How to Generate Contours in ArcGIS for Desktop

This tutorial will show you how to generate contour lines from the LiDAR Image Services located at: https://lidar.geodata.md.gov/imap/rest/services, using ArcGIS for Desktop (requires Spatial Analyst extension). After the contour lines are generated, you will learn how to build an index and symbolize the lines appropriately.

What are contour lines?

Contour lines are vector features used to represent the landscape in a relatively familiar way. A contour is a line through all contiguous points of equal value.

When are contour lines appropriate?

Contour lines are used as a familiar media for representing the elevations of a land surface above sea level. These lines are typically used for basemaps and general topographic representation; contour lines do this appropriately.
Contours should not, on the other hand, be used for analyzing the surface elevations above and beyond for aesthetic purposes. Users who require the raw data, countywide DEMs are available for download from the MD iMAP LiDAR Download page.
First we will need to connect to the MD iMAP Maryland LiDAR Topography Server, for more information please follow this link to learn How to Access Maryland LiDAR Image Services.

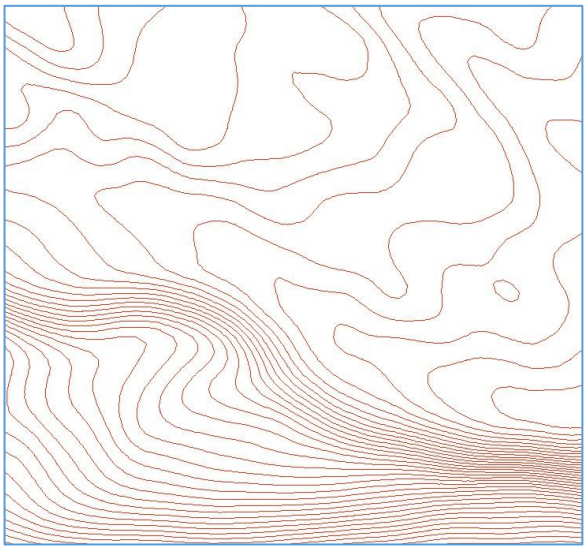
Comparing Raw vs Smooth Contour Lines

Generating Contour Lines in ArcGIS for Desktop

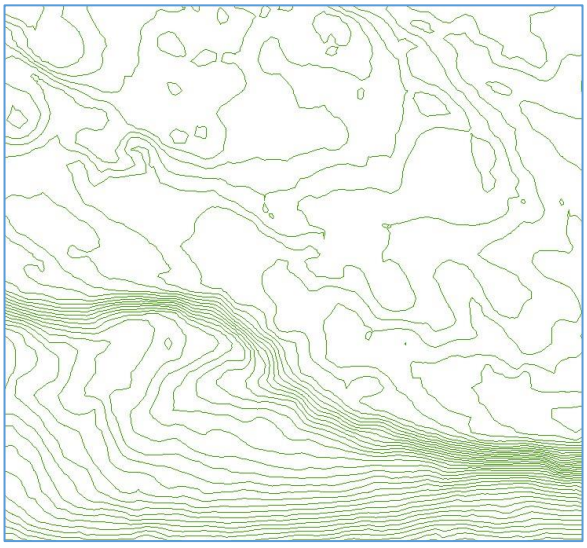
Building Contour Index Lines

Comparing Raw vs Smooth Contour Lines

1. Typically when someone mentions contours lines, the first thing they think of is a topographic map with smooth, rounded curves. See example >>>

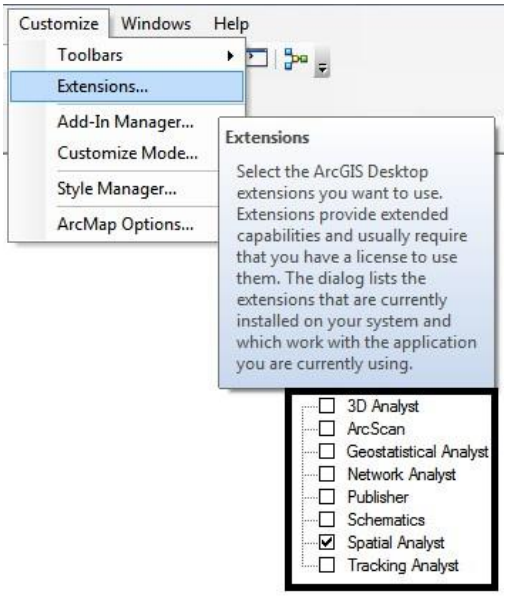


2. The problem with the sample show above resides with the fact that it inaccurately represents the land surface.
   If we were to generate contour lines from a raw DEM, we would expect something like: See example >>>



3. If smooth contour lines are the desired final product, we must generate contours that are data-driven. This is critical to preserving the data's accuracy and minimizing the level of error. DO NOT generate contours and smooth the vector lines after they are built; this method does not determine the direction and level of smoothing based on the DEM. This incorrect method of smoothing is not data-driven and therefore nullifies the accuracy of our data.
   The appropriate method for generating smooth data-driven contour lines is by smoothing the input DEM using the focal statistics tool in ArcGIS. This output will be data-driven and will allow us to build contours at different levels of smoothness; leaving the control at the user's hand.

