



C-QGIS-A+B: QGIS Essentials and Advanced 3.4

An Astun Technology QGIS Course

Code	C-QGIS-A+B
Title	QGIS Essentials and Advanced
Description	Key aspects of using QGIS, Advanced QGIS topics
Required Software	QGIS 3.4
Target Audience	GIS Professionals
Pre-requisites	Basic GIS skills
Duration	3 days
Version	2.0
Updated	07 May 2019
Updated by	Antony Scott
Status	Complete

Introduction

This course is designed to introduce GIS professionals to QGIS, including functionality such as:

- Loading and styling file-based and database data
- Editing data
- Filtering and querying
- Connecting to web services
- Print outputs

It also covers some advanced topics, including:

- Raster processing
- Geo-referencing
- Atlas generation
- Animations

Prerequisites

Delegates should ideally have some experience in a desktop GIS package, for example MapInfo or ArcGIS.

Course Modules: Essentials

- [QGIS-01 v3.0: Getting Started with QGIS](#)
- [QGIS-02 v3.0: Vector Data in QGIS](#)
- [QGIS-03 v3.0: Styling in QGIS](#)

- QGIS-04 v3.0: Select and Filter in QGIS
- QGIS-05 v3.0: Raster Data in QGIS
- QGIS-06 v3.0: QGIS Data Creation and Editing
- QGIS-07 v3.0: QGIS Geo Processing
- QGIS-08 v3.0: PostGIS Data in QGIS
- QGIS-09 v3.0: QGIS Print Layouts
- QGIS-EX01 v3.0: QGIS Essentials - Exercises
- QGIS-P01 v3.0: QGIS Plugins

Course Modules: Advanced

- QGIS-A01: QGIS Atlas v 3.2
- QGIS-A04: QGIS Georeferencing v3.2
- QGIS-A05: QGIS Raster Analysis v 3.2
- QGIS-A06: QGIS Graphical Modeler v3.2
- QGIS-A07: QGIS Time Manager v3.2
- QGIS-A08: QGIS Point Cluster Styling
- QGIS-P01 v3.0: QGIS Plugins

1. Getting Started with QGIS

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1.1. Introduction

QGIS is a mature and fully functional open source desktop Geographic Information System (GIS) package, licensed under the GNU Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows, and Android, and supports numerous vector, raster, and database formats and functionalities.

