INTRODUCTION TO QGIS ('LISBOA' V. 1.8.0)

In this exercise, you will become comfortable with using QGIS (1.8.0) to analyze and map freely available GIS data types. You will explore your GIS data, create new GIS files, do simple geoprocessing analyses, and create and export a map. The data you will be using for this workshop exercise can be found in 'C:\<users>\<username>\Desktop\QGIS\WorkingData' (note: this path might be different depending on what your OS system is, but in general, we will be loading all data in a folder on your Desktop).

QGIS Desktop (aka the QGIS GUI)

QGIS Browser (aka the QGIS version of 'ArcCatalog'…a new v1.8 feature)

Most of the data you will be using for this exercise is freely available at MassGIS (http://www.mass.gov/mgis). All data is in Massachusetts State Plane Coordinate System, Mainland Zone (Fipszone 2001), and the datum is the North American Datum (NAD) 1983. The EPSG (European Petroleum Survey Group) code for this coordinate reference system is: **26986**. The units are meters. More information can be found through the metadata links on the website listed above.

Raster:

- **elevations1.tif** (GeoTIFF)
  This is a DEM (Digital Elevation Model) of Belchertown, MA. Spatial resolution is 3 meters.
- **hillshd10m1.tif** (GeoTIFF)
  This is a hillshade model, resampled from the elevations1 dataset to 10 meter resolution.

Vector:

- **Belchertown_Boundary.shp** (Shapefile)
  This MassGIS political boundary datalayer is a 1:25,000 scale datalayer containing the boundaries of the 351 communities (cities and towns) in Massachusetts.
- **Dams_PVPC.shp** (Shapefile)
  This Massachusetts Dams data layer contains points derived from a dam safety database maintained by the Massachusetts Office of Dam Safety (ODS).
- **HYDRO25K_ARC_Belchertown.shp** (Shapefile)
  HYDRO25K_POLY_Belchertown.shp (Shapefile)
  HYDRO25K_QUABBIN_LUDLOW_RESERVOIR.shp (Shapefile)
  The MassDEP Hydrography layer is an enhanced version of the 1:25000 Hydrography datalayer. The layer is a hybrid of data based on digitized hydrographic features from paper USGS 1:25,000 Topographic Quadrangle maps and data extracted from the MassDEP Wetlands datalayer.
- **EOTROADS_ARC_Belchertown.shp** (Shapefile)
  This layer is the official state-maintained street transportation dataset available from MassGIS and represents local and major roadways, including designations for Interstate, U.S. and State highways.
- **SWP_WATERSHEDS_LUDLOW_QUABBIN.shp** (Shapefile)
  This datalayer contains the watershed extents for all surface water supplies including active, inactive, and emergency sources.
- **zoning_Belchertown.shp** (Shapefile)
  Belchertown zoning data obtained from the Belchertown planning board on 12/2012.
- **Soil_HHEA.mdb** (ESRI Personal/Access Database)
  Subset of data taken from the MassGIS HAMPDEN-HAMPSHIRE EAST SSURGO dataset.
- **mapunit.csv** (comma separated file)
  Subset of data taken from the MassGIS HAMPDEN-HAMPSHIRE EAST SSURGO dataset. Joins to Soil_HHEA.mdb through the primary key field "MUKEY".

GIS: Introduction to QGIS

Throughout this exercise you will practice using QGIS, which is an Open Source Geographic Information System. QGIS was released under the GNU General Public License (GPL), and therefore, developers are free to inspect and modify the source code (fyi: QGIS developers use the Qt toolkit and C++ to develop this product).

Like most open-source platforms there is always a measure of difficulty and imperfection inherent in each release (remember: this is free software). However, QGIS has an ample amount of documentation and users who are here to help you resolve any problems you might have along the way. Below are a few helpful links worth investigating:

- QGIS 24 hr. chat room: http://webchat.freenode.net/?channels=#qgis
- QGIS manuals, user guide, and documentation: http://www.qgis.org/en/documentation/manuals.html
- QGIS style files, symbols and extra stuff. GREAT Cartographic Resource! https://github.com/anitagraser/QGIS-resources

*** START THE EXERCISE BELOW! ***

These are important points that you should read before you go any further!

These are informative tips that may help you in the future!

Lesson 1: Explore Raster Functions and Symbolization

QGIS accepts *many* data formats, however, some proprietary formats (such as ESRI file geodatabases .gdb), are not accepted. ESRI, as a for-profit company, doesn't openly distribute its source codes. Source codes and API's are needed in order to make proprietary file types translatable to open source platforms.

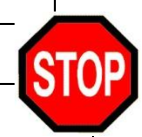
1. Activate QGIS Desktop and select **Add raster layer** → **Browse**

a. *Open a GeoTIFF file,* Go to **C:\<users>\<username>\Desktop\QGIS\WorkingData\Raster**

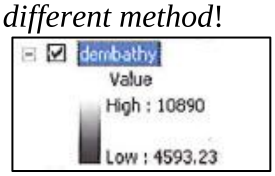
b. Preview the two available raster files by selecting the **[GDAL] GeoTIFF…** option from the file extension pull down.
   - elevations1
   - hillshd10m1

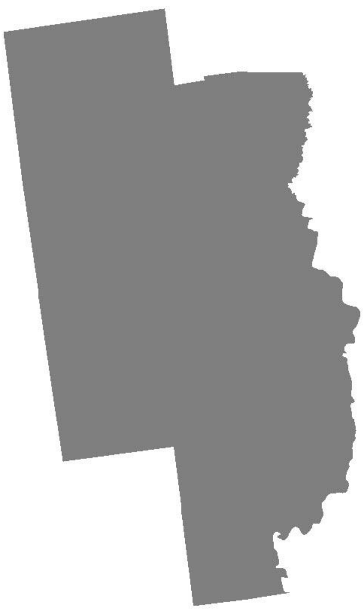
c. Holding the **Shift button**, select the two file and then select **Open**.

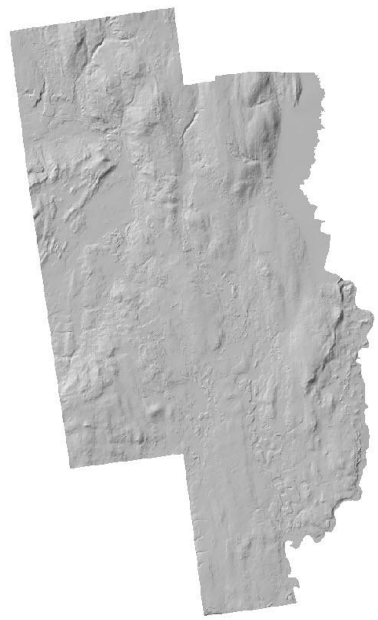
d. The data layers are added to your Table of Contents (aka the **Layers List**) and appear in your **Map** window. Check **off** and **on** the boxes to the left of the layer name. Experiment with moving the layers in different orders. You can also collapse and expand a layer's legend using the toggle switch. Overall, your two default images should resemble the images on the next page. Once you are done exploring, check **off** the hillshd10m1.tif. Leave only the elevations1.tif **on**.

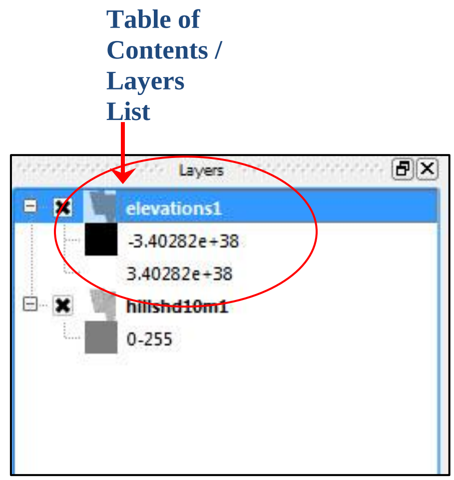


The functionality of the QGIS Desktop GUI is similar to ESRI ArcMap. However, there are some acute differences. One obvious difference is the lack of color gradients available to an ArcMap user as a symbology option. For instance, when adding the DEM file (i.e. elevations1), you might've seen this (below) in the Table of Contents if you had added it into ArcMap. This is just because the defaults are configured different in ArcMap. Don't worry! The same results can be achieved in QGIS with the same data – *by using a different method*!

