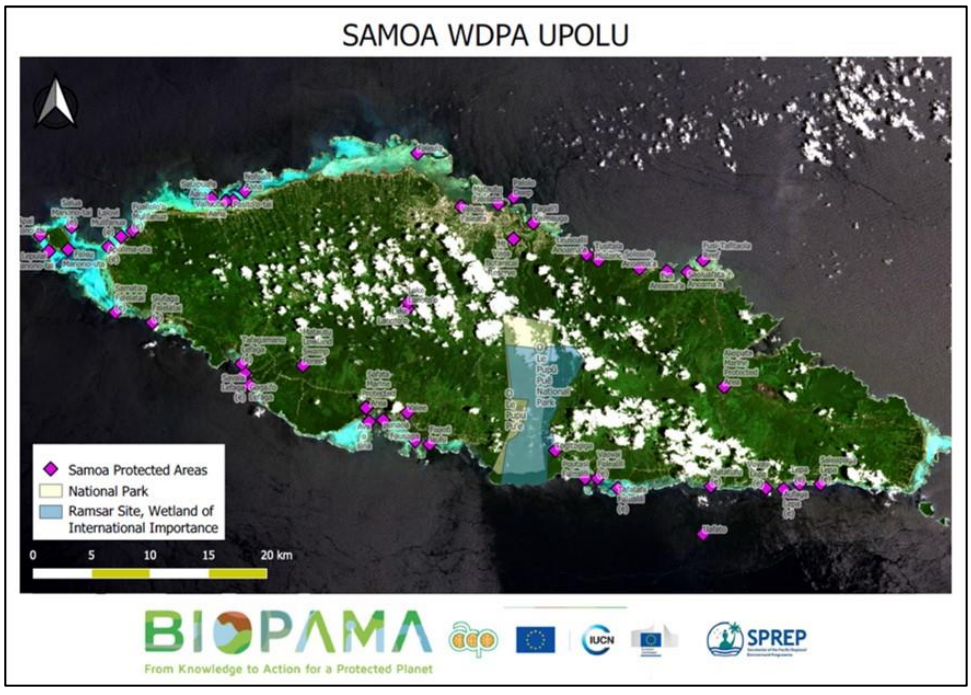
QGIS Fundamentals:

Viewing Spatial Data & Producing a Map.



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What is QGIS and where do I get it?

QGIS is an open source GIS (Geographic Information System) software – which means it's **FREE** for download and use for all your mapping and GIS needs**.**

The software is constantly developing and being improved upon. These training materials are based on the latest stable release that was available at the time: QGIS 3.4. To download the latest version of QGIS visit the official QGIS website, http://www.qgis.org/

Introduction to GIS

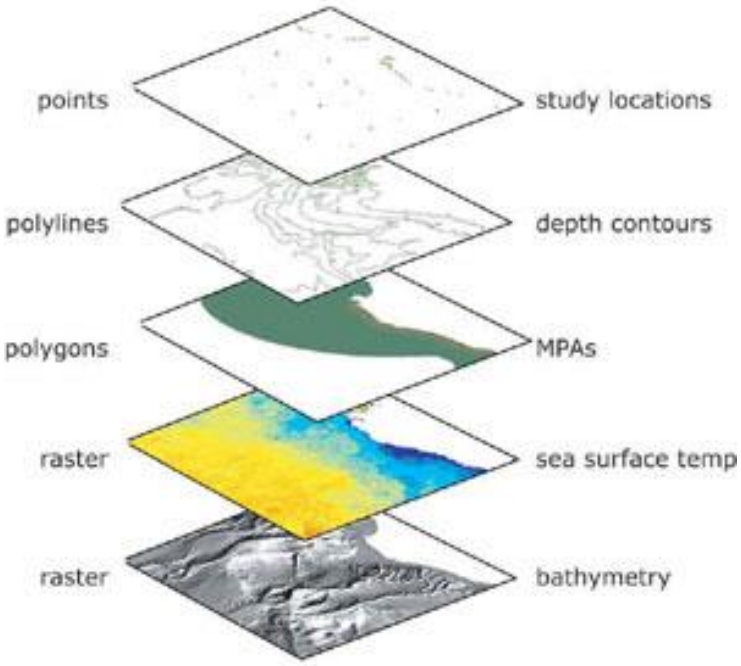
What is a GIS?

A Geographic Information System a software for viewing data with a spatial reference for real-world viewing, mapping and analysis.

The primary segment of the data seen in a GIS is its spatial component – i.e. where is it on earth?

Each piece of data will also contain non-spatial data known as attribute data. Attribute data is generally defined as additional information about a spatial feature, for example, a government building. The actual location of the government building is the spatial data. The attribute data includes the building name, the number of floors in the building, the government departments that use the building, when it was built etc.

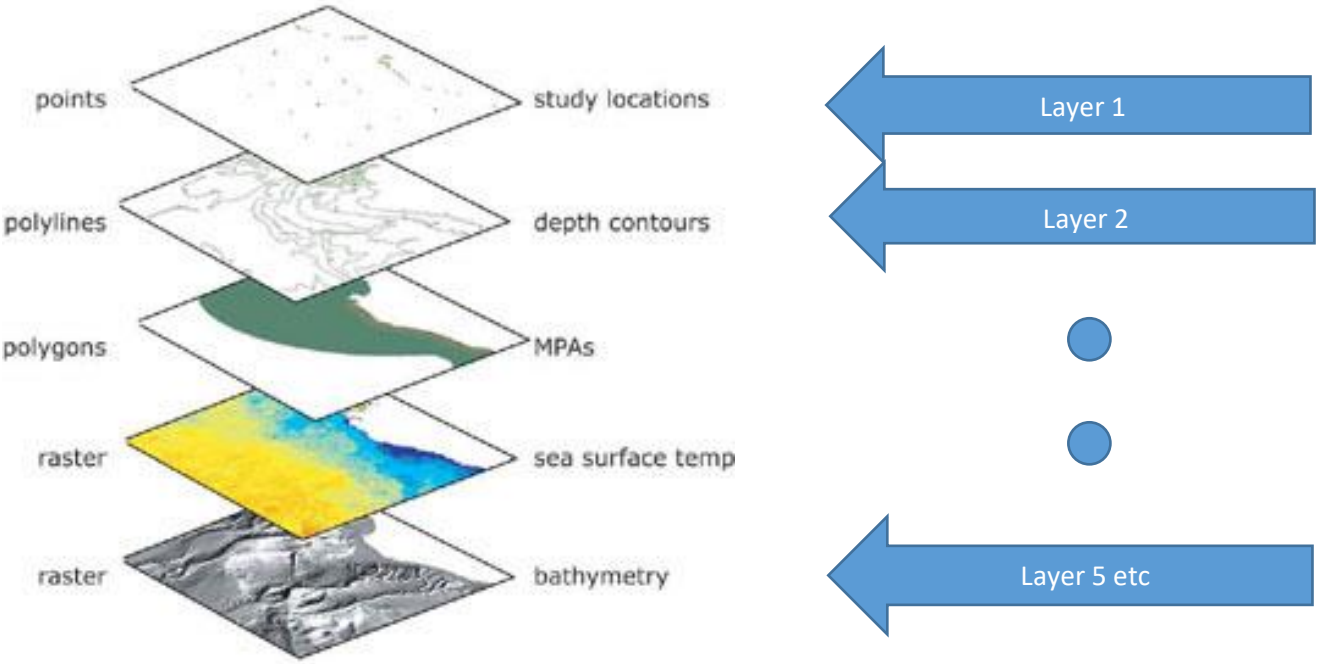
GIS is now commonly used in many aspects of our day-to-day lives. For example, Google Maps on our phones to find an address is a type of GIS.



Quick Glossary

Layers

Layers are the mechanism used to display spatial datasets in QGIS. Each layer relates to a specific dataset and specifies how that dataset is displayed using symbols and text labels. Each map created in QGIS is assembled by adding a series of layers. The two most commonly used types of layer are vector (feature) layers and raster layers.



A Vector layer

A representation of the world using points, lines, and polygons. Vector layers are useful for storing data that has discrete boundaries, such as country borders, land parcels, and streets.

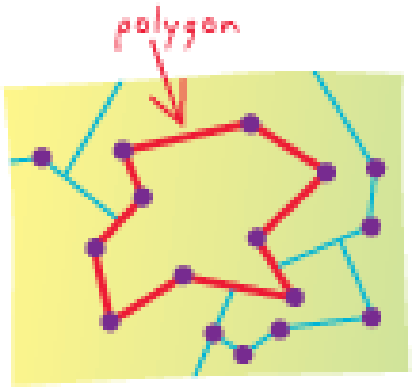


Figure 1 - Points, Lines & Polygons

Polygon - A closed shape

Polyline (or line) – a line connecting two points

Point – a single geographical location

A Raster layer

A spatial data layer that is in the form of an image with pixels. The image is made up of equally sized pixels (or cells) arranged in rows and columns. Each pixel contains an attribute value and location coordinates. Groups of cells that share the same value represent the same type of geographic feature. See two examples below:

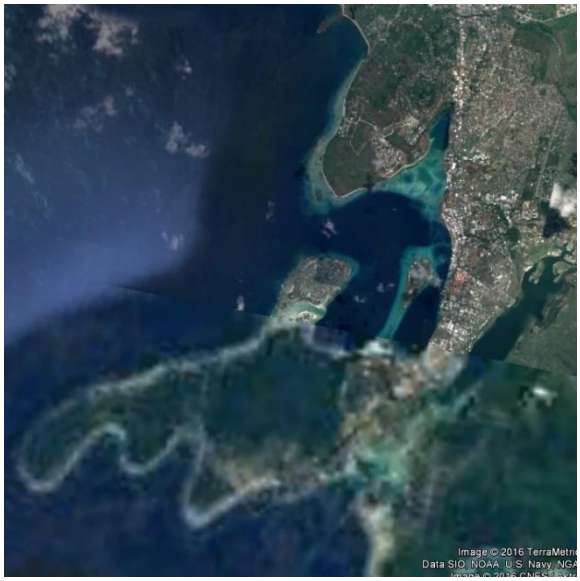


Figure 3 - Aerial image (raster), Port Vila, Vanuatu

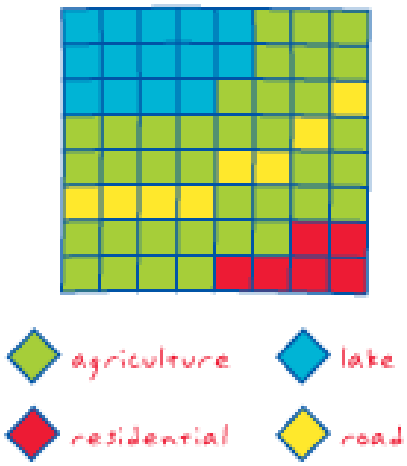


Figure 2 - A Raster Grid

Attribute

Information about a spatial feature. For example, attributes about a school may include the name, level of education, and number of students.

Coordinate system

A coordinate system is a reference system used to represent the locations of geographic features, imagery, and observations such as GPS locations within a common geographic framework.

Scale

A level of resolution or zoom. The relationship between the size of the map and the corresponding size of the real world.

Shapefile (*.shp)

A type of vector data storage format for storing the location, shape, and attributes of geographic features. Each shapefile relates to a specific feature class i.e. the Roads shapefile only contains information on roads

Symbology

Conventions or rules that define how geographic features are represented by symbols on a map.

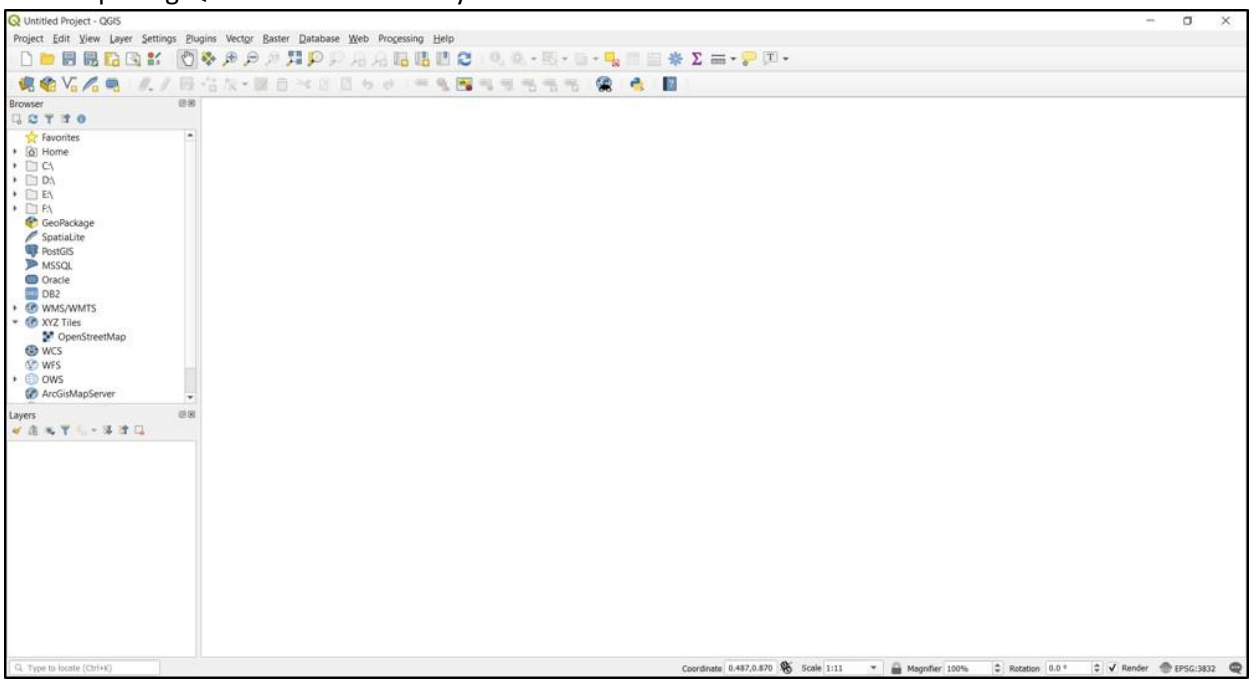
Query
In GIS, a request to select features or records from an attributes table based on user-selected criteria, and to display only those features or records that meet the criteria.

Exercise 1 – Familiarisation with QGIS

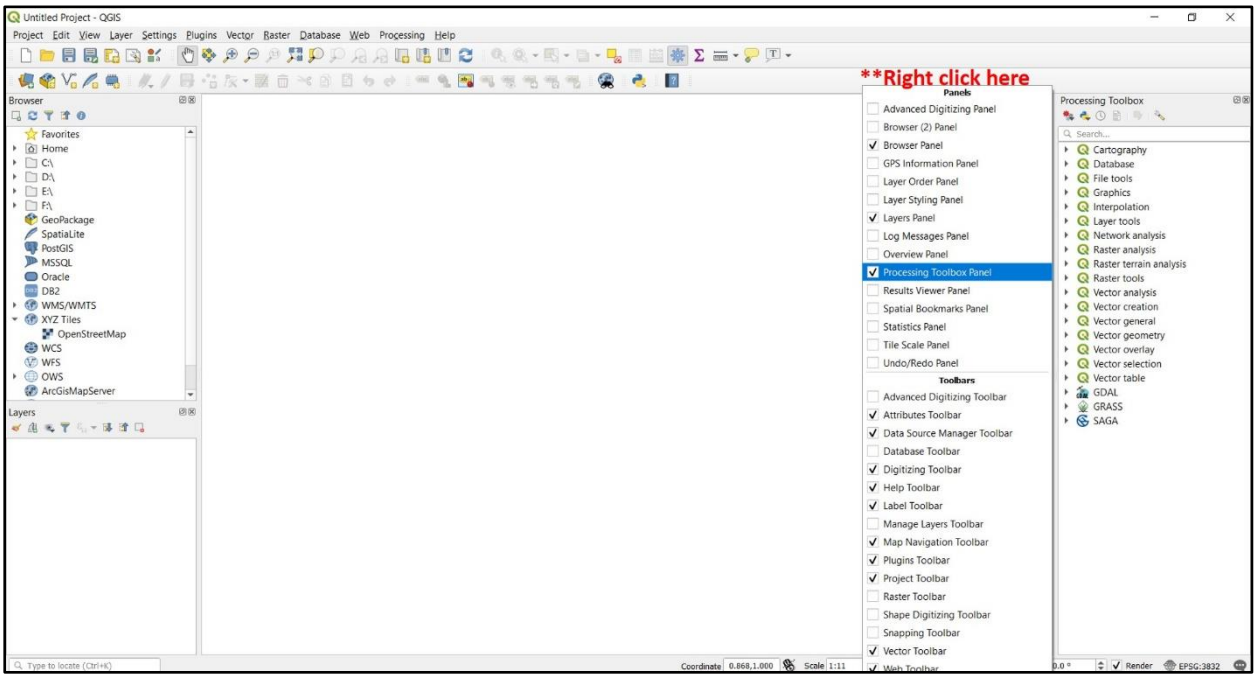
QGIS Work Space

- *Open QGIS from the desktop shortcut, i.e. click on the icon that says "**QGIS desktop**" (DO NOT CLICK ON the icon that says "QGIS Browser")*

When opening QGIS for the first time you will see the screen below:

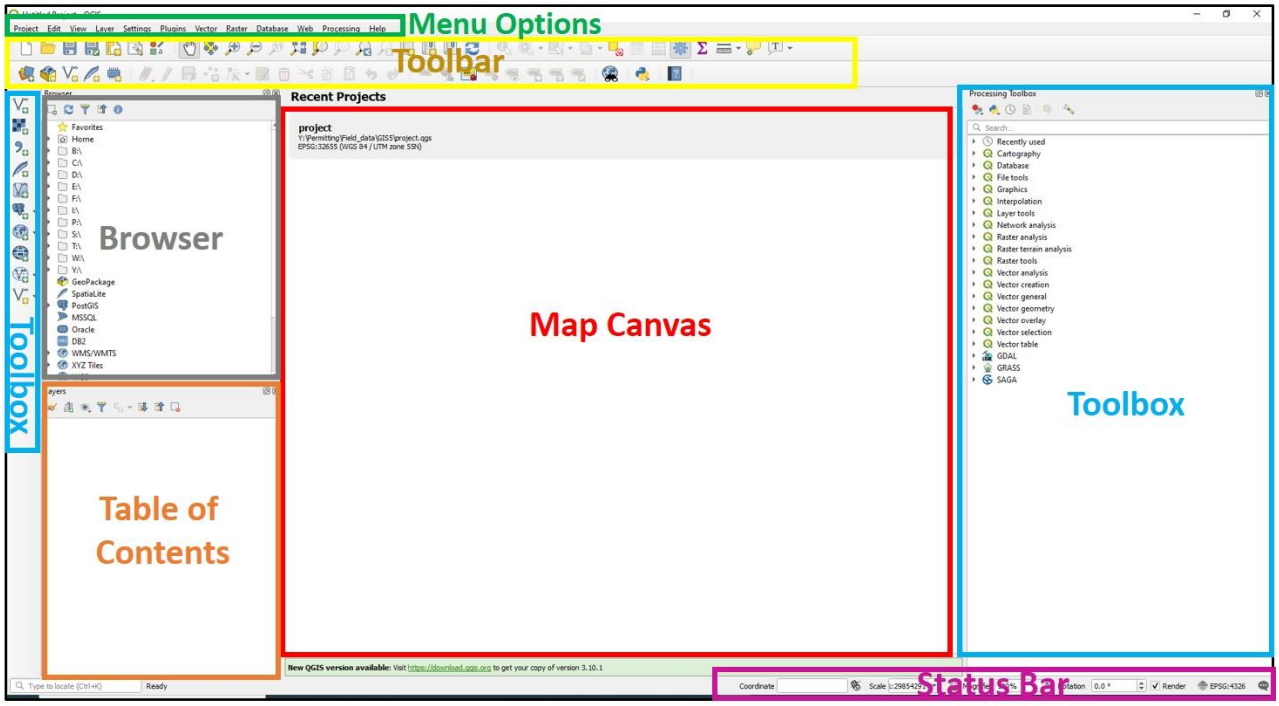


The first step you will do is right click on the blank grey space near the top of the screen. This will open a dialog box that lets the user add panels and toolbars to the user interface.



You will click and add two objects here: The Processing Toolbox Panel and the Manage Layers Toolbar.

Your QGIS should now look like this:



The QGIS work area has seven parts;

- Menu Options
- Toolbar
- Map Canvas
- Browser
- Table of Contents
- Tool Box
- Status Bar

Menu Options

The **Menu Options** bar provides access to various QGIS features using a standard hierarchical menu (drop down menu). Most menu options have a corresponding tool in the **Toolbar** and **Tool Box**, however the menus are not organised exactly like the toolbars and may contain additional tools.

Toolbar

The **Toolbar** provides access to most of the functions found in the menu options bar, plus additional tools for interacting with the map canvas. Each **Toolbar** item has pop-up help available. Hold your mouse over an item and a short description of the tool's purpose will be displayed.

Below is the Managing Layers Toolbar that you added at the beginning of this exercise.

The Managing Layers Toolbar contains frequently used tools relating to GIS layers. The two symbols circled in red represent the 'add vector layer' tool and the 'add raster layer' tool, which will be most commonly used to bring data into the QGIS document.

Parts of the Toolbar can be moved around according to your needs. Additionally, parts of the Toolbar can be switched on/off. Hold the mouse over a blank spot on the Toolbar and click the right mouse button to see the context menu, which allows you to turn on/off tools.

If you have accidentally hidden all your Toolbars, you can get them back by choosing Menu Options – View – Toolbars

Map Canvas

The **Map Canvas** is the main part of QGIS – this is where the maps are displayed. The map displayed in the window will depend on the vector and raster layers you have chosen to load (see sections that follow for more information on how to load layers). The **Map Canvas** can be panned, shifting the focus of the display to another part of the map. The map can also be zoomed in and out. Various other operations can be performed on the map using the Toolbar. The **Map Canvas** and the **Table of Contents** are tightly bound to each other — **the maps in Map Canvas reflect changes you make in the Table of Contents area**.

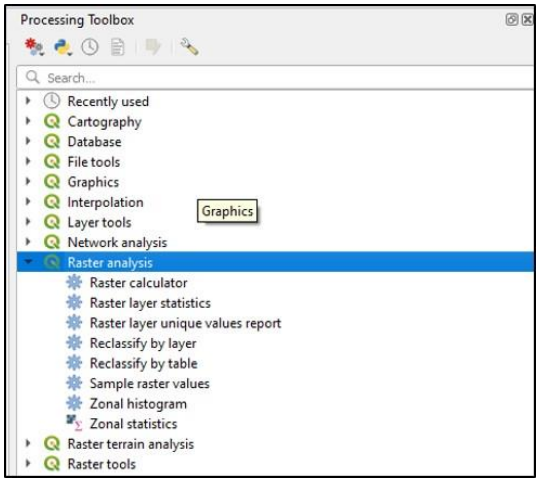
Tip: Zooming the Map with the Mouse Wheel

You can use the mouse wheel to zoom in and out on the map. Place the mouse cursor inside the map area and roll the wheel forward (away from you) to zoom in and backwards (towards you) to zoom out. The zoom is centred on the mouse cursor position.

Table of Contents

The **Table of Contents** area lists all the layers in your map project. Click on a check box to turn a layer on or off. Double click on a layer in the legend to customise its appearance and set other properties (e.g. appearance of symbols, labels). A layer can be selected and dragged up or down in the **Table of Contents** to change the Z-ordering. Z-ordering means that layers listed nearer the top of the **Table of Contents** are drawn over layers listed lower down in the **Table of Contents**.

Tool Box



The Processing Toolbox which contains geoprocessing tools used for creation and analysis of both vector and raster data. As mentioned before, some of these tools will also be available in the **Menu Options** as well.

Status Bar

The **Status Bar** shows you the current position of the mouse pointer in map coordinates (expressed as **decimal degrees** or meters) as well as the map scale and coordinate system. As the mouse pointer is moved across the map view, the coordinates will change. As you zoom in and out of the map, the scale will change.

Exercise 2 – Adding Data

This exercise will familiarise you with QGIS and allow you to examine the different data types available and how to add them to the map.

By completing this exercise, you will learn how to perform the following tasks:

- Add data to a QGIS project
- Open and save QGIS projects

WE WILL USE THE FOLLOWING DATA FOR THIS EXERCISE:

- ***Vector Layer Data***
  1. C:\QGIS_Training_Samoa\02_Datasets**Samoa_coastline.shp**
  2. C:\QGIS_Training_Samoa\02_Datasets**Samoa_roads_2016_OSM.shp**
  3. C:\QGIS_Training_Samoa\02_Datasets**Samoa_village_names.shp**

  (In the folder you will find more datasets, but for now we will use the above)

- ***Raster Layer Data***
  1. C:\QGIS_Training_Samoa\02_Datasets\Imagery**Samoa_Sentinel2_L2A_01252020.tif**

WE WILL BE SAVING THE PROJECT TO:

C:\QGIS_Training_Samoa\03_Workspace

Call the file/project something relevant like: **2020_Samoa_QGIS_Training1**

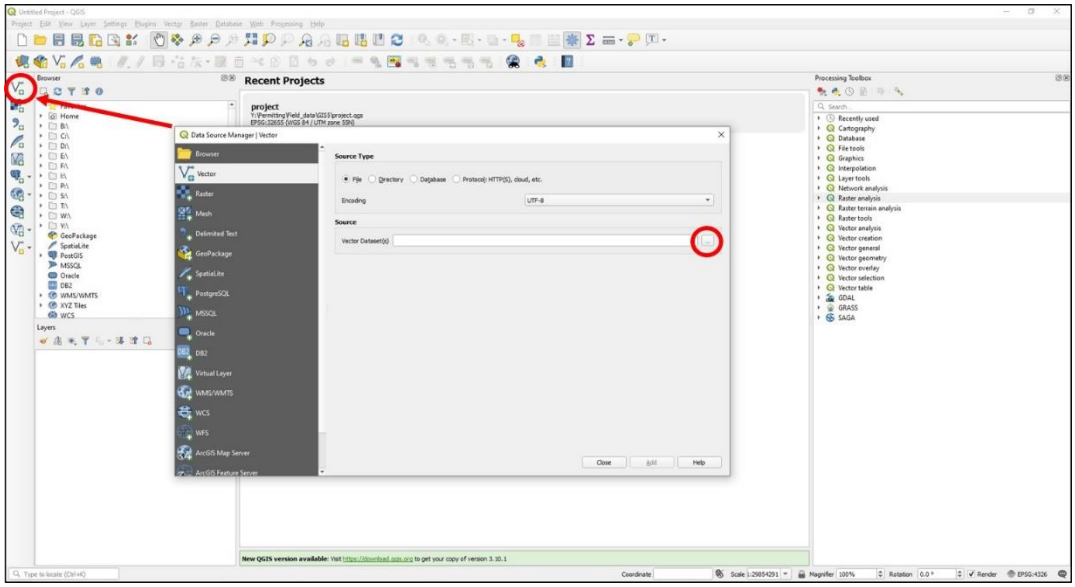
Adding Vector Datasets in QGIS

Vector data is arguably the most common kind of GIS data. It describes geographic data in terms of points, which may be connected into lines and polygons. Every object in a vector dataset is called a **feature**, and is associated with data that describes that feature.

QGIS can support a number of different vector data formats. These include ESRI Shapefiles and MapInfo TAB files, all of which can be used in QGIS in their current formats. We will mostly be using ESRI Shapefiles.