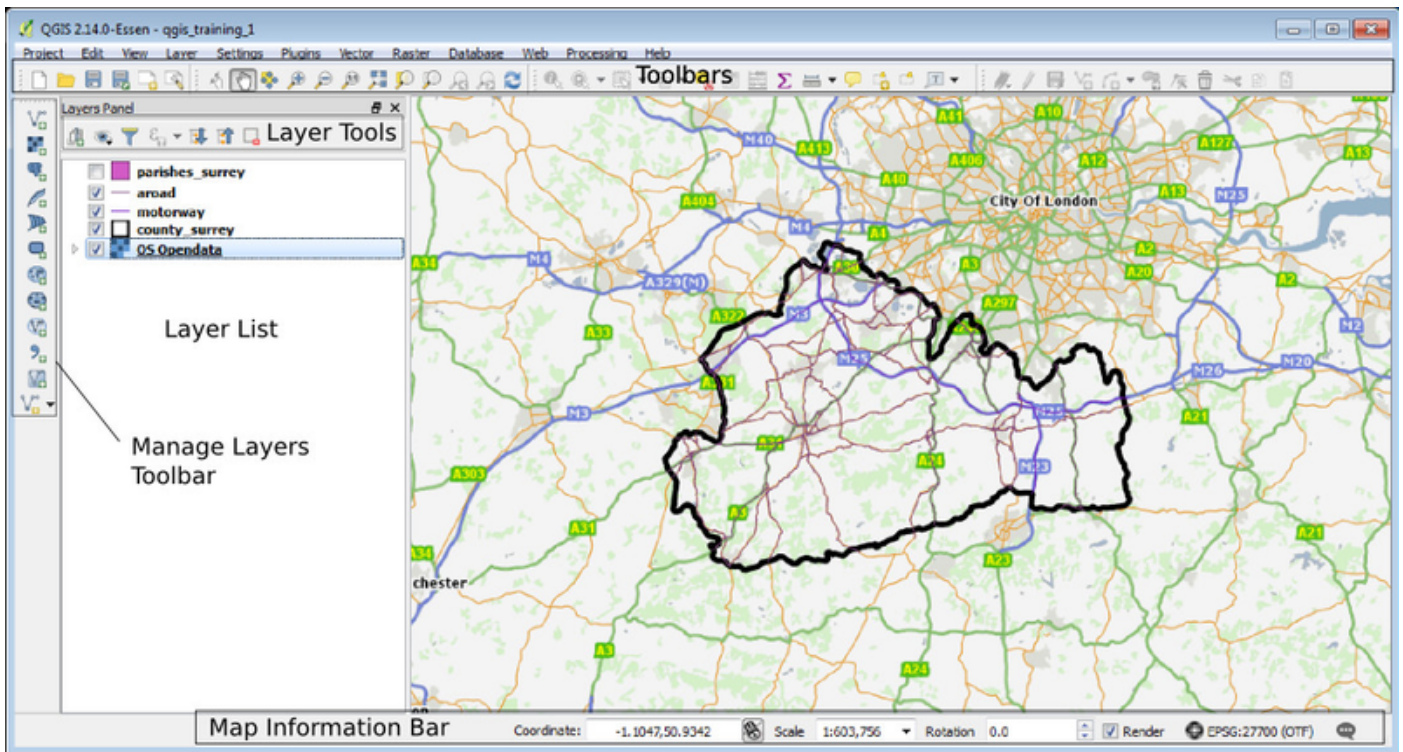
QGIS provides a continuously growing number of capabilities provided by core functions and plugins. You can use it to visualise, manage, edit, analyse data, and compose printable maps. QGIS is a community-driven GIS project - the web site, the source code, the bug tracker and the mailing lists are hosted and partly maintained by OSGeo. The work of QGIS project management is spread across an international team of developers and GIS users who each have a specific area of responsibility.

The main QGIS website is at <http://www.qgis.org/>.

1.2. Menus and Features

QGIS has a configurable interface that can be manipulated and customised according to your preferences -

for example as in the screenshot below. Toolbars and panels can be docked anywhere on the screen or can be floating. For the purposes of this course, it would be helpful if you arranged the QGIS panels to something similar to the image below.



Toolbars and panels can be added and removed by right-clicking in the Toolbar area, or by using the **View** menu .

Tools and Menus

The table below describes the standard menus.

Menu	Purpose	Example tools
<i>Project</i>	Working with projects and printing	<ul style="list-style-type: none"> • Save as... • Project properties • Print composer
<i>Edit</i>	Data editing tools	<ul style="list-style-type: none"> • Add feature • Split features • Rotate point symbols
<i>View</i>	Map navigation and managing toolbars/panels	<ul style="list-style-type: none"> • Zoom • Grid • Toolbars
<i>Layer</i>	Adding and creating new layers as well as viewing layer properties and controls	<ul style="list-style-type: none"> • New shapefile layer • Attributes • Query

<i>Settings</i>	Various configuration settings	<ul style="list-style-type: none"> • Style Manager • Customizations • Snapping options
<i>Plugins</i>	The functionality of QGIS can be extended by bringing in plugins using this menu	<ul style="list-style-type: none"> • Manage and Install plugins
<i>Vector</i>	Tools for working with vector data	
<i>Raster</i>	Tools for working with raster data	
<i>Database</i>	Tools for interfacing with databases including loading data.	<ul style="list-style-type: none"> • DB Manager
<i>Processing</i>	Access processing tasks and model builder	

Most of the tools available in the menu are also available in the toolbars. New menu items (for example **Web**) are sometimes added by plugins.