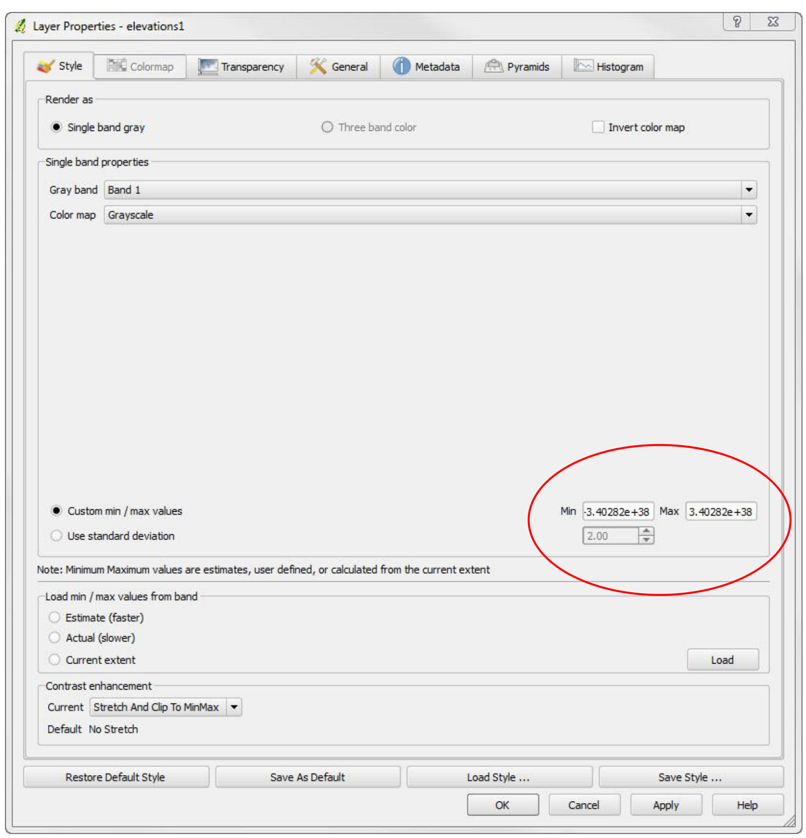






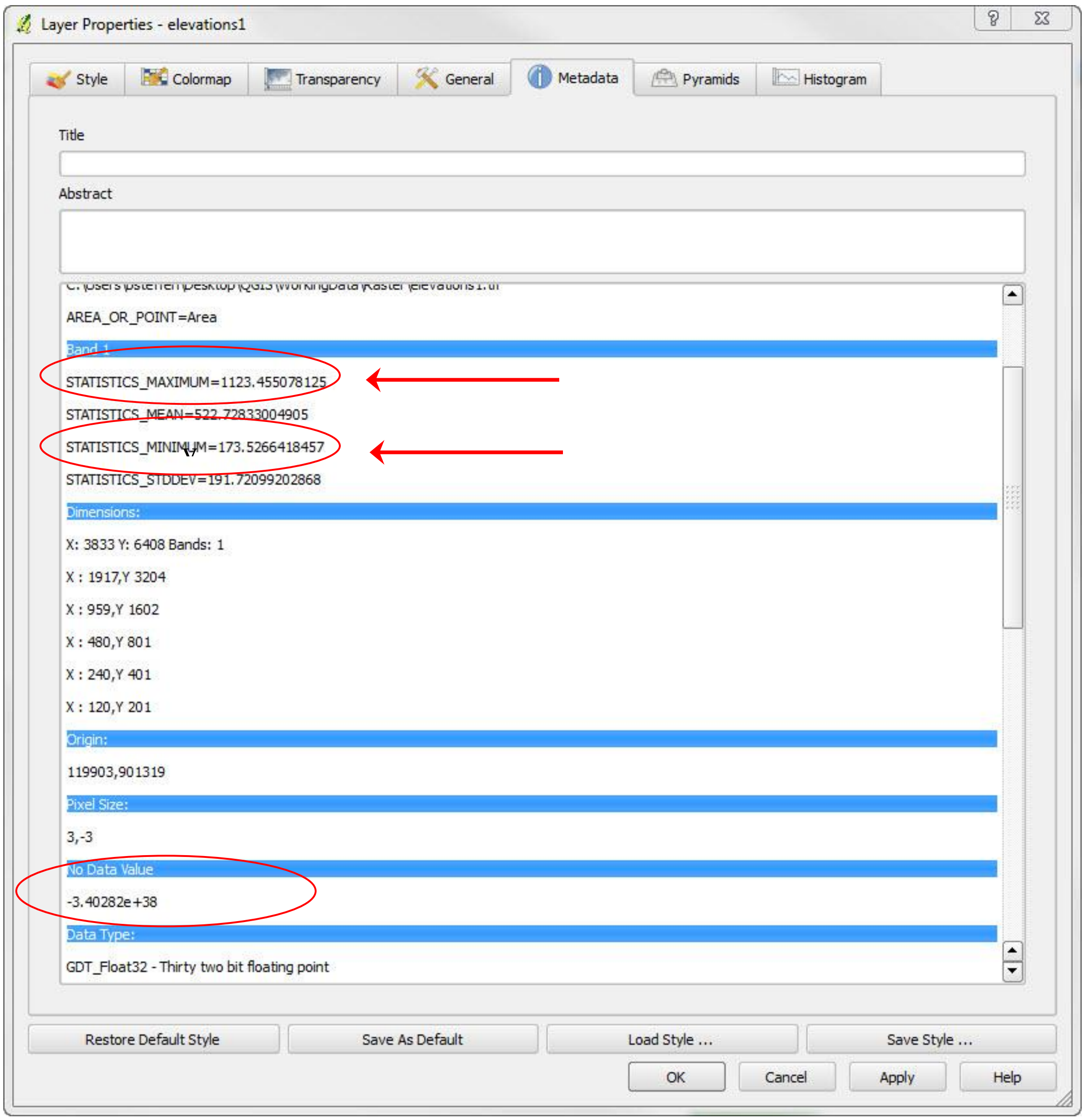


2. *Adjust the DEM display ranges, mask null values, explore value ranges in the* **Layer Properties** *window.* In the above image, you will notice that there is two symbol type options being used to display the elevations1.tif. Gray for a value of "-3.40282e+38" and white for a value of "3.40282e+38". This is curious, and worth investigating. To start, **right click** and **hold** on the layer name. In the window, scroll to the option **Properties**. This will open the **Layer Properties** window. Note that the Min & Max values are the current display settings. Close this window by **left clicking** the far right 'x'.



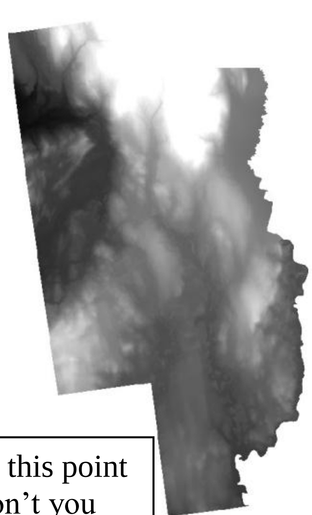
a. *Find the null value(s),* **Left Click** on the **Identify Features**  button in the **View** menu. Click in the white area, near the gray, inside your **Map** window. What information have you learned (i.e. if the white area is symbolized as "3.40282e+38" and the identify tool is calling the white region null, what is the null value)?

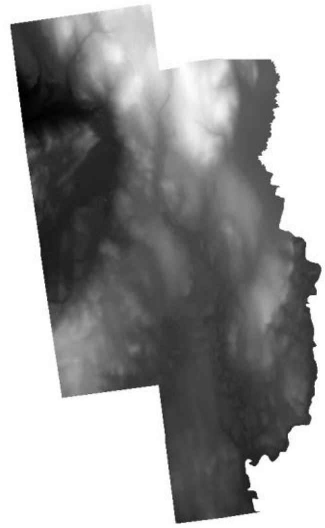
b. Return to the **Layer Properties** window following the steps in #2. Click on the **Metadata** tab. Note the values in the identified in the circles below. From the information you've gathered using the previous steps you should now know there are TWO null/no data values, and the true max/min values of your DEM.



To help you identify what you want (quickly, with a text box) you can **Left Click** on **Map Tips** in the **View** menu. There also are some keyboard shortcuts that can be helpful to learn. For **Identify Features**. "Ctrl + Shift + I" will activate the identity tool. See the User Guide for more on this.

c. *Set the Display to Clip the null values and display a gradient of grayscale based on the standard deviation,* **Left Click** in the **Layer Properties** window on the **Style** tab. Select "Gray band: Band 1" and "Color map: Grayscale". Select "Use Standard Deviation: 2.00". Set Contrast Enhancement to "Current: Stretch And Clip To MinMax". , **Left Click** the "Apply" button, then "OK". Your map screen should match one of the two images on the next page. Can you improve the visualization of high-elevations (view the hillshad10m1.tif if you need help identifying high-elevations) by entering the exact values from STATISTICS_MAXIMUM and STATISTICS_MINIMUM (see above) in the "Custom min/max values" box?





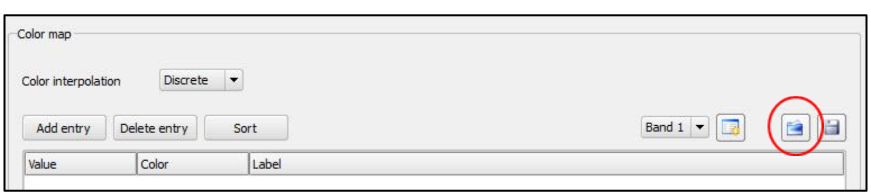
Never hurts to Save! At this point you have done a ***LOT***. Why don't you go to **File → Save Project** and save your QGIS file in your project folder?

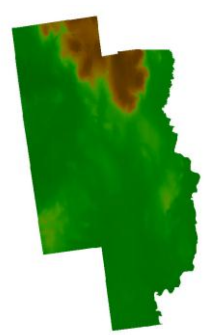
3. What happens when you use the default tools in the **View → Raster** menu?  Locate the "Stretch Histogram to Full Dataset" and "Local Histogram Stretch". Experiment by clicking on these different tools. For a bit of background: the button on the right will stretch the minimum and maximum values to give you the best contrast in the local area that you're zoomed into. It's useful for large datasets. The button on the left will stretch the minimum and maximum values to constant values across the whole image.

   When you are done using these tools return to the **Layer Properties** by following the steps in #2.

