GIS for Designers
VT | A+D | SU22

TUTORIAL 1 | MAPPING AN APPALACHIAN CITY

Zoom: Wednesday 05.25, 6:30-7:30pm
https://virginiatech.zoom.us/j/2981092726

Goals

- Create a QGIS map of your chosen city using Open Street Maps data.
- Stylize your city data.
- Gain familiarity with QGIS platform.

Introduction

In this tutorial we'll go over the basics of using QGIS, which will be our primary application in this class. With QGIS, you can visualize physical geographic data like roads, rivers, and buildings, as well as data associated with geographic areas like census information. QGIS also has a powerful suite of spatial analysis tools, like the distance matrix which can compare proximities of different variables (for instance, racial information correlated with parks vs. industrial space, as we'll look at in Tutorial 5). We'll only use a handful of QGIS's tools in this class, but if you're interested in learning more I recommend QGIS's tutorials: https://www.qgistutorials.com/en/ as a starting point.

First off, you'll each choose an Appalachian city from the list in Step 0. You will use this city for the rest of your tutorials and for your final project. Next, you'll create a basic map of this city in QGIS using **OpenStreetMap** data. Open Street Maps is another free, open-source resource which contains user-inputted geographic information (like Google Maps meets Wikipedia). Because anyone can contribute to the project, OpenStreetMap (OSM) has detailed geographic data in remote places like Tanzania, where NGOs partner with local teams to track indicators of public health, transportation access, living conditions, and other data that relies on accurate maps.

Once you have your city's data, you will style it and create an exportable map. QGIS has many options to style (color and pattern) data by category (eg all rivers are blue), or based on variables (eg topographic lines colored based on their height variable). A successful map should communicate 1) the relevant information, 2) clearly, to your audience, and 3) beautifully, with careful color choice and line weights. Pay particular attention to color, which can easily overwhelm your map.

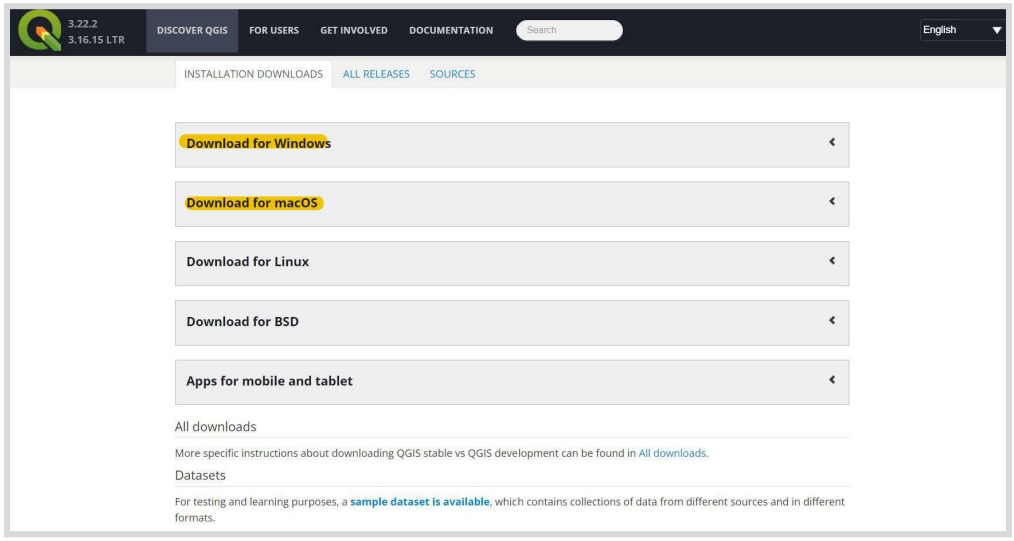
Step 0: Choose a city

For this tutorial and the duration of this class, you will choose a major Appalachian (or adjacent) city to study. Please choose one from the following list.

***NOTE:** if you choose a larger city (**bolded**), you won't be able to download **building data** for the entire city at once. Please skip that part of Step 3.

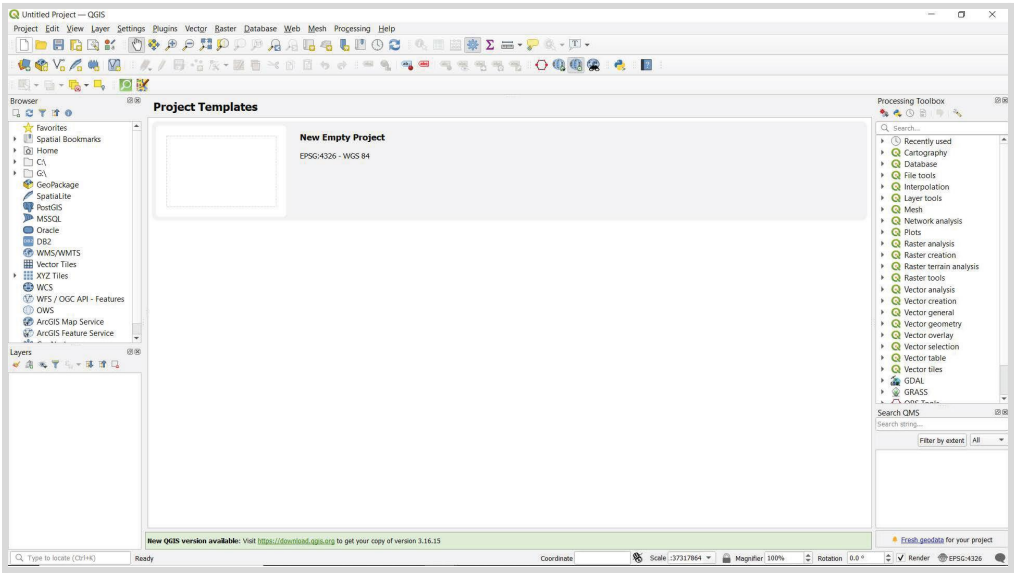
- *Birmingham, AL*
- *Huntsville, AL*
- **Atlanta, GA***
- *Lexington, KY*
- *Asheville, NC*
- **Charlotte, NC***
- **Pittsburgh, PA***
- *Scranton, PA*
- *Chattanooga, TN*
- *Knoxville, TN*
- *Roanoke, VA*
- **Richmond, VA***
- *Charleston, WV*

Step 1: Download and install QGIS 3.22, the most recent long-term release (LTR):
https://qgis.org/en/site/forusers/download.html#



Step 2: Open QGIS and install the QuickOSM extension.

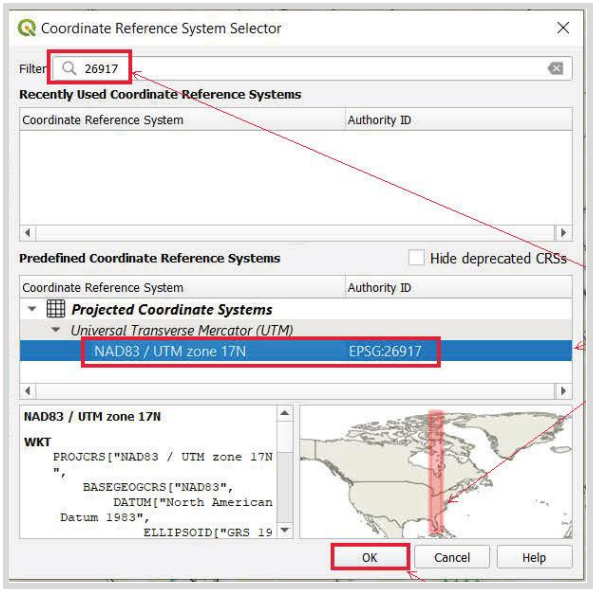
2a Click **New Project**...(you will see an empty white page)



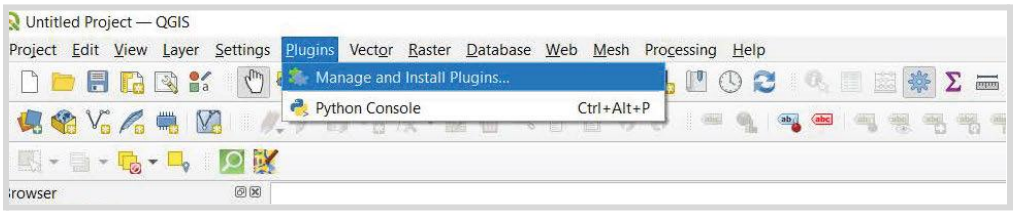
2b **Save** your project somewhere you will not lose it, in a folder where you can also store your project's data.

