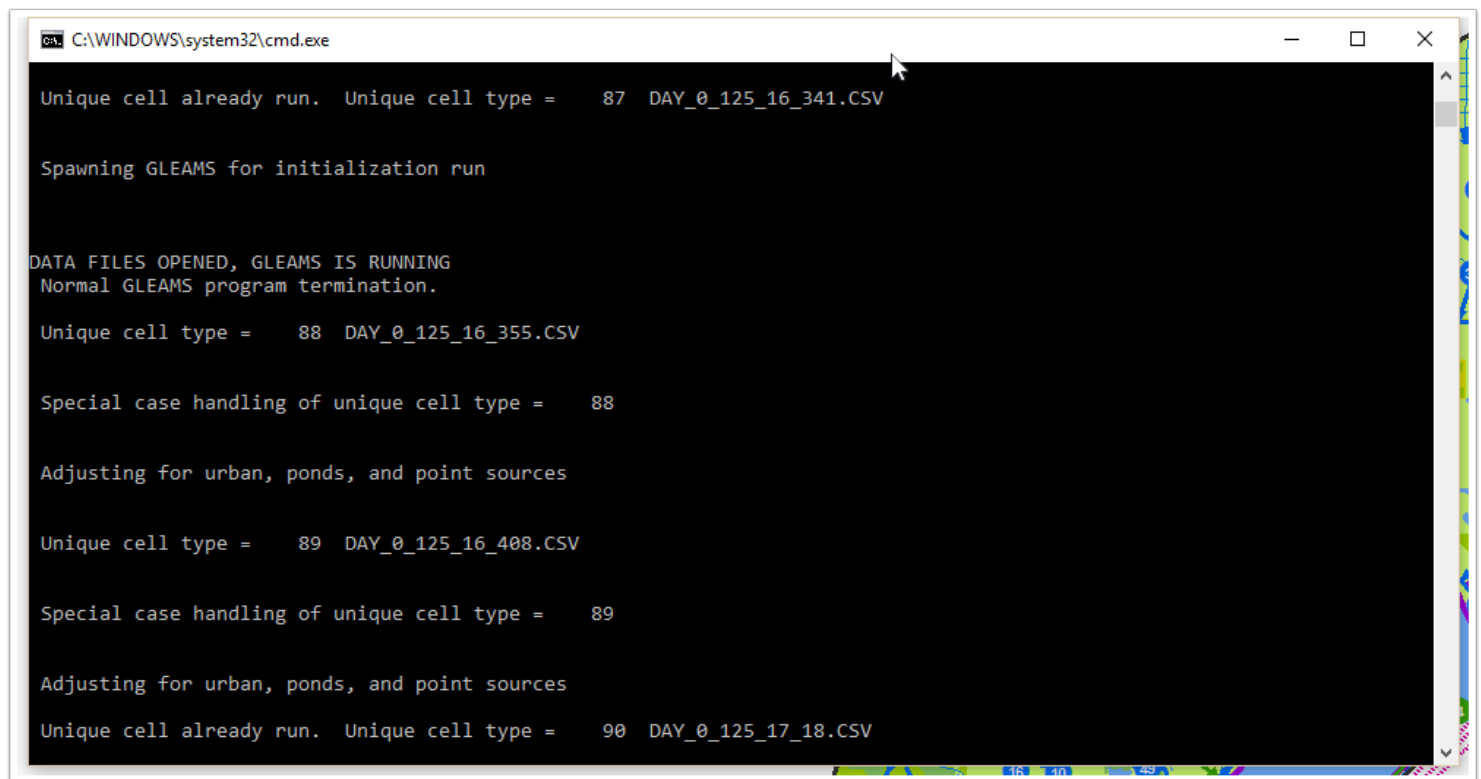
```
C:\WINDOWS\system32\cmd.exe

Unique cell already run. Unique cell type = 49 DAY_0_119_26_26.CSV
Unique cell already run. Unique cell type = 50 DAY_0_119_26_129.CSV
Unique cell already run. Unique cell type = 51 DAY_0_119_26_134.CSV
Unique cell already run. Unique cell type = 52 DAY_0_119_26_145.CSV
Unique cell already run. Unique cell type = 53 DAY_0_119_26_171.CSV
Unique cell already run. Unique cell type = 54 DAY_0_119_26_221.CSV
Unique cell already run. Unique cell type = 55 DAY_0_119_26_308.CSV
Unique cell already run. Unique cell type = 56 DAY_0_119_26_319.CSV
Unique cell already run. Unique cell type = 57 DAY_0_119_26_340.CSV
Unique cell already run. Unique cell type = 58 DAY_0_119_26_355.CSV
Unique cell already run. Unique cell type = 59 DAY_0_119_26_398.CSV
Unique cell already run. Unique cell type = 60 DAY_0_119_27_145.CSV
Unique cell already run. Unique cell type = 61 DAY_0_119_27_355.CSV
Unique cell already run. Unique cell type = 62 DAY_0_119_70_221.CSV
Unique cell already run. Unique cell type = 63 DAY_0_119_70_378.CSV
```

85. New Dayfiles

If a Dayfile does not exist, BUCShell will run the appropriate land source model. Here, we converted the land use in the wetland polygon to Freshwater Marshes, WAM land use ID 16. When a unique cell combination is encountered with land use 16, if the Dayfile does not already exist the Special Case land source model will run.

Here, for the unique cell type 88, the utility zone is 0, the rain zone is 125, the land use ID is 16, and the soil ID is 355 (Smyrna). The text "Special case handling of unique cell type = 88" indicates that the Special Case model has run.



```
C:\WINDOWS\system32\cmd.exe

Unique cell already run. Unique cell type = 87 DAY_0_125_16_341.CSV

Spawning GLEAMS for initialization run

DATA FILES OPENED, GLEAMS IS RUNNING
Normal GLEAMS program termination.

Unique cell type = 88 DAY_0_125_16_355.CSV

Special case handling of unique cell type = 88

Adjusting for urban, ponds, and point sources

Unique cell type = 89 DAY_0_125_16_408.CSV

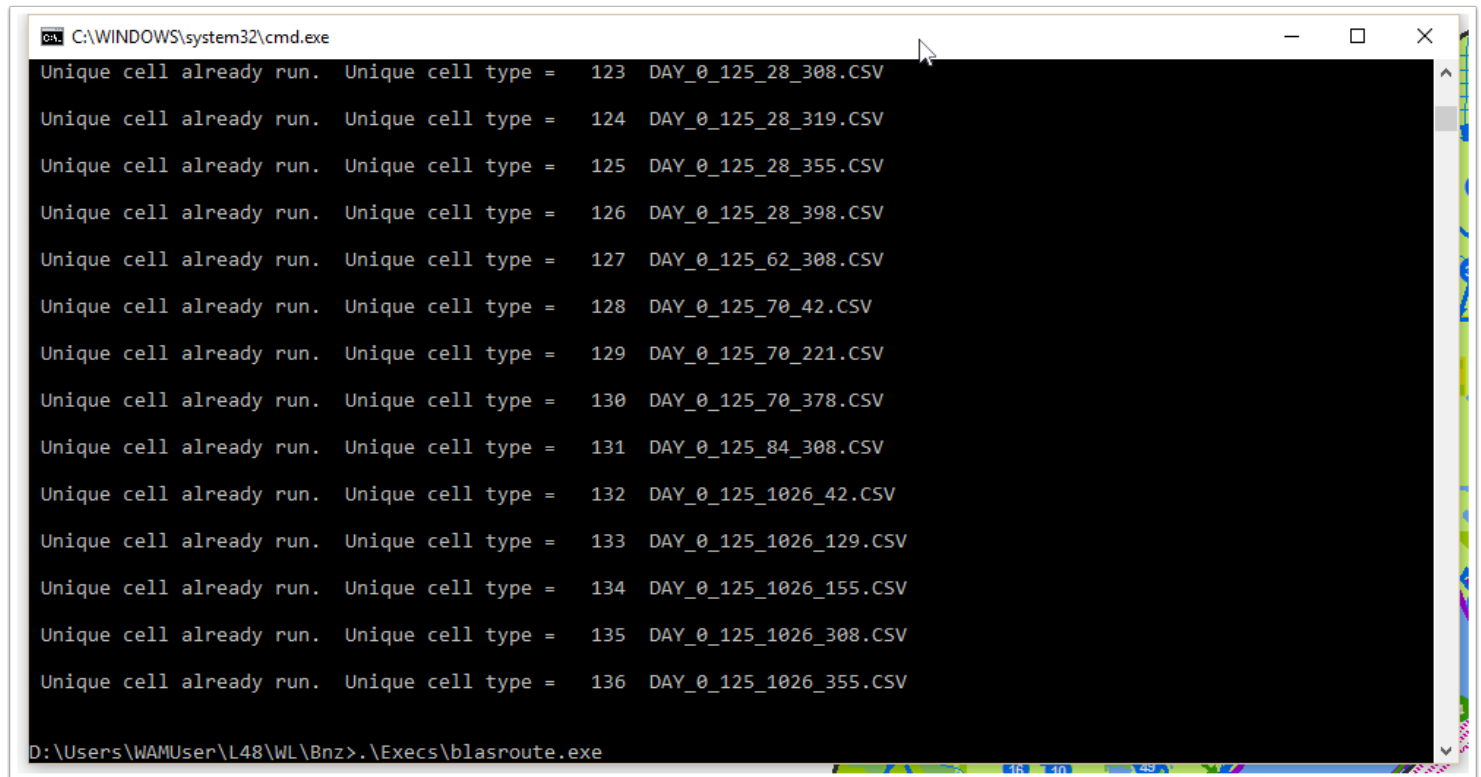
Special case handling of unique cell type = 89

Adjusting for urban, ponds, and point sources

Unique cell already run. Unique cell type = 90 DAY_0_125_17_18.CSV
```