4. *Create a custom colormap using a text file of elevation assigned R,G,B values*. In the **Layer Properties → Style** menu set "Color map: Colormap". Note that the **Colormap** tab in the **Layer Properties** menu becomes active. Select the **Colormap** tab.

   a. In the **Colormap** tab, find the "Load color map from file" option (see below). **Left click** on it and Go to **C:\<users>\<username>\Desktop\QGIS\WorkingData\Raster\Analysis**. Select and open the elevationcolor.txt. In the **Colormap** tab in the **Layer Properties** click the "Apply" button, then "OK". Repeat step #4 to return to the **Colormap** tab. Click on Color entry 10 and "Delete entry". Then Click on "Add entry" and select the newly added "Custom color map entry". By **Left clicking** inside the ramp menu, enter your null value of "-3.40282", and select a yellow color from the **Select Color** menu. Label it as "Color entry 10 new". Click the "Apply" button, then "OK". What happens? Return to the **Colormap** tab, select "Save Style", and save your custom colormap as "ElevationColor_Lab1.qml" in **C:\<users>\<username>\Desktop\QGIS\WorkingData\Raster\Analysis**.

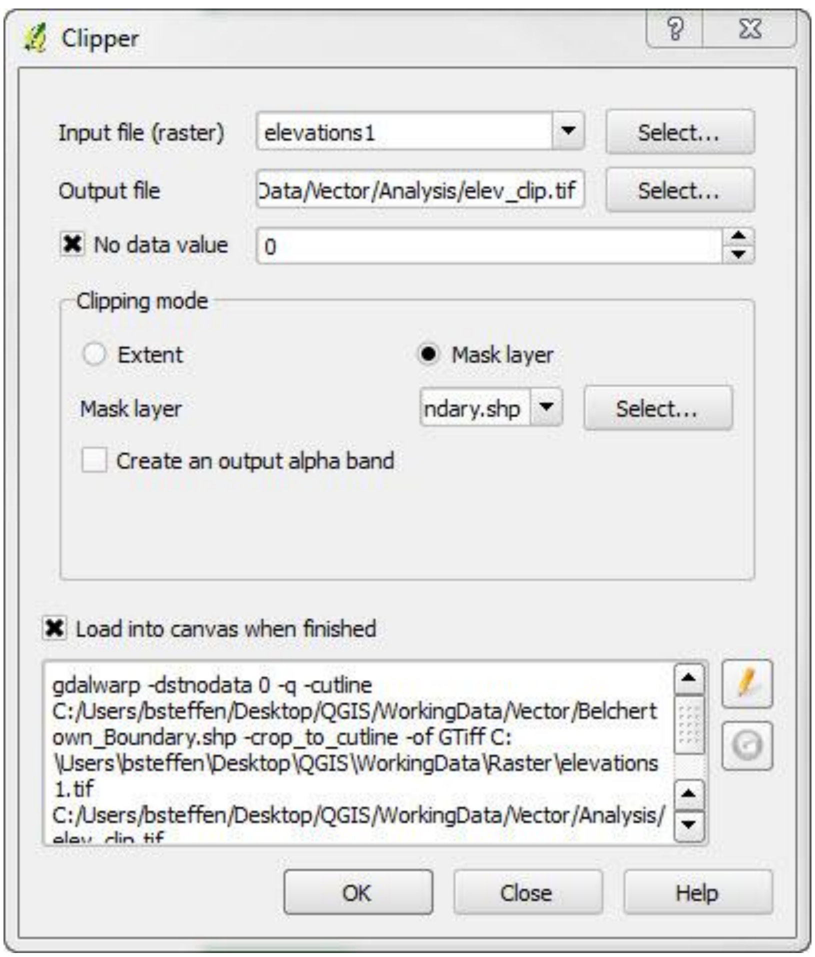




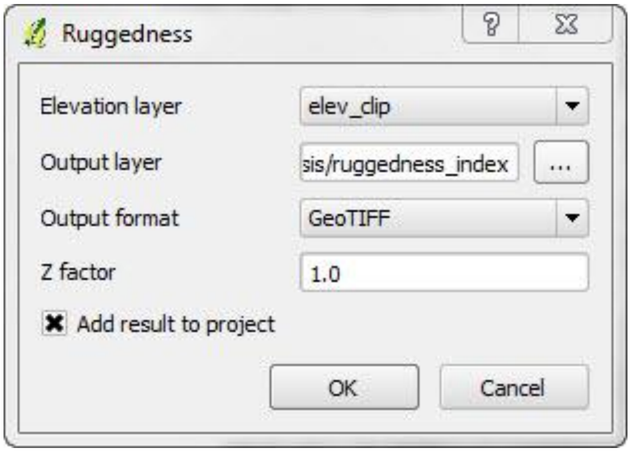
5. *Create a Terrain Ruggedness Index (TRI) analysis*. A Ruggedness Index is a quantitative measurement of terrain heterogeneity. It is a common GIS analysis used by environmental planners to quantify and pinpoint species habitats. Recently TRI was applied to bathymetric grids of the seafloor in the Stellwagen Marine Sanctuary located in Boston, Massachusetts. The high variability of the seabed terrain (formed largely by glacial processes) corresponded to the regions wide range of habitats and high biodiversity. For more information see: Riley, S.J., DeGloria, S.D., Elliot, R. 1999. A terrain ruggedness index that quantifies topographic heterogeneity. Intermountain journal of Sciences. 5, 23-27.

   a. *Add the 'Raster based terrain analysis' from the QGIS Plugins Manager*. **Left Click** and hold on the **Plugins** tab on the upper menu bar. Go to **Plugins** → **Manage Plugins**. Enter 'Raster Terrain Analysis plugin' into the Filter. Make sure it is checked in the left checkbox, then select 'OK'.

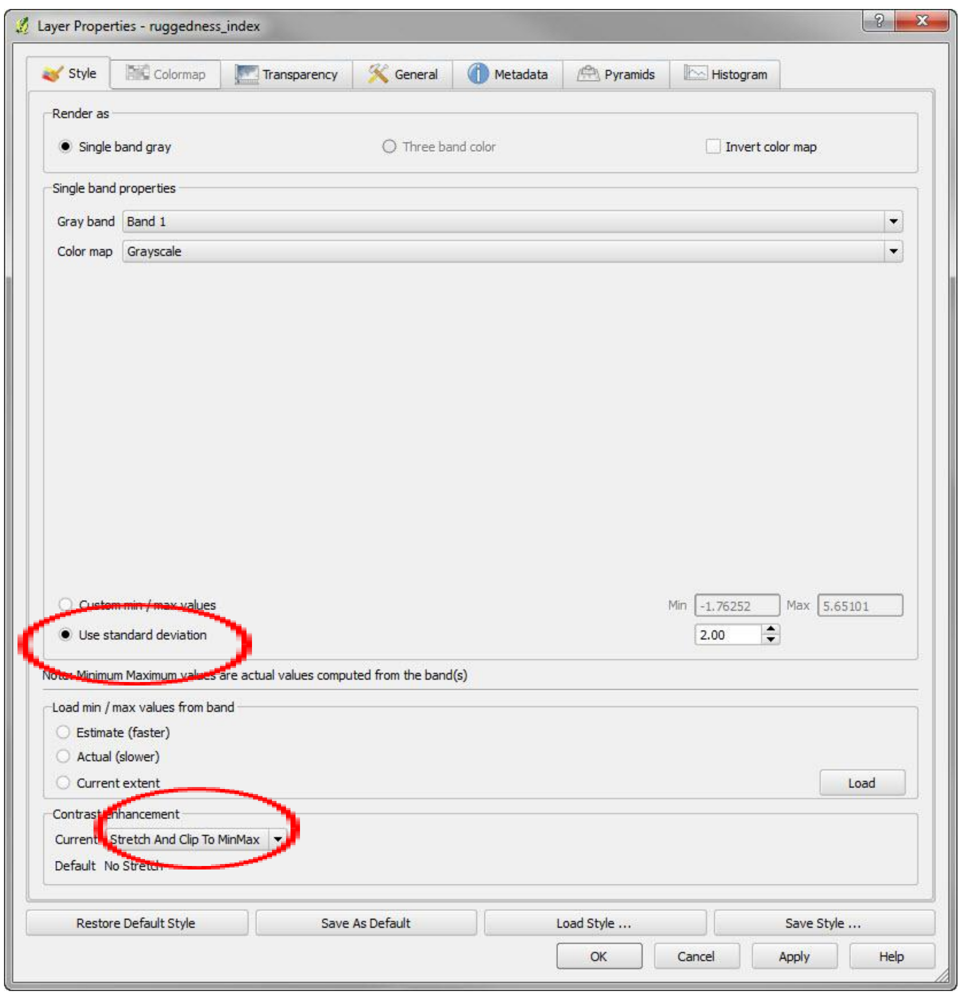
   b. *Clip out our 'null' values*. In the main **View** toolbar go to **Raster** → **Extraction** → **Clipper**. In the **Clipper** window name your "Output file "elev_clip" and save it in the **C:\<users>\<username>\Desktop\QGIS\WorkingData\Raster\Analysis** folder. Select "Mask layer" as your 'Clipping mode'. In the Selection dialog, go to **C:\<users>\<username>\Desktop\QGIS\WorkingData\Vector** and select the Belchertown_Boundary.shp and click 'Open'. Fill out the rest of the window as you see below.

