NRCS Engineering Tools

The NRCS Engineering Tools are a python-based collection of tools for very specific hydrologic and terrain-based workflows and analysis of high-resolution elevation data. They are intended to assist NRCS staff with supplemental data review and preliminary design of watersheds and the determination of Runoff Curve Numbers. Many of the tools require a Standard (or higher) license for ArcGIS Desktop, as well as the Spatial Analyst or 3D Analyst extension. See the Version 2.0_ReadMe.txt file in the installation folder for more setup information.

Installation

No special admin privileges are required to install the tools. Simply download the tools to your computer and then add the toolbox to ArcToolbox. Please also make sure that the Spatial Analyst and 3D Analyst extensions are enabled in ArcMap. The tools should be run from ArcMap and not from standalone ArcCatalog.

Template Setup

A blank template is provided in the install folder for your use. It contains no data layers and a rudimentary layout. You can modify this template and layout, as needed, but it is recommended that you save your customized templates to the "My Templates" folder provided with the install, as well as another backup location for recovery outside of the Engineering Tools installation folder. The devs will leave the "My Templates" folder with the Engineering Tools installation empty in future releases so an overwrite should not occur, but it always pays to have backups anyway.

The first time you add data to a template, the data frame will take on the coordinate system of the first layer added. For that reason, when you create your own custom template, you should add the most commonly used reference DEM used in your work area. Alternately, you can manually assign your desired coordinate system to your data frame by setting the Data Frame Properties. For many engineering projects, this is often a local coordinate system to a state, region, or county, rather than a UTM or a system with national coverage.
NOTE: Once you start a project (Define AOI) with the Engineering Tools, all data in that project will use the starting coordinate system and you cannot change it for a different project site or AOI. Instead, you must start a new project in a new workspace and you should be sure to set the Coordinate System of your Data Frame before using Define AOI in that new project.

Common Terms

The following terms are frequently used by the Engineering Toolbox tools or help files:

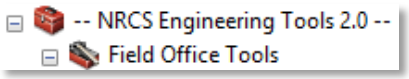
***Workspace*:** A folder that you define to contain a project. It is strongly encouraged to always set your workspace folders to be unique for every project (avoid multiple projects in the same workspace) and that they be stored on a local drive. You can use network drives to backup or exchange projects, but runtime work should always be done on the local drive for best performance and to prevent crashes that could corrupt files if there is a loss of connectivity.

Geodatabase: A geodatabase is simply a database that contains GIS files. Typically, each project has a geodatabase stored in the Workspace folder where most of the data generated by these tools gets stored.

***DEM*:** A Digital Elevation Model, or DEM, is a raster GIS layer that stores elevation values. It's like a picture for elevation, instead of color signatures.

Running Tools/Scripts

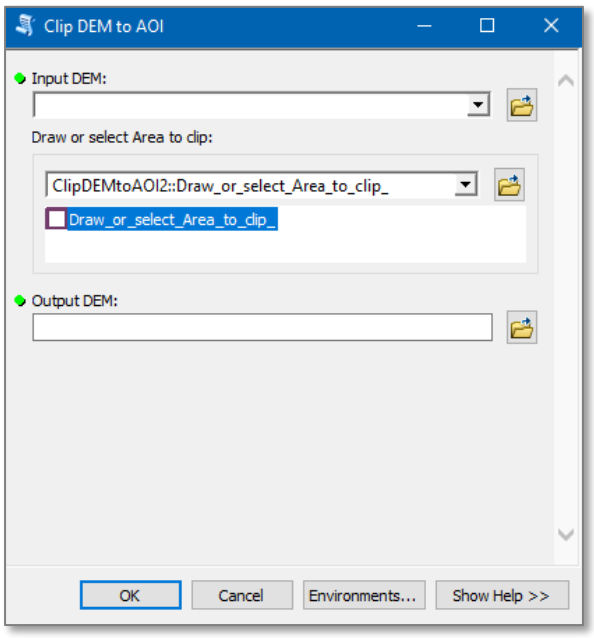
For each tool that is opened, the required parameters are indicated by a green dot. These parameters must be populated before a tool can be run. Any parameter with a yellow triangle is a warning (usually warning you that you will be overwriting an existing file). Finally, a red "x" indicates a problem with the parameter, and you can click it to see information about the error. Please seek assistance from your first line of GIS support on errors before contacting the developers. If you have an error that you believe to be a genuine bug (either from parameters or from a tool's output messages), please log it on the Issues page for this toolbox on GitHub. Maintenance of these tools by the developers is "as time permits" outside of their normal duties, so please be patient for any requests.



NRCS Engineering Tools: Field Office Toolset

Field Office Tools: Clip DEM to AOI

Allows a user to clip out part of a Digital Elevation Model (DEM) to a specified boundary extent.



Input DEM: Select a source DEM file from the drop down or by using the Browse folder. This DEM should cover an area larger than your intended project site.