86. Running BLASRoute

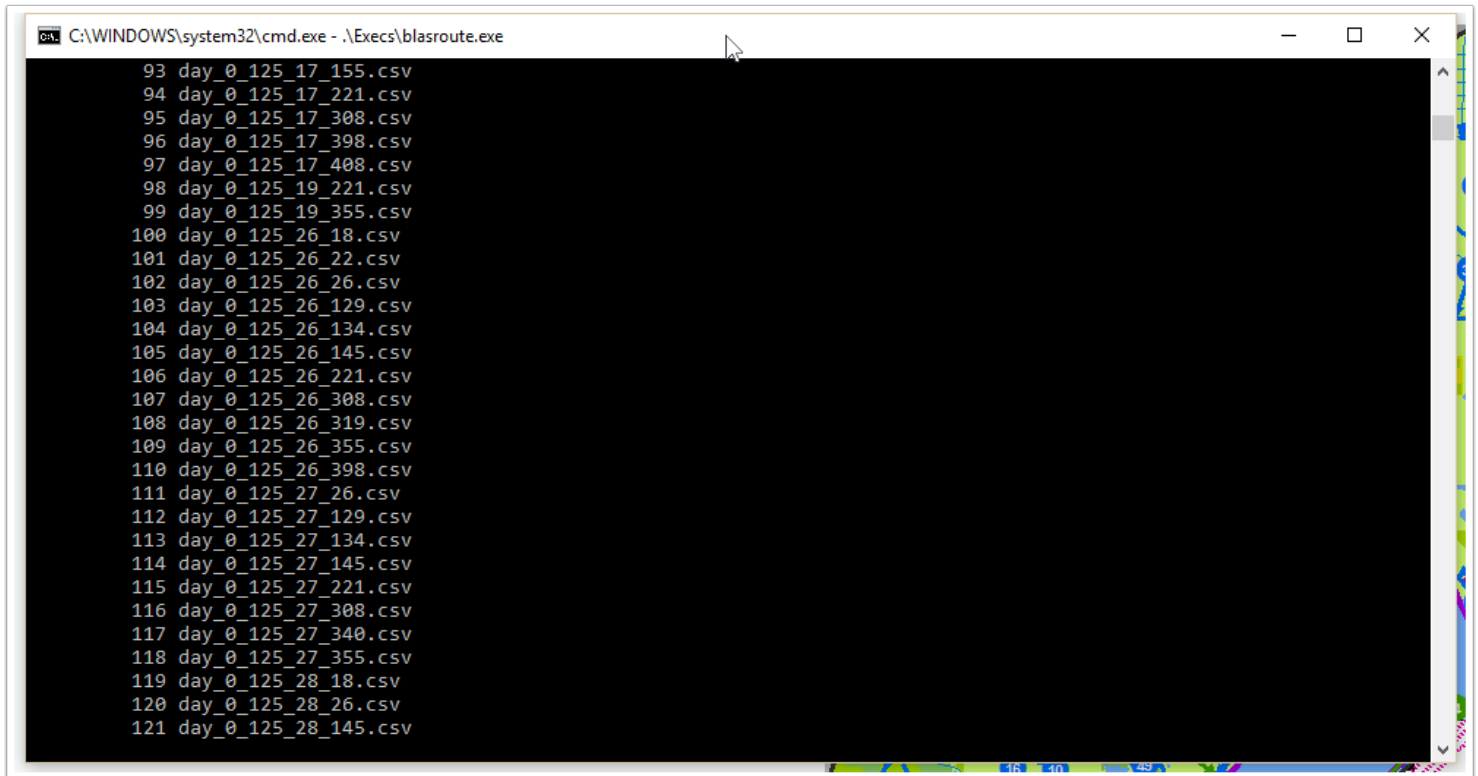
Once BUCShell is complete (with no errors), BLASRoute needs to be run. Typically, it is best to actually run BUCShell again to make sure all of the dayfiles have been created. Since all (or at least most) of the Dayfiles have already been completed, this step should go very fast. When done, type ".\Execs\blasroute.exe" and press Return.



```
C:\WINDOWS\system32\cmd.exe
Unique cell already run. Unique cell type = 123 DAY_0_125_28_308.CSV
Unique cell already run. Unique cell type = 124 DAY_0_125_28_319.CSV
Unique cell already run. Unique cell type = 125 DAY_0_125_28_355.CSV
Unique cell already run. Unique cell type = 126 DAY_0_125_28_398.CSV
Unique cell already run. Unique cell type = 127 DAY_0_125_62_308.CSV
Unique cell already run. Unique cell type = 128 DAY_0_125_70_42.CSV
Unique cell already run. Unique cell type = 129 DAY_0_125_70_221.CSV
Unique cell already run. Unique cell type = 130 DAY_0_125_70_378.CSV
Unique cell already run. Unique cell type = 131 DAY_0_125_84_308.CSV
Unique cell already run. Unique cell type = 132 DAY_0_125_1026_42.CSV
Unique cell already run. Unique cell type = 133 DAY_0_125_1026_129.CSV
Unique cell already run. Unique cell type = 134 DAY_0_125_1026_155.CSV
Unique cell already run. Unique cell type = 135 DAY_0_125_1026_308.CSV
Unique cell already run. Unique cell type = 136 DAY_0_125_1026_355.CSV
D:\Users\WAMUser\L48\WL\Bnz>.\Execs\blasroute.exe
```

87. BLASRoute Phase 1

BLASRoute runs as a single program, but there are two distinct parts that occur as you may notice. During the first part the unique grids are read into the program, e.g., at the top unique cell number 93, "day_0_125_17_155.csv" was read in.



```
C:\WINDOWS\system32\cmd.exe - .\Execs\blasroute.exe
93 day_0_125_17_155.csv
94 day_0_125_17_221.csv
95 day_0_125_17_308.csv
96 day_0_125_17_398.csv
97 day_0_125_17_408.csv
98 day_0_125_19_221.csv
99 day_0_125_19_355.csv
100 day_0_125_26_18.csv
101 day_0_125_26_22.csv
102 day_0_125_26_26.csv
103 day_0_125_26_129.csv
104 day_0_125_26_134.csv
105 day_0_125_26_145.csv
106 day_0_125_26_221.csv
107 day_0_125_26_308.csv
108 day_0_125_26_319.csv
109 day_0_125_26_355.csv
110 day_0_125_26_398.csv
111 day_0_125_27_26.csv
112 day_0_125_27_129.csv
113 day_0_125_27_134.csv
114 day_0_125_27_145.csv
115 day_0_125_27_221.csv
116 day_0_125_27_308.csv
117 day_0_125_27_340.csv
118 day_0_125_27_355.csv
119 day_0_125_28_18.csv
120 day_0_125_28_26.csv
121 day_0_125_28_145.csv
```

88. BLASRoute phase 2

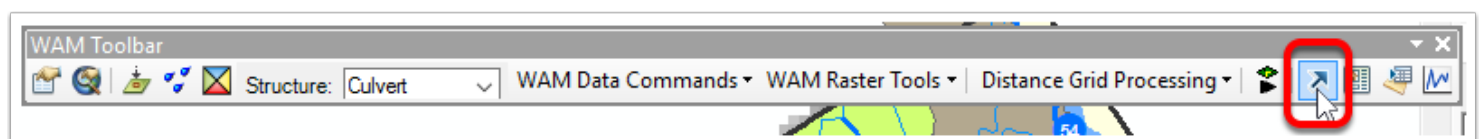
The next part of BLASRoute consists of the actual routing process. This is usually the most time-consuming part. As the program runs, each row shows data for a particular day, with the first number being the minimum time step taken (in seconds), then the year and day-of-year (e.g., the top line is day 050 of the year 2002), followed by data on which reach is the most restrictive, meaning the reach that's taking the most effort to calculate, here at the top, reach 7, then next-most restrictive is reach 8, and so on. For advanced users, this information helps to optimize the network when creating a WAM scenario.

```

C:\WINDOWS\system32\cmd.exe - .\Execs\blasroute.exe
127. 2002050 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.75
127. 2002051 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.75
127. 2002052 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.75
127. 2002053 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.75
127. 2002054 8 1.00 7 1.00 6 0.89 5 0.82 32 0.78 28 0.75
127. 2002055 8 1.00 7 1.00 6 0.89 5 0.82 32 0.78 28 0.76
127. 2002056 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.76
139. 2002057 8 1.00 6 0.99 5 0.96 32 0.91 28 0.88 24 0.88
134. 2002058 6 1.00 8 0.96 43 0.84 28 0.82 32 0.82 24 0.79
134. 2002059 6 1.00 8 0.96 43 0.84 28 0.82 32 0.82 24 0.79
135. 2002060 6 1.00 5 0.93 32 0.87 24 0.84 25 0.84 43 0.83
135. 2002061 6 1.00 5 0.93 32 0.88 24 0.84 43 0.83 25 0.83
135. 2002062 6 1.00 5 0.93 32 0.88 28 0.86 43 0.83 24 0.83
127. 2002063 7 1.00 8 1.00 6 0.89 5 0.82 32 0.77 25 0.74
134. 2002064 6 1.00 7 0.92 32 0.86 28 0.83 43 0.82 24 0.82
127. 2002065 7 1.00 8 1.00 6 0.89 5 0.82 32 0.77 28 0.76
126. 2002066 7 1.00 8 1.00 6 0.89 5 0.82 32 0.77 25 0.77
127. 2002067 8 1.00 7 1.00 6 0.89 5 0.82 32 0.77 28 0.75
127. 2002068 7 1.00 8 1.00 6 0.89 5 0.82 32 0.77 28 0.75
127. 2002069 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 28 0.76
122. 2002070 7 1.00 8 1.00 6 0.89 5 0.82 56 0.79 32 0.78
122. 2002071 7 1.00 8 1.00 6 0.89 5 0.82 56 0.80 32 0.78
122. 2002072 7 1.00 8 1.00 6 0.89 5 0.82 56 0.81 32 0.78
120. 2002073 7 1.00 8 1.00 6 0.89 56 0.83 5 0.82 32 0.77
125. 2002074 7 1.00 8 1.00 6 0.89 5 0.82 32 0.77 28 0.76
127. 2002075 7 1.00 8 1.00 6 0.89 5 0.82 25 0.78 32 0.78
127. 2002076 7 1.00 8 1.00 6 0.89 5 0.82 25 0.78 32 0.78
119. 2002077 7 1.00 8 1.00 6 0.89 56 0.86 5 0.82 32 0.77
126. 2002078 7 1.00 8 1.00 6 0.89 5 0.82 32 0.78 43 0.77
  
```

89. Load the Output Grids

When BLASRoute is complete, the results can be viewed in ArcMap using some of the output tools. The first step is to process and load the output grids. Click the small blue arrow that points up and to the right:

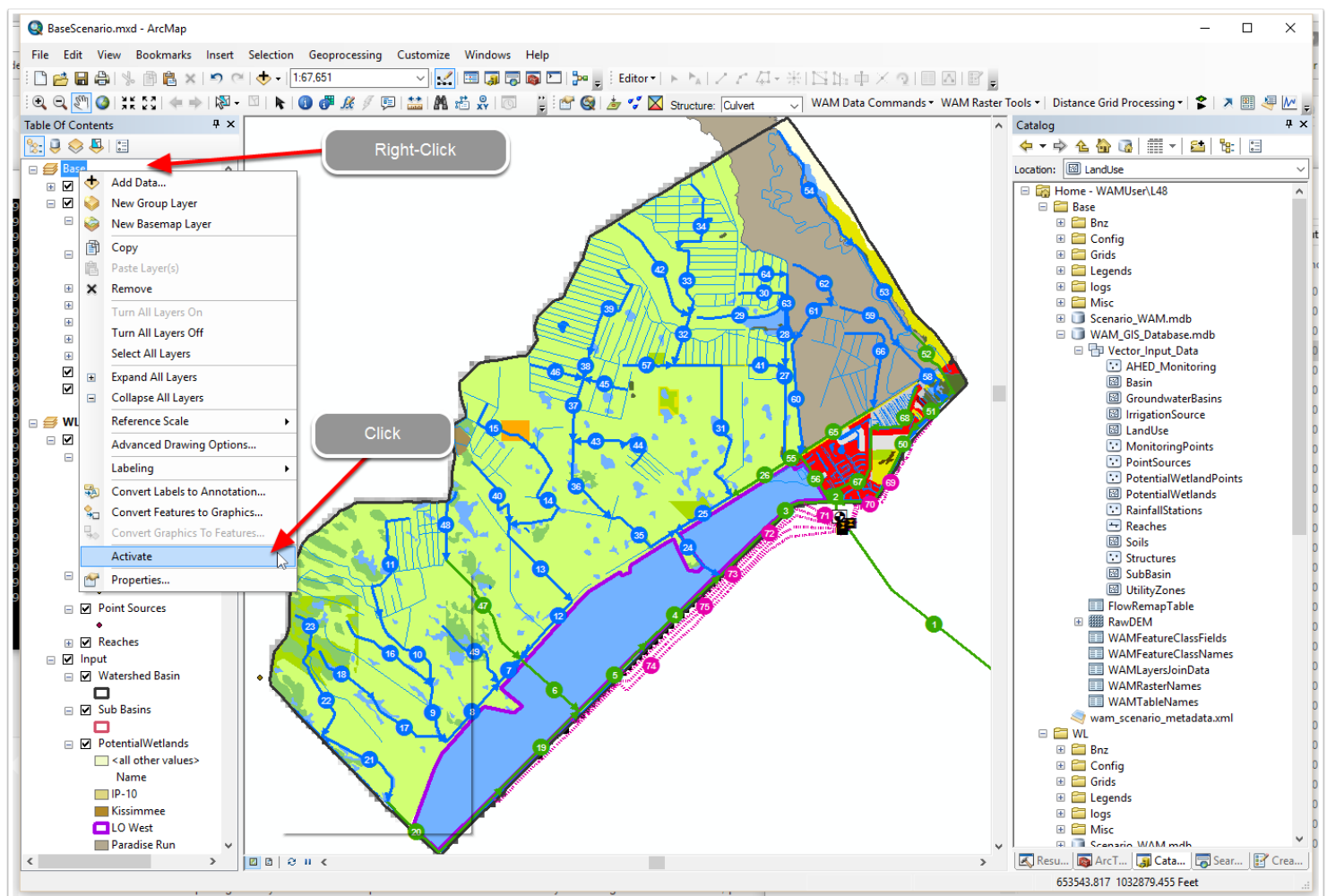


90. If Things Go Wrong

One error that may occur here is that the ESRI Grids can not be created. This may happen, for example, if the user is working in a directory with a long pathname that is mapped across a network, not locally. If this happens, the only option is to move the project and scenarios to a directory with a shorter path name, or move it to a local directory.

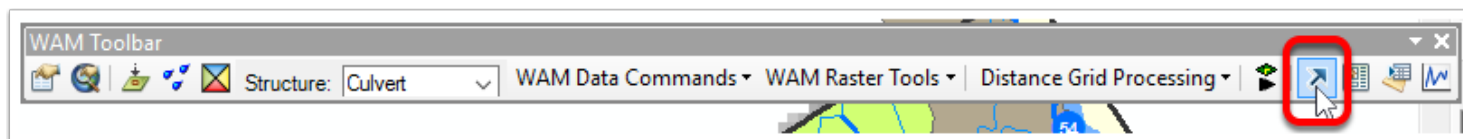
91. Activate the Base Scenario

In order to compare results of the WL scenario against the Base scenario, the output grids must also be loaded in the Base scenario. To do this, we first need to switch back to the base scenario to load the output data into that scenario, too. Right click on the "Base" data frame, and then select "Activate". After a few moments the Base scenario should be the active layer. Make sure the "Base" Data Frame is in **bold**.



92. Load the output in the Base Scenario

As with the WL layer, load the output data grids so that results between the two scenarios can be compared. Wait until all the layers have been added to the map.

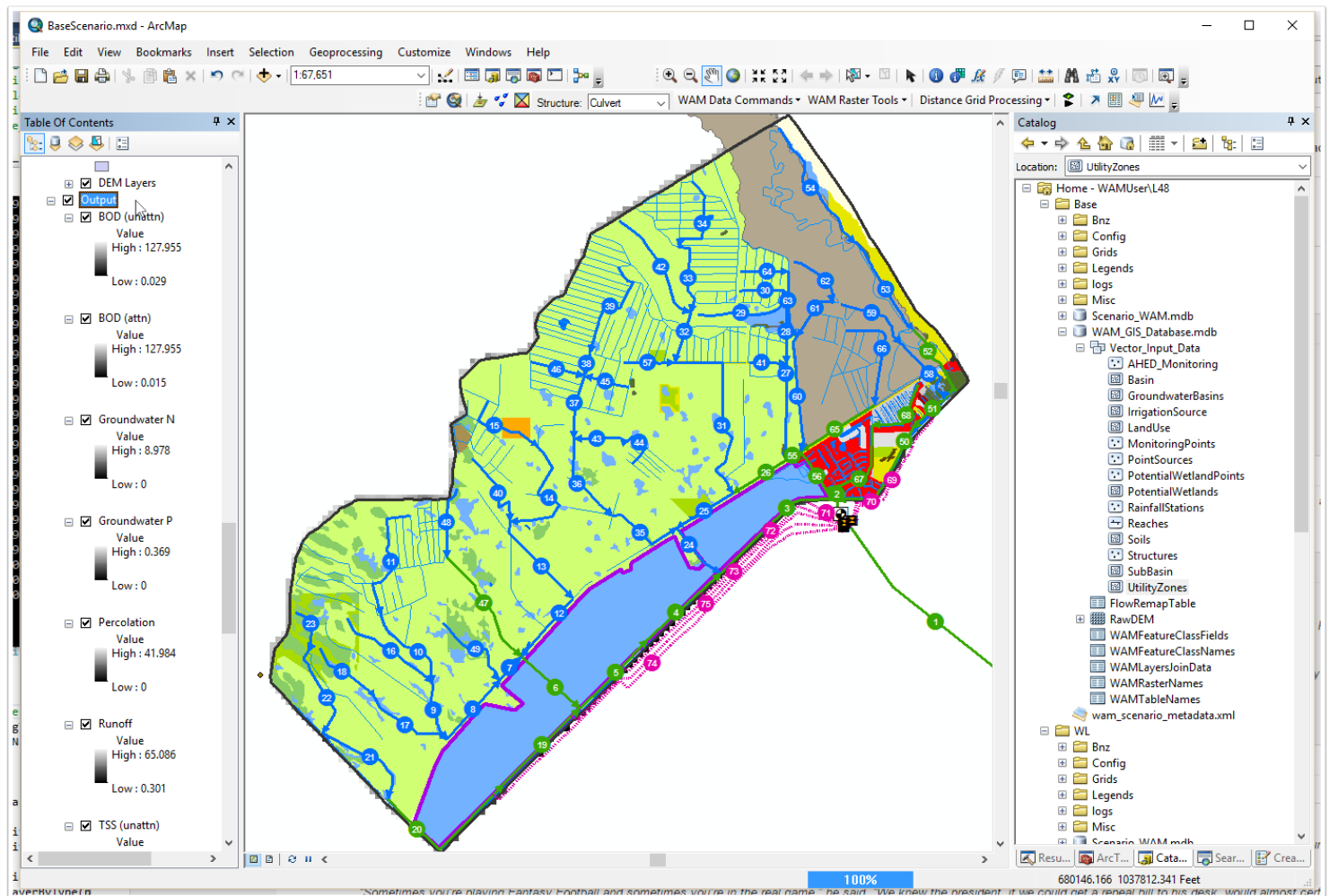


93. Go back and active the WL scenario

Activate the "WL" Data Frame and make sure the WL layer is in **bold**.

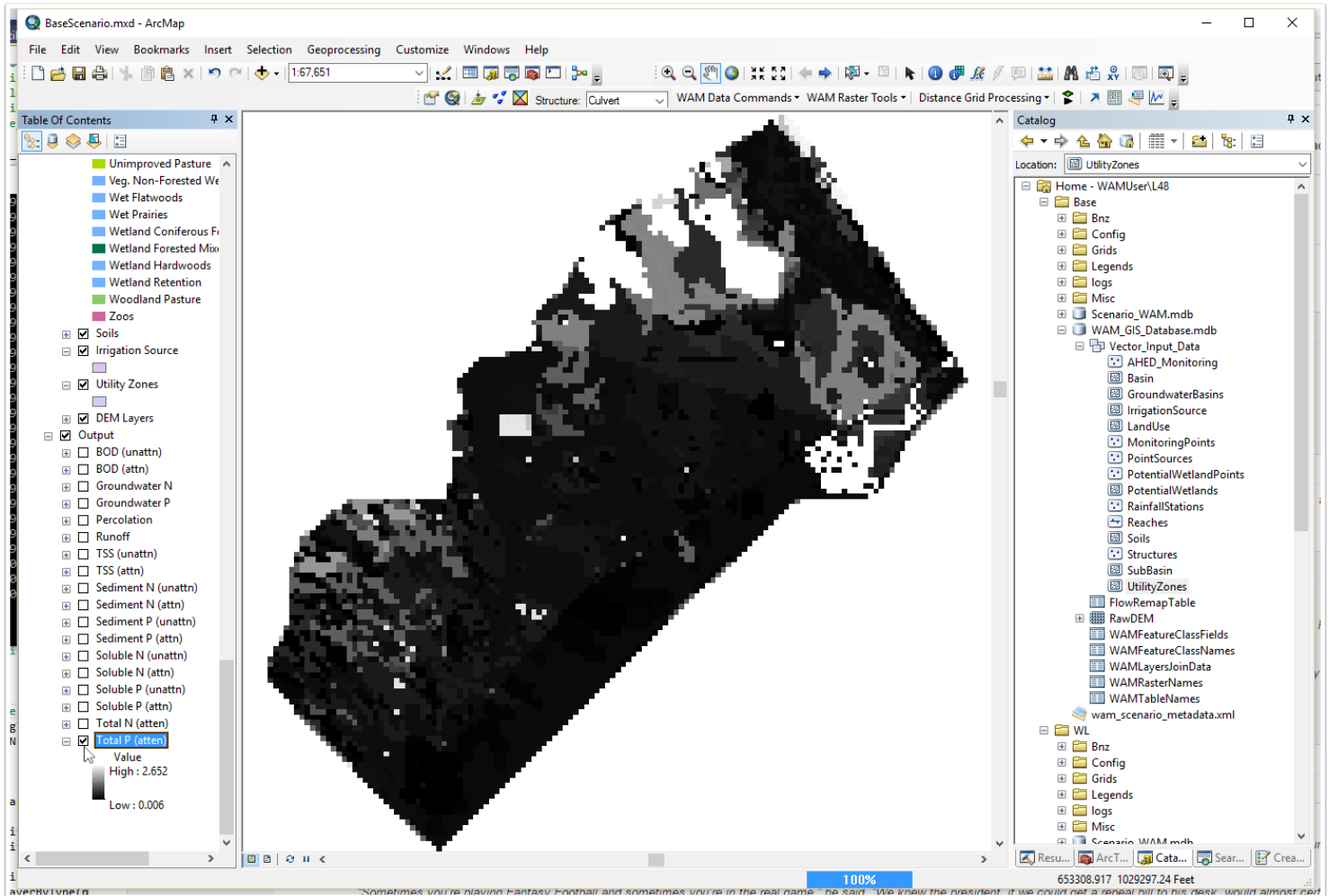
94. The output layers

A number of output grids get added to the map during the previous steps. These are raster layers representing annual averages of runoff, percolation of water to groundwater, nutrient loading, etc. These are added to a group layer named "Output" that is located under the "Base Maps" and "Input" group layers. To see the layers, you can turn off the base maps and input layers by clicking the check boxes next to the group layers.