Layers Panel

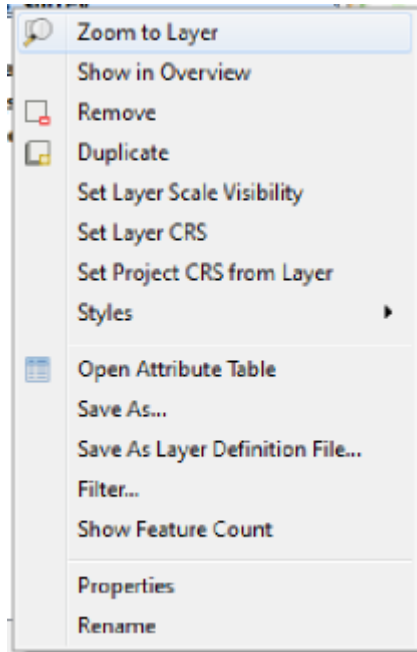
The **Layers Panel** shows a list of map layers that are currently available to display on the map. This might include web services, base maps, raster layers, vector datasets and tables.

Note that:

- Layer order is controlled by default from the Layers Panel; however it can alternatively be controlled by the **Layer Order Panel**. Load this panel and use the **Control rendering order** checkbox to toggle between the configurations.
- Whichever method of layer ordering is used, the layers at the top of the list will appear uppermost on the map, potentially hiding layers lower in the list.
- You can drag and drop layers to move them up and down the list.
- You can create a group to hold a number of layers by right-click in the layer list, or using the Add Group button at the top of the Layers Panel to create a group, then drag layers into the group.
- Click and hold on the group title (or **Right-click > Rename**) on a group title to edit its name.
- The layer list will show legend information, indicating the symbology used in the map.

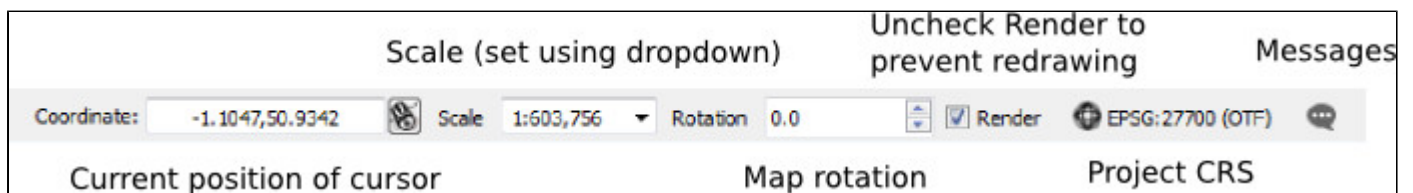


- Right-click on a layer for a menu of options for an individual layer



Information Bar

The information bar below the map window provides information about the current map. It is often useful for changing scale, and checking the current Coordinate Reference System. You can also use it to stop rendering the map following a zoom or pan if you have a large number of layers on the map.



The button to the right of the Coordinate box can be toggled to show the current map extents.

1.3. Projects

On opening QGIS, a new project will always be created (though not saved), and QGIS will also show a list of recently-opened projects in the map window. Note that only one project can be opened at any one time in one QGIS instance, although you can open a second instance of QGIS to open a second project. When you save a project, the current state of the GIS map window and layers panel will be saved, including styling, map layout and other settings.

Save a Project

To save a project, go to **Project > Save**, press **CTRL-S**, or use the **Save** icon in the toolbar. The current project is saved as a .qgs file.

Creating a New Project

To create a new project, go to **Project > New**, press **CTRL-N**, or use the **New** icon in the toolbar. If the current project has not been saved, a prompt message will appear asking you to save it first.

Opening Projects

To open an existing project, go to **Project > Open**, press **CTRL-O**, or use the **Open** icon in the toolbar, then navigate to the file location of the .qgs file. Alternatively, to find a recent project, go to **Project > Open Recent** to see a list.

If you are running QGIS from a standard installation, you can also navigate to the project file in a file explorer, and double click on it.

The QGS Project File

The .qgs file holds all the configuration information about the project including:

- Layers and layer order
- Styles and labelling
- Map windows setup
- Queries
- Joins
- Project properties
- Print Composers

The project file is stored as XML, so it is possible to open it a text or XML editor. However it is not recommended that you make changes here unless you are familiar with the file structure - but if you do, make a backup copy before you start.

Note that source data is not saved in the project file - it remains in its source files and databases, with the .qgs file simply holding references.

