Calculating Geometry and Drainage Density (ArcGIS 10.3.x)

Prior to beginning the process of calculating drainage density for a basin or sub-basin, it is important to ensure that you have all of the necessary data to perform the analyses. This includes the lengths for all channels (rivers, streams, etc.) that fall within the basin boundaries, as well as the value for the total area of the basin.

Drainage density is calculating using the following formula:

$$\text{Drainage Density} = \frac{\text{total length channels (m)}}{\text{basin area (m}^2\text{)}} = m^{-1}$$

The procedure outlined below provides the steps for calculating drainage density in ArcGIS 10.3.x.

Note: It is important that the data you are working with is in a projected coordinate system with relevant units. Using unprojected data (data in a geographic coordinate system) as input for these calculations will yield erroneous results.

Step 1   Adding Fields

Open ArcMap and use the *Add Data* tool to add the stream and basin boundary files that you will be working with to the map document. Right-click the stream layer's name in the table of contents and select *Open Attribute Table*.

Examine the stream attribute table to determine if there is already a field containing values for stream length. If a length field does not already exist, then this property can be calculated with minimal effort using the following steps:

1. Click the *Table Options* icon from the top left corner of the attribute table dialog and select *Add Field*.
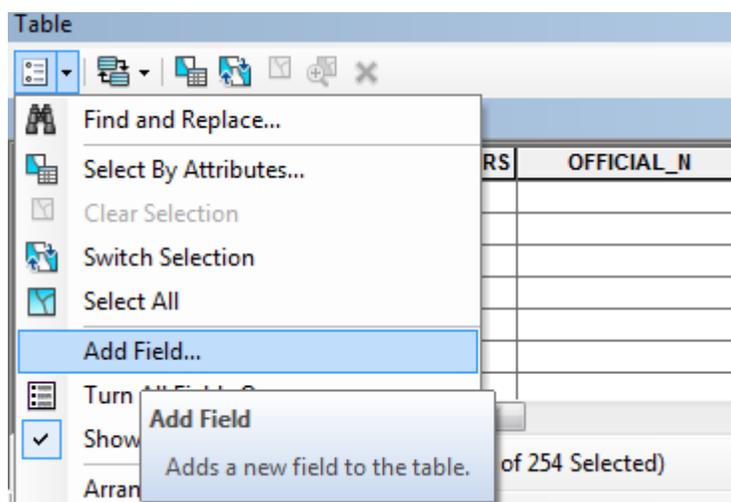
2. Enter a short, descriptive name for the field and select the data type as *Double*. Leave all other defaults and click *OK.* The new field will be appended to the layer's attribute table.
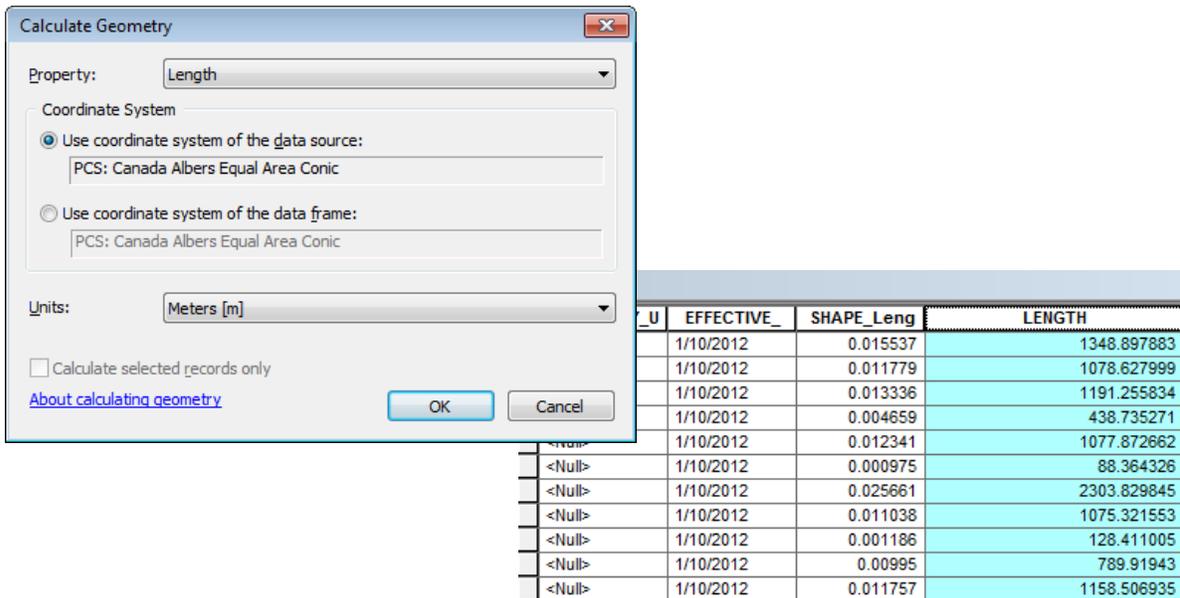