Draw or select Area to clip: Click the red box option to interactively draw an Area of Interest in your map session. Alternately, you can select an existing polygon layer in the drop down or by using the Browse button. Any given area of interest must be a polygon layer containing only a single polygon.

Output DEM: Use the Browse folder button to specify an output folder or database for the clipped DEM file and a file name.

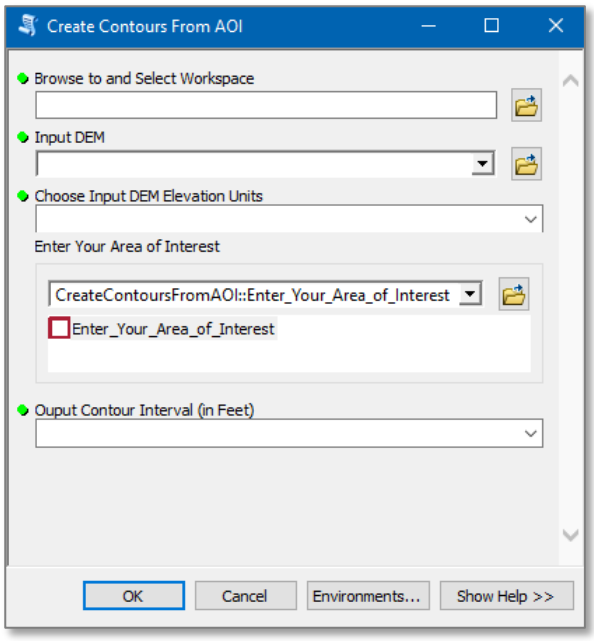
If using a file geodatabase to store the output DEM file, no file extension is needed with the file name.

If using a standalone raster file, then the .TIF or .IMG format extensions are recommended to be included with the file name.

Field Office Tools: Create Contours from AOI

(Spatial Analyst Required)

Allows a user to create smoothed contours for an area of interest at a specified contour interval



Browse to and Select Workspace:
Provide the path to a local folder that will serve as your project workspace.
It is highly recommended that you choose a local (C:) folder without spaces or special characters in the path name. If you have already established a workspace, you may specify the same path.

Input DEM: Choose your Input DEM from the map or by using the Browse button.

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

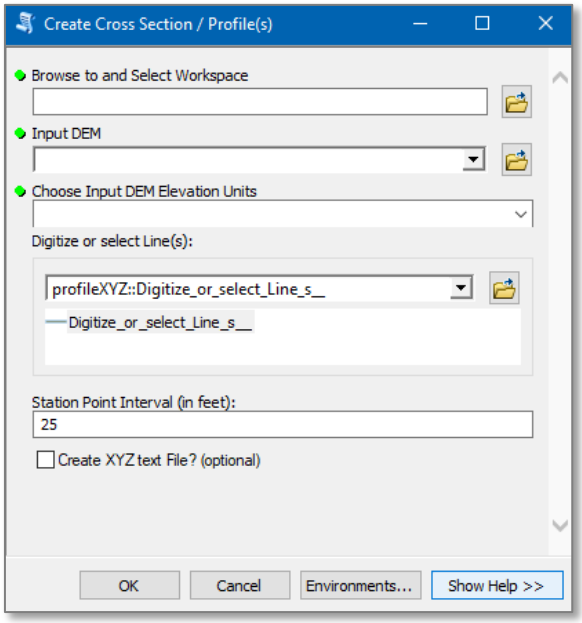
e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

Enter Your Area of Interest: Click the red box option to interactively draw an Area of Interest in your map session. Alternately, you can select an existing polygon layer in the drop down or by using the Browse button. Any given area of interest must be a polygon layer containing only a single polygon.

Output Contour Interval (in Feet): Specify the desired contour interval (in feet). Contours will be created in feet, with every fifth contour value indexed.

Field Office Tools: Create Cross Section / Profile(s) (Spatial Analyst Required)

Creates cross sections or profiles from a user specified line and interval.



Browse to and Select Workspace:
Provide the path to a local folder that will serve as your project workspace.

It is highly recommended that you choose a local (C:) folder without spaces or special characters in the path name. If you have already established a workspace, you may specify the same path.

Input DEM: Choose your Input DEM from the map or by using the Browse button

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

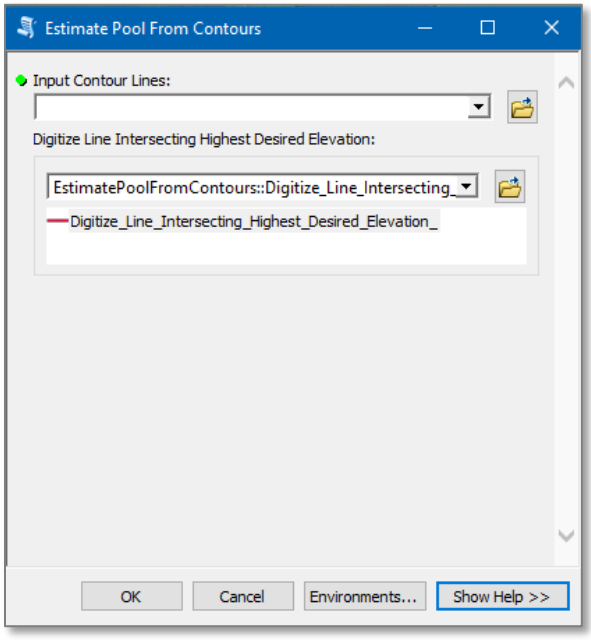
Digitize or select Line(s): Use the blue line icon to interactively draw a profile line or cross section lines. Alternately, use the Browse button to select an input line file that contains your profile or cross section lines.