2c Set your CRS in **Project > Properties > CRS**. This will be the first step of any new map.

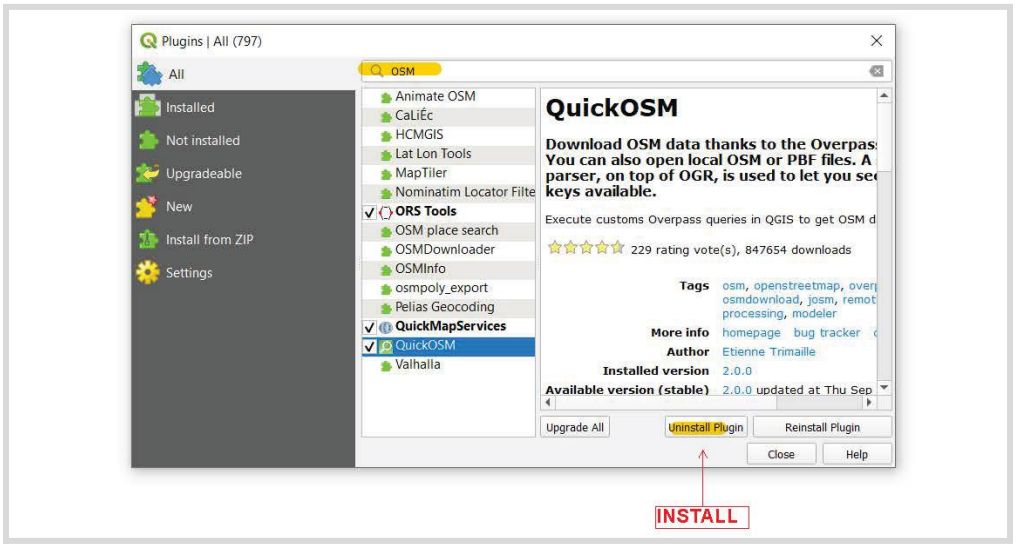
> Your map's **Coordinate reference systems** (CRS), which relates to a map's projection system, essentially defines where the map will be least distorted, and how. Because the earth is spherical and maps are flat, there is necessarily distortion in geographical features. Generally, the more accurate a geography's shape is, the less accurate its size will be. Think of how the familiar Mercator projection flattens the globe so that countries near the equator look too small relative to countries near the poles.
>
> The CRS defines where the map's projection measures distortion from, based on a **latitudinal** reference (the equator), and a **longitudinal** reference (varies). QGIS's default CRS, called **WGS 84**, takes its longitudinal reference from the IERS Reference Meridian a.k.a. Prime Meridian, which runs north to south near Greenwich, England. So, the farther your Appalachian city is from England, the more distortion you'll see in measurements with WGS 84. Read more about it on QGIS's documentation.
>
> To make sure measurements and geometries in your map are accurate, you'll need to choose a local CRS. **UTM (Universal Transverse Mercator)** is a CRS with different longitudinal references around the globe from UTM 1 to UTM 60. Many countries favor UTM for its flexibility. You can find your city's UTM zone here. For instance, since I mapped Blacksburg, VA in this tutorial, I used NAD83/UTM zone 17N (N for northern hemisphere; NAD83 for North American Datum).



2d Open **Plugins > Manage and Install Plugins**…



2e Search for **QuickOSM**. Click **Install Plugin**

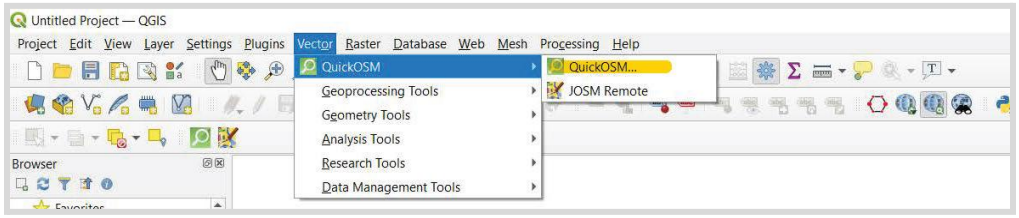


Step 3: Query "OSMdata

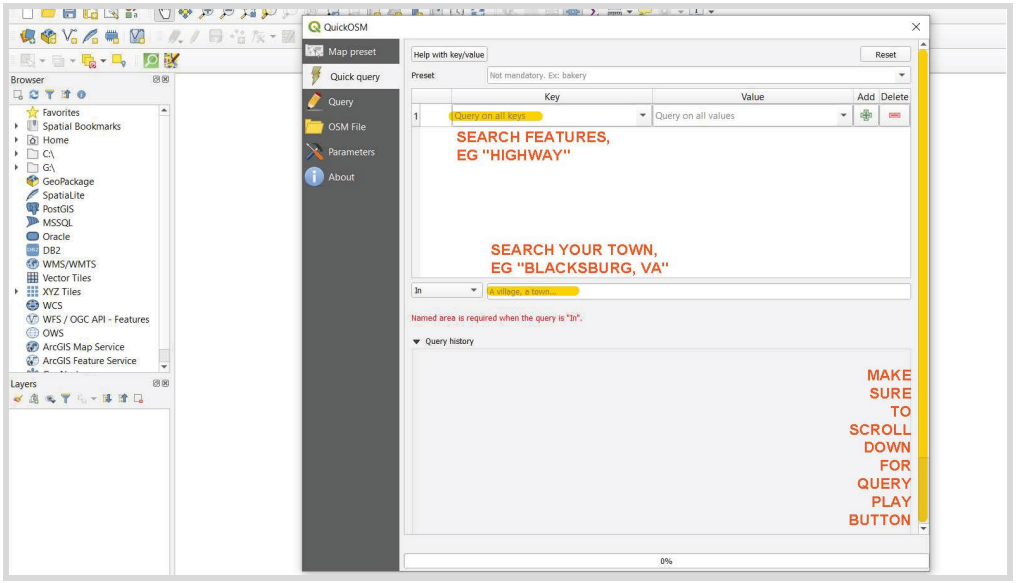
Search your Appalachian city and separately query the "waterway", "highway" (this includes all roads and paths, but excludes waterway), and "building" data. Refer to https://wiki.openstreetmap.org/wiki/Map_features for more on OSM feature classification.

> **Note:** I will be mapping Blacksburg for the images in this tutorial, but you should use your chosen city from the list in Step 0.

3a Open **Vector > QuickOSM > QuickOSM**

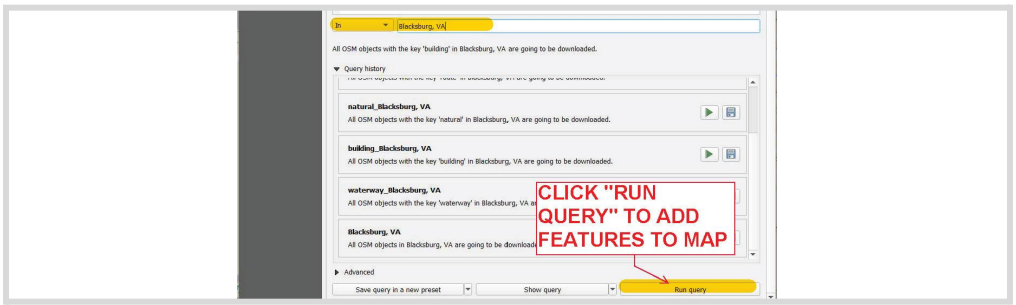


3b Search for each feature in the "**Key**" search bar: start with "waterway". **Type in the city and state to the "In" field (eg "Blacksburg, Virginia")**



3c Scroll down, and click "**Run Query**" to add the features to your map. Repeat step 3b for the "**highway**" and "**building***" features. Note that the QuickOSM popup will not close automatically.