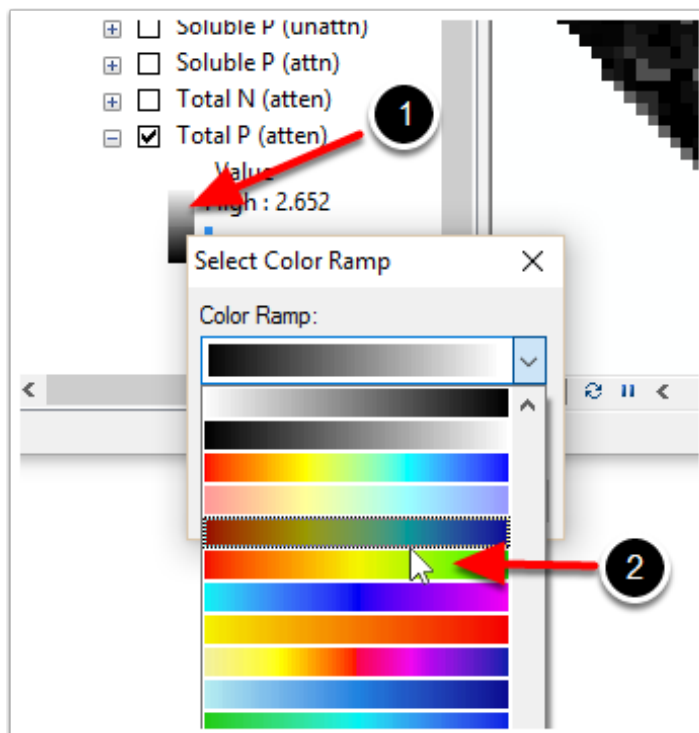
95. Viewing the Total P Grid

Here, all the output layers except the bottommost - "Total P (atten)" - have been collapsed by clicking on the "-" next to the layer name, and then clicking in the check box to hide the layer. Checked layers are visible, those that are unchecked are not.



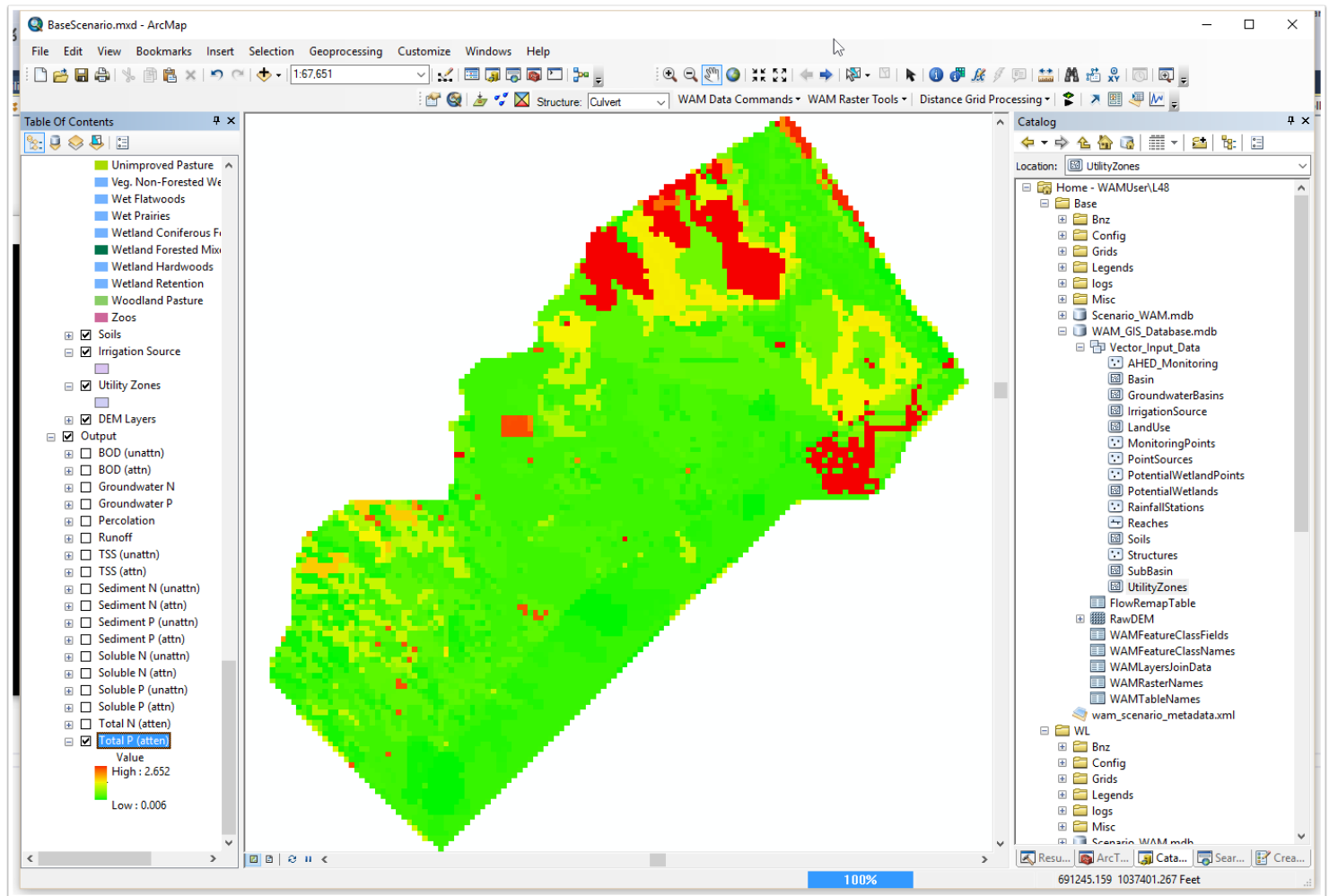
96. Change the Color Ramp

Click on the (1) black-to-white color bar to bring up the "Select Color Ramp" dialog, then select an appropriate color ramp. Here the red-to-green ramp is chosen, and the "Invert" box is checked afterwards so that green represents low values and red represents high values. Click OK.



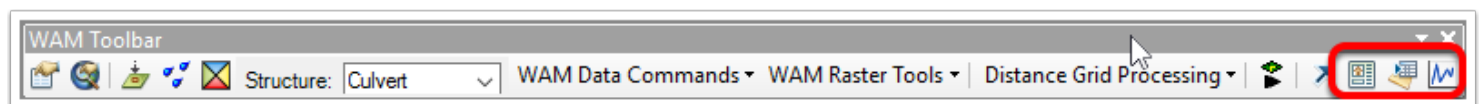
97. Total P Results

The green areas have low total P loading, the red areas have high loading. The values are in average kg/ha/y. The red areas at the top of the basin are due to the underlying soil type (you can make the soil layer visible to see this).



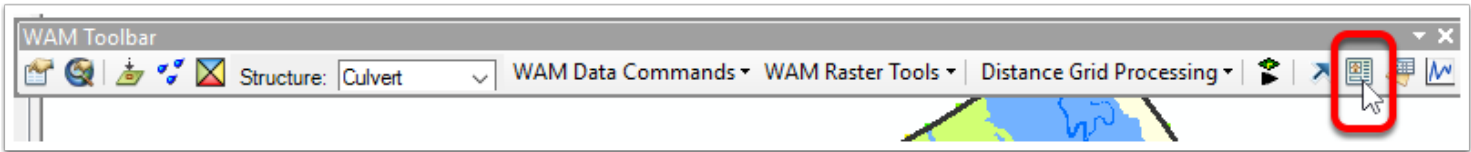
98. Compare Results Between Scenarios

The last three buttons on the WAM Toolbar are used to bring up different comparison methods. The first of these is used to view a summary of the grid outputs.



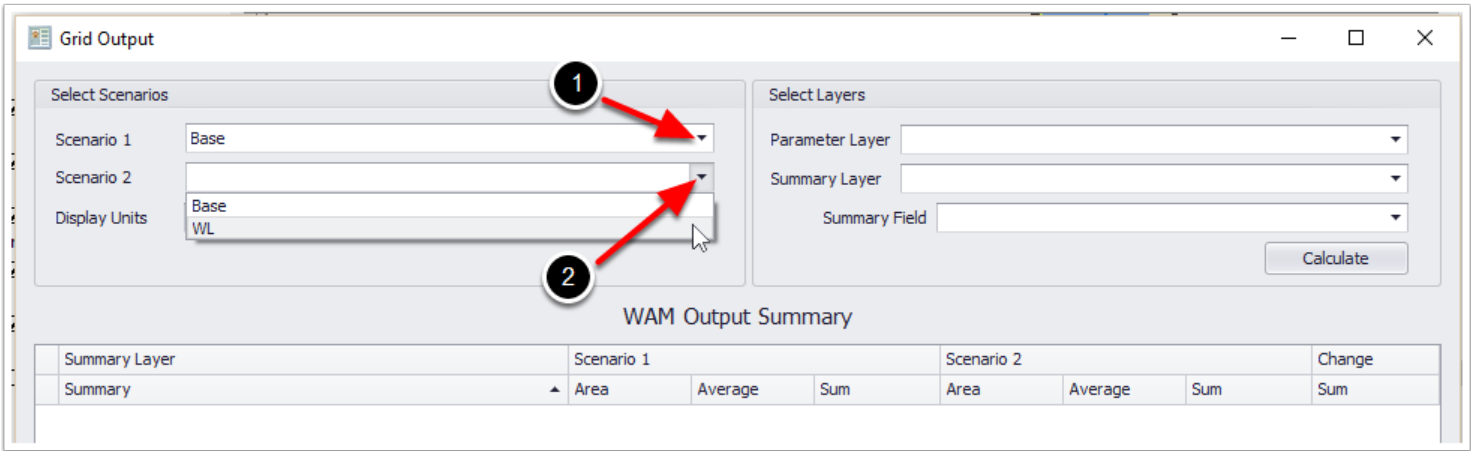
99. Grid Output Tool

The first tool is the grid output tool. Click on it to bring up the form. **Note:** some installations of ArcGIS may not be able to sucessfully display output from this tool.