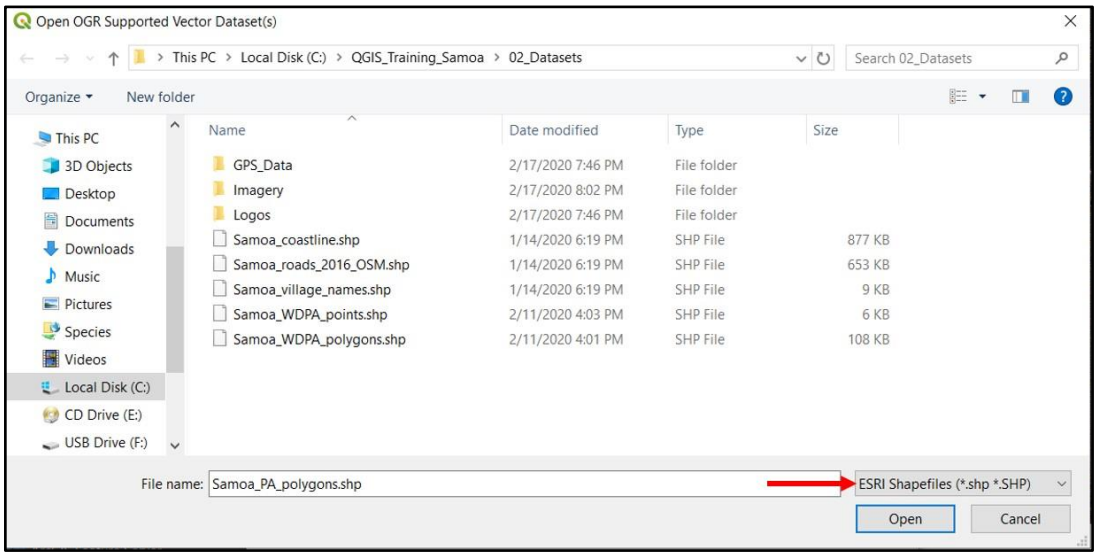
- *Locate and press the Add Vector Layer button*

You will be presented with the dialog box below:



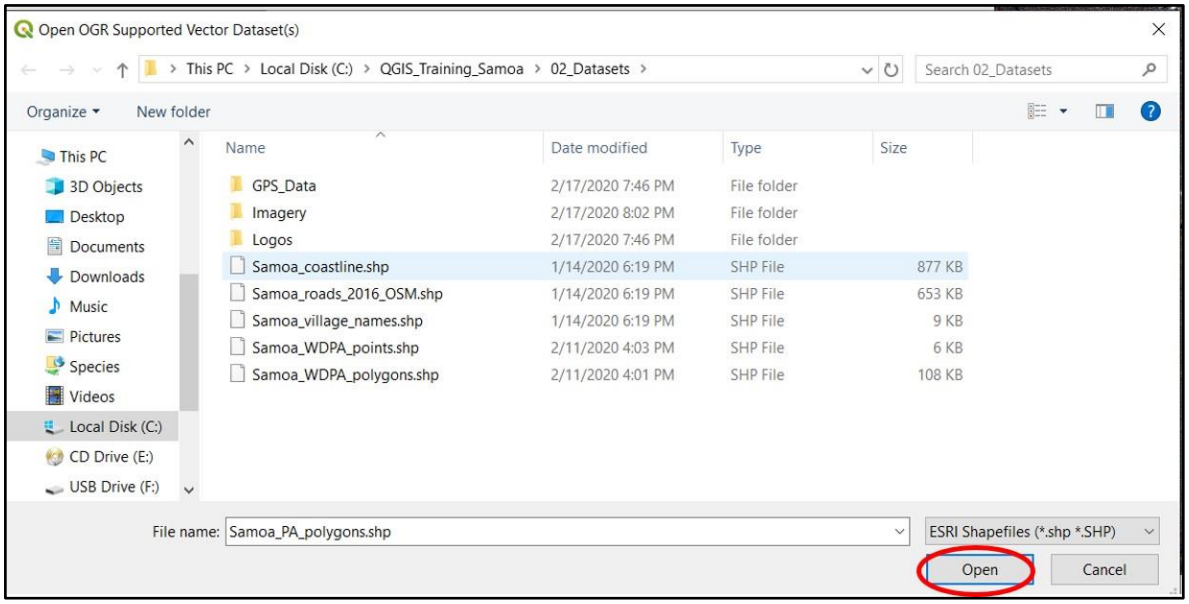
- *Click the …. button and navigate to:* C:\QGIS_Training_Samoa\02_Datasets\

- *Click on All files (*) and filter the displayed files by selecting ESRI Shapefiles from the drop down menu*

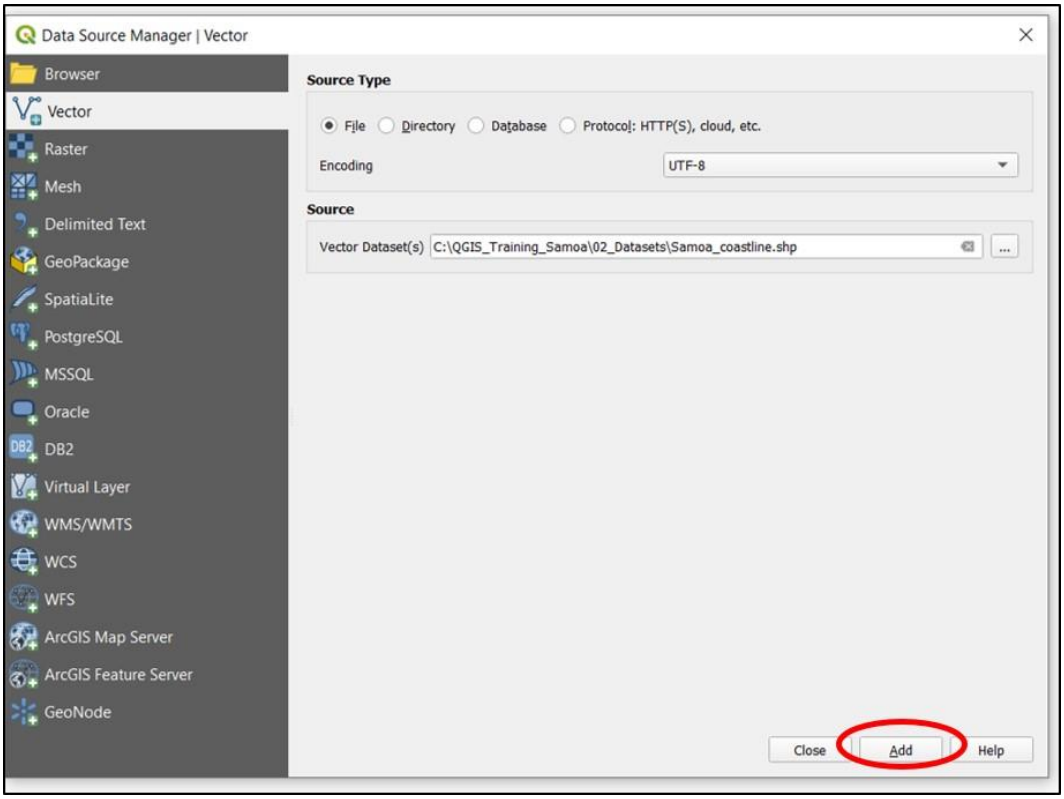


You will only see the files (*.shp) we want to use

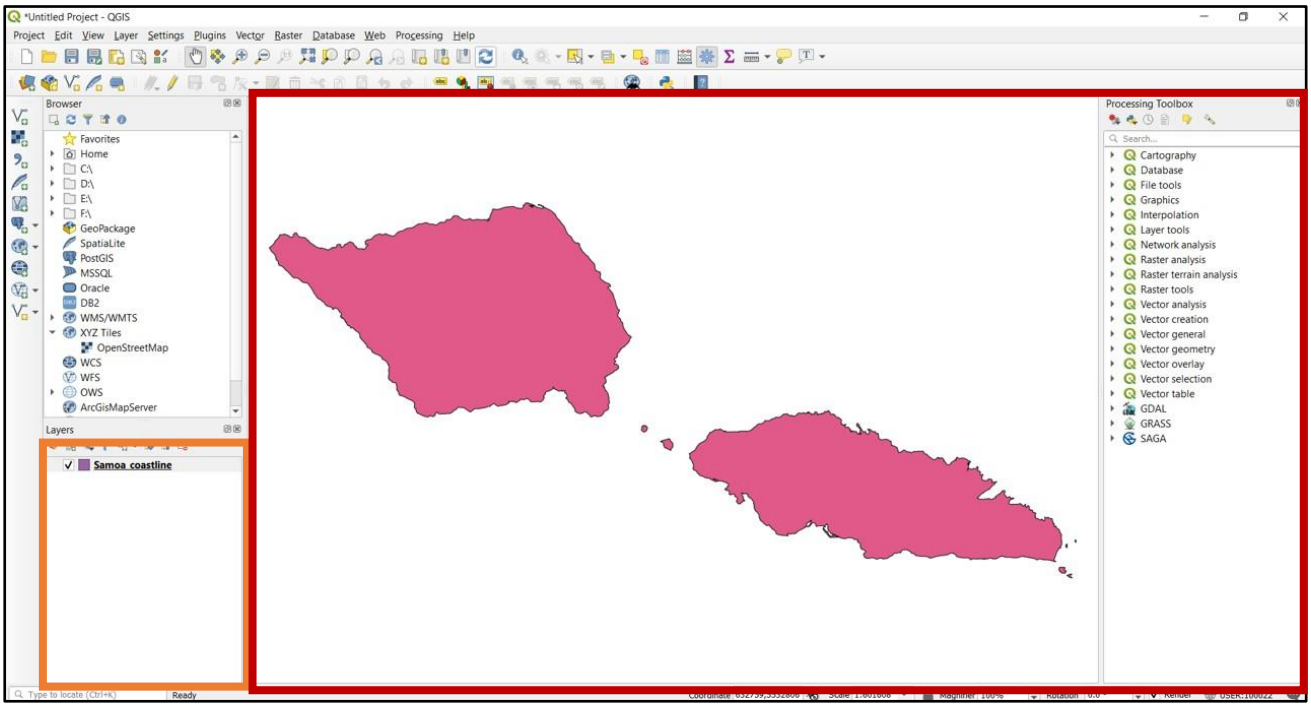
- *Select **Samoa_coastline.shp** and click Open*



- *You should then see the dialog box below*
- *Click Add*

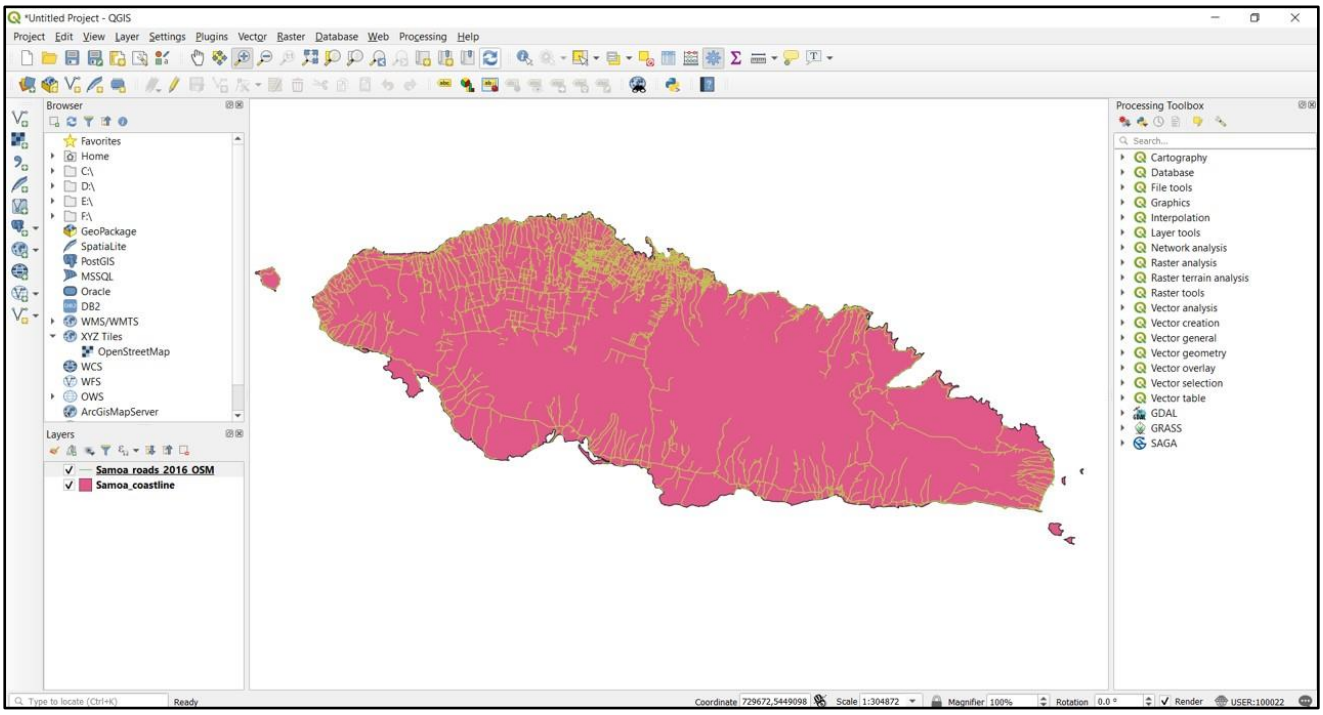


If you have successfully added a vector layer you should see the layer in the **Table of Contents** and an image on the **Map Canvas**



- *Repeat the process to add the following vector layer to the map:* C:\QGIS_Training_Samoa\02_Datasets**Samoa_roads_2016_OSM.shp**

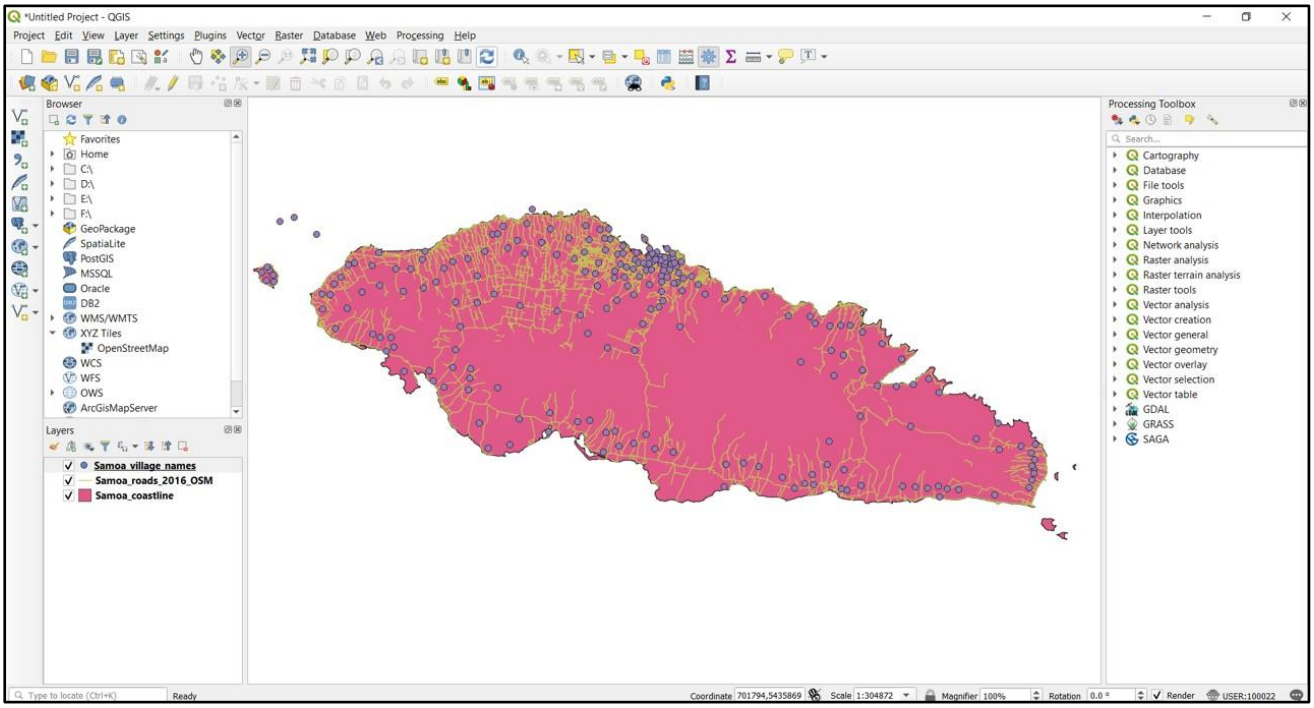
Zoom to Upolu and the result should look something like this:



- *And once more, repeat the process to add the following vector layer to the map:*

C:\QGIS_Training_Samoa\02_Datasets**Samoa_village_names.shp**

The result should look something like this:

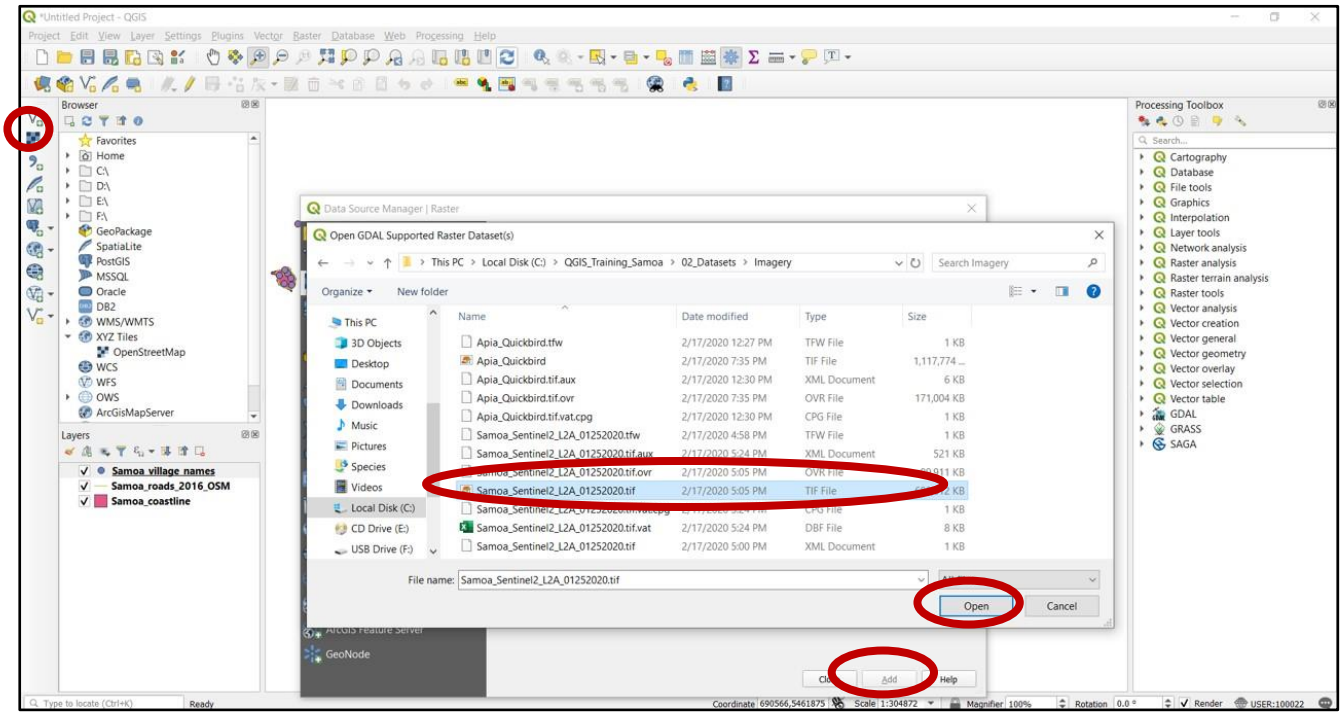


Adding Raster Data in QGIS

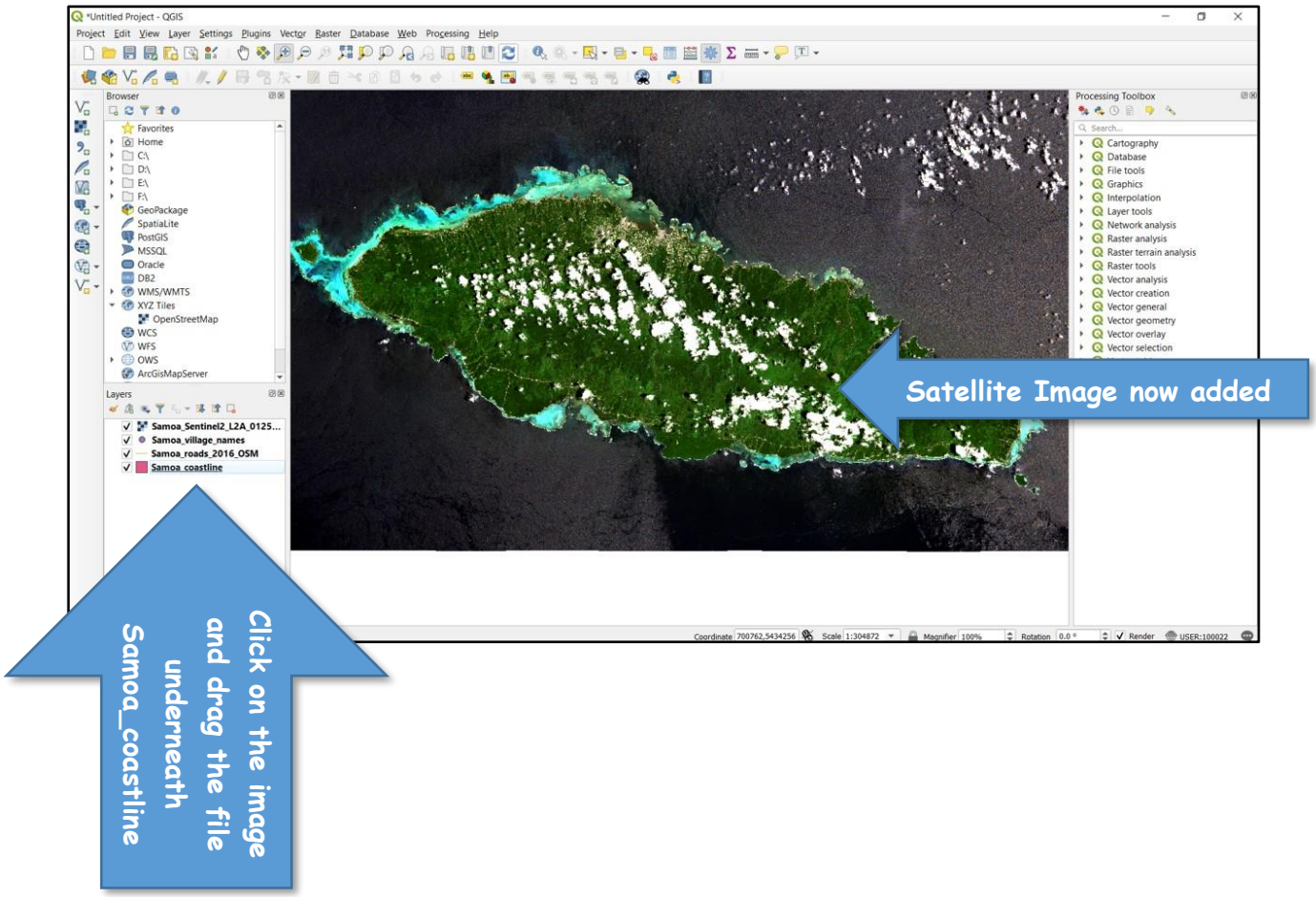
Raster data is quite different from vector data. Vector data (point, line and polygons) are features that are constructed out of mathematical vector points (a line is a connection of two points, a polygon is a connection of many vector points). Raster data, however, is like an image. Although it may portray various properties of objects in the real world, these objects don't exist as separate objects; rather, they are represented using pixels of various different colour values.

- *Locate and press the Add Raster Layer button (under the Add Vector button)*

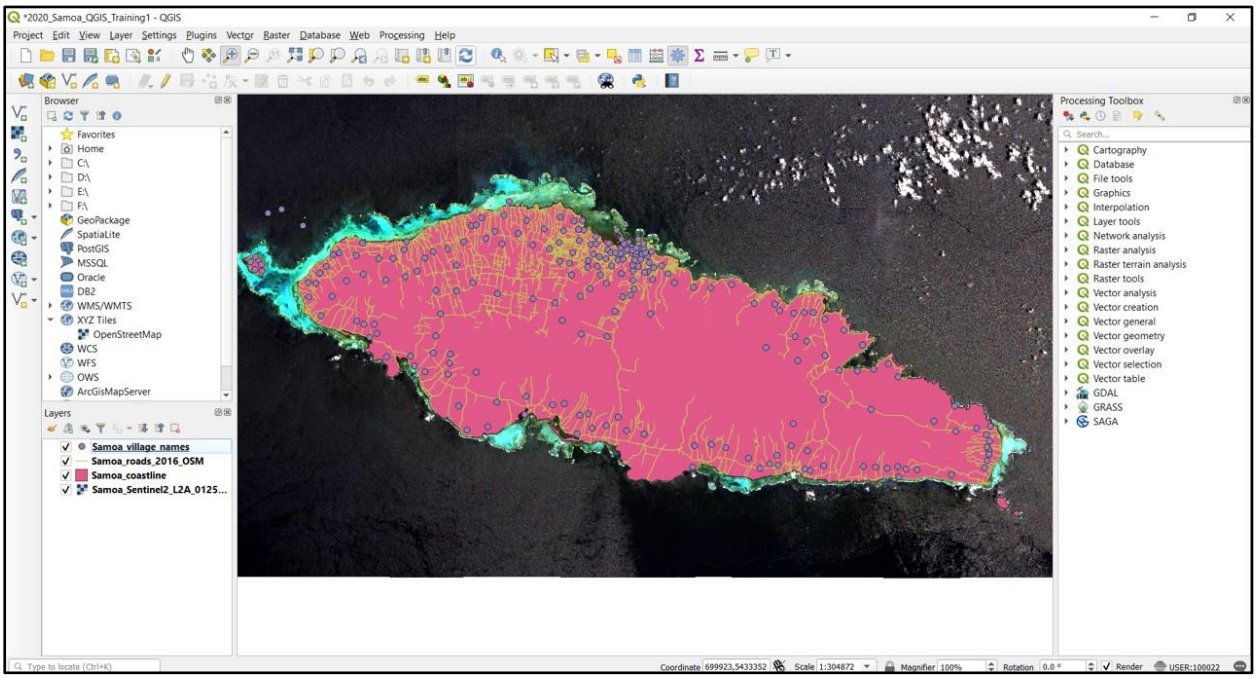
- *Navigate to: C:\GIS_Training \02_Datasets\Imagery*
- *Select the file* ***Samoa_Sentinel2_L2A_01252020.tif***
- *Click Open and then Add to add it to the map*



As the raster file is quite large it may take a little time for it to be displayed on the **Map Canvas**



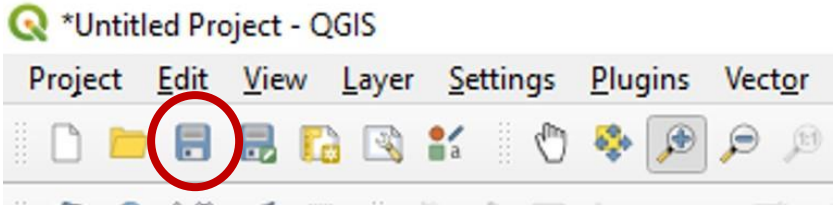
Click on the raster file and drag it underneath the Samoa_coastline.shp. You have now placed the raster image as the last layer in the **Map Canvas**



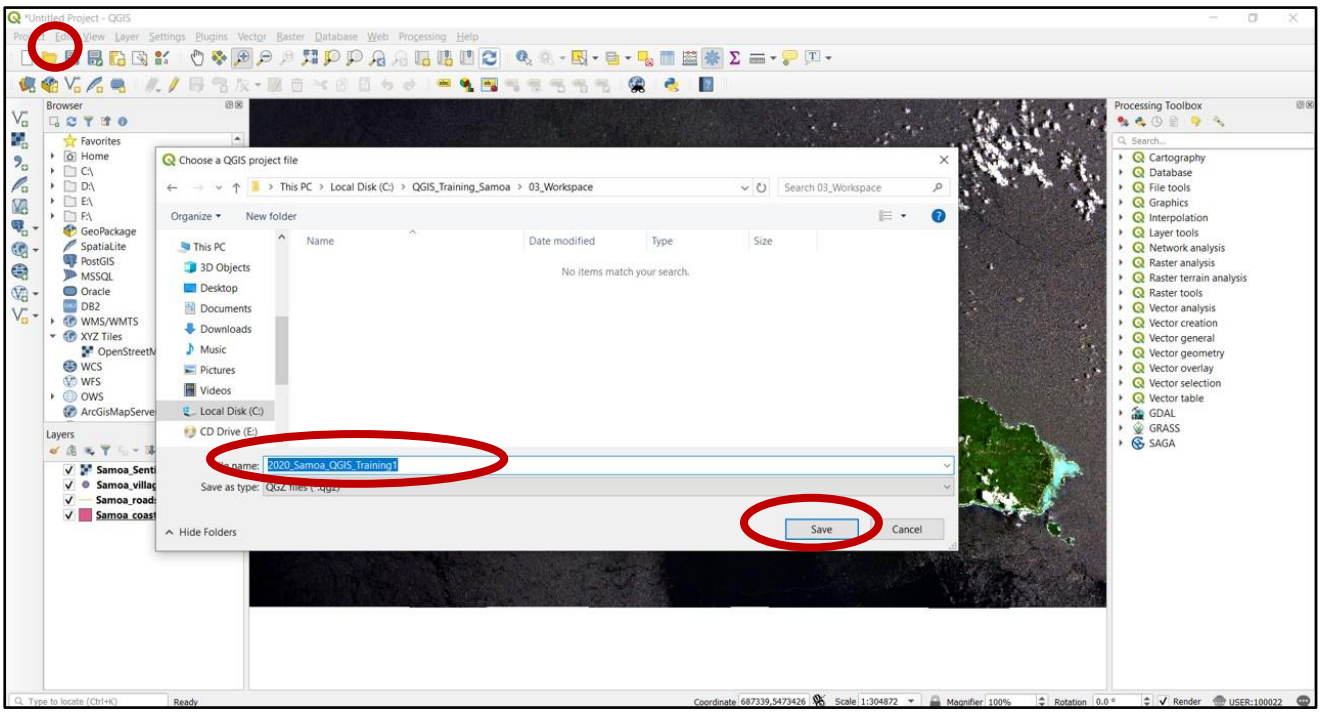
Saving and Opening QGIS Projects

Once we have some vector and raster layers loaded into our map we need to save it!! Saving our project so that we can come back to it later if we need to.

