ArcSLAMM v 1.0 User Guide

Contact:

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Overview:

The ArcSLAMM package is a set of ArcGIS script tools organized in a single toolbox as well as a set of database files and this and other user guide documentation. The purpose of the ArcSLAMM package is to provide geoprocessing functionality that will allow the urban stormwater quality model WinSLAMM (Source Loading and Management Model for Windows) to be more efficiently applied for small to moderate sized urban watersheds. The tools in the ArcSLAMM toolbox are meant to be used as part of a workflow that results in the creation of WinSLAMM compliant database files that can be used in WinSLAMM for individual modeling or batch processing of multiple drainage areas or catchments. The ArcSLAMM tools work with a customized intelligent geodatabase created to allow easy creation of WinSLAMM compliant files.

The ArcSLAMM package and toolbox constitutes a loose coupling with WinSLAMM software in which the ArcSLAMM tools are used for pre-processing and post-processing data to prepare for WinSLAMM modeling and for visualizing output from WinSLAMM.

This document attempts to give an overview of the process that a user (e.g. municipality, academic, consultant) would use to work through the process of using ArcSLAMM and WinSLAMM software together. We provide this guidance using example data from Cedar Falls, Iowa. We provide very limited details about running the WinSLAMM model itself, rather we focus on using ArcSLAMM in conjunction with WinSLAMM.

Credits:

The ArcSLAMM package was originally created by the GeoTREE Center as part of the Iowa Water Center grant entitled 'Community-wide Urban Storm Water Planning Utilizing LiDAR, the WinSLAMM Model, and GIS' (Subaward No. 424-17-04C). The Iowa Water Center is a federally funded center located at Iowa State University (http://www.water.iastate.edu/) which funds research related to water quality, water quantity, and human dimensions of water-resources management in Iowa. PV & Associates, the developer of WinSLAMM also provided a small amount of funding to complete the development of the ArcSLAMM package.

The development of these tools was based on the hard work of a number of UNI Geography undergraduate students including Bernard Conrad, Rebecca Gronewold, and Dan Murphy.

Requirements, assumptions, and support:

The ArcSLAMM toolset and associated geodatabase and lookup files are provided free of charge with limited support based on the discretion/time availability of the GeoTREE Center. An extended version of the package, named ArcSLAMM Plus will soon be made available for a minimal cost through PV & Associates, the developer/distributor of the WinSLAMM software. The ArcSLAMM Plus package will include more dedicated user support based on the cost of purchasing the software. ArcSLAMM Plus will include further tools and another geodatabase to extend capabilities to work with the Standard Land Use module of WinSLAMM. The WinSLAMM modeling software is not part of this distribution and can be acquired at cost at http://winslamm.com/purchase.html. This documentation is not going to give a thorough description or details regarding the workings of the WinSLAMM software. Details on WinSLAMM can be found at http://winslamm.com.

The ArcSLAMM package described here has been tested using ArcGIS 10.2.1 (Advanced Edition), the Spatial Analyst extension and WinSLAMM v10.1.1. Major changes to WinSLAMM database formats in future versions could render the database files created with ArcSLAMM 1.0 software unusable. The GeoTREE Center intends to endeavor to work with PV & Associates in the future to keep the software working together.

The documentation here assumes you are familiar with using ArcGIS Desktop (ArcMap and ArcCatalog). The document also assumes some familiarity with WinSLAMM software itself. The *Elevation and Catchment Area Tools* will require a Spatial Analyst license. The other tools should work with any ArcGIS license level although it has only been tested on ArcGIS Advanced license.

Data Provided:

A variety of pieces are provided as part of the download of ArcSLAMM. Below you will find a description of the directory structure and an overview of the purpose of files in those directories. Before doing anything with this data it is recommended that you make a backup copy of all the data.

```
\data
    \base_data
        \lookup
        \WinSLAMMSourceArea.gdb
    \example_data
```

- The \base_data\lookup directory holds

  - a database file called BaseWinSLAMM_10_1.mdb which is an empty base WinSLAMM database file. When prompted to choose a 'Base WinSLAMM Database' when running the *Create WinSLAMM Compliant Databases* tool you should choose this file. That tool will make a copy of the BaseWinSLAMM_10_1.mdb file and then populate data from the Geodatabase feature class for each WinSLAMM compliant database it is creating. The BaseWinSLAMM_10_1.mdb database has certain things set that you might want to change such as which pollutants are being modeled and several parameter files (e.g. rainfall) to use. If you want to change these parameters so they will be used in your ArcSLAMM-WinSLAMM-ArcSLAMM workflow you should make a copy of BaseWinSLAMM_10_1.mdb, rename and save it, open in WinSLAMM, make the relevant changes and then use this version with the *Create WinSLAMM Compliant Databases* tools.
  - A file called Lookup.csv. This file should not be altered in any way. When prompted to choose a 'Lookup .csv' when running the Create WinSLAMM Compliant Databases tool you should choose this file. It contains necessary information to translate data held in the geodatabase feature class to the WinSLAMM compliant databases being created.
- WinSLAMMSourceArea.gdb is a customized geodatabase file, created for the ArcSLAMM package, which contains a feature class called WinSLAMMSourceArea_FC. This feature class allows the creation of polygon features that represent detailed WinSLAMM source area categories that are needed for WinSLAMM modeling. As delivered the feature class is empty with no records (a blank slate). See the description under \Documents\SourceAreaFieldGuide.pdf for a description of the concept of source areas. You should make a copy of this WinSLAMMSourceArea.gdb before you begin digitizing your own features in it. After making a copy you can rename the .gdb and feature dataset as you would like to be more meaningful for you and the study area you are working on. The name of the feature class (WinSLAMMSourceArea_FC) cannot be changed as it is participating in a topology within the feature dataset as well as domains. You should however change the coordinate system of the feature dataset to match those of your local study area before you actually digitize any polygon features. You can do this by right-clicking on the feature dataset, choosing Properties, and setting under XY Coordinate System.
- \example_data
  - This directory contains two Digital Elevation Model (DEM) raster datasets, a streams Shapefile, a pour points Shapefile, as well as a file geodatabases with example detailed source area feature polygon data. All of the data are for an area in Cedar Falls, Iowa. You can follow steps under ArcSLAMM Practice/Demonstration Steps below using the data in this directory to learn how to use the ArcSLAMM tools in conjunction with WinSLAMM.

\Documents

- Contains this user guide documentation
- SourceAreaFieldGuide.pdf

- In this document each potential WinSLAMM source area type is listed and the associated attributes are detailed. WinSLAMM uses the concept of 'source areas' which are analogous to detailed land use/cover classes with qualifications based on certain things like whether the source area is connected to an impervious area and what type of soil falls in that area. There are several main classes such as roofs, parking, unpaved parking, driveways, sidewalks, landscaped areas, undeveloped areas, streets, and other areas which then are subdivided up based on qualifying attributes. So for example, there are actually 12 separate Roofs classes as they are broken out based on whether they are pitched or flat, which soil type they fall in, etc. In total, there are approximately 80 separate source area types. When creating these features in ArcMap with editing you choose just the source area type and the associated attributes are taken care of by the geodatabase intelligent features. When digitizing source area features you must also indicate whether each source area feature is within a wider land use class of institutional, commercial, residential, industrial, or other urban.

\tools

- This directory contains the ArcSLAMM toolbox (ArcSLAMM_v1.tbx)

Tool Overview:

Below we give a brief overview of the ArcGIS script tools available in ArcSLAMM and their general purpose. The tools have a number(letter) associated with them to indicate the general order they might be used. However, it is possible that you might not need to use the 1 and 2 tools as they are pre-processing tools to organize data properly. The general flow of using the tools would be as below if you are starting with a non-hydrologically enforced DEM:

- *1-Derive Soil Type from SSURGO* is a preprocessing step and should be run before developing detailed source area spatial data using the WinSLAMMSourceArea.gdb. The tool takes publicly available SSURGO soils databases, clips the soils data to study area, reclassifies hydrological soil group attribute to WinSLAMM soil types, and produces a new feature class that can be used in creating detailed source areas. *This step is ideally carried out before digitizing detailed source areas in the WinSLAMMSourceArea_FC*.
- *2a-Hydrologically Enforce Digital Elevation Model (DEM)* is used to burn a stream network into a DEM in order to aid in the creation of drainage area/catchment boundaries.
- To derive catchment/drainage area boundaries you can use either of these tools:
    - *2b-Catchment Delineation for Stream Segments* if you want to derive catchments for your whole study area based on ArcGIS defined stream segments OR
    - *2c-Catchment Delineation for Pour Points* if you want to only derive catchments for specific outlet points in your study area
- *3-Intersect Catchments with WinSLAMM Detailed Source Areas* is used to develop an interesected feature class that holds all of the necessary WinSLAMM attributes for detailed source areas and a catchment identifier which is carried forward to the next tool.

- The *4-Create WinSLAMM Compliant Databases* tool is used to derive a unique WinSLAMM compliant database for each unique catchment/drainage area.
    - In between this and next step you would likely run WinSLAMM in a batch mode with files created by the *Create WinSLAMM Compliant Databases* tool
- The 5-*Join WinSLAMM Output Back to Spatial* tool is used after running WinSLAMM simulations for each individual catchment/drainage area using the batch mode in WinSLAMM. This tool allows the results from those simulation be tied back to the GIS data for map-based visualization.

Below you will find an example which details steps to carry out for a complete ArcSLAMM –> WinSLAMM –> ArcSLAMM workflow. A detailed step-by-step example, based on data provided in the data download package, will take the user through data creation, using ArcSLAMM tools for pre-processing, running WinSLAMM, and using ArcSLAMM tools for post-processing map-based visualization of WinSLAMM outputs.

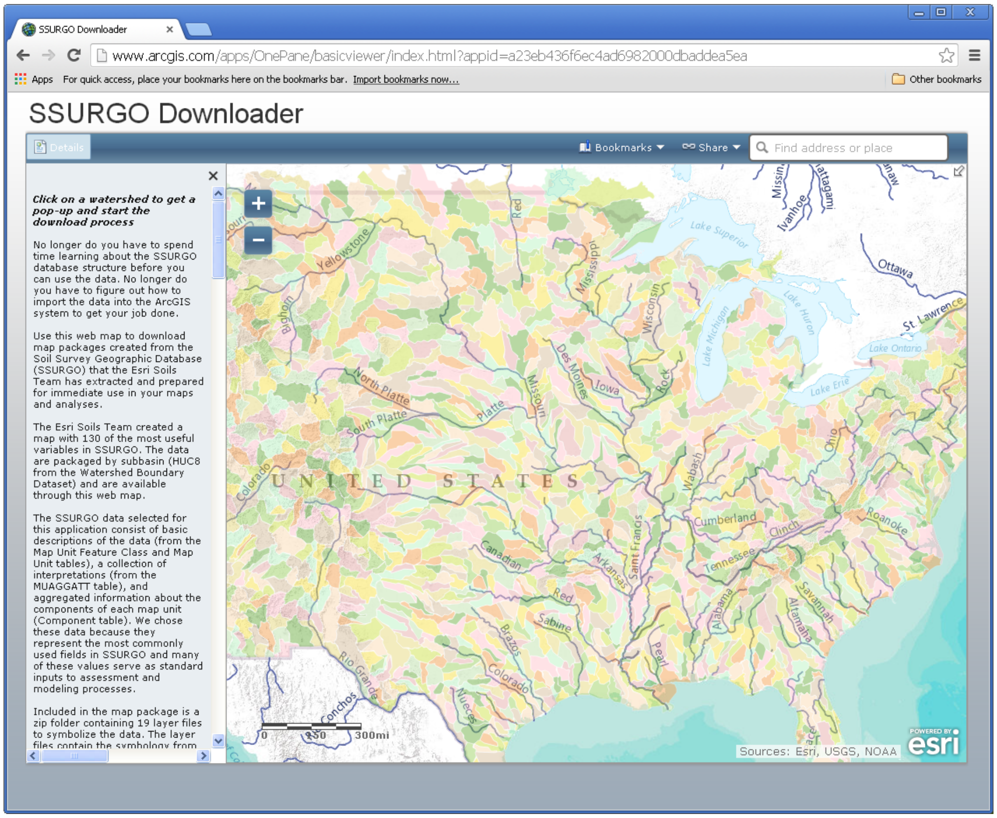
Pre-processing steps to prepare detailed source area data for use with ArcSLAMM

The purpose of the overall ArcSLAMM package is to allow the use of ArcGIS as a pre- and post-processing utility that greatly expands upon and improves the efficiency of using GIS and WinSLAMM to carry out modeling for larger urban study areas. Part of the ArcSLAMM distribution package is a customized file geodatabase which allows the use of ArcGIS editing tools to create polygons which hold the necessary detailed source area attributes necessary to run WinSLAMM. The general process is to prepare these detailed source areas, intersect with catchment/drainage areas, create WinSLAMM compliant databases for each catchment/drainage area, carry out WinSLAMM modeling for single catchment/drainage areas or in a batch mode, and finally to bring modeled WinSLAMM results back to ArcGIS for visualizing modeled outputs in map form.

One attribute that is necessary to develop WinSLAMM detailed source area features is a simplified soils characterization of ‘silty’, ‘sandy’, or ‘clayey’. The *Derive Soil Type from SSURGO* ArcSLAMM tool provides an easy mechanism to process SSURGO soil data into a format that will make it easier to include when digitizing polygon features in the source area feature class in the customized geodatabase (WinSLAMMSourceArea.gdb).

You can easily download SSURGO soils data by watershed from an ArcGIS Online site created by ESRI (http://www.arcgis.com/apps/OnePane/basicviewer/index.html?appid=a23eb436f6ec4ad6982000dbaddea5ea). ***Warning:*** *This is a secondary product derived from USDA NRCS SSURGO soils data and does not necessarily represent the most up to date official SSURGO soils data. Please read ESRI’s explanation of how these data were derived at the above site.* However, the ESRI site provides a convenient method to access SSURGO soils data and the *Derive Soil Type from SSURGO* ArcSLAMM tool provides an efficient method to derive the soil attribute necessary to run WinSLAMM. The *Derive Soil Type from SSURGO* ArcSLAMM tool is a pre-processing tool which makes it easy to derive the soils attribute but the user can derive the soil information from other sources using other methods. Reference the official website of

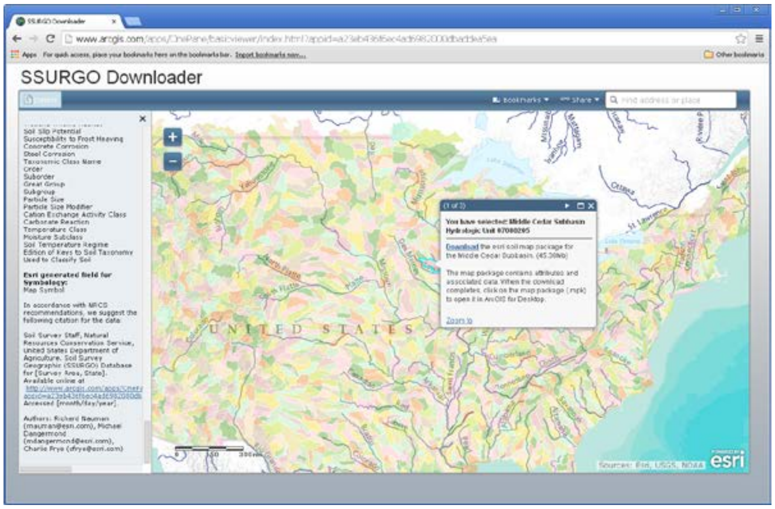
USDA NRCS to learn more about soils data-
http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/.



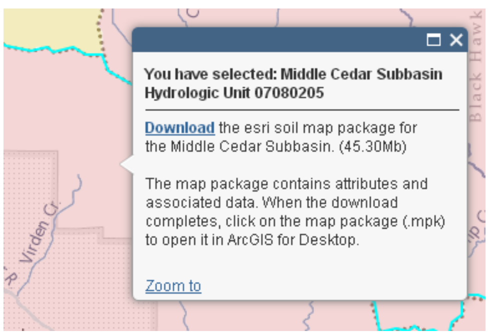
The steps below indicate how to download data from the above site and how to use the *Derive Soil Type from SSURGO* tool to process that data. These steps will require that you have a feature class (Shapefile or geodatabase feature class) representing the boundary of your study area. This feature class will be used to clip out the SSURGO soils data. You might want to create a directory called \soils which will hold the data you download in following steps.

Derive Soil Type from SSURGO

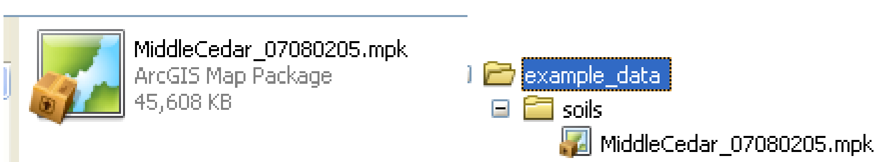
1. Open http://www.arcgis.com/apps/OnePane/basicviewer/index.html?appid=a23eb436f6ec4ad6982000dbaddea5ea and zoom to the watershed that contains your study area. If your study area crosses two (or more waterhseds) you will have to download both and repeat these steps. In this example we are choosing the Middle Cedar Subbasin in Iowa which contains the study area we will use below. You can type in Cedar Falls, IA if you want to search for a place.