Generating Contour Lines in ArcGIS for Desktop



1. Open ArcMap.

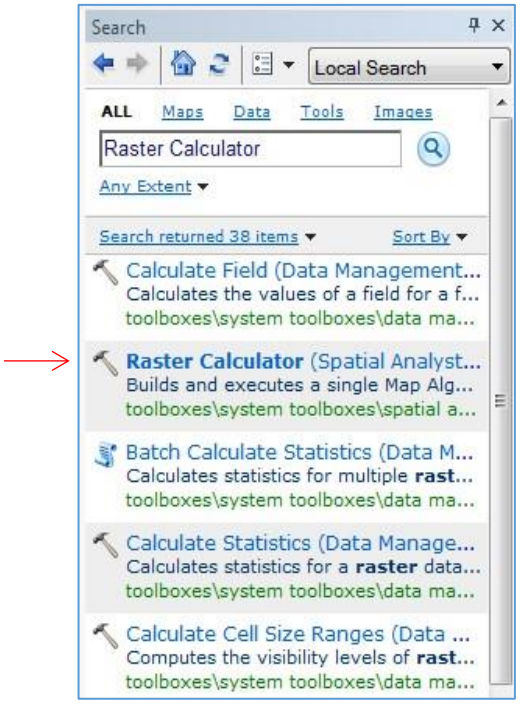
2. Check out Spatial Analyst Extension:

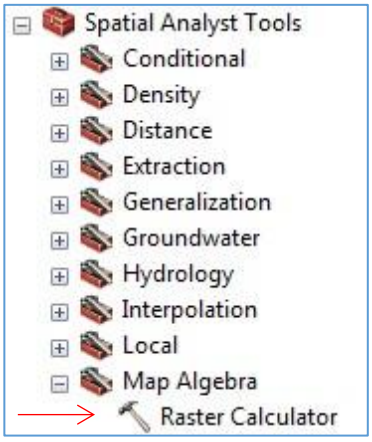
3. Add the desired Image Service to your map.
   For more information on accessing Maryland LiDAR image services, please read How to Access Maryland LiDAR Image Services.

4. Extract the area of interest for local processing.
   For more information on the image service extraction process, please read How to Extract from Image Services in ArcGIS for Desktop.

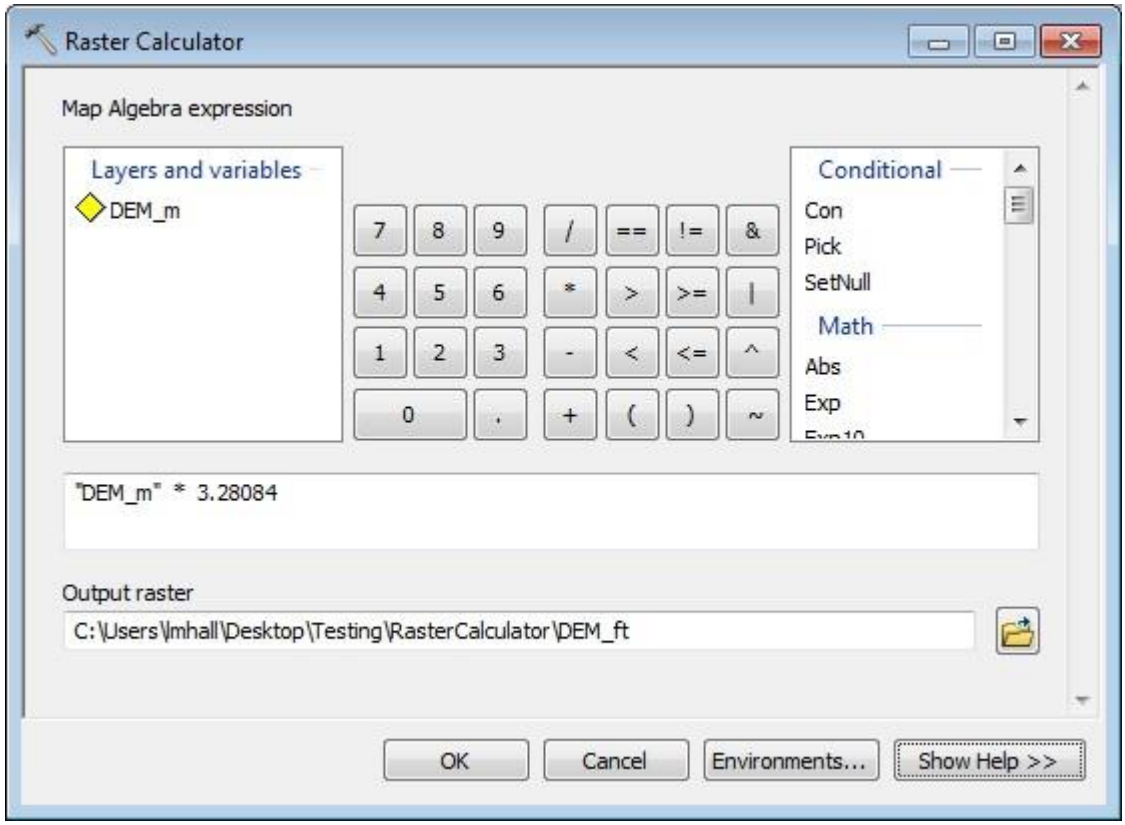
5. This step assumes you are working with the DEM_m product and need to convert it to feet elevation units first. If you already have your DEM in the appropriate elevation units, click here to skip ahead.