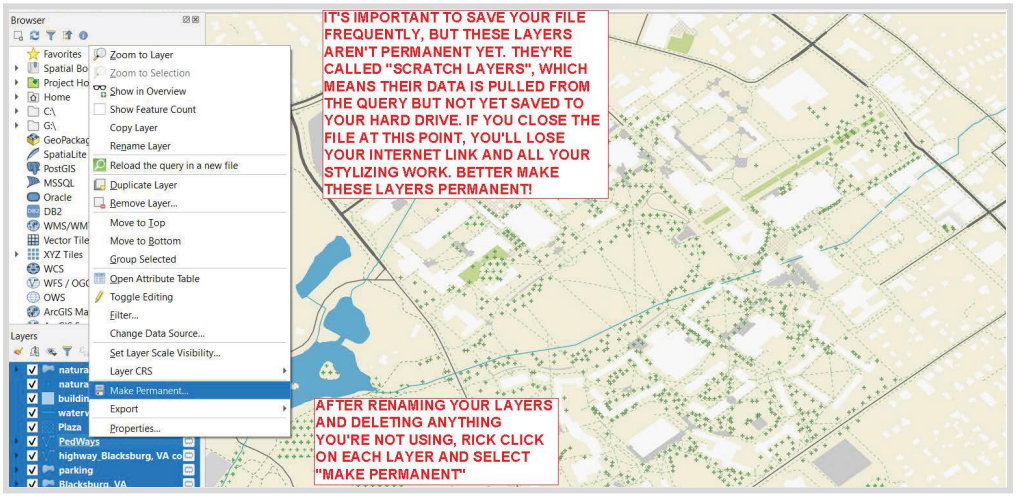
*building data won't be searchable for entire larger cities, as noted above.



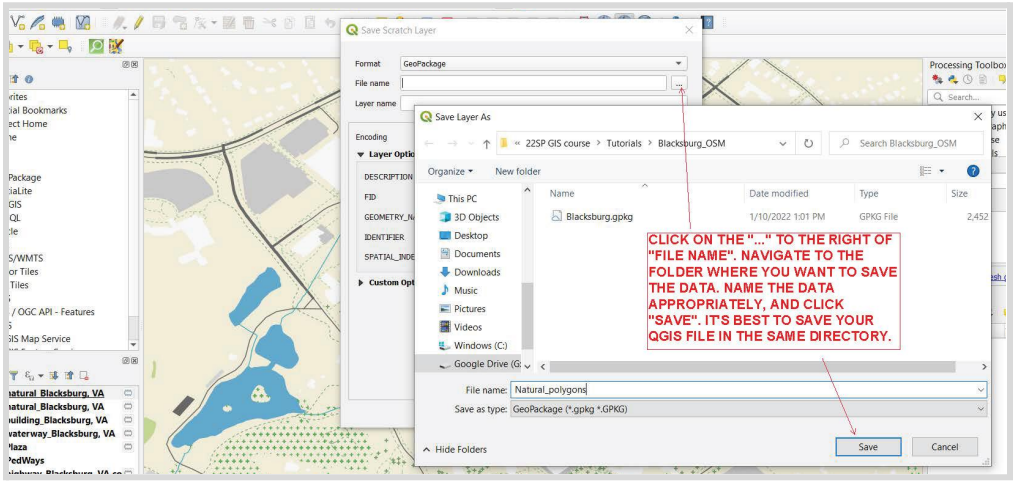
Step 4: Save your scratch layers as permanent layers. Save your file.

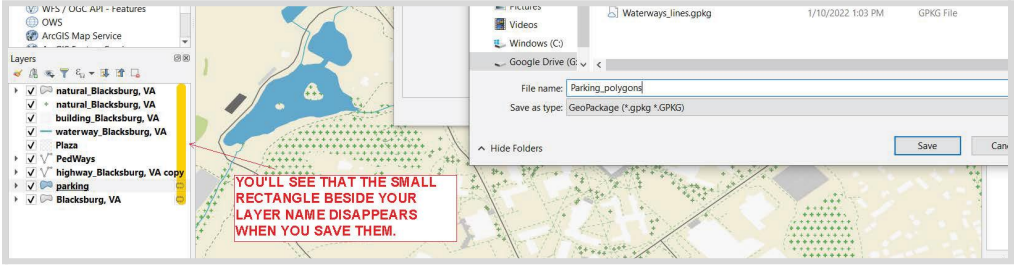
4a Look at the “Layers” window (lower left). The **gray rectangle symbol to the right of the layer name** means that it’s a **scratch layer, or temporary layer.** The QuickOSM query pulls feature data from the internet, but doesn’t save it to your computer. To **save your feature data**, right click on each layer and select “**Make Permanent**…”

> NOTE: if you save and close your file without saving the scratch layers, your map features will disconnect from OSM and you will lose your map.



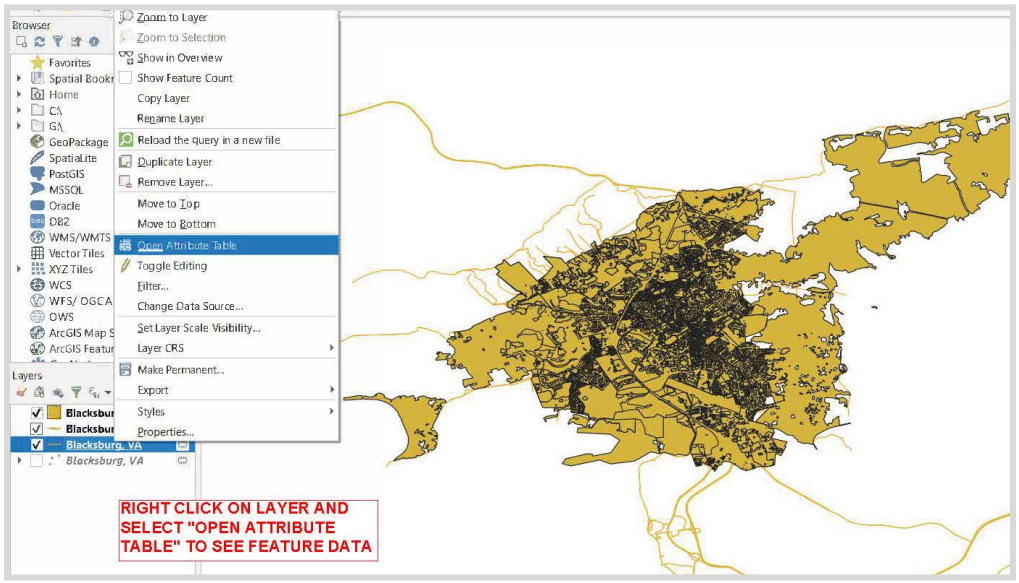
4b Click on the ellipses (...) to the right of the “File Name” box. Navigate to the local folder **where you saved your QGIS file** and then **create a “Data” folder for your layers**. Name your layers clearly (for instance, “Waterways_lines” or “Buildings_polygons”).