- *Locate and press the Save Project button*



- *Navigate to C:\QGIS_Training_Samoa\03_Workspace*
- *Save the project as **2020_Samoa_QGIS_Training1***



- ***Close** QGIS and then open it again*
- *Locate and press the Open Project button*
- *Navigate to C:\QGIS_Training_Samoa\03_Workspace*
- *Select **2020_Samoa_QGIS_Training1.qgs** file*
- *Click Open*

Make sure that your project loads successfully, we will use it for the next exercise.

Exercise 3 – Changing the Display of Layers

The following exercise will teach you how to label and modify the display of the layers in the map.

By completing this exercise, you will learn how to perform the following tasks:

- Adding labels
- Apply simple symbology to vector layers
- Symbolise data by attributes
- Apply transparency to map layers

USE THE FOLLOWING PROJECT/LAYERS FOR THIS EXERCISE:

- ***Project***
- C:\QGIS_Training_Samoa\03_Workspace**2020_Samoa_QGIS_Training1**

- ***Layers***

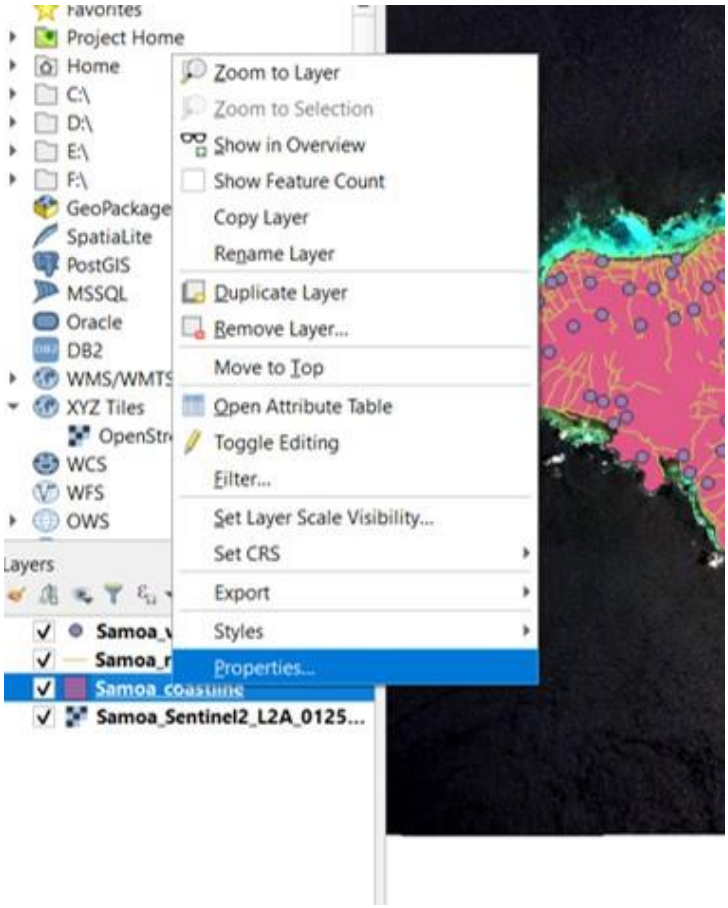
  We will use coastline boundary, roads, and location points (from previous Exercise 2) *PLUS* some protected areas layers:
  C:\QGIS_Training_Samoa\02_Datasets**Samoa_WDPA_Polygons.shp**
  C:\QGIS_Training_Samoa\02_Datasets**Samoa_WDPA_Points.shp**

Labelling Features

In addition to changing the style, another way of displaying more information on your map is to use labelling. You can label the individual features in a layer using any of the attributes relating to that layer.

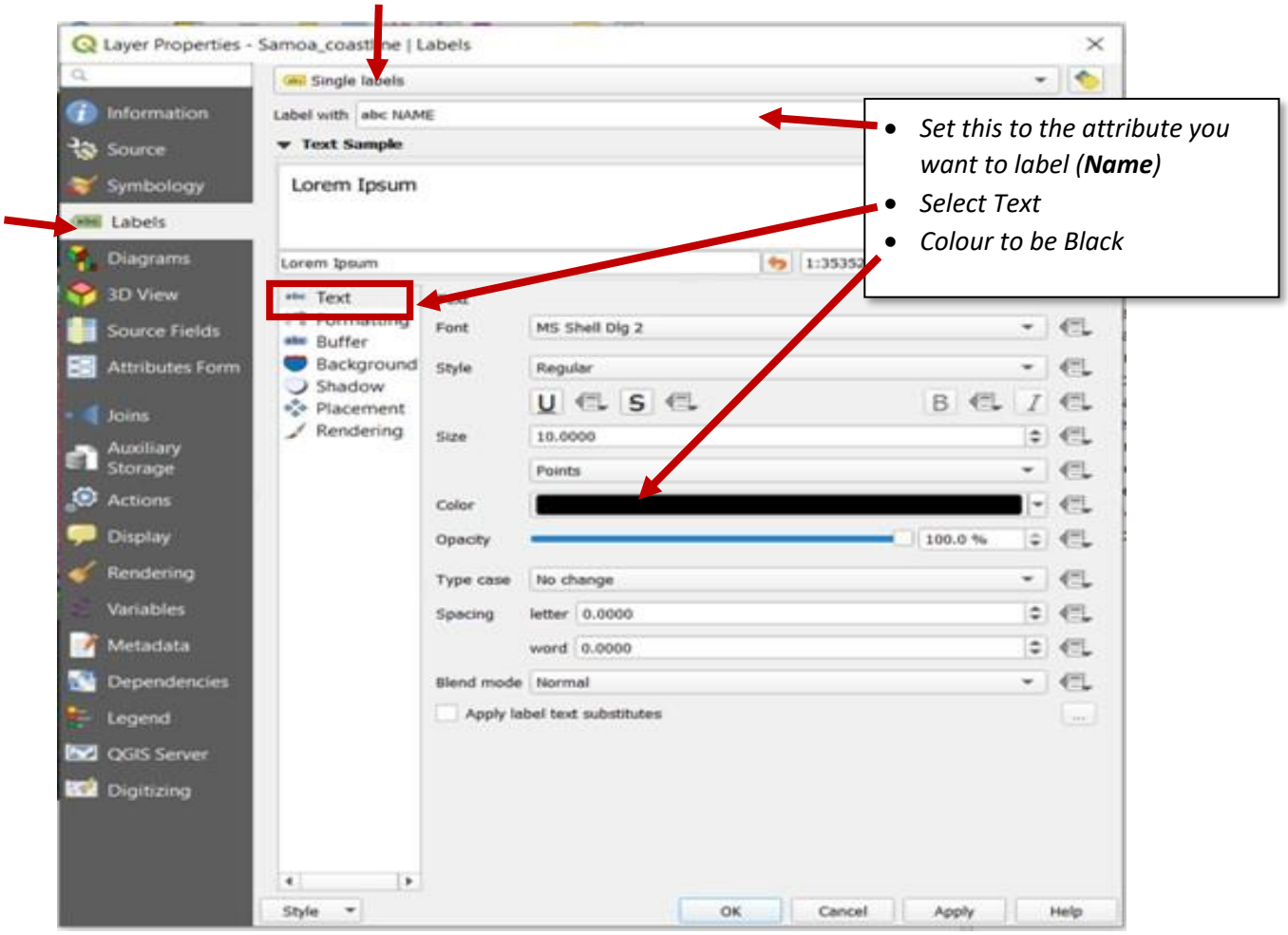
In this section we are going to label the following layer: **Samoa_coastlines**

- *Right click the* **Samoa_coastlines** *vector layer select Properties*

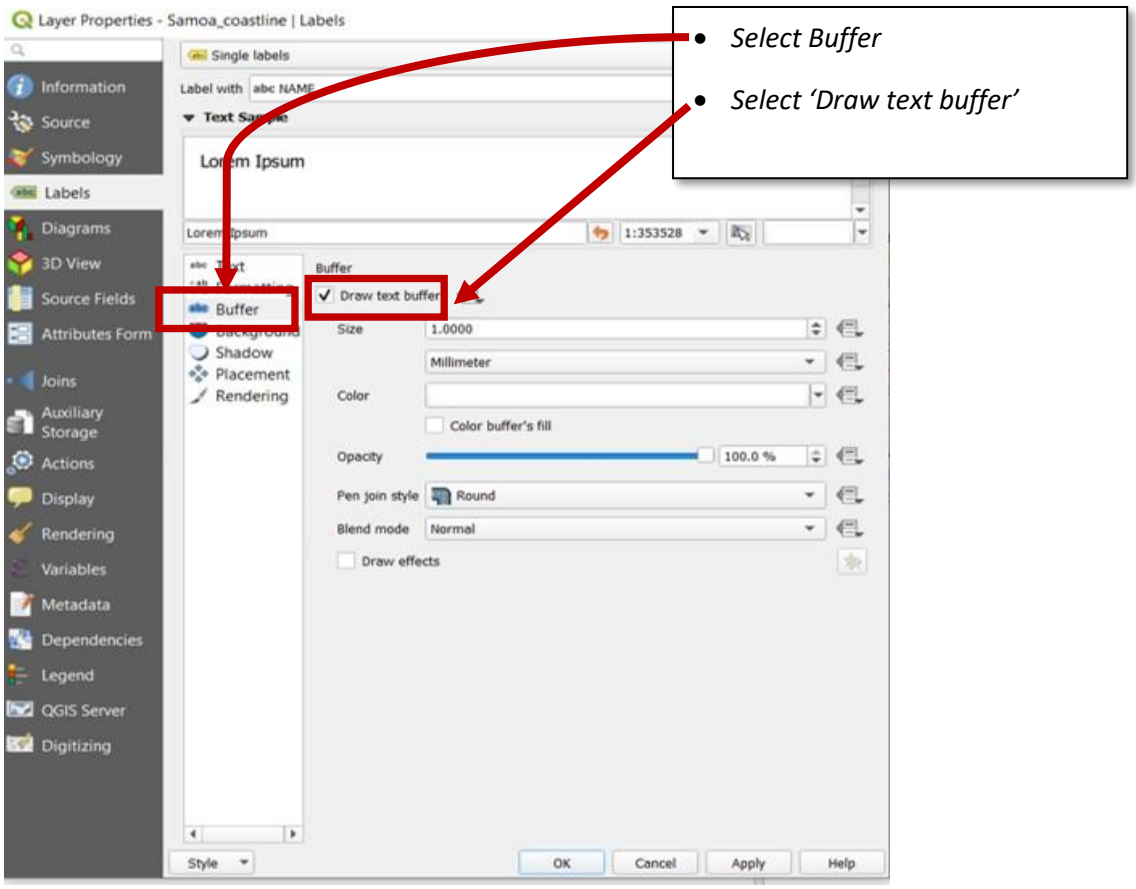


- *Open the* ***Properties*** *for the layer and go to the Labels tab*

- *Select the* ***Label*** *tab, in the top option select* ***Single Labels*** *and Label this layer box as below:*

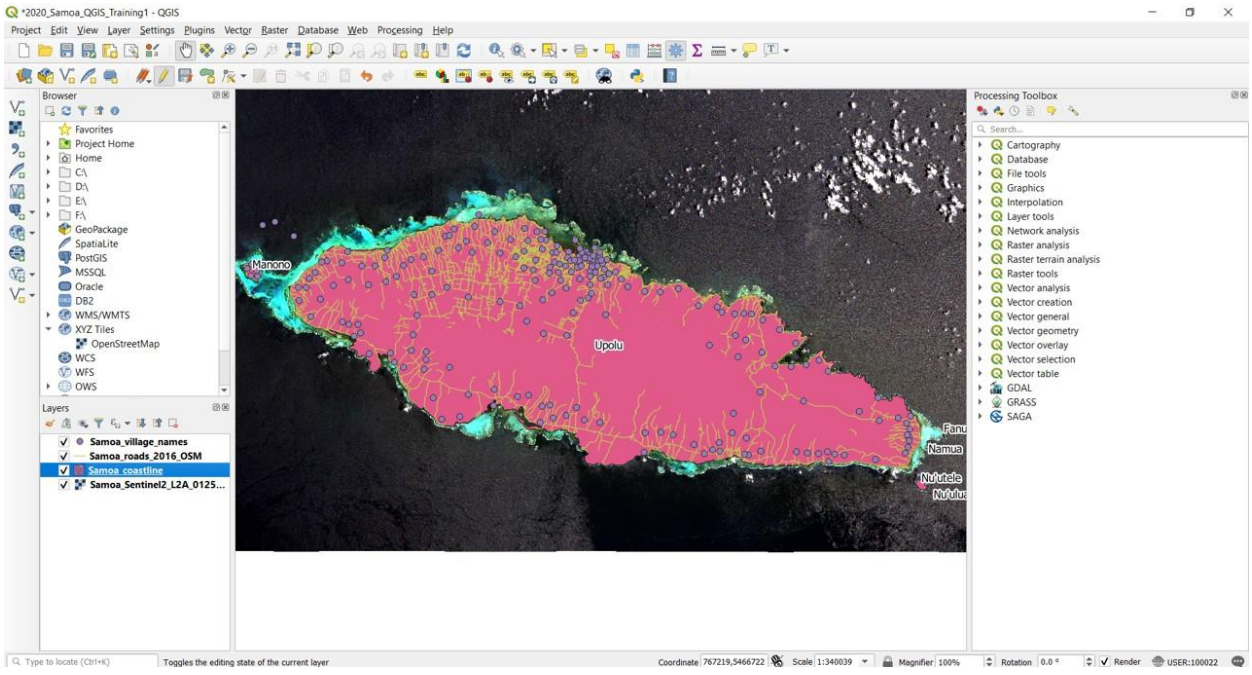


And lets give it a buffer to make the labels stand out from the data



- *Click **OK***

The Islands should now be labelled as below:



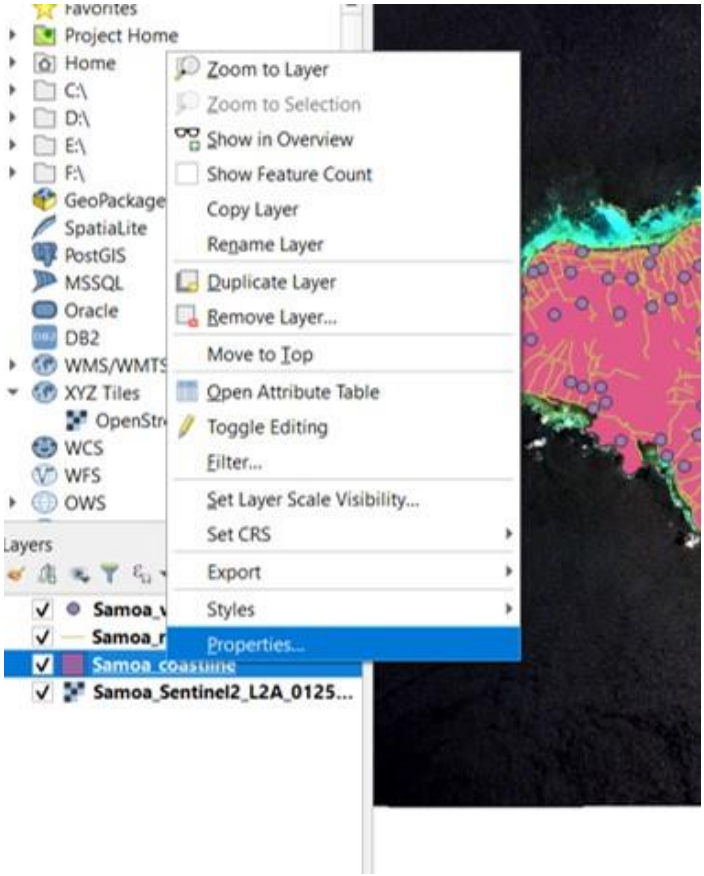
Note: To turn the labels off you simply uncheck the Display labels box in the layer properties.

Save the project

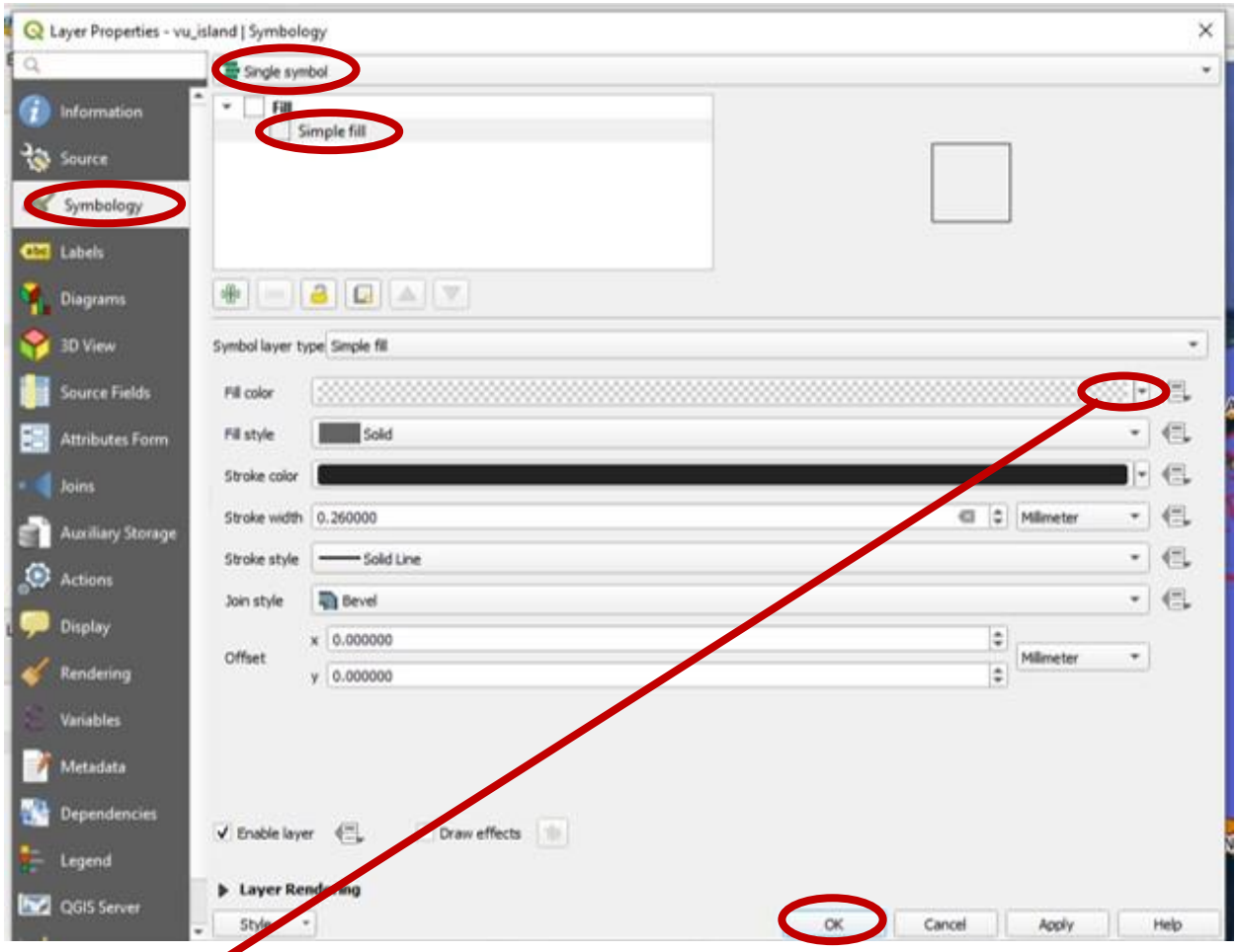
Simple Symbology (Polygon)

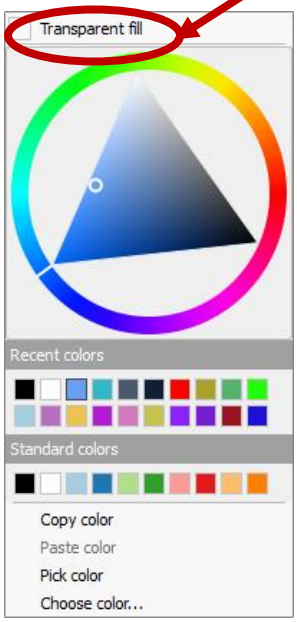
When you add a layer to the map it will be loaded in a default symbology (i.e. colour, line thickness, etc.). Modifying the default symbology of a layer is a simple task. You can change the symbology inside of QGIS to make the map look the way you want. The changes that you make to symbology are relevant to the current map only (i.e. if you add the layer into a different map it will open with the default symbology again).

- *Right click the* **Samoa_coastline** *vector layer select Properties*

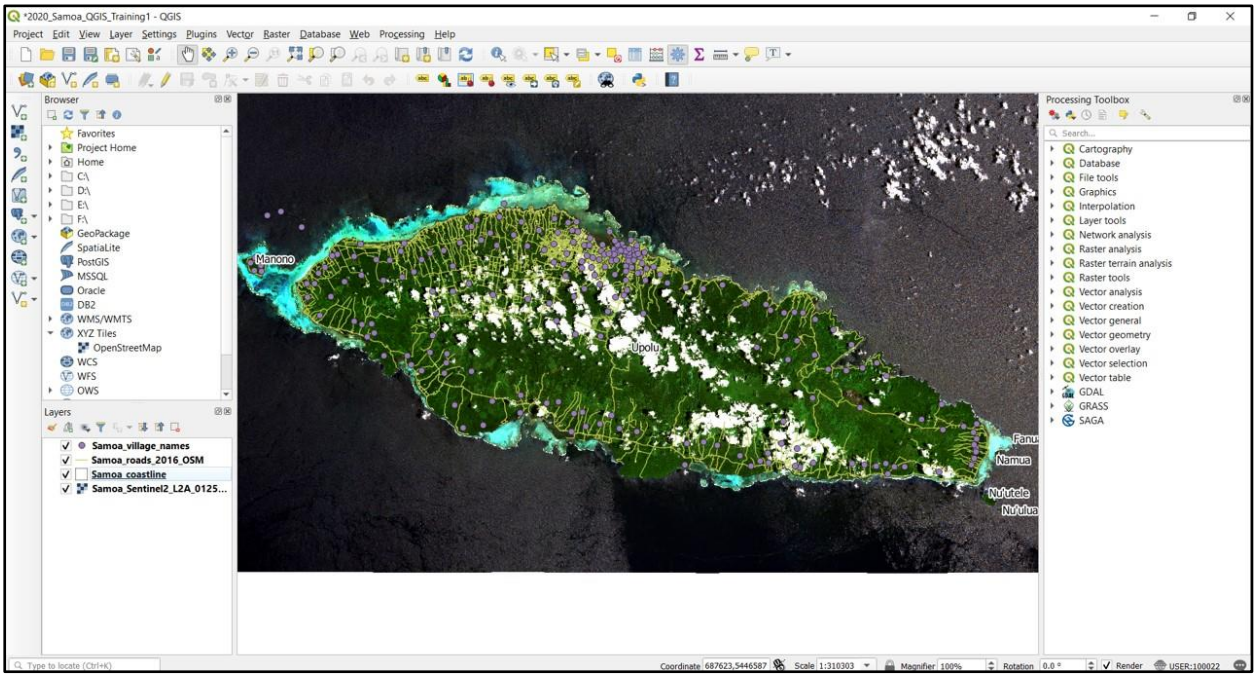


- *Select **Symbology***
- *Select **Simple Symbol** from the pulldown menu at the top of the dialog box*
- *Select **Simple Fill***
- *Select **Transparent Fill under the Fill Option***
- *Click **OK***