- In the mapping application, click on the watershed to open the popup. Click Download and save it to a location of your choice. For this example, a \soils directory was created in the \example_data folder. How your download occurs might depend on how your browser is set up to download files.

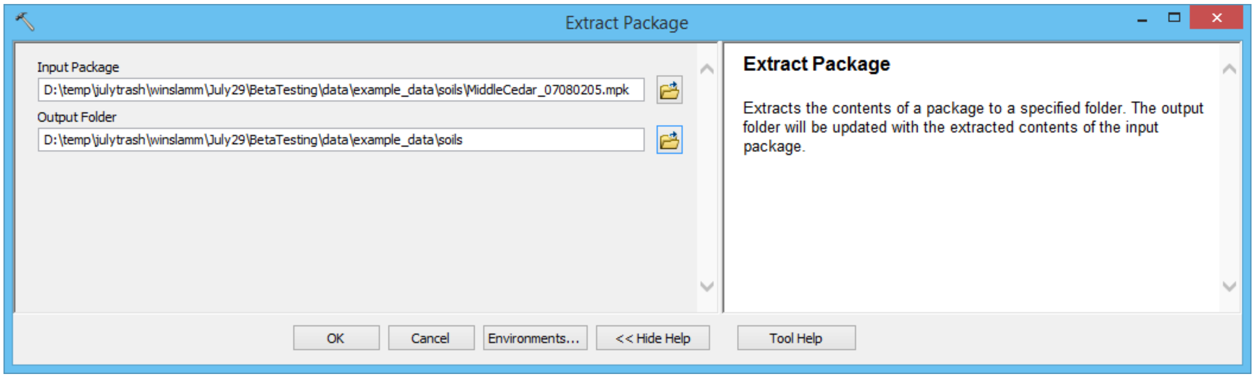


2. At this point you will have downloaded an ESRI Map Package (.mpk) file. Map Package files are a mechanism created by ESRI to easily distribute an ArcMap document (.mxd) and the data contents held in that .mxd. The SSURGO .mpk files will contain an .mxd file and all data associated with it – in this case a geodatabase containing feature classes representing the watershed boundary and the soils data for that watershed. Based on example above this is what the map package file looks like. The map package file is basically a zipped file.

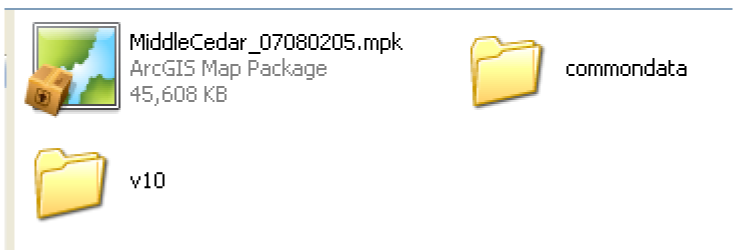


3. There are multiple ways to extract the contents of the .mpk file including using an extraction program like 7-Zip, dragging and dropping the file onto ArcMap data frame, or using the Extract Package tool from ArcToolbox. We suggest using the Extract Package tool (Data Management Tools – Package – Extract Package) and demonstrate this below.
4. In ArcMap (or ArcCatalog) open the Extract Package tool (ArcToolbox – Data Management Tools – Package) and navigate to the directory holding the Input Package (.mpk file downloaded). Also

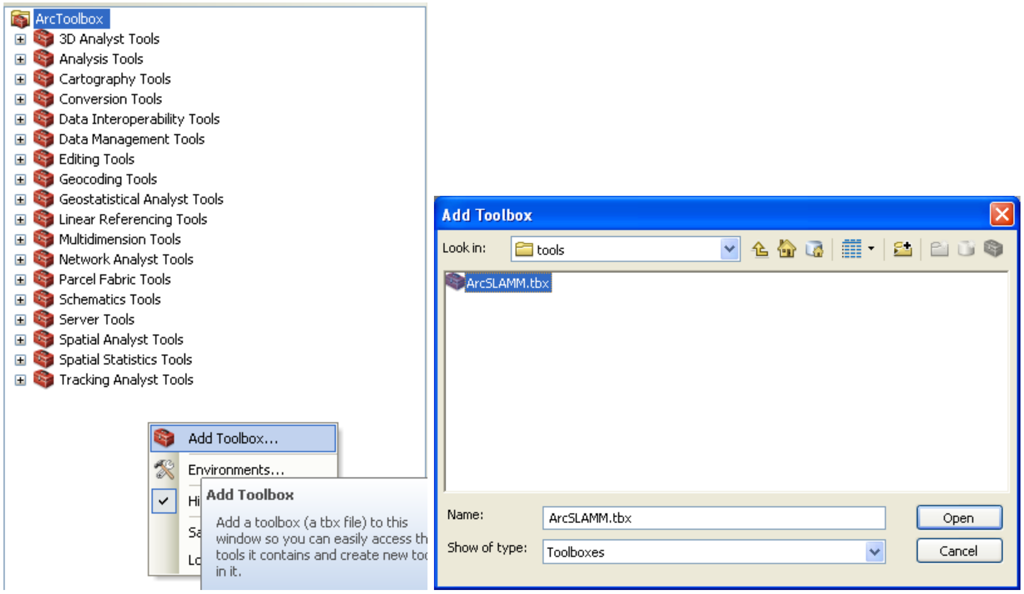
indicate the directory that you would like to extract the data too. This is an intermediate step so you can put this data wherever you like but we suggest the \soils directory mentioned above.



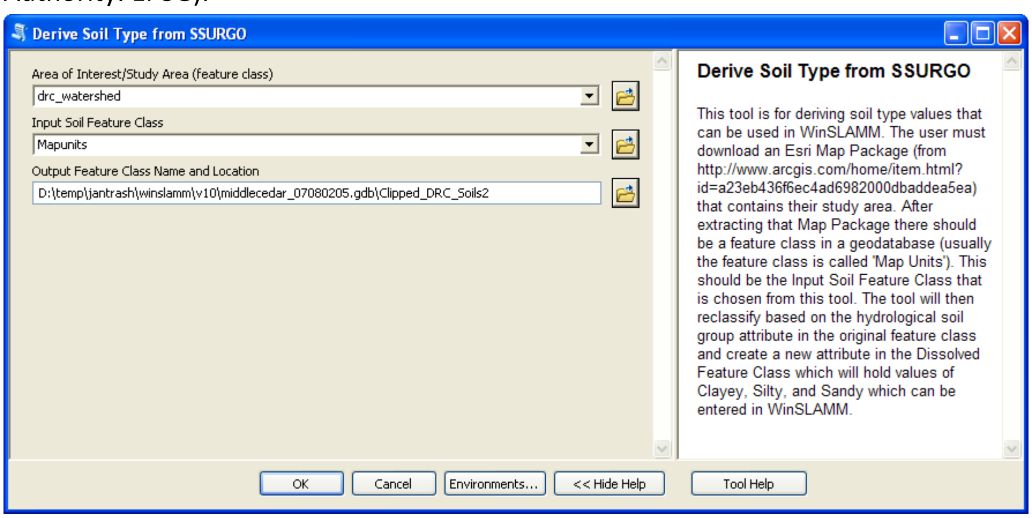
5. After running the Extract Package tool you should see the following in the directory you extracted to (in this case the .mpk file is in the same directory).

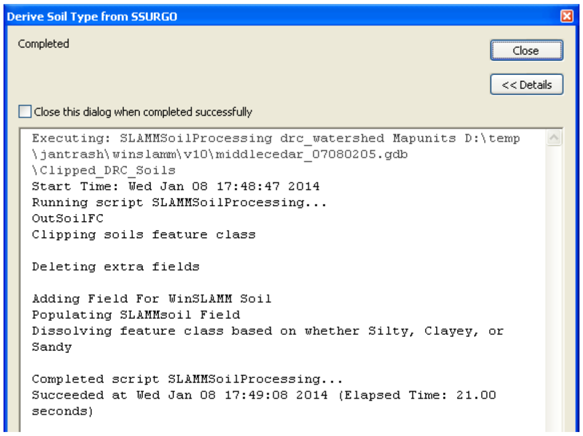


6. When looked at in ArcCatalog the v10 folder has a geodatabase which holds a geodatabase which holds two feature classes – Mapunits and Subbasin. The Mapunits feature class holds soil survey polygons with a large number of attributes including the hydgrpdcd (hydrological soil group). This attribute will be used by the *Derive Soil Type from SSURGO* tool to derive a new reclassified attribute called SLAMMSoil attribute which will hold values of silty, sandy, and clayey.
7. Open ArcMap and make sure that ArcToolbox is open and activated. Add the ArcSLAMM toolbox in the \tools directory by right-clicking, choosing Add Toolbox, navigating to the \tools directory which contains the toolbox, selecting it, and choosing Open.

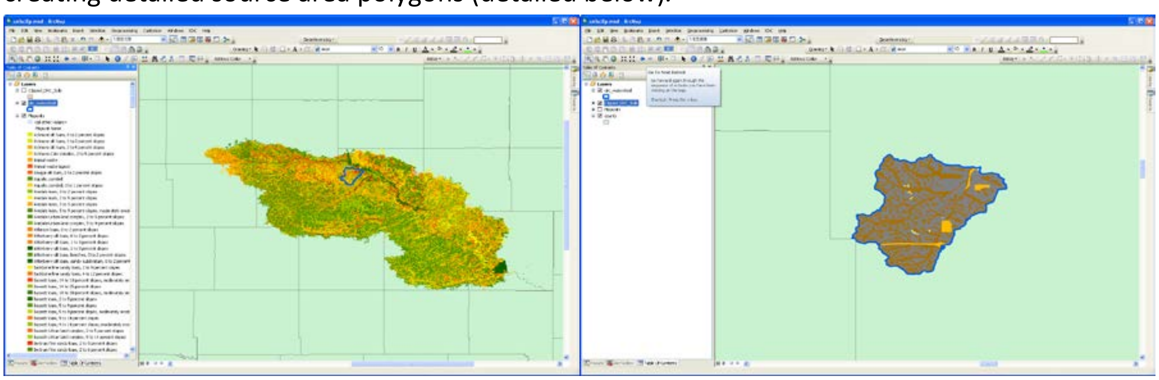


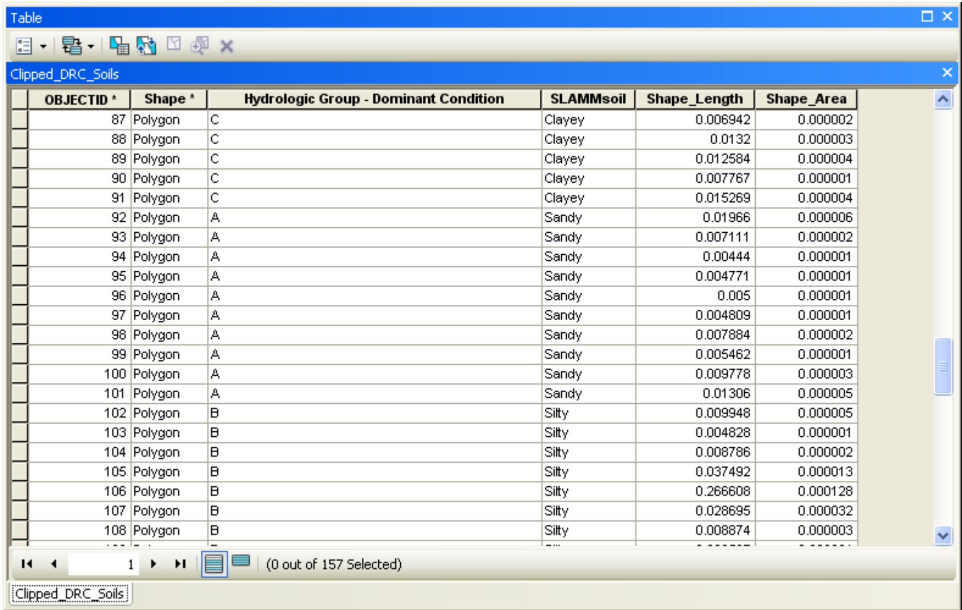
8. Double-click the Derive Soil Type from SSURGO tool from ArcSLAMM toolbox. Choose the polygon feature class which you want to use to clip the soils data (Area of Interest/Study Area (feature class)). Choose the soils feature class in the geodatabase you extracted from the .mpk file as the Input Soil Feature Class. Set the Output Feature Class Name and Location to either a directory or a file geodatabase where you want to store the data. You can store the new feature class in the same geodatabase that holds the original soils data. The clipped feature class will have the same spatial reference of the original data (GCS_North_American_1983 - WKID: 4269 Authority: EPSG).





9. After you run the tool the clipped soil layer with two soil related attributes in the table should be created and added to ArcMap. These two attributes: the Hydrologic Group – Dominant Condition (hygrpdcd) is an original attribute from the SSURGO data while the SLAMMSoil attribute holds the reclassified values of silty, sandy, and clayey which are required for WinSLAMM use. In the screenshots below the original SSURGO soils data, the clipped soils data, and the table demonstrating the fields after clipping.
10. **Warning:** It is likely that some polygons do not have a value for the original SSURGO attribute – Hydrologic Group – Dominant Condition (hygrpdcd). Thus they will not have a reclassified SLAMMSoil value which you need to help you create WinSLAMM source area polygon features. Thus it is up to the user to decide how to populate the SLAMMSoil attribute on their own before creating detailed source area polygons (detailed below).





Table

Clipped_DRC_Soils

OBJECTID *	Shape *	Hydrologic Group - Dominant Condition	SLAMMsoil	Shape_Length	Shape_Area
87	Polygon	C	Clayey	0.006942	0.000002
88	Polygon	C	Clayey	0.0132	0.000003
89	Polygon	C	Clayey	0.012584	0.000004
90	Polygon	C	Clayey	0.007767	0.000001
91	Polygon	C	Clayey	0.015269	0.000004
92	Polygon	A	Sandy	0.01966	0.000006
93	Polygon	A	Sandy	0.007111	0.000002
94	Polygon	A	Sandy	0.00444	0.000001
95	Polygon	A	Sandy	0.004771	0.000001
96	Polygon	A	Sandy	0.005	0.000001
97	Polygon	A	Sandy	0.004809	0.000001
98	Polygon	A	Sandy	0.007884	0.000002
99	Polygon	A	Sandy	0.005462	0.000001
100	Polygon	A	Sandy	0.009778	0.000003
101	Polygon	A	Sandy	0.01306	0.000005
102	Polygon	B	Silty	0.009948	0.000005
103	Polygon	B	Silty	0.004828	0.000001
104	Polygon	B	Silty	0.008786	0.000002
105	Polygon	B	Silty	0.037492	0.000013
106	Polygon	B	Silty	0.266608	0.000128
107	Polygon	B	Silty	0.028695	0.000032
108	Polygon	B	Silty	0.008874	0.000003

1 (0 out of 157 Selected)

Clipped_DRC_Soils

Digitizing/creating WinSLAMM compliant source area feature classes

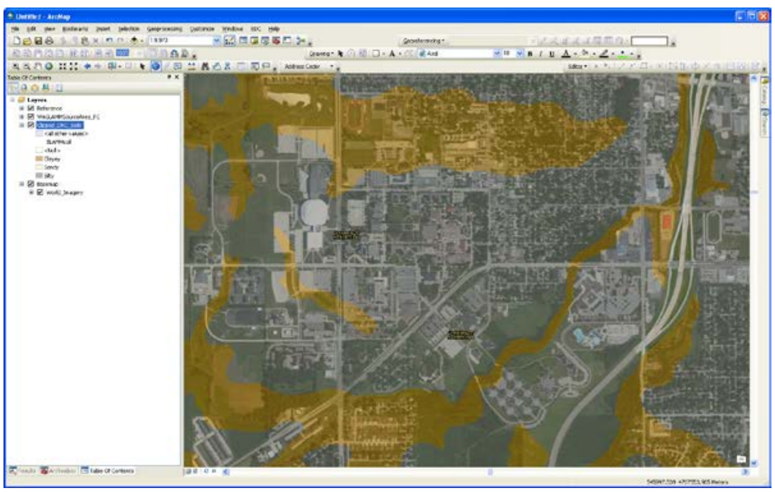
Having the soils feature class with sandy, silty, and clayey classification allows the user to move on to the steps necessary to create polygon features in the source area feature class in their copy of the customized geodatabase (WinSLAMMSourceArea.gdb). At this point we are going to give a short overview of steps to create and set attributes for source area polygons. This document will not provide highly detailed instructions on creating these features but will provide a basic overview of how to create features. To successfully populate a detailed source area feature class requires the user to have a basic understanding of editing in ArcMap including topological editing. Also, to fill in attributes properly requires the user to understand the concepts underlying the WinSLAMM source areas. You can seek help on these topic at http://winslamm.com/default.html and http://resources.arcgis.com/en/help/main/10.2/index.html#/What_is_editing/01m500000003000000/. In the \Documents folder of the ArcSLAMM package download, there is a document (SourceAreaFieldGuide.pdf) which provides information on the WinSLAMM source area types.