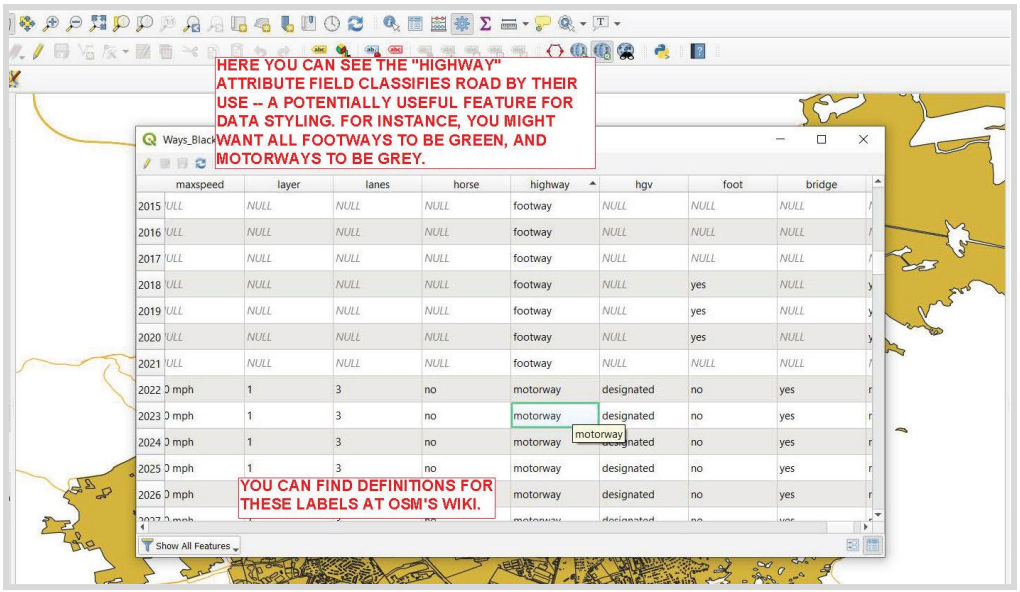


Step 5: Open the data table and see what information is available about different feature types.

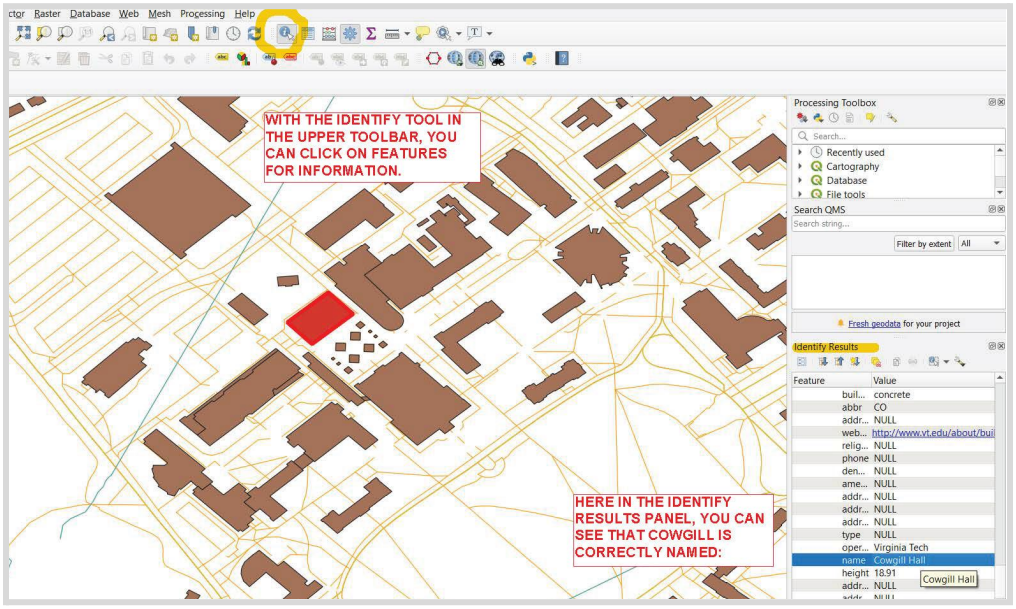
5a Right click on any of your layers and select "**Open Attribute Table**" to see the data associated with features in that layer. The attribute table is the spreadsheet of information associated with each geographically-pinned feature (the points, polylines, and polygons).



5b OpenStreetMaps has a TON of fields, most of which aren't used for every feature. "NULL" means the field has no information for that particular feature. You can find specific definitions for the labels OSM uses like "apartment" and "motorway" in the OSM Wiki. Note that because OSM is an open-source, community-driven project, the feature information isn't always accurate (but the shape, location, and size of features is generally accurate).



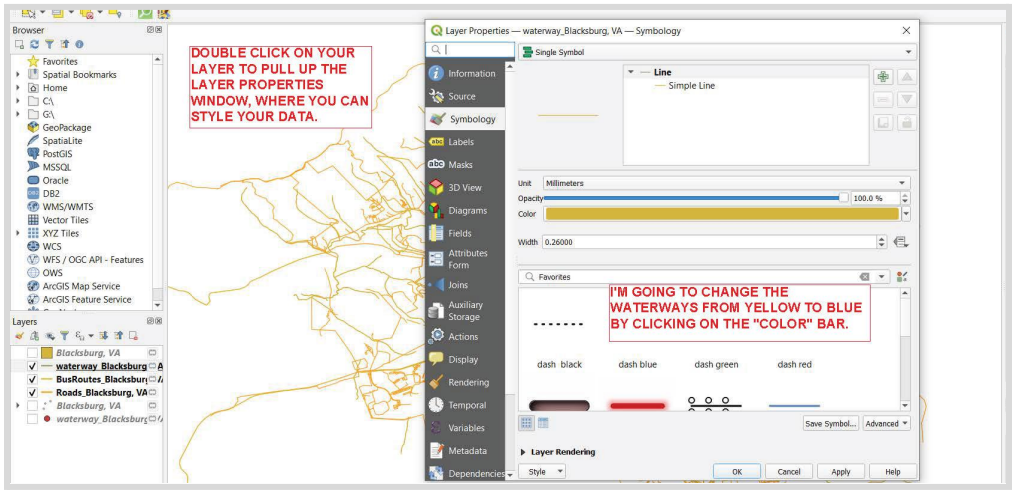
5c Use the “Identify” tool in the top toolbar to identify specific features by clicking on them. Here, you can see that I clicked on Cowgill.

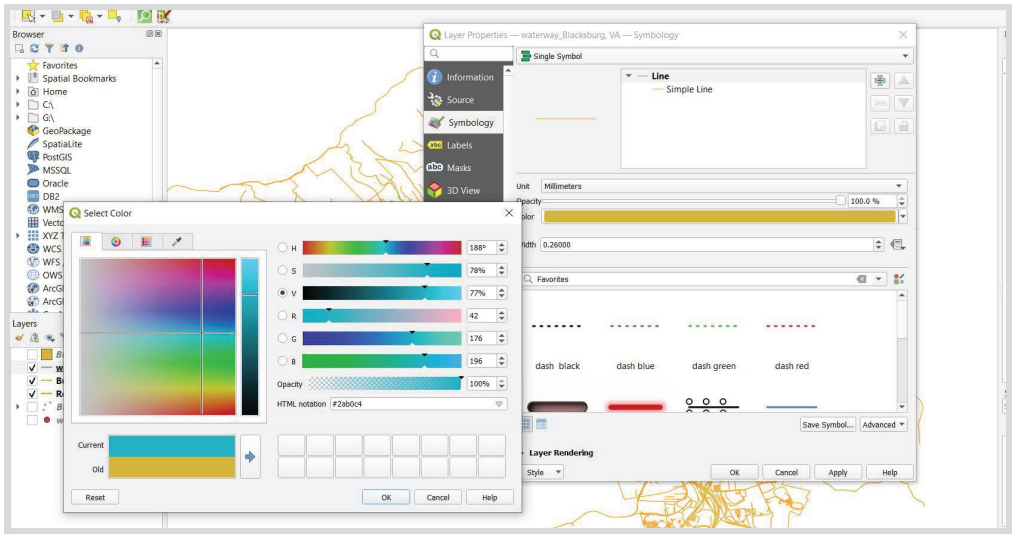


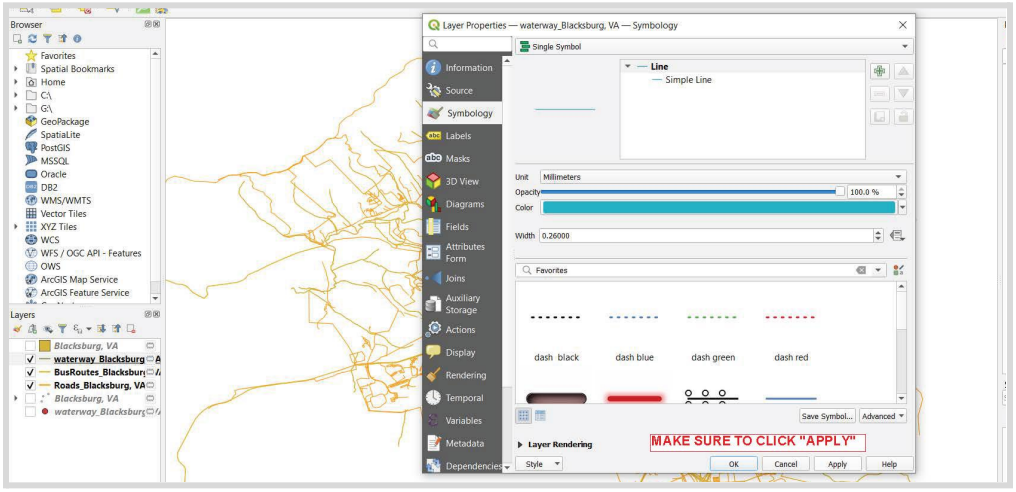
Step 6: Style data by color and "type".