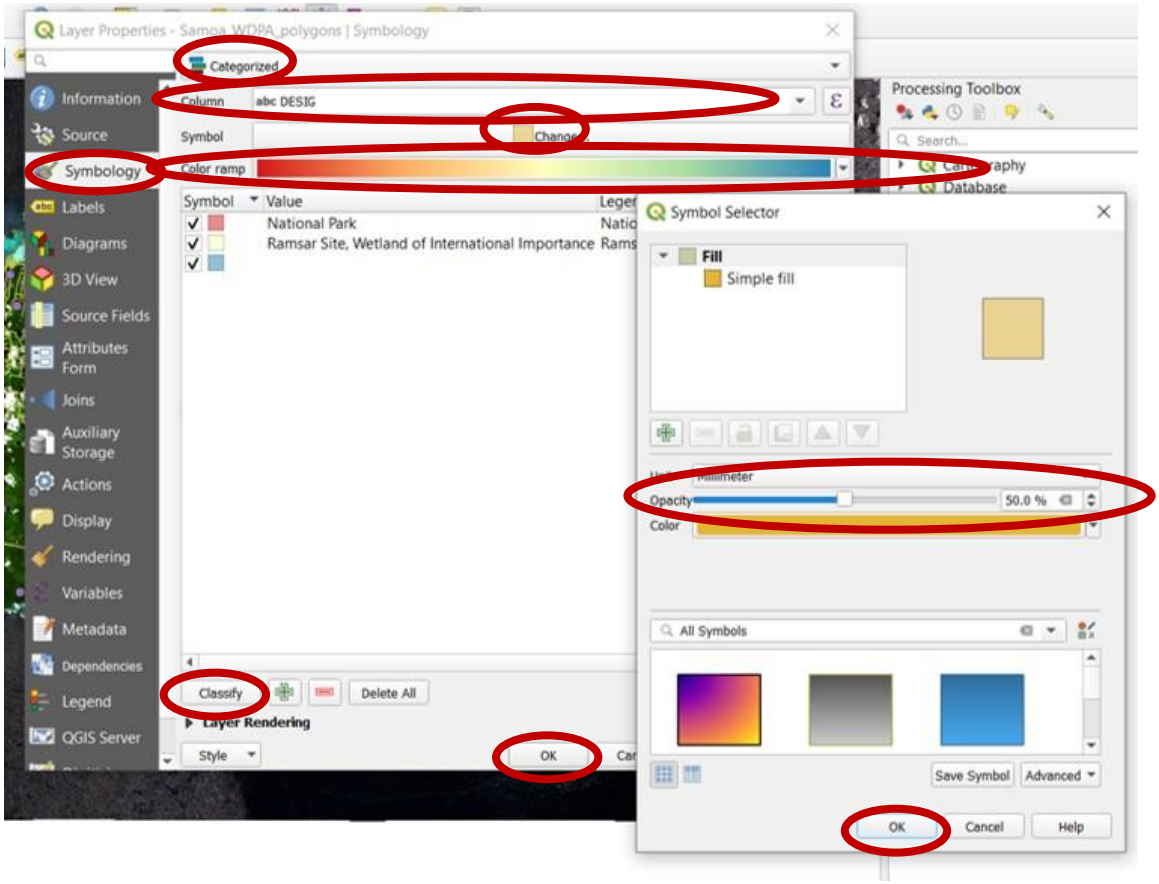


The output should look something like this:

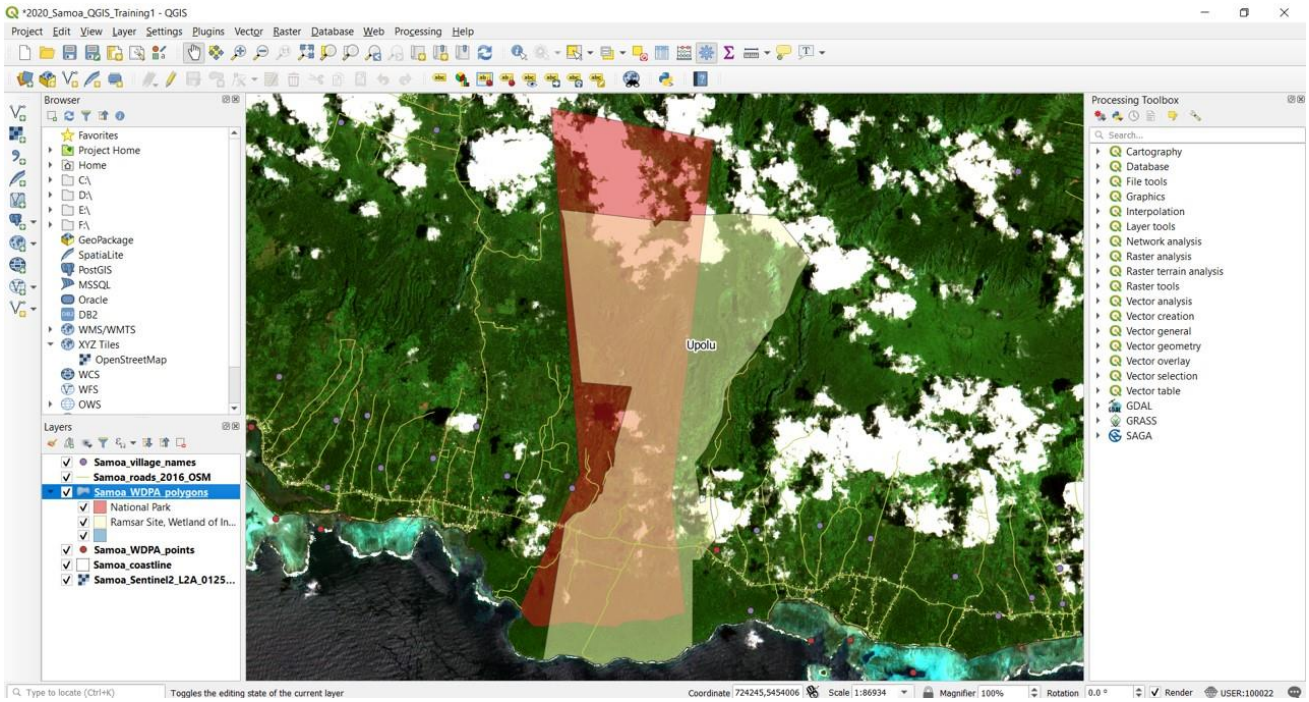


OK looking good! Let's add the WDPA Protected Area layers and style that up by Category:

- *Drag in the **Samoa_WDPA_Polygons.shp** and **Samoa_WDPA_Points.shp** into your workspace*
- *Right click the **Samoa_WDPA_Polygons** vector layer and select Zoom to Layer*
- *Right click the **Samoa_WDPA_Polygons** vector layer select Properties*
- *Select **Symbology***
- *Select **Categorized***
- *Select **Column** to Categorize by, in this case **'DESIG'***
- *Under **Symbol**, click **Change** then then make the **Opacity** to 50% and click **OK***
- *Under **Color Ramp**, select **Spectral***
- *Select **Classify***
- *Click **OK***

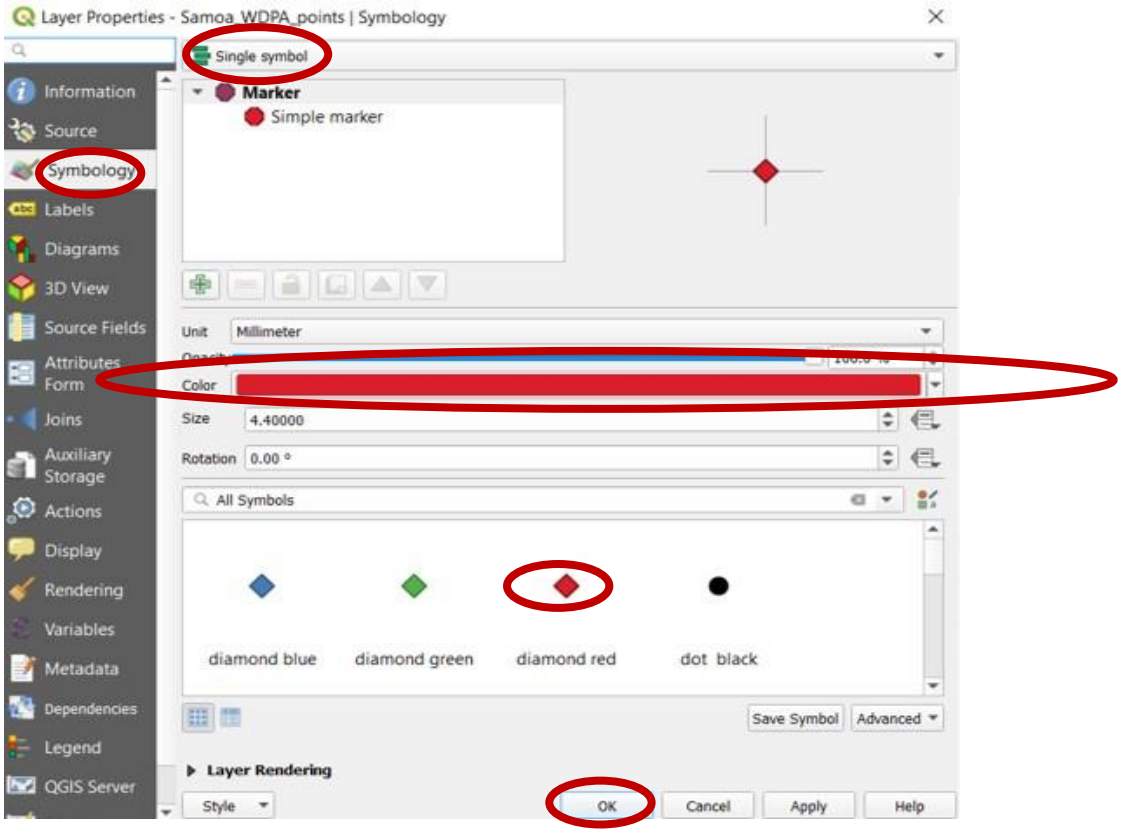


The output should look comething like this:



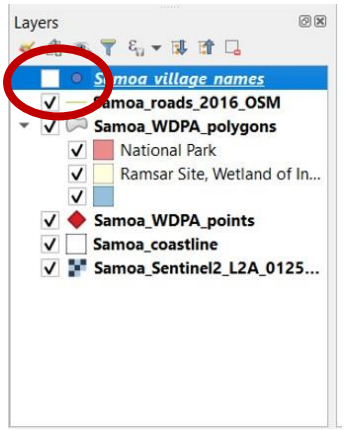
Point Symbology

- *Right click the **Samoa_WDPA_Points** vector layer and select Zoom to Layer*
- *Right click the **Samoa_WDPA_Points** vector layer select Properties*
- *Click on "Simple Marker" to change the point symbol (the Marker)*

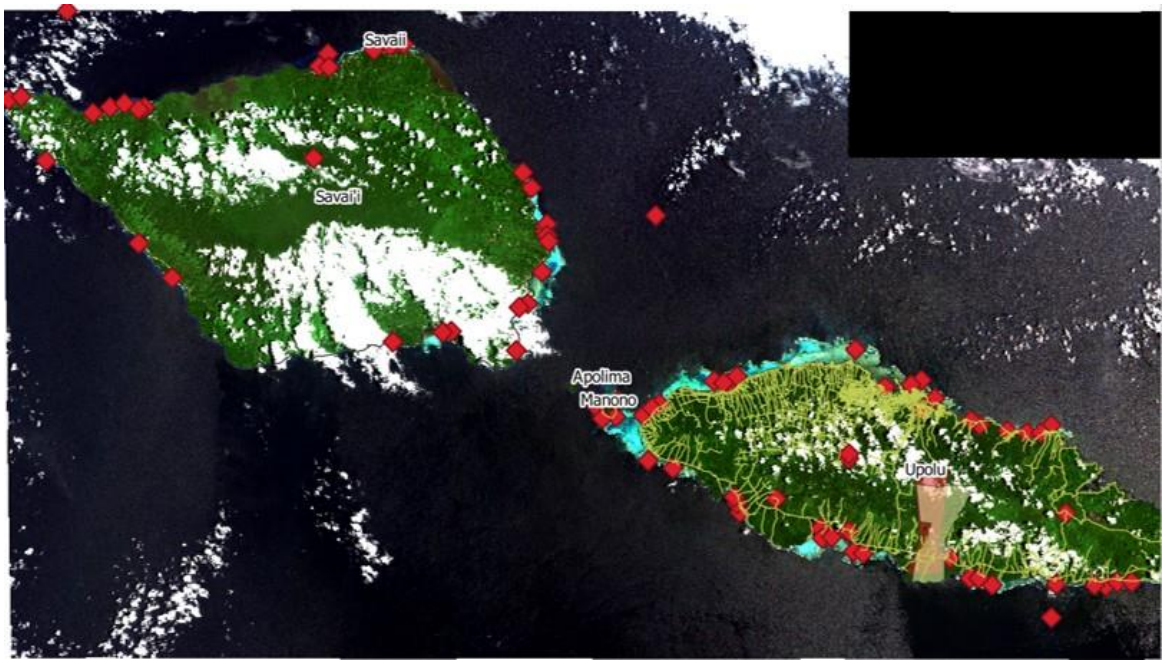


You see that there are a variety of style options to choose from. We want to change our marker from a circle to a red diamond (or whatever you want), change the colour and the size

- *Click Apply to save the changes and apply them to the layer*
- *Then click OK to return to the map.*
- *The map looks a little messy so we want to make the **Samoa_village_names** not visible on the map in order to make the protected areas stand out more. We can simply uncheck the layer **Samoa_village_names** in the* Table of Contents



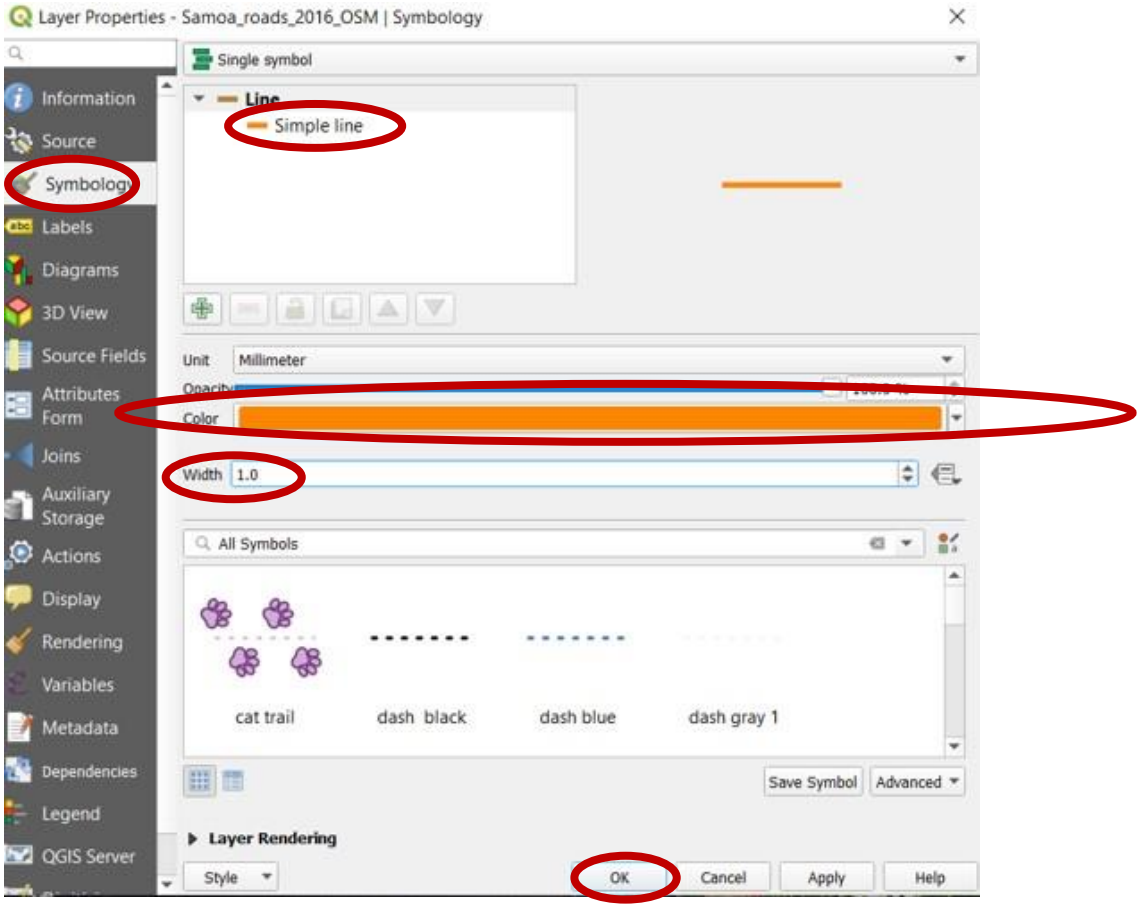
- *The results should look something like this:*



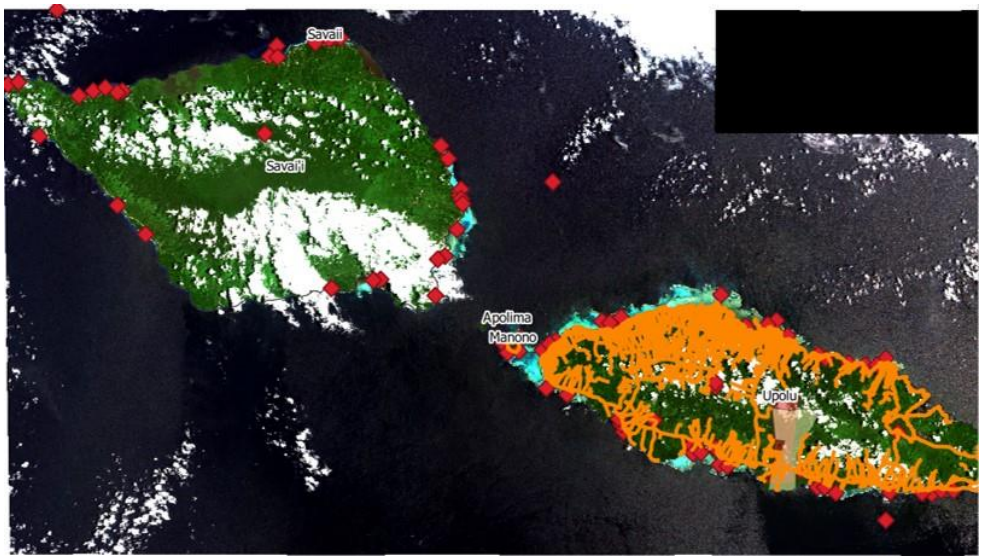
Line Symbology

Changing the symbology of a line is similar to changing a point.

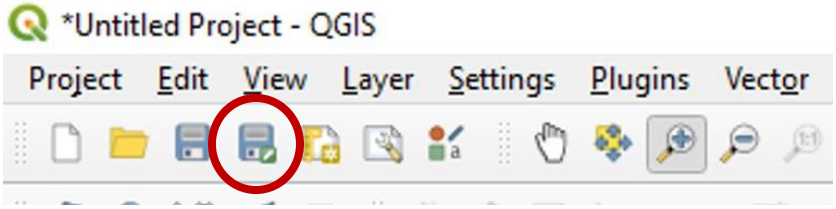
- *Right click **Samoa_roads_2016_OSM** and select Properties*
- *Select the Symbology tab*
- *Click on "Simple line", change the colour to orange and the stroke width to 1 mm*



- *Click Apply to save the changes and apply them to the layer*
- *Then click OK to return to the map. The results should look something like this*



- *Locate and press the Save Project As button*



  - *Navigate to* C:\QGIS_Training_Samoa\03_Workspace
  - *Save the project as* ***2020_Samoa_QGIS_Training2***

Exercise 4 – Creating Maps

The following exercise will teach you how to create an output map that can be inserted into reports, posted on web pages, or used for meetings and consultation.

By completing this exercise, you will learn how to perform the following tasks:

- Prepare a map that you can publish for reports, the web and/or meetings

USE THE FOLLOWING LAYERS FOR THIS EXERCISE:

- ***Vector layers***
  Polygon layer – **Samoa_WDPA_Polygons.shp**
  Point layer – **Samoa_WDPA_Points.shp**

- ***Raster layers***
  Samoa_Sentinel2_L2A_01252020.tif

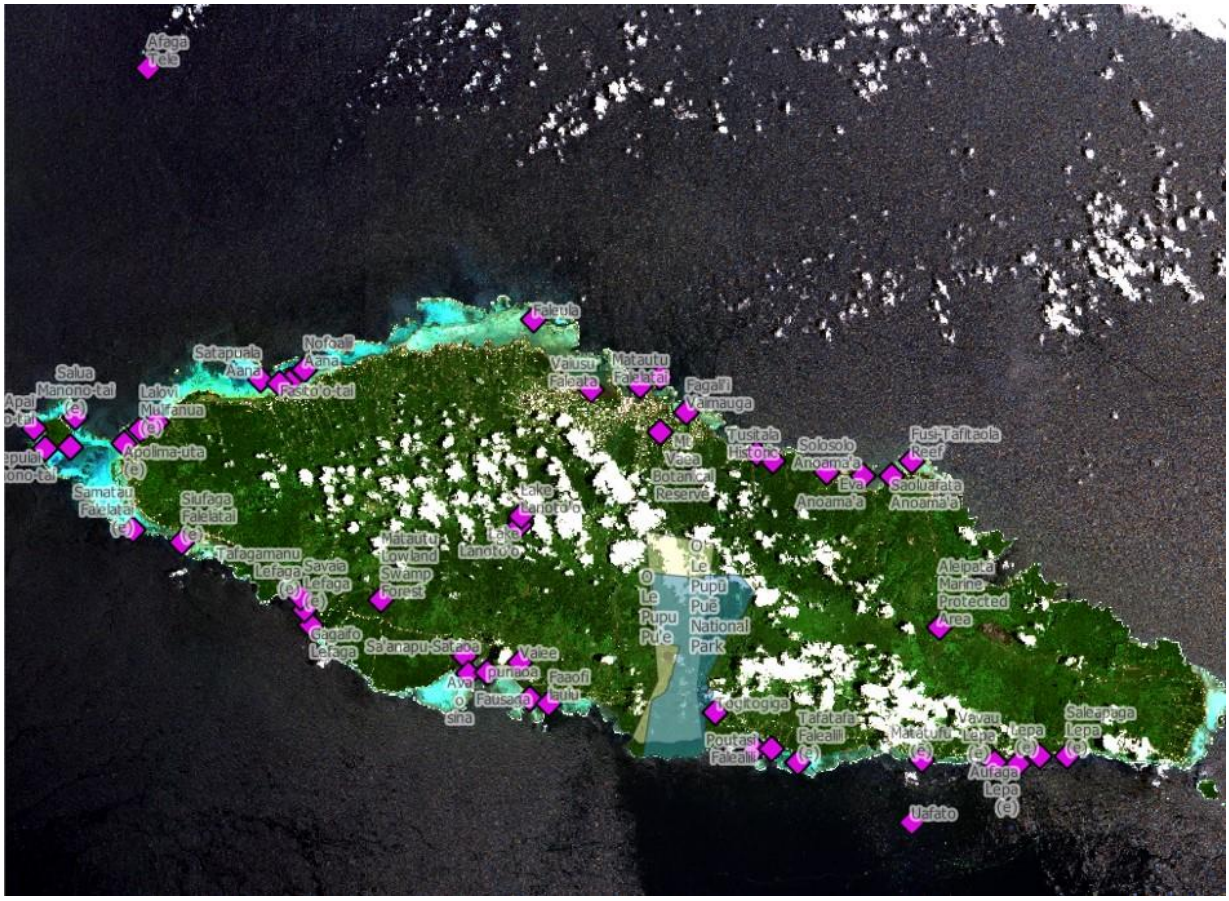
Prepare Your Map

Before you create a map for printing (hardcopy or PDF) you will need to prepare the map layers so they look the way you want them to.

- *Using the skills you have picked up already, add in datasets and set up the symbology and labelling for your layers as per the following:*
  - *Add in the Samoa satellite imagery raster layer*
  - *Add in the layers* Samoa_WDPA_Polygons.shp and:
    1. *Categorize the symbology to colour the polygons in a variety of colours by designation ("DESIG")*
    2. *make the areas 50% transparent and*
    3. *label polygons with NAME, set the opacity to 60% to make it transparent, set the text size to 8*
    4. *under Formatting tab there is a* ***Wrap on Character*** *option, this will let you decide how to shorten the labels so they don't overrun and look messy, we will simply add a space here to make the labels more concise*
    5. *add a buffer around the label and set the opacity to 60%*
  - Add Samoa_WDPA_Points.shp and *label points with NAME and add white buffer, set both to 50% transparent, and set the Wrap on Character option to have a space*

- *Zoom into Uplou*

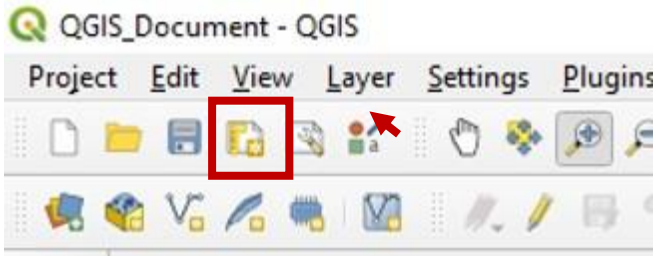
Your screen should look similar to the image on the following page.



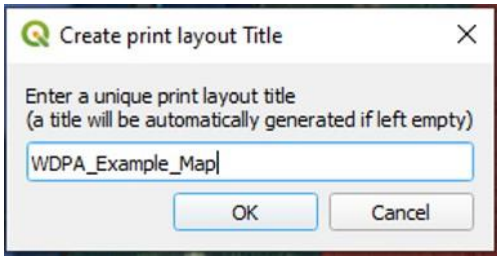
Print Composer

The Print Composer is the tool that we use to create an output map. The map can then be used in a document, printed or emailed.