Station Point Interval (in feet): Assign an interval value in feet for the distance at which a new station point will be created along each line.

Create XYZ text File? (optional): Check this box if you want the tool to generate a text file of XYZ coordinates of the determined stations along the lines.

Field Office Tools: Estimate Pool from Contours (Spatial Analyst Required)

Quickly estimate the storage potential of a proposed pool or structure by intersecting contour lines with a user provided dam, dike or berm.



Input DEM: Select the contour line layer that corresponds with your Area of Interest. The input contour layer must have been created with the tools in the NRCS Engineering Toolbox.

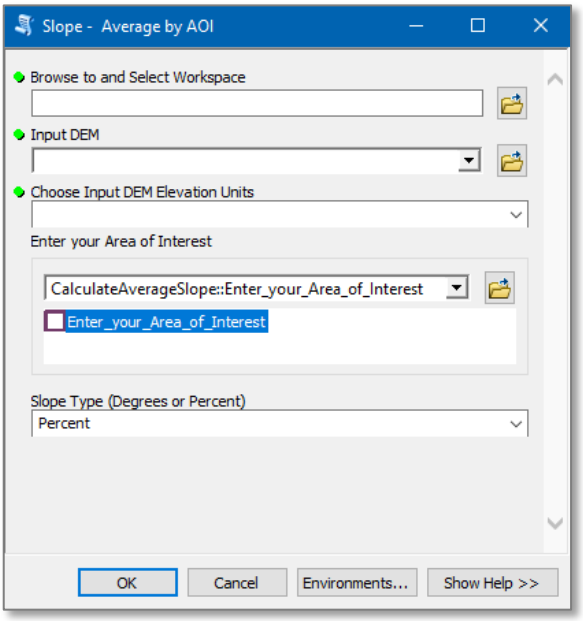
Digitize Line Intersecting Highest Desired Elevation: Use the red line icon to digitize a line that will serve as a dam or dike, making sure both ends intersect the highest contour you wish to close. Alternately, select a layer that contains such a line using the drop down or the Browse folder button.

The proposed pool area must be on the topographic left of the line(s) provided -- i.e. the water must pool on your left if you are standing on the digitized line and looking in the direction the line is drawn.

Field Office Tools: Slope – Average by AOI

(Spatial Analyst Required)

Calculate the average slope across the entire extent of one or more polygons.



Browse to and Select Workspace:
Provide the path to a local folder that will serve as your project workspace.

It is highly recommended that you choose a local (C:) folder without spaces or special characters in the path name. If you have already established a workspace, you may specify the same path.

Input DEM: Choose your Input DEM from the map or by using the Browse button

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

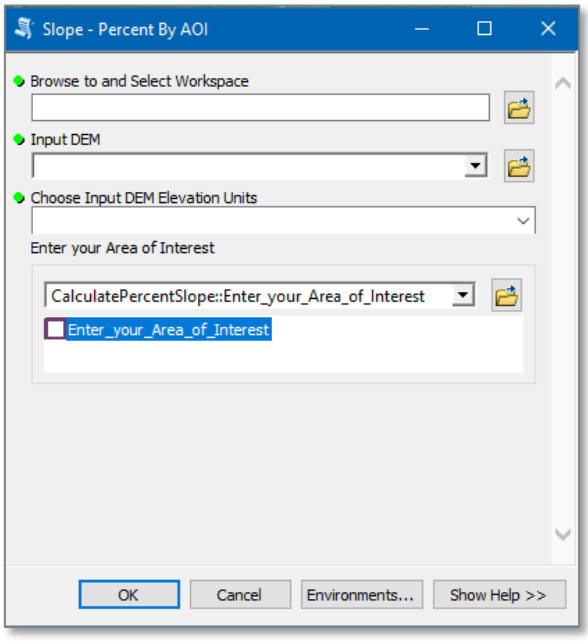
Enter Your Area of Interest: Click the red box option to interactively draw an Area of Interest in your map session. Alternately, you can select an existing polygon layer in the drop down or by using the Browse button. Any given area of interest must be a polygon layer containing only a single polygon.

Slope Type (Degrees or Percent): Assign the slope calculations to be created using Percent or Degrees.

