A Brief Introduction to QGIS 2.14

This guide provides a quick introduction to QGIS, a cross-platform open source GIS software that provides standard analysis tools found in other GIS software, such as ArcGIS. This guide assumes that you are familiar with general GIS concepts, and is written primarily as a demonstration for those transitioning from ArcGIS to QGIS. QGIS integrates with other open source GIS packages including PostGIS, GRASS, MapServer. In addition, there are various plugins that can extend QGIS's core capabilities. This guide goes over how to install the current QGIS Long Term Release (LTR) 2.14 on a Windows 10 64-bit OS, and gives a brief introduction to the software. More information on QGIS can be found at http://www.qgis.org/en/site/. A user guide and training manual for QGIS 2.14 can be found here: http://docs.qgis.org/2.14/en/docs/index.html.

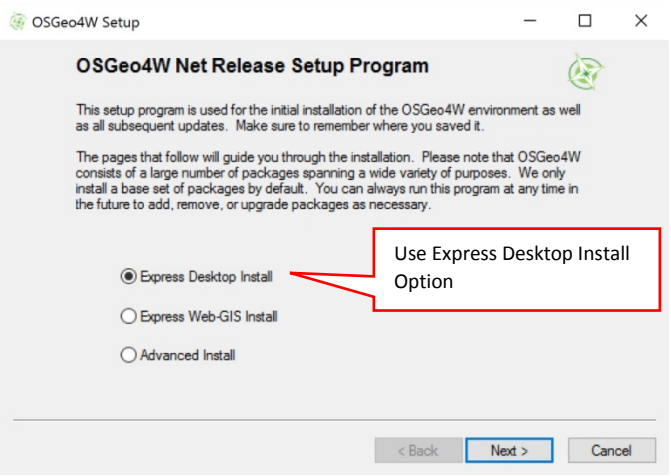
1 Installing QGIS Using OSGeo4W

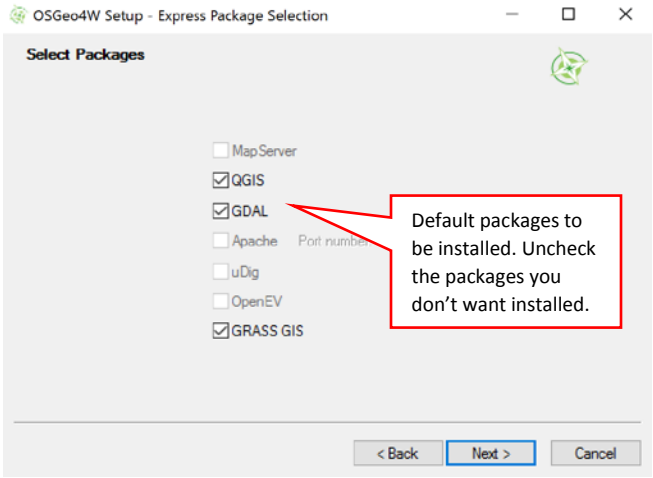
Installing QGIS is fairly simple. For this example, the OSGeo4W 64-bit installer is used. I like this installer because it can also be used to install other open source packages at one time. It's a bundled set of packages that you can choose what to install and/or update. For new users the standalone installers are recommended. For more advanced users you can use the OSGeo4W package to install several versions in parallel. The installer is able to install from internet or just download all needed packages beforehand. The downloaded files are kept in a local directory for future installations.

1. Go to the website, http://www.qgis.org/en/site/forusers/download.html and download the version of QGIS for your OS. You can download the QGIS Standalone version or OSGeo4w installer, which can be downloaded via the QGIS download page or it can be found here: https://trac.osgeo.org/osgeo4w/.

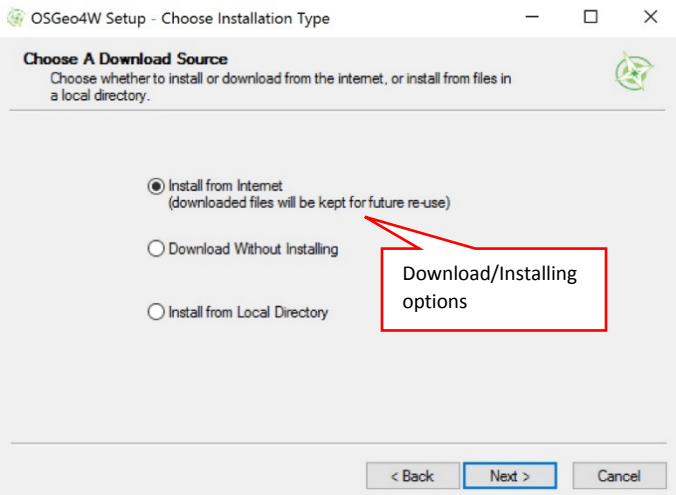
   Note 1: I am using the OSGeo4W 64-bit installer downloaded directly from osgeo.org site. The 64-bit and 32-bit installers include different packages, so make sure you check out which open source packages are in each of the installer before you decide which on one to use. https://trac.osgeo.org/osgeo4w/.

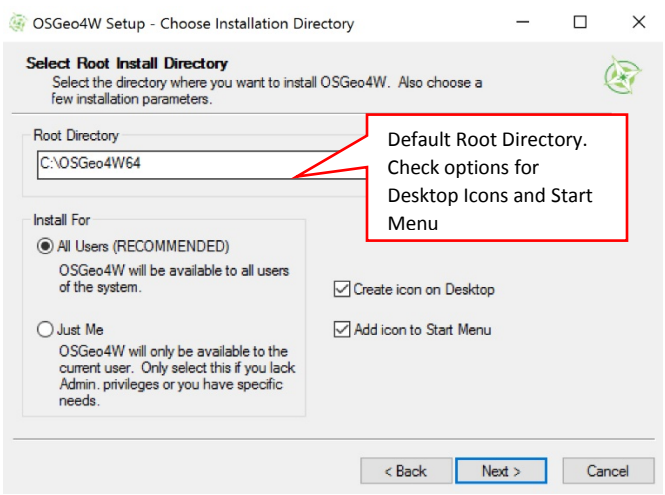
2. After downloading the installer, double click on it to start installation.





Go through the installation process using default options. Choose download source – use the Install from Internet option. Use the default root installation directory as C:\OSGeo4W. Install for all users and select options to create icons on desktop and start menu. During the installation process you may also get a window that says other required software dependencies are needed – install them.





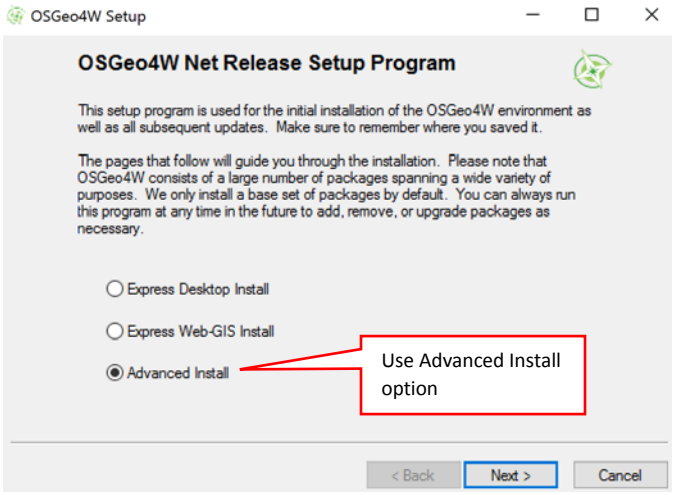
1.1 Optional FileGDB Driver Installation

There are two drivers available as part of GDAL that can be used to work with ESRI/ArcGIS file geodatabases (*.gdb). OpenFileGDB is the built-in driver that is normally installed, however it only provides read access to file geodatabses. FileGDB driver depends upon Esri's File Geodatabase SDK, but it provides both read and write access to file geodatabases. For more information on the GDAL file geodatabase drivers, see: OpenFileGDB and FileGDB. This optional installation portion guides you through installing the GDAL FileGDB driver.

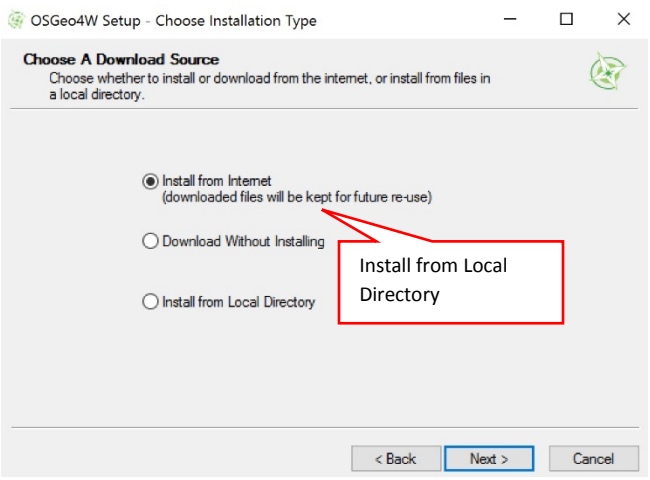
Note 2: I think this option to install the gdal-filegdb driver is only available using osgeo4w installer downloaded from the osgeo.org website. I did use the latest osgeo4w installer downloaded from qgis website and it did not have the gdal-filegdb option.

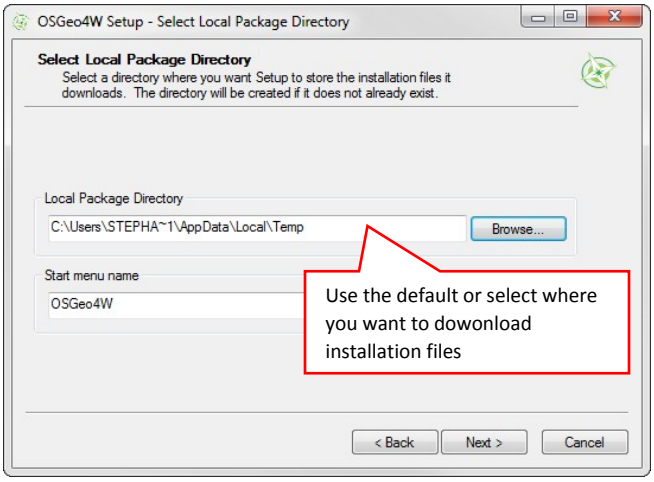
1. In the Startup menu (bottom left corner) find the OSGeo4W application folder, and click on Setup to open up the Setup window (same as in step 2 above).

2. In the Setup window, select the Advanced Install option and click Next

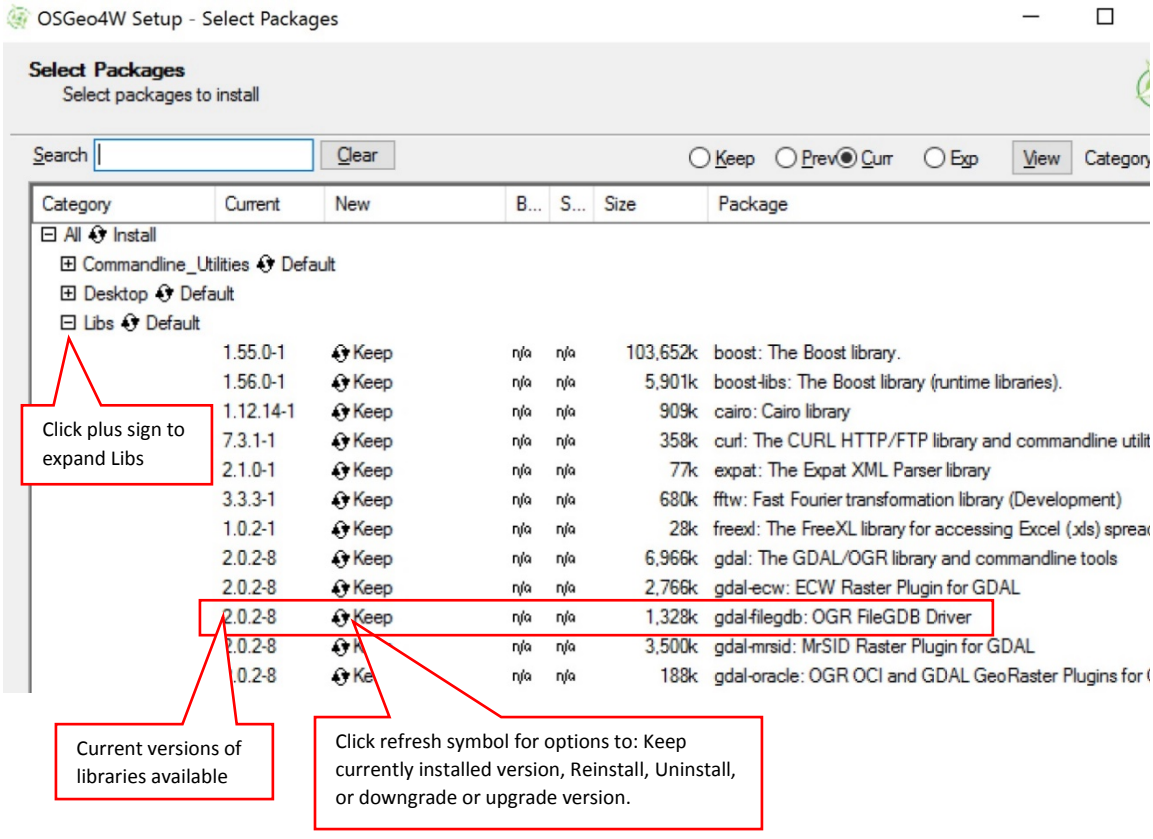


3. Click Install from Install from Internet, then select the directory where you downloaded the installation packages if different from the default path (e.g. C:\Users\stephanies\AppData\Local\Temp).





4. In the Select Packages window, expand Libs section. Find the option, gdal-filegdb: OGR FileGDB Driver, then click the "refresh" symbol for options to either: Install, Uninstall, Keep, Upgrade or Downgrade a library package. Finish the installation process.



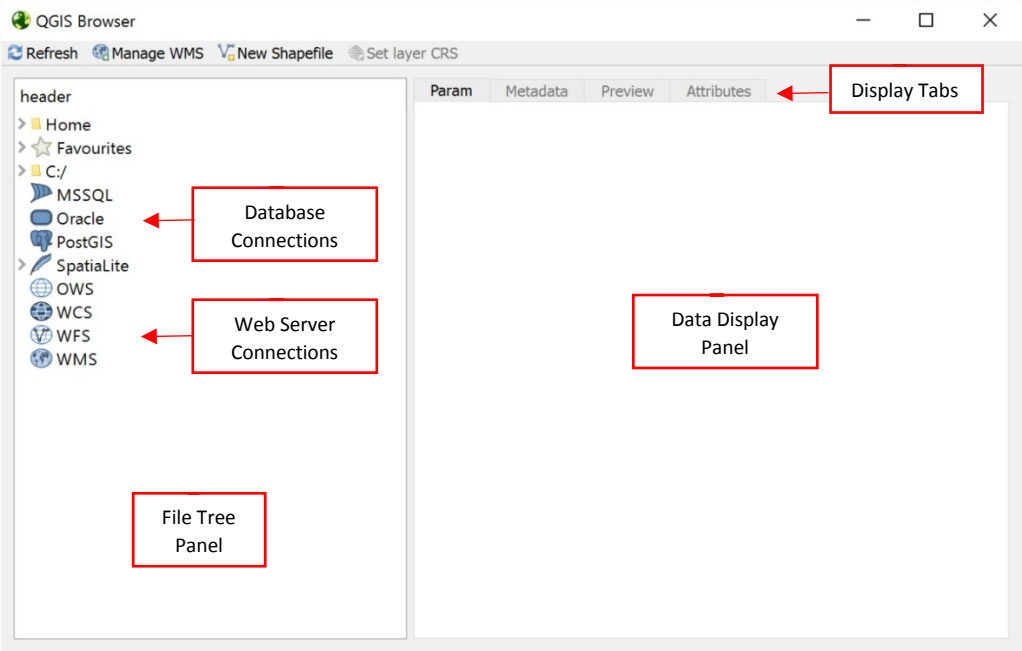
1.2 Uninstalling QGIS

To uninstall QGIS that you installed using the OSGeo4W utility, just delete the root directory and associated folders (e.g. C:\OSGeo4W and C:\Users\stephanies\.qgis). Desktop icons and folder in the Startup menu need to be removed manually.