a. **Style at least one feature by "Categorized".**
b. **Style at least one feature by "Graduated".**

6a Double click on the layer to pull up the **Layer Properties** dialogue. The **Symbology** tab should automatically be selected. You can see the basic information of the feature's color and linetype, and change it by double clicking.

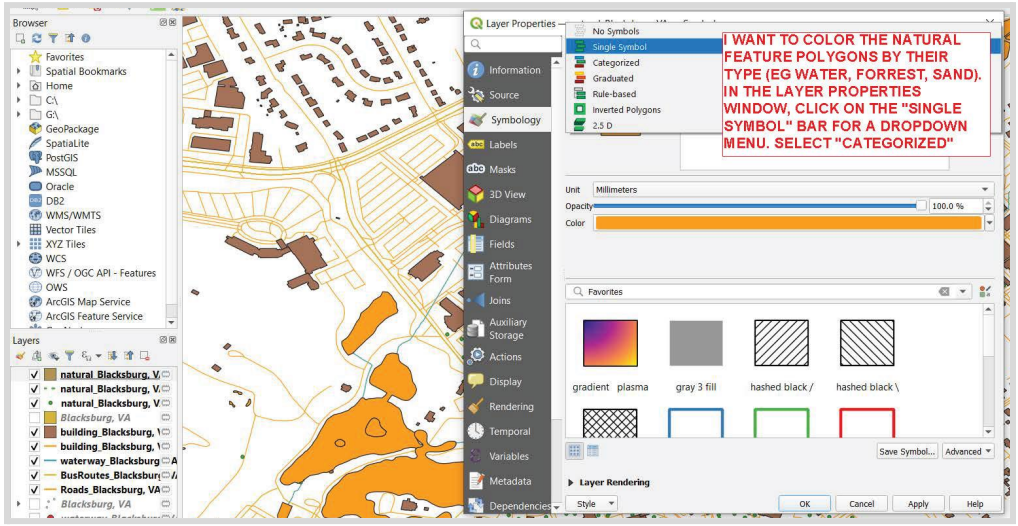




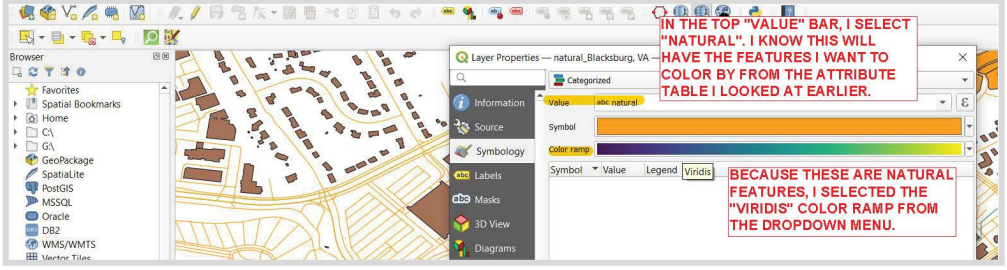


6b Now the waterways features are colored blue.

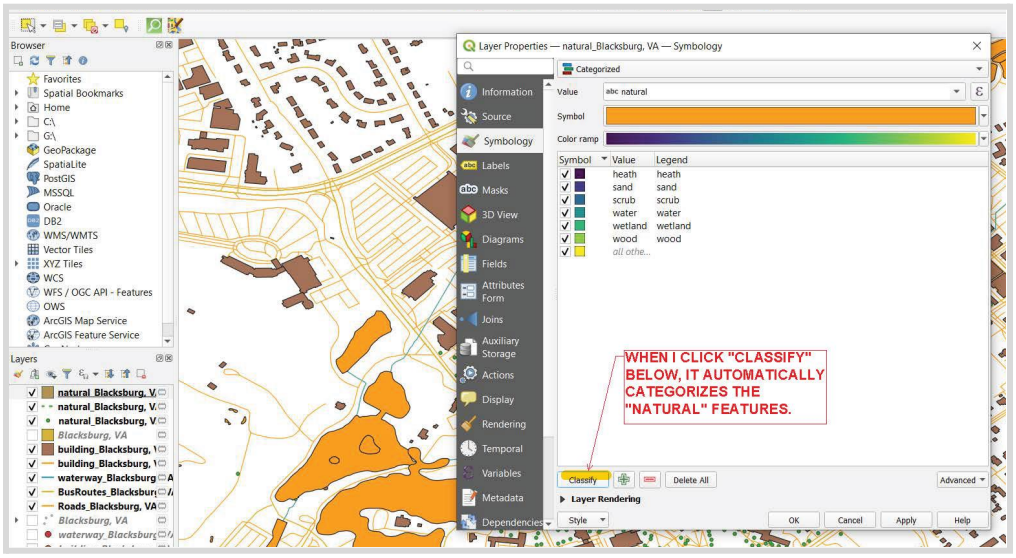
6c Next, let's color features differently according to their attributes. First, go back to the QuickOSM plugin and **download "natural" features** in your city. Save the scratch layer as a data layer. Then, double click on the new layer to pull up the "Layer Properties" box. Click on the "**Symbology**" tab, click "Single Symbol" to see the dropdown menu at the top. Select "**Categorized**".



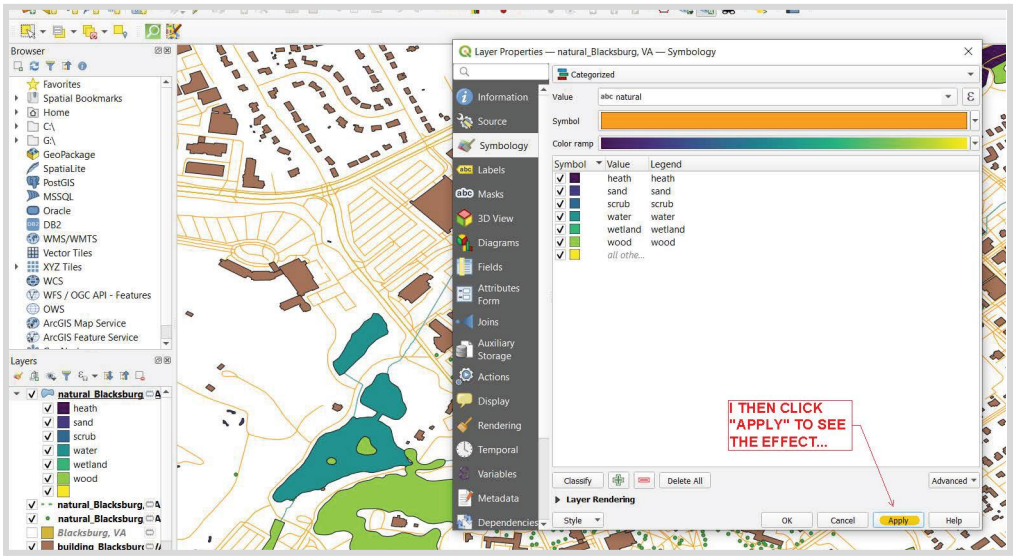
6d The top "**Value**" bar is the attribute field used to color the features. Refer to the "Fields" tab (left, below "Diagrams") to see the layer's available fields. I'm going to select the field "natural", which contains values like"water", "woods", "wetlands", etc. that I want to base my colors on. I'll set the "Color ramp" to an appropriately natural color scheme.