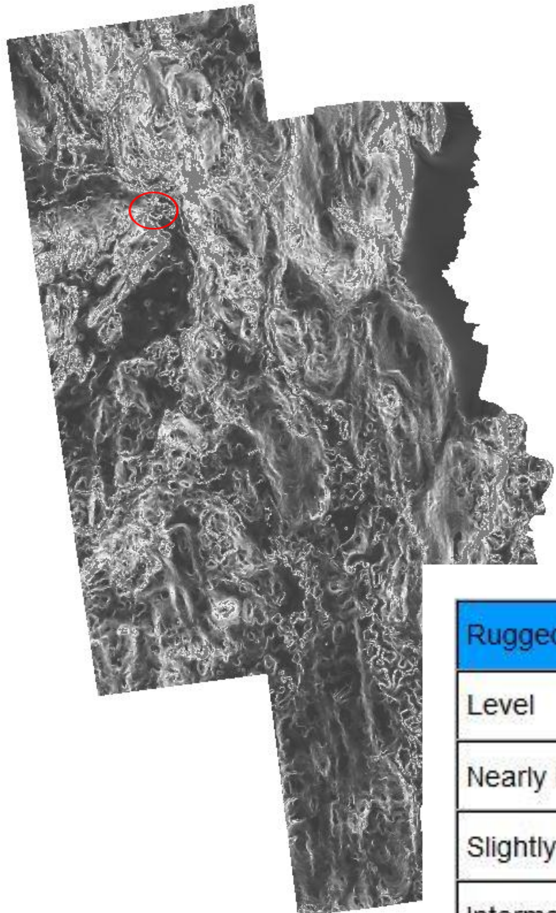


c. In the main **View** toolbar go to **Raster** → **Terrain Analysis** → **Ruggedness Index**. Fill out the menu as shown below. In "Elevation layer" select 'elev_clip'. In "Output Layer" make sure to save your file as "ruggedness_index" in the **C:\<users>\<username>\Desktop\QGIS\WorkingData\Raster\Analysis** folder. Save the "Output format" as a "GeoTiff". Make sure there is a check in "Add result to project". Click 'OK'.



Initially, your results will be set to the default gray display value that you first encountered when initially loading elevations1.tif. However, this can be remedied by **Right Clicking** on your ruggedness_index.tif and going to **Layer Properties** and adjusting the settings as seen below. The image should look like the following on the next page.





d. *Evaluate data results*. The Riley index ranges used for understanding ruggedness are presented in the chart below. Notably, if you look at the **Histogram** tab in the **Layer Properties** window, you can see that most of our data falls in the "Level" classification (in fact, pretty much all of it). The areas on the higher end of 'Level' range, tend to be near the peaks of mountains, or where changes in elevation are more dramatic. Using the **Transparency** tab in **Layer Properties**, see if you can change the 'Global Transparency' levels of your ruggedness_index.tif to be able to see the hillshd10m1.tif underneath. Use the **Identify Features** tool to click around on high elevation areas (I've circled one target spot in red on the image to your left to help you start).

Ruggedness Classification	Ruggedness Index Value
Level	0 – 80m
Nearly Level	81 – 116m
Slightly Rugged	117 – 161m
Intermediately Rugged	162 – 239m
Moderately Rugged	240 – 497m
Highly Rugged	498 – 958m
Extremely Rugged	959 – 4397m

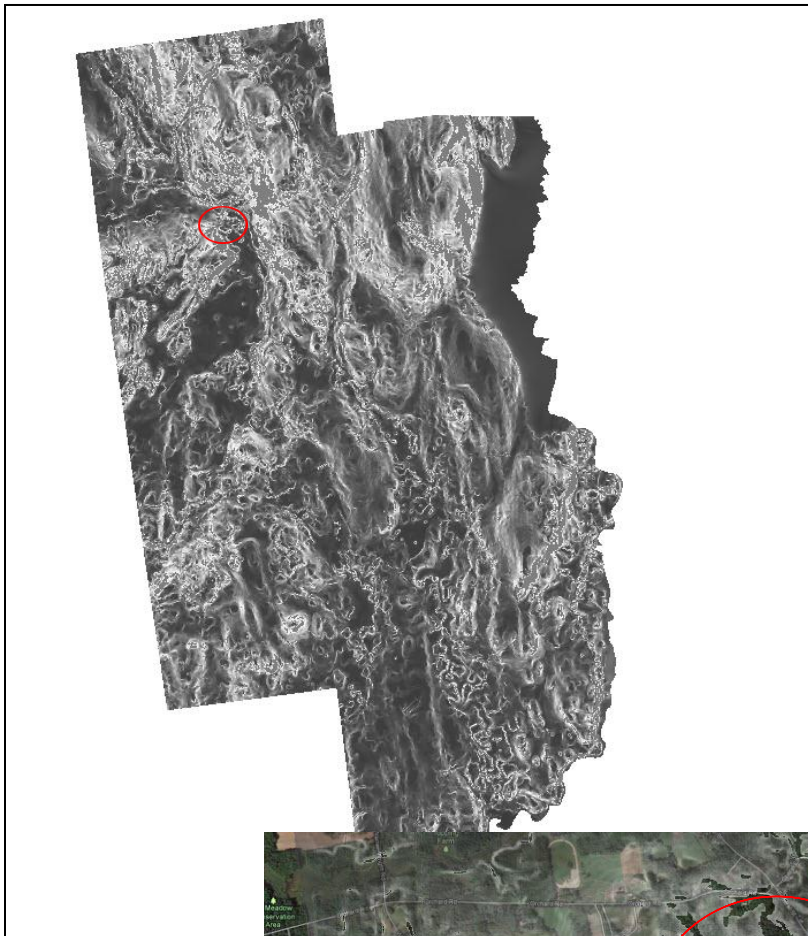
Riley's TRI is just an index…based on two cell-neighborhood calculations. Interpretation is what makes the analysis meaningful. Geomorphologist's find it useful for visualizing slope AND proximity characteristics…for example, a steep AND smooth surface (which would have a high TRI) vs. flat and bumpy.

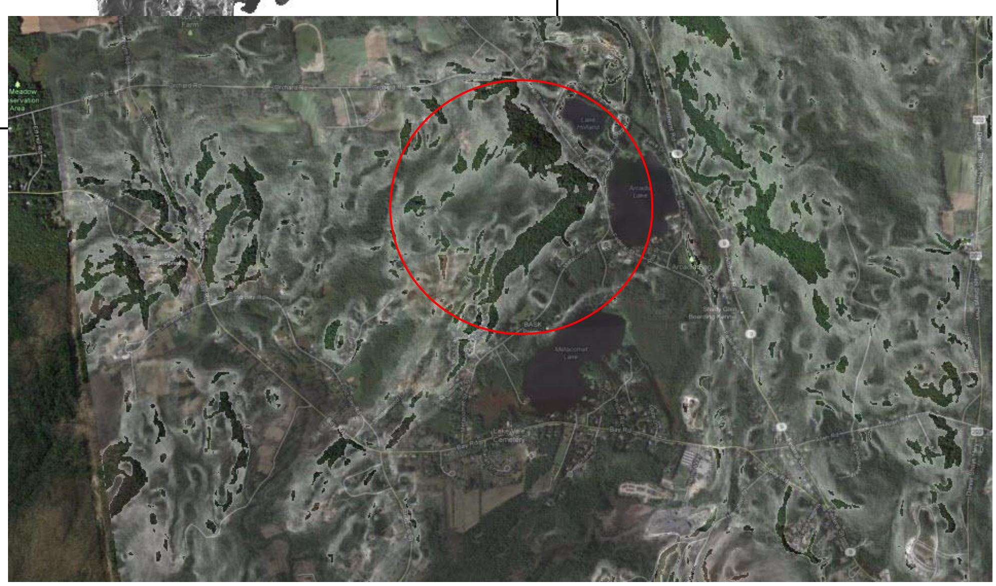
6. *Add an aerial Google image from OpenLayers*. In the main menu, go to **Settings** → **Project Properties**. Make sure the "Coordinate Reference System" is set to: 'NAD83 / Massachusetts Mainland EPSG: 26986'. **Left Click** on the "Enable 'on the fly' CRS transformation". Click 'OK'.

☒ Enable 'on the fly' CRS transformation

a. *Add the OpenLayers Plugin from the Python Plugin Installer Library*. '**Left Click** and hold on the **Plugins** tab on the upper menu bar. Go to **Plugins → Fetch Python Plugins**. Enter 'OpenLayers Plugin' into the Filter. Make sure it is selected and then click "Install plugin".

b. Go to **Plugins → OpenLayers plugin → Add Google Hybrid layer**. Adjusting the transparency levels on ruggedness_index.tif, can you locate the two lakes that are near the areas of 'higher ruggedness' located by the target spot shown on this below image? When you are done, save and close your project. You've completed Lesson 1!