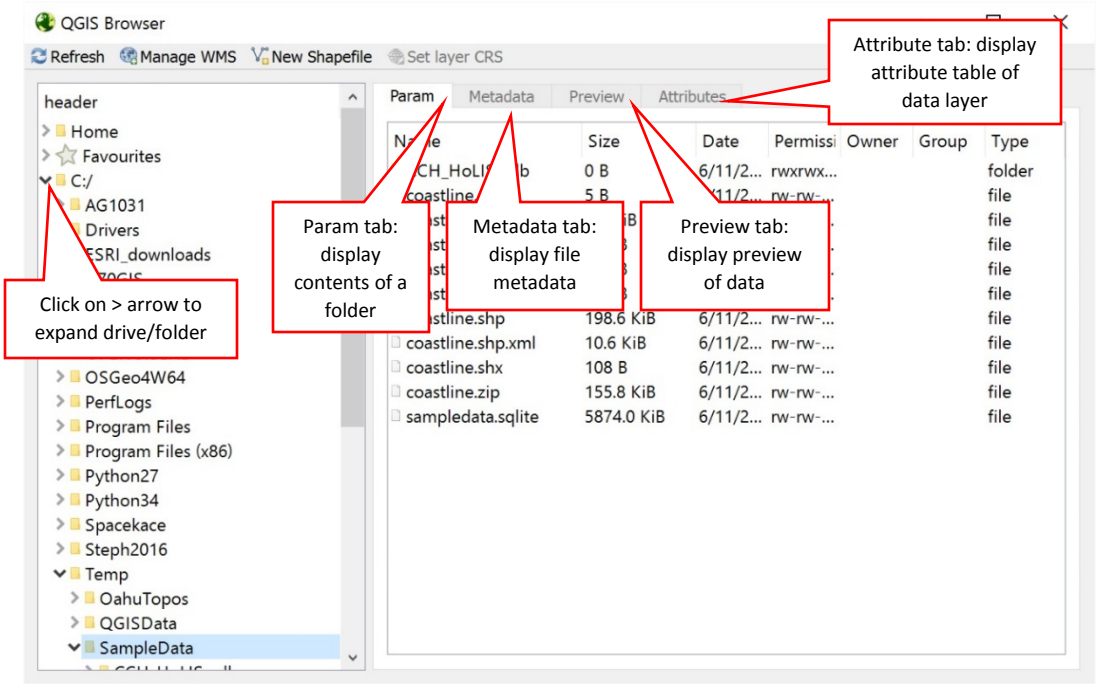
2 QGIS Browser

The QGIS Browser is like Windows explorer for spatial data. It allows you to browse through and work with your data. If you're familiar with ArcGIS, then QGIS Browser is equivalent to the ArcCatalog application. There is also a Browser Panel in QGIS Desktop. The QGIS Browser is pretty much self-explanatory and easy to use.

1. Open QGIS Browser. It should look something similar to the image below.



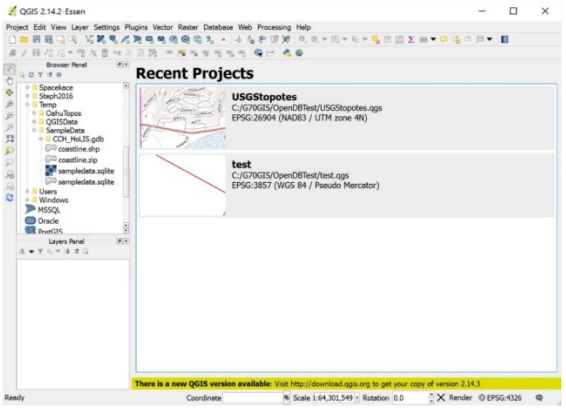
2. Click on the little arrow > to expand a folder or drive.



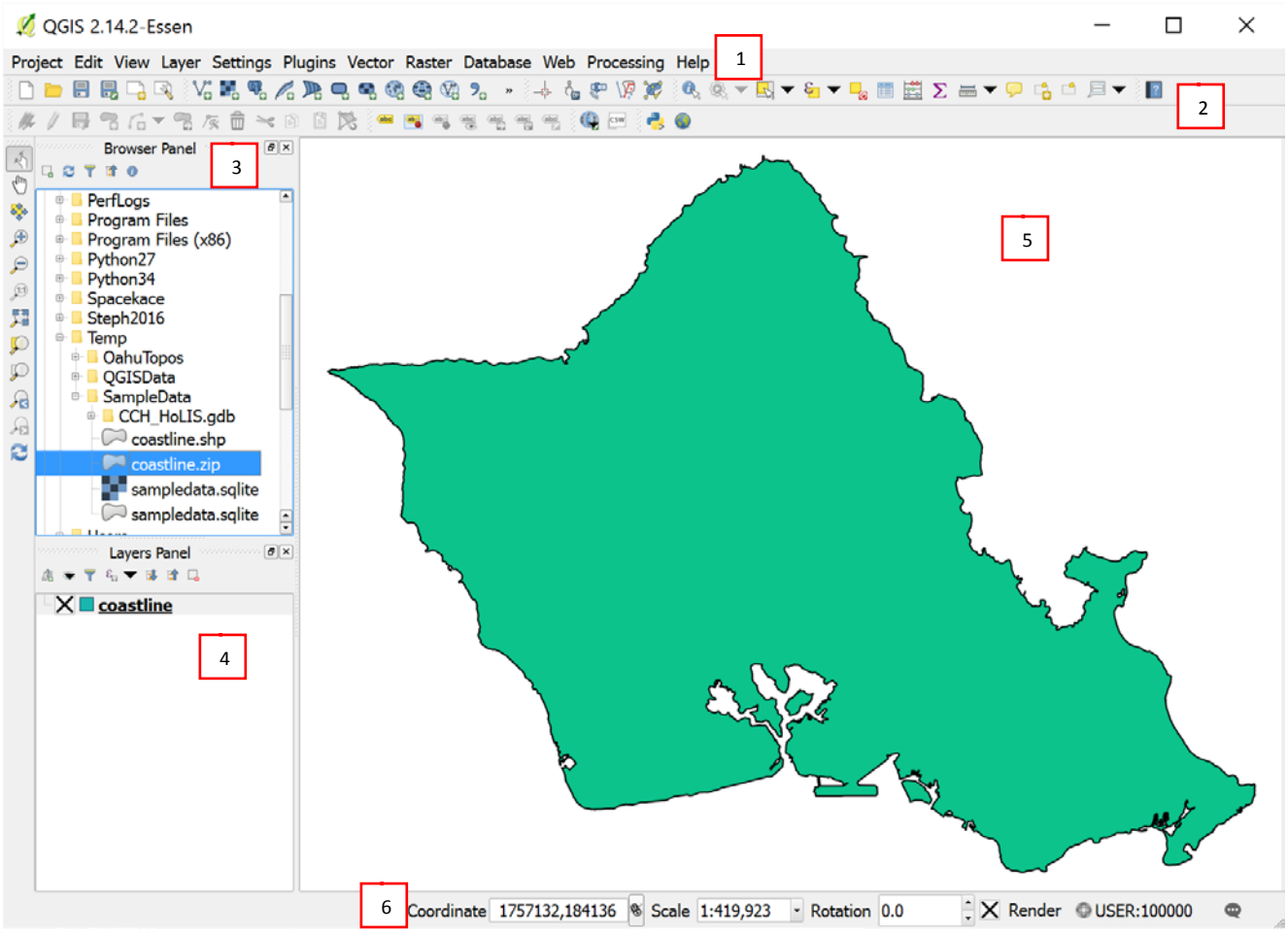
3 QGIS Desktop Interface or GUI

QGIS Desktop is used to make maps, edit data, and do GIS analyses. If you're familiar with ArcGIS, QGIS Desktop works similar to ArcMap.

1. Open QGIS Desktop. Your GUI may look slightly different than the image below.



2. Components of the user interface



1) Main Menu: Provides access to various features and functions of the application in a standard hierarchy menu style. The Main Menu cannot be moved unlike the toolbars and panels

2) Toolbars: Buttons that provide a one click access (i.e. shortcuts) to many of the features and functions found in the Main Menu. Toolbars are movable and can be docked or free floating.

3) Browser Panel: shows a listing of files on your computer. You can drag and drop GIS files into the Layers Panels to view them. This panel is movable and can be hidden/shown on the GUI. Similar to the stand-alone QGIS Browser.

4) Layer Panel: shows a listing of map layers that are in your current project. Layers can be turned on/off, grouped, change drawing order, etc. Again think of this as the Table of Contents in ArcMap.

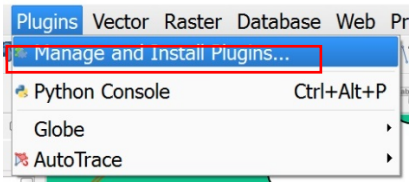
5) Map Display Panel: shows a geographic display of GIS layers in the Layers Panel.

6) Status Bar: shows the current scale of the map display, coordinates of the current mouse cursor position, and the coordinate reference system (CRS) of the project. See Section 4 below for some explanations of coordinate systems and map scale.

3.1 Installing QGIS Plugins

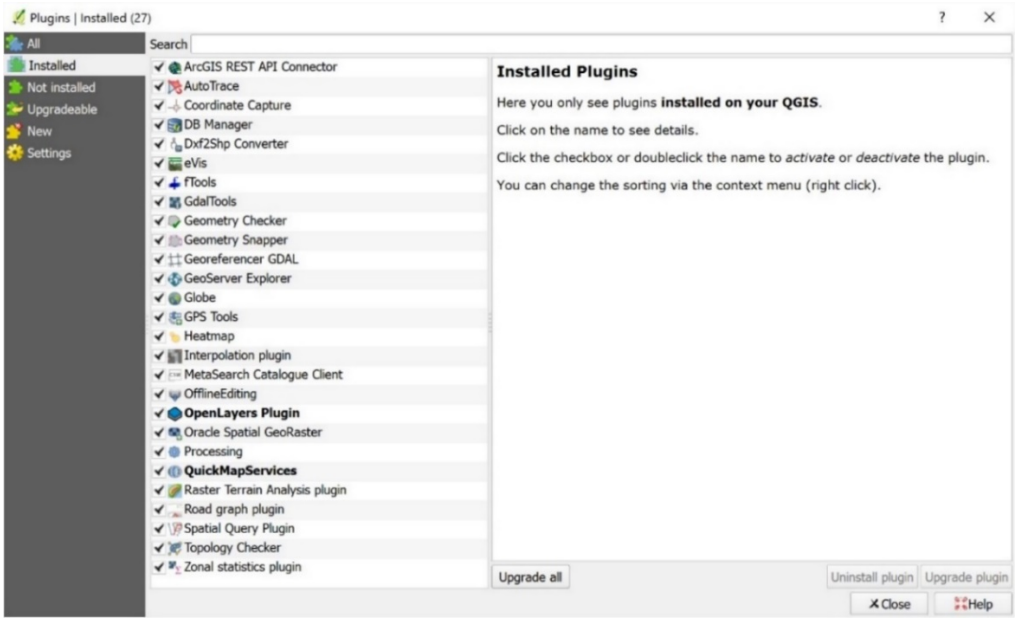
There are many plugins that allows you to extend the capabilities of QGIS. A plugin that I find very useful is QuickMapService plugin that lets you add several basemaps (e.g. Google imagery, OpenStreetmap). Steps 2 and 3 below show you how to install the plugin and use it to add Google aerial or other basemaps to QGIS. Use the plugin and basemaps at your own risk as the legality of usage of some basemaps may be a gray area or not allowed.

1. Configuring Plugins: Plugins menu >> Manage and Install Plugins. A pop up window will display a "Fetching Plugins" then the Plugins window will display.

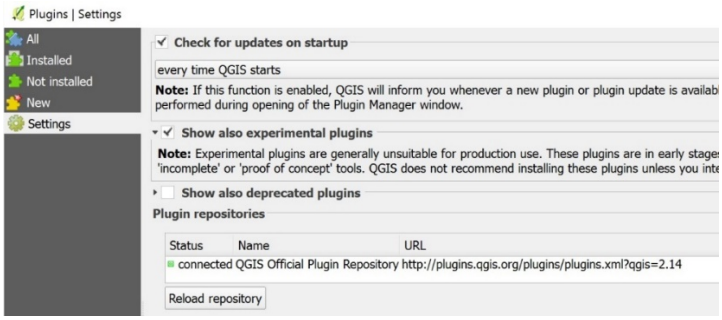


Note 2: You will need to have internet access since QGIS is fetching the plugin repository online.

The Plugins window is shown below. Here you can install/uninstall, activate/deactivate, and upgrade plugins. You can also search using keywords to find plugins.

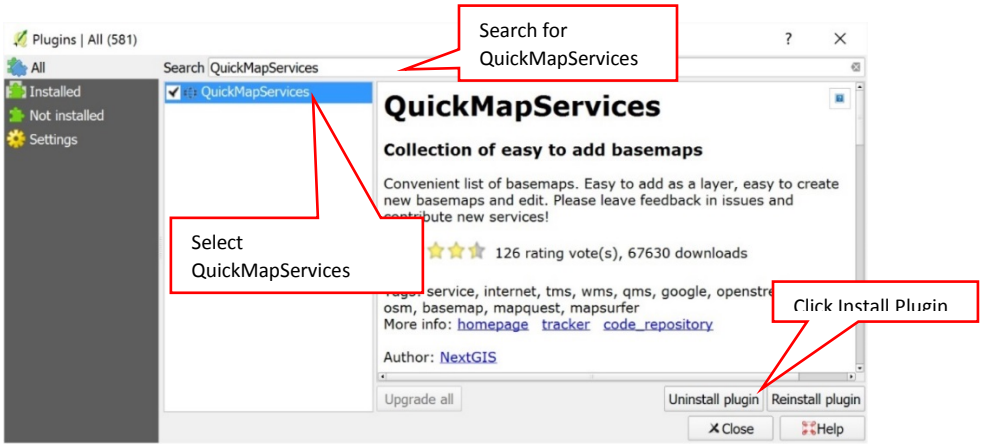


Under Settings: you can set QGIS to check for updates on startup, and also to not show deprecated plugins.

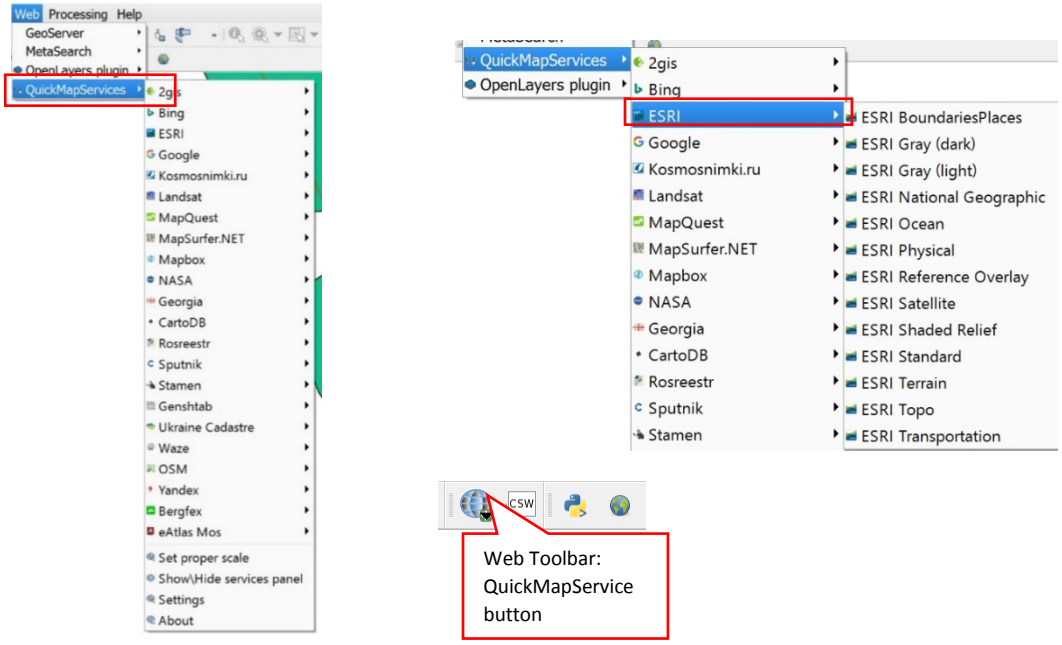


2. Install QuickMapServices Plugin. In the Plugins window, search for QuickMapServices, then select it from the list and install it.