6e Next, click “**Classify**” at the bottom. Q will automatically divide the Color ramp into “steps” and assign one to each value in the selected field. In this case we have six different values, and “all others” (which usually means “NULL”). You can change the color of each value by clicking the Symbol box beside it. You can also group values (for instance, if you want “wetland” and “water” to be the same color) by selecting both and right clicking to “Merge Categories”.

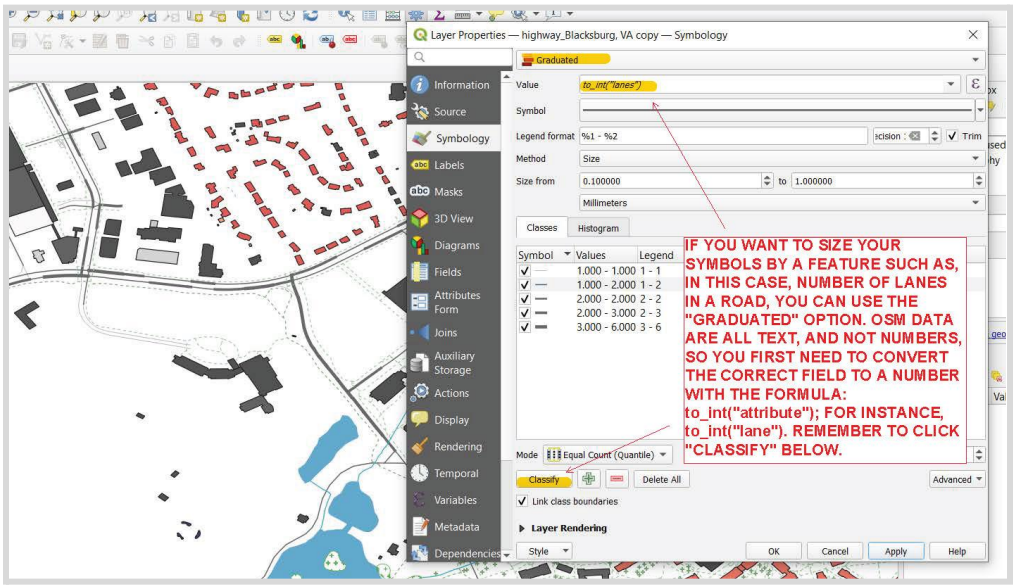


When you apply the effect, the “Layers” window (lower left) automatically displays the new color scheme. This is a preview of the map’s legend (to be covered later).

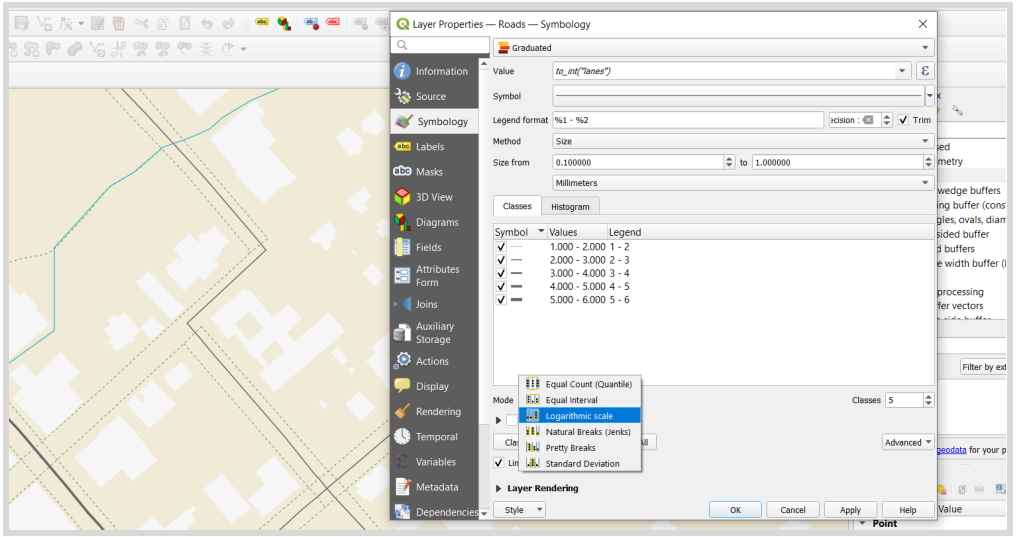


6f Finally, you can display your features according to a numerical value like size, height, or year. This time, in the “Layer Properties” box dropdown the “Symbology” menu and select “Graduated.” Like with “Categorical”, the “Value” box designates the field that will be used to determine symbology.

> **Note:** because QGIS stores all its attributes as strings (text), rather than numbers, you’ll have to convert the field. This can be done simply with a formula in the Value box: to_int(“field”). For instance, I wanted to size my roads based on the number of lanes, so I put to_int(“lanes”) into the Value box. Again, refer to the “Fields” tab for available fields.

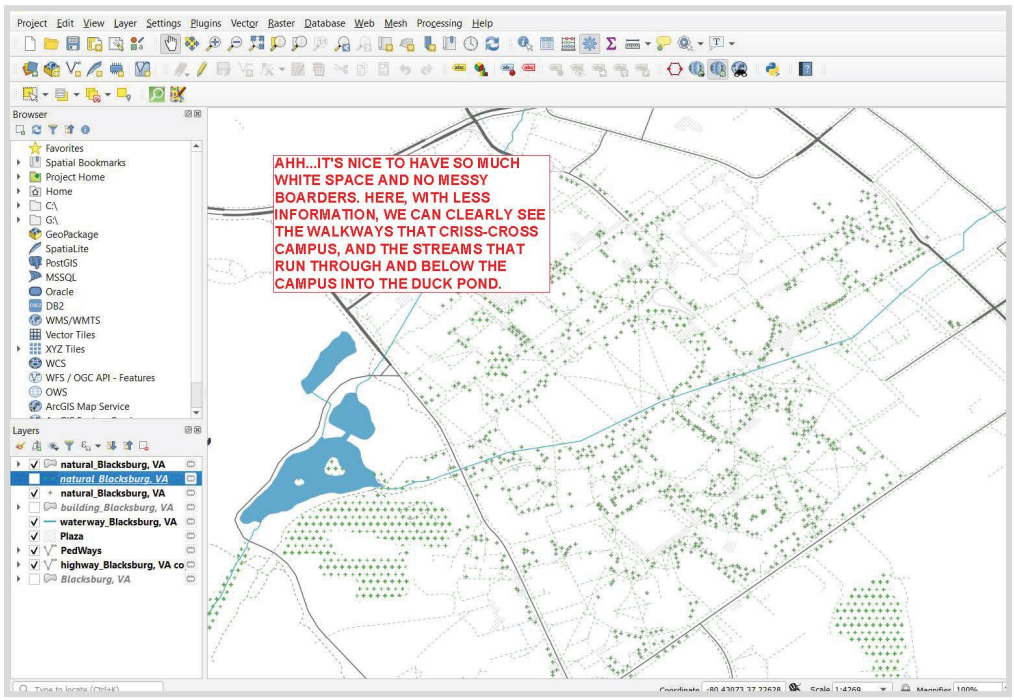


This tool is a powerful way to analyze your feature data. Check out the “Histogram” tab to see the breakdown of values. Try different “Modes” to see how the data can be broken up (for instance, I’d prefer “Equal Interval” to “Equal Count” – so that I have 1 lane, 2 lanes, etc. instead of a breakdown based on the concentration of values). **NOTE:** Features with “NULL” in the chosen field will not be shown. To fix this, see [StackExchange post.]