Project Properties

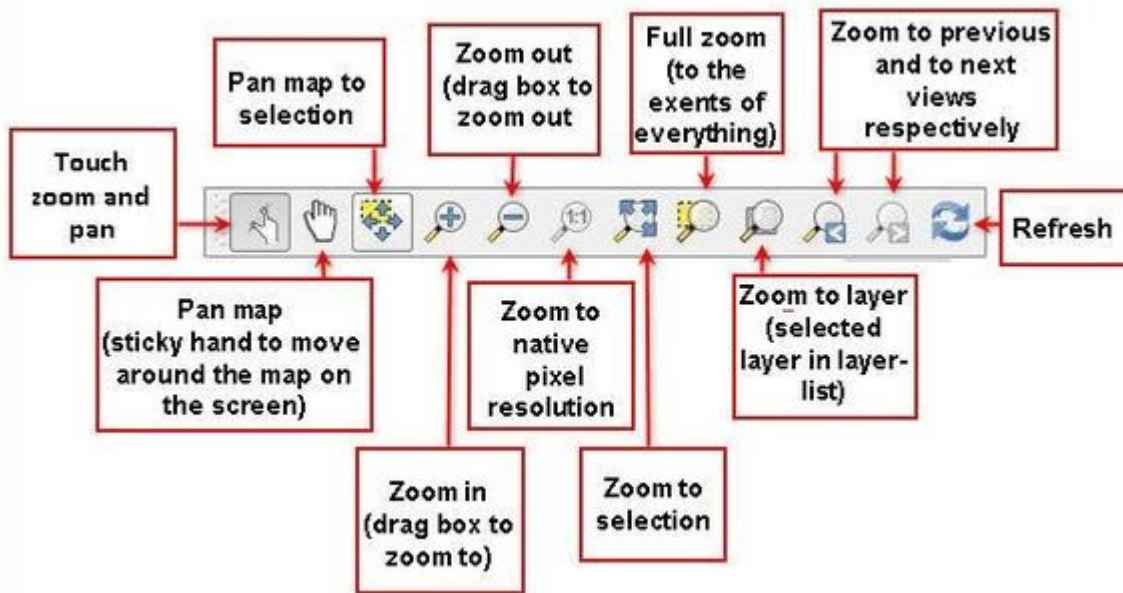
The **Project Properties** dialogue is in the **Project** menu. Here there are a series of controls and settings which apply to the current project only.

Some of the main settings are listed below.

- **General**
 - **Project title:** this will be displayed in the title bar of the QGIS window
 - **Selection color:** the colour of items when they are selected
 - **Background color:** the colour used for the background of the map
 - **Save path:** paths to data sources can be either relative or absolute
 - **Measurement units:** for distance and area
 - **Project scales:** defines the pre-set scales in the information bar
- **CRS**
 - Sets the native Coordinate Reference System for a project, with the ability to allow transformations to be carried out on the fly where multiple CRSs are in use.
- **Default Styles**
 - These can be set to be applied to new layers

1.4. Map Navigation

Map navigation is generally carried out from the **Map Navigation** tool bar. The diagram below shows purpose of the main tools.



The mouse wheel is usually the easiest way of navigating the map; zoom in and out by moving the wheel, and pan by holding the wheel down and dragging.