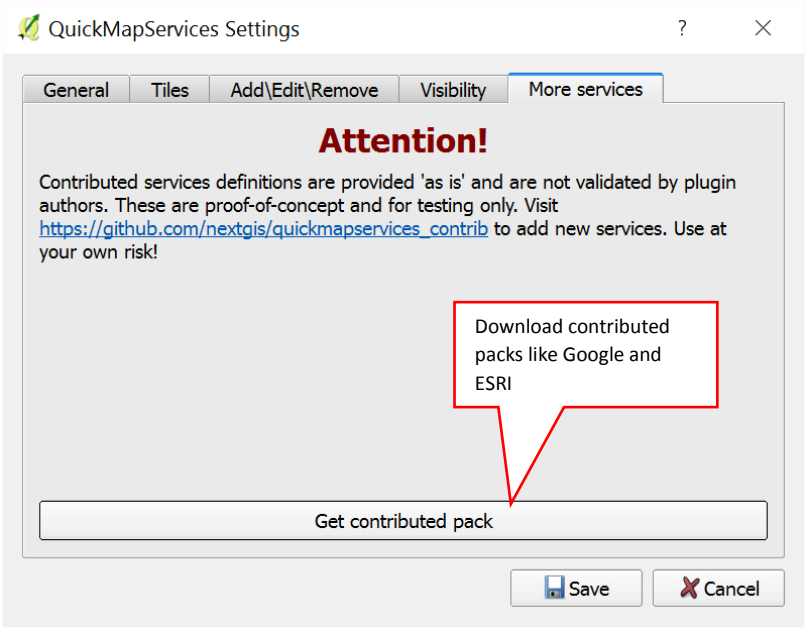
Note 3: I already have QuickMapServices plugin installed so I only get the options to Uninstall, Reinstall or Update plugins.



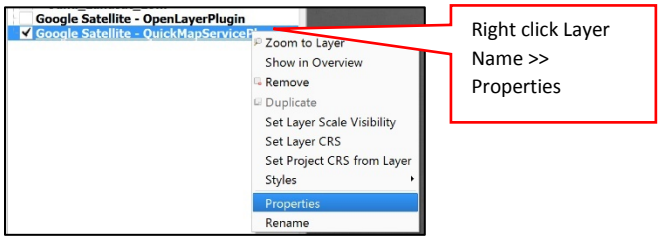
3. Using QuickMapServices Plugin after you install it. Go to Web menu >> QuickMapService. The QuickMapServices plugin will also have a button in the Web Toolbar. For those who familiar with ESRI online basemaps, the same set of basemaps can also be accessed in the QuickMapService Plugin.

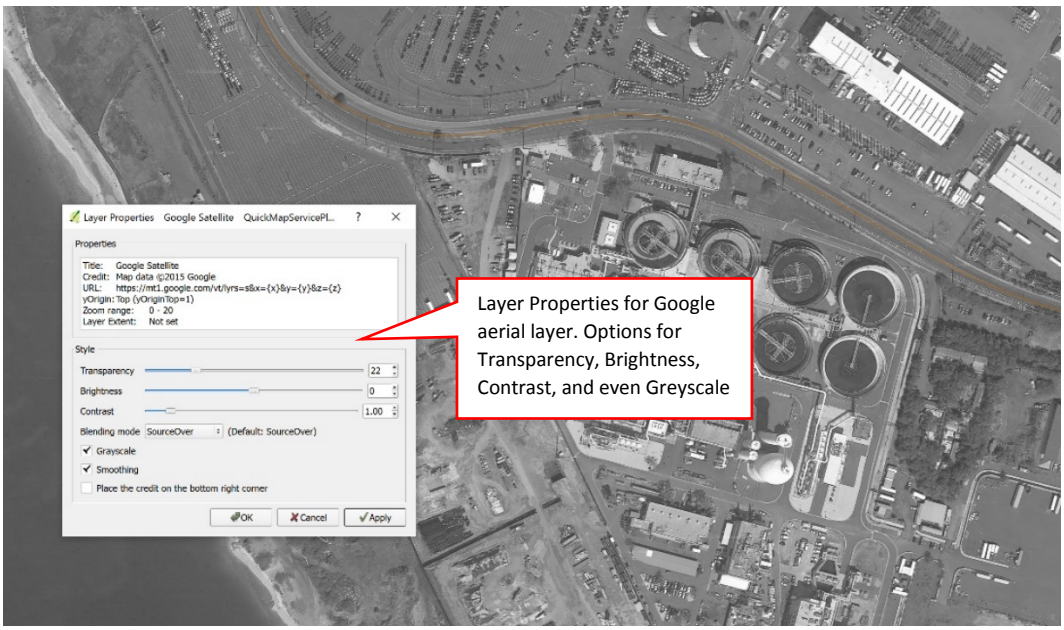


If after you install QuickMapServices and you don't see Google or ESRI basemap options, go to Web menu >> QuickMapServices >>Settings >> More Services, and downloaded contributed packs. Change any other options you like using the tabs in the Settings window.

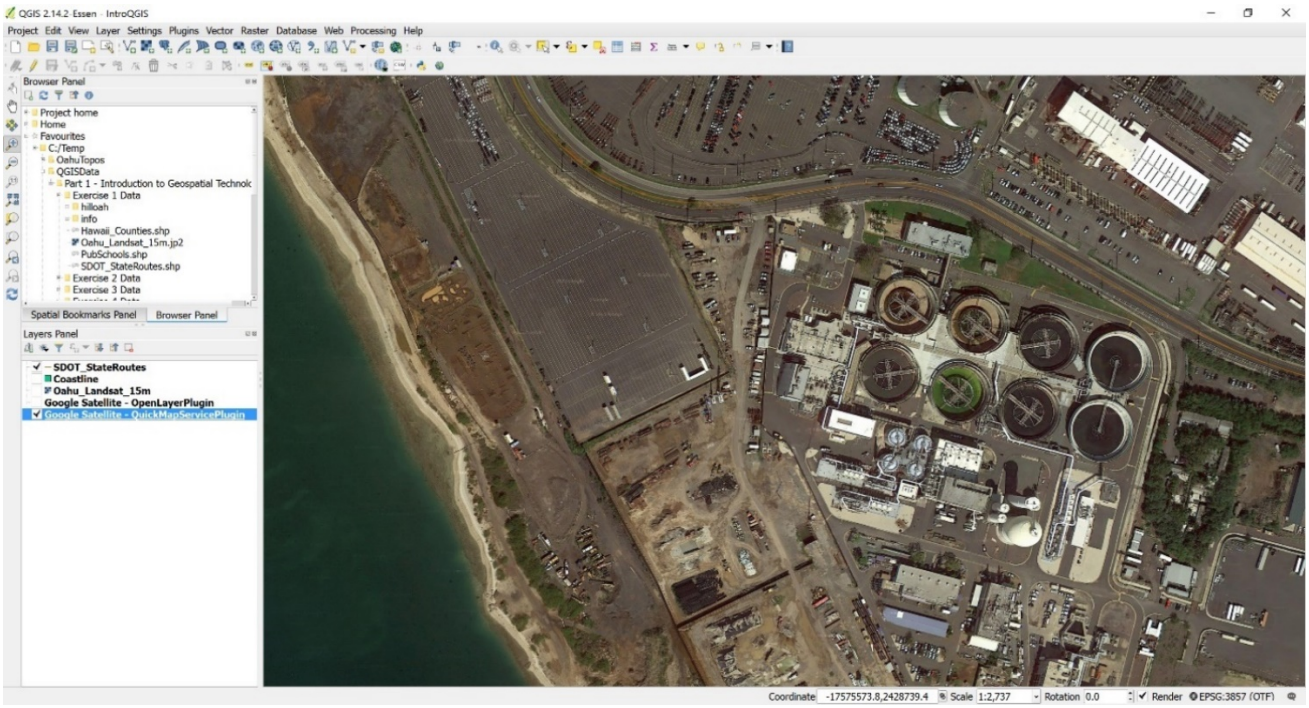


4. Depending on the basemap you use, you can change the how it is displayed via the Layer Properties window.



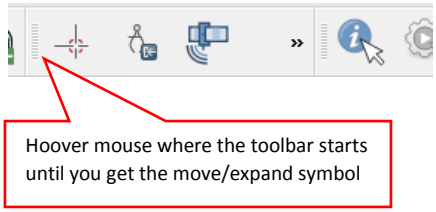


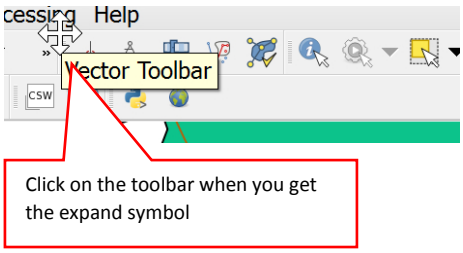
Example of Goolge aerial basemap added via QuickMapServices Plugin

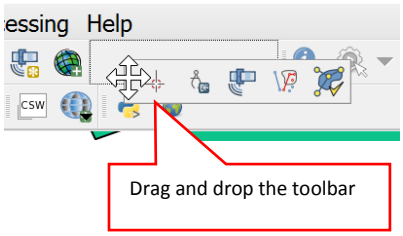


3.2 Configuring the user interface

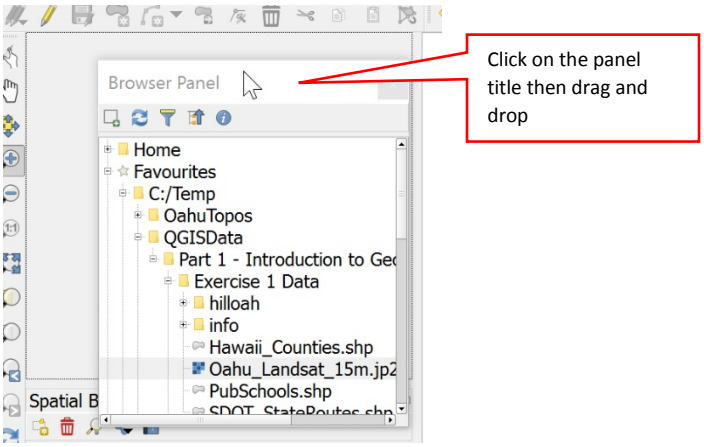
1. Moving Toolbars and Panels
   - To move a toolbar, hoover your mouse over the toolbar you want to move until you get white expand/move symbol then click and drag and drop the toolbar to anywhere or have it free floating



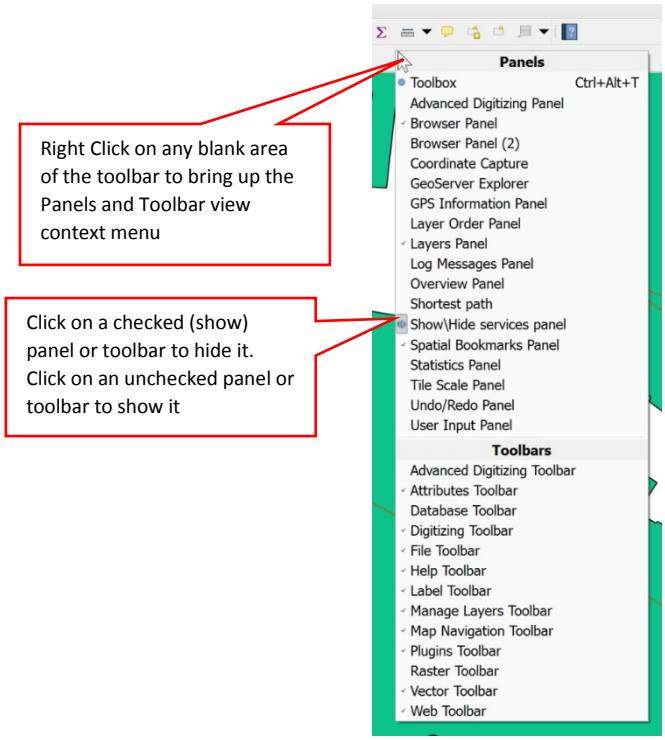




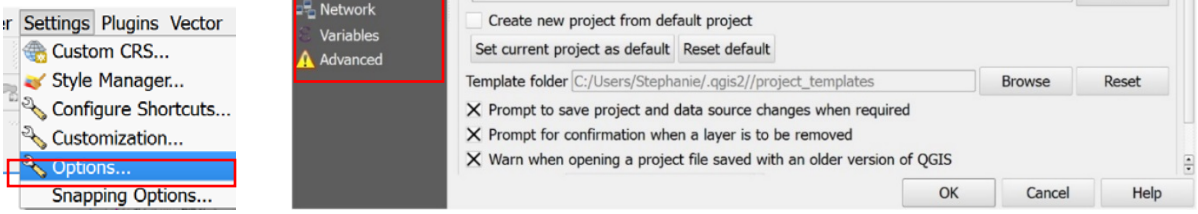
   - To move a panel, click on the panel title (e.g. Browser Panel) and drag and drop.



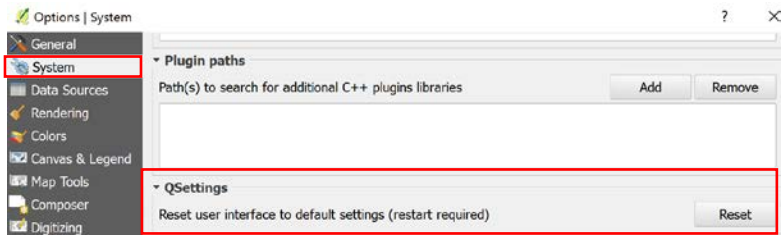
2. Hide or shown Toolbars and Panels: Right click in any blank area on the toolbar to get the Panel and Toolbars menu. Click on a checked or unchecked Panel (s) or Toolbar(s) to toggle between hiding and showing them. A good one to panel to show is the Spatial Bookmarks panel so you can bookmark your map extents. Works the same way as Spatial Bookmarks in ArcMap.



3. You can customize many aspects of the user interface through the Options window: go to Settings menu >> Options.



4. To reset QGIS Desktop to its default settings: Settings menu >> Options >> System >> QSettings Reset button



4 Coordinate Reference System and Map Scale

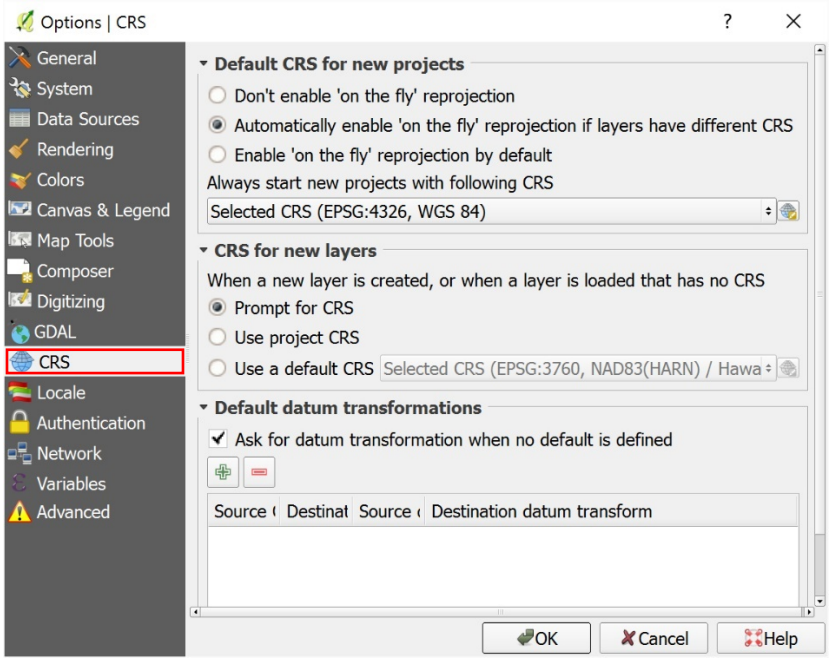
Coordinate Reference System (CRS) and map scale in QGIS can be a little bit confusing, so I will attempt to do a brief explanation here. CRS are specified by EPSG codes in QGIS. EPSG is an acronym for European Petroleum Survey Group, which publishes a database of coordinate systems and datums that is used as the open source standard.