   Using the [Search] tool [], locate and open the Raster Calculator tool.
   You can also locate the "Raster Calculator" tool in the "Spatial Analyst Tools" toolbox





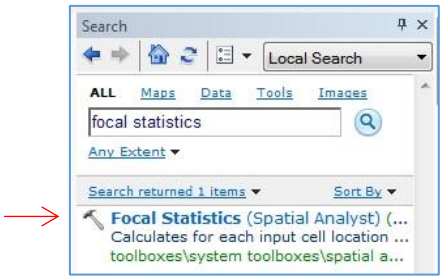
6. Using the “Layers and Variables” section of the tool, double click your variable (input raster dataset). Using the calculator in the tool, multiply the raster by 3.28084. Make sure to follow proper syntax. Select your output workspace and output raster name. Click [OK] to run calculation.

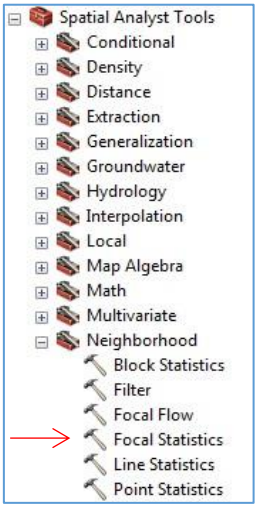


Note: The LiDAR data in Maryland needs Quality Level 2 (QL2) specifications, with NVA (NonVegetated Vertical Accuracy) at 95% Confidence Interval, of less than or equal to 19.6cm. Our conversion to the 5th decimal place is well within the accepted level of accuracy for the QL2 data we are working with.

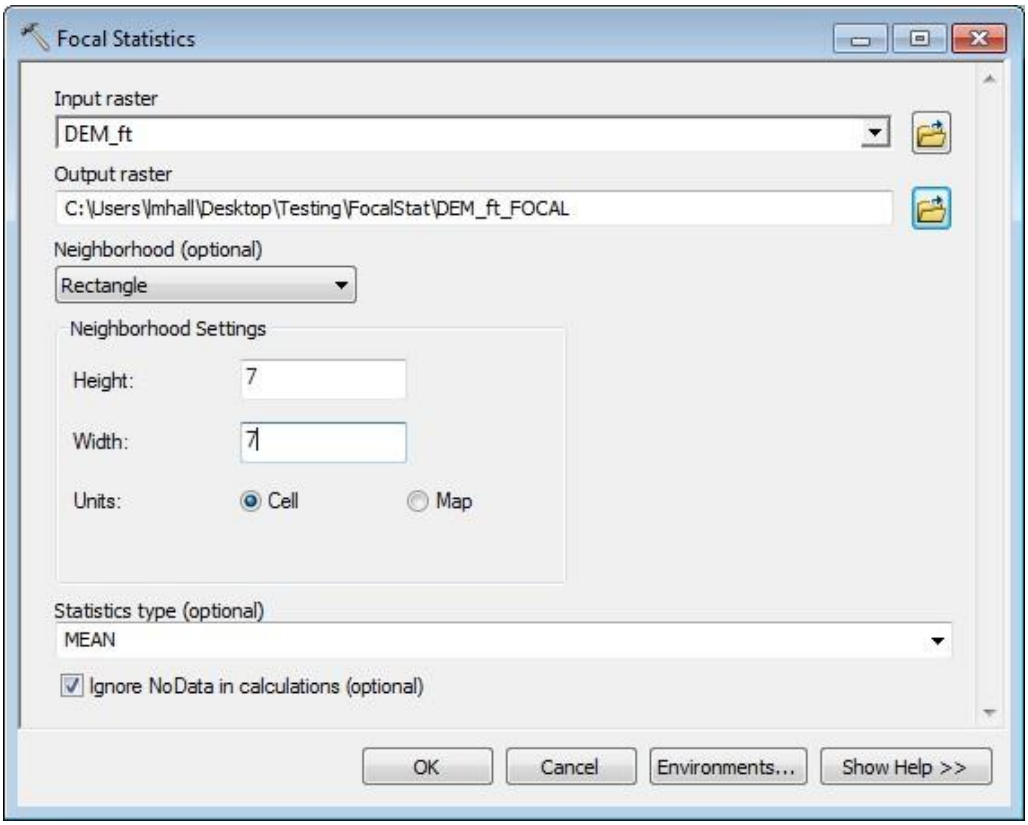
7. In order to create smooth contour lines, we first need to smooth our DEM to ensure the vector output is data-driven. The most efficient way of doing this in ArcGIS is by using the Focal Statistics tool in the Spatial Analyst toolbox.