1.5. Coordinate Reference Systems (CRS)

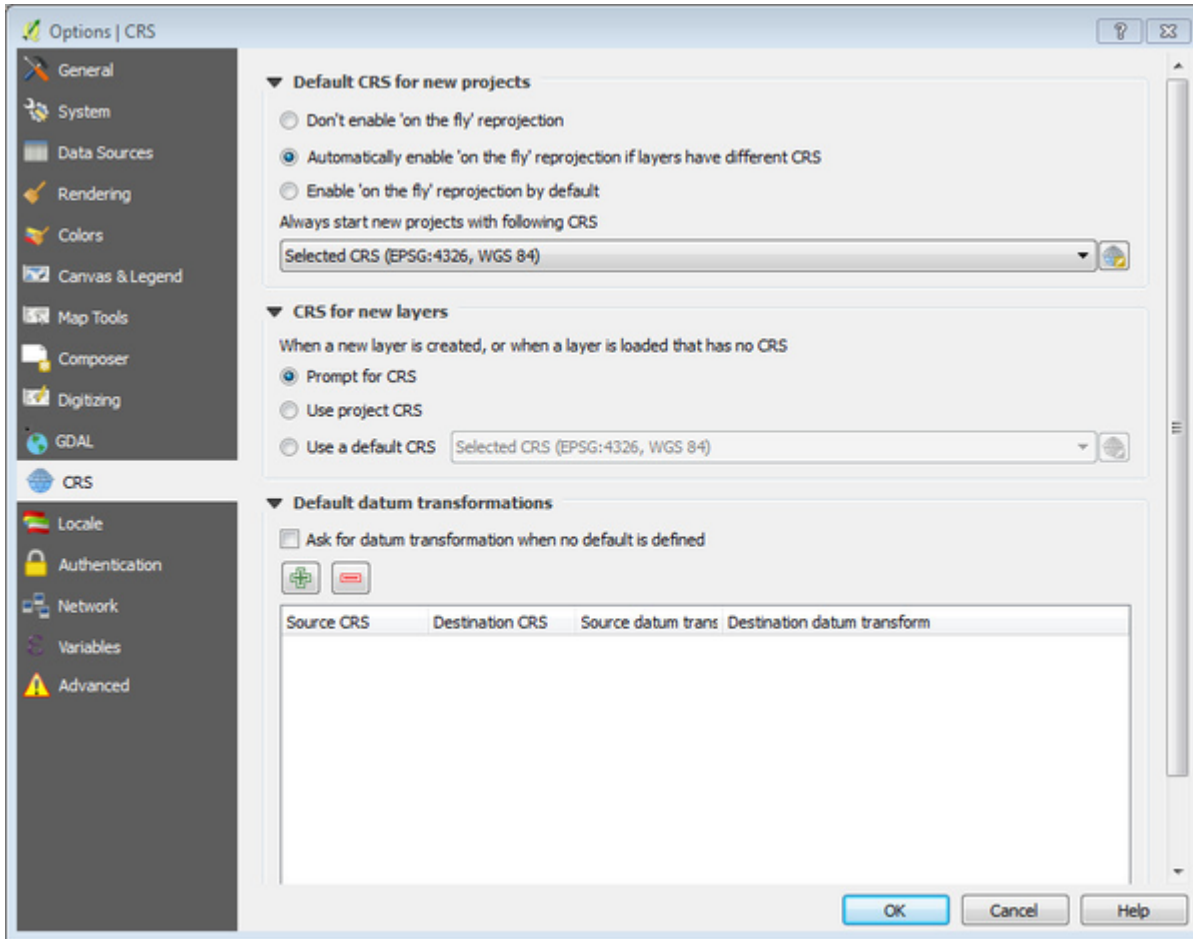
QGIS can use and translate between all major CRSs, following the EPSG numberings. For example:

- EPSG 4326: WGS 84 (Long / Lat)
- EPSG 3857: WGS 84 Pseudo Mercator (used by Google Maps)
- EPSG 27700: OSGB 1936 British National Grid

The CRS used can be set at a number of different points in the system:

1. Default CRS for new projects
2. Default CRS for new layers, and for loading layers with no CRS
3. Defined CRS for a project
4. Defined CRS for a layer