ESRI uses a modified version of the EPSG model. Coordinate systems in ArcGIS is specified by WKIDs, which is equivalent to the EPSG codes when the Authority is listed as EPSG (see image below). For more information on EPSG codes, see EPSG.org. To find EPSG codes, see spatialreference.org or see prj2epsg.org to import/convert and ESRI *.prj (projection file) to an EPGS equivalent code.

4.1 Coordinate Reference System (CRS)

4.1 Default Global CRS used in QGIS:

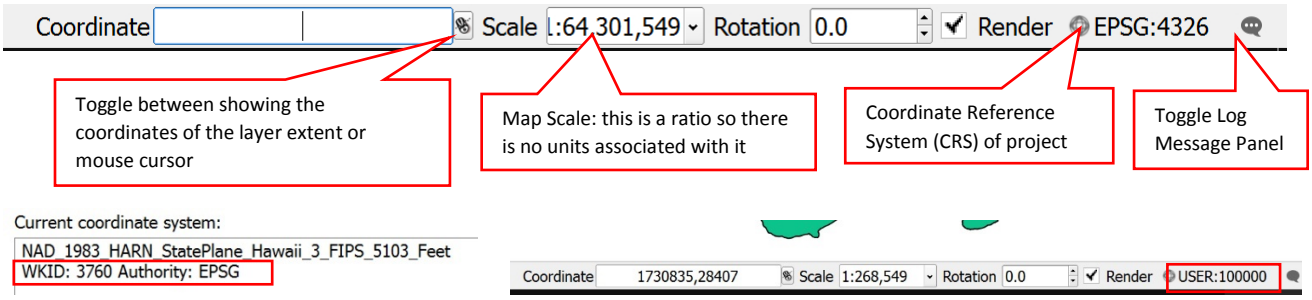
The default CRS of QGIS is WGS84 or EPSG: 4326. You can change the default CRS options, go to Settings menu >> Options >> CRS tab.



4.2 Project based CRS:

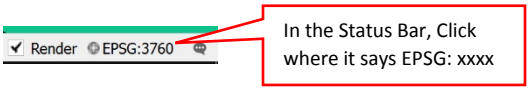
When you open a new QGIS project, it defaults to the global CRS of WGS84 or EPSG 4326, unless you have changed the global default settings (see 1.1 above). The first layer you add to the project will set the project's CRS to that of the layer. The unit of measurement and display XY coordinates will also be set to the layer's CRS.

Below is an example of an Oahu coastline shapefile which was created in ArcGIS using NAD83 HARN, State Plane Hawaii Zone 3, Feet (WKID/EPSG = 3760). When added to a new QGIS project, the CRS in the status bar should show EPSG 3760, but it is not. Rather the project CRS is shown as USER: 10000 or a custom user defined. This happens when the CRS names and/or projection parameters don't match what QGIS uses, even though the data is shown in the correct location (as indicated by the coordinates).

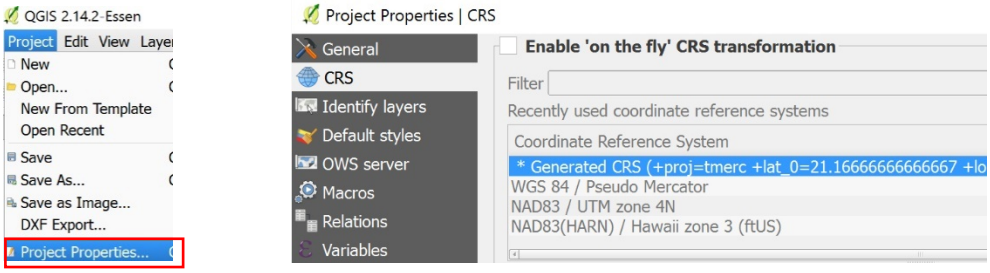


There are 3 ways to set the Project CRS:

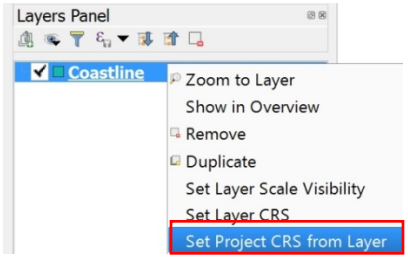
- Clicking the CRS on the status bar to bring up the Project CRS window.



- Go to Project menu >> Project Properties >> CRS tab. Note you can also enable on-the-fly projection here.



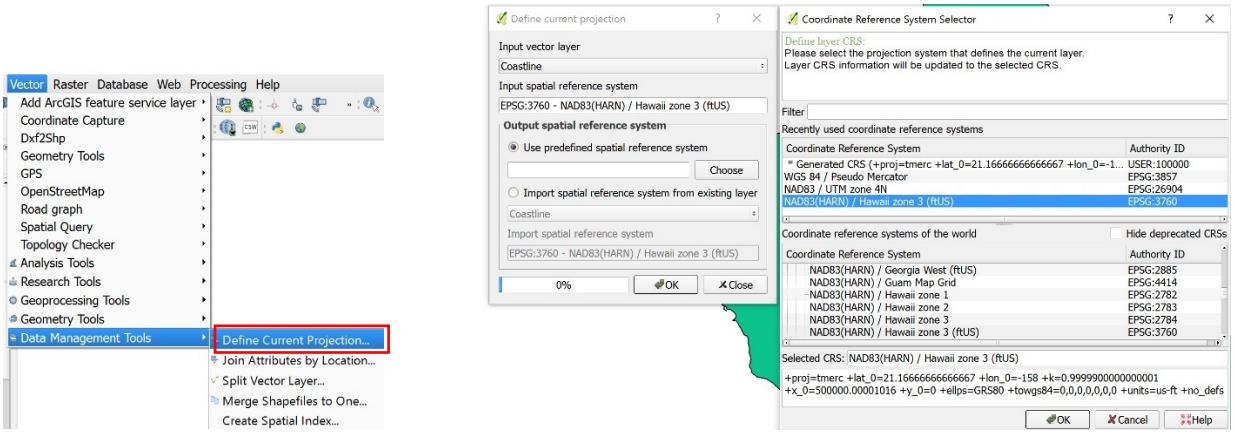
- In the Layers panel, right click layer name >> Set Project CRS from Layer.



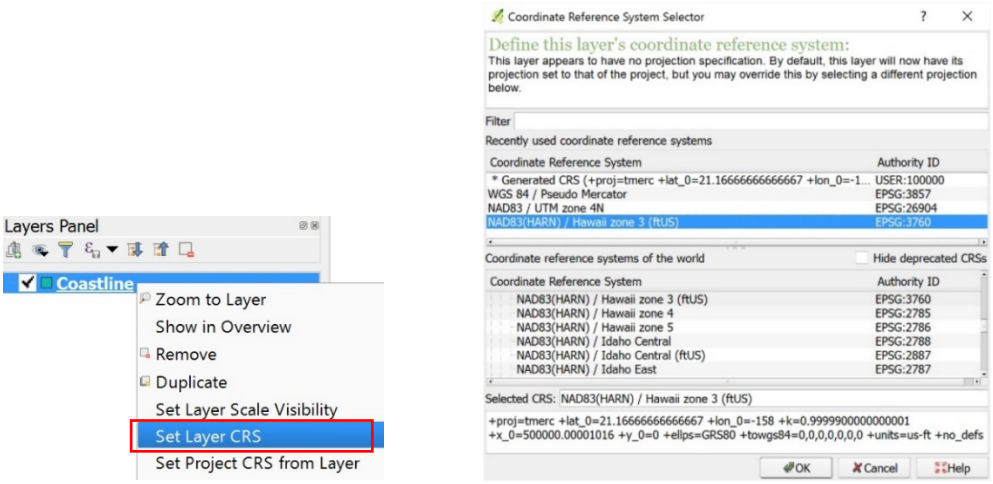
4.3 Define Layer CRS:

Defining a layer's CRS just means that you are explicitly telling QGIS what the layer's existing/known CRS/EPSG code is. There are 2 methods to define layer CRS.

- Go to Vector menu >> Data Management Tools >> Define Current CRS

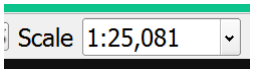


- In Layers panel, right click layer name >> Set Layer CRS

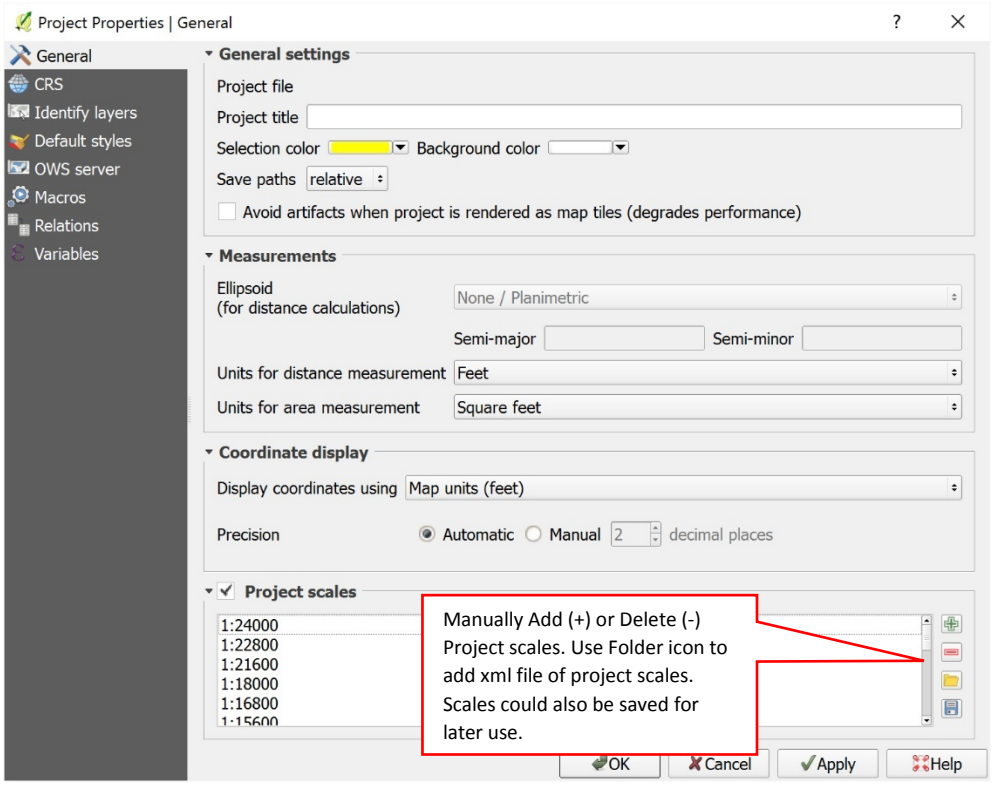


4.2 Map Scale

The map scale you see in the status bar in QGIS is a ratio and could be any unit you want – for example it could be 1": 25,081", 1': 25,081', or 1 mile: 25,081miles. But since the CRS of the project is set to NAD83 HARN, State Plane Zone 3, Feet the map unit defaulted to feet (see Project Properties example below). So I could take the ratio 1:25,081 to be 1': 25,081', however, this is hard to understand. Normally you would want units that are more easily understood, such as 1" = 500' or 1" = 500 meter, and so on. Using this sample in feet, let's say you want to view the layer at a scale of 1" = X feet: you take 25,081 and divide it by 12 (since 12" = 1') to get 1" = 2090'.



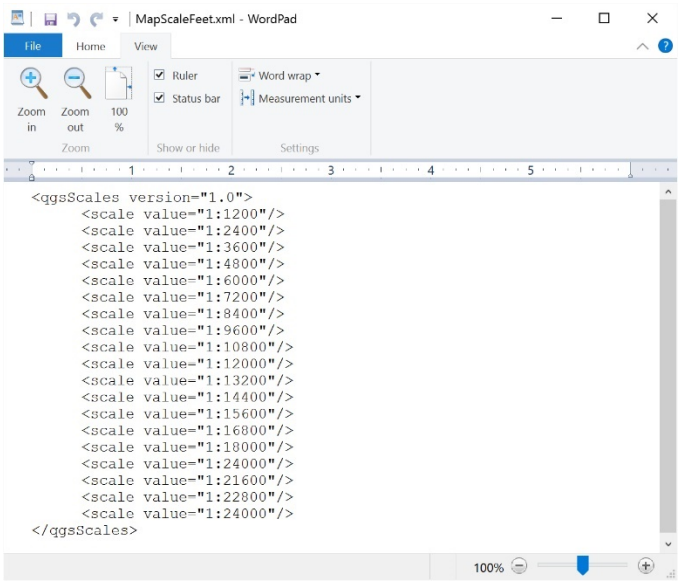
In the Project Properties window, General tab: you can see what units are used for the Measurements and Coordinate Display as well as a set of Project Scales options. As mentioned earlier the measurement units and coordinate display defaults to the Project CRS. In the example shown below, I am using feet as my units and I have a set of Project Scales in an xml file that I've added for this project.

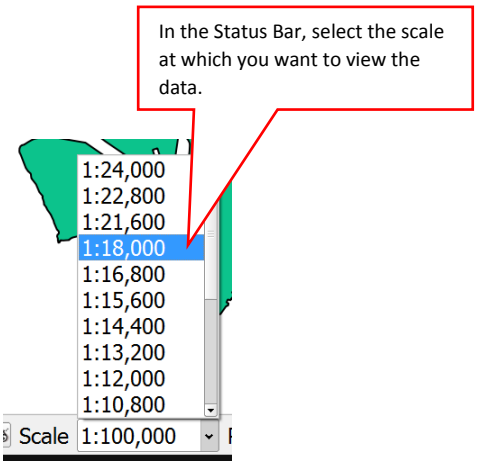


List of project scale ratio and corresponding map scales in feet.

Project Scale Ratio	1" = X Feet
1:1,200	100
1:2,400	200
1:3,600	300
1:4,800	400
1:6,000	500
1:7,200	600
1:8,400	700
1:9,600	800
1:10,800	900
1:12,000	1,000
1:13,200	1,100
1:14,400	1,200
1:15,600	1,300
1:16,800	1,400
1:18,000	1,500
1:19,200	1,600
1:20,400	1,700
1:21,600	1,800
1:22,800	1,900
1:24,000	2,000

Example of an xml file with the map scales that I want for my project. You can create this xml in WordPad, NotePad, or any text editor.





Note 4: Understanding the map scale is important in getting a correct scale bar for your map. Scale bar is discussed in the Map Composer Section 6.

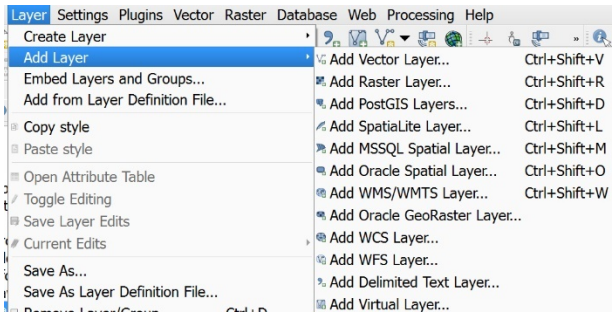
5 Working with Spatial Data in QGIS Desktop

With QGIS you can add the typical GIS data in various formats, such as shapefiles, geopackages, spatialite, ESRI geodatabase (gdb, mdb), PostGIS database, and so on. One thing I like about QGIS is it can view a zipped shapefile.