- *From the toolbar select New Print Composer*



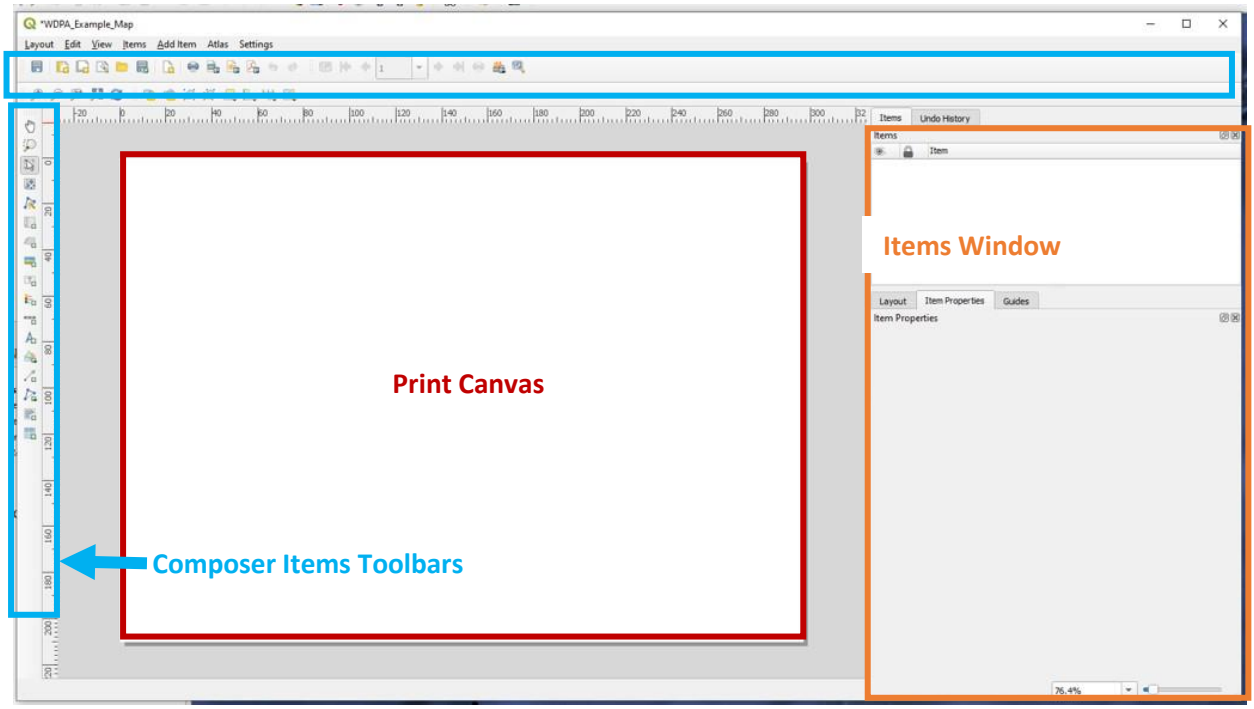
- *Name your new print layout "WDPA_Example_Map"*



- *Click OK*

A new window will open. This is the Print Composer window (see next page) where we will put all of our map elements together. There are several components to the Composer window, many are similar to the QGIS work space. The main parts of the Print Composer window that we will be using are the:

- **Composer Items Toolbars**
- The **Print Canvas**, and
- The **Items Window**



Composer Items Toolbars

There are many different tools in the **Composer Items Toolbars.** The more commonly used tools are described below:

Save Project

Export as PDF

Revert to the last change (or undo last action)

Restore last change (redo last change)

Add new map from QGIS map canvas to print canvas

Add image to Print Canvas

Add label to Print Canvas

Add new legend to Print Canvas

Add new scale bar to Print Canvas

Add arrow to Print Canvas

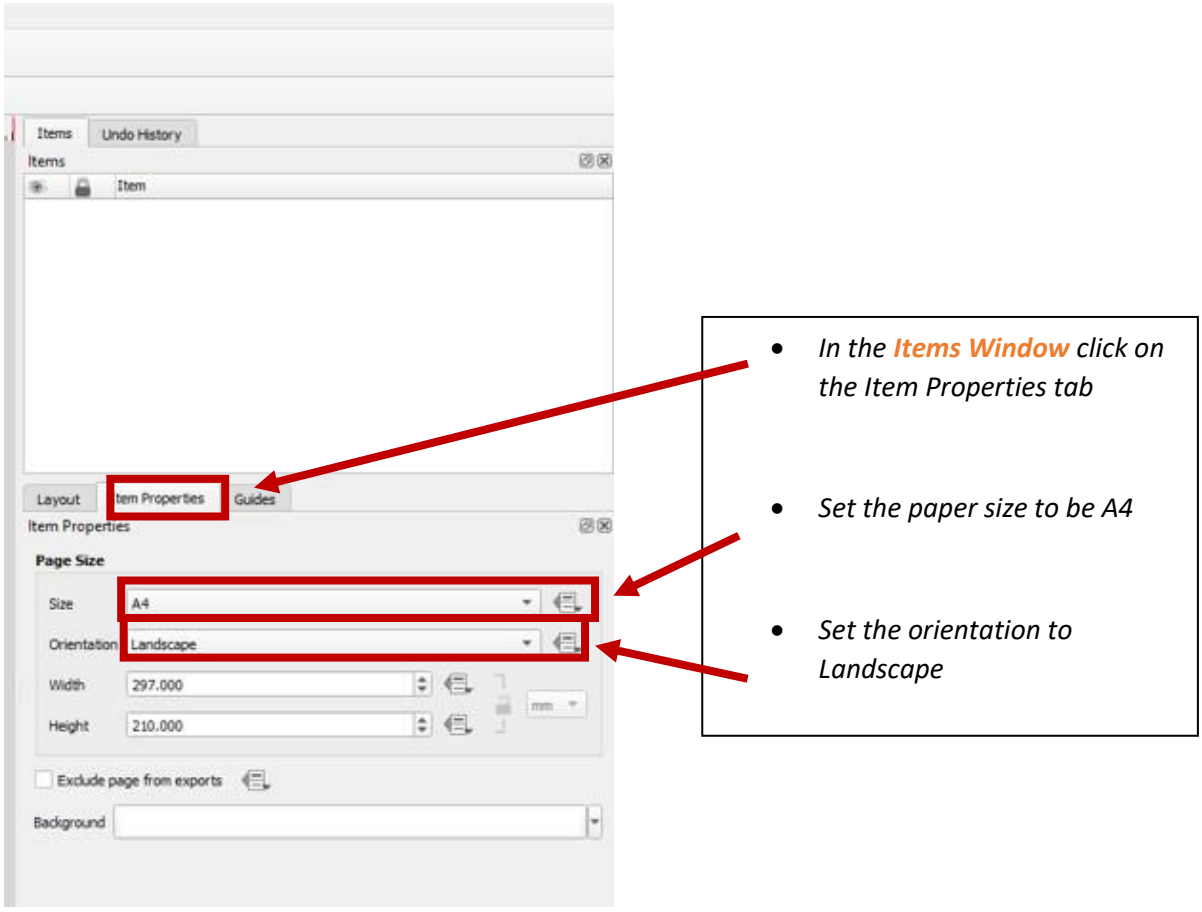
Print Canvas

The **Print Canvas** is similar to the **Map Canvas**. This is where all the elements of a map are put together, ready for publishing.

Items Window

The **Items Window** is where you edit all aspects of the **Print Canvas** and the items you have added to the **Print Canvas.**

Before you begin to put anything on the map, the first thing that you need to set is the size of paper the map will be published on. Right click on the **Print Canvas** and then select ***Properties***.

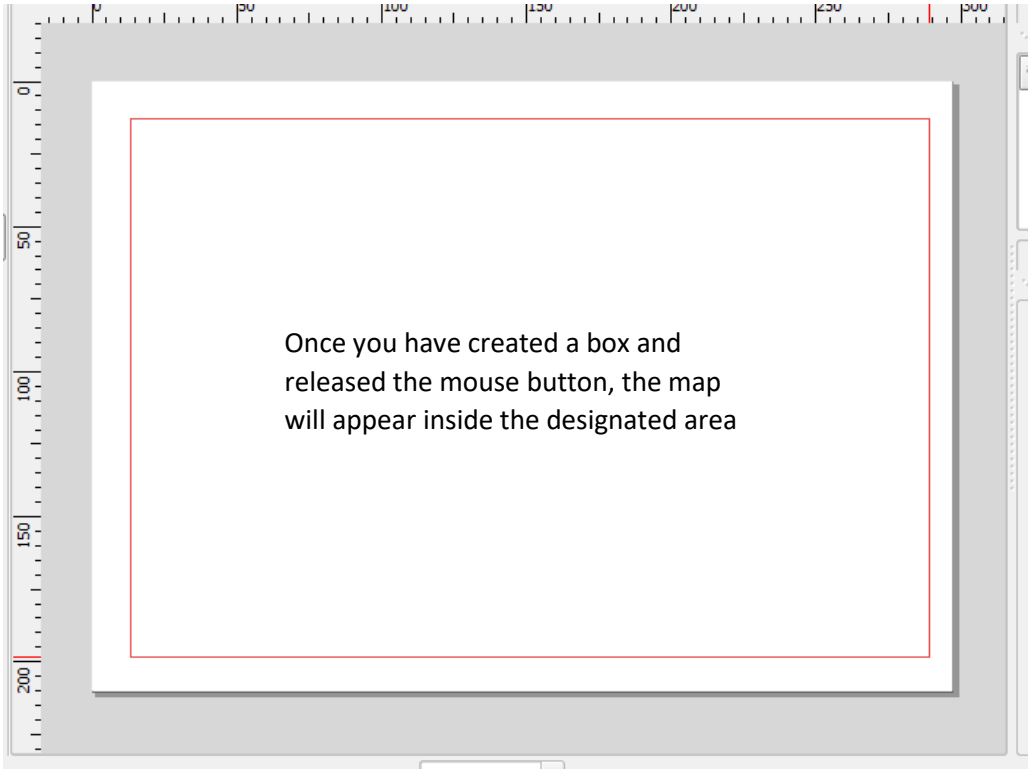


Next we will start to add all the different elements to the page that we need to create a map. Everything required for putting a map together can be found in the **Composer Items Toolbars** on the left of screen and under the menu options.

Add Map

We will now add the map to the page, keeping in mind not to put anything too close to the edges (printers have margins), and to leave yourself enough room to add all the other elements.

- *Select Add Map tool*  *from the toolbar on the left*
- *Click near the top left corner of the page and drag a box to the bottom right to insert the map*



We will now look at how the map is positioned. Does it show the area we would like it to? Is there enough space around the map to add a title, legend and scale bar?

To adjust the placement of the map on the page and the extent of the map we can use the following map composer tools:

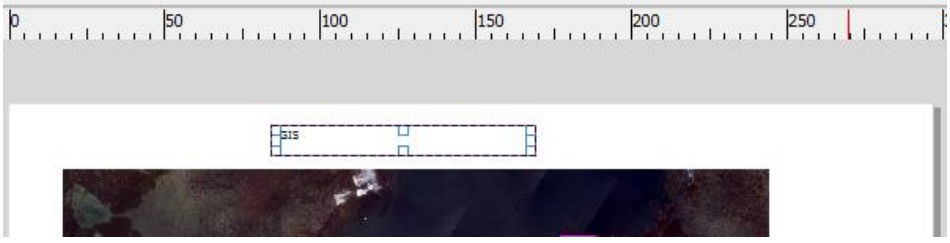
The select/move item tool  allows you to select and reposition any element on the **Print Canvas**, for example the box that the map is in or the legend.

The move item content tool  allows you to reposition the map within its box.

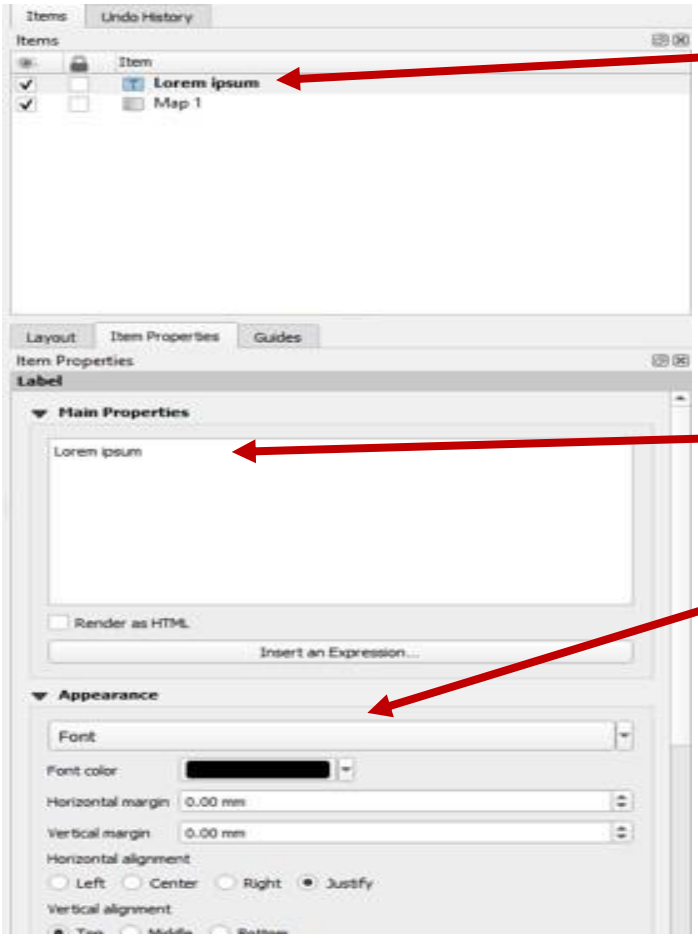
Add Title

All maps should have a title. The purpose of the title is to tell the viewer what they are looking at.

- *Select Add Label*  *from the* **Composer Items Toolbars**
- *Left click on some of the white space at the top of the page and drag the cursor to create a text box*



This will add a small text box to the map (with the word Lorem ipsum inside) that you can now update using the Item Properties dialog in the **Items Window**.

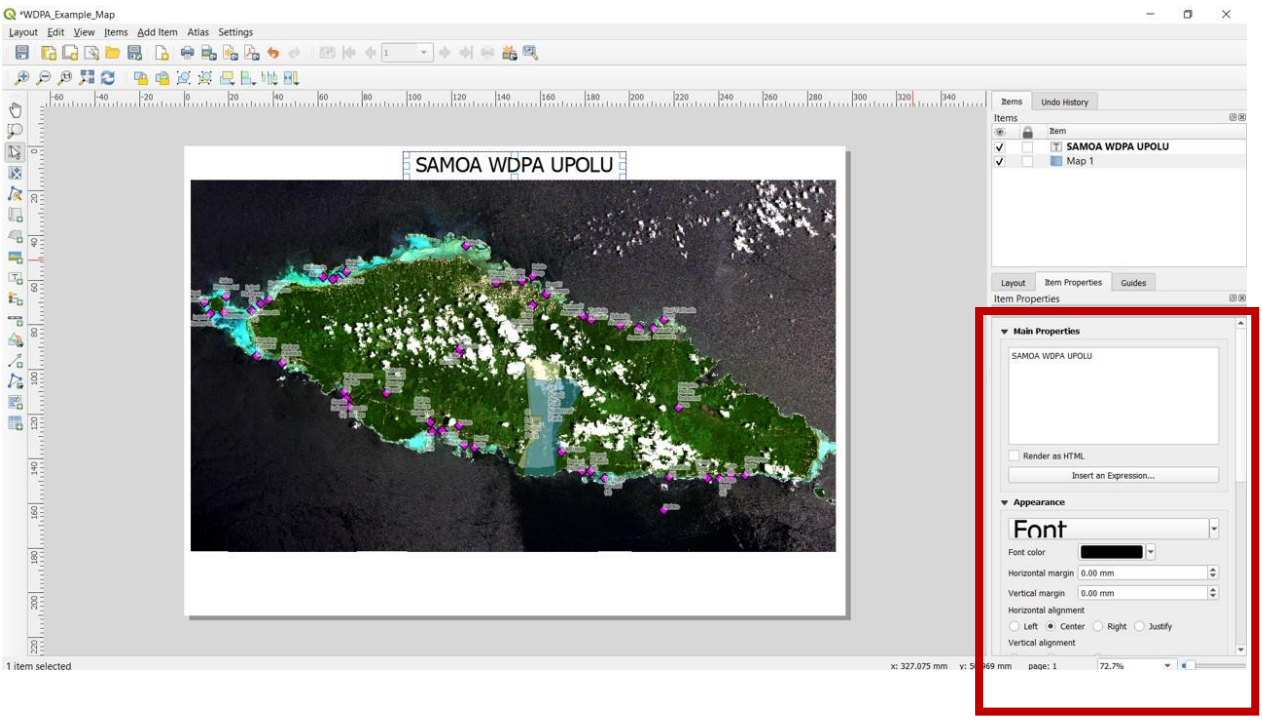


- *Click on the label in the **Items Window***

This allows us to edit this particular item

- *Change the map label to "SAMOA WDPA UPOLU"*
- *Click the Font button to open the Font edit window*
- *Change Font to size 26*

- *Place Title text at the top and centre of the **Print Canvas** (use the red/blue guide lines to assist)*
- *Under Items properties – Appearance – Horizontal alignment, check the circle for "Centre"*



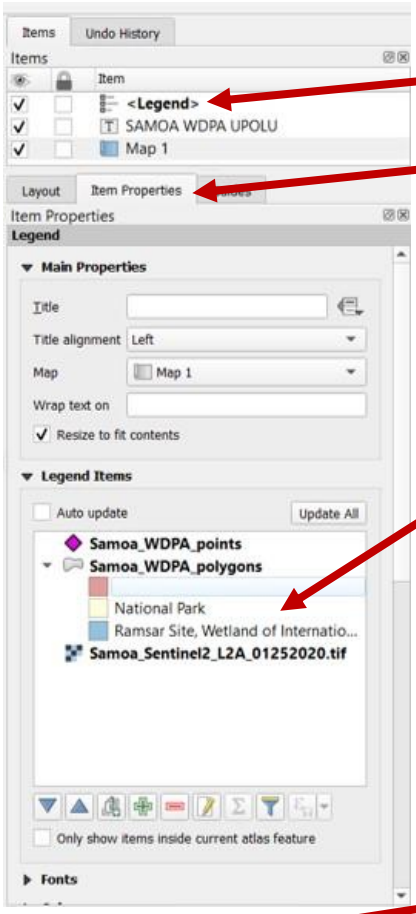
Add Legend

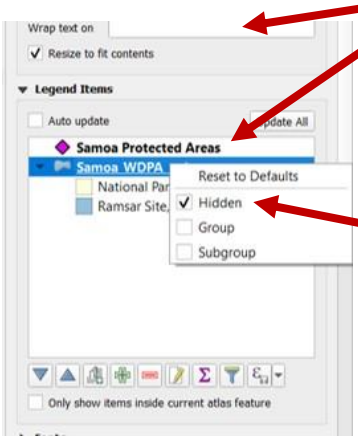
We will now add a legend to our map. A legend provides valuable information to help people interpret what a map is showing.

- *Select the Add Legend tool*  *from the* **Composer Items Toolbars**
- *Left click on the* **Print Canvas** *to add the legend*

This will add the legend to your map with default settings, which will include adding an item for each layer in the QGIS **TABLE OF CONTENTS**. We don't need all of the layers displayed in the legend so we will remove some of them.

- *Use the Select/move item tool*  *to position the legend on the right side of the page*





- *Click on "Legend" in the* ***Items Window***
- *Under the* ***Item properties*** *tab, scroll down to Legend items*
- *Click on unwanted layers (if any)*
- *Then click on the red "-" button*

This will remove the unwanted layers from the legend

This will change the legend so only the layers that we think are useful are displayed

We can also click on the layer names and rename the layers.

We can use the **Wrap text on** option here and use specific symbols to wrap the words after we rename them. For example: changing the name of Ramsar Site, Wetland of International Significance to Ramsar Site, Wetland of*International Significance and setting the **Wrap text on** option to * will make the name more compact

And finally, we can right click on the layer name and check the Hidden option to hide it from the Legend

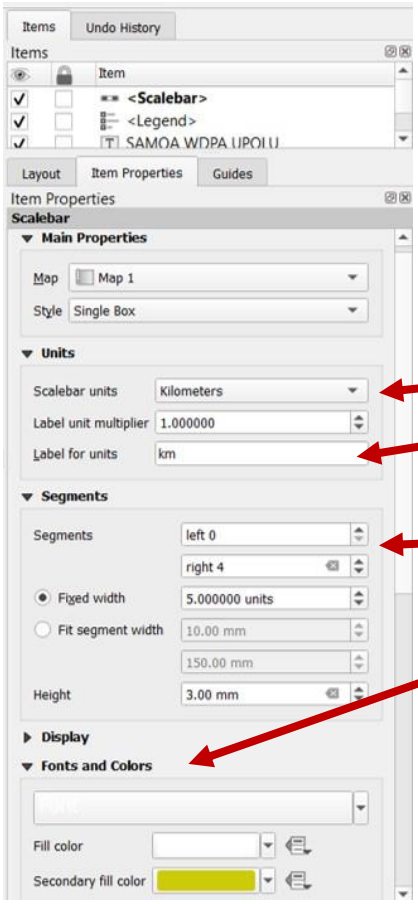
Using what you have learned, try producing a legend like the one below:

Add Scale bar

Another important item to have on your map is a scale bar. The scale bar helps viewers visually understand the size of the area covered by the map.

- *Select Add Scale bar tool* *from the* **Composer Items Toolbars**
- *Left click on the* **Print Canvas** *to add the scale bar*

Now that the scale bar has been added to the map we will edit it further using the **Items Window**.



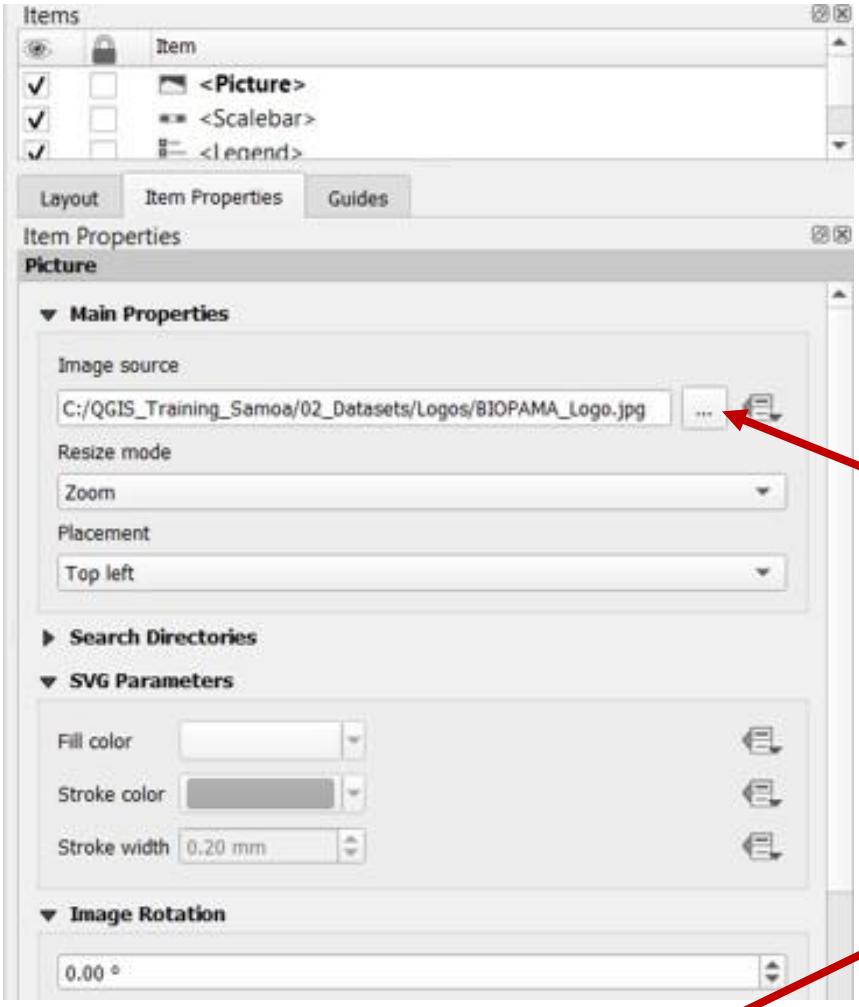
- *Set the Units to kilometers*
- *Make sure the Label says km (to indicate that the scale is in metres)*
- *You can change the Segments to adjust scale bar*
- *And you can change the color of the fonts and how the scale bar looks under the* ***Fonts and Colors*** *option*

Add Image (Logos, North Arrow)

You can also add an image to the map, for example, a North arrow, company logo or a photo that accompanies the map. The image must be in a standard image format e.g. a JPEG file.

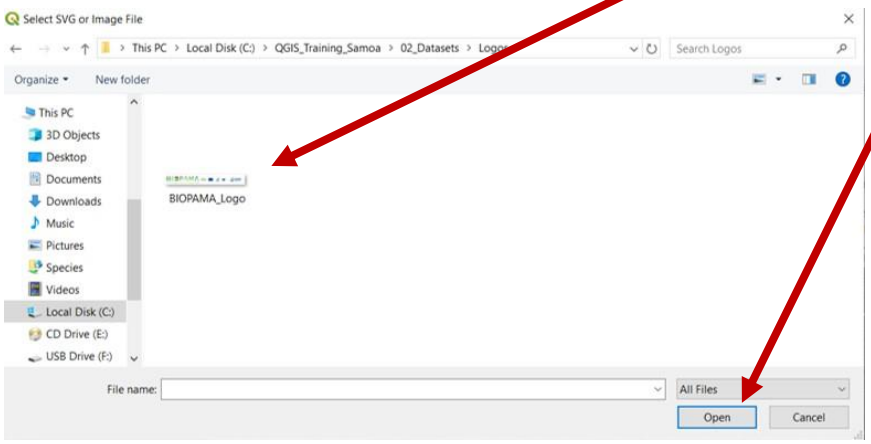
- *Select the Add Image tool* *from the* **Composer Items Toolbars**
- *Left click in a white space on the* **Print Canvas** *and drag the cursor to create a box*

You will now have an empty box displayed on the **Print Canvas**. Next, we need to import an image into this box using the **Items Window.**



Click on the browse *button and navigate to C:\QGIS_Training_Samoa\02_Datasets\Logos*

- *Click on the BIOPAMA Logo Image*
- *Click Open*



The Project logo should appear on the print canvas. Position the logo in the bottom left hand corner under the map in the white space.

Repeat this process by adding a north arrow to the upper left hand corner of the map. North Arrows can be found in the directory: C:\Program Files\QGIS 3.4\apps\qgis-ltr\svg\arrows\

Finalising and Exporting the Map

You now have all the elements that are required for the final output map. You should inspect the map and the elements to see if they need rearranging and to check the map looks good.

- *Resize and move the various map elements on the page to reduce the amount of white space that is present (you may need to adjust font sizes etc. for the title and the legend)*

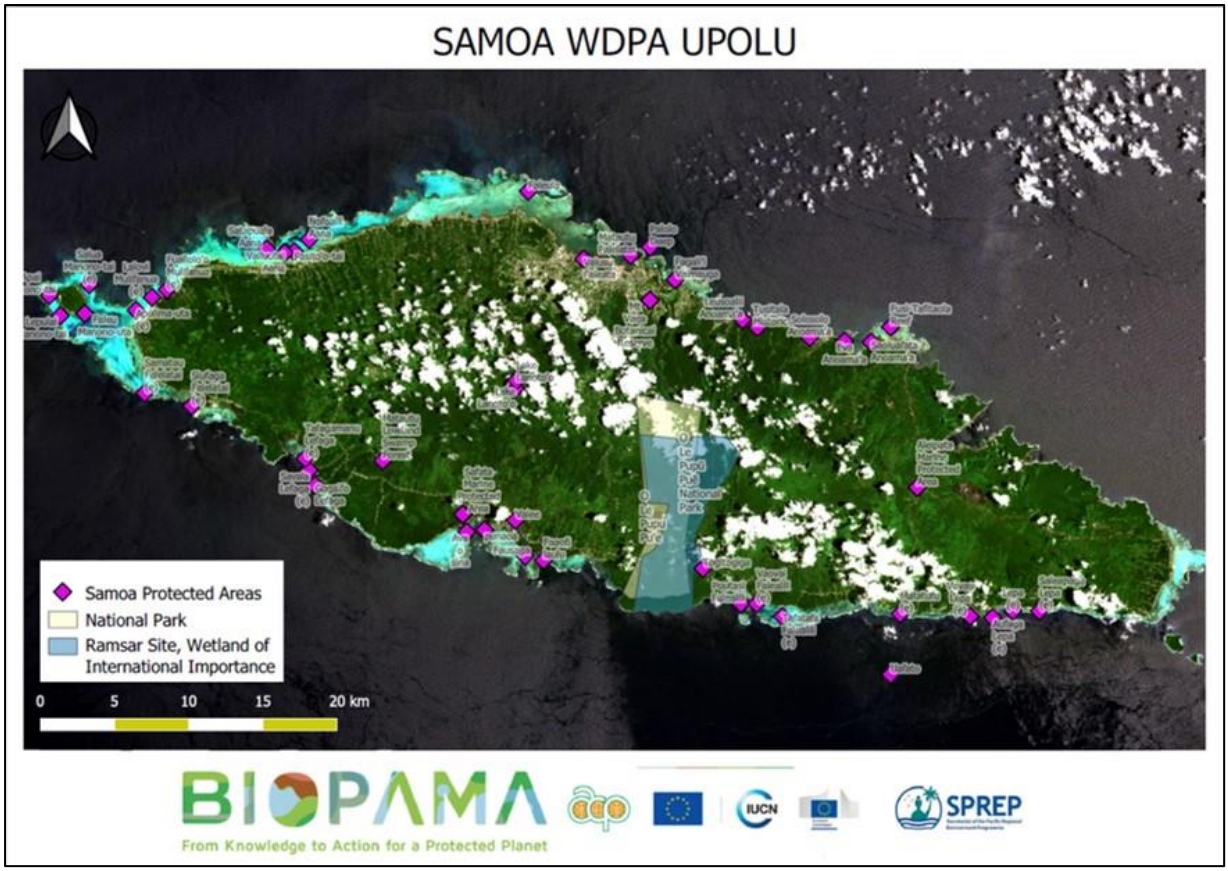
When the map looks good and displays all the information you need in the best possible way, it is now time to export it.

- *Select the Export as PDF tool*  *from the* **Composer Items Toolbars**

This will open a Save dialog box.