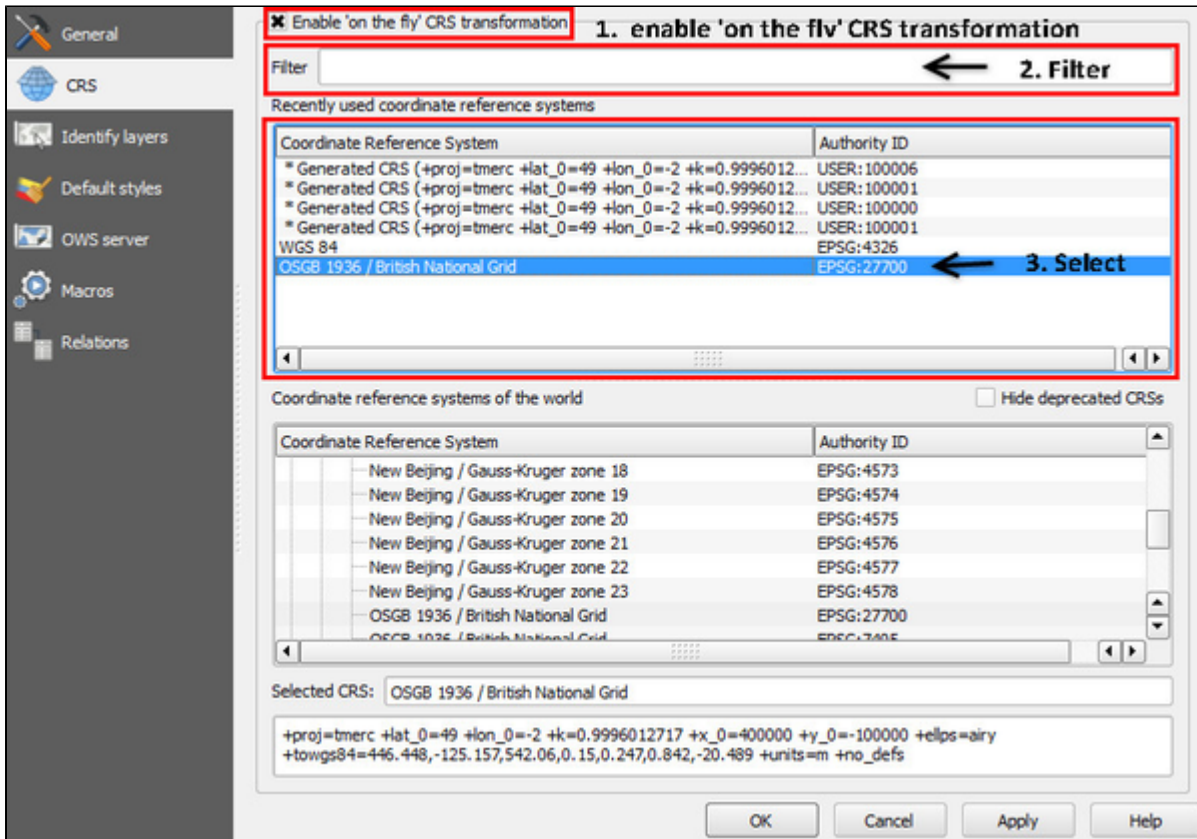
For 1 and 2 above, the default CRS for both projects and new layers can be set in **Settings > Options > CRS:**



For example, you might want to set this to EPSG:27700 British National Grid when first installing QGIS.

For an individual project, the CRS can be defined under **Project > Project Properties**.