5.1 Adding Data

1. There are several options for adding data layers to the Layer Panel:

   - Layer Menu >> Add Layer >> Select a data type to add



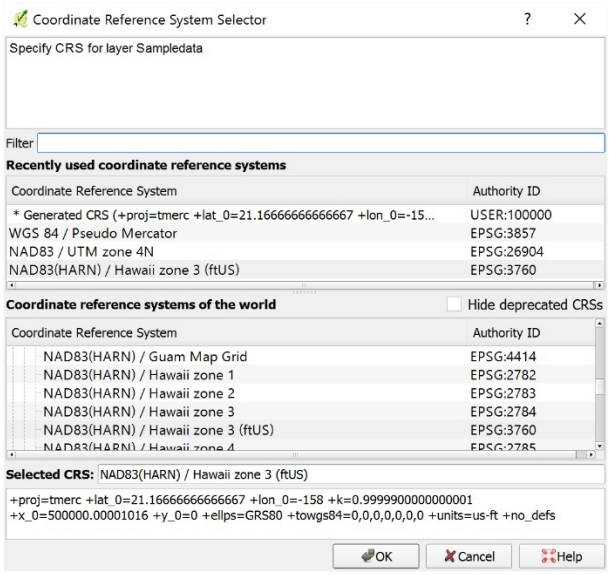
   - Manage Layers Toolbar has the same Add Layer functions as in the Layers Menu via click buttons.

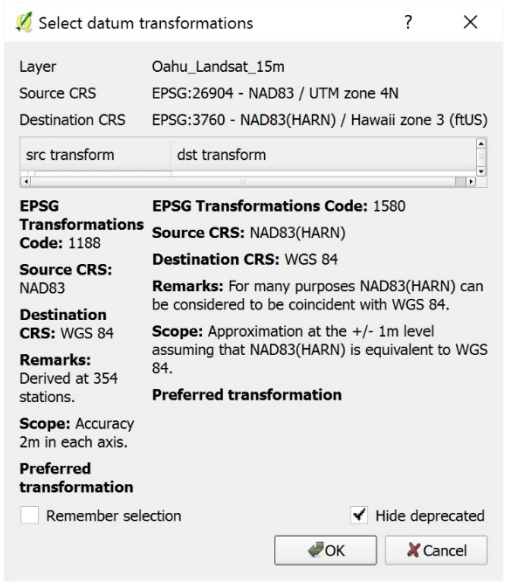
   - Shortcut: Double clicking on the data layer in the Browser Panel will add the file to the Layer Panel

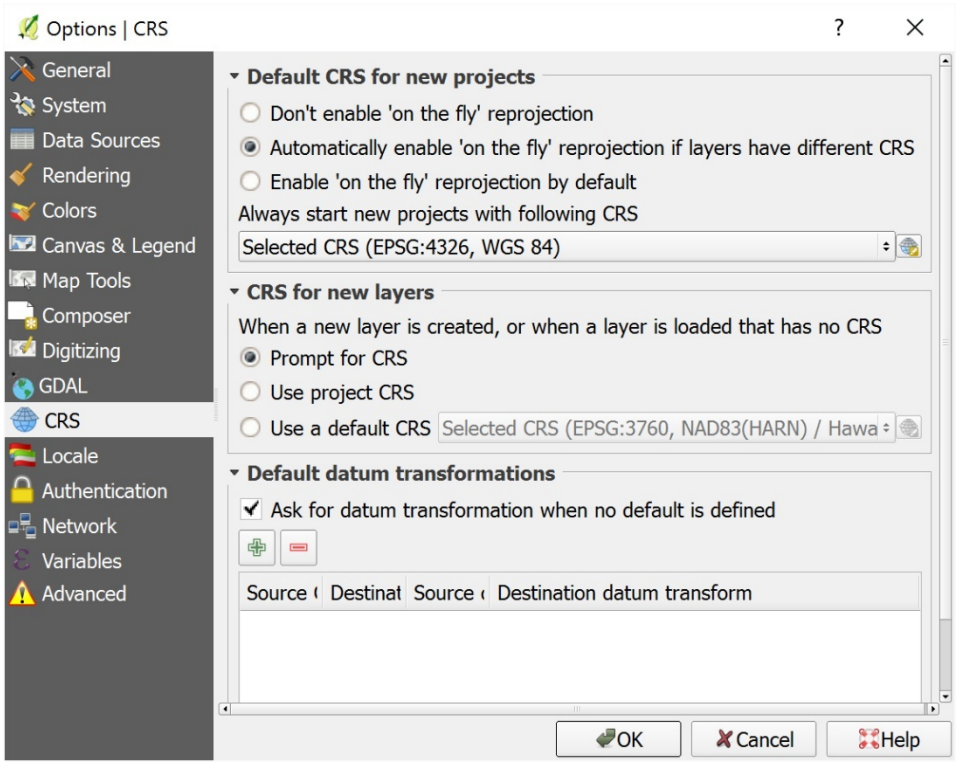
   - Shortcut: Click and drag the shapefile from the Browser Panel to the Layer Panel

2. CRS and Transformation Settings

   When you added a data layer to QGIS, you may get popup windows asking you to select a CRS or a Transformation for the data being added. These popup windows are based on the options in the QGIS default settings (Settings menu >> Options).







Notice in the example QGIS Setting Options that I have set to Automatically enable on the fly reprojection if layers have different CRS and to Prompt for CRS when creating a new layer or when a layer is loaded that has not CRS, and to ask for datum transformation when no default is defined.

3. Adding Open Geospatial Consortium (OGC) Web Services: WMS, WFS, WCS

In QGIS you can also connect to Open Web Services (OWS), such as Web Map Service (WMS), Web Feature Service (WFS) or Web Coverage Service (WCS). The easiest way to think about these services is by the types of data they provide. WMS serves up georeferenced map images of geospatial data (e.g. JPG, PNG, FIG files). WFS provides the vector geospatial data used to make the maps. Unlike with WMS, which is just a map image, with WFS you can

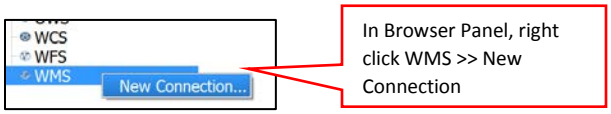
query, edit, and manipulate the vector file information. WCS provides coverage data that can be thought of as the raw raster data behind an image (e.g. DEM, TIN, Raw Landsat data, etc.), which you can download and work with. More information on these web service standards be found here: http://www.opengeospatial.org/standards.

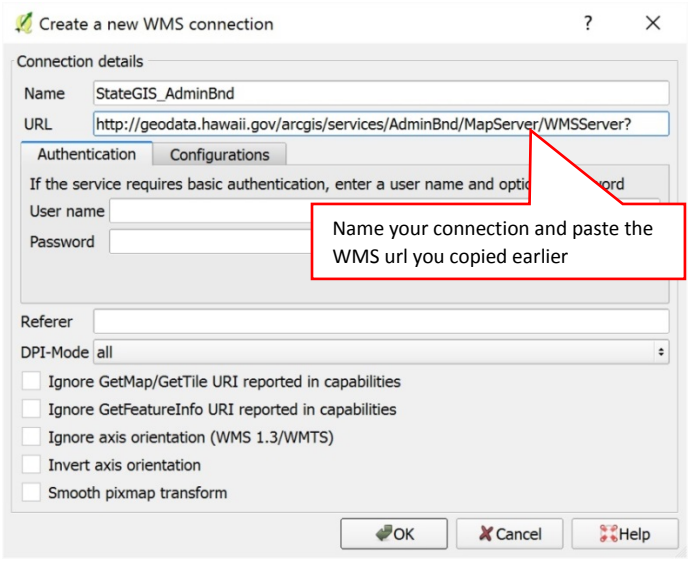
Below are some examples of WMS and WFS web services from the Hawaii Statewide GIS Program's Map Server.

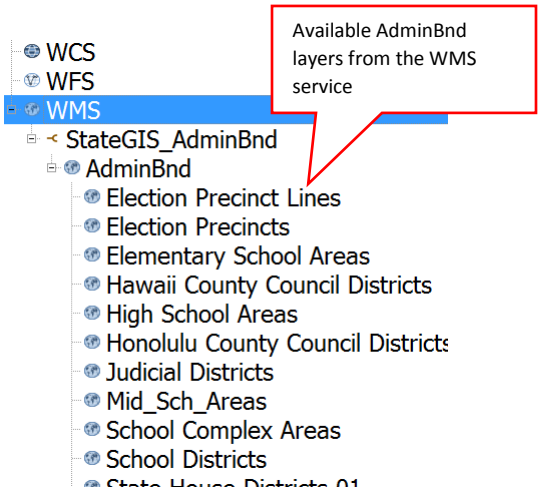
1. Go to the main Hawaii Statewide GIS Program's ArcGIS REST services: http://geodata.hawaii.gov/arcgis/rest/services.

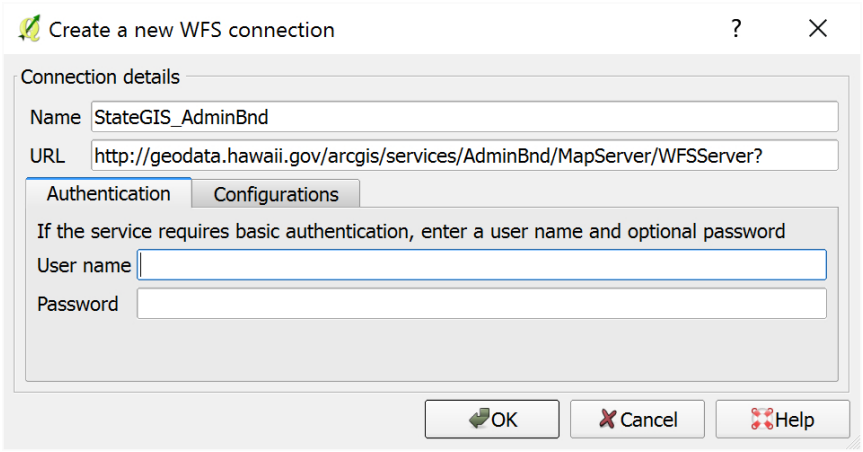
2. Click on a service. At the top of the map service page, you should see JSON, SOAP, WMS, WFS. Selecct

3. In QGIS Desktop, Browser Panel, right click WMS >> New Connection. In the New Connection window: Give the connection a name and paste the WMS URL you copied earlier into the URL field. Click OK.

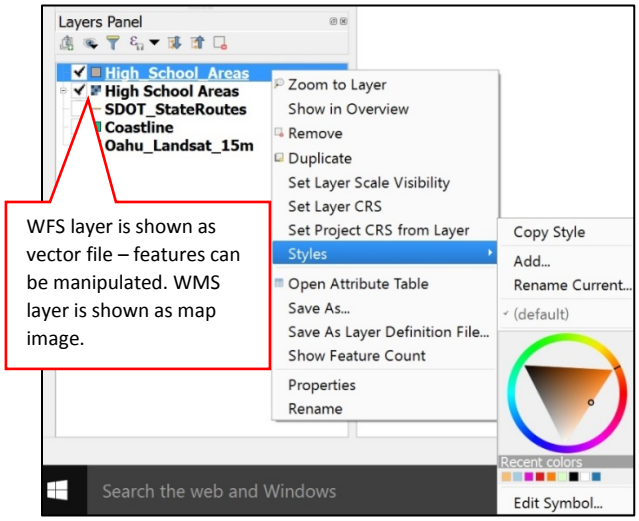








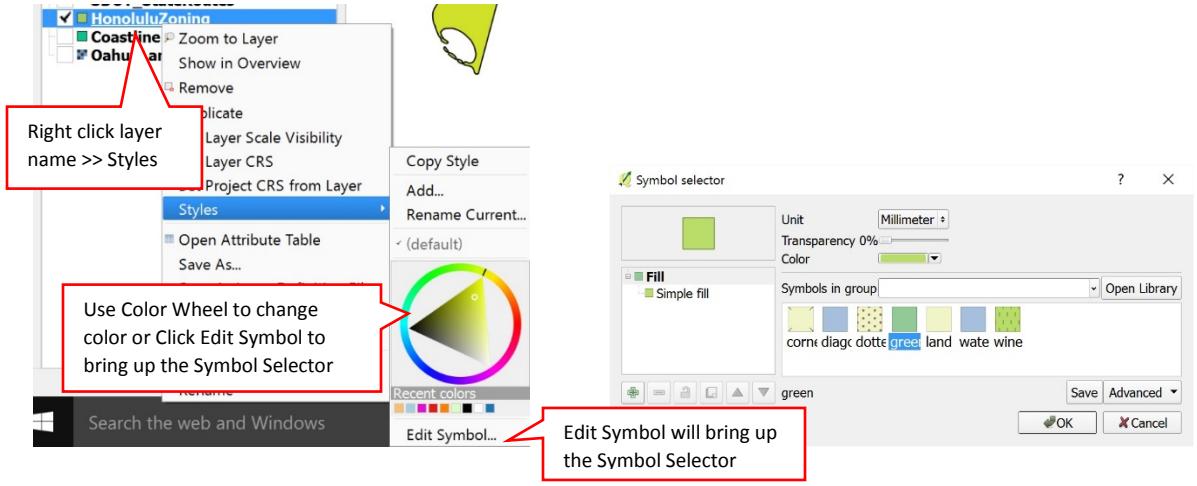
Notice the difference in how the layers from the WMS and WFS are displayed. The High School Areas layer from WFS is a vector file with features that can be manipulated (e.g. open attribute table and change symbology), whereas the same layer from WMS is displayed as a raster image.



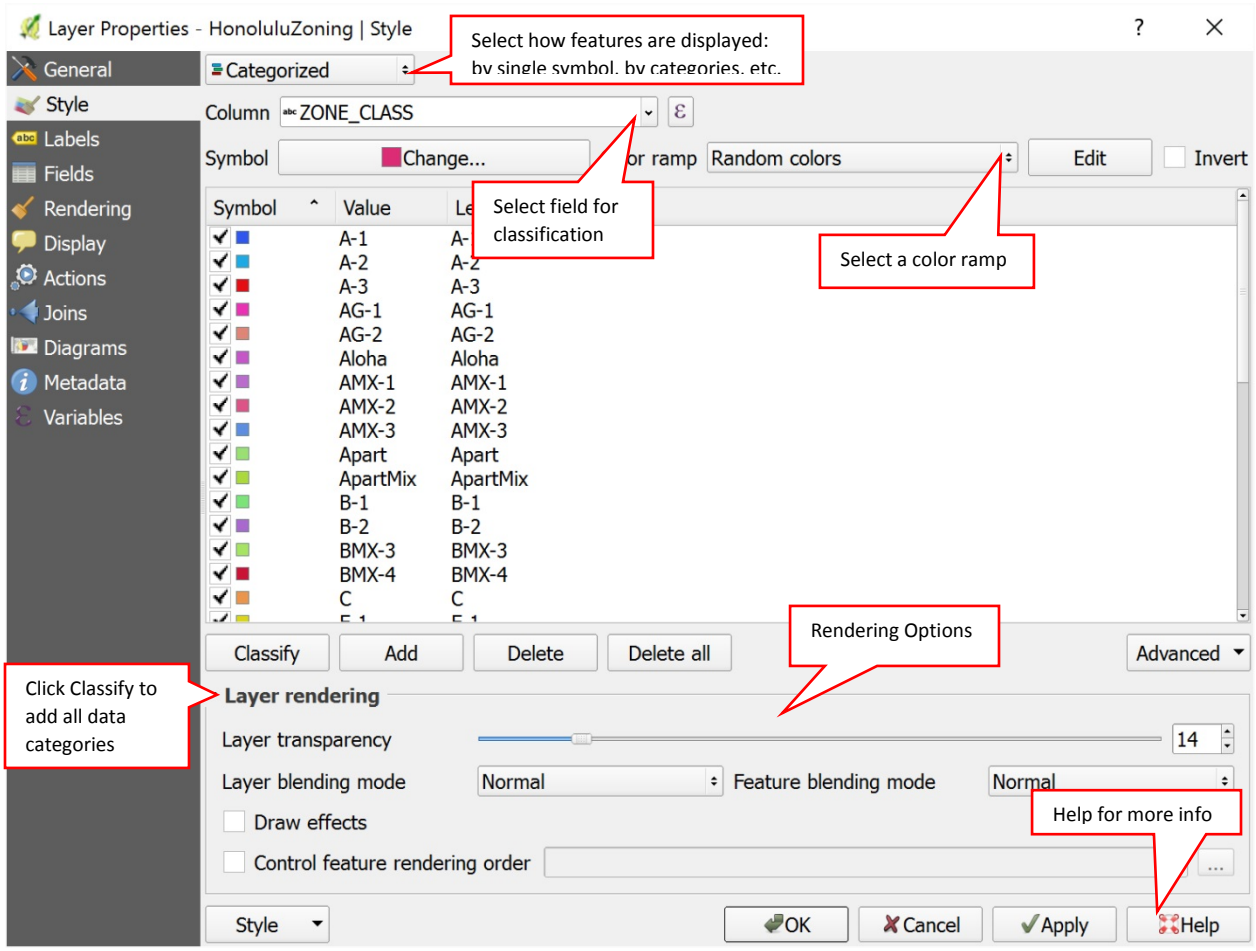
5.2 Symbology

When you add a layer to the Layer Panel, QGIS will display it using a default symbol representing the feature type of the data and a randomly assigned color. Symbology options are located in the Layer Properties window. There are many options to choose from. Shown here are some ways to access the symbology options available in QGIS.