8. Using the [Search] tool [], locate and open the Focal Statistics tool.
You can also locate the “Focal Statistics” tool in the “Spatial Analyst Tools” toolbox.



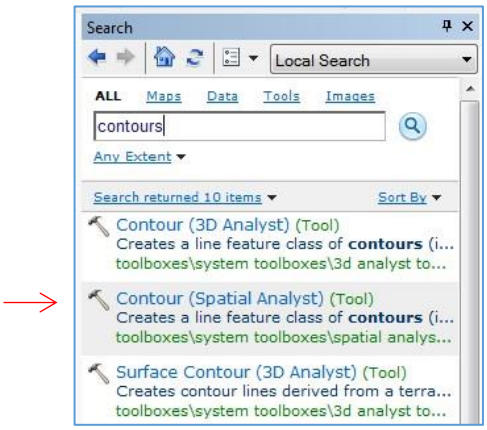


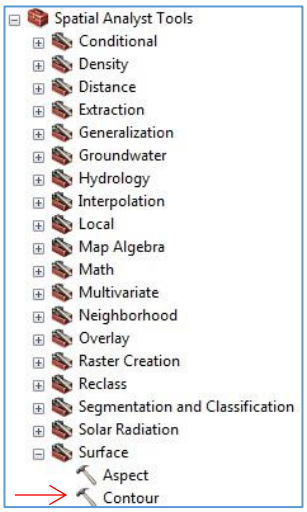
9. Set your “Input Raster”: DEM_ft
Set your “Output Raster”: DEM_ft_FOCAL
Note: (Name this output appropriately – You will not want to use this output raster for anything other than generating your smooth contours… Make sure this layer is not used for any other processing that requires the original DEM for input)
Set your “Neighborhood Settings”: In this example we are using 7x7 for the smoothing.
Leave the rest default and click [OK]



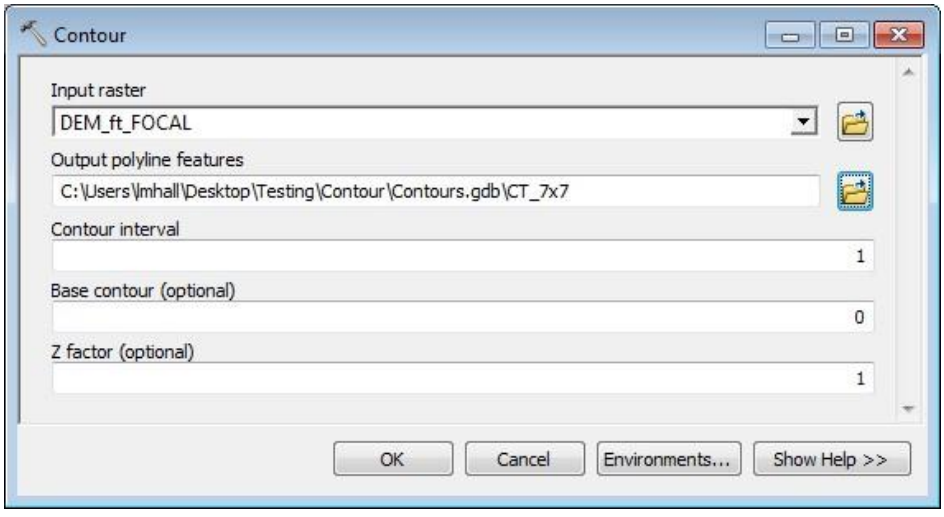
10. You may not notice any visible difference between your DEM_ft raster and the DEM_ft_FOCAL raster.
    The output raster is created by calculating for each input cell, the average of the values within the specified neighborhood. For a 7x7 neighborhood, each cell has been calculated to equal the average of the 49 cells surrounding it.

11. With this new raster, "DEM_ft_FOCAL" we can now generate smooth contour lines.
    Using the [Search] tool [], locate and open the Contour tool.
    You can also locate the "Contour" tool in the "Spatial Analyst Tools" toolbox.