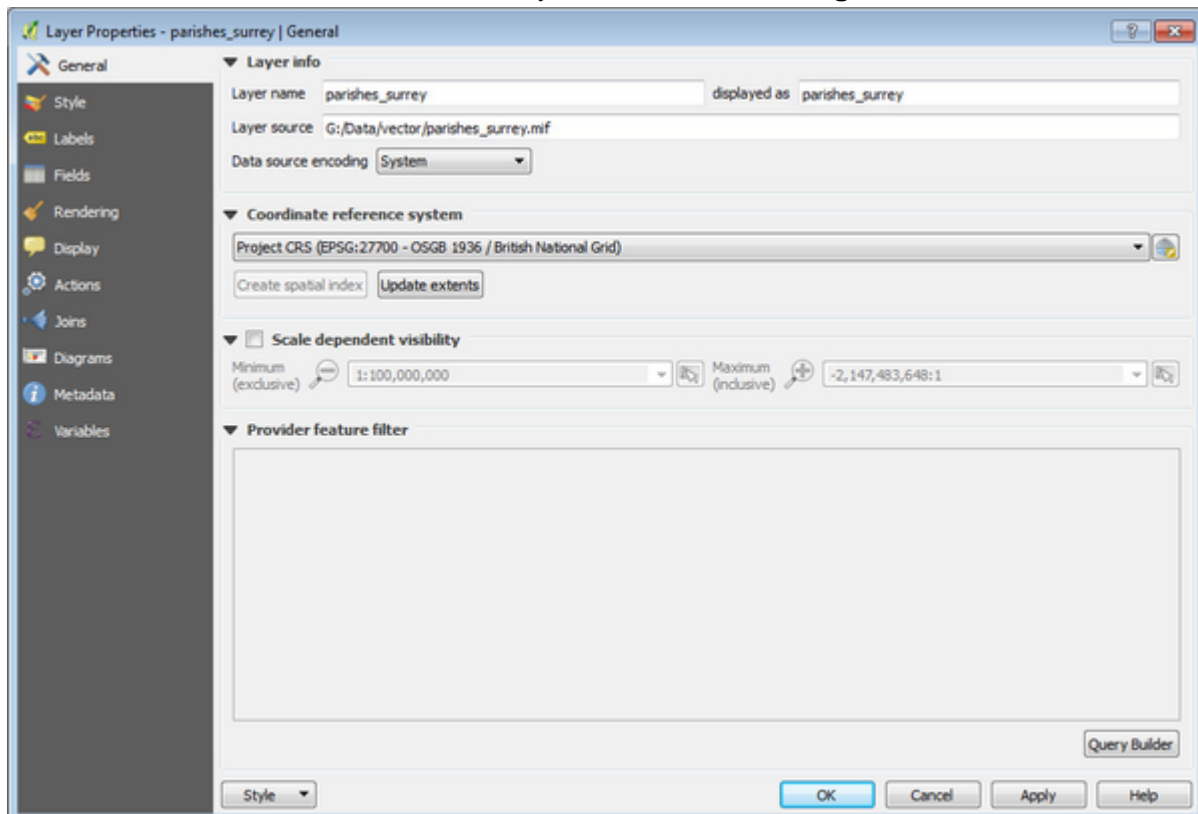
To change the CRS for a project you will first need to check **Enable 'on the fly' transformations** if this is not already set - this enables layers with different CRSs to be correctly displayed together. The layers themselves remain in their native CRS.



1. Select the Coordinate Reference Systems (CRS) tab
2. Filter and select the required CRS.
3. Press **OK**

Defining a CRS for an individual layer is done in the layer properties, if it is incorrect.

1. Select the relevant layer and **Right-click** > **Properties**



2. Select the **General** tab
3. Under Coordinate reference system, select using the dropdown list or the **Select CRS** button to the right
4. Filter and select the correct CRS

1.6. QGIS Browser

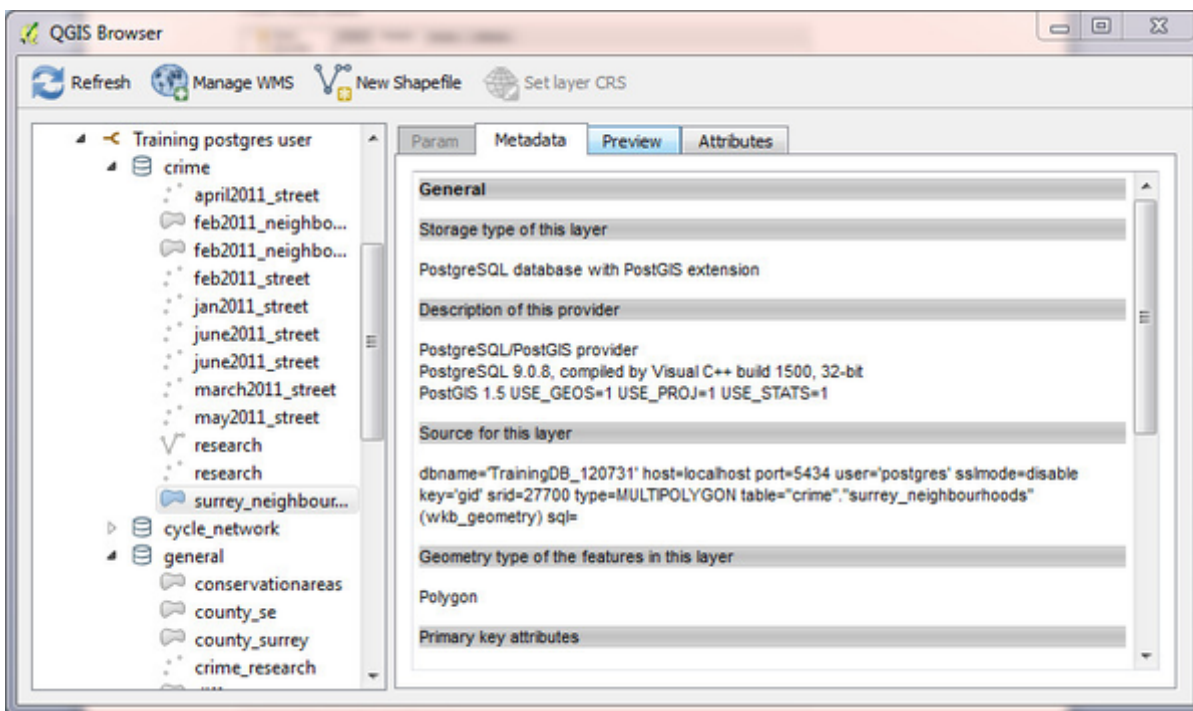
The QGIS Browser is a standalone application which can be used to navigate spatial data in files, databases and web services, and preview the content, including both geometry and attributes. For ESRI users it could be considered an equivalent to ArcCatalog.