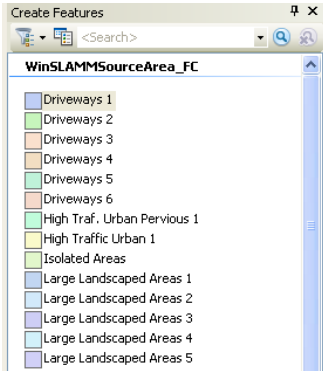
Before creating your own WinSLAMM source area features you should ***create a copy*** of the WinSLAMMSourceArea.gdb you downloaded for digitizing source areas. It is also likely you will want to rename the geodatabase to a more descriptive name for your study area. In addition, as mentioned previously ***you should change the spatial reference/coordinate system of the feature dataset*** to your local conditions. While digitizing you will also want to use, as referenced, the soils feature class created in steps above and high-resolution imagery for your study area. We are not giving precise instructions here regarding reprojecting data to the coordinate system of your choice but it is likely you should do so.

It is ***highly recommended*** that you reproject the WinSLAMMSourceArea_FC in your copy of the WinSLAMMSourceArea.gdb to the projection/spatial reference that is best suited for your study area.

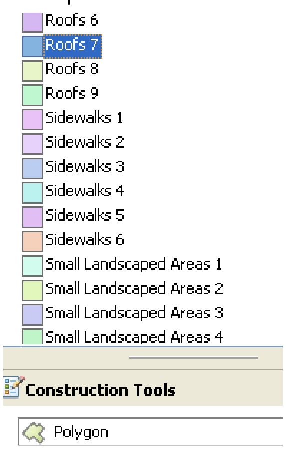
You can do this by right-clicking on the WinSLAMMSourceArea_FDS, choosing Properties, and XY Coordinate System tab and then choosing the system you would like to use. As the base geodatabase is distributed the WinSLAMMSourceArea_FC has no features in it and is in the NAD_1983_UTM_Zone_15N coordinate system (used in Iowa).

The steps immediately below give a short example of how to create source area polygons and set the proper attributes for these features. Again, these steps assume you have made a copy of the geodatabase and reprojected the feature dataset (and contained feature class) to a local coordinate system. They also assume that you have some base imagery to use for digitizing features on-screen.

1. Open a new ArcMap document and add the reprojected WinSLAMMSourceArea_FC feature class from your copied geodatabase (add this one first), the imagery you would like to use, and the soils feature class with the SLAMMSoil attribute. It is a good idea to symbolize the soils data with the SLAMMSoil attribute. In the example below we have symbolized that way and have 50% transparency. In this view, there are silty (gray) and clayey soils (orange/brown).

2. Zoom into an area to digitize. For the detailed digitizing necessary, you will want to be zoomed to a level (e.g. ~1:500-1:1000) where you can capture the level of detail necessary.
3. Add the Editor toolbar in ArcMap (Customize – Toolbars – Editor) and choose Editor – Start Editing. Choose the WinSLAMMSourceArea_FC to edit and click OK>.
4. Open the Create Features window.  You should see that in that window you have the list of potential source areas.

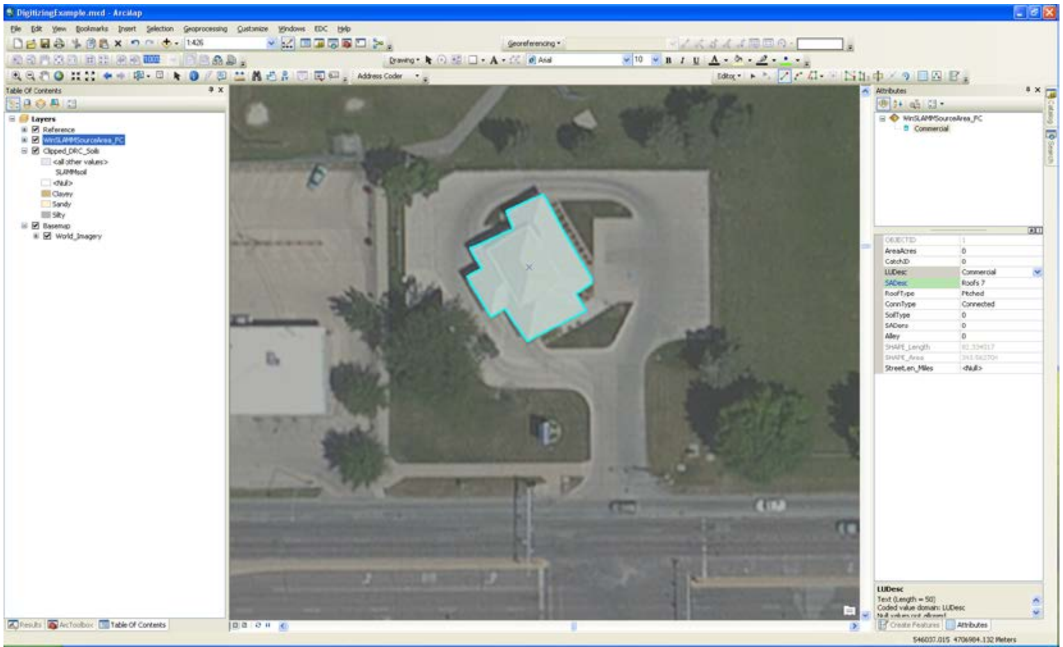


5. When creating an independent polygon (i.e. in this case the first polygon or one that is not going to share an edge with an existing polygon at time of polygon creation) choose the correct source area type and click Polygon. In the example below we are going to create a polygon of Roofs 7 source area polygon. The description of Roofs 7 is shown from the SourceAreaFieldGuide below. So in the WinSLAMM system, Roofs 7 represents a building with a pitched roof that is connected to impervious areas.



6. Digitize the polygon.

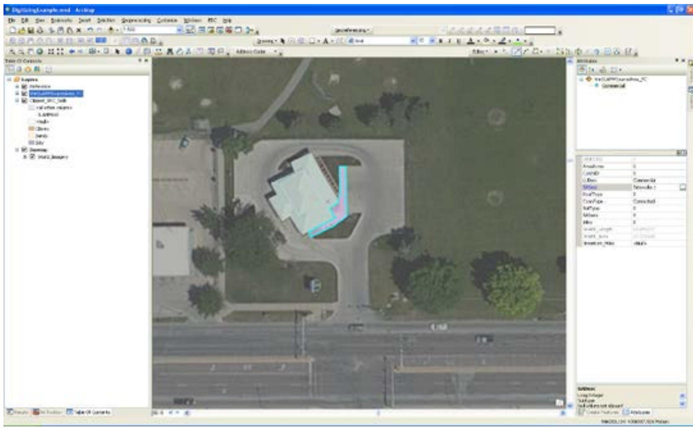
7. Open the Attributes window  . When you choose the source area type and then digitize the polygon, the other WinSLAMM required attributes (RoofType, Connected, SoilType, SADens, Alley) are automatically populated based on the domains/subtypes built into the geodatabase. However, the LUDesc (Residential, Institutional, Industrial, Commercial, Other Urban) must be set. In this example, we have digitized a bank building setting it as a Roofs 7 (a connected building with a pitched roof that is in Commercial land use).



8. When creating a polygon with a shared edge choose the source area type and then choose Auto Complete Polygon construction tool. 

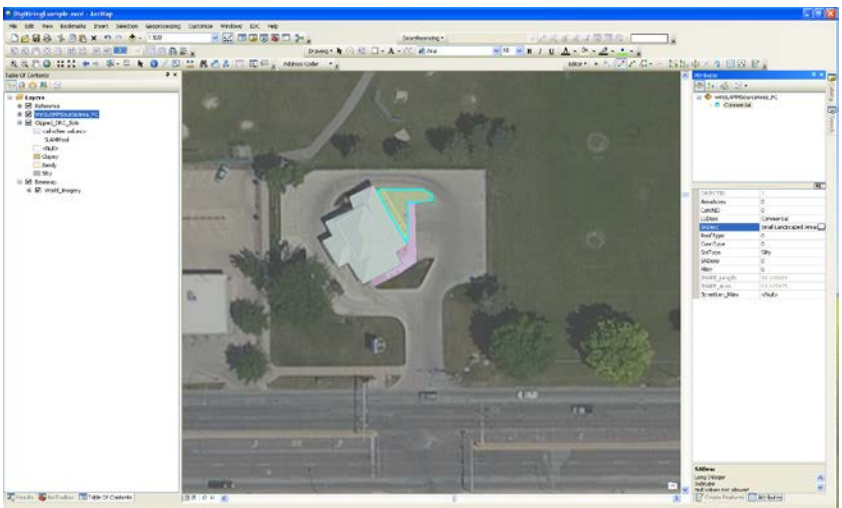
. By using this tool you ensure that the topological integrity will be enforced. When using this tool you want to start and end your digitizing within the existing polygon that will share the edge with polygon you are digitizing.

9. Digitize the polygon and then open the Attributes window. In this example we have digitized a polygon with Sidewalks 1 source area polygon (Connected) again in commercial land use.



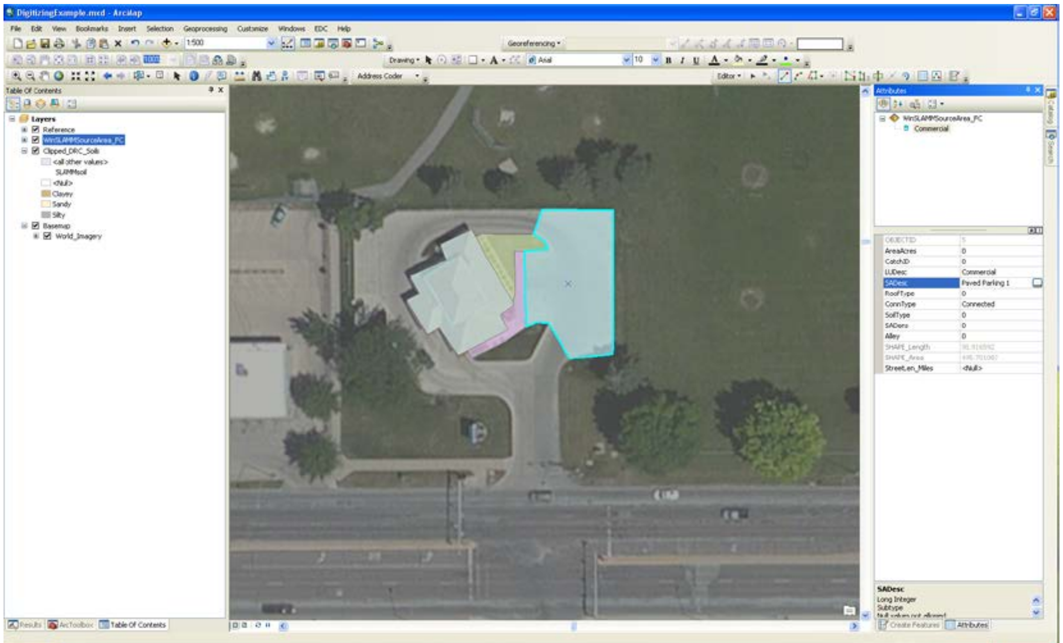
OBJECTID	5
AreaAcres	0
CatchID	0
LUDesc	
SADesc	Sidewalks 1
RoofType	0
ConnType	Connected
SoilType	0
SADens	0
Alley	0
SHAPE_Length	62.148968
SHAPE_Area	62.199352
StreetLen_Miles	<Null>

10. In the next screenshot we have created a polygon which is the source area Small Landscaped Areas 2 (disconnected, silty soil) in commercial land use.

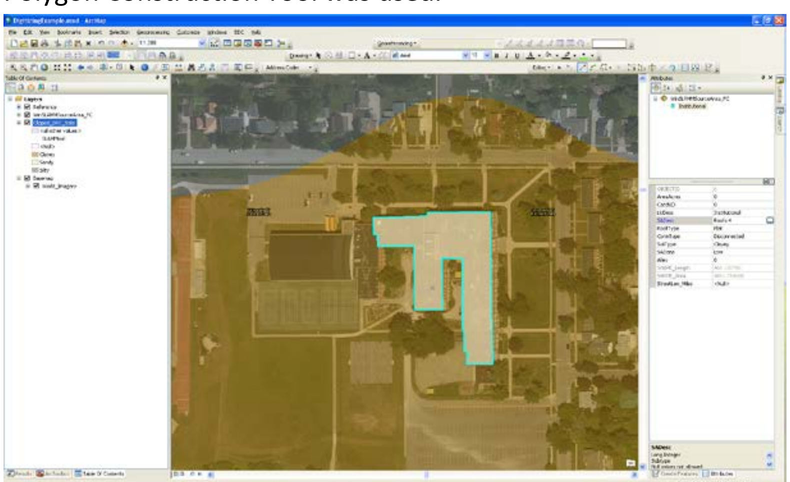


OBJECTID	3
AreaAcres	0
CatchID	0
LUDesc	Commercial
SADesc	Small Landscaped Area:
RoofType	0
ConnType	0
SoilType	Silty
SADens	0
Alley	0
SHAPE_Length	50.160689
SHAPE_Area	83.165475
StreetLen_Miles	<Null>

11. In the next screenshot we have created a polygon which is Paved Parking 1 (connected) in commercial land use. For each of these last three polygons we used the Auto Complete Polygon construction tool.



12. In the example below we have digitized a high school building in an area of clayey soils. This building is mainly surrounded by grass and is an area without a lot of other buildings around. Thus we have chosen a source area type of Roofs 4 (flat roof, disconnected, clayey soil, and low source area density) and Institutional. As this was created without any shared boundary the Polygon Construction Tool was used.



OBJECTID	6
AreaAcres	0
CatchID	0
LUDesc	Institutional
SADesc	Roofs 4
RoofType	Flat
ConnType	Disconnected
SoilType	Clayey
SADens	Low
Alley	0
SHAPE_Length	468.133786
SHAPE_Area	4881.754655
StreetLen_Miles	<Null>

13. While digitizing your detailed source area features you should use tools from the Topology toolbar () to interactively check for any topological errors. This is an ongoing process during your digitizing process.
14. In addition you should check for attribute errors – especially double-checking that you have identified the LUDesc class for each polygon feature created.
15. After digitizing all polygons in your study area you can go on to utilize the ArcSLAMM tools below. In the steps below we use a detailed digitized source area feature class for Cedar Falls, Iowa.

ArcSLAMM Practice/Demonstration Steps

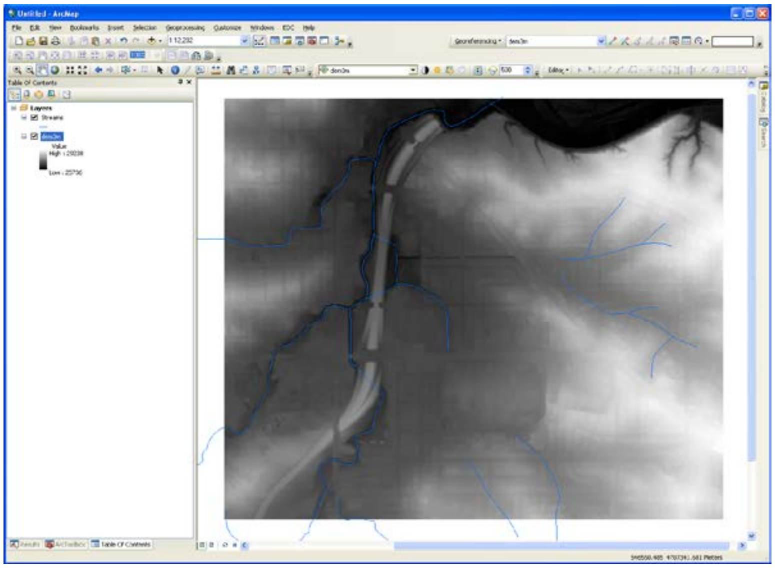
This section will provide example steps to carry out a full modeling effort using ArcSLAMM and WinSLAMM for a detailed source area feature class. In this example we are using an area of Cedar Falls, Iowa in which several thousand features (~1000 acres) of detailed source areas have been digitized. These features are stored in the ArcSLAMM_CFExample.gdb\SourceArea_CF\WinSLAMMSourceArea_FCImport feature class that was delivered in the ArcSLAMM package in the \example_data directory.

The first set of tools used under the *Elevation and Catchment Area Tools* toolbox are optional and if you already have defined drainage areas/catchments than you can skip them.