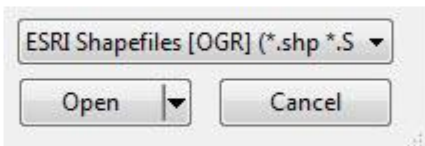


Lesson 2: Explore Vector Functions and Symbolization

1. Activate a new QGIS Desktop session and select **Add vector layer** → **Browse**

   a. *Open shapefiles,* Go to **C:\<users>\<username>\Desktop\QGIS\WorkingData\Vector**

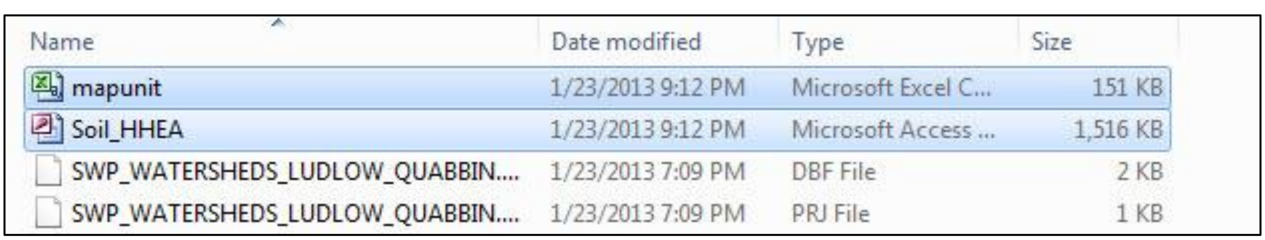
   b. Preview the 8 available shapefiles by selecting the **ESRI Shapefiles [OGR]…** option from the file extension pull down. Hold the **Shift** key to click and add all of the following:



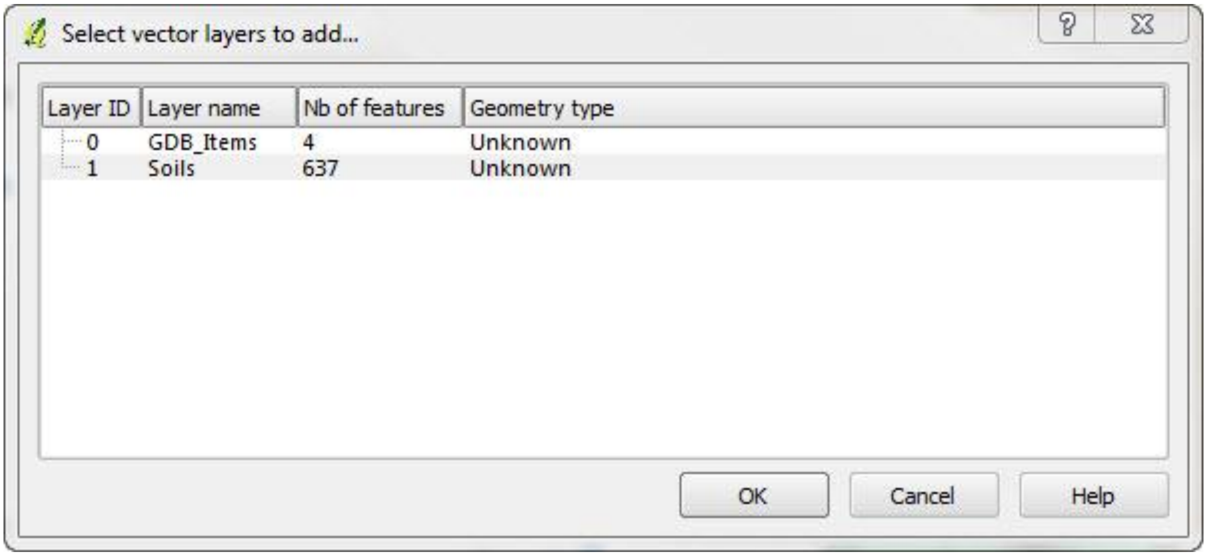
   - Belchertown_Boundary.shp
   - Dams_PVPC.shp
   - EOTROADS_ARC_Belchertown.shp
   - HYDRO25K_ARC_Belchertown.shp
   - HYDRO25K_POLY_Belchertown.shp
   - HYDRO25K_POLY_Belchertown.shp
   - HYDRO25K_QUABBIN_LUDLOW_RESERVOIR.shp
   - SWP_WATERSHEDS_LUDLOW_QUABBIN.shp
   - zoning_Belchertown.shp

   c. Preview the 1 available ESRI personal database & the 1 available csv file by selecting the **All files (*)…** option from the file extension pull down. Hold the **Shift** key to click and add all of the following:

   - mapunit.csv
   - Soil_HHEA.mdb



d. In the **Select vector layer to add…** window select the Soils feature class, and click 'OK'.



2. *Join Soils.mdb to the mapunit.csv based on the "MUKEY" field. Map Prime Farmland Soils in Belchertown from this newly attributed data.* Preview the attributes of the mapunit.csv and the Soils.mdb by **Right Clicking** and holding on the layer name in the **Layers List**. Scroll and select **Open Attribute Table** for BOTH layers. Note that Soils.mdb doesn't have much information….we are going to perform a join to create a new soils layer with more data in it.

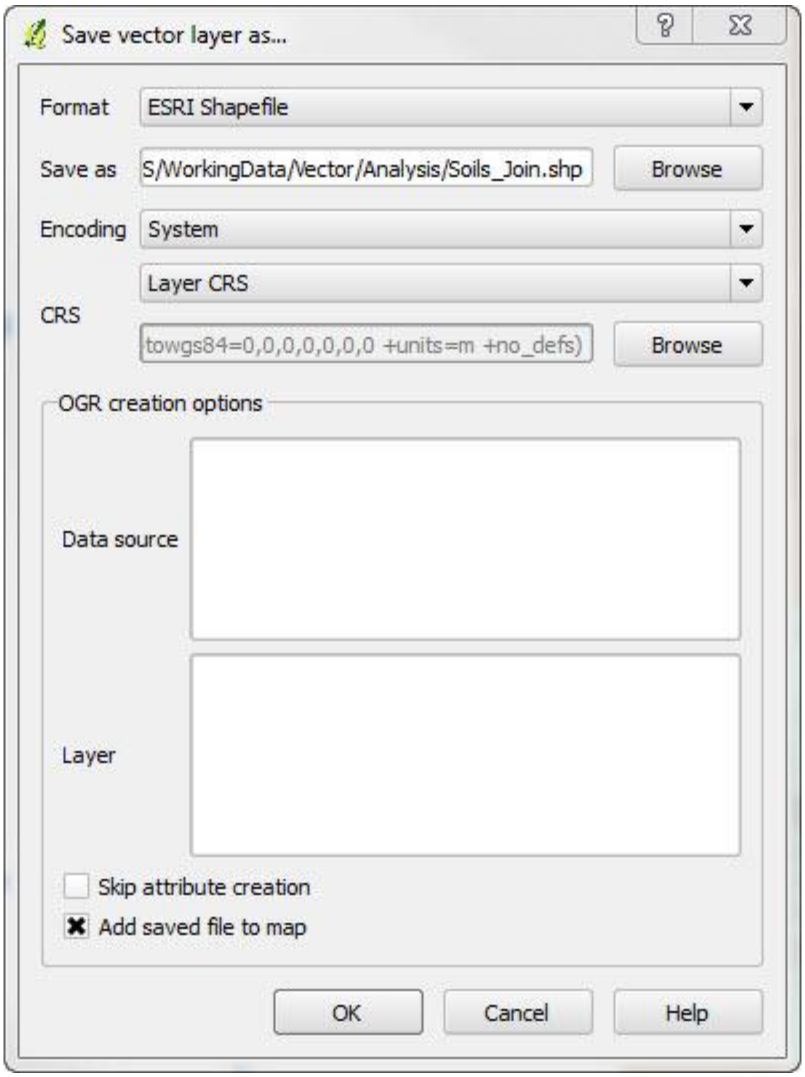
a. **Right click** on Soils.mdb, select **Properties** → **Joins**. Click the green plus sign to open the **Add vector join** window. Fill this window out as you see below, then Select 'OK'. In the **Joins** window select 'Apply' then 'OK'.

b. **Right click** on Soils.mdb, select **Open Attribute Table**. You should now see all the data from the mapunit.csv included in the attribute table.