Field Office Tools: Slope – Percent by AOI

(Spatial Analyst Required)

Create a slope raster layer for an area of interest. Output of this tool is always percent, not degrees.



Browse to and Select Workspace:
Provide the path to a local folder that will serve as your project workspace.

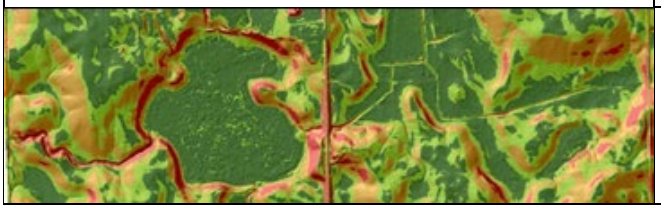
It is highly recommended that you choose a local (C:) folder without spaces or special characters in the path name. If you have already established a workspace, you may specify the same path.

Input DEM: Choose your Input DEM from the map or by using the Browse button

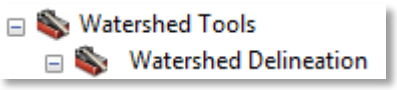
Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

Enter Your Area of Interest: Click the red box option to interactively draw an Area of Interest in your map session. Alternately, you can select an existing polygon layer in the drop down or by using the Browse button. Any given area of interest must be a polygon layer containing only a single polygon.



Results: The results are a raster layer of slope, with percentage breakdowns of 0-3%, 3-6%, 6-12%, and >12%.

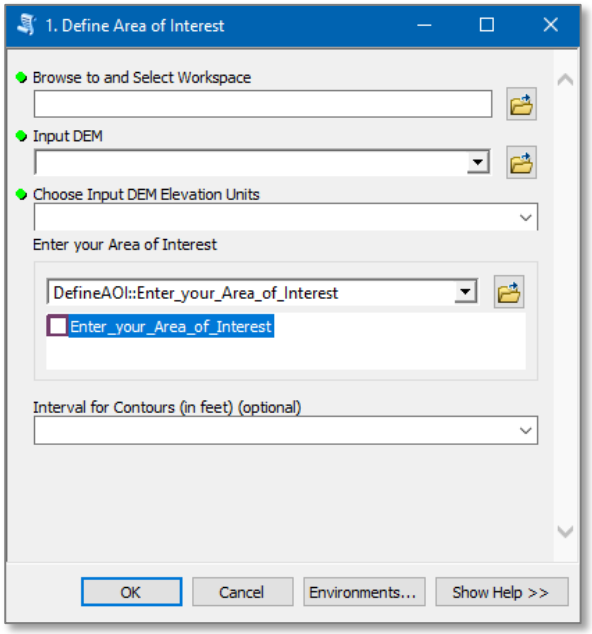


NRCS Engineering Tools: Watershed Delineation Toolset

Watershed Delineation: 1. Define Area of Interest

(Spatial Analyst Required)

Clips a DEM to an Area of Interest and creates layers for contours and the project DEM along with a corresponding Hillshade and Depth Grid layer.



Browse to and Select Workspace:
Provide the path to a local folder that will serve as your project workspace.

It is highly recommended that you choose a local (C:) folder without spaces or special characters in the path name. If you have already established a workspace, you may specify the same path.

Input DEM: Choose your Input DEM from the map or by using the Browse button

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

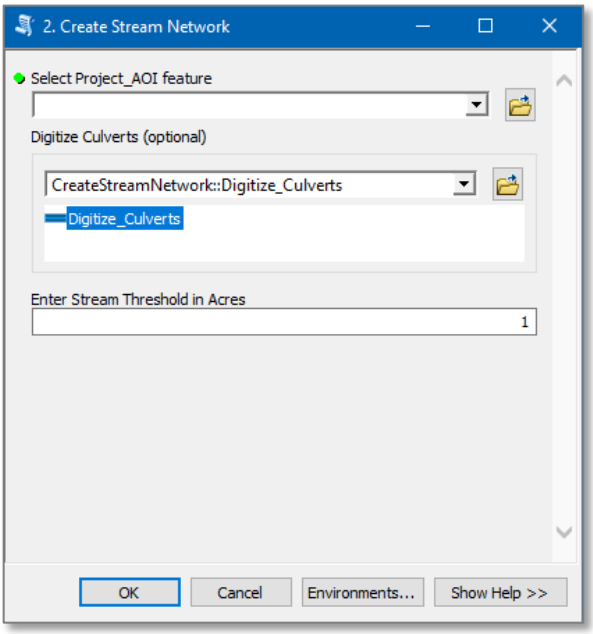
Enter Your Area of Interest: Click the red box option to interactively draw an Area of Interest in your map session. Alternately, you can select an existing polygon layer in the drop down or by using the Browse button. Any given area of interest must be a polygon layer containing only a single polygon.

Interval for Contours (in Feet) (optional): Specify the desired contour interval (in feet). Contours will be created in feet, with every fifth contour value indexed. If left blank, no contours will be created.