3. You will now calculate the length of each stream segment in the stream layer. If you do not currently see the *Editor* toolbar on your screen, browse to *Customize > Toolbars* and place a check mark beside *Editor* in the list provided. The toolbar should appear on your screen. To begin an editing session, click the *Editor* drop down arrow and select the option to *Start Editing*.
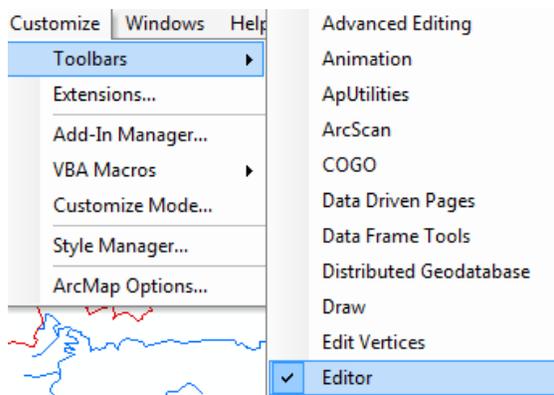
4. Return to the stream attribute table and scroll over until you see the length field created in Steps 1 and 2. Right-click the field name and select *Calculate Geometry*.
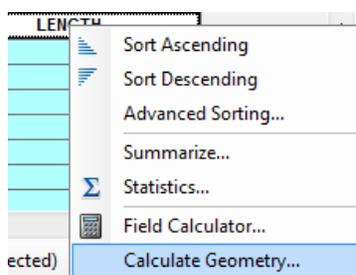
5. Set the *Property* field to *Length*, then select your desired coordinate system and units. Click *OK*. The length of each line segment is calculated and entered to its corresponding row in the attribute table.

	_U	EFFECTIVE_	SHAPE_Leng	LENGTH
		1/10/2012	0.015537	1348.897883
		1/10/2012	0.011779	1078.627999
		1/10/2012	0.013336	1191.255834
		1/10/2012	0.004659	438.735271
	<Null>	1/10/2012	0.012341	1077.872662
	<Null>	1/10/2012	0.000975	88.364326
	<Null>	1/10/2012	0.025661	2303.829845
	<Null>	1/10/2012	0.011038	1075.321553
	<Null>	1/10/2012	0.001186	128.411005
	<Null>	1/10/2012	0.00995	789.91943
	<Null>	1/10/2012	0.011757	1158.506935

6. Click the *Editor* drop down arrow and select *Stop Editing.* Save your edits when prompted.

Note: *If there is a length field present, but the data has been provided with a geographic coordinate system, then it will be necessary to first project the layer and then recalculate the length field using the steps above. Different projections will result in different values for geometric properties.*

Step 2   Calculate basin area

Repeat the steps outlined above to calculate the total area for your basin or sub-basin polygon. This time, add a field called AREA with a Double data type to your basin layer. Start an editing session, select *Calculate Geometry*, and calculate the geometric property of *Area*. Ensure that the coordinate system and units match those of the stream layer.