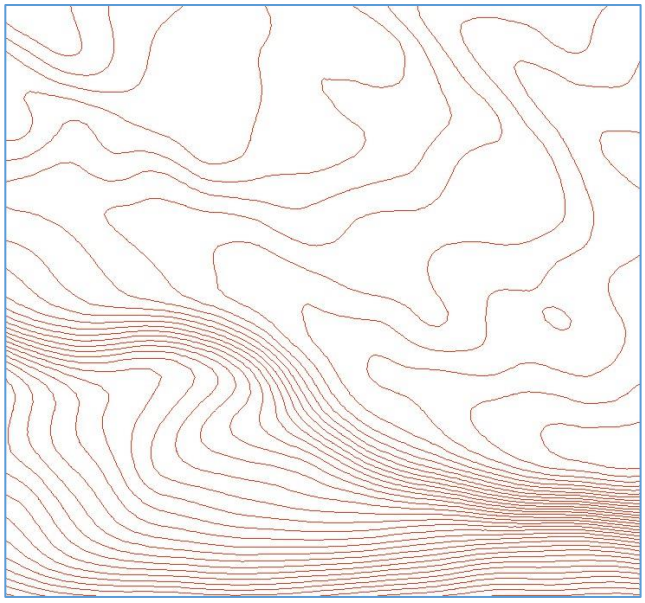
12. Set your "Input Raster": DEM_ft_FOCAL
    Set your "Output polyline features": CT_7x7
    Note: Contour lines can be very large depending on your AOI (area of interest). Therefore it is recommended to work within a File GDB in ArcGIS. Countywide contour lines at 1ft intervals can easily exceed the 2GB limitation set on shapefiles.
    Set your "Contour Interval": 1 leave the rest as default and click [OK]



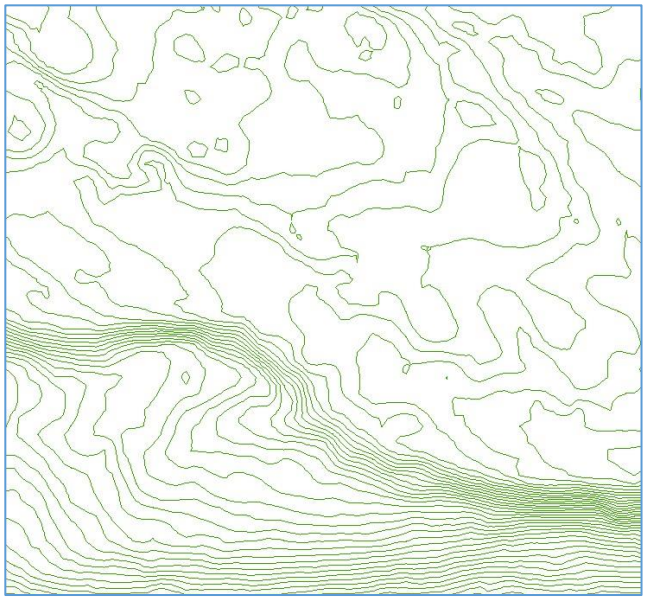
13. Now run the same tool, but this time we will change the “Input Raster” to produce the raw contours (use the DEM_ft without the applied focal statisitc)

Set your “Input Raster”: DEM_ft
Set your “Output polyline features”: CT_raw
Note: Contour lines can be very large depending on your AOI (area of interest). Therefore it is recommended to work within a File GDB in ArcGIS. Countywide contour lines at 1ft intervals can easily exceed the 2GB limitation set on shapefiles. Set your “Contour Interval”: 1 leave the rest as default and click [OK].

Compare the results below:



CT_7x7

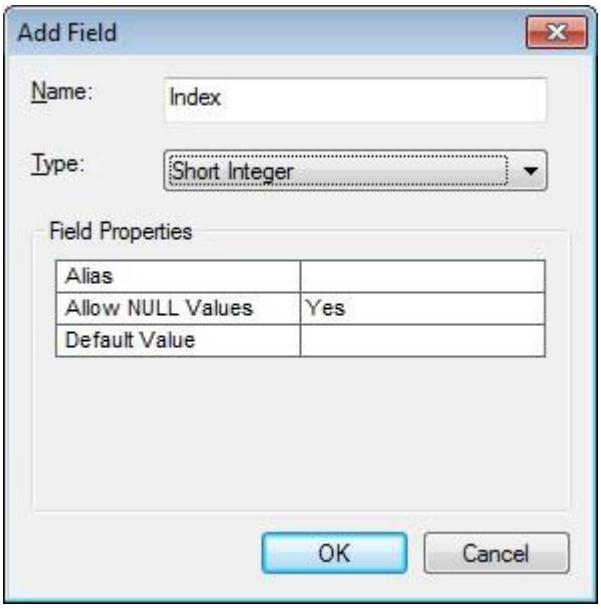


CT_raw

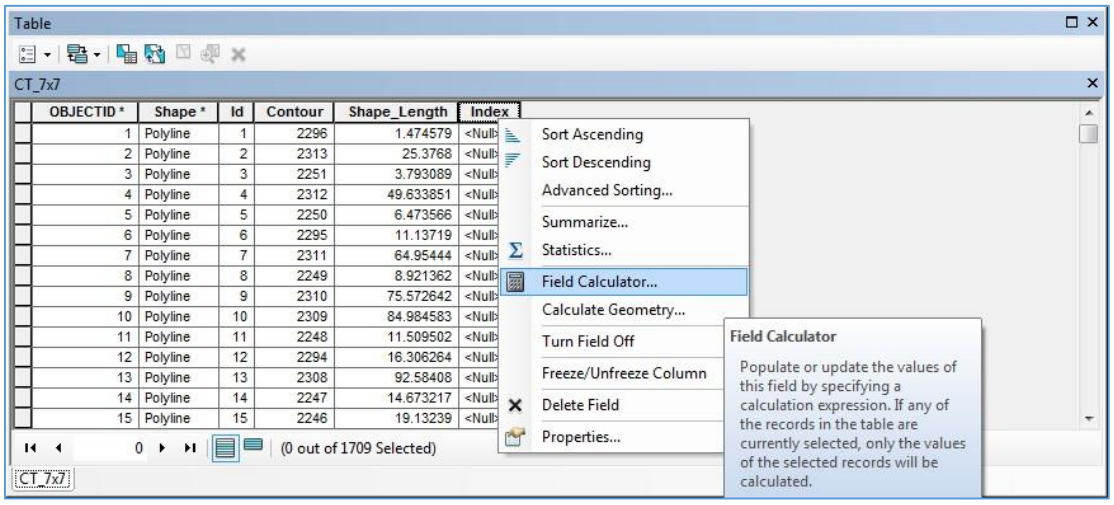
Building Contour Index Lines

1. Indexing your contours after they have been generated is an efficient way to setup labels and symbology across different intervals.

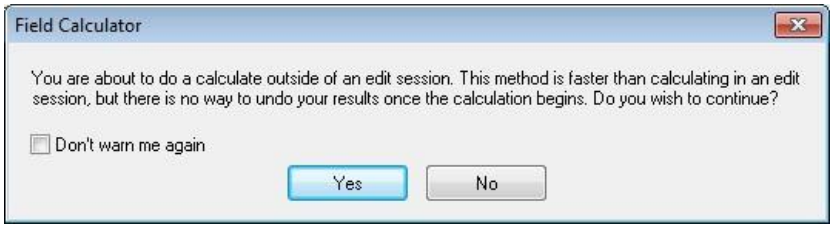
2. Open the attribute table for your contour line feature class; click “Options” [ ] > “Add Field…”
   Name the new field, “Index”
   click [OK]



3. Right click the new field in the attribute table, scroll down and select “Field Calculator”

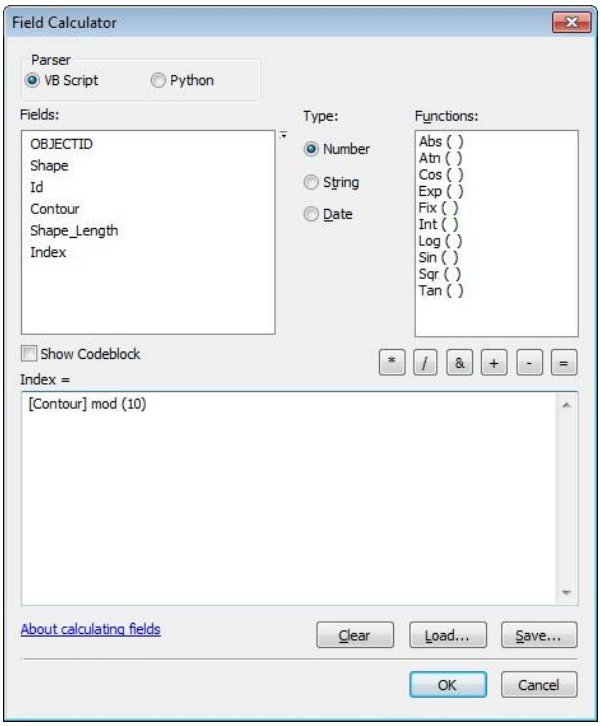


4. If you are outside of an editing session, click [Yes] when prompted or begin an editing session prior to calculating the new field.



5. For this example, we will calculate the 10ft index: Double click “Contour” under the Fields section to add it to the expression with proper syntax.
   Type in a space, and type “mod” (without quotations).
   After “mod”, type another space, then “(10)” (without quotations).