Watershed Delineation: 2. Create Stream Network

(Spatial Analyst Required)

Creates a linear stream network, allowing for user defined culvert to burn in small flow channels to enforce the raster data that will be built for upcoming watershed delineation steps.



Select Project_AOI feature: Select the project AOI feature created in the previous step for the current project.

Digitize Culverts (optional): IF the depth grid created in step #1, imagery, or local knowledge indicate the need for culverts to better route flow use the blue line to interactively draw line segments to move flow past Lidar modeled barriers, such as roads. This should be done both within the likely watershed area and near it so that overflow from neighboring watersheds doesn't alter the extent of the watershed you are attempting to delineate.

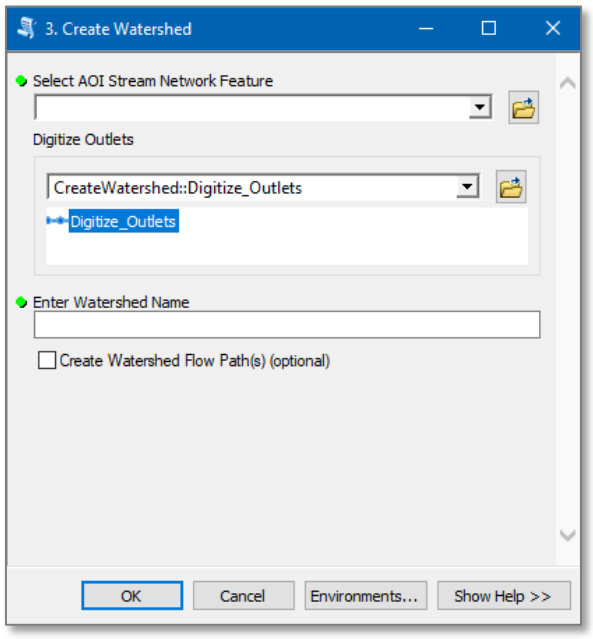
Alternately, you can select a line layer that contains culverts or flow enforcement from the drop down or by using the Browse button.

Enter Stream Threshold in Acres: Enter the number of acres required for overland flow to be aggregated before it is considered a stream. The typical range for local watersheds is 1-6 acres.

Watershed Delineation: 3. Create Watershed

(Spatial Analyst Required)

Delineates one or more watersheds from user provided line(s) defining pour point locations.



Select AOI Stream Network Feature: Browse to or select the stream features corresponding with your area of interest that was generated in step #2.

Digitize Outlets: Use the blue line button to digitize line features at the desired pour point, dam, dike, or terrace location(s). Multiple lines may be provided and a unique Subbasin will be created for each entered line.

The entire area contributing to the provided line(s) will be delineated, therefore make the line features as long or short as is appropriate to your desired outcome.

Alternately, select a layer that contains your outlet lines from the drop down or by using the Browse folder button.

Enter Watershed Name: Enter a name that will be assigned to the resulting watershed features. Existing names will automatically be appended with the next available incremental integer value.

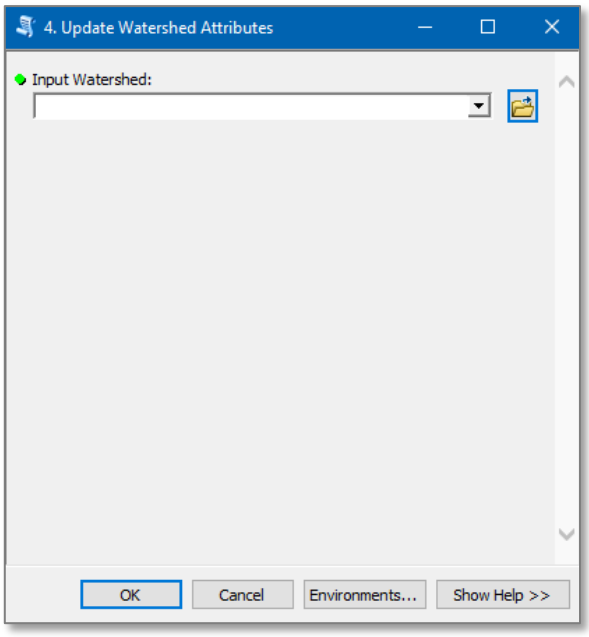
Create Watershed Flow Path(s) (optional): Select this option in order to derive the primary flow path for each resulting watershed. Results may be edited after execution if routing or other changes are necessary.

After running this tool, you may open an edit session and make manual changes to the Watershed boundary or Flow Paths, as needed. Be sure to save your edits and close your edit session before moving on to the next tool.

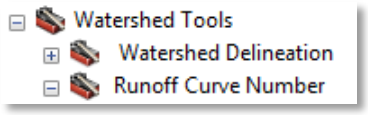
Watershed Delineation: 4. Update Watershed Attributes

(Spatial Analyst Required)

Updates watershed area, average slope, and flow path length (if present) if any manual edits to the exiting watershed delineation(s) were made after running step #3.