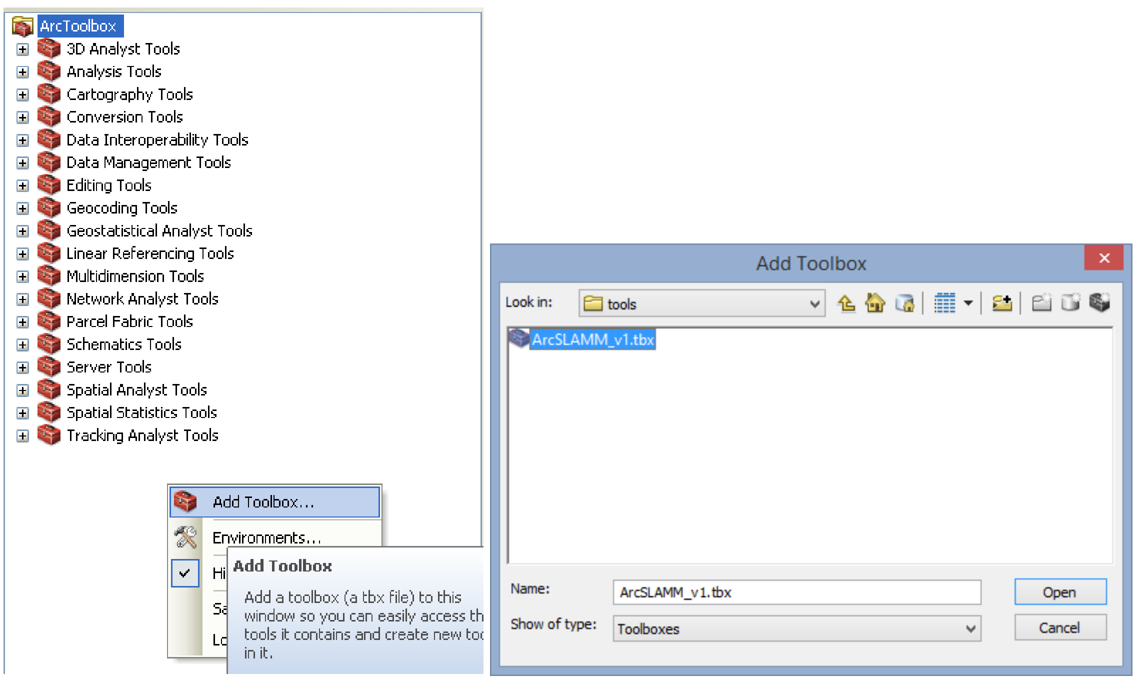
Before altering any data in any way it is a good idea to create a backup copy of the entire download package.

Hydrologically Enforce DEM

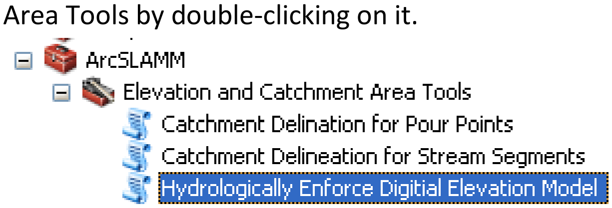
16. This is a step that does not need to be carried out if you already have a hydrologically enforced DEM.
17. Open ArcMap and add the \data\example_data\dem3m raster dataset as well as the \data\example_data\Streams.shp. The dem3m raster is a DEM derived from LiDAR data in Iowa and downloaded from the Iowa Department of Natural Resources.



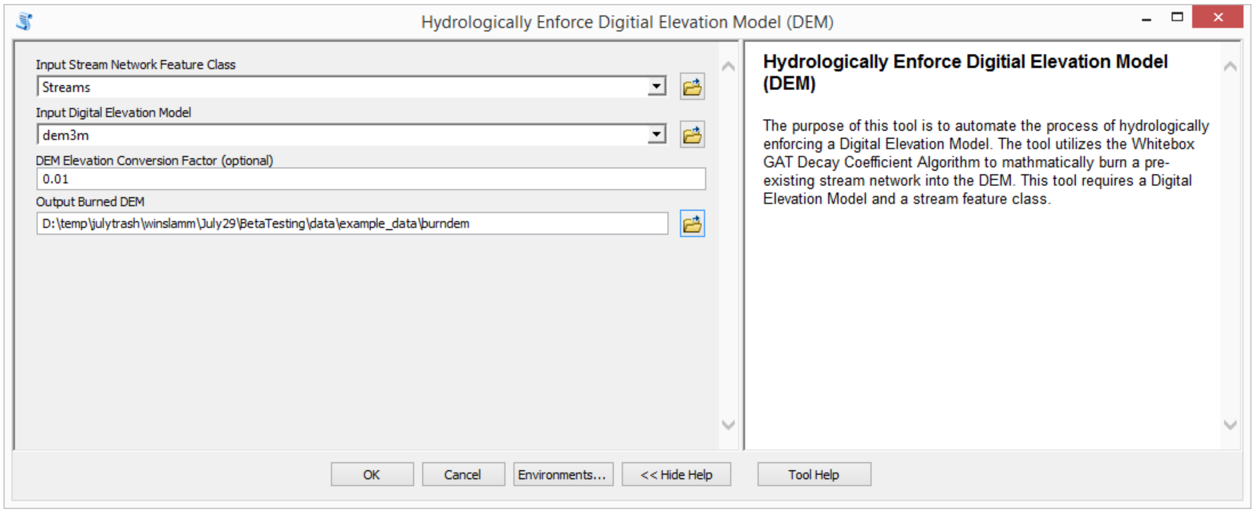
18. Save the .mxd file as with a name you choose in a location of your choice. Here it has been saved as DemoTest_1.mxd.
19. With ArcToolbox open in ArcMap add the ArcSLAMM toolbox from the \tools folder by right-clicking, choosing Add Toolbox, navigating to the \tools directory which contains the toolbox, selecting it, and choosing Open.



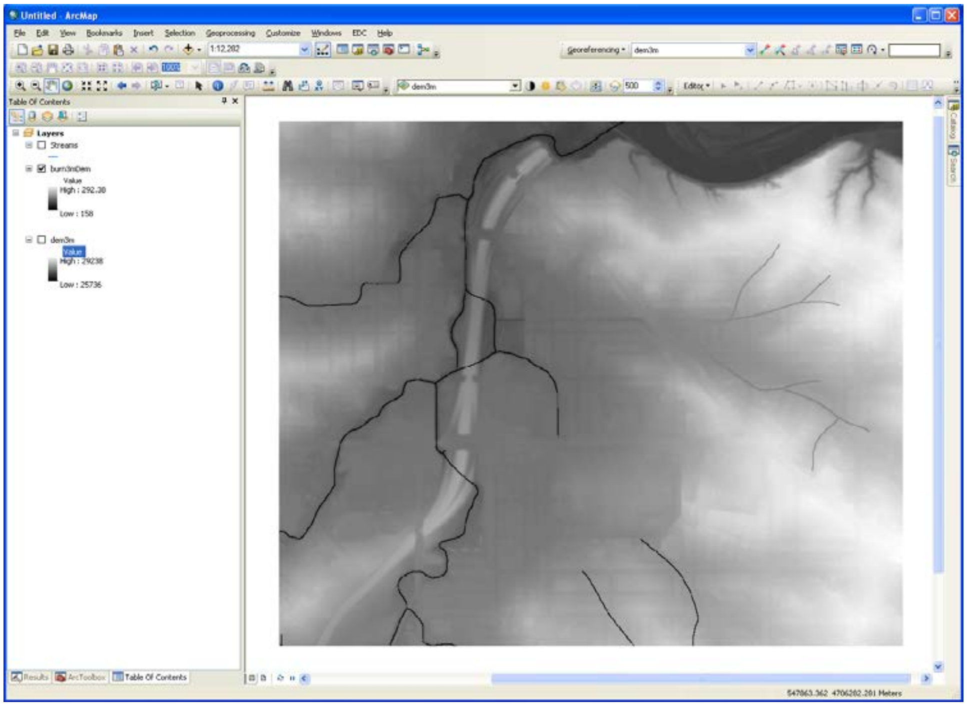
20. Open the Hydrologically Enforce Digital Elevation Model tool in the Elevation and Catchment Area Tools by double-clicking on it.



21. Fill in the first three parts of the tool dialog as seen below. We are choosing the Steams layer we added and the DEM we added. We set the DEM Elevation Conversion Factor to 0.01 because in this case our DEM (derived from Iowa LiDAR data) has elevation units in centimeters while the horizontal units of our coordinate system are meters (NAD 1983 UTM Zone 15N).



22. For the Output Burned DEM parameter, navigate to where you want to store the new DEM that is going to be created. In this example I named it burndem and stored it in same directory as the original DEM (see above). This new 'burned' DEM will be used as the hydrologically enforced DEM going forward. You can choose where you want to put it. When you have parameterized the tool dialog click OK to run the tool.
23. If the tool successfully runs you should have a new DEM which has had streams burned into it added to your ArcMap document. The purpose of this is to attempt to make sure that the DEM will not have any artificial blockages. It is common, especially with LiDAR data, to have situations in which the DEM does not capture things like culverts going under roads which will then block water flow in any hydrological functions using that DEM.

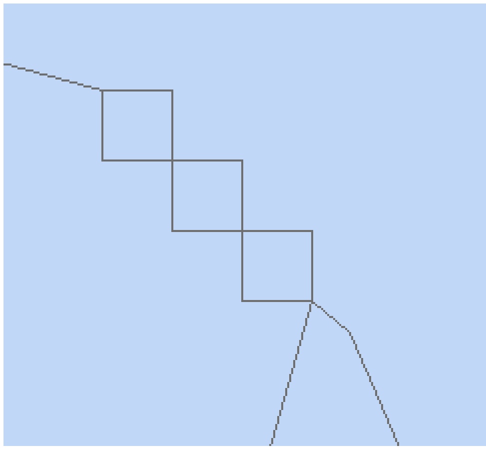


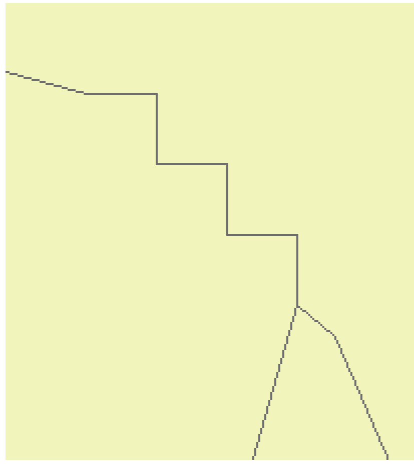
Catchment delineation for Stream Segments

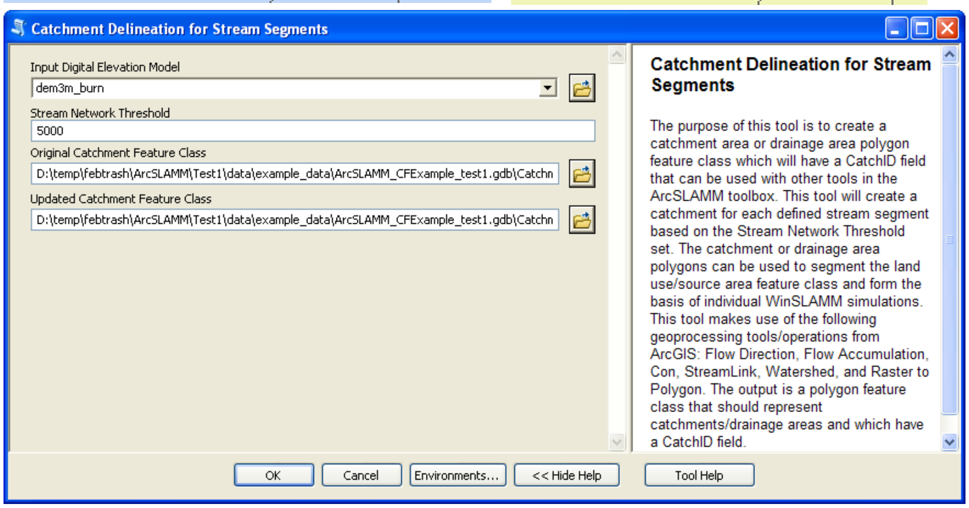
24. The purpose of this tool is to delineate drainage area/catchment boundaries for partitioning up the study area for WinSLAMM modeling. If you already have your drainage area/catchment boundaries defined than you don't need to carry out this step. This specific tool is meant to break up the entire study area into drainage/catchment areas based on a drainage area size threshold. If you only want to delineate drainage area/catchment boundaries for specific outlet points skip to the next tool (*Catchment Delineation for Pour Points).*
25. Open the Catchment Delineation for Stream Segments tool and parameterize as follows

   a. Input Digital Elevation Model – output burned DEM from Step 5 above or an equivalent from your own source.
   b. Stream Network Threshold – in this case set the value to 5000. This means that each catchment derived will be approximately 5000 cells so the application will produce catchments that are approximately 45,000 sq. meters (~11 acres).
   c. Original Catchment Feature Class – navigate to where you want to store this feature class which will be a polygon feature class representing catchments. This feature class will not be edited to remove very small catchment areas. It might be a good idea to put it in the same geodatabase that holds the source area feature class being used in this example - i.e. \example_data\ArcSLAMM_CFExample.gdb. Named Catchments5000 here.
   d. Updated Catchment Feature Class – navigate to where you want to store this feature class which will be a polygon feature class representing catchments. This feature class

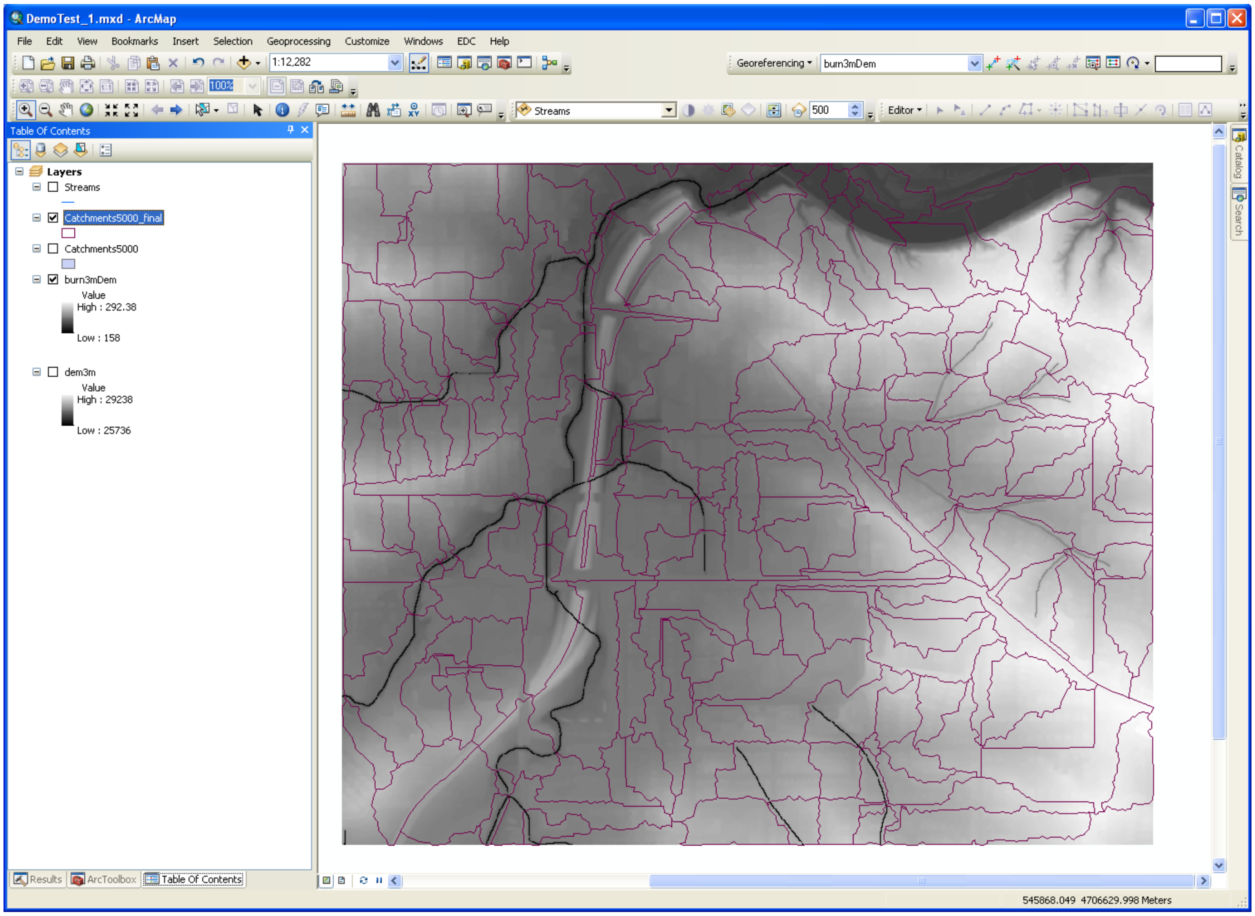
will be a copy of the Original Feature Class which has been edited to remove or merge very small sliver polygons into larger catchment polygons (In screenshots below the Original Catchment Feature Class has had small polygon considered catchments which are removed in the Updated Catchment Feature Class). Named Catchments5000Final.