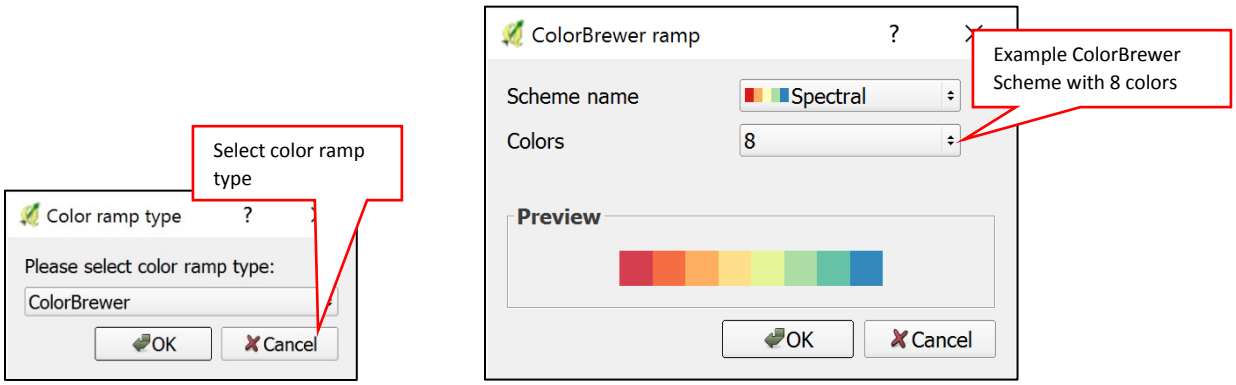
1. Quick access to Styles color wheel or Edit Symbol: Right click on layer name, Styles.



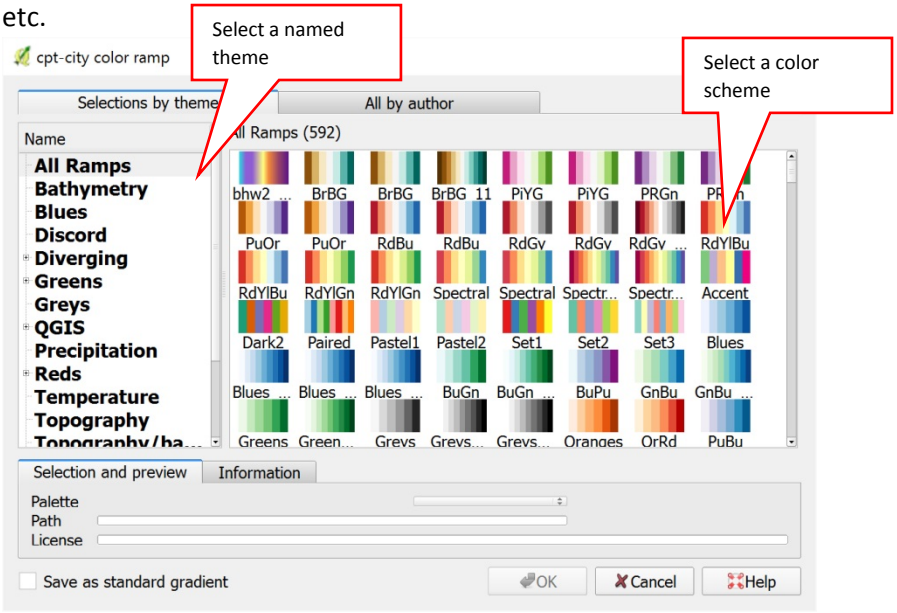
2. Layer Properties Style Tab: Double click on the layer name or right click on layer name >> Properties >> Style tab.



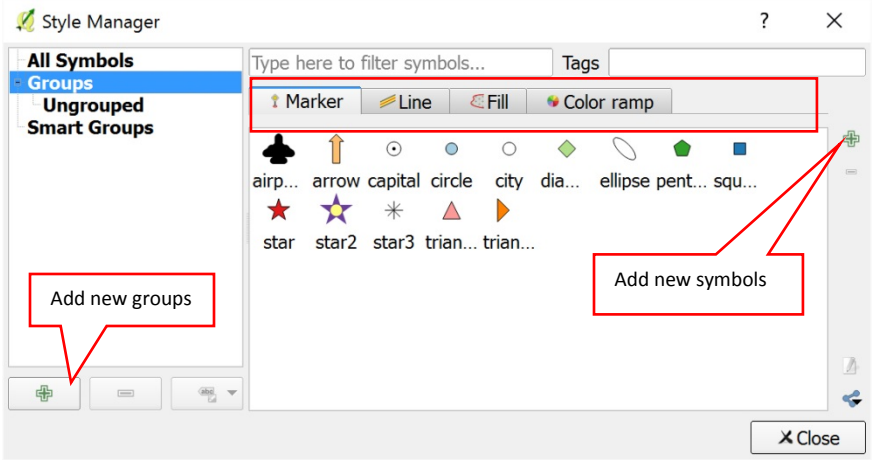
If you select New Color Ramp Type, there more options such as ColorBrewer and Cpt City color schemes.



The cpt-city color ramps shown below give you more of the traditional color ramps for Bathymetry, Topography, etc.

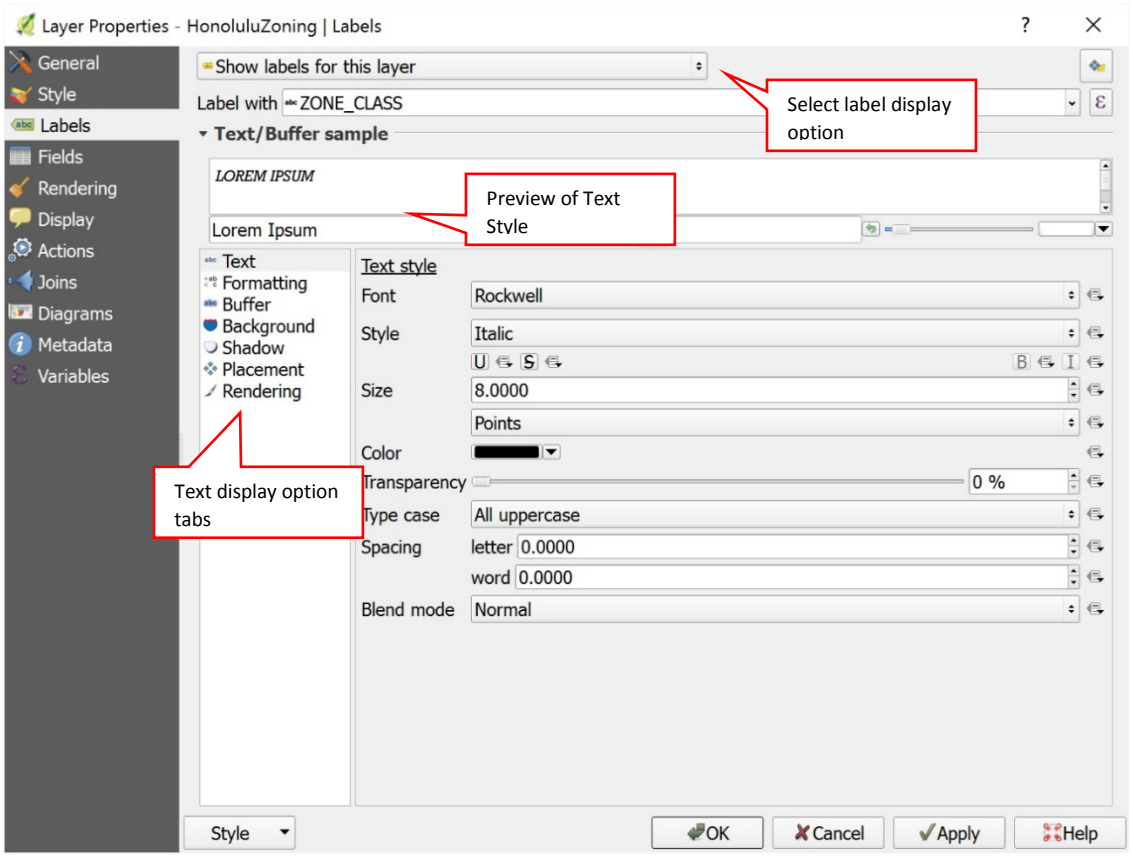


3. Style Manager: Settings menu >> Style Manger. Use the Style Manger to add new symbols and create groupings.

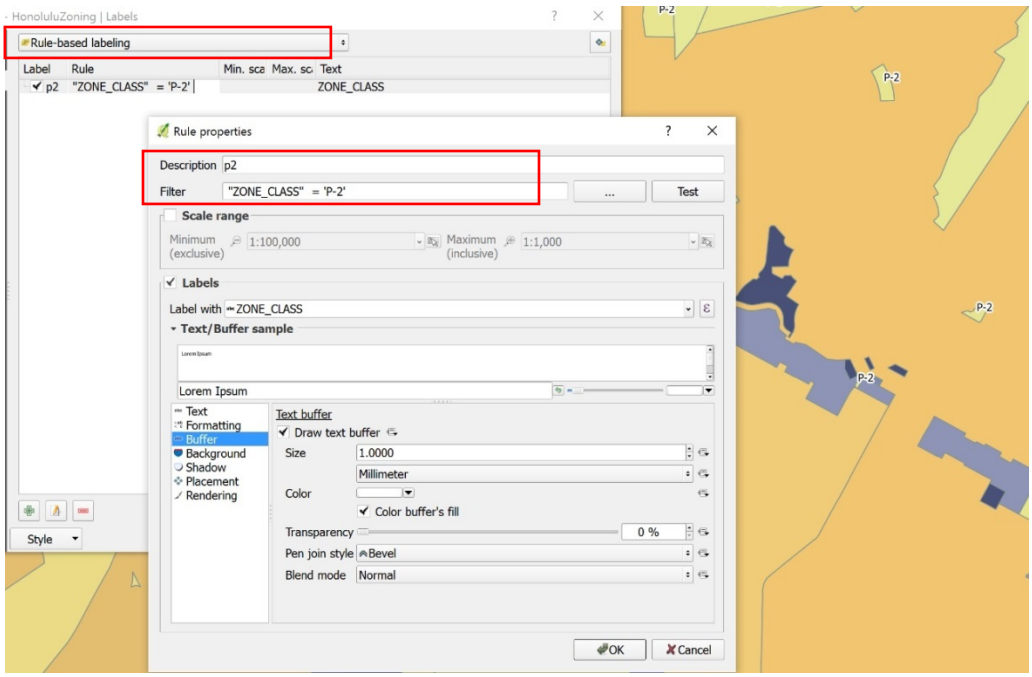


5.3 Labels

There are many labeling options available in QGIS. Go to Layer Properties window >> Label tab to see options. Click the Help button for more information on each of the options.



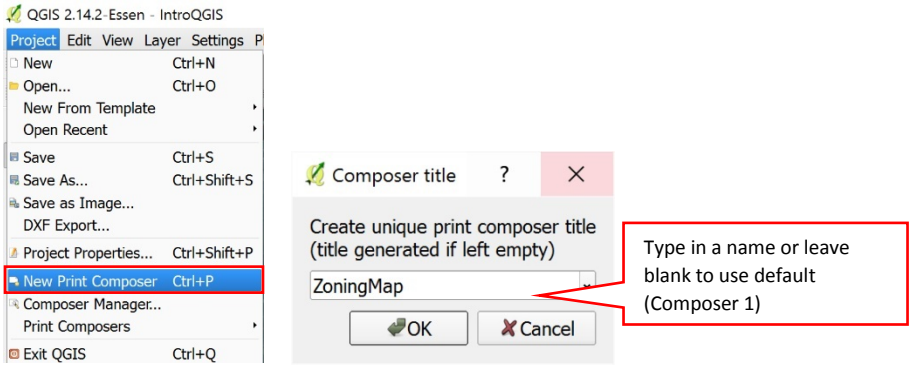
An example of a rule-base labeling is shown below: Display labels for features zoned P-2.



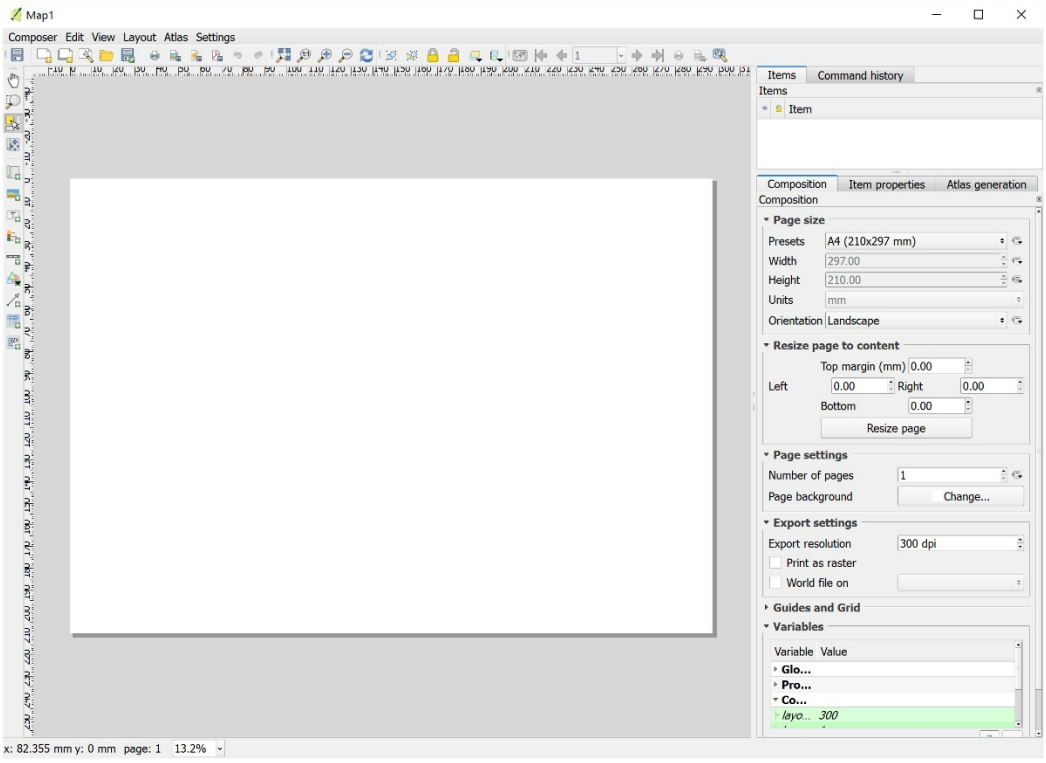
6 Print Composer

The Print Composer is a separate window that you use to make compose maps. The Print Composer and Map View windows are not dynamically linked. A change in the Map View (e.g. adjusting zoom) will not affect what is in the Print Composer, unless you manually update it. The Print Composer allows you to customize many details of the canvas, map, and legend. You can have multiple print layouts per map project or multiple maps per print layout.