- *Save the PDF as 'Samoa WDPA map' to the file location C:\QGIS_Training_Samoa\04_Outputs*

- *Open your PDF once it has finished exporting and take a look at it*



Congratulations on creating and publishing a map using QGIS!

Exercise 5 – Navigating in QGIS

The following exercise will examine how to use the Table of Contents and to navigate around the map in QGIS.

By completing this exercise, you will learn how to perform the following tasks:

- Utilise the pan and zoom tools
- Access the **TABLE OF CONTENTS**

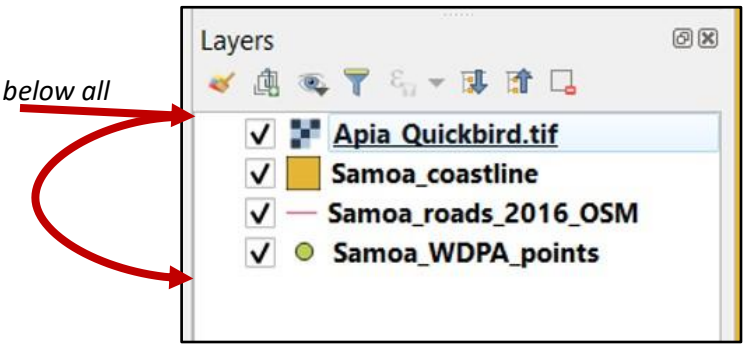
Using Table of Contents

You may have found when you added all of your layers to the map you were unable to see some of the information (particularly if a raster image ended up on top of some vector data). The order in which the layers are listed in the **TABLE OF CONTENTS** is the order in which the map will draw them (i.e. the top map layer will be at the top of the **TABLE OF CONTENTS**).

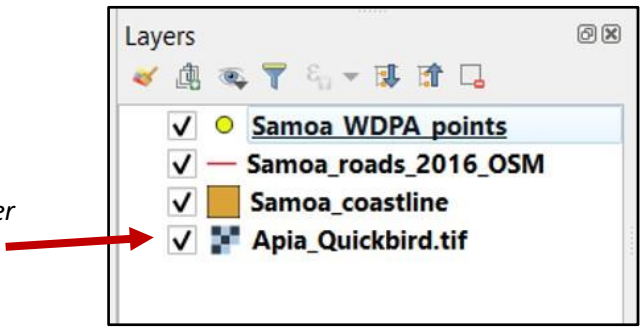
We will rearrange some of the layers to change the display of data. A general rule to follow is place all point vector layers at the top, followed by line vector layers, polygon vector layers, and with raster layers at the bottom. By ordering your **TABLE OF CONTENTS** in this way, you will ensure that the maximum amount of information is displayed on the map.

- *Change the order of the layers in the **TABLE OF CONTENTS** by left clicking (don't release the click) and dragging a layer to a new position*
- *Order the layers so that point layers are at the top (i.e. Samoa_WDPA_points), followed by line layers (i.e. Samoa_Roads_2016_OSM), then the polygon layer (i.e. Samoa_coastline) and at the bottom the raster layer (i.e. Apia_Quickbird.tif)*

- *Drag the raster layer below all of the other layers*



- *Turn off the Apia_Quickbird.tif raster layer by clicking the **X** next to the layer name*



Navigating the Map

Now that you have a project set up with some layers it's time to move around the map and take a look. You will find all of the navigation tools together on a **Toolbar**. There are Pan tools (these will move the map around without changing the scale) and Zoom tools (these will change the scale and position of the map).

Select (click on) these frequently used navigation tools to explore the map:

TOUCH PAN and ZOOM – allows you to use your laptop touch pad to pan (i.e. move around the map) and to zoom in/out

PAN – click on the map and hold the click, to drag (move) the map around (note, the scale of the map does not change)

PAN TO SELECTION – allows you to pan the map to the location of any selected features

ZOOM IN – click the map or drag a box to zoom in on a location

ZOOM OUT – click the map or drag a box to zoom out from a location

ZOOM TO NATIVE PIXEL RESOLUTION – zooms to best scale for viewing the raster layers in the map

ZOOM FULL – zooms to the full extent of all layers in the map

ZOOM TO SELECTION – zooms to extent of any selected features in the map

ZOOM TO LAYER – zooms to full extent of the selected layer in the **TABLE OF CONTENTS**

ZOOM LAST – goes back to the previous view, before your last navigation action (i.e. 'undo')

ZOOM NEXT – opposite of Zoom Last, moves forward (i.e. 'redo')

REFRESH – if the map fails to draw, this will refresh the view

A regularly used navigation tool is the Zoom to Layer tool. This allows you to zoom to the extent of a Layer.

- *First use the Zoom Full tool till you can see all of Samoa*
- *Right click on the Apia_Quickbird.tif layer and select Zoom to Layer*

This will zoom you in on Apia harbour and show all the points associated with the Points of Interest layer.

You can also zoom to a layer by selecting the layer in the **TABLE OF CONTENTS** and then right clicking on the layer. This will present you with a list of options at the top of the list is “Zoom to Layer”.

Now we will look for features that we recognise in Apia.

- *Turn on raster layer Apia_Quickbird.tif*
- *Turn off Samoa_coastline layer*
- *Use the Pan tool to find the MNRE building where this training is being held*
- *Note that the imagery is not current as the newer TATTE building is not constructed in the imagery. This is a good example of the raster data not containing appropriate information to indicate the year of capture. We only know the area (Apia) and source of the data (Quickbird satellite).*

Save the project as C:\QGIS_Training_Samoa\03_Workspace\2020_Samoa_QGIS_MyProject.qgs

Exercise 6 – Attribute Tables

The following exercise will introduce you to attribute tables and the data contained within them. It will cover how to query information from these tables.

By completing this exercise, you will learn how to perform the following tasks:

- Identify features on the map
- Open and explore attributes tables
- OPTIONAL EXTRA – Selecting features

USE THE FOLLOWING PROJECT/LAYERS FOR THIS EXERCISE:

- ***Project***

C:\QGIS_Training_Samoa\03_Workspace\2020_Samoa_QGIS_MyProject.qgs

- ***Layer***

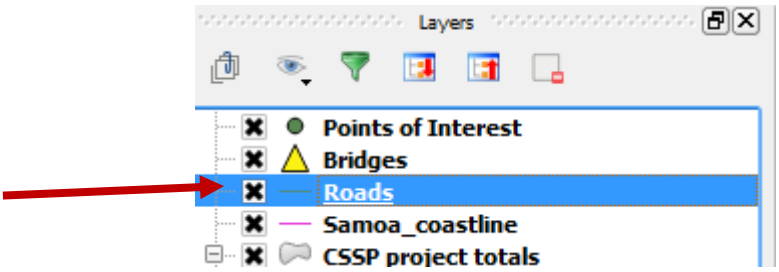
Samoa_roads_2016_OSM

Identify Features on the Map

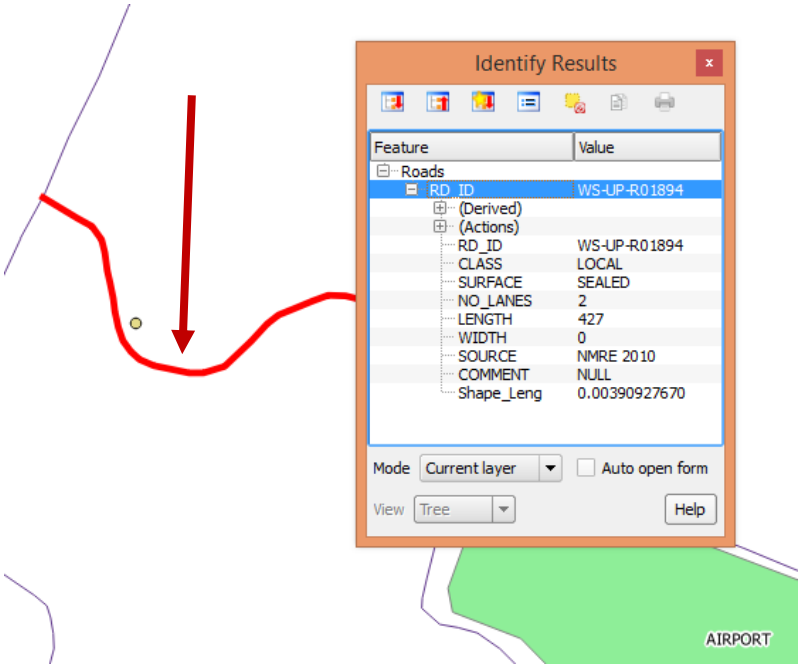
The ability to query the information in the map is very important. The easiest way to query information in a map is by using the Identify Features tool.

- *Select the Identify Features tool*

- *Select the layer that you want to identify from the* **TABLE OF CONTENTS**



- *Click on a road feature in the map (it will open the dialog box with all the attributes for that feature)*



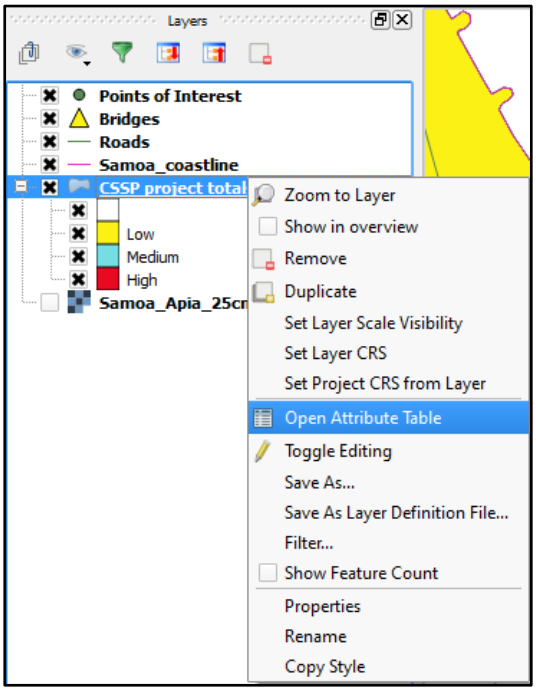
You may need to scroll across or resize the window to see all of the attributes and values associated with that feature. If there are no features at the location you click then no dialog box will appear. If you want to identify features from a different layer then you will need to highlight that layer in the **TABLE OF CONTENTS** first before clicking on the map.

- *Close the Identify Results box using the X in the upper right hand corner*

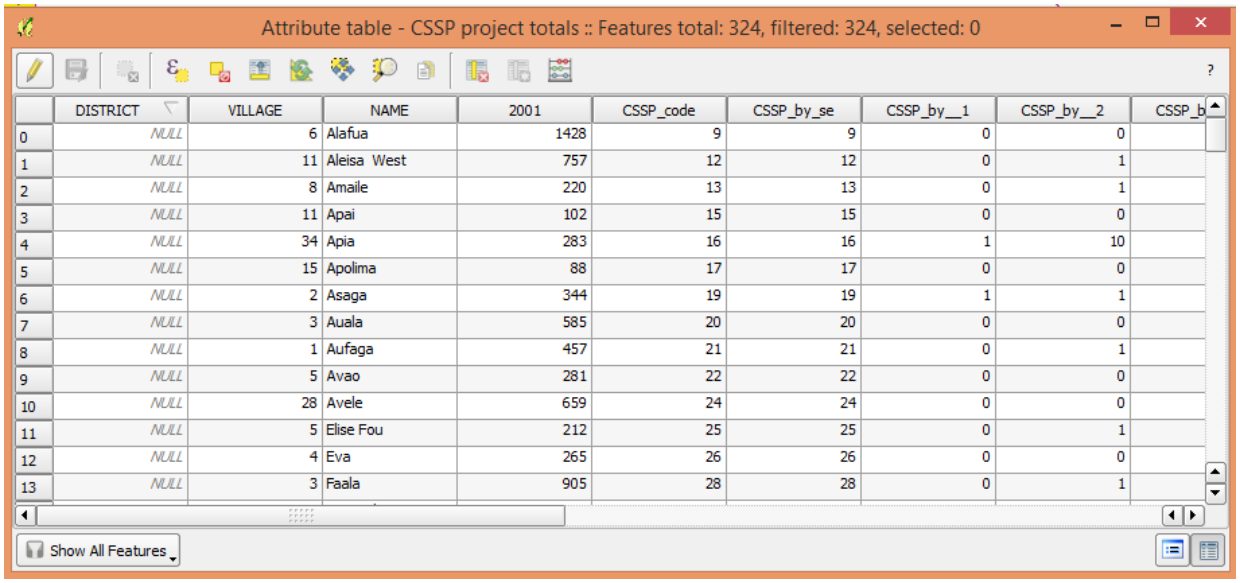
Open Attribute Table

Each vector layer that you have added to the map has 2 parts to it. There are the geographical features (the points, lines and polygons that you see on the map) and the attribute information that sits behind the geographical features. For each feature in the map there will be a corresponding record/row in the attribute table for that layer.

- *Right click the CSSP project total layer and select Open Attribute Table*



Below is an example of how an attribute table may look.



	DISTRICT	VILLAGE	NAME	2001	CSSP_code	CSSP_by_se	CSSP_by__1	CSSP_by__2	CSSP_b
0	NULL	6	Alafua	1428	9	9	0	0	
1	NULL	11	Aleisa West	757	12	12	0	1	
2	NULL	8	Amaile	220	13	13	0	1	
3	NULL	11	Apai	102	15	15	0	0	
4	NULL	34	Apia	283	16	16	1	10	
5	NULL	15	Apolima	88	17	17	0	0	
6	NULL	2	Asaga	344	19	19	1	1	
7	NULL	3	Auala	585	20	20	0	0	
8	NULL	1	Aufaga	457	21	21	0	1	
9	NULL	5	Avao	281	22	22	0	0	
10	NULL	28	Avele	659	24	24	0	0	
11	NULL	5	Elise Fou	212	25	25	0	1	
12	NULL	4	Eva	265	26	26	0	0	
13	NULL	3	Faala	905	28	28	0	1	

Running across the top you have all the different attribute names (or columns) and running down the side you have each the different records (or rows) of the table. Each one of the records in the table represents a feature in the map. You can sort rows in ascending or descending order by clicking the field names.

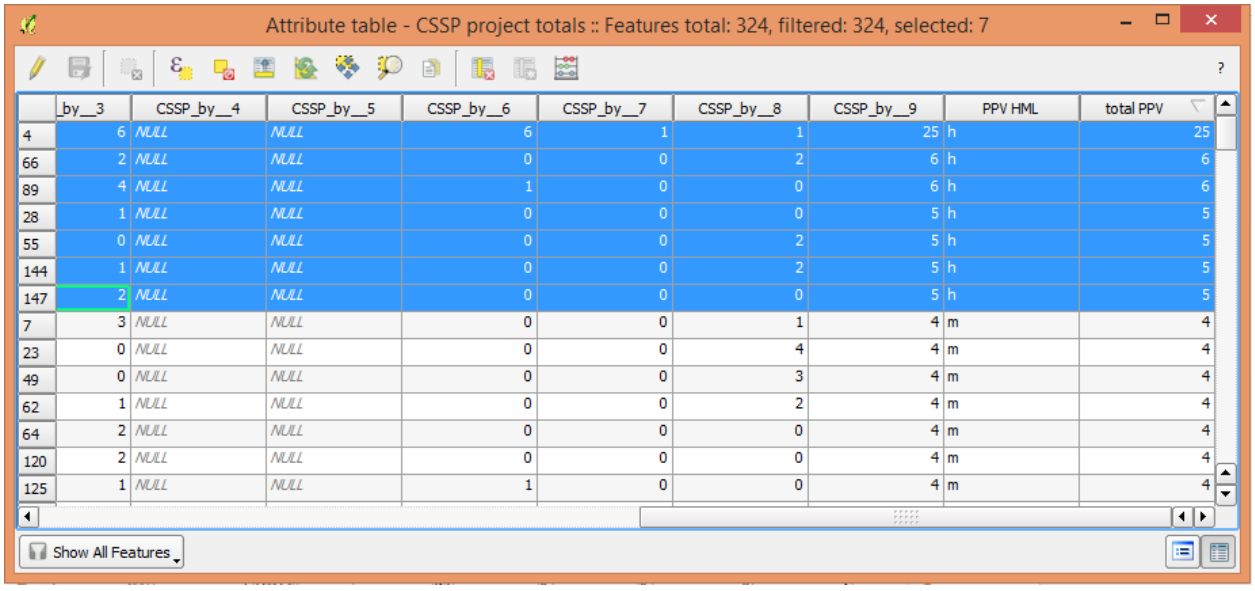
We are going to sort the table by the number of projects per village.

- *Scroll across the Attribute table to the column titled 'total PPV'*
- *Click on the column name*

It should sort the table from lowest number to highest number.

- *Click on the column title again*

This time it should sort the table from highest to lowest value.



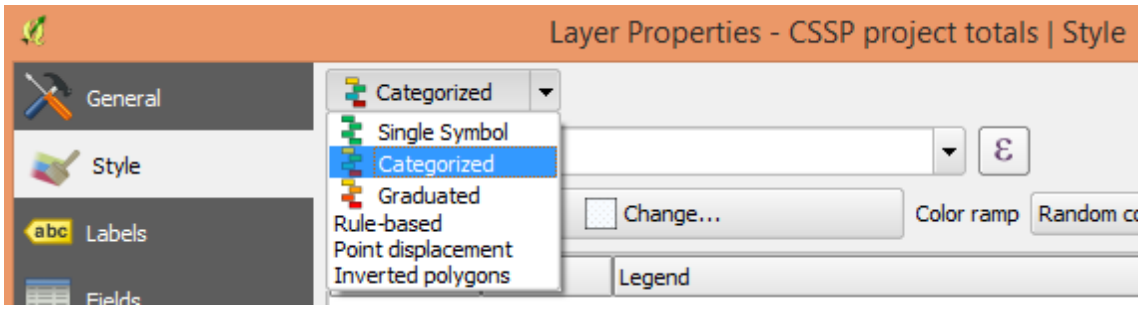
	by__3	CSSP_by__4	CSSP_by__5	CSSP_by__6	CSSP_by__7	CSSP_by__8	CSSP_by__9	PPV HML	total PPV
4	6	NULL	NULL	6	1	1	25	h	25
66	2	NULL	NULL	0	0	2	6	h	6
89	4	NULL	NULL	1	0	0	6	h	6
28	1	NULL	NULL	0	0	0	5	h	5
55	0	NULL	NULL	0	0	2	5	h	5
144	1	NULL	NULL	0	0	2	5	h	5
147	2	NULL	NULL	0	0	0	5	h	5
7	3	NULL	NULL	0	0	1	4	m	4
23	0	NULL	NULL	0	0	4	4	m	4
49	0	NULL	NULL	0	0	3	4	m	4
62	1	NULL	NULL	0	0	2	4	m	4
64	2	NULL	NULL	0	0	0	4	m	4
120	2	NULL	NULL	0	0	0	4	m	4
125	1	NULL	NULL	1	0	0	4	m	4

- *Close the attribute table using the X in the upper right hand corner*

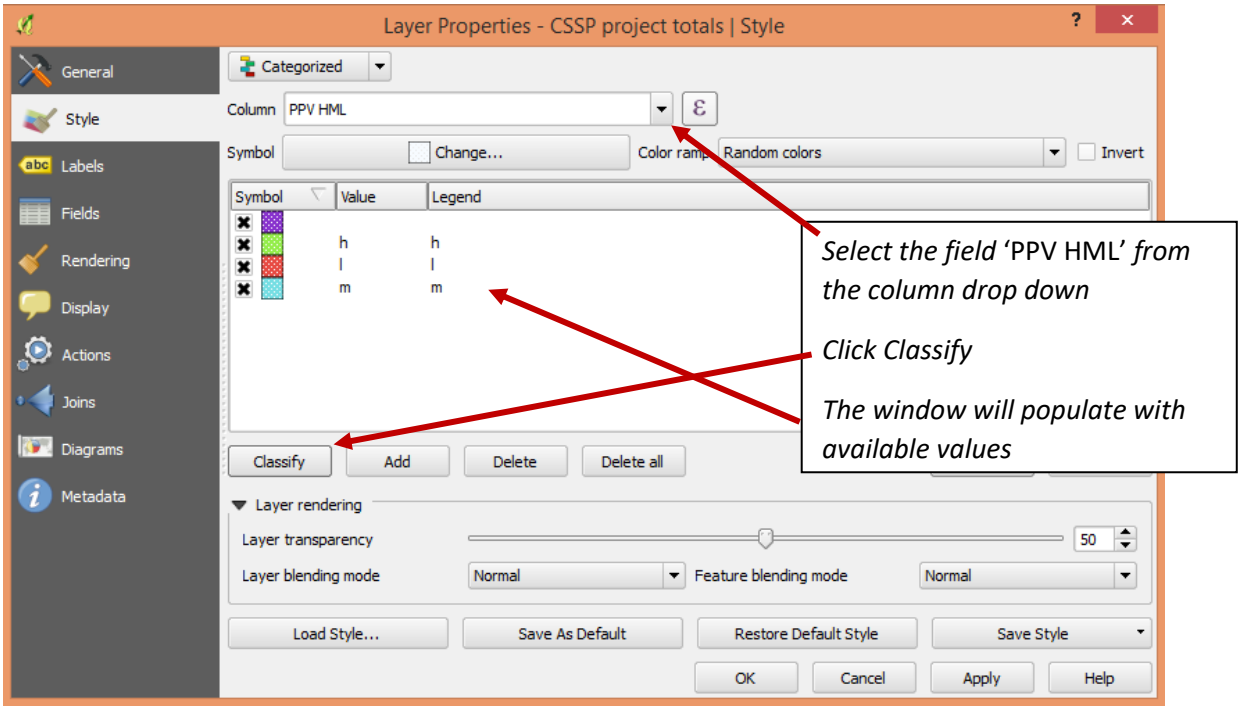
Symbolizing by Attributes

For this exercise we will now combine our knowledge of Attribute tables and how to change the symbology of a layer. Up until this point we have been symbolizing all of our data in a single layer the same way, i.e. all the points are the same shape and colour. This works well for most data, but in some cases we want to be able to distinguish between different attributes within the same layer (e.g. if we have a roads layer that contains highways, sealed roads and dirt tracks we will want to illustrate each of these road types using a different symbol in our map). To achieve this we can use the **Categorized** option for symbology.

- *Open the Properties for the CSSP project totals layer*
- *On the Style tab select Categorized from the Style drop down*



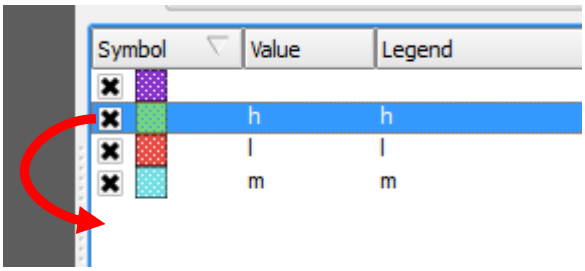
- *From the Column drop down select PPV HML (see image below)*
- *Click Classify*



Once you have the window populated with all the available values for an attribute you can then modify the symbols of each as required.

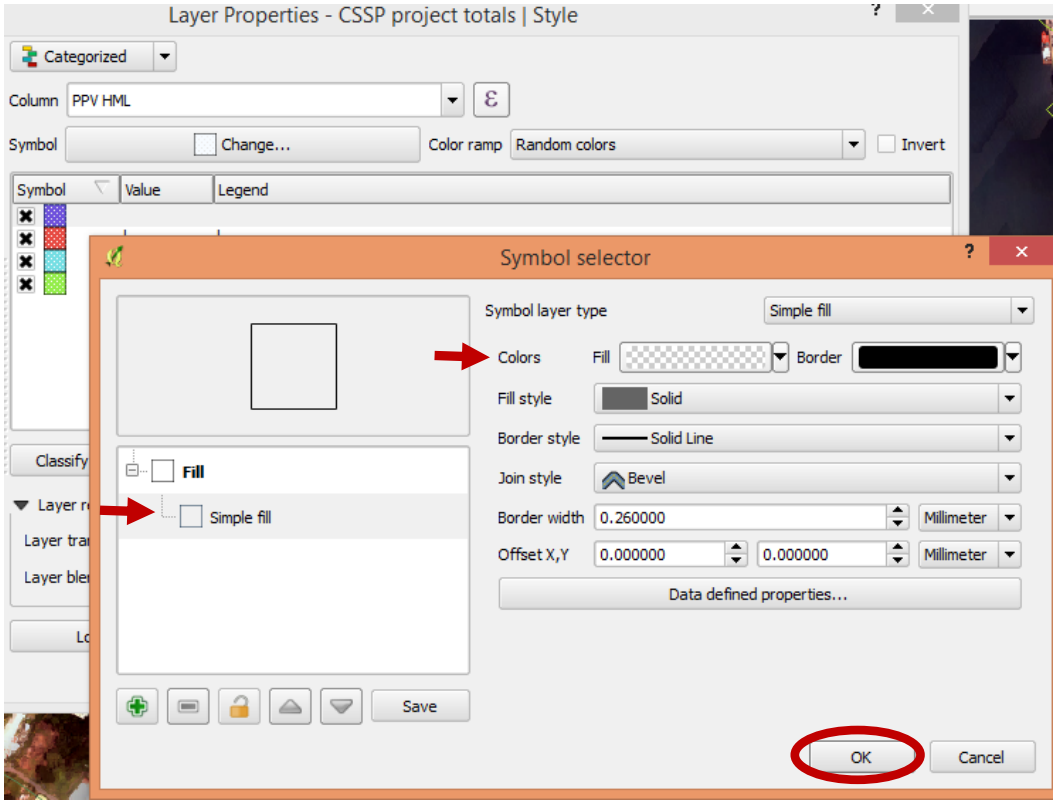
Firstly, rearrange the symbols.

- *Click and hold on the 'h' value*
- *Drag the 'h' value to the bottom of the list*

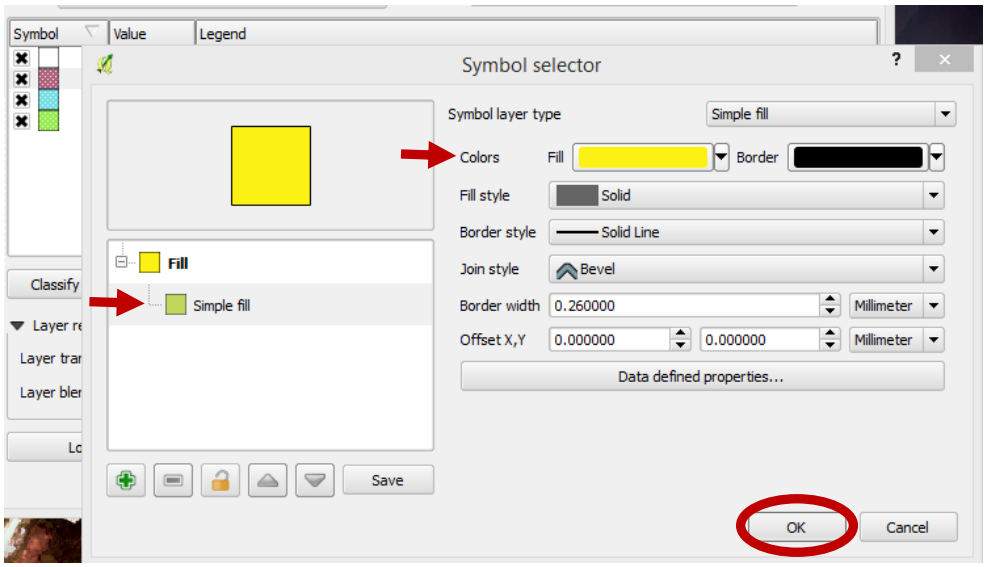


Now we will change the symbol colours and fill.