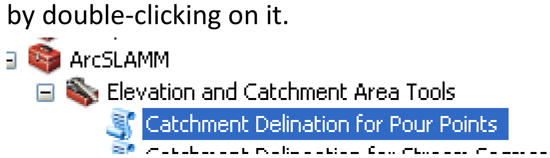


26. The two catchment feature classes are added to the map. The second one has small catchment polygons dissolved into larger neighboring polygons (threshold is approximately < 0.25 acres). Screenshot below shows the second one displayed over the burned DEM. This catchment feature class can be used later with the *Intersect Catchments with WinSLAMM Detailed Source Areas* tool.



Catchment delineation for Pour Points

27. With this tool you are also going to derive catchment boundaries but in this case only for designated areas that drain to outlet points.
28. With the .mxd from above add the \data\example_data\PourPts.shp
29. Open the Catchment Delineation for Pour Points tool in the Elevation and Catchment Area Tools by double-clicking on it.

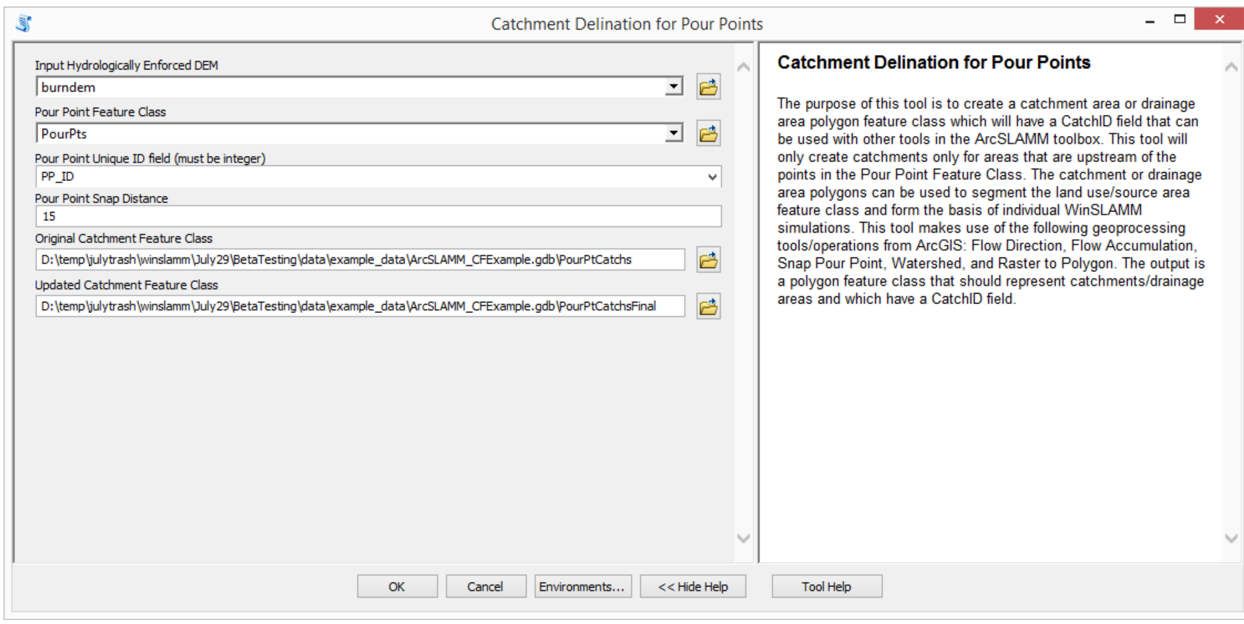


30. Populate the tool dialog as follows:
    a. Input Hydrologically Enforced DEM – the burned DEM created in steps above.
    b. Pour Point Feature Class – this should be a feature class that represents outlets for drainage areas that you want to calculate boundaries for. In this example use PourPts.shp added to map in step above.
    c. Pour Point Unique ID Field – this is the unique identifier associated with pour point that will be carried through to the catchment and on through the WinSLAMM modeling process. This must be an integer field. In this example choose PP_ID.

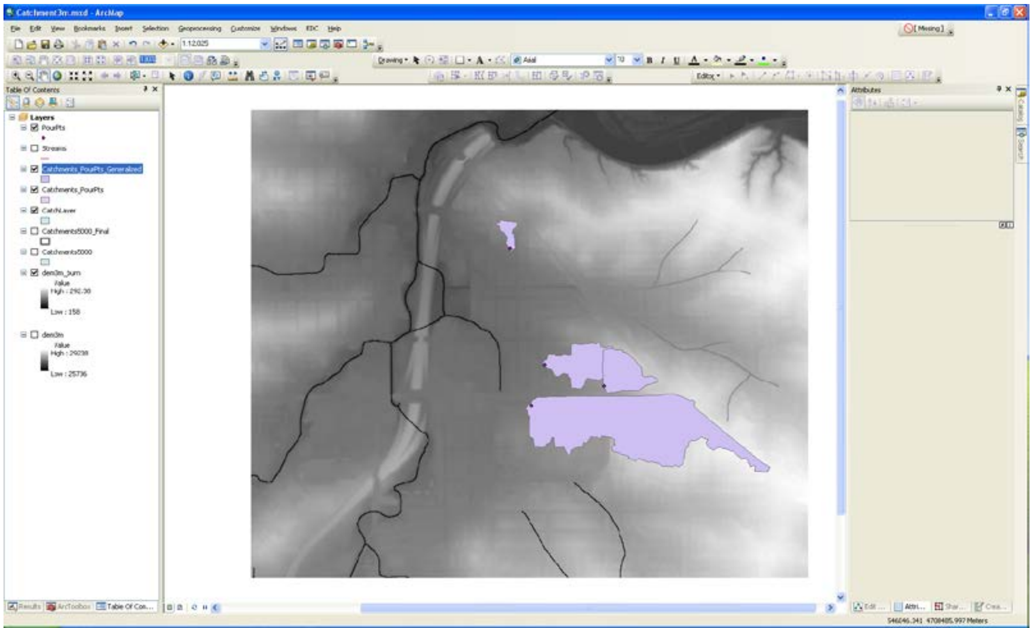
d. Pour Point Snap Distance – this is a parameter that serves as a search tolerance to move the pour point to an area of high accumulated flow. The tool will look for the cell with the highest level of flow accumulation within the radius specified and use this as the outlet of the catchment to be derived. The unit is the same as the horizontal unit of the DEM. In this case set it to 15 (units are meters). *This parameter can affect the area defined as a drainage area so you might need to use trial and error to decide the correct distance.*

e. Original Catchment Feature Class – this is the catchment feature class (drainage area for the outlet point) that will be created for the pour points. You could place this feature class where you like and name it what you want. In our case we are naming it Catchment_PourPts and putting it in \example_data\ArcSLAMM_CFExample.gdb.

f. Updated Catchment Feature Class – this is a copy of the catchment feature class above but with any small sliver type polygons removed (see description in Step 9 above). This is likely the catchment feature class that you will move forward with to later modeling steps. We have named this Catchments_PourPts_Generalized.

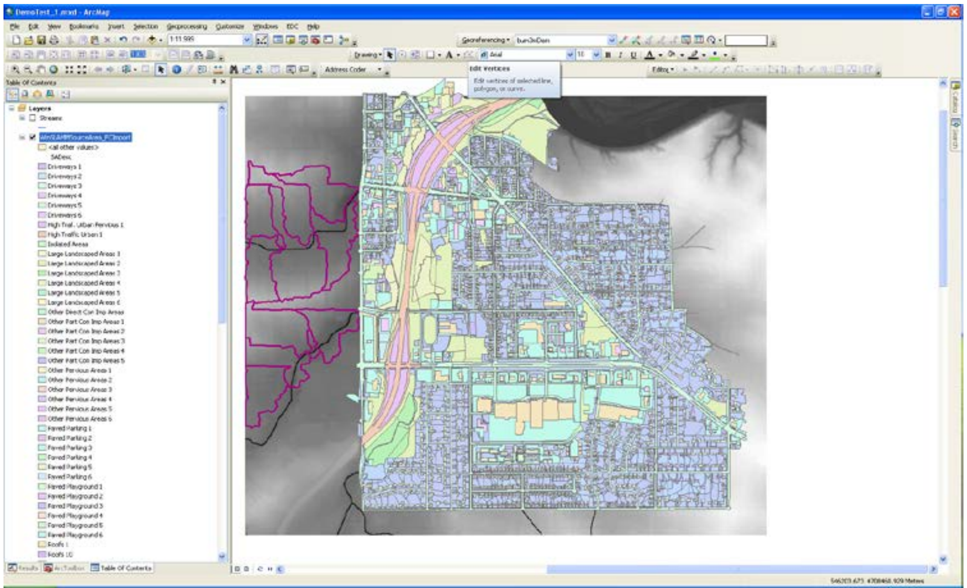


31. After running the tool two catchment feature classes are added to the map. The second one (Catchment_PourPts_Generalized) has small catchment polygons dissolved into larger neighboring polygons (threshold is approximately < 0.25 acres). Screenshot below shows the second one displayed over the burned DEM.

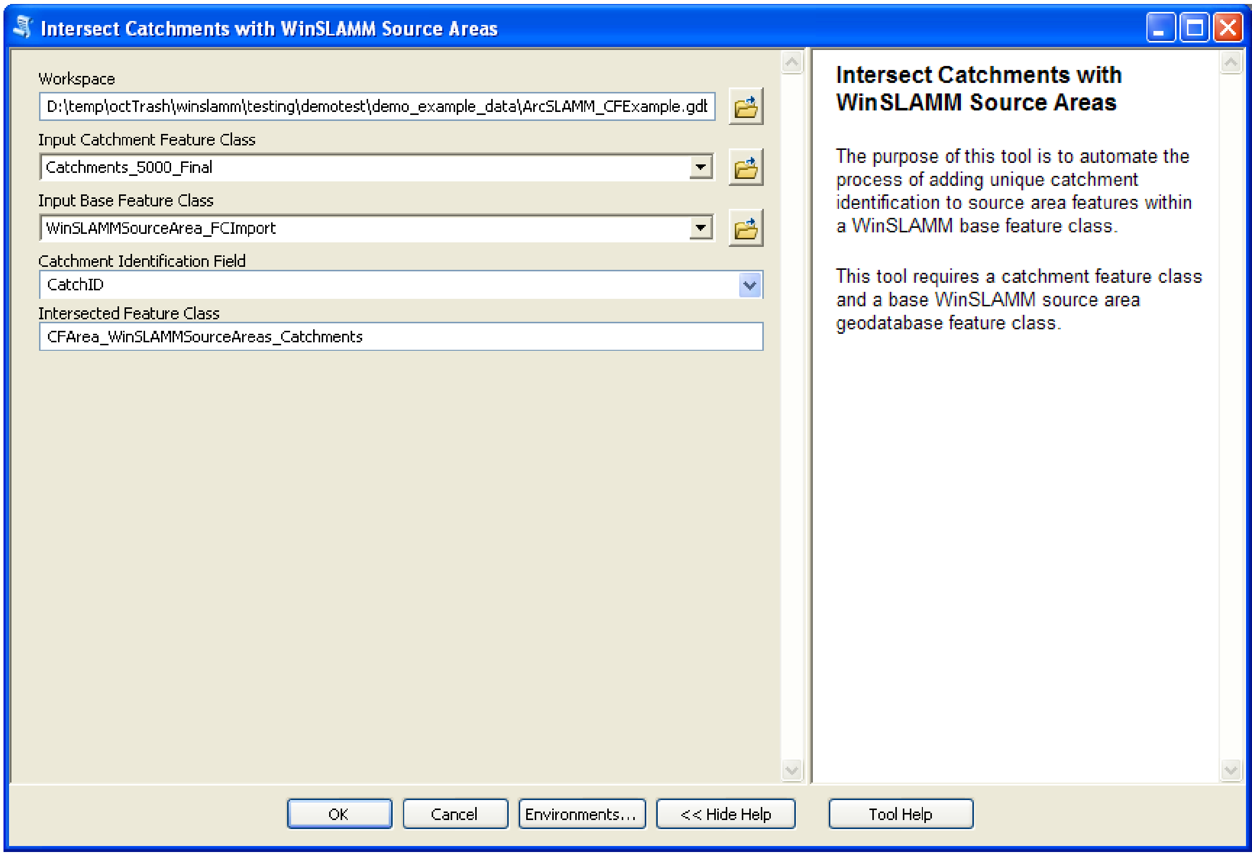


Intersect Catchments with WinSLAMM Source Areas

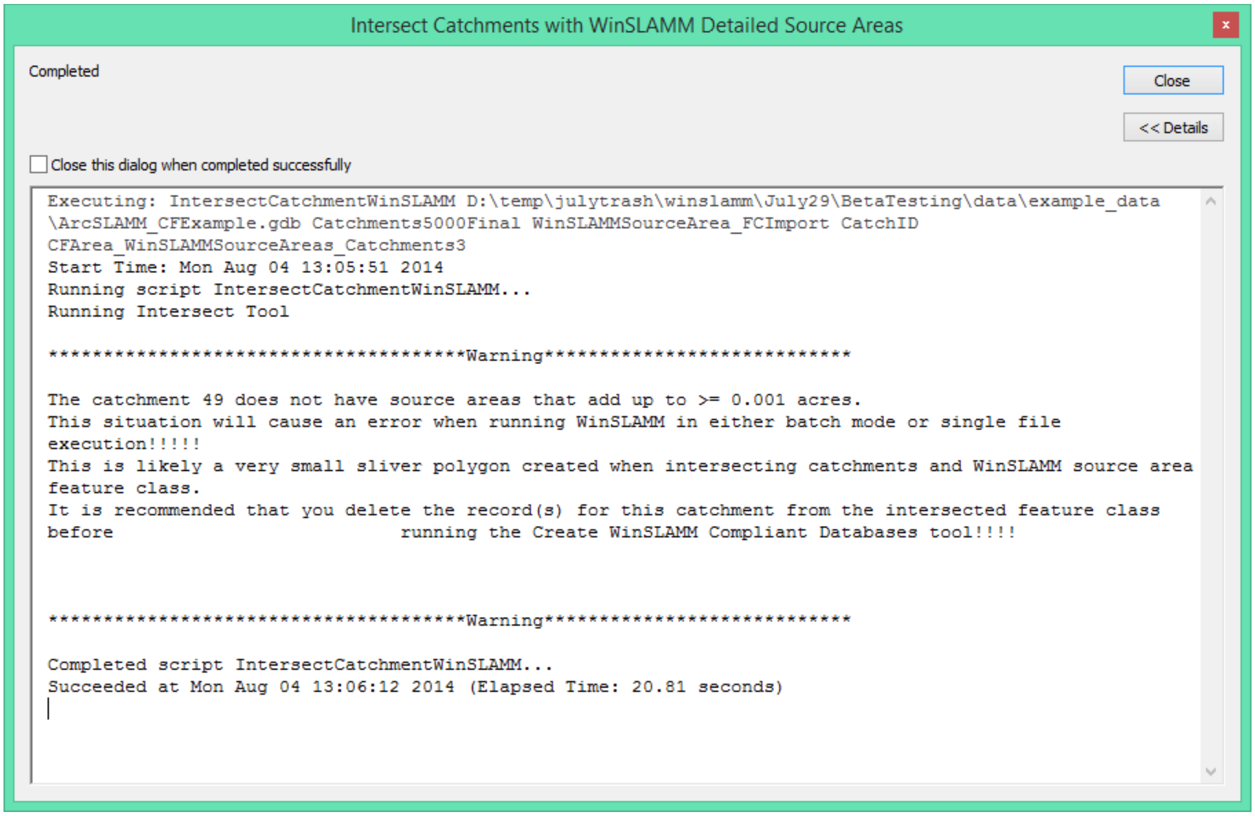
32. The purpose of this step is to intersect the catchments with the detailed WinSLAMM source areas that have been digitized for WinSLAMM modeling. This is a step necessary in order to prepare for the creation of a WinSLAMM compliant database for each drainage area/catchment using the C*reate WinSLAMM Compliant Databases* tool.
33. Add the WinSLAMMSourceArea_FCImport feature class from \data\example_data\ArcSLAMM_CFExample.gdb\WinSLAMMSourceArea. This feature class has detailed digitized features which have WinSLAMM source area classes created using the custom intelligent file geodatabase. Also add in the catchment feature class you want to use moving forward. In this case we are using the Catchment_5000_Final feature class we created in steps above. ***This would be a good time to double check that you have no missing attributes in the detailed source area feature class***. ***Any errors in this database will carry through and cause problems later. A common error would be a missing land use type for a given polygon.***