   [Contour] mod (10)



   Click [OK]

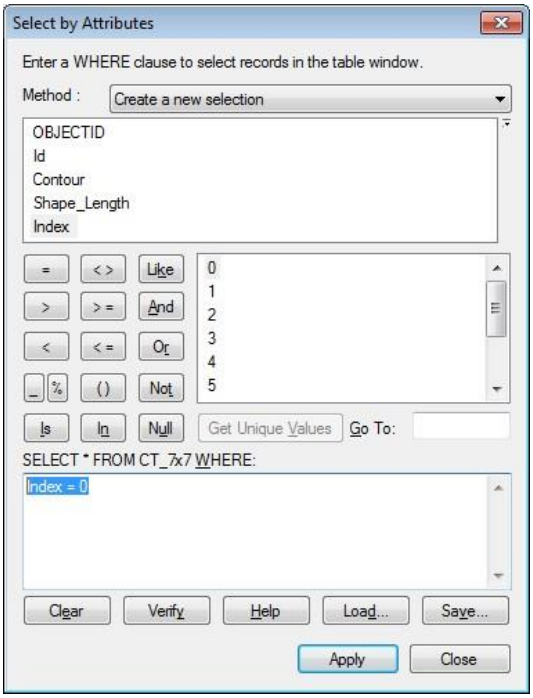
6. In computing, the modulo operation returns the remainder of a number after dividing it by another. In our expression we set a modulo of 10, returning a value of 0 for any number that is divisible by 10. Querying the "Index" field for all values of 0 will give us the 10ft index, or intervals, of our contour lines.

   Open the attribute table for your contour line feature class; click "Options" [] > "Select by Attributes…"

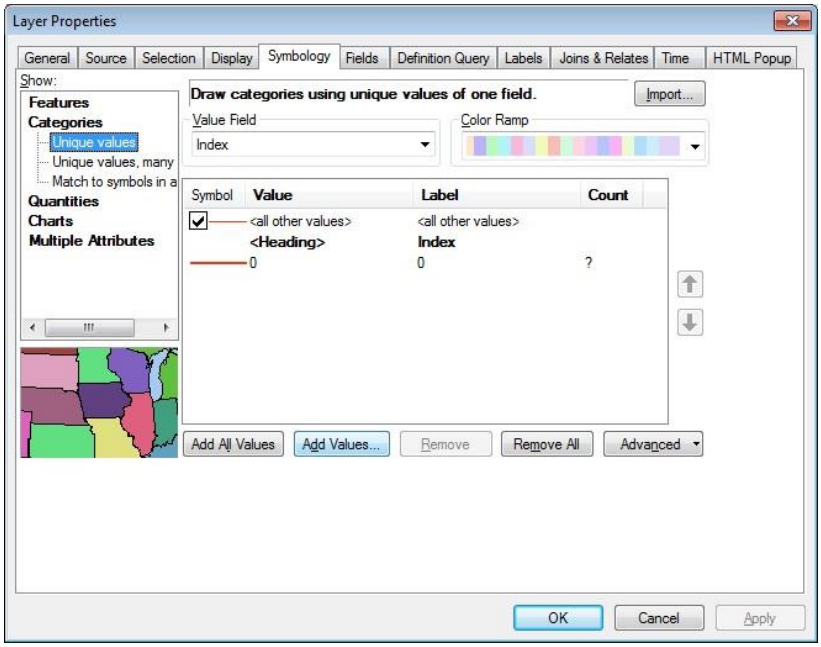
   Type the expression:
   Index = 0

   Click [Apply]

   With our 10ft index lines selected, we can create a new layer from the selected features, symbolize and label the index contours.

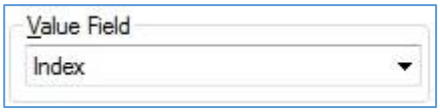


7. Open the layer properties for the contour feature class > Navigate to the Symbology tab.



8. Select “Unique Values” under “Categories” in the Symbology tab of the layer properties:

9. Select “Index” from the “Value Field” dropdown menu:

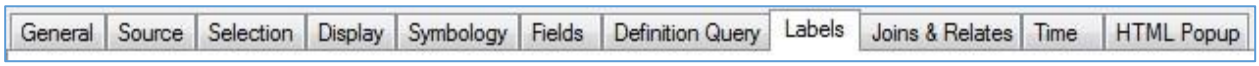


Click “Add Values” [

] and select the Index (0) features.