- *Double click on the symbol at the top of the list with no name*
- *Click on Simple fill*
- *Change the Colour Fill to Transparent fill (using the drop down box)*
- *Click OK*

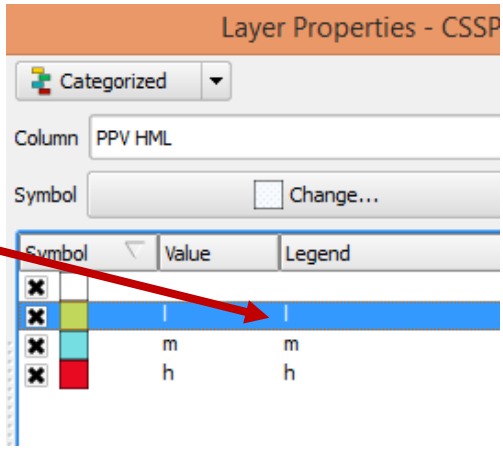


- *Double click on the symbol with 'l'*
- *Click on Simple fill*
- *Change the Colour Fill to yellow (using the drop down box)*
- *Click OK*

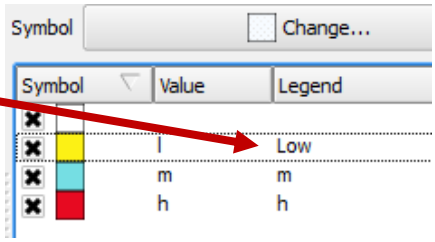


- *Change the Symbol marked 'm' to Blue*
- *Change the Symbol marked 'h' to Red*

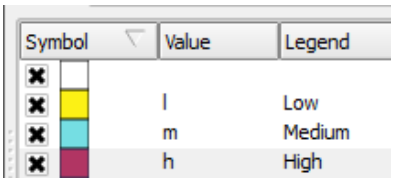
The symbols should now look similar to the image below. Next we will edit the **TABLE OF CONTENTS** label.



- *Double click on the 'l' in the legend column, you can now edit this box*



- *Type in 'Low' and click Apply*



- *Repeat this process changing 'm' to 'Medium' and 'h' to 'High'*
- ***Change the layer transparency to 0%***
- *Click Apply*
- *Click OK*

- *Use the Zoom full tool*  *to see the whole map*

In the **TABLE OF CONTENTS** you will now see that under the CSSP project totals layer there are the 4 categories we have just made and they are labelled 'Low', 'Medium' and 'High', with the top one left blank.

Selecting Features (optional extra)

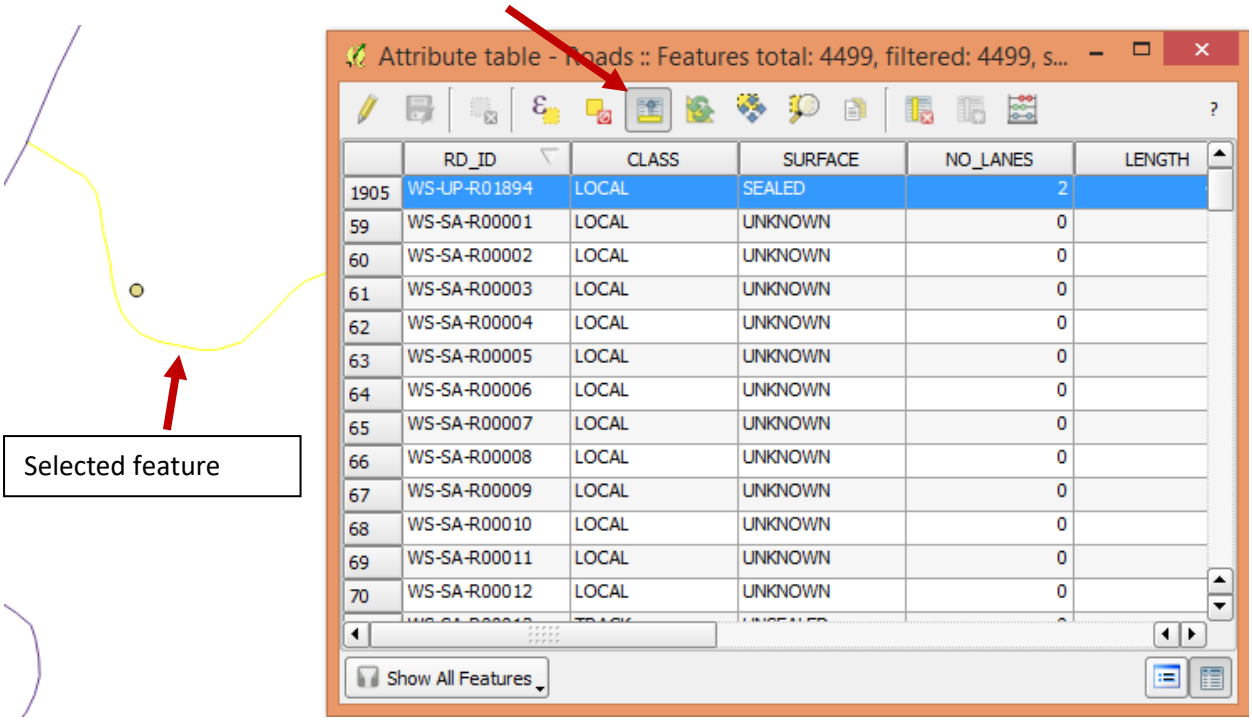
There are 3 different methods that we can use for selecting features in the map, we can (1) select features interactively in the map by clicking on them, (2) select them inside the attribute table, or (3) build queries to select features. The first two are the simplest methods so we will explore them now.

- *Select the road layer in the* **TABLE OF CONTENTS**
- *Select the Select Feature by Area or Single click tool*

- *Click on one of the features (i.e. roads) in the map (it should highlight the road in yellow)*
- *Open the Attribute table for the road layer*

The record for the selected feature (road) could be anywhere in the Attribute table so we will promote it to the top so that you don't have to go looking for it.

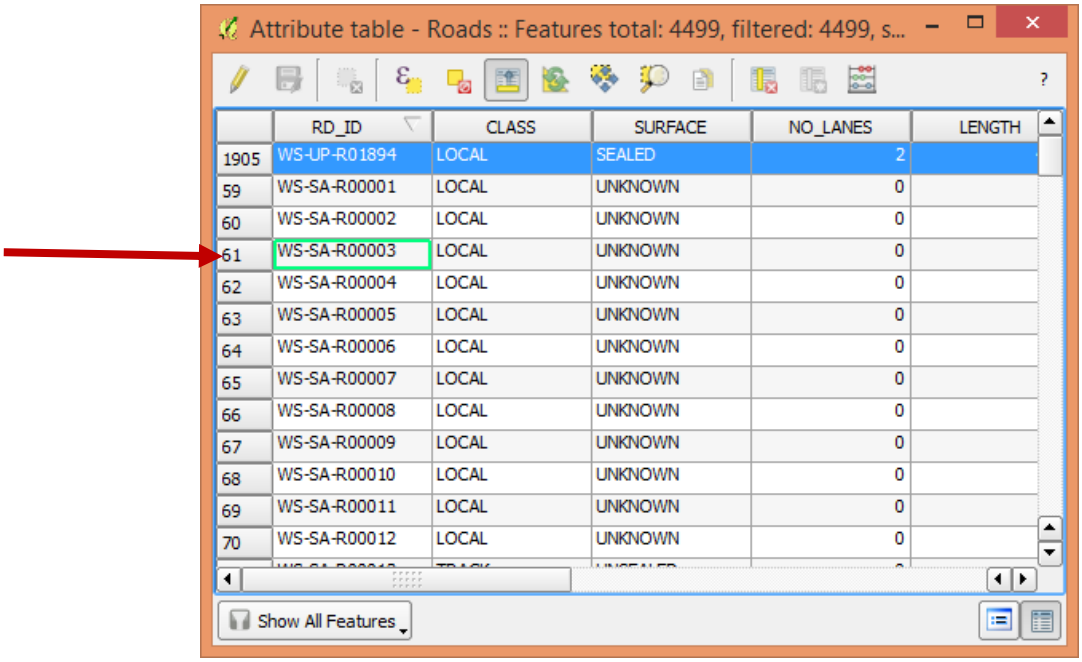
- *In the Attribute table click the Move selection to top button*



	RD_ID	CLASS	SURFACE	NO_LANES	LENGTH
1905	WS-UP-R01894	LOCAL	SEALED	2	
59	WS-SA-R00001	LOCAL	UNKNOWN	0	
60	WS-SA-R00002	LOCAL	UNKNOWN	0	
61	WS-SA-R00003	LOCAL	UNKNOWN	0	
62	WS-SA-R00004	LOCAL	UNKNOWN	0	
63	WS-SA-R00005	LOCAL	UNKNOWN	0	
64	WS-SA-R00006	LOCAL	UNKNOWN	0	
65	WS-SA-R00007	LOCAL	UNKNOWN	0	
66	WS-SA-R00008	LOCAL	UNKNOWN	0	
67	WS-SA-R00009	LOCAL	UNKNOWN	0	
68	WS-SA-R00010	LOCAL	UNKNOWN	0	
69	WS-SA-R00011	LOCAL	UNKNOWN	0	
70	WS-SA-R00012	LOCAL	UNKNOWN	0	

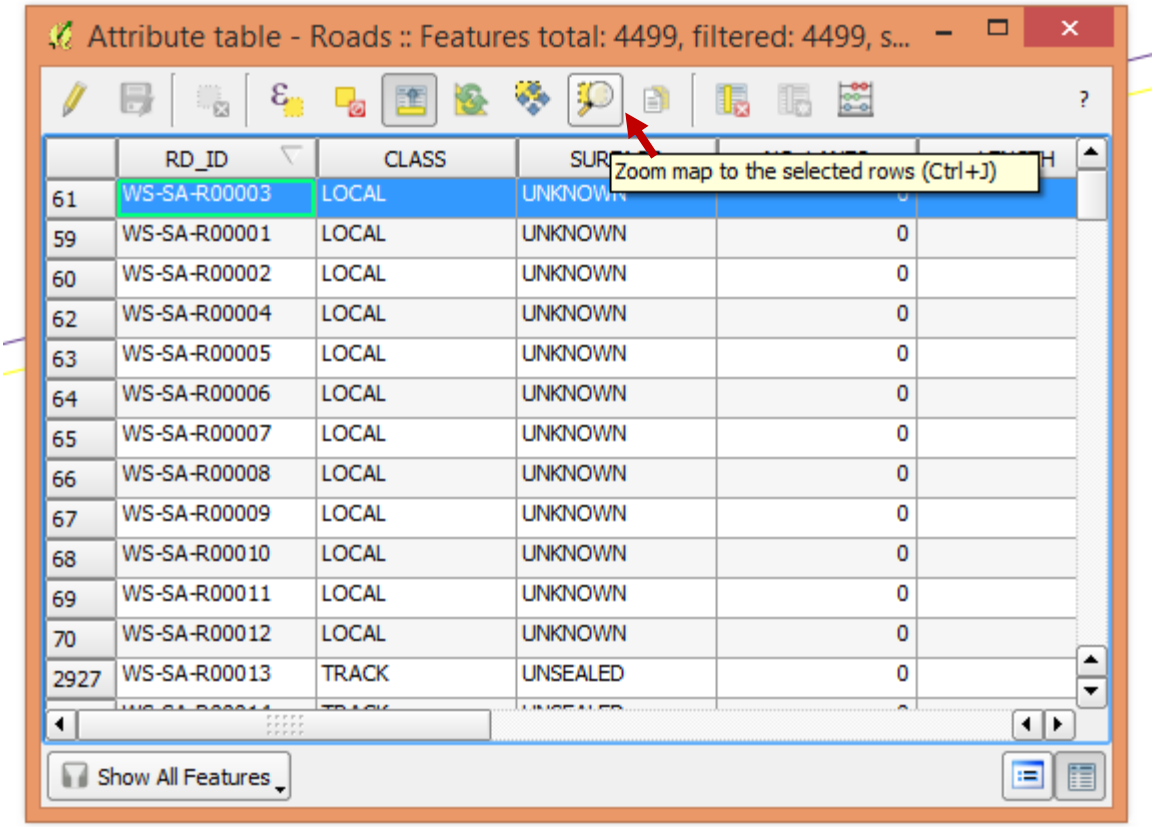
You should now see the selected feature (road) highlighted in the first row of the table. We have selected a feature in the map and then shown this in the table; now we will do the reverse and select a feature in the table and show it on the map.

- *In the Attribute table select a different feature (road) by left clicking the grey area on the left hand side*



This should change the highlighted row to the one you have selected. You should notice that the original feature (road) in the map is no longer selected. The link between the table and the map is always live. Now we need to find this feature on the map.

- *Click the Zoom map to the selected rows button in the Attribute table*

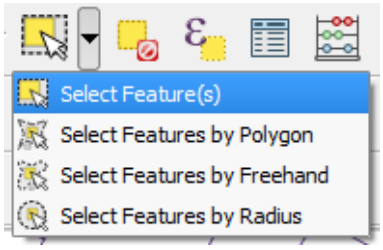


This will take the map to the location of the feature (road) you have just selected.

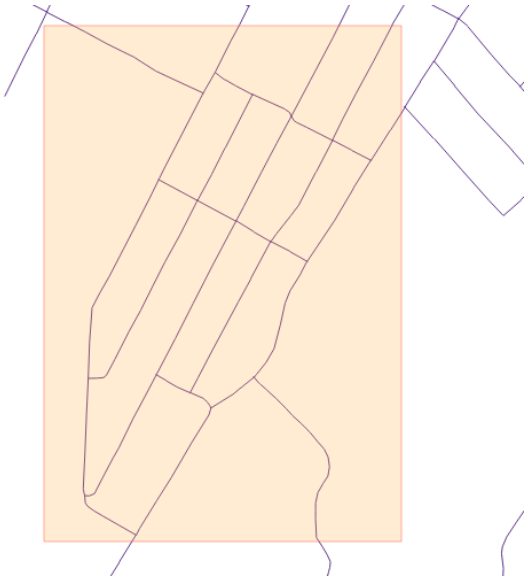
- *Close the Attribute table to view the selected feature*

This exercise has shown you how to select single features and show them in the table and on the map. It is just as easy to select multiple features.

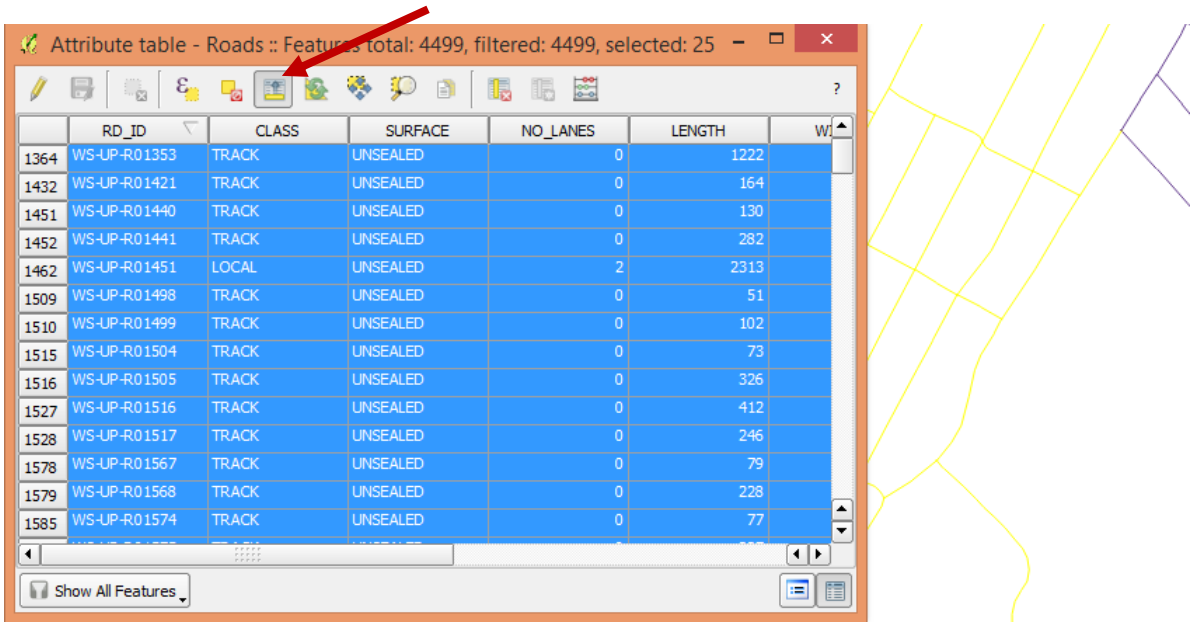
- *Navigate to an area of Apia with lots of roads*
- *Click the Select Features tool drop down to see the options available*



- *Choose Select Feature(s) and draw a box around several roads in the map*



- *Open the Attribute table and click the Move selection to top button to see the result*



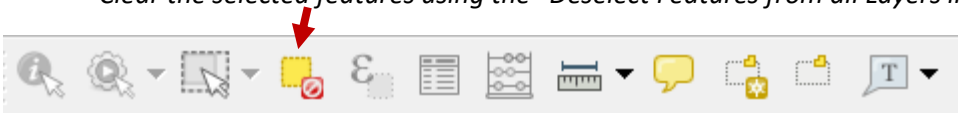
You should have multiple records selected in the Attribute table this time.

You can select multiple records in the table as well, by clicking and dragging from inside the table.

- *Experiment with the other selection tools in the drop down list so you understand how they work*
- *Try opening the Attribute tables in other layers and selecting features in those*

When you have finished selecting features in the map and the Attribute table you can clear any selection in the map by clicking the "Deselect Features from all Layers in the map" button.

- *Clear the selected features using the "Deselect Features from all Layers in the map" button*



Exercise 7 – Creating Shapefiles

The following exercise will take you through how to setup your own shapefiles for data management.

By completing this exercise, you will learn how to perform the following tasks:

- Create new empty shapefiles (vector layers) and populate them with attribute fields

USE THE FOLLOWING LAYER FOR THIS EXERCISE:

- ***Raster Layer***

Apia_Quickbird.tif

Create New Shapefiles

Shapefiles are the most commonly used file format for creating and editing data within GIS software, including QGIS. You can transfer shapefiles to and from different GIS software packages without having to do any kind of data conversion. We will now create a new shapefile using a raster layer.

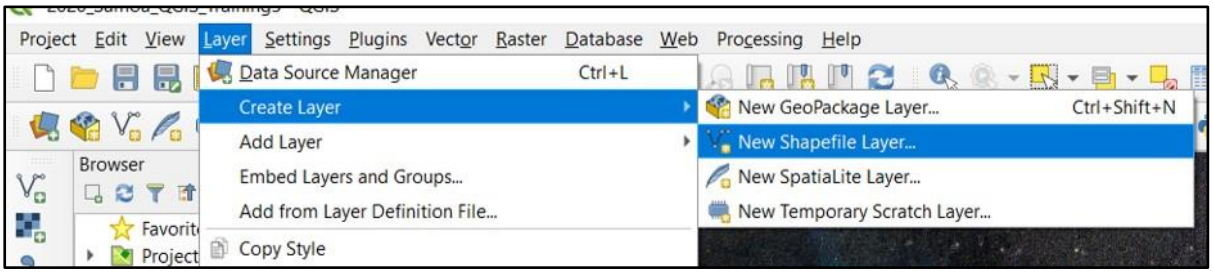
- *Turn off all the layers*
- *Turn on the Apia_Quickbird.tif layer*

We are going to use this raster layer as the base to capture all of our information or data.

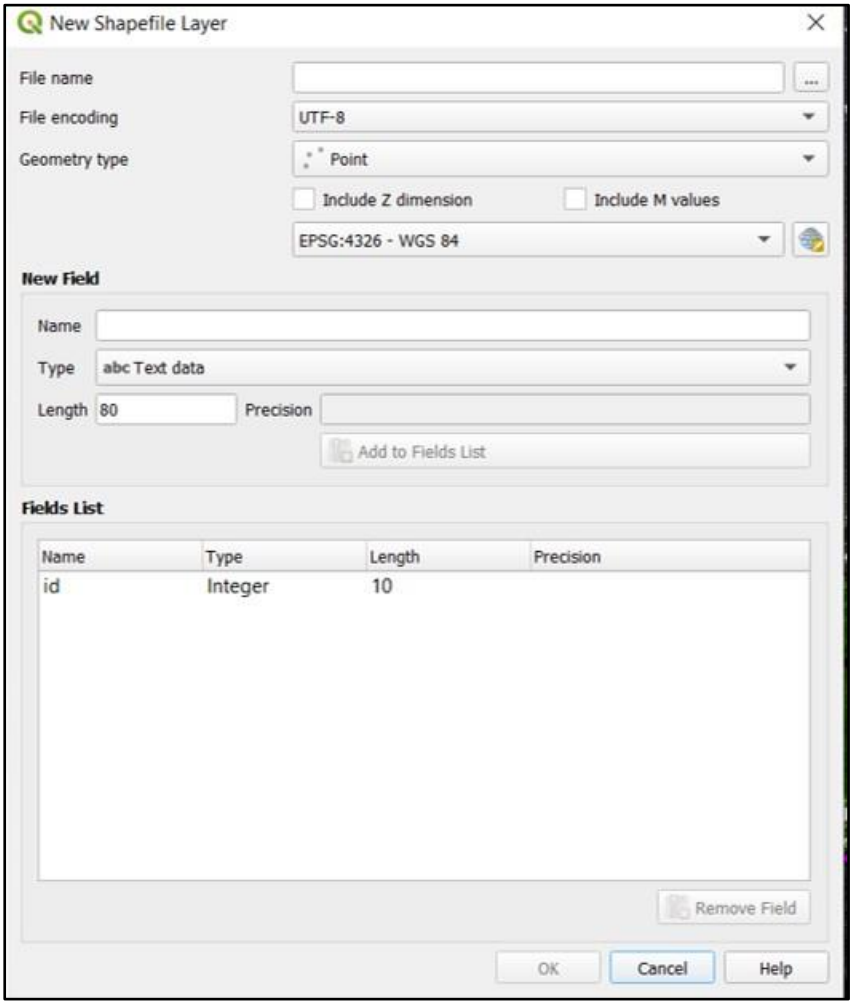
- *Zoom your map into Apia city centre (use the image below as a guide)*

Now that we have zoomed in on the area we are interested in we can start to create some empty shapefiles (vector layers).

- *Select Create Layer from the Layer menu, and then the New Shapefile Layer tool.*

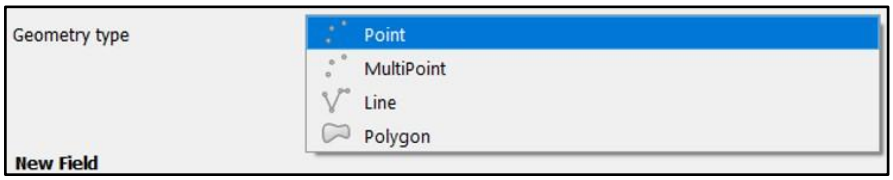


This will launch the dialog box below, for creating a new empty shapefile (vector layer).



We will break down each part of this dialog box so you can understand how to setup your first shapefile.

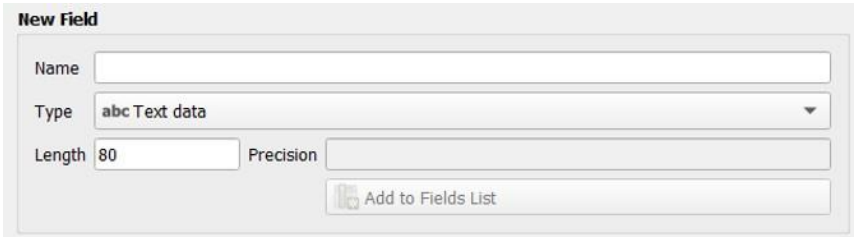
- File name – this is the name of the shapefile and location where you would like to store it.
- File encoding – this sets the format of the text for specific language characters such as ~ and accent marks. We will use the default value of UTF-8 in our exercise.
- Geometry Type (Point, Multipoint, Line, Polygon) – this determines the type of geometry for the data that you want to capture. Once you create the layer this part cannot be changed. Including a Z dimension allows you to store three-dimensional data (such as elevation) and M values allow for attributes to be stored with the vertex of the feature. We will not use either of these for now.



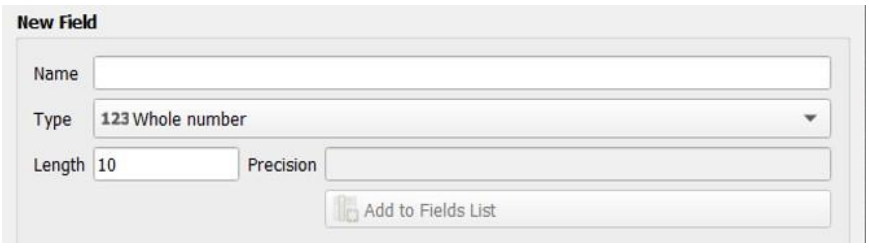
- Coordinate System (Specify CRS) – This allows you to specify the coordinate system that you want to use for your shapefile. You should choose the same coordinate system as used for the satellite image, which also matches the coordinate system for your region (today we will use the default coordinate system).

- New attribute – This is where we create the fields (columns) in our attribute table, which allows us to capture data for selected features from the image. If you forget to add a field at this stage it is not a big deal, fields can be added to a table at any stage. There are 4 different types of fields that you can create:

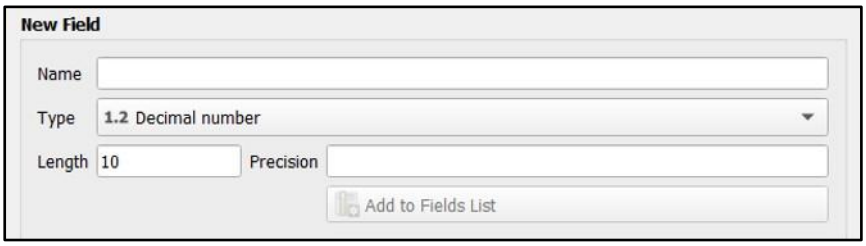
  - Text data – A field to hold text values (e.g. names of things, comments, etc.). The maximum width for this field is 80 characters. When you create a text field you need to set the size (width) of that field. Always allow for a few more characters than you think you will need.



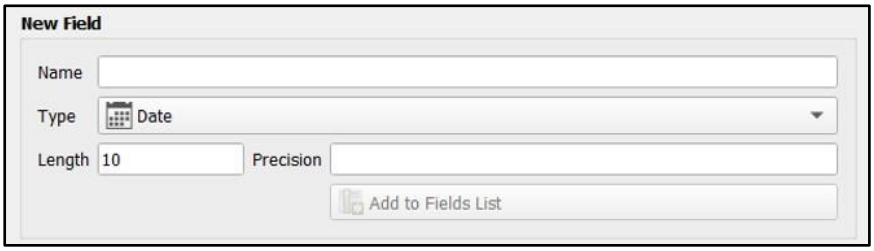
  - Whole number – A field to hold whole numbers (no decimal places). You need to set the width of this field, i.e. the number of digits the field can hold (e.g. if you set the width to 3, the maximum number you can input is 999). Always allow for more digits than you think you will need.



  - Decimal number – A field that can hold numbers that have decimals places. For this field you need to set both the width (number of digits) and the precision (how many decimal places to go to). The number of decimal places counts towards the overall field width (e.g. if you set the width to 7 and the precision to 3, the maximum number you can input is 9999.999).



- Date – A field that can hold dates that use the "/" symbol. For this field you just need to set the width, i.e. the number of characters (e.g. 10/11/14 would be 8 characters wide).