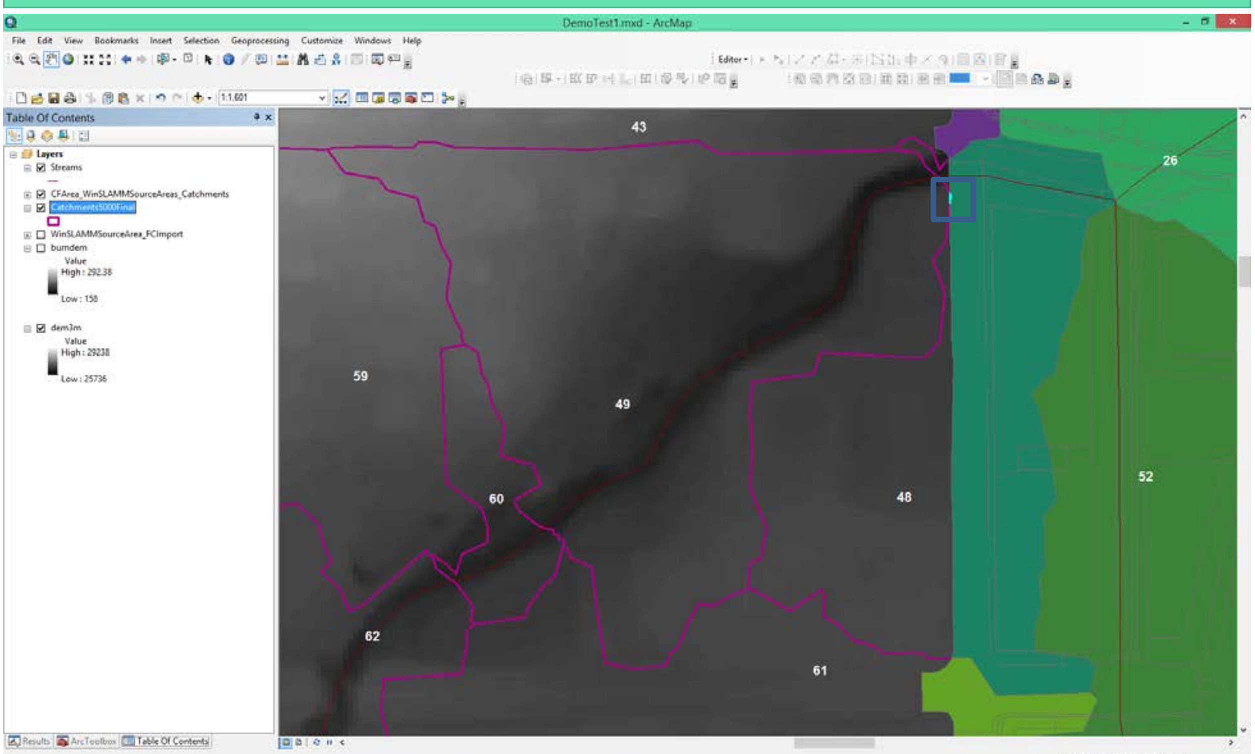
34. Open the *Intersect Catchments with WinSLAMM Source Areas* tool and parameterize as follows
    a. Workspace – set it equal to the geodatabase which contains the feature dataset which contains your feature class of source areas shown above. In our example it is..\data\example_data\ArcSLAMM_CFExample.gdb.
    b. Input Catchment Feature Class – this is the feature class which was created using either the *Catchment Delineation from Stream Segments* or *Catchment Delineation for Pour Points* tools. We are using the one called Catchments5000Final created using the *Catchment Delineation from Stream Segments* tool.
    c. Input Base Feature Class – this is the detailed WinSLAMM source areas feature class that is shown in Figure above. In this example it is called WinSLAMMSourceArea_FCImport.
    d. Catchment Identification Field – this is the field that holds a unique identifier from the catchment feature class identified in b. above. In this case we are using the CatchID field. The unique identifiers held in this field will be carried through to the WinSLAMM databases and used to join WinSLAMM outputs back.
    e. Intersected Feature Class – this should be the name of the feature class that is going to be created and will be placed in the Workspace indicated in a. above. In our case we are naming it CFArea_WinSLAMMSourceAreas_Catchments.



35. It is possible that you will get a warning message during the execution of the *Intersect Catchments with WinSLAMM Detailed Source Areas* if you have a drainage area/catchment that has very small area (see screenshot below). This is usually due to a situation where the catchment is much larger than your digitized source area. In the second screenshot below we see in our example that CatchID = 49 is mainly outside of the digitized source areas. In this case there is just a tiny sliver of the catchment which intersects the digitized source areas. As the warning message says you should delete the record(s) for this catchment as if you continue forward with it there will be problems with WinSLAMM. So using the editing functionality in ArcMap delete those records (3rd screenshot below).

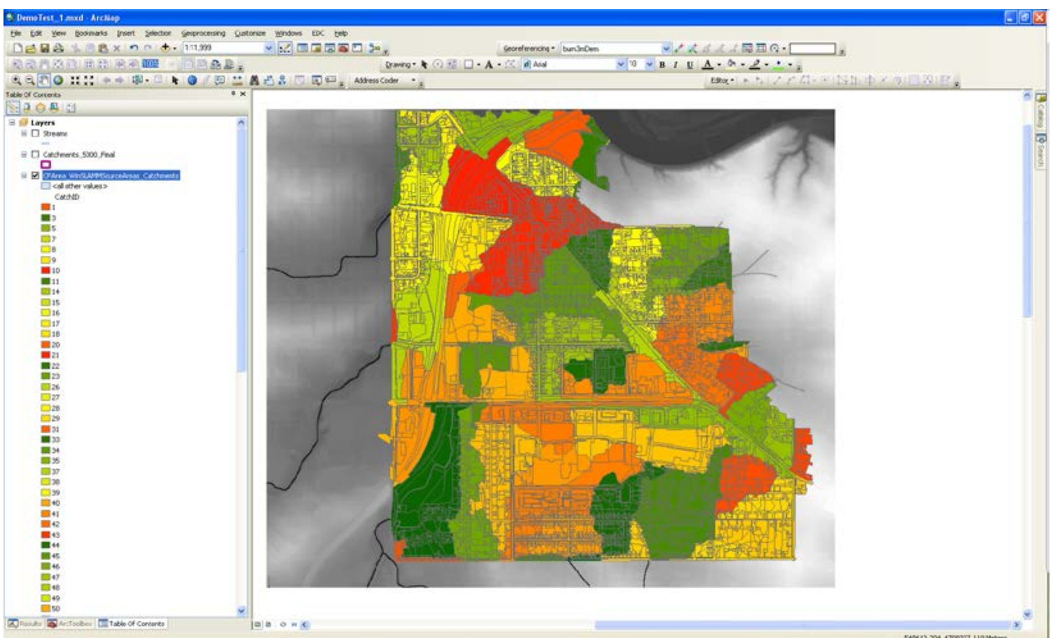


Intersect Catchments with WinSLAMM Detailed Source Areas
Completed
Close
<< Details
Close this dialog when completed successfully
Executing: IntersectCatchmentWinSLAMM D:\temp\julytrash\winslamm\July29\BetaTesting\data\example_data \ArcSLAMM_CFExample.gdb Catchments5000Final WinSLAMMSourceArea_FCImport CatchID CFArea_WinSLAMMSourceAreas_Catchments3
Start Time: Mon Aug 04 13:05:51 2014
Running script IntersectCatchmentWinSLAMM...
Running Intersect Tool
**************************************Warning****************************
The catchment 49 does not have source areas that add up to >= 0.001 acres.
This situation will cause an error when running WinSLAMM in either batch mode or single file execution!!!!!
This is likely a very small sliver polygon created when intersecting catchments and WinSLAMM source area feature class.
It is recommended that you delete the record(s) for this catchment from the intersected feature class before running the Create WinSLAMM Compliant Databases tool!!!!
**************************************Warning****************************
Completed script IntersectCatchmentWinSLAMM...
Succeeded at Mon Aug 04 13:06:12 2014 (Elapsed Time: 20.81 seconds)



DemoTest1.mxd - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
Table Of Contents
Layers
Streams
CFArea_WinSLAMMSourceAreas_Catchments
Catchments5000Final
WinSLAMMSourceArea_FCImport
burndem
Value
High : 292.38
Low : 158
dem3m
Value
High : 29238
Low : 25736
43
26
59
49
60
48
52
62
61

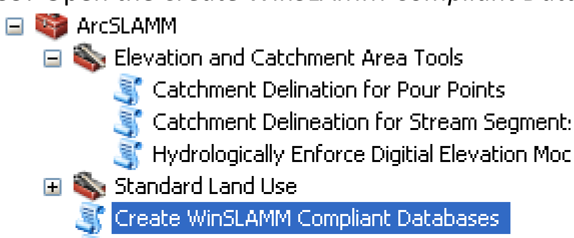
36. If you haven't already done so, add the resulting layer to the .mxd document and symbolize it with unique values using the CatchID field you will see that the intersected layer will look like the screenshot below.



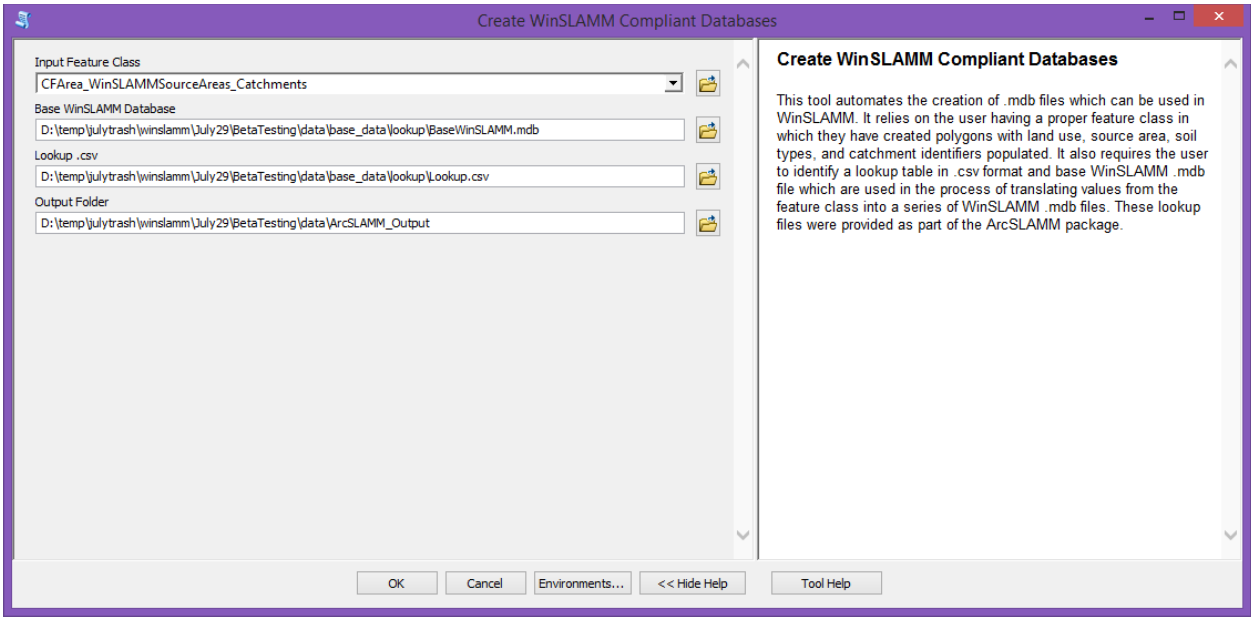
Create WinSLAMM Compliant Databases

37. The purpose of this step is to create individual unique WinSLAMM compliant databases containing summarized source area information for each unique drainage area/catchment in the study area. The tool uses the intersected feature class created from steps above as well as a base WinSLAMM database and a lookup table use to translate to the necessary WinSLAMM details.

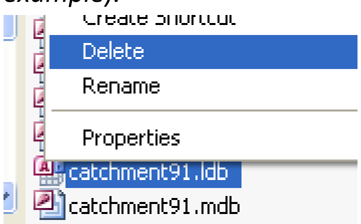
38. Now you have a feature class that is ready to move forward to preparing WinSLAMM compliant databases that can be used. Before moving on with this tool it is a good idea to create a separate directory to hold the files that will be created. In this case we have created a directory called ArcSLAMM_Output in \data directory.
39. Open the *Create WinSLAMM Compliant Databases* tool.

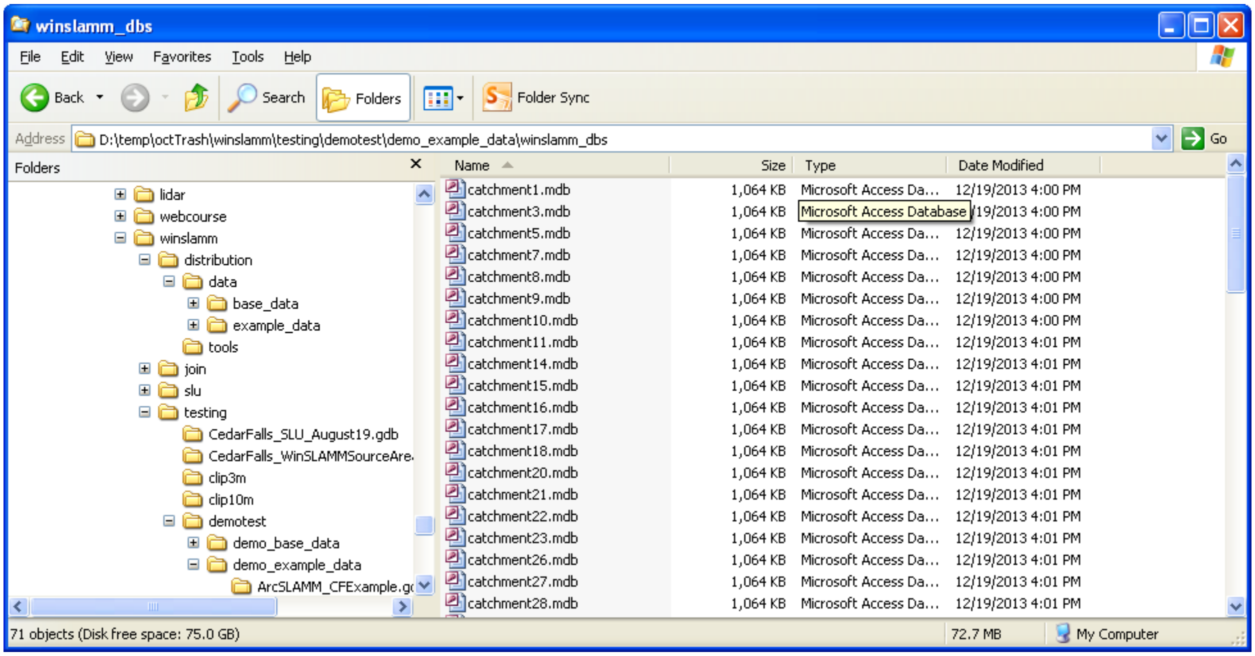


40. Parameterize the tool as follows:
    a. Input Feature Class – choose the intersected feature class that was created from running the *Intersect Catchments with WinSLAMM Source Areas* directly above (in this example called CFArea_WinSLAMMSourceAreas_Catchments.
    b. Base WinSLAMM Database – this is a version of a WinSLAMM datbabase (an .mdb file) that will be copied and populated by this tool with source area values from the feature class from figure above. You should use the database from base_data\lookup\BaseWinSLAMM_10_1.mdb or a copy of that file which has been modified for your particular location/situation. ***Warning: A copy of this file should have been made in advance of this step in order to save changes like the Pollutants being modeled, the rainfall or other files or other parameters that are being used for your particular modeling situation. This base file will be used as a base for each database file created with the land use/source areas being read from the intersected feature class. So you should make changes to the base WinSLAMM database prior to running the Create WinSLAMM Compliant Databases tool so those are stored in each database file created with this tool.***
    c. Lookup .csv – this is a .csv file which holds lookup values to translate from values in the feature class from figure above to the exact formats necessary in the WinSLAMM compliant databases being created as output from this tool - …base_data\lookup\Lookup.csv.
    d. Output Folder – this should be an empty folder where you want to write the WinSLAMM database files. In this case we are using a folder called \ArcSLAMM_Output. When you run the tool it might take a few minutes as it is creating a database for every unique catchment. In the example shown, 70 unique catchments had databases created and it took approximately 3 minutes.