STOP

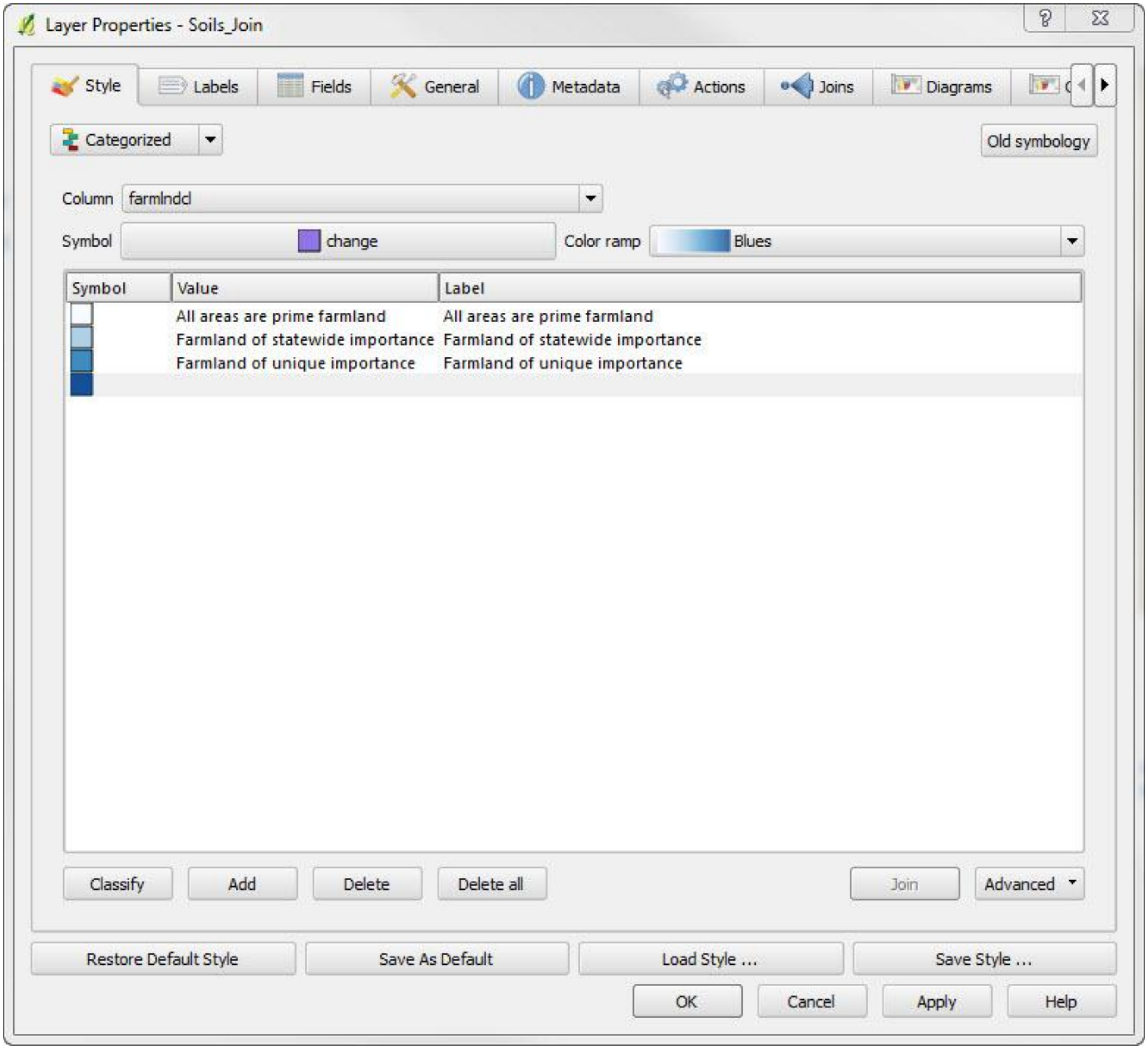
This ‘Join’ is just temporary. It is NOT part of the attribute table for Soils.mdb, but just linked dynamically. To permanently join the attributes, you must save it as a new layer.

c. **Right click** on Soils.mdb, select **Save As…** . In the **Save vector layer as…** window, browse to **C:\<users>\<username>\Desktop\QGIS\WorkingData\Vector\Analysis** and save a shapefile called ‘Soils_Join.shp’. Fill out the form like below, and then select ‘OK’.

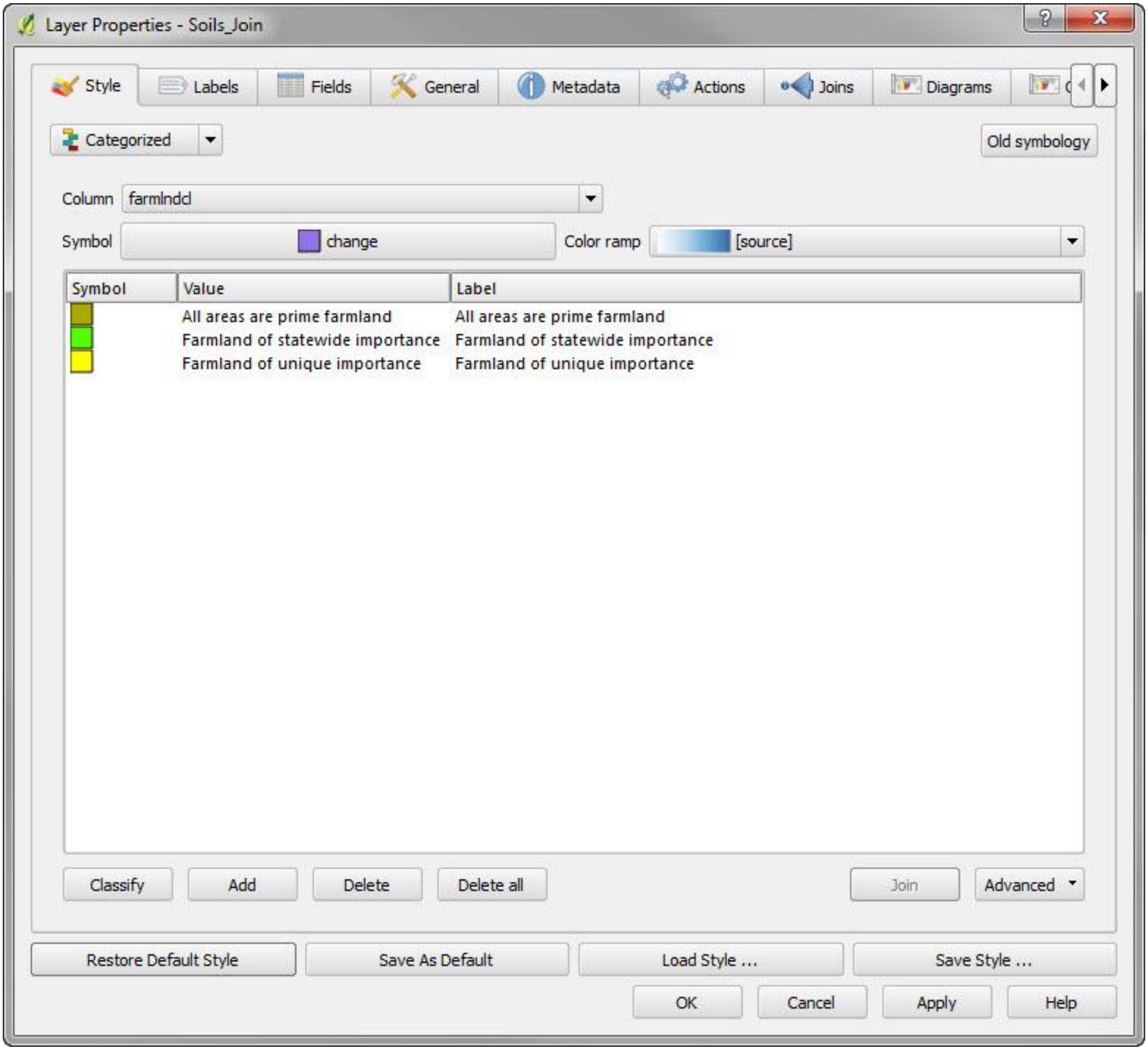


d. With the new Soils_Join.shp, **Right Click** and open the Attribute table. Verify that all the join attributes were permanently saved.

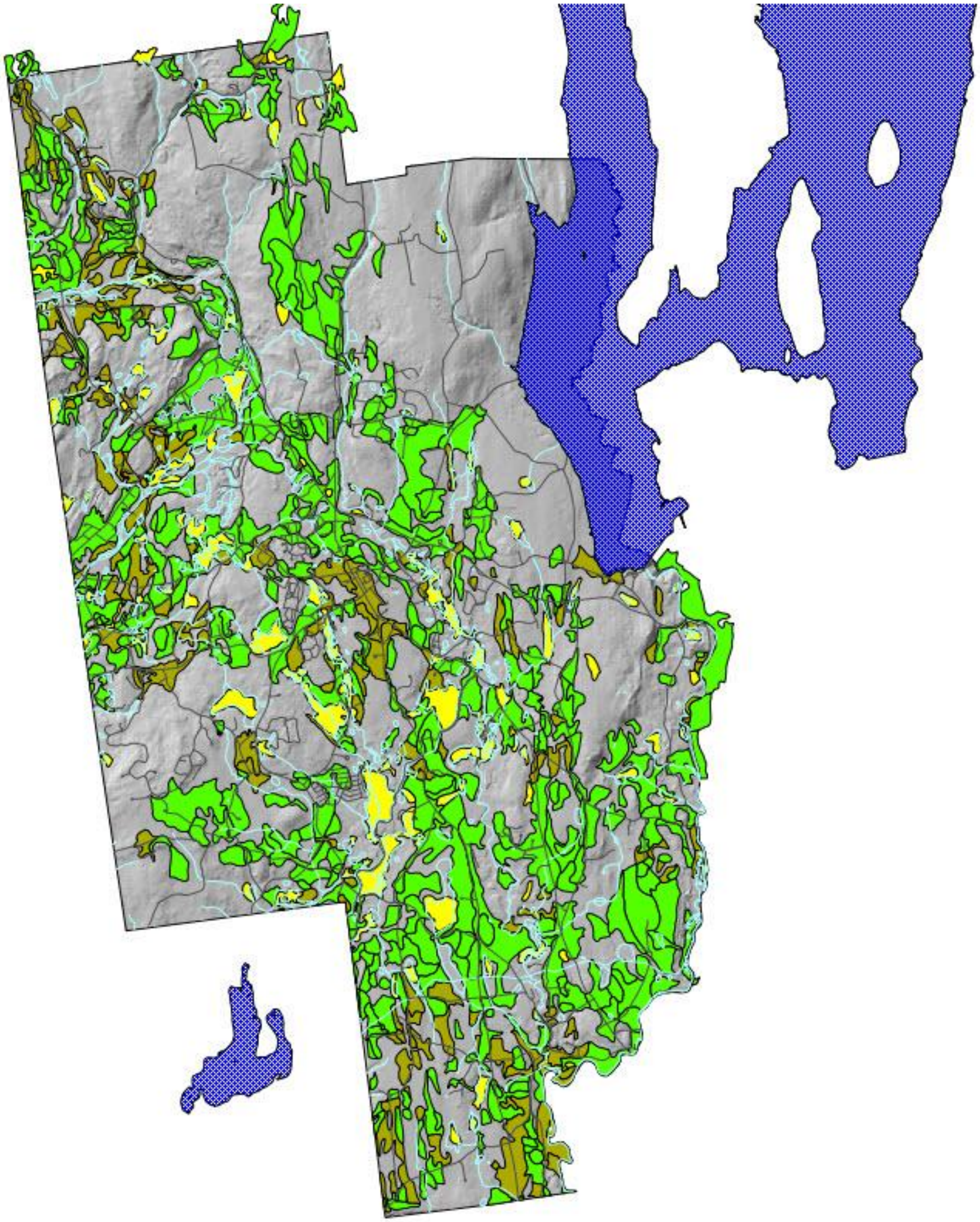
e. The Field ‘farmlndcl’ is the Field we want to symbolize our data by. Find this field in the Attribute table, then close the Attribute table. **Right Click** and select **Properties → Style**. In the **Style** window, Select the drop-down option of ‘Categorized’. **Select** for “Column: ‘farmlndcl’” and then select “Classify”. Your window should look something like the image below. Highlight and then select ‘Delete’ for the category that has no values.