100. The Grid Output Tool Form

Select the scenarios to compare by clicking on the down arrows (1) to select the base scenario, and (2) to select the WL scenario

A screenshot of the 'Grid Output' dialog box. It has two main sections: 'Select Scenarios' and 'Select Layers'. In the 'Select Scenarios' section, 'Scenario 1' is set to 'Base' and 'Scenario 2' is empty. 'Display Units' is set to 'WL'. In the 'Select Layers' section, 'Parameter Layer', 'Summary Layer', and 'Summary Field' are all empty. A 'Calculate' button is at the bottom right. Two red arrows with circular numbers point to the dropdown arrows: arrow 1 points to the arrow for 'Scenario 1', and arrow 2 points to the arrow for 'Scenario 2'. Below these sections is a 'WAM Output Summary' table.

Summary Layer	Scenario 1			Scenario 2			Change
Summary	Area	Average	Sum	Area	Average	Sum	Sum

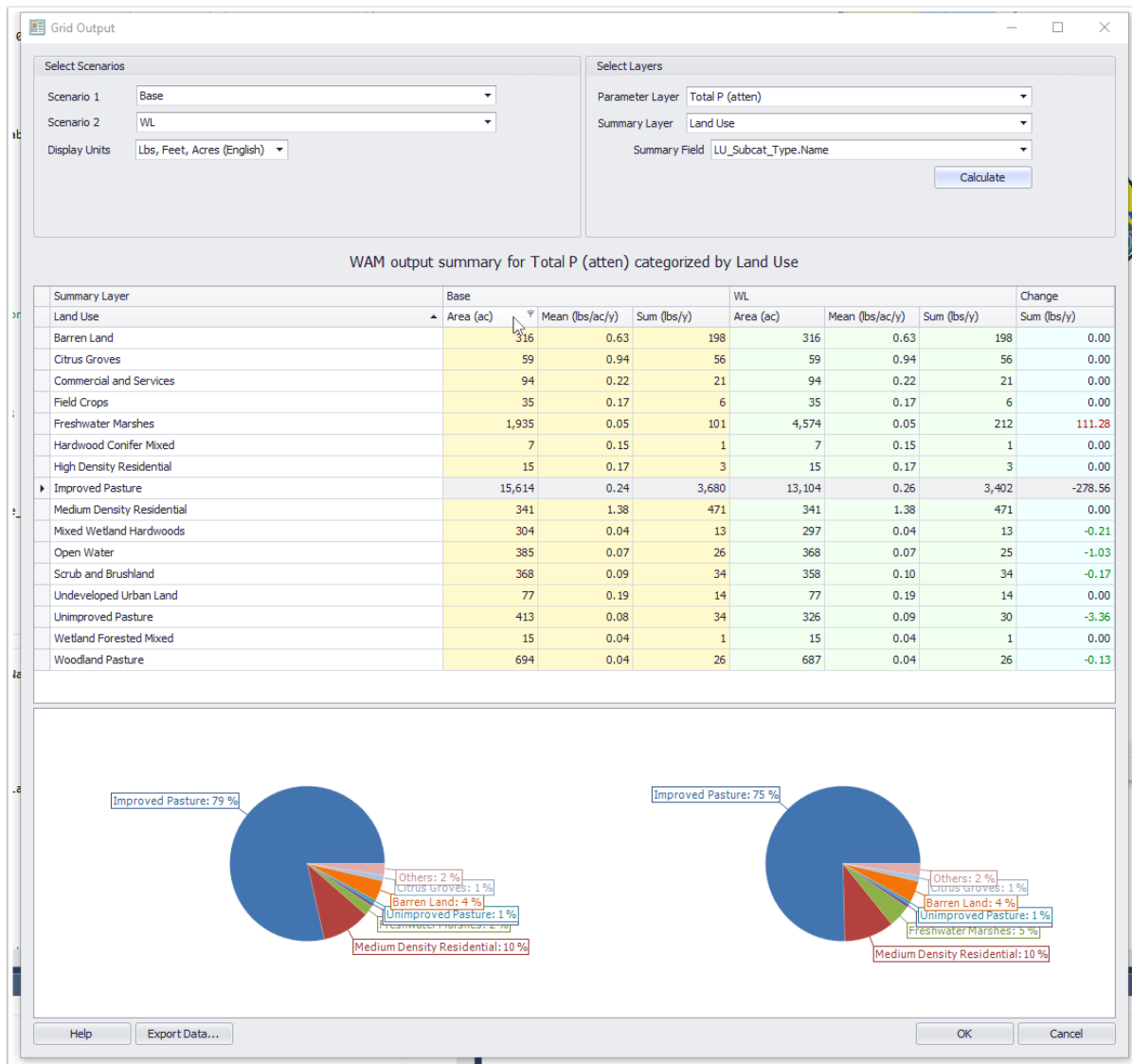
101. Complete the Other Layers

For the parameter layer (the output values of interest) select "Total P (atten)", for the summary layer, select "Land Use", and for the summary field select "LU_Subcat_Type.Name" (the WAM subcategory name.) Click the Calculate button

The screenshot shows the 'Grid Output' window with two main sections: 'Select Scenarios' and 'Select Layers'. The 'Select Scenarios' section on the left has three dropdown menus: 'Scenario 1' set to 'Base', 'Scenario 2' set to 'WL', and 'Display Units' set to 'Lbs, Feet, Acres (English)'. The 'Select Layers' section on the right contains three dropdown menus: 'Parameter Layer' set to 'Total P (atten)' (marked with a black circle and the number 1), 'Summary Layer' set to 'Land Use' (marked with a black circle and the number 2), and 'Summary Field' set to 'LU_Subcat_Type.Name' (marked with a black circle and the number 3). A blue 'Calculate' button is located below these dropdowns (marked with a black circle and the number 4). A mouse cursor is pointing at the 'Calculate' button.

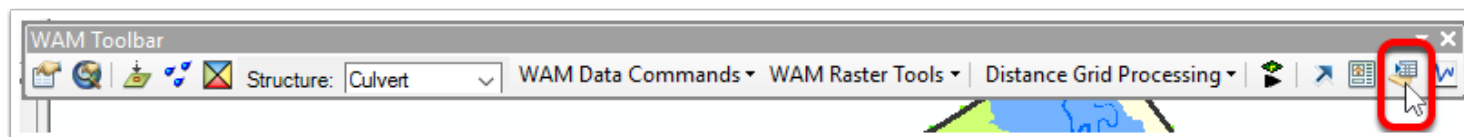
102. Grid Output

This will show the changes from one scenario to the next. Note that Improved pasture has decreased in acreage from 15,614 to 13,104, while the loading has decreased, in total, by 278.56 lbs/y. The loading for freshwater marshes has increased by 111.28 lbs/y (due to the increased area), but the overall total P loading has decreased by ~170 lbs/y. The grid can be sorted by columns by clicking in the column header, for example, it can be sorted by acres by clicking in the column "Area (ac)" Note that the data can be exported to an Excel spreadsheet by clicking on the Export... button and choosing a name and location for the exported file.



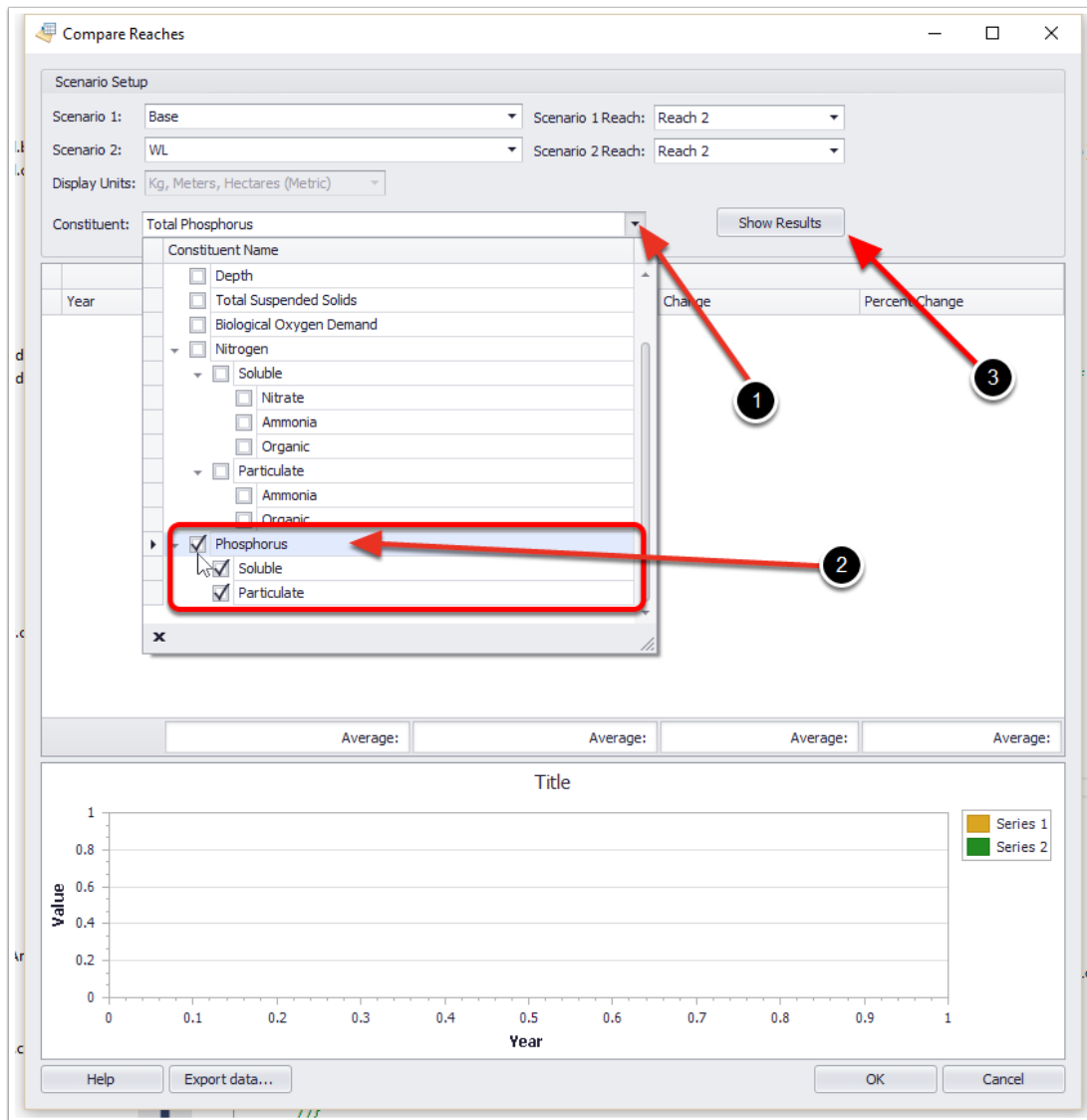
103. Compare Reach Output

The next tool allows comparison of loading in reaches. Click on the button to view a summary grid of reach data:



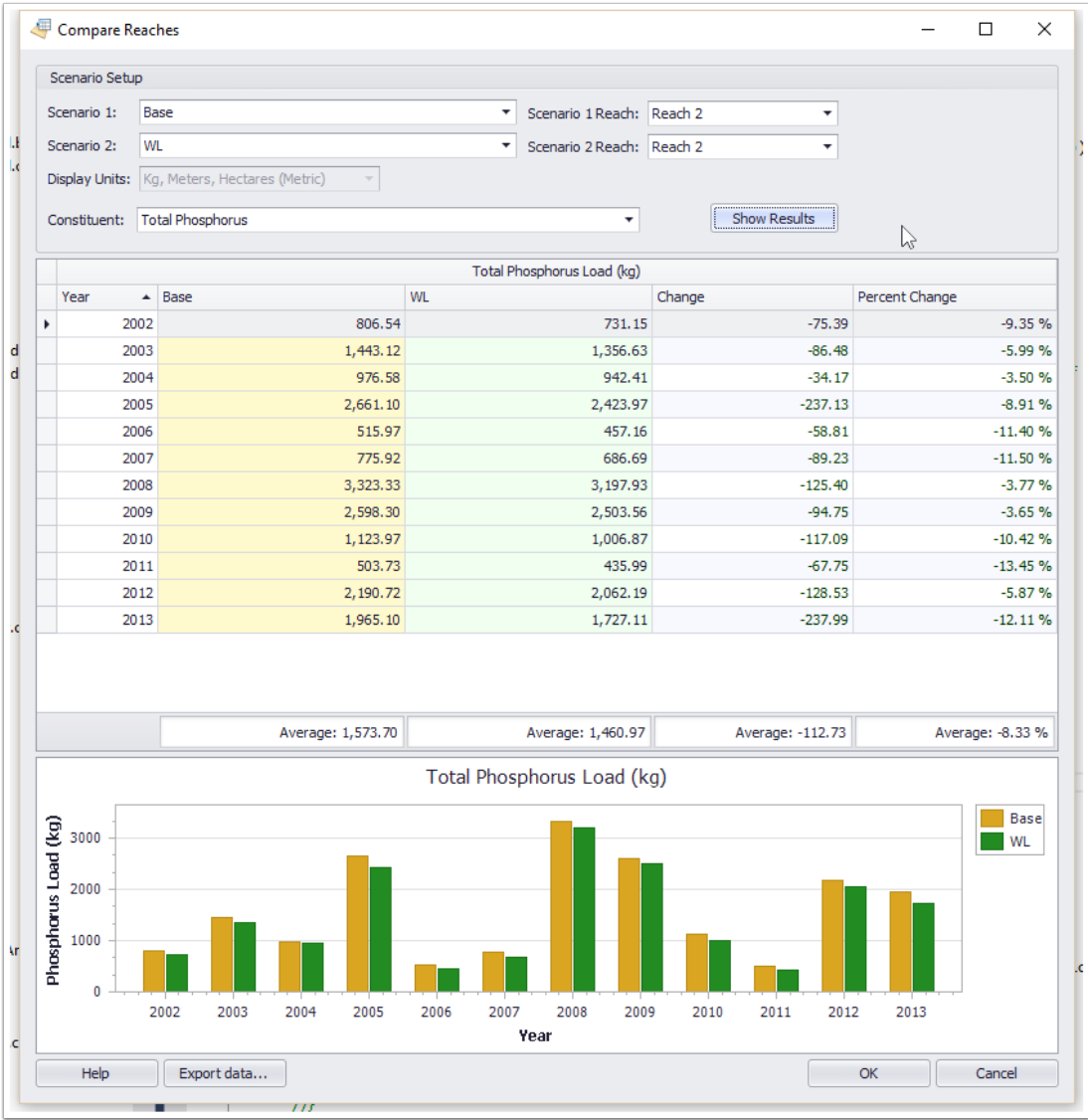
104. Compare Reaches

For scenario 1, again choose the base scenario and WL for scenario 2. For the reaches, select Reach 2 for both since it is the outlet. Now, (1) click on the down arrow in the Constituent control, and (2) click on the "Phosphorus" check box to select both soluble and particulate forms, and (3) click on "Show Results".



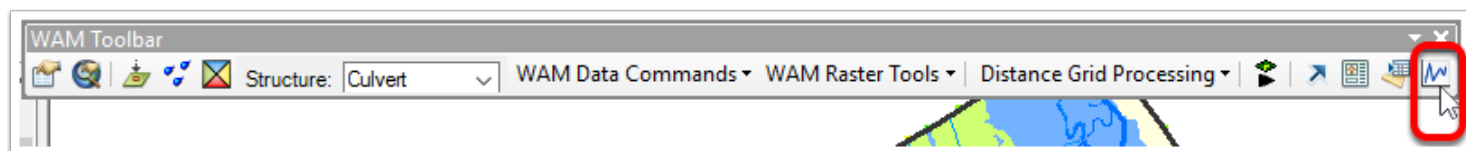
105. Total P Results in Reach 2

A year-by-year summary is given of the load in kilograms with the average values for each column shown at the bottom, along with a summary bar chart. As with the grid output, the data on the grid (but not the chart) can be exported. Click "OK" when finished.



106. Reach Chart Tool

The last tool is the reach chart tool, at the far right end of the WAM toolbar. Click on it to bring up the reach chart form



107. The Reach Chart Form

This form has a grid where specifications for multiple data series can be added as desired. For the first row, click on the scenario box and select "Base"

A screenshot of the ReachChartForm window. The window has a title bar and a menu bar. Below the menu bar, there are tabs for "Design" and "Other". The "Design" tab is active, showing a "Chart Type" section with icons for Column, Line, Pie, Bar, Area, and Other Charts. To the right of the "Chart Type" section is a "Palette" section with several color swatches. Below these sections is a table with the following columns: Scenario, Reach, Reach End, Constituent, Type, Cumulative, Axis, and Pane. The first row of the table is selected, and a red arrow points to the "Scenario" dropdown menu, which is open and showing the options "Base", "WL", and "Measured Data". The "Base" option is highlighted. At the bottom of the window, there is a "Build Chart" button.

Scenario	Reach	Reach End	Constituent	Type	Cumulative	Axis	Pane
Base	Reach	Downstream		Conc	☐	Left	1

108. First Data Series

Fill in the rest of the first row as shown.

The screenshot shows the 'ReachChartForm' window. The 'Chart Tools' tab is active, with 'Design' and 'Other' sub-tabs. The 'Chart Type' section includes icons for Column, Line, Pie, Bar, Area, and Other Charts. The 'Appearance' section shows various chart styles. Below these is a table with the following data:

Scenario	Reach	Reach End	Constituent	Type	Cumulative	Axis	Pane
I Base	Reach 2 (2)	Downstream	Total Phosphorus	Conc	☐	Left	1

At the bottom of the window, there is a 'Build Chart' button and a status bar showing 'Record 1 of 1'.

109. Add a Second Series

To add a second data series, click on the "+" button at the bottom of the top panel to append a series

This screenshot is similar to the previous one, but it highlights the 'Append' button at the bottom of the top panel. A red arrow points from a callout box labeled 'Append a data series' to the '+' button in the status bar. The callout box is a grey rounded rectangle with the text 'Append a data series' in white. The status bar also shows 'Record 1 of 1' and a 'Build Chart' button.

110. Fill in the second series data

Fill in the next series as shown, using the WL scenario but keeping everything else the same. Click on "Build Chart"

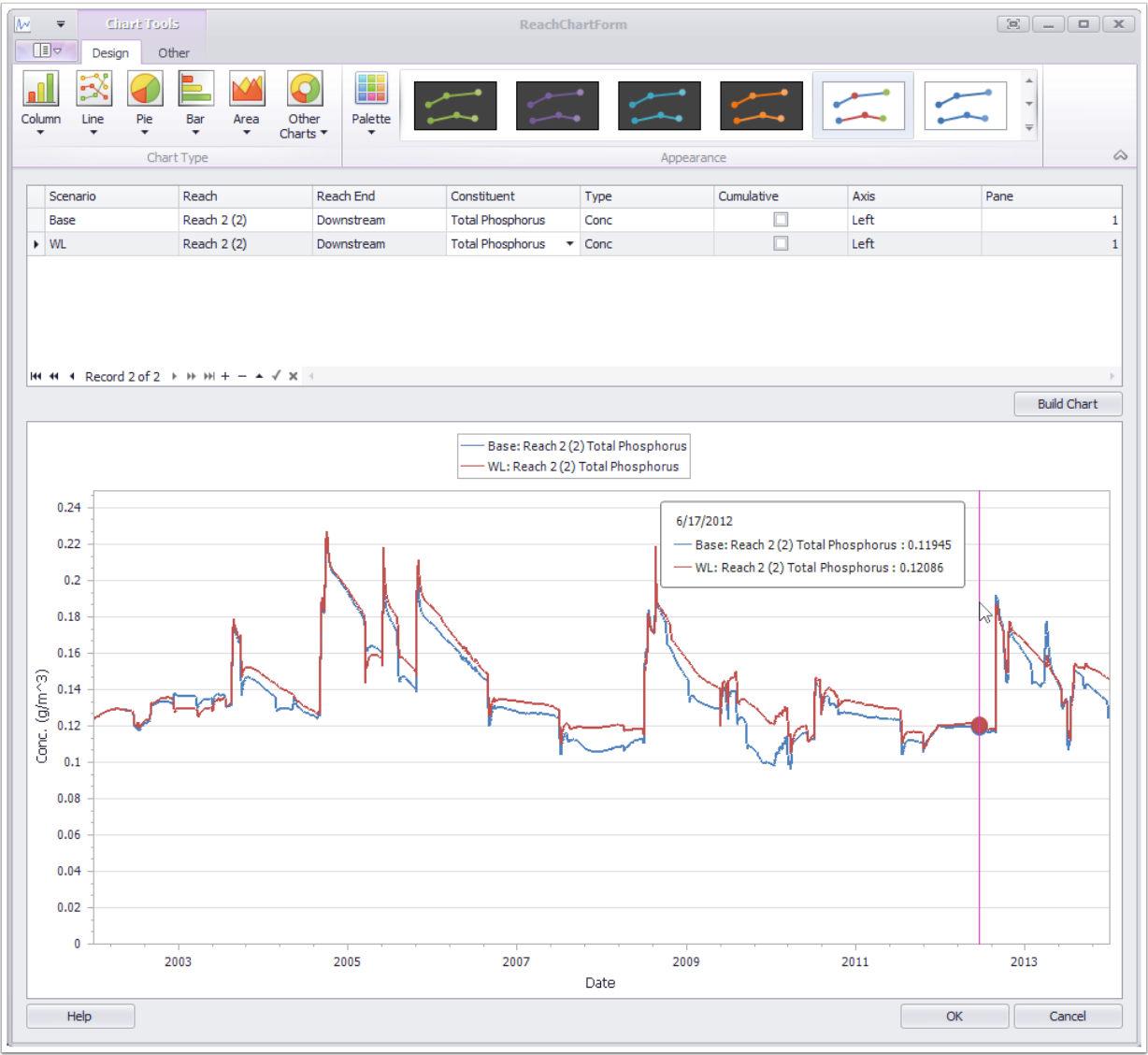
Scenario	Reach	Reach End	Constituent	Type	Cumulative	Axis	Pane
Base	Reach 2 (2)	Downstream	Total Phosphorus	Conc	☐	Left	1
WL	Reach 2 (2)	Downstream	Total Phosphorus	Conc	☐	Left	1