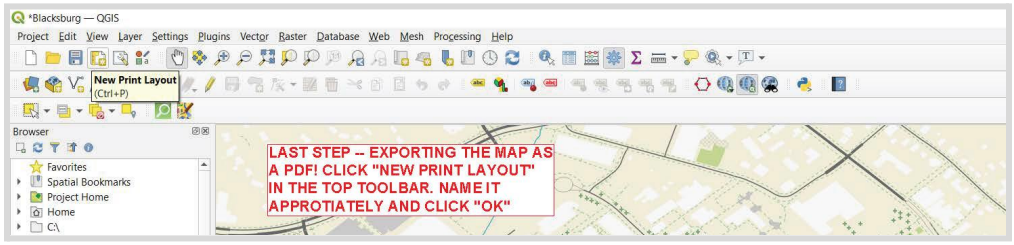
Step 7: Name your layers (right click > “Rename Layer”) by their feature type. Delete unused layers.

Note: you can turn off layer visibility with the check mark beside it (in the “Layers” windows, lower left). Try turning on and off layers and see how much information you need to keep. I removed the point features and many of the line features.

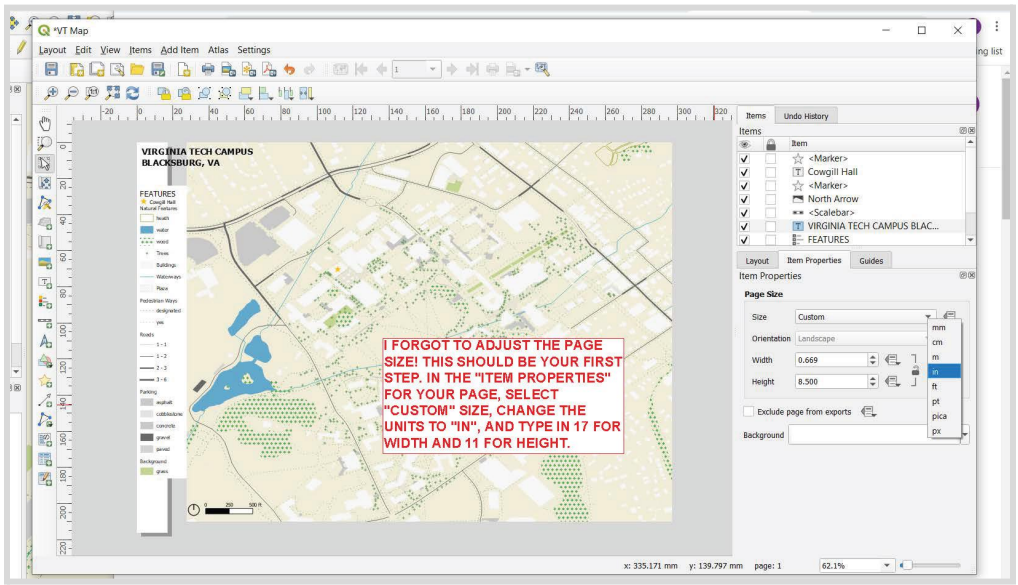


Step 8: Export map as 11x17 pdf, with legend, scale, and north arrow.

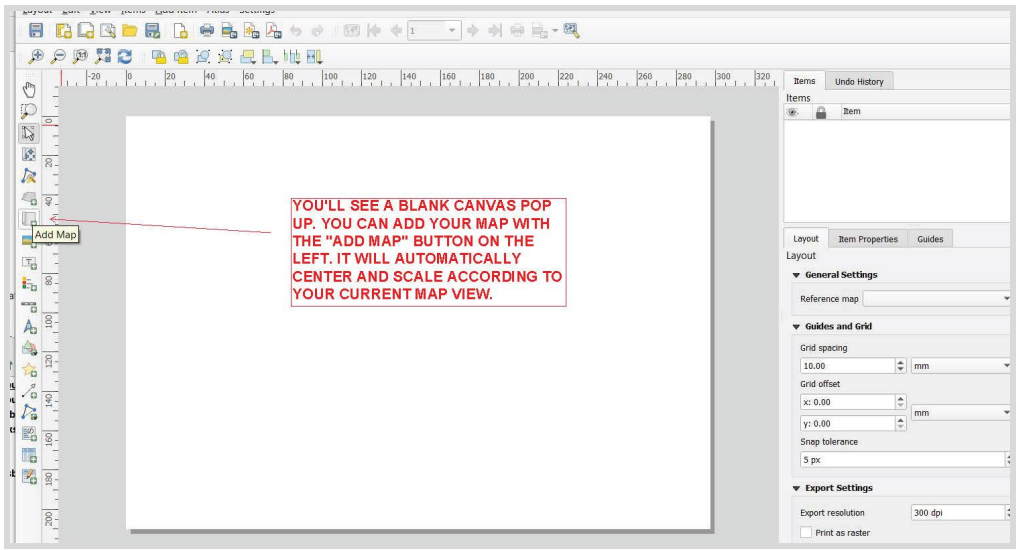
8a In the upper toolbar, select “New Print Layout.” Name your layout and click “Ok”.



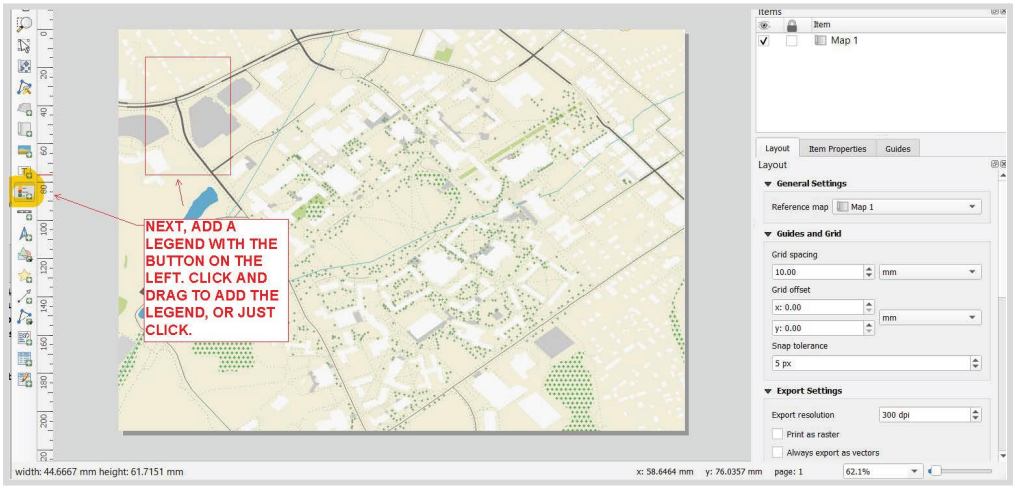
8b First, you should adjust your page size. Right click on your canvas and select “Page Properties”. In the right window, select “in” as your unit and set the width to 17 and height to 11.

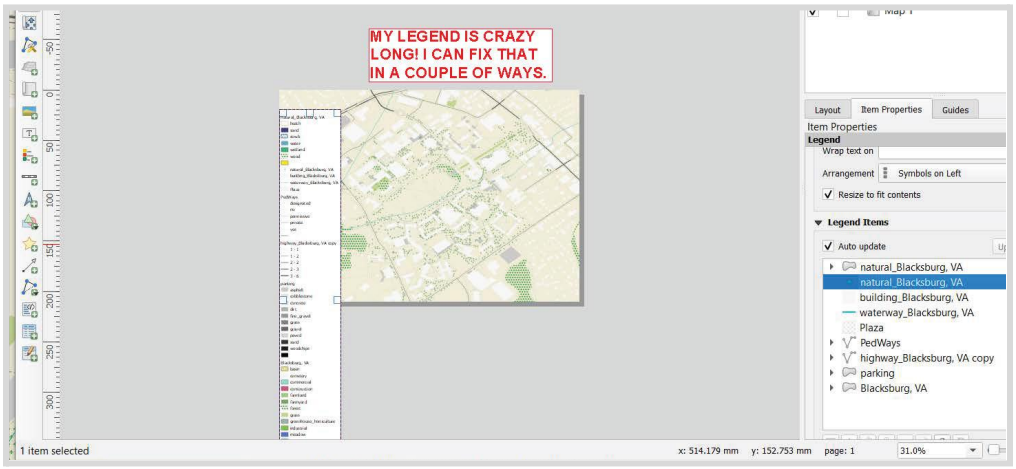


8c Next, select “Add Map” from the left toolbar to add your map. It will default to your current location and zoom level.