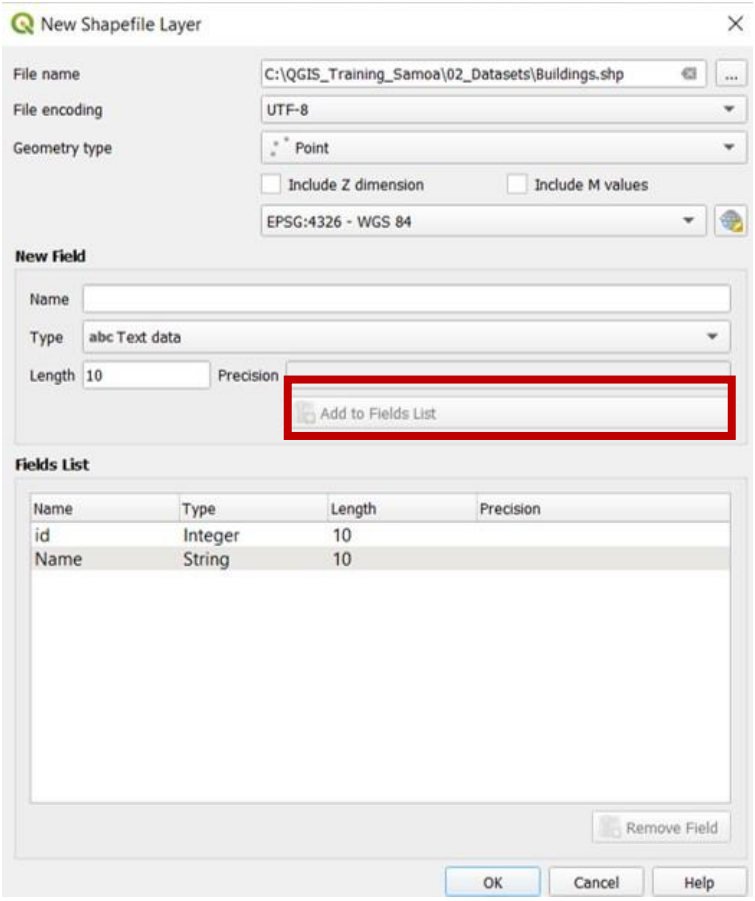
- *Using the above as a guide create a new point shapefile using the following settings*:

Type: *Point*
New Attribute
Name: *Name*
Type: *Text data*
Width: *50*

- *Click the Add to attributes list button to add the new attribute (see dialog box below).*

By default, a new layer should already have the id field (which you should see in the Attributes list).

- *Click OK and save the shapefile to C:\QGIS_Training_Samoa\02_Datasets\Buildings.shp*



Your new shapefile layer should be automatically added into the map and appear in the **TABLE OF CONTENTS**.

Creating New Line and Polygon Shapefile Layers (optional extra)

- *Repeat the process used to make a new point shapefile to create a new line shapefile layer with the following settings:*

Type: *Line*

New Attribute

Name: *Name*
Type: *Text data*
Width: *50*

- *Click the Add to attributes list button to add the new attribute*
- *Now add a second new attribute with the following settings*

New Attribute

Name: *Length*
Type: *Decimal number*
Width: *13*
Precision: *3*

- *Click the Add to attributes list button to add the new attribute*
- *Click OK and save the shapefile to C:\QGIS_Training_Samoa\02_Datasets\Apia_Roads.shp*

- *Lastly, create a polygon shapefile with the following settings:*

Type: *Polygon*
New Attribute
Name: *Name*
Type: *Text data*
Width: *50*

- *Click the Add to attributes list button to add the new attribute*
- *Now add a second new attribute with the following settings*

New Attribute
Name: *Type*
Type: *Text*
Width: *20*

- *Click the Add to attributes list button to add the new attribute*
- *Click OK and save the shapefile to C:\QGIS_Training_Samoa\02_Datasets\Building_footprints.shp*

We now have our new shapefile layers ready to begin editing.

- ***Save the project!***

Exercise 8 – Creating and Editing Points and Polygons

The following exercise will introduce you to the feature editing tools available in QGIS. We will use the zoomed in image from Exercise 6.

By completing this exercise, you will learn how to perform the following task:

- Create and edit new points and polygons

USE THE FOLLOWING LAYERS FOR THIS EXERCISE:

- ***Raster layer*** **-** Apia_Quickbird.tif
- ***Vector layer*** **-** Buildings.shp, Building_footrpints.shp

Editing Toolbar

The Editing toolbar contains all of the tools that we need to create or edit the features in our map. This toolbar is briefly described below.

 Current Edits – This button shows all current edits.

 Toggle Editing – This button will start and stop an editing session for a layer. You can edit as many layers as you like but the layer has to be highlighted in the **TABLE OF CONTENTS** in order to edit the features.

 Save Edits – This will save the changes that you have made (i.e. new features you have created or edits). When you toggle to stop editing you will be asked to save any changes you have made. It is a good idea to save your work as you go.

 Add Feature(s) – This is how you create new features on a map. Select this tool and then click on the map to create new features.

 Add Polygon Feature(s) – Use this tool to move a feature on the map. You select this tool then click and drag the feature on the map to its new location.

 Vertex Tool – Use this tool to move part of a feature. You select the feature first then use this tool to reshape the parts of the line or the polygon that you want to move.

 Simultaneous Attribute Edit – Use this tool to overwrite the attributes for one or more selected features.

 Delete Selected – This tool will delete selected features. You select the feature(s) using the selection tools first.

 Cut Feature – This tool will cut a selected feature.

 Copy Feature – This tool will copy a selected feature.

 Paste Feature – This tool will paste a previously cut or copied feature.

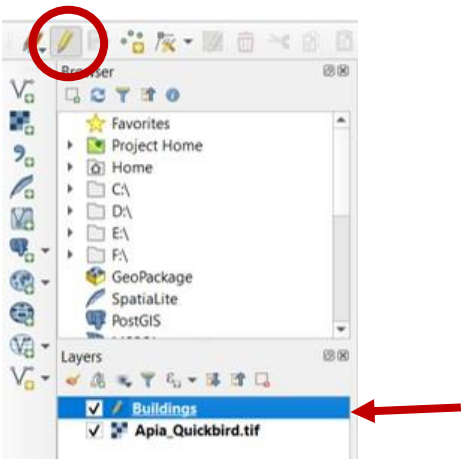
 Undo Edit Feature – This tool will erase the last edit that was made.

 Redo Edit Feature – This tool will readd an edit that was previously undone.

Creating and Editing Points

In this exercise we will create points for the empty point shapefile we created in the previous exercise.

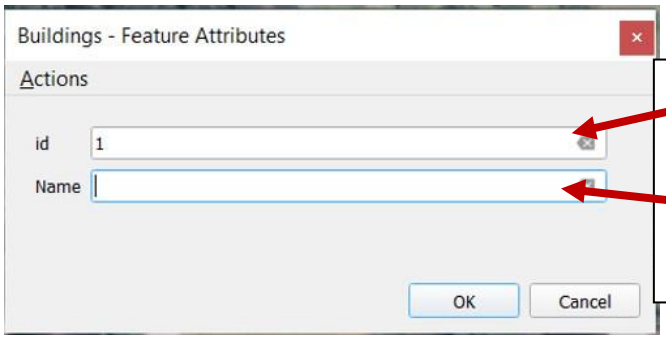
- *Select the Buildings layer in the* **TABLE OF CONTENTS**
- *Click the Toggle Editing button*



This will start an editing session for our point layer. You will see that more editing tools are now available for use.

- *If you are not already zoomed into downtown Apia, zoom into Apia*
- *Select the Add Feature(s) tool* 
- *Left click on the map to add a point (it doesn't matter where)*

An input box will appear similar to the one below. This will allow you to input attribute values for the point you have just created.



- *In the id field write '1'*
- *In the Name field write "Fono Parliament Building"*

- *Click OK to finish creating the point*

We now have our first new point feature in the map. Next we will move its location.

- *Click the Move Feature(s) tool* 
- *Move the cursor over your point*
- *Left click and hold over the point*
- *Move the cursor to the Fono Parliament Building and release the mouse button*

The point should now display on the new location.

To delete a point, follow these steps:

- *Click the Toggle Editing button (if you are not already in an editing session)*
- *Click the Select Single Feature tool*  *(we used it in an earlier exercise)*
- *Click on the point to select it – the point will be highlighted yellow*
- *Click the Delete Selected tool*  *on the Editing toolbar*

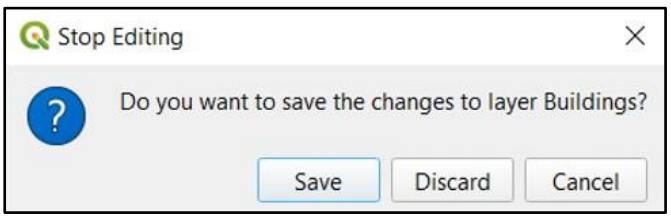
Warning! This will delete the selected feature immediately. You can use the tool to delete more than 1 feature at a time if you like. If you delete the feature by accident you can use *Undo Edit Feature* to restore it.

You now know how to create, move and delete points.

When you have finished editing the new layer you need to end the editing session and save your edits:

- *Click the Toggle Editing button* 

The following dialogue box will appear

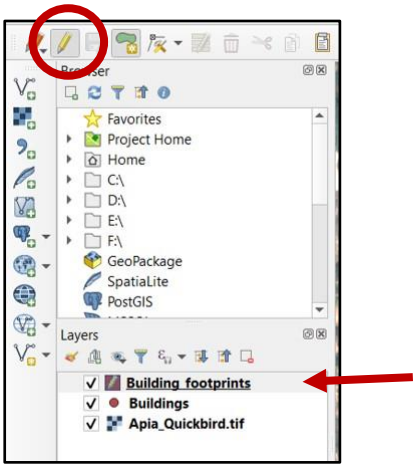


- *Click Save*

Creating and Editing Polygons

In this exercise we will create polygons for the empty polygon shapefile we created in the previous exercise.

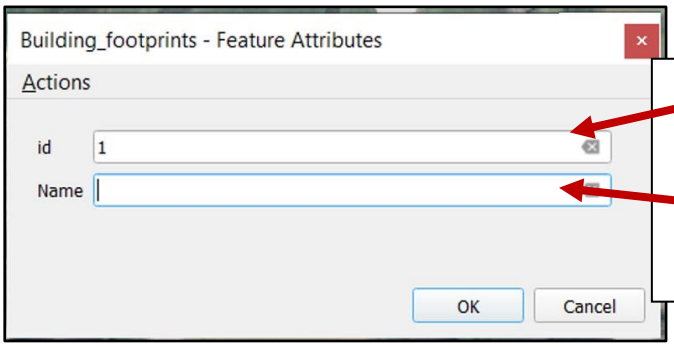
- *Select the Building_footprints layer in the* **TABLE OF CONTENTS**
- *Click the Toggle Editing button*



This will start an editing session for our polygon layer. You will see that more editing tools are now available for use.

- *Select the Add Polygon Feature(s) tool* 
- *Left click on the map to add a vertex and then trace the outline of the Fono Building by left clicking to add vertices at the four corners of the building. Once you have traced the outline of the building's roof, right click to finish the polygon and add attributes.*

An input box will appear similar to the one below. This will allow you to input attribute values for the point you have just created.



- *In the id field write '1'*
- *In the Name field write "Fono Parliament Building"*

- *Click OK to finish creating the polygon*

We now have polygon features in the map. We can edit, move, and delete polygons using the same tools that we used in our point example above.

Exercise 9 – Importing GPS Data into QGIS

The following exercise will introduce you how to import GPS data into QGIS to view point locations.

By completing this exercise, you will learn how to perform the following tasks:

- Add in delimited text data containing GPS coordinates
- Add in GPX files containing waypoints

USE THE FOLLOWING LAYERS FOR THIS EXERCISE:

- ***Delimited Text layer –*** Sample_GPS.csv

Delimited Text Layers

Delimited text layers are commonly used file formats for storing attribute data along side geospatial coordinates. You are able to import this table into QGIS and plot the locations using the coordinates in the file. It is extremely important that you know the coordinate system that the data were collected in or the data will be projected into the wrong coordinate system. We will now edit a sample .csv (comma separated values) file, which is a commonly used delimited text file, to store coordinates collected from the field.

Using Excel or another text editor program, open the sample .csv file:

C:\QGIS_Training_Samoa\02_Datasets\GPS_Data\ Sample_GPS.csv

The example table should look something like this:

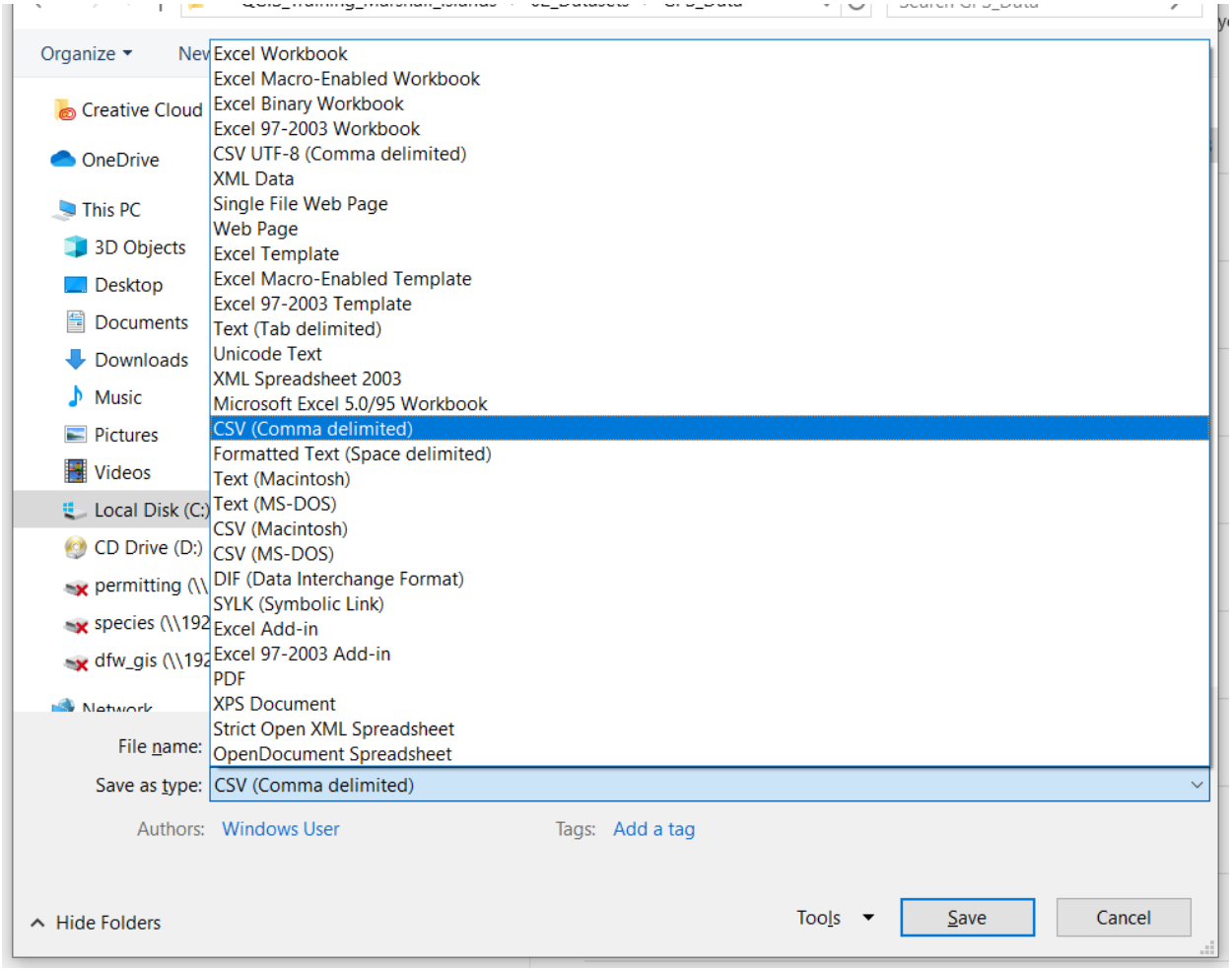
A	B	C	D
ID	X-coord	Y-coord	Notes

- *In the **ID** field, type the name of the point collected in the field. This will help identify the point in case there are any mistakes in data entry.*
- *In the **X-coord** field, type the x coordinate (UTM or longitude) of the waypoint.*
- *In the **Y-coord** field, type the y coordinate (UTM or latitude) of the waypoint.*
- *In the **Notes** field, please add in any description of the location of the point. For example, northwest corner of a building, etc.*

Please use the example below for guidance:

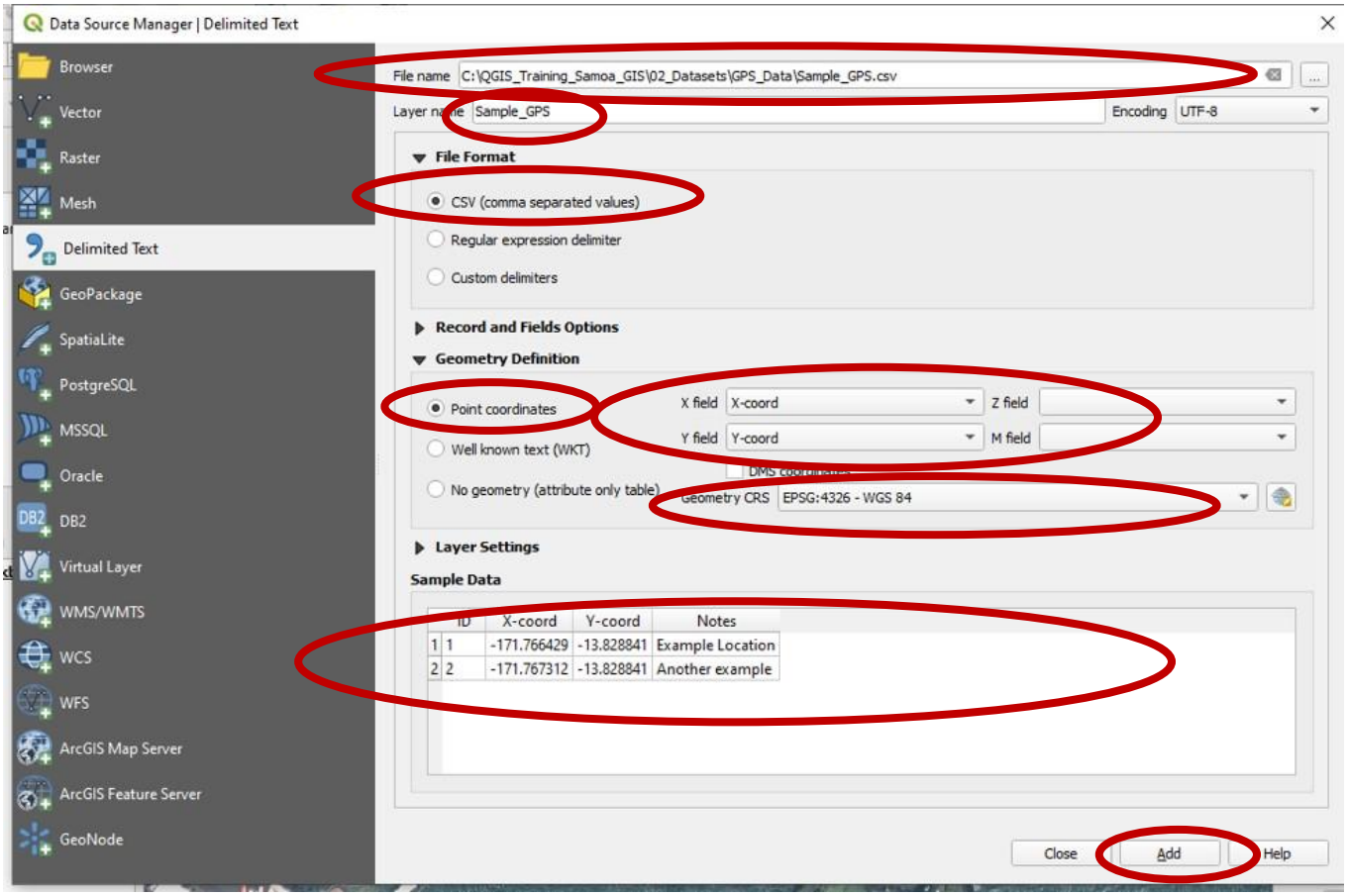
	A	B	C	D	E
1	ID	X-coord	Y-coord	Notes	
2	1	-171.766429	-13.828841	Example Location	
3	2	-171.767312	-13.828841	Another example	
4					
5					

When finished, save the file as a comma delimited text file (.csv). In Excel, this can be done by choosing the **Save As** button and select **CSV (Comma delimited)** option. When saving, Excel will ask you a couple of times if this is the format you would like to use. Please select Yes.



Click the Add Delimited Text Layer button  . A dialog box will open that will look similar to others you have used to add in other data files.

- *For **File Name**: Navigate to C:\QGIS_Training_Samoa\02_Datasets\GPS_Data*\Sample_GPS.csv
- ***Layer name**: you can name the layer whatever best represents the data collected*
- ***File Format:** please select CSV (comma separated values)*
- ***Geometry Definition:***
    - *Select **Point coordinates***
    - ***X field**: the field in the csv file that contains the x coordinates*
    - ***Y field**: the field in the csv file that contains the y coordinates*
    - ***Geometry CRS**: Select the coordinate system that the data were collected in*
- *Click **Add***

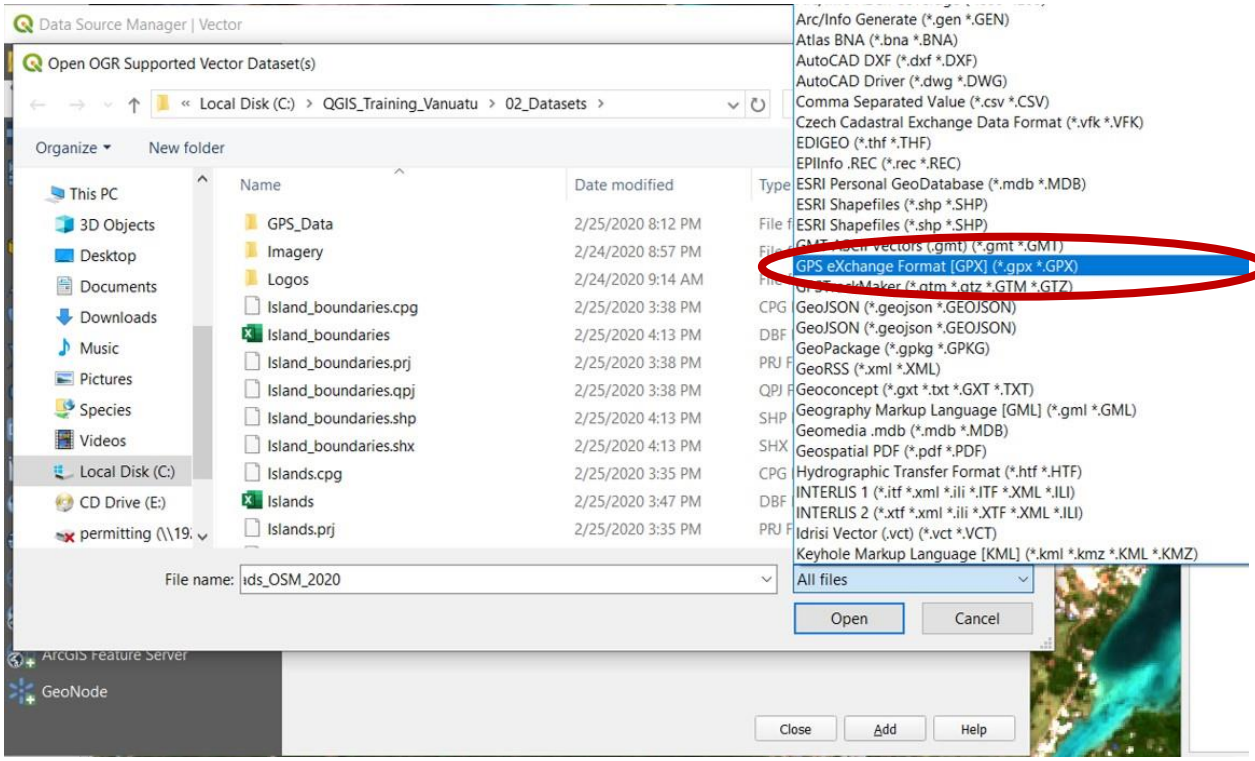


Points should now display in the QGIS interface.

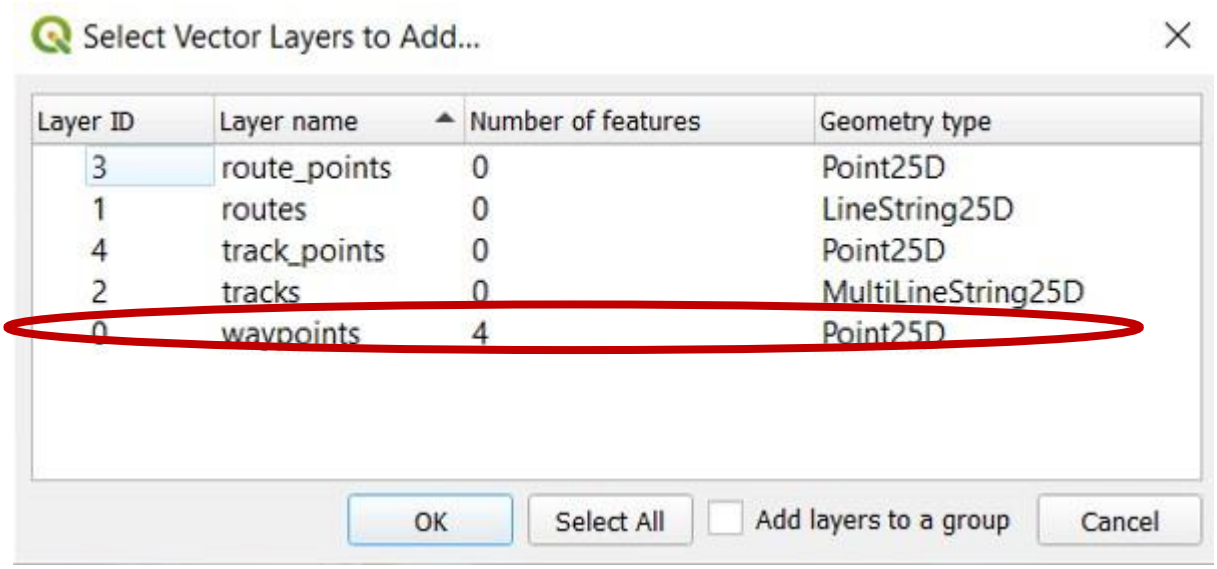
GPX files from Garmin GPS Units

You can also add in waypoints using GPS eXchange Format (.gpx) files. In QGIS, GPX files are added by using the ***Add Vector Layer*** button, similar to how you added in shapefile data in Exercise 2. The main

difference is you can change the file format option to ***GPS eXchange File [GPX]*** to specifically look for GPX files.



Upon adding in the data, you will be prompted to specify which data you would like to add.



Select Waypoints to display point data that you collected in the field and select OK. Your point data will now be loaded into QGIS.

NOTE: You can also drag and drop your GPX files into Google Earth for display.

Additional Resources

Free online guides:

Visit the main QGIS website: http://www.qgis.org/en/site/

Read the user's guide: https://docs.qgis.org/3.4/en/docs/user_manual/

Follow the training manual: https://docs.qgis.org/3.4/en/docs/training_manual/

For the basics of GIS: https://docs.qgis.org/3.4/en/docs/gentle_gis_introduction/

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