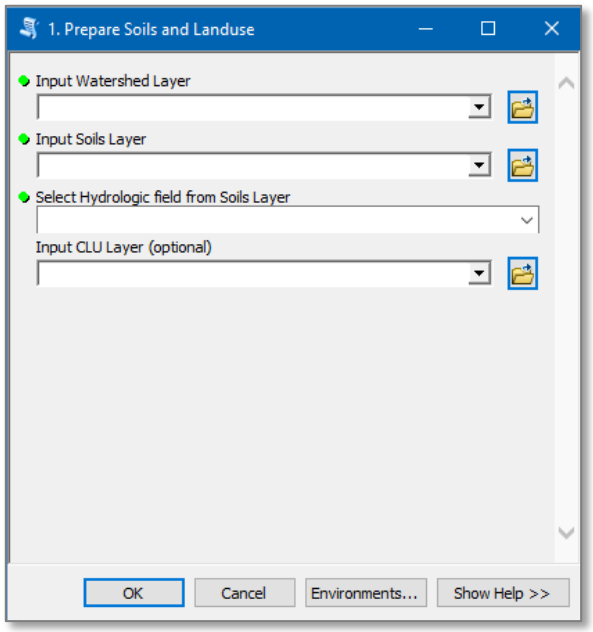
Input Watershed: Select the watershed layer generated by step #3.



NRCS Engineering Tools: Runoff Curve Number Toolset

Runoff Curve Number: 1. Prepare Soils and Landuse

Creates a soils layer and a land use layer that matches the watershed layer extent(s) for use in editing to prepare for the step #2 in the RCN toolset.



Input Watershed Layer: Select the watershed layer generated by step #3 in the watershed delineation toolset.

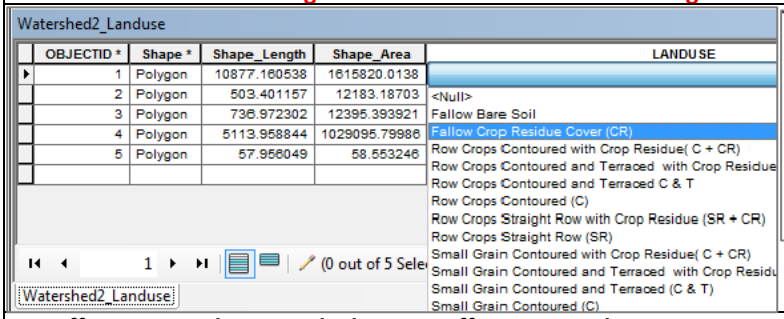
Input Soils Layer: Select the soils layer that covers your area of interest/watersheds. The layer must contain an MUNAME filed and a field that contains the hydrologic group values for each map unit.

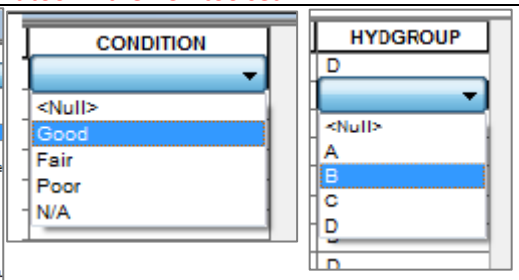
Select Hydrologic field from Soils Layer: Use the drop down to select the attribute field from your specified soils layer which contains the hydrologic group values.

Input CLU Layer (Optional): You can provide a CLU layer (USDA internal only) or a similar land divisions layer such as parcels, cadastral, or vector land use that will be used to pre-divide the land use layer that this tool generates. This can be useful to reduce the number of subsequent edits if such layers approximate the actual land use extents. Note, the layer must be a vector layer and cannot be a raster layer (such as a land use raster layer).

If the optional layer covering this area has too many small cut outs of possible land uses, then the use of this option may be counterproductive and lead to an increased number of edits being needed to correct the output land use layer from this tool.

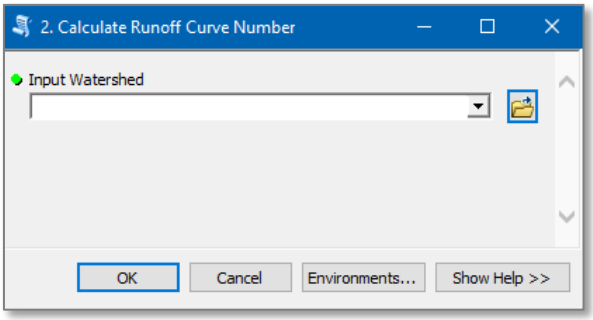
Once RCN Tool #1 has executed, a Watershed Land Use and Watershed Soils layer will be added to the map. Use an edit session to assign attributes to the Landuse and Condition fields of the Land Use layer and to assign final attributes for any combined Hydrologic groups in the Soils layer (e.g. C/D to C or D, etc...). Save edits and stop editing when finished and before running the next tool in the RCN toolset.