1. Opening New Print Composer: Project menu >> New Print Composer. Then give the new print composer a title.

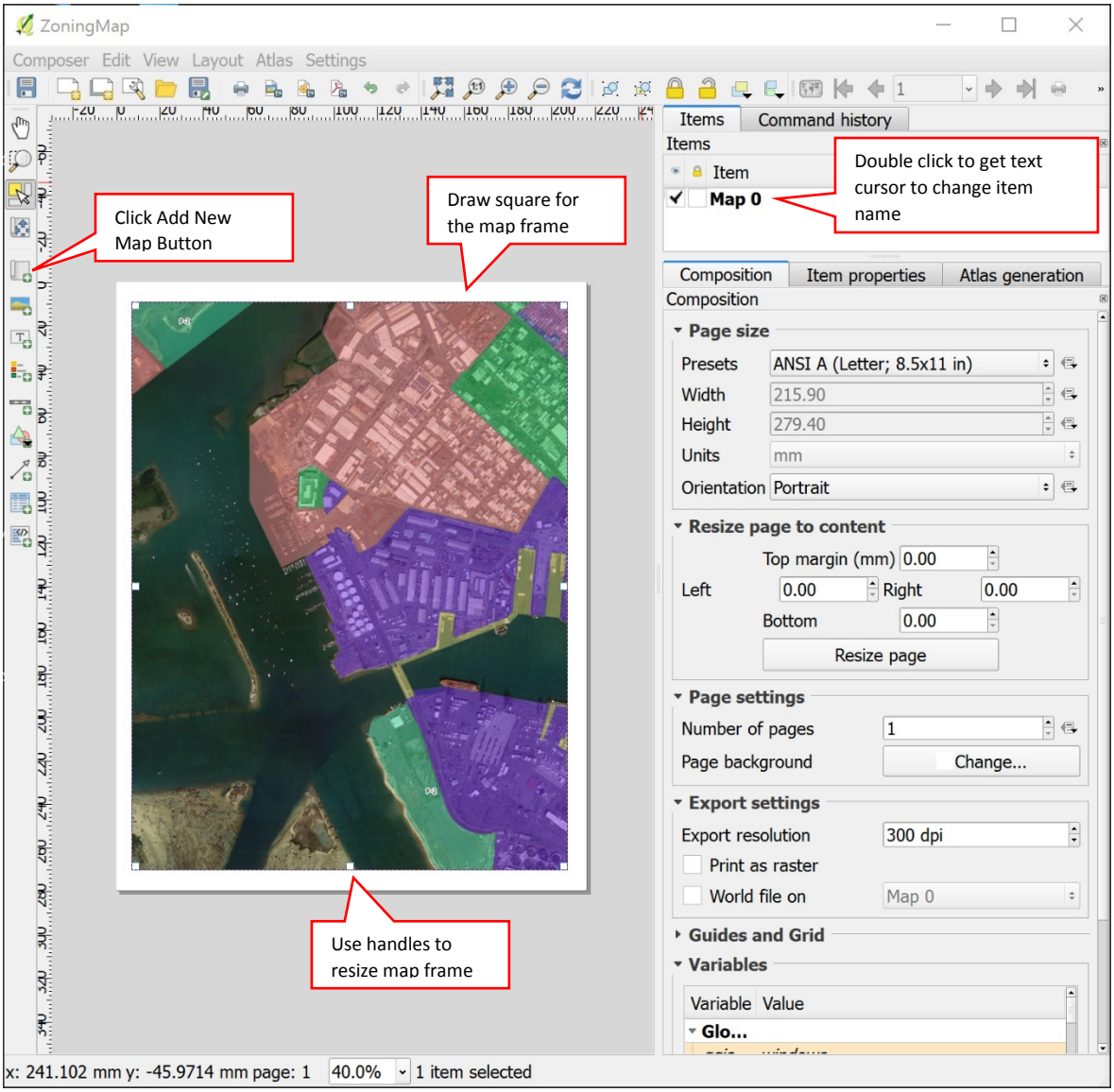


The default new Print Composer window:

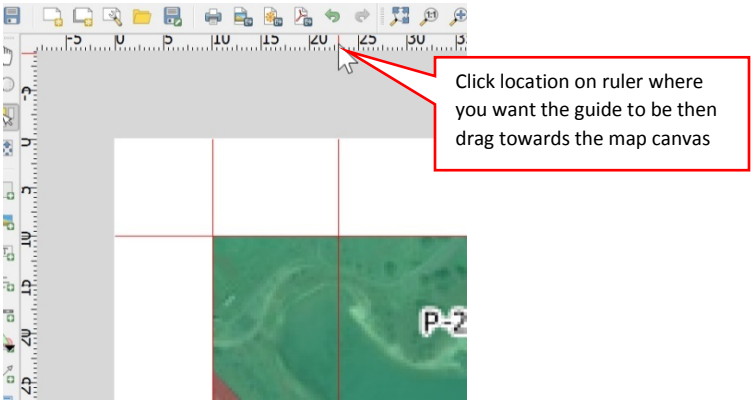


2. Add New Map to the composer. Click the Add New Map Button and draw a square for the map frame on the page.

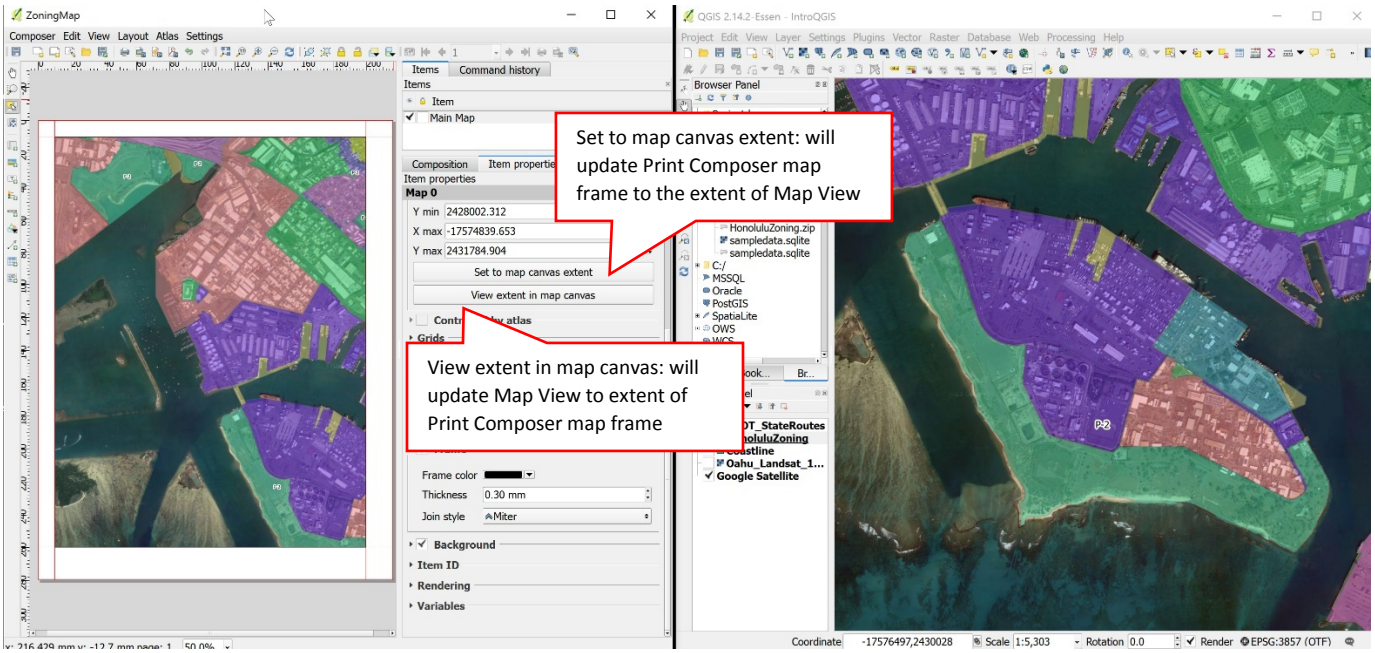
Note 5: The grid, ruler, page size units are hard coded to be in mm, even though page size is set to ANSI A (8.5x11 in)



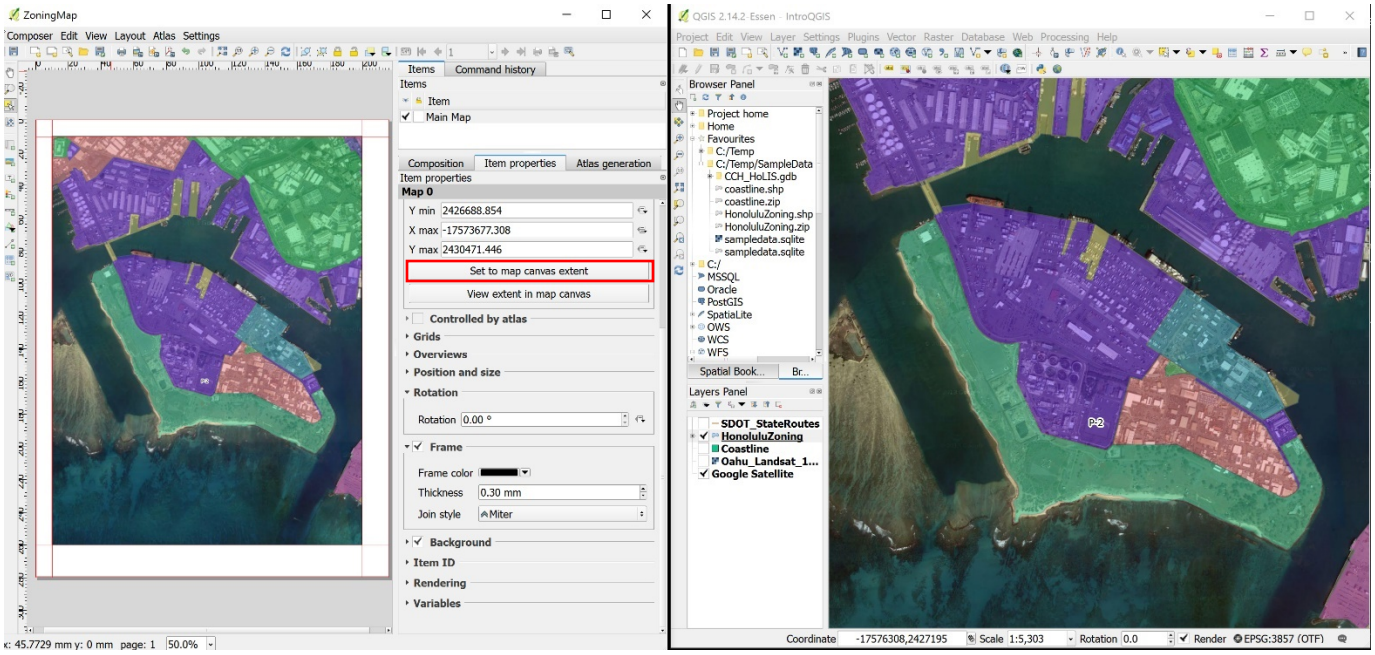
3. Add ruler guides: Click on location on ruler where you want the guide to be (thin red line) then drag it towards the map canvas.



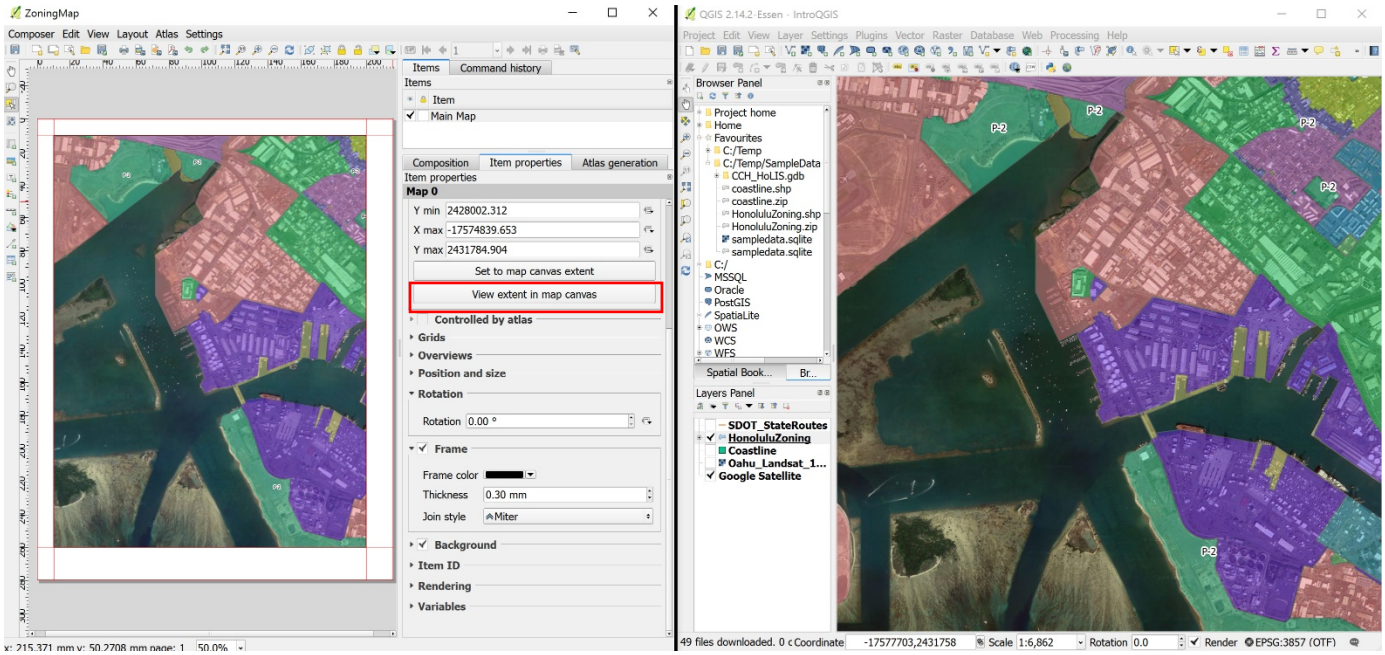
4. Manually linking Print Composer View and Map View in the Item Properties tab.