Record 2 of 2

Build Chart

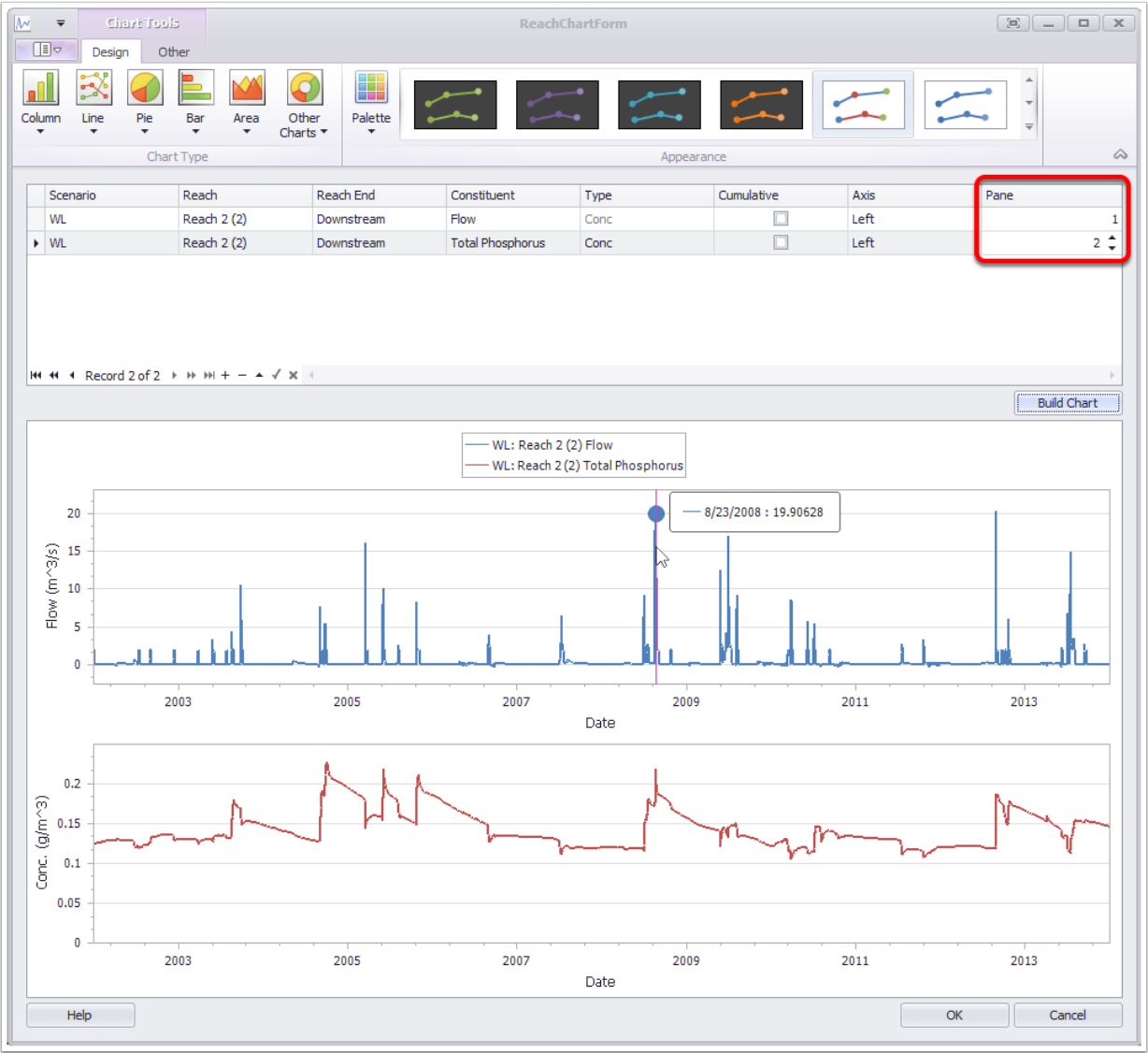
111. View the output

The output chart appears in the bottom panel. Mousing over the chart shows the values on a specific day in a callout.



112. Viewing Other Data

Two different constituents can be viewed, or a constituent can be compared against flow. Here, the WL scenario is used for both series, and the constituent for the first series is "Flow" while the second is still Total P. Note that the Total P is shown on a second pane that is chosen by clicking on the arrows in the last column. Click "Build Chart" to create the chart.



113. Comparing with Measured Data

In addition to data simulated by WAM, the Chart Form also has (limited) capability to show measured data in the same plot as the simulated data from WAM. In the Scenario column, click on the drop-down button and choose

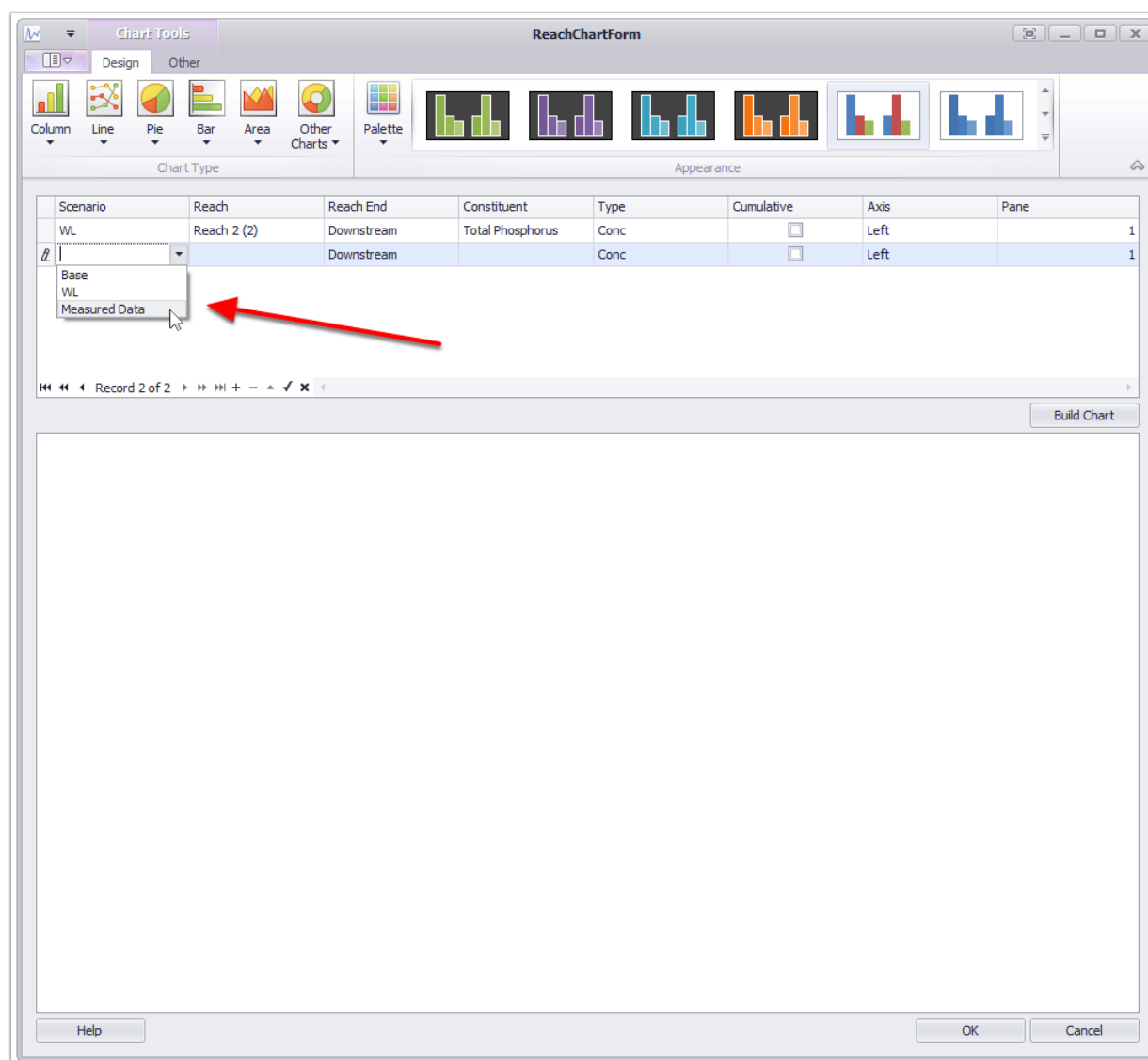
"Measured Data". Note: the measured data must be in comma separated value (CSV) format, with each row having two values representing a date and a measured value. The first column needs to be the date in M/D/Y format, while the second should be the measured value, e.g.:

```
MeasurementDate,Total P (mg/L)
```

```
1/27/2003,0.056
```