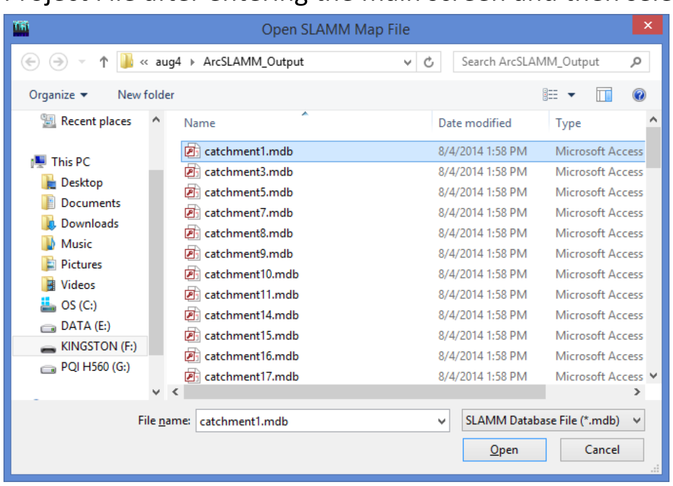
41. After running the tool you should see a set of output .mdb files (69 in this example) in the directory you indicated in dialog above (see below). ***Warning:*** *There is a known issue after running the Create WinSLAMM Compliant Databases tool. The ArcSLAMM tool (ArcGIS) creates a lock file and holds on to that file after it creates the last database. In the small screenshot below you can see that there is a file called catchment91.ldb, in addition to the catchment91.mdb file. If this .ldb file is not deleted it will raise an error in WinSLAMM if you try run using the associated .mdb file. To work around this issue you should close ArcMap at this point and then go to Windows Explorer and manually delete the file with the .ldb extension (catchment91.ldb in this example).*



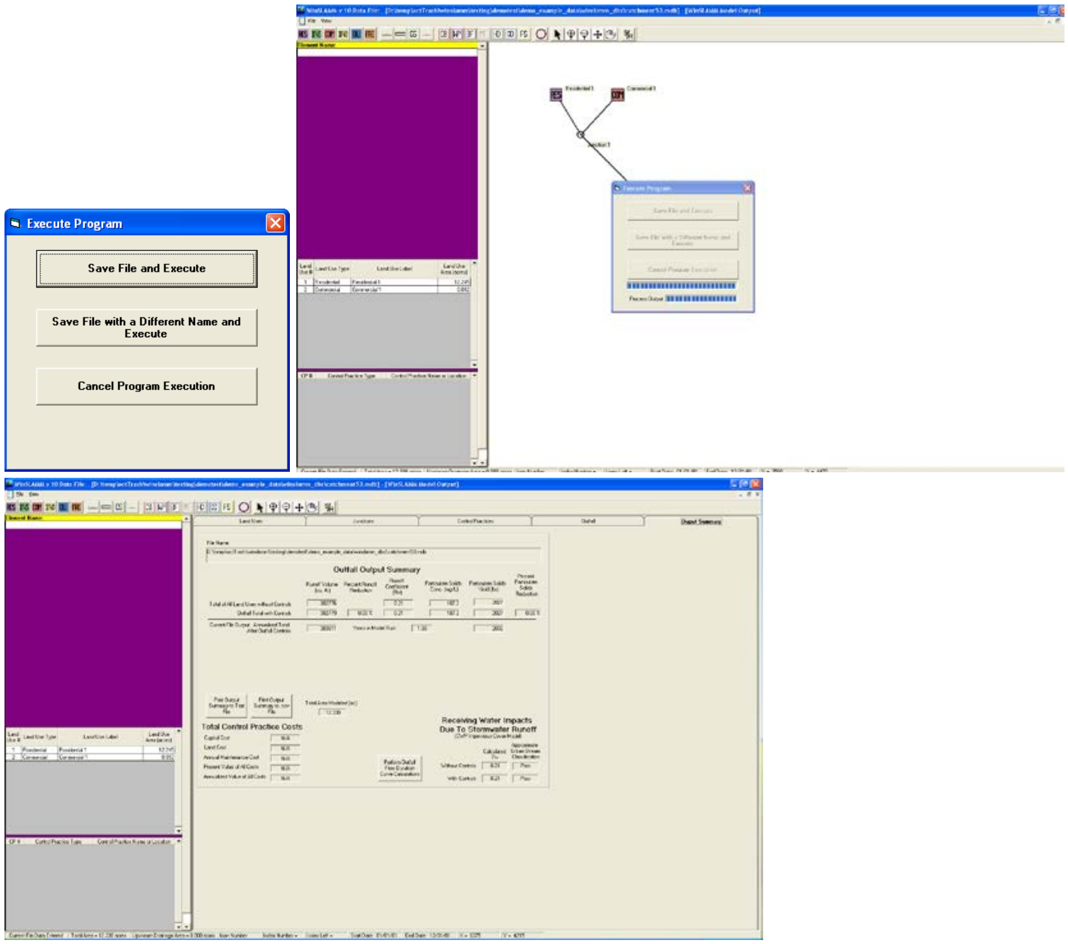


Using WinSLAMM Compliant files in WinSLAMM

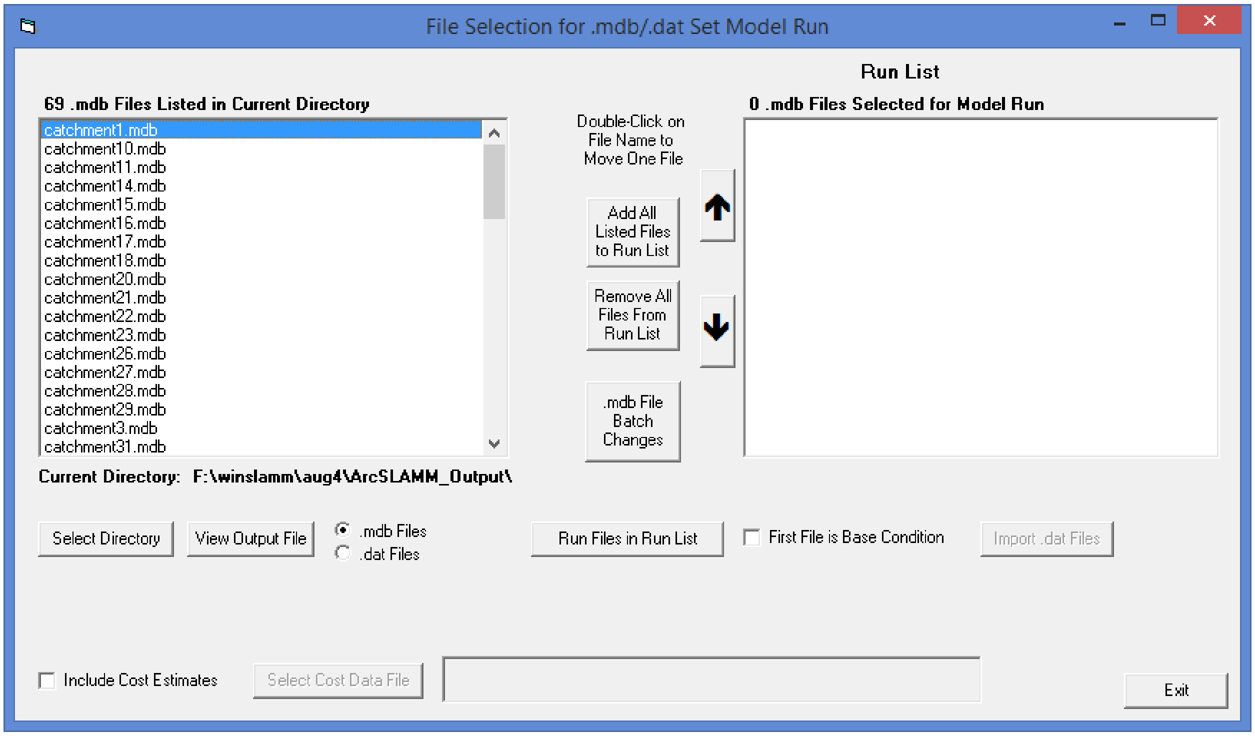
42. The databases created with the *Create WinSLAMM Compliant Databases* tool can be used in the WinSLAMM program to either run simulations for individual catchments or batch run simulations for multiple catchments. In addition individual catchment files can be opened up in WinSLAMM and edited to introduce Best Management Practices (BMPs).
43. In order to run a single simulation the user should start WinSLAMM and choose File – Open Project File after entering the main screen and then select the file they want, and click Open.

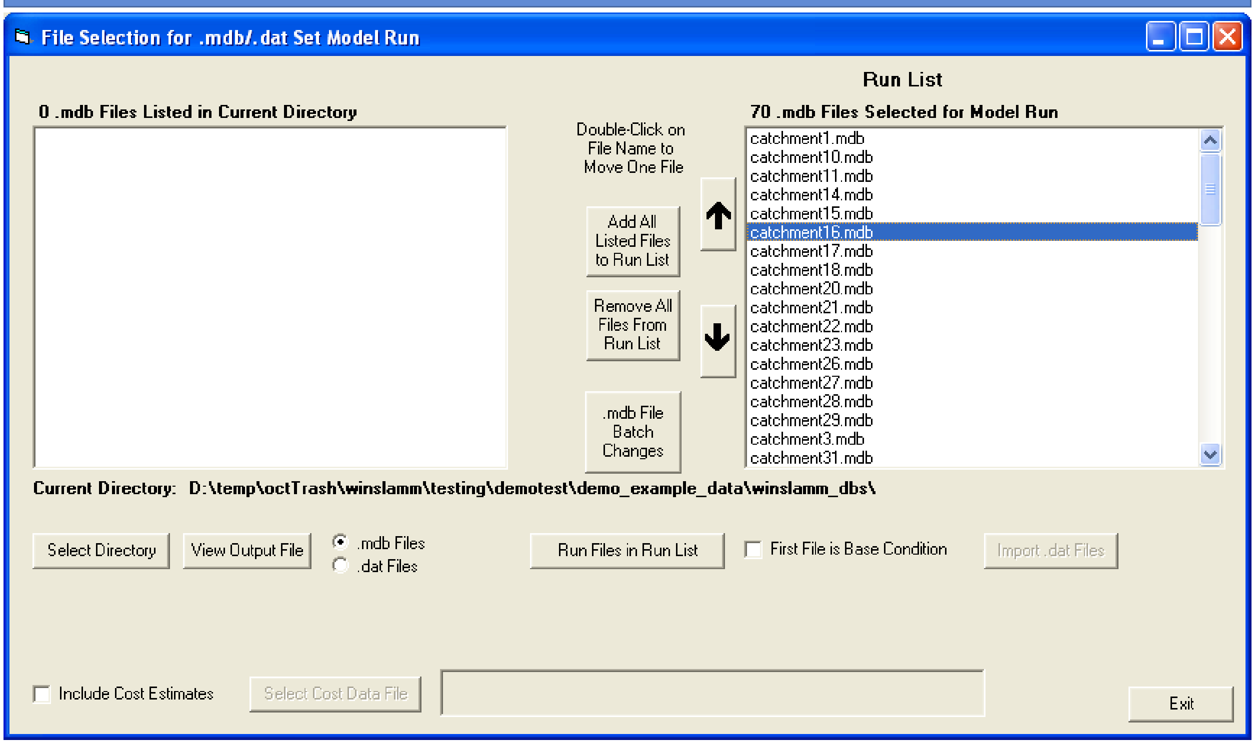


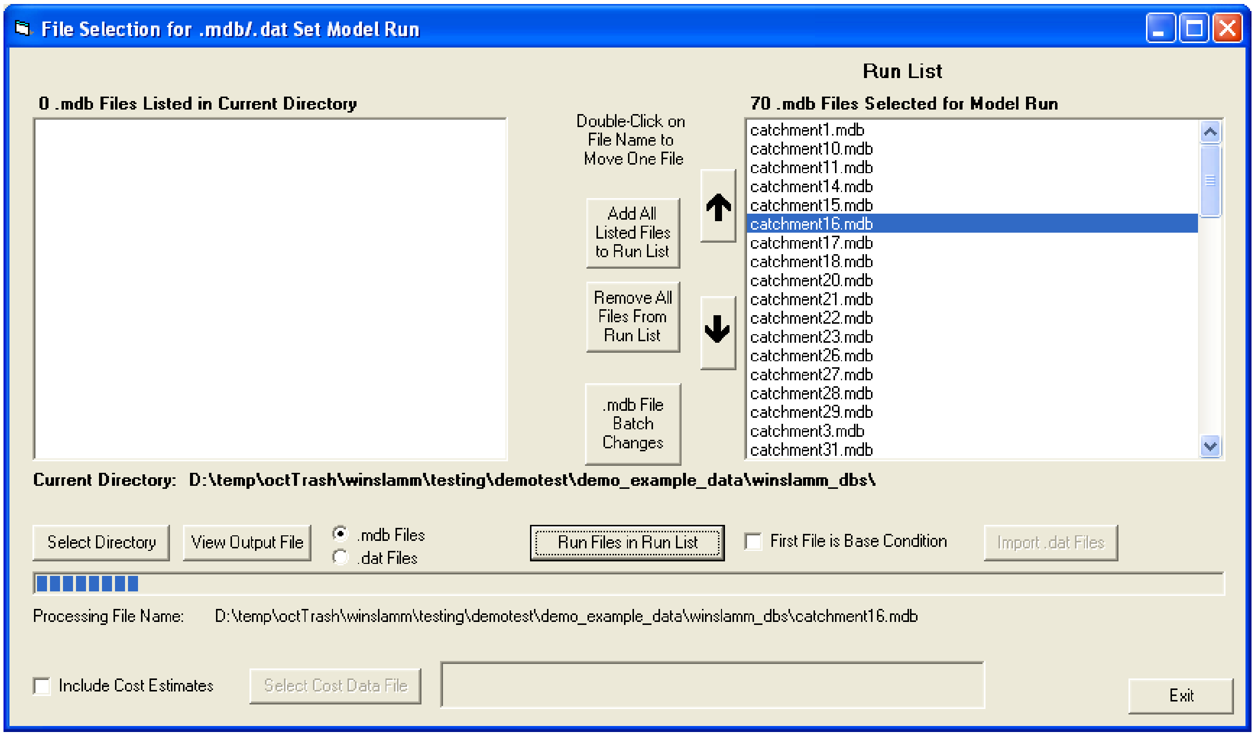
44. Then by choosing Run – Current Project File and clicking Save File and Execute on the opened dialog the user can run the simulation.



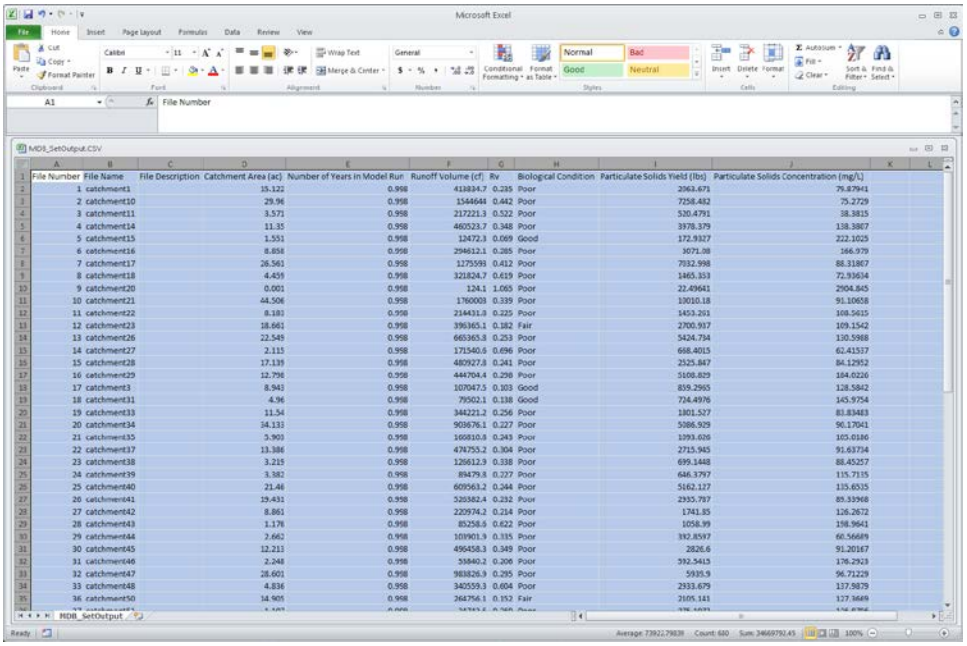
45. In order to run simulations for all of the WinSLAMM compliant database files created above choose Run – Set of Project files. Navigate to the correct directory and click OK. You will see a list of files in the left panel. Choose Add All Listed Files to Run List to add all of them. Click the Run Files in Run List button and WinSLAMM will batch run simulations for all files.