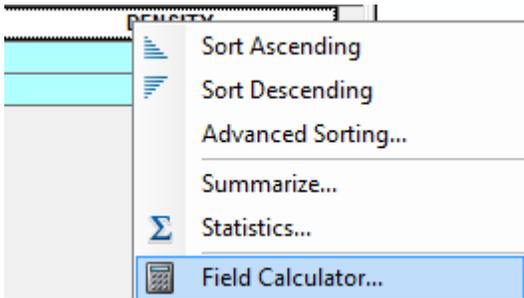### Step 3 Calculate drainage density

Use the instructions provided above to add a new field to your basin/sub-basin layer. Call the field DENSITY and select a data type of *Double*.

You will now use the field calculator to calculate drainage density. The field calculator is provided for use when you wish to perform calculations that are not included as built-in functions within ArcGIS. The equation for drainage density, as we have seen previously, is as follows:

$$\text{Drainage Density} = \frac{\text{total length channels (m)}}{\text{basin area (m}^2)} = m^{-1}$$

You can see from the equation that you are required to sum the lengths of the channels. It is not necessary to do this manually; instead, open the attribute table associated with your channels, right-click on the LENGTH field, and select *Statistics.* The resulting dialog provides summary statistics for the field, including the SUM of all values. Make note of the total sum – you will use this number in the next step.

Start an editing session and then open the basin attribute table. Right-click on the DENSITY field and select *Field Calculator*.

Enter the following expression to the Field Calculator using the tools provided:

`Total channel length / [AREA of basin]`
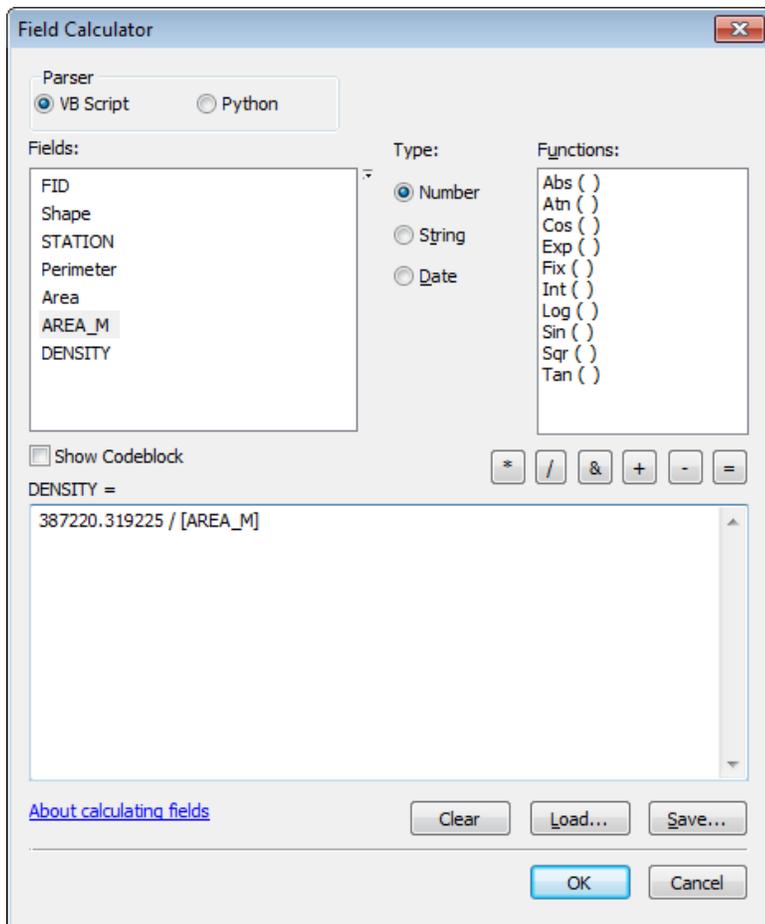
Click OK to calculate the value/s for drainage density. Your density field will be populated with the density calculation for each individual basin that is represented in your attribute table.

For further assistance with this guide or other topics related to geospatial and statistical data or software, please contact us at madgichelp@trentu.ca.