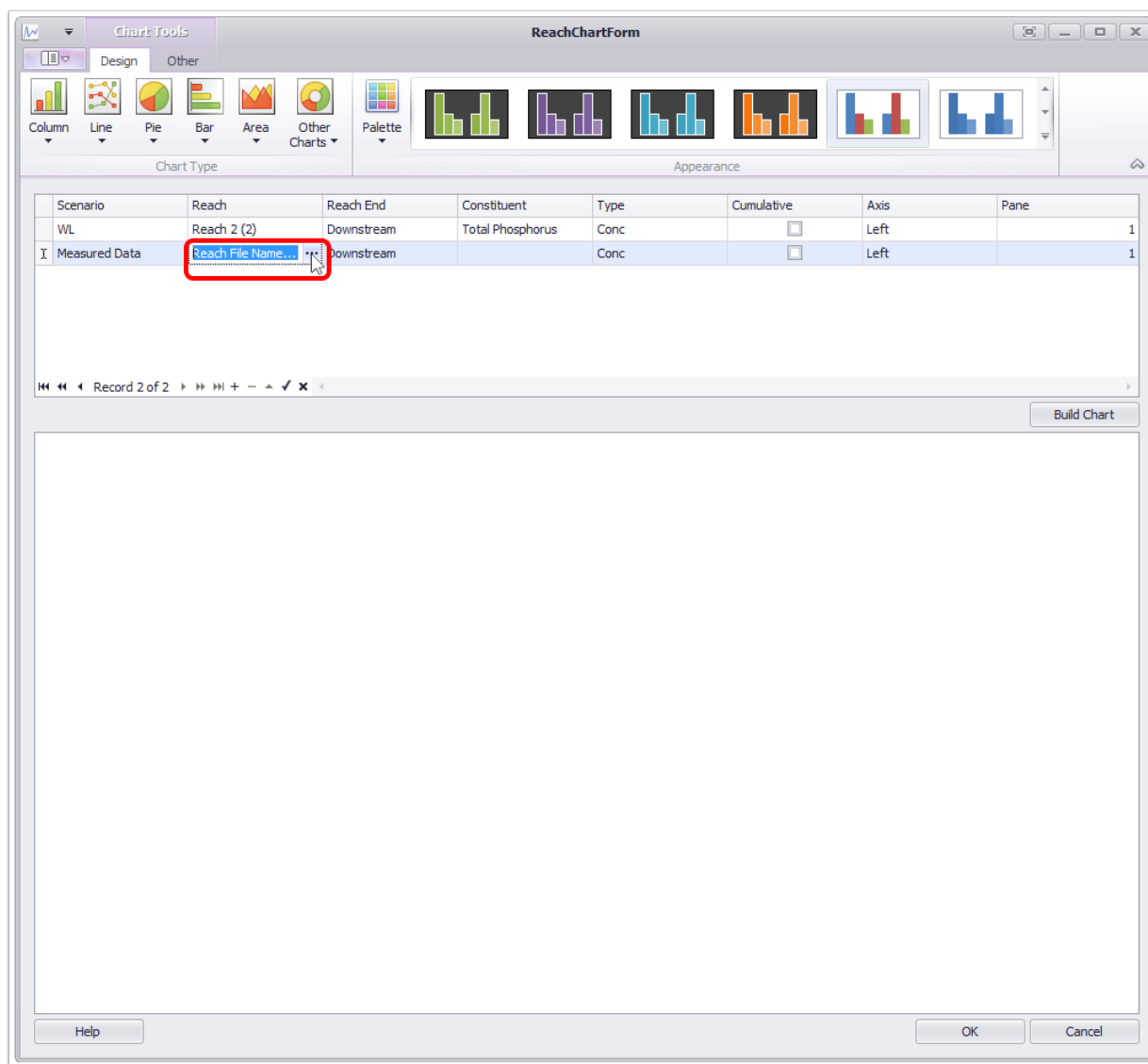
```
2/24/2003,0.065
```

```
...
```



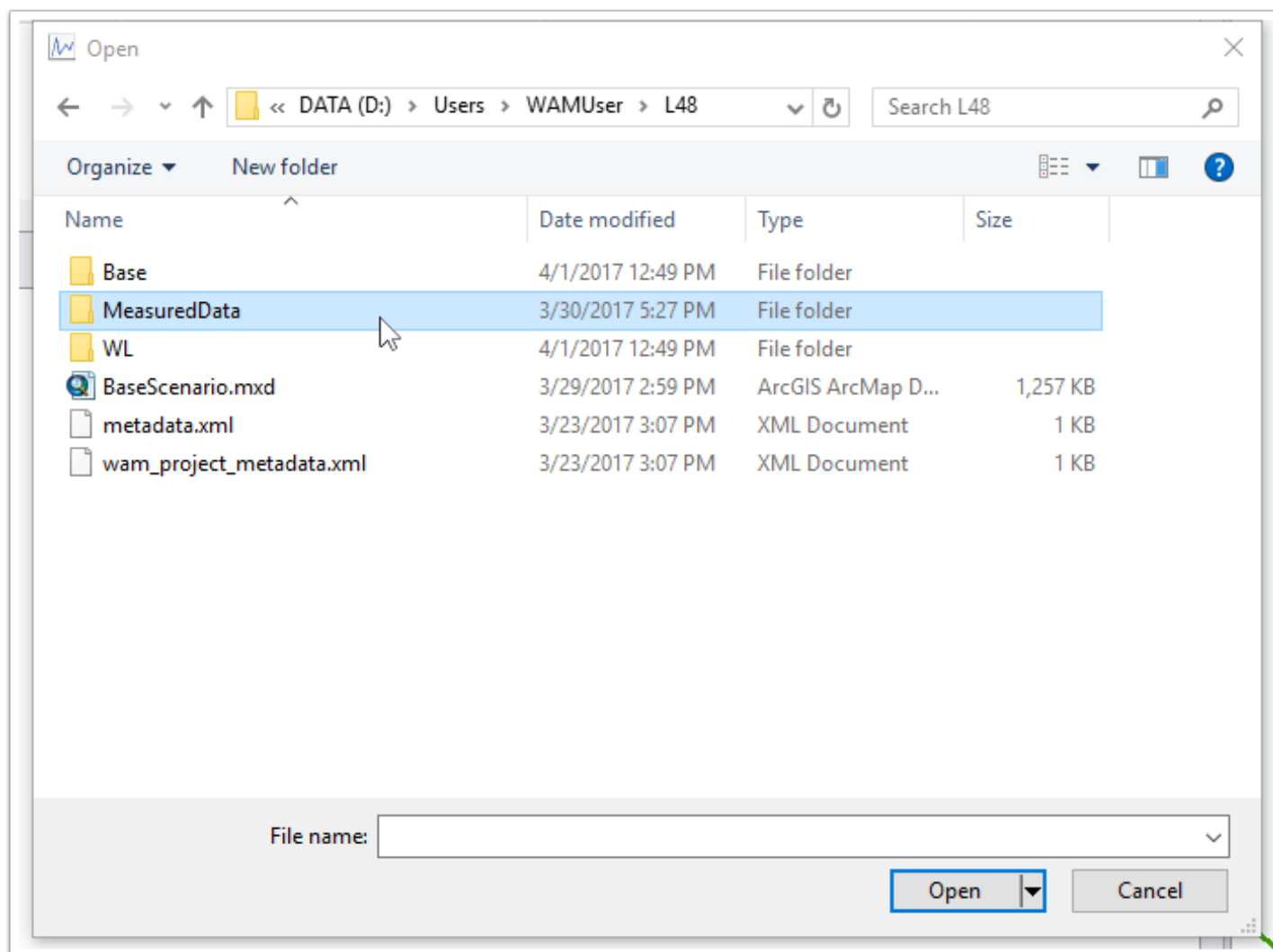
114. Select the File

In the "Reach" column, click in the box and then on the button showing the elipsis ("..."). A file browser window should open.



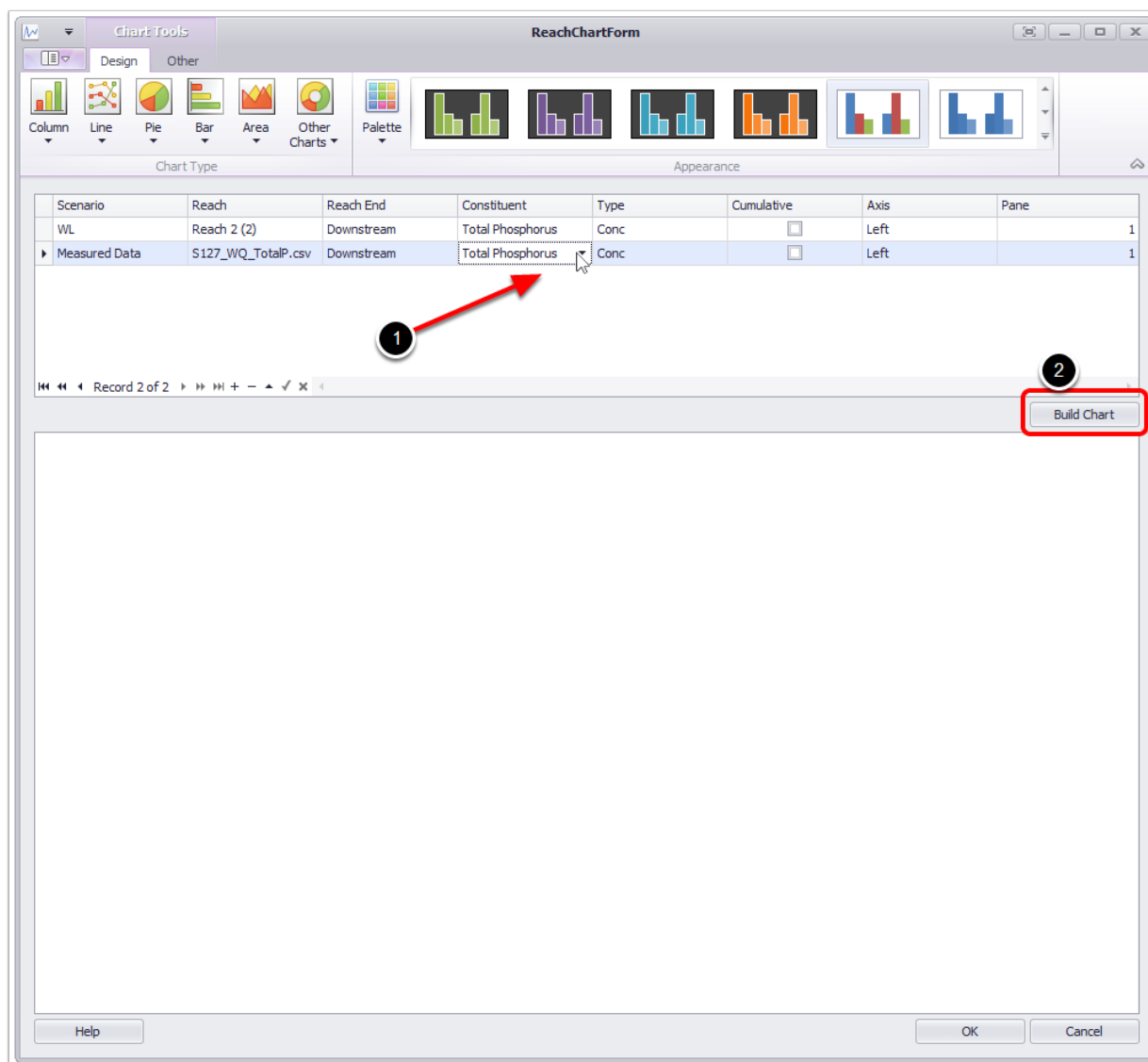
115. Browse to the Data Files

In the L48 project folder open the "MeasuredData" folder and then open the file "S127_WQ_TotalIP.csv".



116. Fill in the Rest

Select (1) "Total Phosphorus" for the constituent and (2) click "Build Chart". Note that the user must ensure that the measured data is in the correct form and the correct type (here total P), and that the selection of "Total Phosphorus" in the constituent column does not guarantee (obviously) that the file chosen actually has total P measurements.



117. Simulated and Measured Data

Note that the time interval is automatically expanded so that all simulated and measured values can be observed.