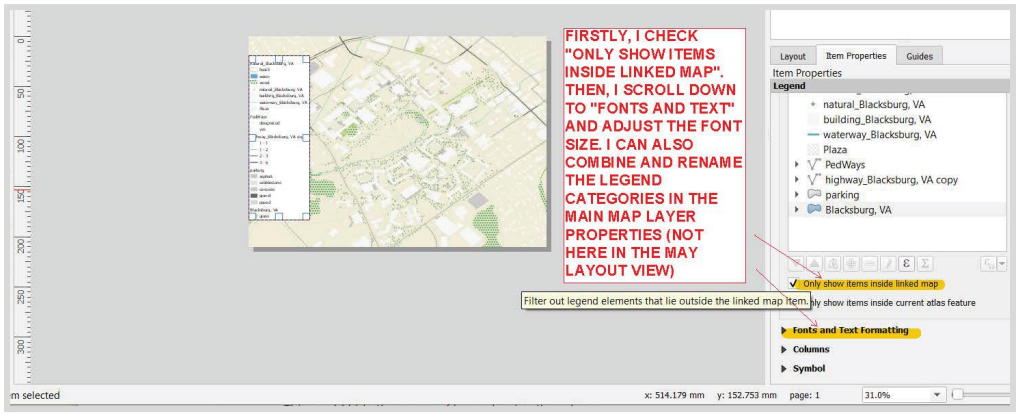


8d Now select “Legend” from the left toolbar. Like mine, yours might be way too long to fit on the page.

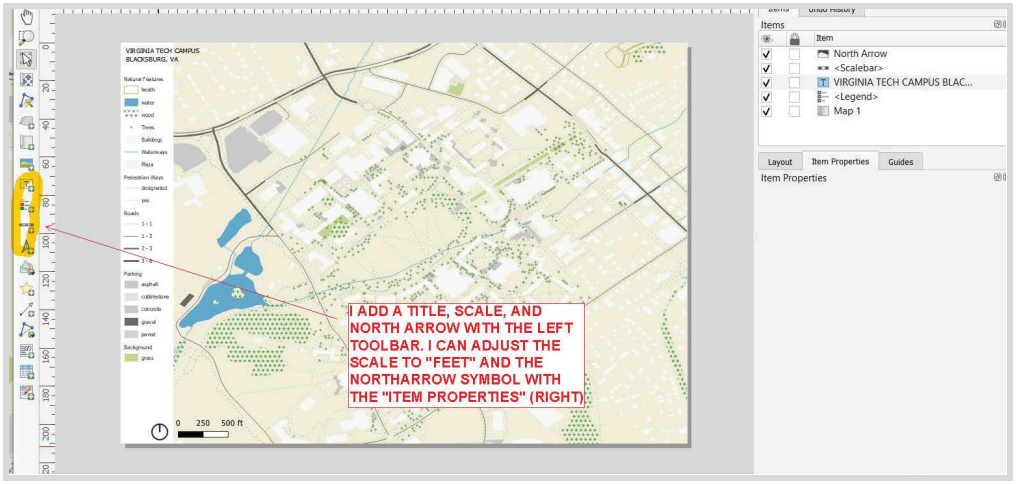




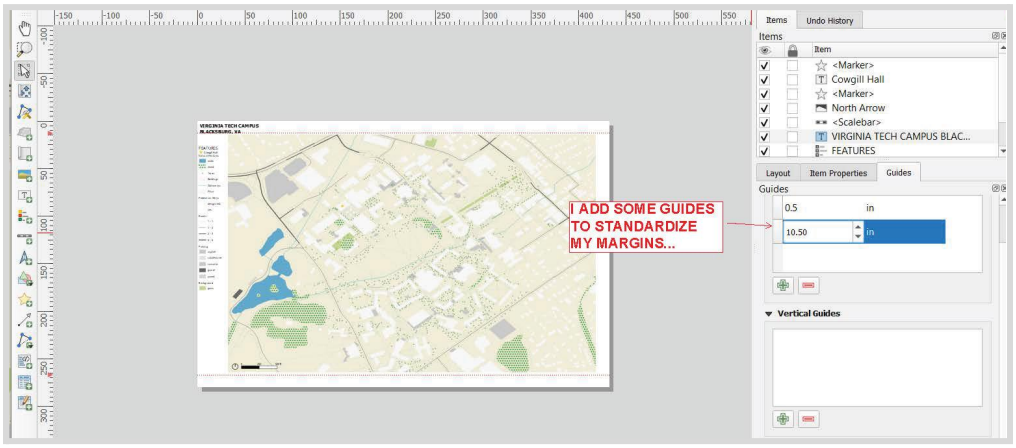
We can fix this first by selecting “Only show items inside linked map” in the right “Item Properties” window. This hides the legend items not visible on the current map. Second, we can adjust the font size in “Fonts and Texts”. Third, we can return to our map and manually combine or rename legend entries in the “Symbology” tab of “Layer Properties”.



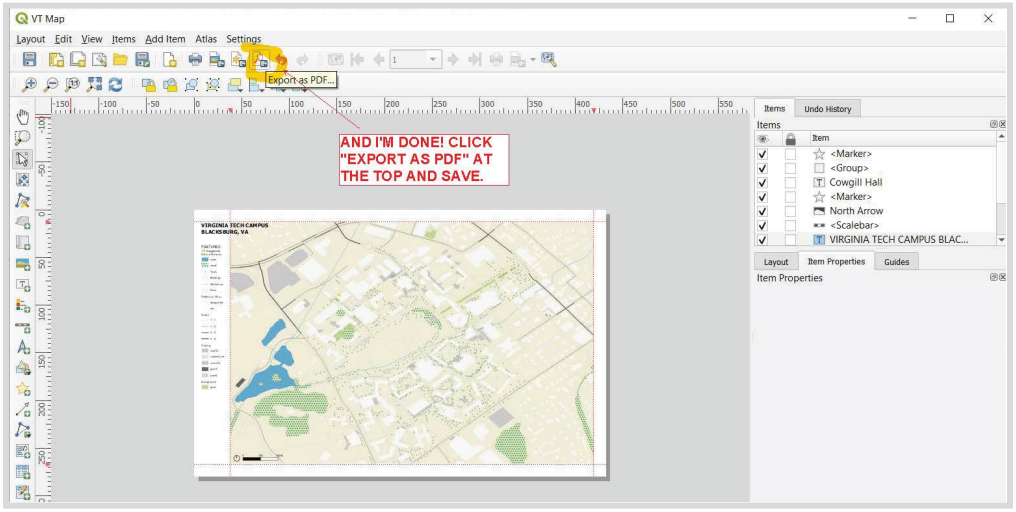
8e Add a north arrow and scale to your map from the left toolbar. You can adjust the graphics of these, and the units of the scale, in the “Item Properties” window. You might also want to add a title with the text box tool.



8f Optionally, adjust your map content and add margins using the “Guides” tab (lower right window, beside “Item Properties”).



8g Lastly, click “**Export as PDF**” in the upper toolbar to save your finished map.



- **Bonus** -

Step 9: Try expressions like “if” and “or” in data styling using the expression editor, as described in this QGIS doc:
https://docs.qgis.org/2.14/en/docs/user_manual/working_with_vector/expression.html
https://gis.stackexchange.com/questions/402942/using-conditional-statement-in-qgis-for-polygon-categorization

Step 10: Export your new map(s) as pdf with legend and include them in your Tutorial 1&2 submission. Include a screenshot of your expression window.