10. Double click the symbol for your added value “Index(0)” Set line color and width for index lines.

11. Navigate to the “Labels” tab of the properties window:



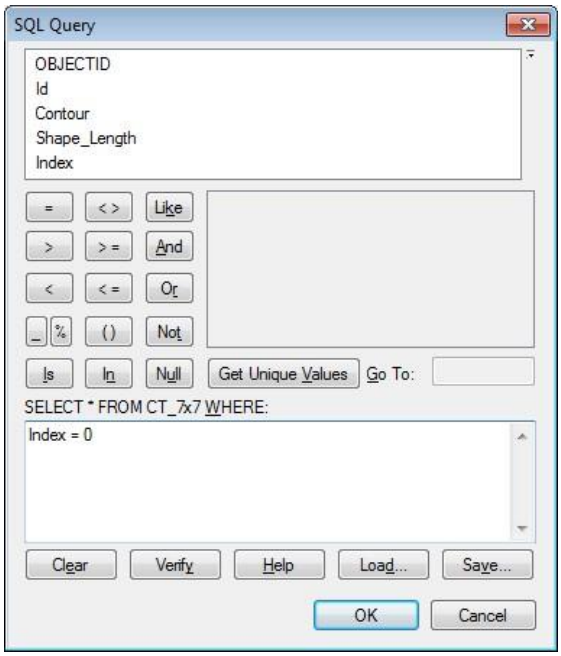
12. Check the box for “Label features in this layer”
Select the method “Define classes of features and label each class differently”.

13. Click “SQL Query” [

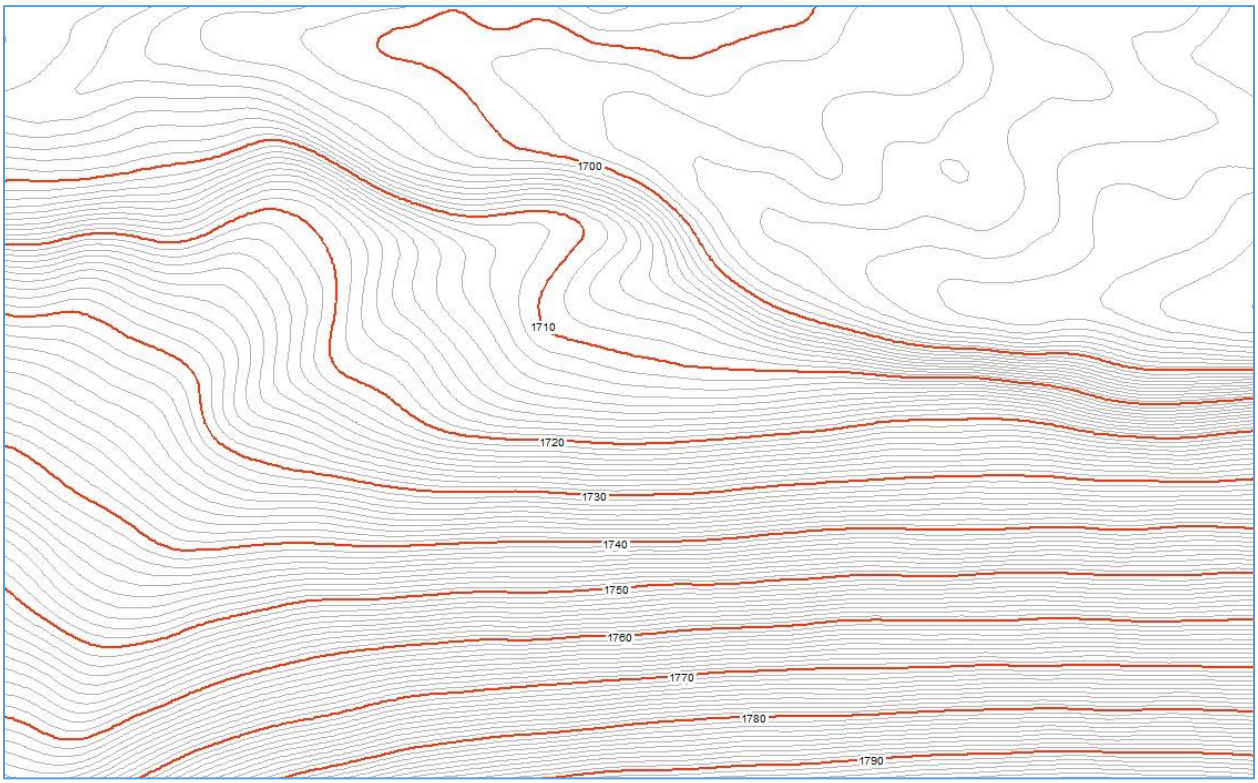
] to write the expression for labelling our index

14. Using our same expression “Index = 0”, set the labelling definition for the contour index:

Click [OK]



15. Close layer properties > Inspect map for labels and symbology:



ADDITIONAL RESOURCES

For more information about Maryland LiDAR, please visit the Maryland LiDAR Overview page

For more information about additional training opportunities, please visit the MD iMAP Training Overview page, or contact Lisa Lowe, Senior GIS Analyst with the Maryland Department of Information Technology, Geographic Information Office at lisa.lowe@maryland.gov.

For additional MD iMAP datasets, please visit the GIS Data Catalog

For all other inquiries related to Maryland LiDAR, please contact the GIO Office at service.desk@maryland.gov.