f. *Experiment with the vector symbology*. Using the **Symbol properties** window (to get there, double-click on the individual symbol icons below the Symbol column in the **Style** window, and click on ‘Change’ in the Symbol Selector window right above the ‘Saved Styles’ text), to change the colors of the categories. Select ‘Symbol layer type: Simple fill’, and set the colors to resemble the graphic on the next page. Click ‘Apply’ and ‘OK’.

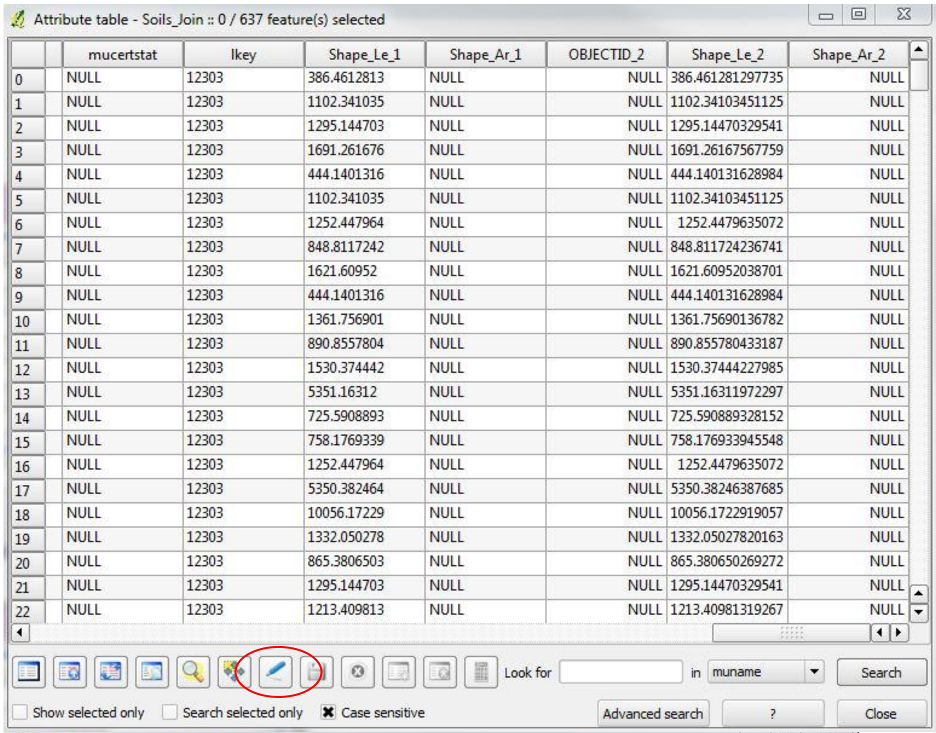


g. *Continue to experiment with the vector symbology*. For all the files available to you in the given map document, continue to experiment with changing colors and moving the layers around in the **Layers List** (*note: some layers might need to be turned off, others might need to be added from your \Raster\ folder). See if you can try to recreate the map in the image shown on the next page.

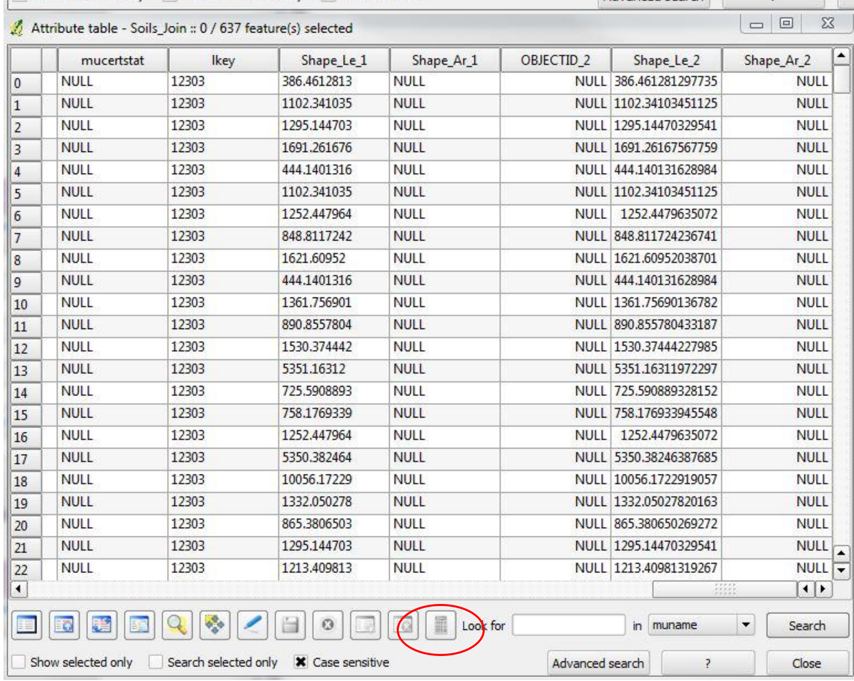


3. *Calculate the acreage of 'farmlndcl' soils*. Within the Soils_Join.shp layer, select the **Open Attribute Table**. In order to calculate a field in QGIS you must enable editing. To do this select the option highlighted in the below graphic.

To enable editing, you can also use the Keyboard shortcut (Ctrl+E).



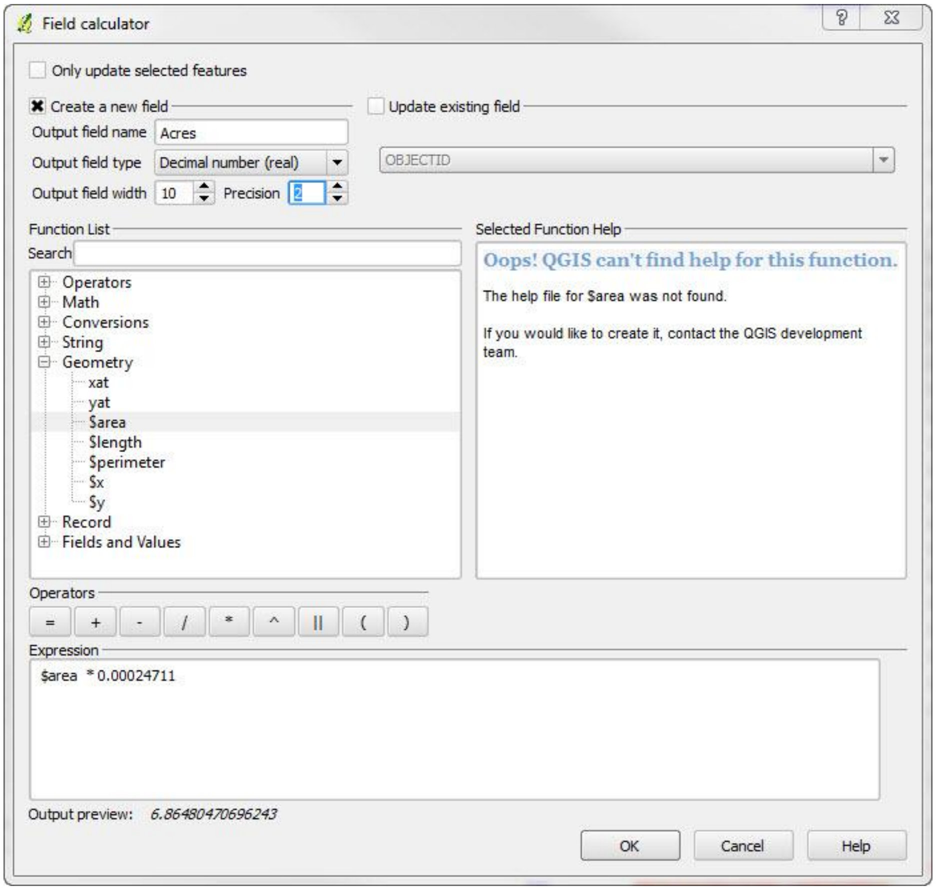
	mucertstat	lkey	Shape_Le_1	Shape_Ar_1	OBJECTID_2	Shape_Le_2	Shape_Ar_2
0	NULL	12303	386.4612813	NULL	NULL	386.461281297735	NULL
1	NULL	12303	1102.341035	NULL	NULL	1102.34103451125	NULL
2	NULL	12303	1295.144703	NULL	NULL	1295.14470329541	NULL
3	NULL	12303	1691.261676	NULL	NULL	1691.26167567759	NULL
4	NULL	12303	444.1401316	NULL	NULL	444.140131628984	NULL
5	NULL	12303	1102.341035	NULL	NULL	1102.34103451125	NULL
6	NULL	12303	1252.447964	NULL	NULL	1252.4479635072	NULL
7	NULL	12303	848.8117242	NULL	NULL	848.811724236741	NULL
8	NULL	12303	1621.60952	NULL	NULL	1621.60952038701	NULL
9	NULL	12303	444.1401316	NULL	NULL	444.140131628984	NULL
10	NULL	12303	1361.756901	NULL	NULL	1361.75690136782	NULL
11	NULL	12303	890.8557804	NULL	NULL	890.855780433187	NULL
12	NULL	12303	1530.374442	NULL	NULL	1530.37444227985	NULL
13	NULL	12303	5351.16312	NULL	NULL	5351.16311972297	NULL
14	NULL	12303	725.5908893	NULL	NULL	725.590889328152	NULL
15	NULL	12303	758.1769339	NULL	NULL	758.176933945548	NULL
16	NULL	12303	1252.447964	NULL	NULL	1252.4479635072	NULL
17	NULL	12303	5350.382464	NULL	NULL	5350.38246387685	NULL
18	NULL	12303	10056.17229	NULL	NULL	10056.1722919057	NULL
19	NULL	12303	1332.050278	NULL	NULL	1332.05027820163	NULL
20	NULL	12303	865.3806503	NULL	NULL	865.380650269272	NULL
21	NULL	12303	1295.144703	NULL	NULL	1295.14470329541	NULL
22	NULL	12303	1213.409813	NULL	NULL	1213.40981319267	NULL