File Selection for .mdb/.dat Set Model Run
Run List
69 .mdb Files Listed in Current Directory
catchment1.mdb
catchment10.mdb
catchment11.mdb
catchment14.mdb
catchment15.mdb
catchment16.mdb
catchment17.mdb
catchment18.mdb
catchment20.mdb
catchment21.mdb
catchment22.mdb
catchment23.mdb
catchment26.mdb
catchment27.mdb
catchment28.mdb
catchment29.mdb
catchment3.mdb
catchment31.mdb
Double-Click on File Name to Move One File
Add All Listed Files to Run List
Remove All Files From Run List
.mdb File Batch Changes
0 .mdb Files Selected for Model Run
Current Directory: F:\winslamm\aug4\ArcSLAMM_Output\
Select Directory
View Output File
.mdb Files
.dat Files
Run Files in Run List
First File is Base Condition
Import .dat Files
Include Cost Estimates
Select Cost Data File
Exit


File Selection for .mdb/.dat Set Model Run
Run List
0 .mdb Files Listed in Current Directory
Double-Click on File Name to Move One File
Add All Listed Files to Run List
Remove All Files From Run List
.mdb File Batch Changes
70 .mdb Files Selected for Model Run
catchment1.mdb
catchment10.mdb
catchment11.mdb
catchment14.mdb
catchment15.mdb
catchment16.mdb
catchment17.mdb
catchment18.mdb
catchment20.mdb
catchment21.mdb
catchment22.mdb
catchment23.mdb
catchment26.mdb
catchment27.mdb
catchment28.mdb
catchment29.mdb
catchment3.mdb
catchment31.mdb
Current Directory: D:\temp\octTrash\winslamm\testing\demotest\demo_example_data\winslamm_dbs\
Select Directory
View Output File
.mdb Files
.dat Files
Run Files in Run List
First File is Base Condition
Import .dat Files
Include Cost Estimates
Select Cost Data File
Exit



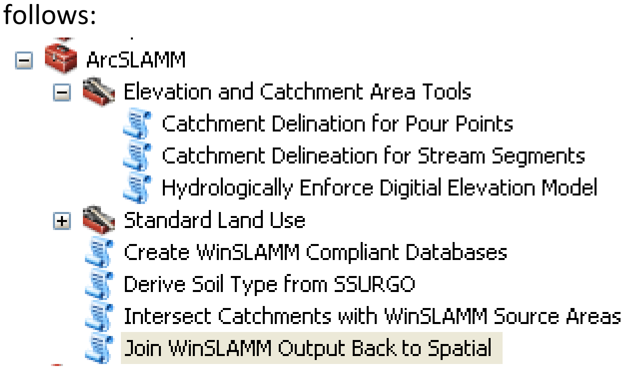
46. When you run WinSLAMM in batch mode for all of the catchment .mdb's, a .csv called MDB_SetOutput.csv is produced which holds certain outputs (depending on the Pollutants that were modeled) for each individual catchment. These outputs can be joined back to the intersected feature class shown after Step 15 or the catchment feature class shown after Step 9. A screenshot of the .csv is shown below. ***Warning:*** *If you encounter any kind of error for any of the catchment files when running in batch mode it is likely that the output file WinSLAMM creates (MDB_SetOutput.csv) might be corrupted. Make a note of which catchment file had an error, delete that file, delete the MDB_SetOutput.csv file, and rerun the batch WinSLAMM simulation.*



File Number	File Name	File Description	Catchment Area (ac)	Number of Years in Model Run	Runoff Volume (cf)	Rv	Biological Condition	Particulate Solids Yield (lbs)	Particulate Solids Concentration (mg/L)
1	catchment1		15.122	0.998	413834.7	0.235	Poor	2063.671	79.87941
2	catchment10		29.96	0.998	1544644	0.442	Poor	7258.482	75.2729
3	catchment11		3.571	0.998	217221.3	0.522	Poor	520.4791	38.3815
4	catchment14		11.35	0.998	460523.7	0.348	Poor	3978.379	138.3807
5	catchment15		1.551	0.998	12472.3	0.069	Good	172.9327	222.1025
6	catchment16		8.858	0.998	294612.1	0.285	Poor	3071.08	166.979
7	catchment17		26.561	0.998	1275593	0.412	Poor	7032.998	88.31867
8	catchment18		4.459	0.998	321824.7	0.619	Poor	1465.353	72.93634
9	catchment20		0.001	0.998	124.1	1.065	Poor	22.49641	2904.845
10	catchment21		44.506	0.998	1760003	0.339	Poor	10010.18	91.10658
11	catchment22		8.181	0.998	214431.0	0.225	Poor	1453.261	108.5615
12	catchment23		18.661	0.998	396365.1	0.182	Fair	2700.937	109.1542
13	catchment26		22.549	0.998	665365.8	0.253	Poor	5424.734	130.5988
14	catchment27		2.115	0.998	171540.6	0.696	Poor	668.4015	62.41537
15	catchment28		17.139	0.998	480927.8	0.241	Poor	2525.847	84.12952
16	catchment29		12.798	0.998	444704.4	0.298	Poor	5108.829	184.0226
17	catchment3		8.943	0.998	107047.5	0.103	Good	859.2965	128.5842
18	catchment31		4.96	0.998	79502.1	0.138	Good	724.4976	145.9754
19	catchment33		11.54	0.998	344221.2	0.256	Poor	1801.527	83.83483
20	catchment34		34.133	0.998	903676.1	0.227	Poor	5086.929	90.17041
21	catchment35		5.903	0.998	166810.8	0.243	Poor	1093.026	105.0186
22	catchment37		13.386	0.998	474755.2	0.304	Poor	2715.945	91.63734
23	catchment38		3.215	0.998	126612.9	0.338	Poor	699.1448	88.45257
24	catchment39		3.382	0.998	89479.8	0.227	Poor	646.3797	115.7135
25	catchment40		21.46	0.998	609563.2	0.244	Poor	5162.127	135.6535
26	catchment41		19.431	0.998	520382.4	0.232	Poor	2935.787	89.33968
27	catchment42		8.861	0.998	220974.2	0.214	Poor	1741.85	126.2672
28	catchment43		1.178	0.998	85258.6	0.622	Poor	1058.99	198.9641
29	catchment44		2.662	0.998	101901.9	0.335	Poor	392.8597	60.56689
30	catchment45		12.213	0.998	496458.3	0.349	Poor	2826.6	91.20167
31	catchment46		2.248	0.998	55840.2	0.206	Poor	592.5415	176.2923
32	catchment47		28.601	0.998	983826.9	0.295	Poor	5939.9	96.71229
33	catchment48		4.836	0.998	340559.3	0.604	Poor	2933.679	137.9879
36	catchment50		14.905	0.998	264756.1	0.152	Fair	2105.141	127.3669

Join WinSLAMM Output Back to Spatial

47. At this point we have run simulations for 69 separate drainage areas/catchments in WinSLAMM and we want to visualize the results from that back in ArcGIS. To do this we will use the MDB_SetOutput.csv file create and join the modeled values back to the intersected drainage area/catchment and source area feature class we used above.
48. Back in ArcMap click the Join WinSLAMM Output Back to Spatial tool and parameterize as follows:

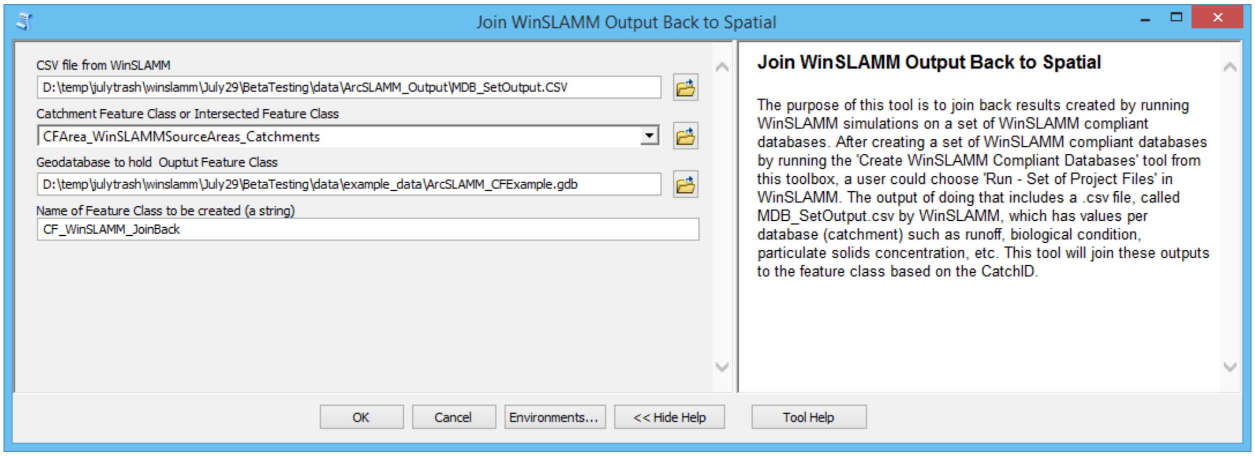


   a. CSV file from WinSLAMM – this should be the MDB_SetOutput.csv which is in the directory where the WinSLAMM databases were created. In the example above this was .. data\ArcSLAMM_Output\MDB_SetOutput.CSV.
   b. Catchment Feature Class or Intersected Feature Class - you can join the output results back to either the catchment feature class or the intersected feature class created earlier. If you use the catchment feature class, there might be some catchments which didn't intersect or only partially intersected any of the detailed source areas. In this example we are joining back to the intersected feature class (CFArea_WinSLAMMSourceAreas_Catchments). Another alternative is you could dissolve the intersected feature class based on the Catch_ID field and then use this tool.

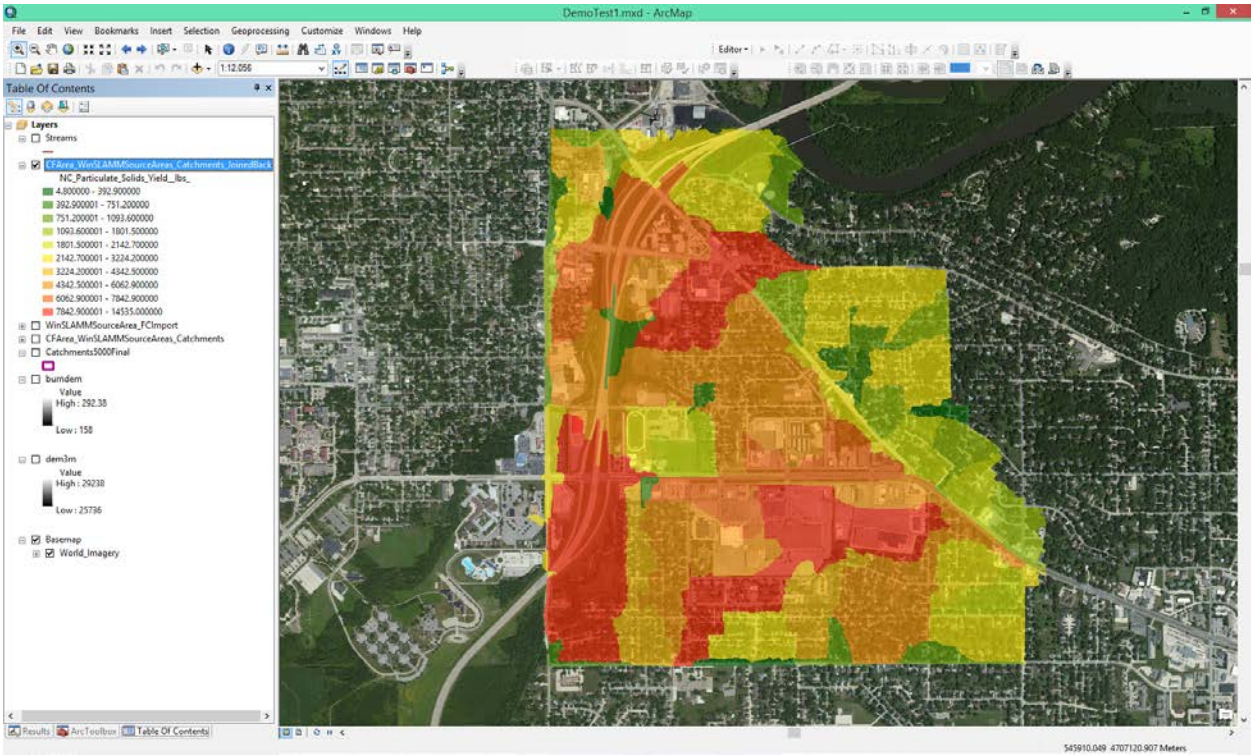
Warning: If you have a selection on the feature layer you choose for this parameter only those features selected will be joined and exported to the newly created feature layer.

c. Geodatabase to hold Output Feature Class – this should be the geodatabase where you stored the catchment feature class and intersected feature class as well as the original detailed source area feature class.

d. Name of Feature Class to be created (a string) – the result of this tool will be a feature class with output fields joined in. In this example we have named it CFArea_WinSLAMMSourceAreas_Catchments_JoinedBack.



49. After running the tool the feature class should automatically be added to ArcMap. You can symbolize by the numeric attributes that have been joined back to the spatial data using the standard symbolization methods in ArcMap. In the first screenshot example the field 'NC_Particulate_Solids_Yield_lbs_) was used. In the second example Runoff_Volume_cf_ was used.


DemoTest1.mxd - ArcMap
File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help
1:12,056
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Layers
Streams
CFArea_WinSLAMMSourceAreas_Catchments_JoinedBack
NC_Particulate_Solids_Yield__lbs_
4.800000 - 392.900000
392.900001 - 751.200000
751.200001 - 1093.600000
1093.600001 - 1801.500000
1801.500001 - 2142.700000
2142.700001 - 3224.200000
3224.200001 - 4342.500000
4342.500001 - 6062.900000
6062.900001 - 7842.900000
7842.900001 - 14535.000000
WinSLAMMSourceArea_FCImport
CFArea_WinSLAMMSourceAreas_Catchments
Catchments5000Final
burndem
Value
High : 292.38
Low : 158
dem3m
Value
High : 29238
Low : 25736
Basemap
World_Imagery
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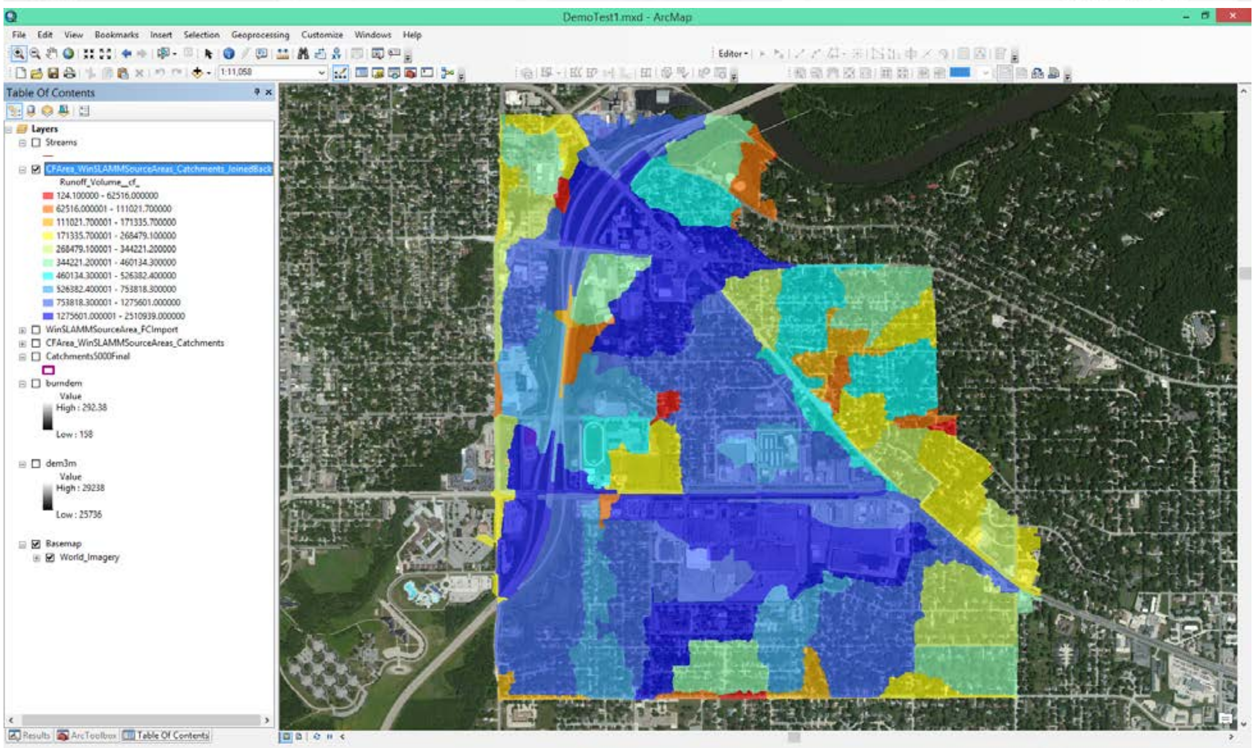
545910.049 4707120.907 Meters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Streams
CFArea_WinSLAMMSourceAreas_Catchments_JoinedBack
Runoff_Volume__cf_
124.100000 - 62516.000000
62516.000001 - 111021.700000
111021.700001 - 171335.700000
171335.700001 - 268479.100000
268479.100001 - 344221.200000
344221.200001 - 460134.300000
460134.300001 - 526382.400000
526382.400001 - 753818.300000
753818.300001 - 1275601.000000
1275601.000001 - 2510939.000000
WinSLAMMSourceArea_FCImport
CFArea_WinSLAMMSourceAreas_Catchments
Catchments5000Final
burndem
Value
High : 292.38
Low : 158
dem3m
Value
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