Runoff Curve Number: 2. Calculate Runoff Curve Number

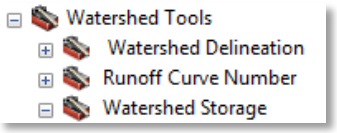
Calculates a weighted average runoff curve number for the input watershed(s).



Input Watershed: Select the watershed layer generated by step #3 in the watershed delineation toolset. Land use and soils must also be completely populated with final land use and soils attributes prior to running this tool.

A weighted average runoff curve number will be determined and assigned to the attribute table of the specified watershed layer. A detailed RCN layer of land use, condition, and soils combinations will also be added to the map.

A PDF report of the same results, and detailed breakdown of the land uses and soils that resulted in the weighted RCN number will also be generated in the project workspace for the current watered.

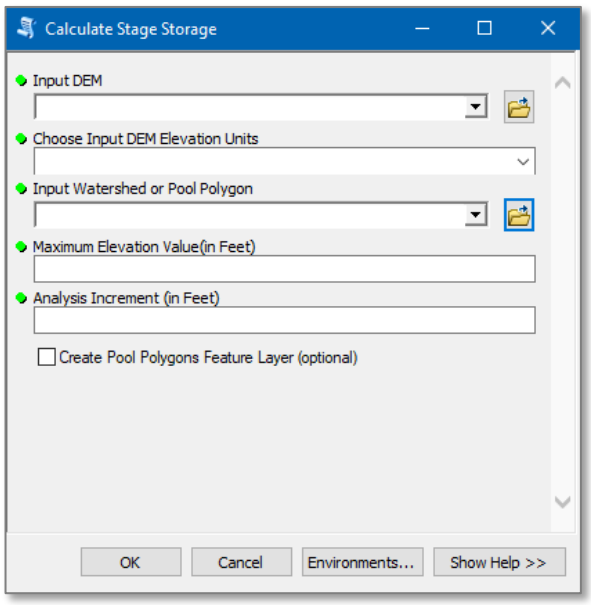


NRCS Engineering Tools: Watershed Storage Toolset

Watershed Storage: Calculate Stage Storage

(Spatial Analyst and 3D Analyst Required)

Calculates and returns the storage volume and surface area within a watershed pool at a user specified depth interval. Includes option for an output of a pool at each elevation interval. Output is an All Pools layer.



Input DEM: Choose your Input DEM from the map or by using the Browse button

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

Input Watershed or Pool Polygon: Select the watershed or pool boundary for which to calculate storage. It must be a single feature. If the layer contains multiple features, first export a single feature to a separate file to be used here.

Maximum Elevation Value (in Feet): Enter the maximum elevation of the pool. Storage will be calculated between the maximum and minimum elevation within the provided boundary.

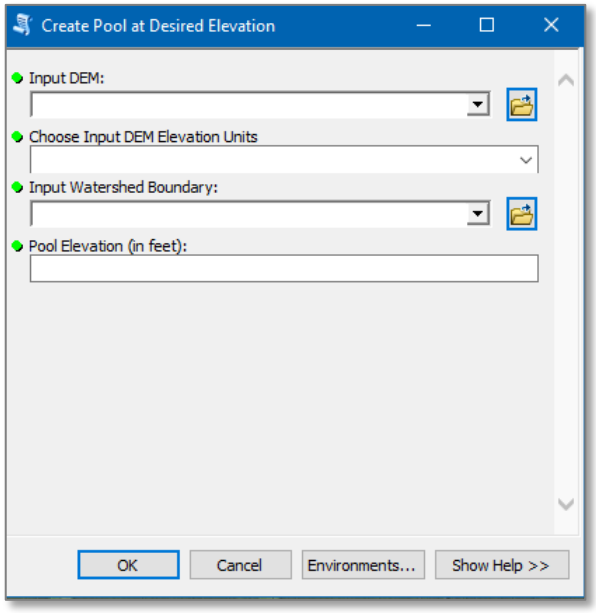
Analysis Increment (in Feet): Specify an incremental depth in feet.

Create Pool Polygons Feature Layer (optional): Check this option to create a pool polygons layer containing each stage storage elevation.

Watershed Storage: Create Pool at Desired Elevation

(Spatial Analyst and 3D Analyst Required)

Creates a pool polygon and calculates storage volume at a user provided elevation using a watershed, pool, or AOI boundary to limit the analysis extent.



Input DEM: Choose your Input DEM from the map or by using the Browse button.

Choose Input DEM Elevation Units: Specify the z-units of the input DEM. This is done to assign proper conversions for any scenarios where XY units of the DEM's coordinate system differ from the z-units of the DEM.

e.g. If your DEM has Elevation values in Feet, but the XY units are in Meters, then you must select "Feet" in this option to get the correct outputs. Z-units are values within the raster data of the DEM and therefore do not show up in the Properties view of the DEM layer. You must look at the legend or symbology of your DEM to see the value range and determine the likely z-units.