	mucertstat	lkey	Shape_Le_1	Shape_Ar_1	OBJECTID_2	Shape_Le_2	Shape_Ar_2
0	NULL	12303	386.4612813	NULL	NULL	386.461281297735	NULL
1	NULL	12303	1102.341035	NULL	NULL	1102.34103451125	NULL
2	NULL	12303	1295.144703	NULL	NULL	1295.14470329541	NULL
3	NULL	12303	1691.261676	NULL	NULL	1691.26167567759	NULL
4	NULL	12303	444.1401316	NULL	NULL	444.140131628984	NULL
5	NULL	12303	1102.341035	NULL	NULL	1102.34103451125	NULL
6	NULL	12303	1252.447964	NULL	NULL	1252.4479635072	NULL
7	NULL	12303	848.8117242	NULL	NULL	848.811724236741	NULL
8	NULL	12303	1621.60952	NULL	NULL	1621.60952038701	NULL
9	NULL	12303	444.1401316	NULL	NULL	444.140131628984	NULL
10	NULL	12303	1361.756901	NULL	NULL	1361.75690136782	NULL
11	NULL	12303	890.8557804	NULL	NULL	890.855780433187	NULL
12	NULL	12303	1530.374442	NULL	NULL	1530.37444227985	NULL
13	NULL	12303	5351.16312	NULL	NULL	5351.16311972297	NULL
14	NULL	12303	725.5908893	NULL	NULL	725.590889328152	NULL
15	NULL	12303	758.1769339	NULL	NULL	758.176933945548	NULL
16	NULL	12303	1252.447964	NULL	NULL	1252.4479635072	NULL
17	NULL	12303	5350.382464	NULL	NULL	5350.38246387685	NULL
18	NULL	12303	10056.17229	NULL	NULL	10056.1722919057	NULL
19	NULL	12303	1332.050278	NULL	NULL	1332.05027820163	NULL
20	NULL	12303	865.3806503	NULL	NULL	865.380650269272	NULL
21	NULL	12303	1295.144703	NULL	NULL	1295.14470329541	NULL
22	NULL	12303	1213.409813	NULL	NULL	1213.40981319267	NULL

Then select the 'Field Calculator' highlighted in the above graphic.

a. In the **Field Calculator**, create "Output field name: Acres". Select **Geometry** → **$area**. window. Fill out the rest of the window out as you see below, then Select 'OK'. In the Attribute table, check your results, and once done disable editing, save changes, and close the window.



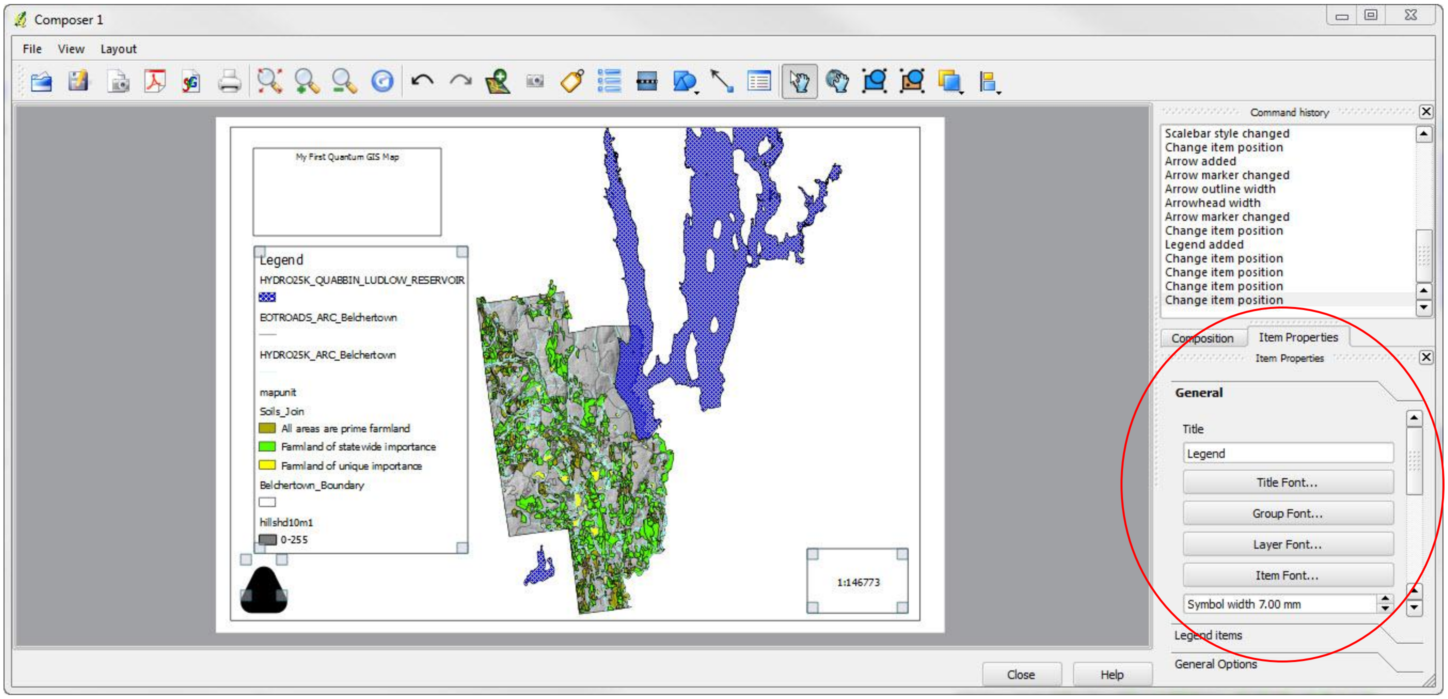
When calculating the area of polygons with field calculator, the units are those of the current projection. In this case: meters.

4. *Make a simple map using 'Print Composer'*. In the main window, go to **File** → **New Print Composer**. It will open a new window. To add the map that you've been working on, go to **Layout** → **Add Map**. Then in the main screen, **Right Click** and **Hold** your mouse as you drag the map image across your screen at a diagonal. After you have added your map, use the **Layout** menu to add a Legend, Label, Arrow, and Scalebar (set the Style to 'Numeric').

Experiment with changing these different map elements by using the '**Item Properties**' tab (circled on the next page) in the far-right corner of the **Composer** window.

<u>Your map can look however you choose, however, the more you work with it the better it will look!</u>

When you are done go to **File** → **Export as Image** and save the file (as a .jpeg) in your project folder within the **C:\<users>\<username>\Desktop\QGIS\WorkingData\Vector\Analysis** directory. When you are done, save and close your project. You've completed Lesson 2!


Composer 1
File
View
Layout
Command history
Scalebar style changed
Change item position
Arrow added
Arrow marker changed
Arrow outline width
Arrowhead width
Arrow marker changed
Change item position
Legend added
Change item position
Change item position
Change item position
Change item position
Composition
Item Properties
Item Properties
General
Title
Legend
Title Font...
Group Font...
Layer Font...
Item Font...
Symbol width 7.00 mm
Legend items
General Options
Close
Help
My First Quantum GIS Map
Legend
HYDRO25K_QUABBIN_LUDLOW_RESERVOIR
EOTROADS_ARC_Belchertown
HYDRO25K_ARC_Belchertown
mapunit
Soils_Join
All areas are prime farmland
Farmland of statewide importance
Farmland of unique importance
Belchertown_Boundary
hillshd10m1
0-255
1:146773