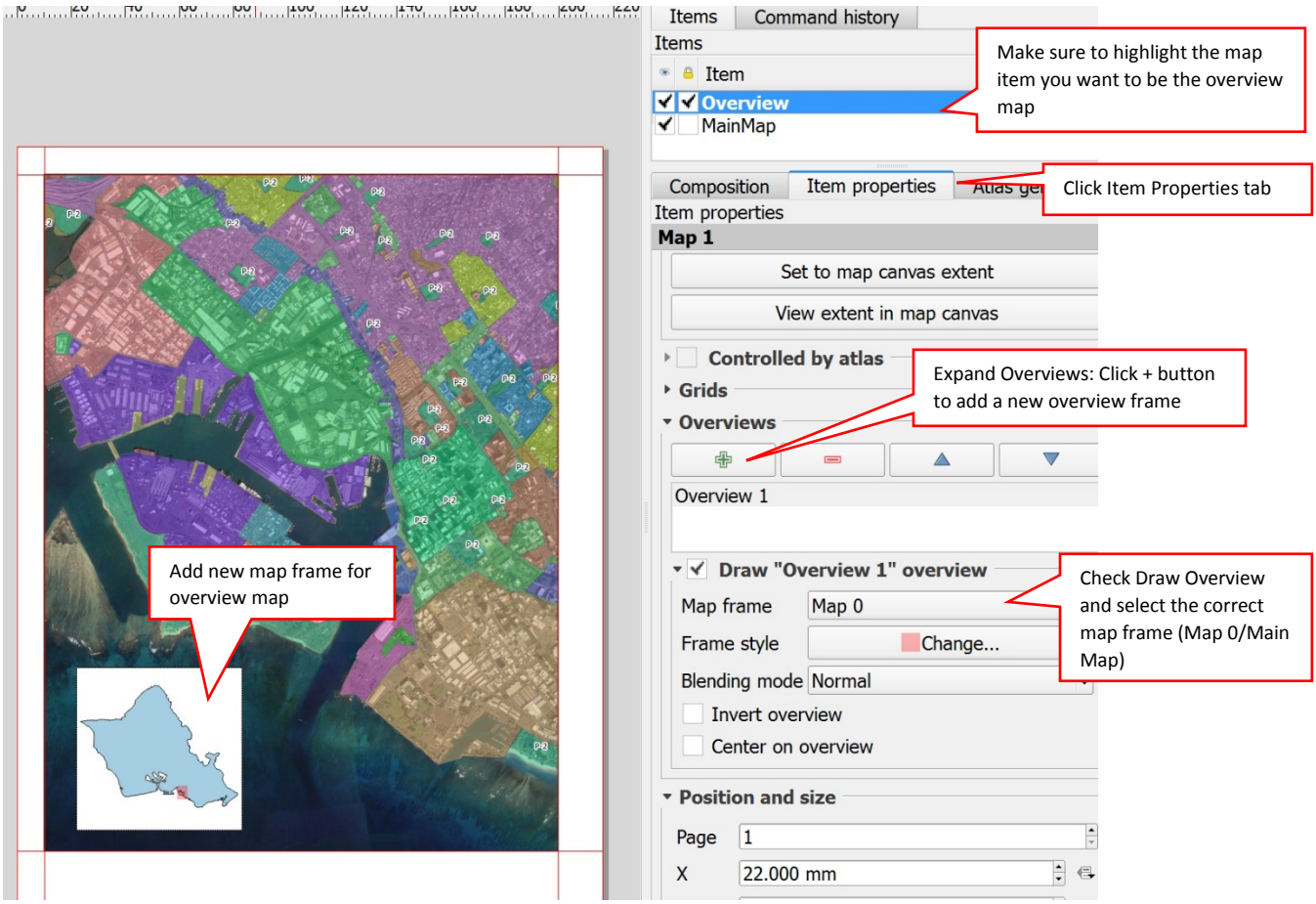
Set to map canvas extent: notice the map frame in Print Composer is now updated to the extent of the Map View.



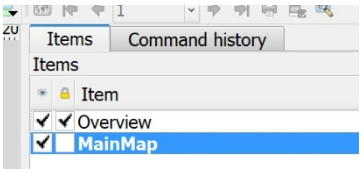
View extent in map canvas: Notice that the Map View is now updated with the same extent as the Print Composer



5. Add a new overview map. Use the Add New Map button and draw a new map frame for the overview map with and AOI.



Once you get the individual map frames the way you want it to be, you should lock it.

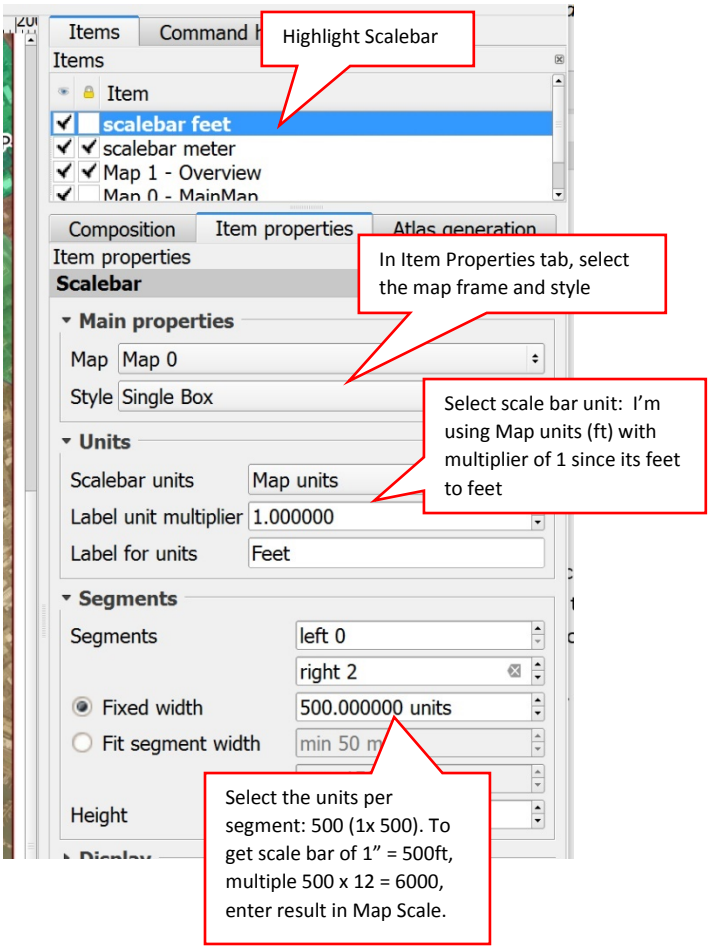


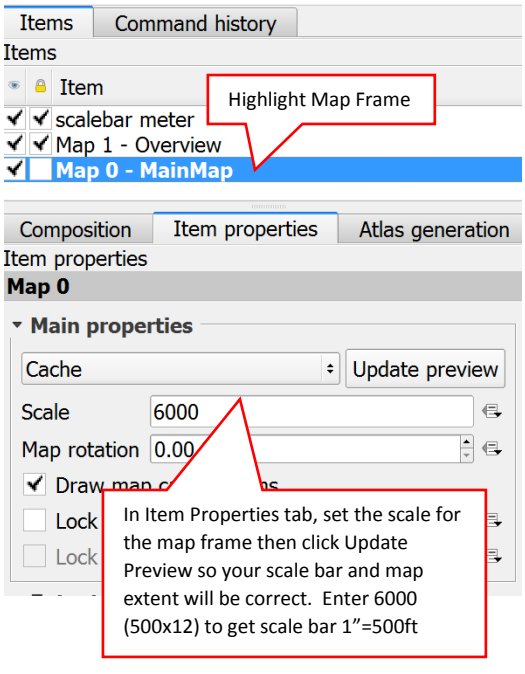
6. Scale Bar: Scale bars in QGIS is a bit confusing and not as easy to do or understand as with ArcGIS.

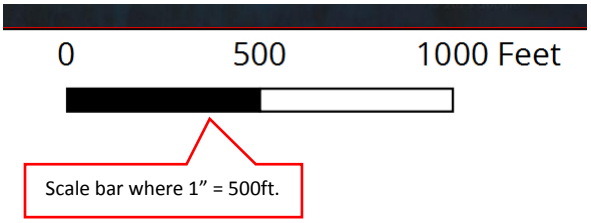
   Click the Add New Scale Bar button or got to Layout menu >> Add Scale Bar. Then click on the map canvas where you want to put the scale bar. In the example below, I want add a scale bar that is 1" X Ft. Remember that my map units are in feet, corresponding to the CRS of my project (EPSG: 3760 or NAD 83 HARN, State Plane Zone 3, Feet).

   Example: Scale bar in feet:

   - Select the Scale bar unit: Map Units (which is feet)
   - Enter multiplier: 1 (no conversion really as I'm taking the map scale ratio feet: feet)
   - Decide how many units you want each segment to be: e.g. 500 ft. Take this number and multiple by conversion factor (500 x 1 = 500), and input the result as the segment size parameter.

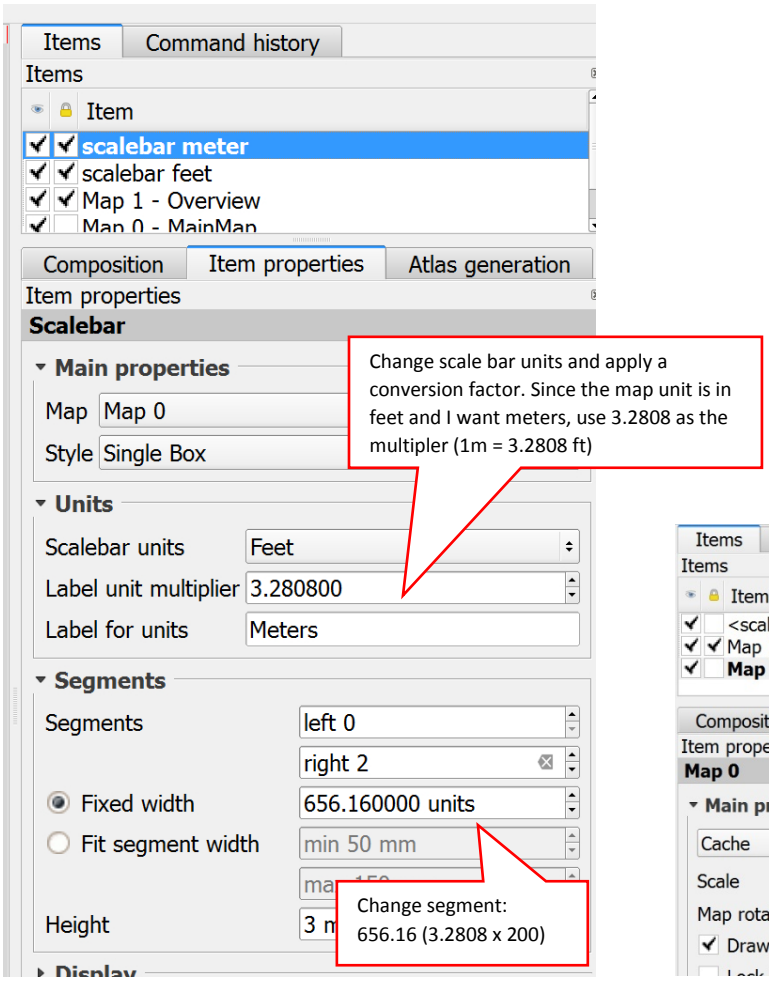


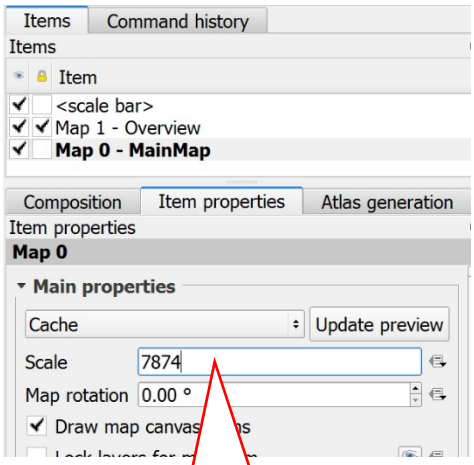


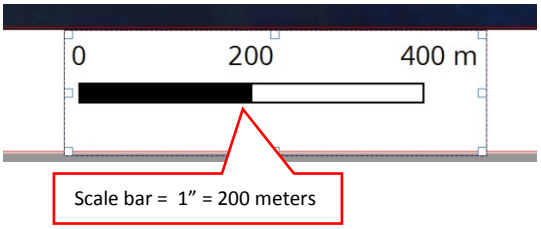


Example of Scale bar in Meters: Think about how many units you want an individual segment of the scale bar to represent then do the conversion (e.g. meters to feet which is the default map unit).

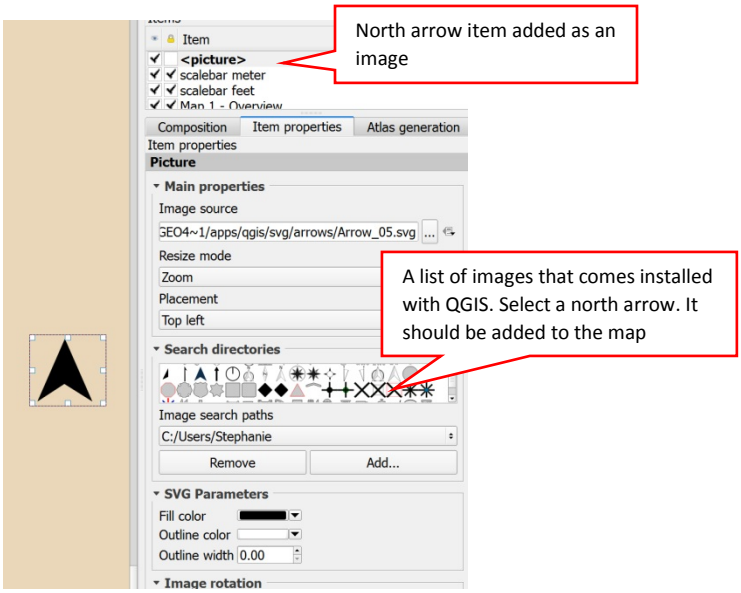
- Select the Scale bar unit: Feet or Map Units (which is also in feet)
- Enter multipiler: 3.2808 (1m = 3.2808ft)
- Decide how many units you want each segment to be: e.g. 200 meters. Take this number and multiple by conversion factor (200 x 3.2808 = 656.16), and input the result as the segment size parameter.



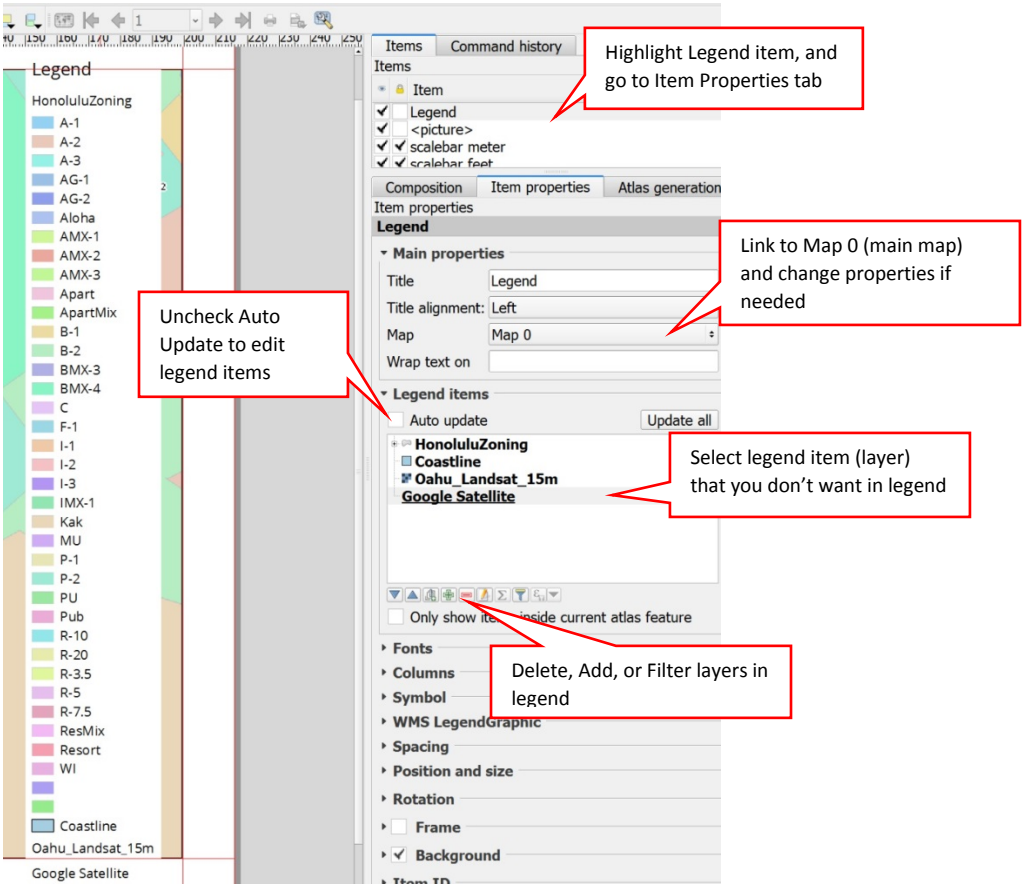




7. North Arrow: QGIS doesn't has very limited north arrow graphics. Although you can add your own custom svg files. It is added to the print composer as an image, so it's not very intuitive as it should be. Click the Add Image button or Layout menu >> Add Image. Draw a box on the map canvas where you want the north arrow.



8. Legend: Click Add Legend button or Layout >> Add Legend. Then click on map canvas where you want the legend to be. Notice all the layers in your map project is added the legend even though some layers are not turned on.



9. Export Map: there are a few options for exporting your map. Go to Composer menu >> Export as Image, PDF, SVG.