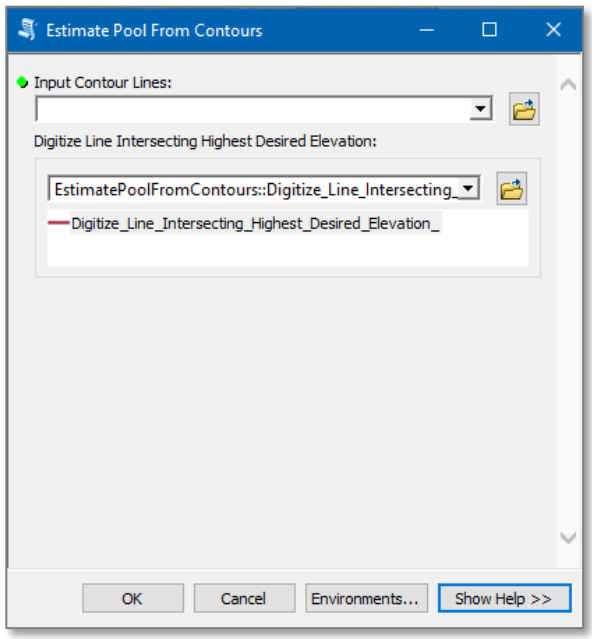
Input Watershed Boundary: Select the watershed or pool boundary for which to calculate storage. It must be a single feature. If the layer contains multiple features, first export a single feature to a separate file to be used here.

Pool Elevation (in feet): Specify an elevation for the desired pool (in feet).

A pool polygon will be created at the specified elevation and added to the map. Its attributes will contain the surface area and volume in acres-ft.

Watershed Storage: Estimate Pool from Contours (Spatial Analyst Required)

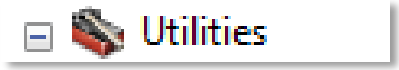
Quickly estimate the storage potential of a proposed pool or structure by intersecting contour lines with a user provided dam, dike or berm.



Input DEM: Select the contour line layer that corresponds with your Area of Interest. The input contour layer must have been created with the tools in the NRCS Engineering Toolbox.

Digitize Line Intersecting Highest Desired Elevation: Use the red line icon to digitize a line that will serve as a dam or dike, making sure both ends intersect the highest contour you wish to close. Alternately, select a layer that contains such a line using the drop down or the Browse folder button.

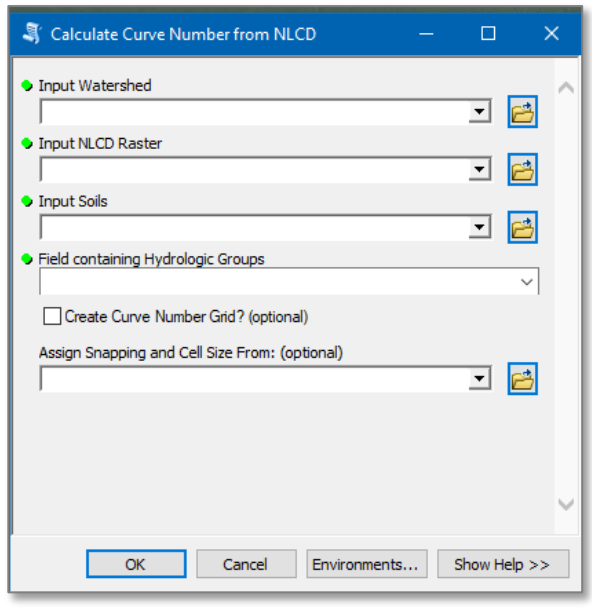
The proposed pool area must be on the topographic left of the line(s) provided -- i.e. the water must pool on your left if you are standing on the digitized line and looking in the direction the line is drawn.



NRCS Engineering Tools: Watershed Utilities

Watershed Tools → Utilities: Calculate Curve Number from NLCD (Spatial Analyst Required)

Uses NLCD raster data and input soils data to calculate a weighted Runoff Curve Number for a watershed. Intended for use with large watersheds. Makes several assumptions about land use and soil attributes..



Input Watershed Boundary: Select the watershed layer. It must be a watershed layer generated from step #3 in the Watershed Delineation toolset.

Input NLCD Raster: Select the NLCD raster layer covering your watershed or Area of Interest.

Input Soils: Select the soils layer that covers your area of interest/watersheds. The layer must contain an MUNAME filed and a field that contains the hydrologic group values for each map unit.

Field containing Hydrologic Groups: Use the drop down to select the attribute field from your specified soils layer which contains the hydrologic group values.

Create Curve Number Grid? (optional): Enable this option to create a raster layer of the detail RCN breakdowns by land use and soils.

Assign Snapping and Cell Size From (optional): If you enable the option to create an RCN grid, then you can also set the snap raster and resolution (it is recommended to select the DEM for your project Area of Interest for this).