The Browser can be used in two modes:

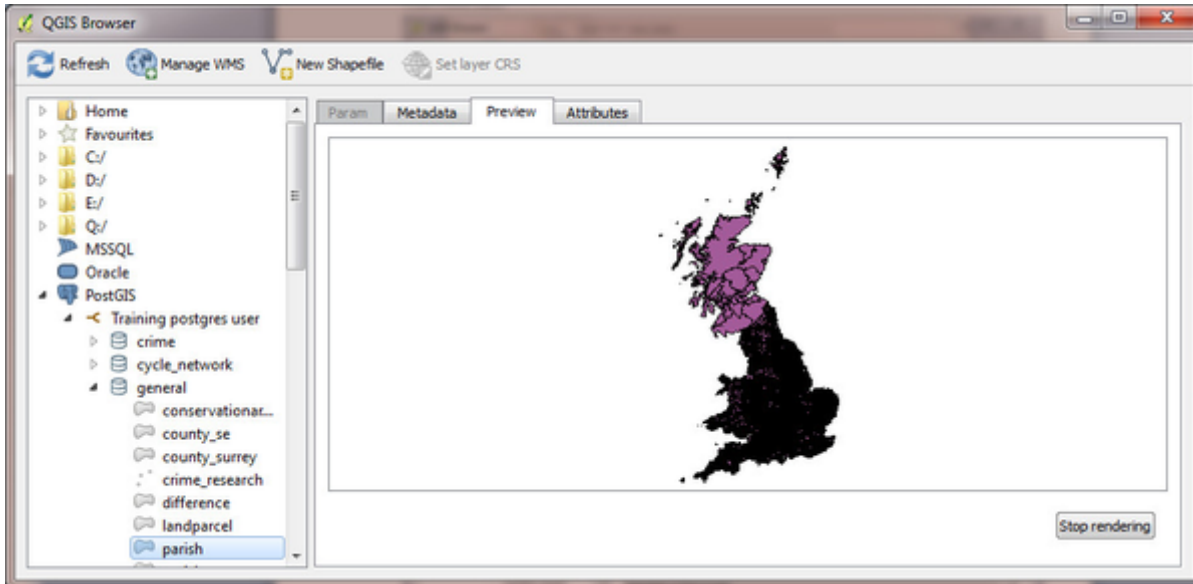
- launch it from the start menu or a shortcut if you have QGIS installed on your machine
Note that if you are running QGIS from the Portable GIS memory stick, you will need to launch the browser from the shortcut on the root of the stick
- bring a more limited version (without preview) into QGIS as a panel, using **View > Panels > Browser**

Below are some examples of the functions in the full Browser.

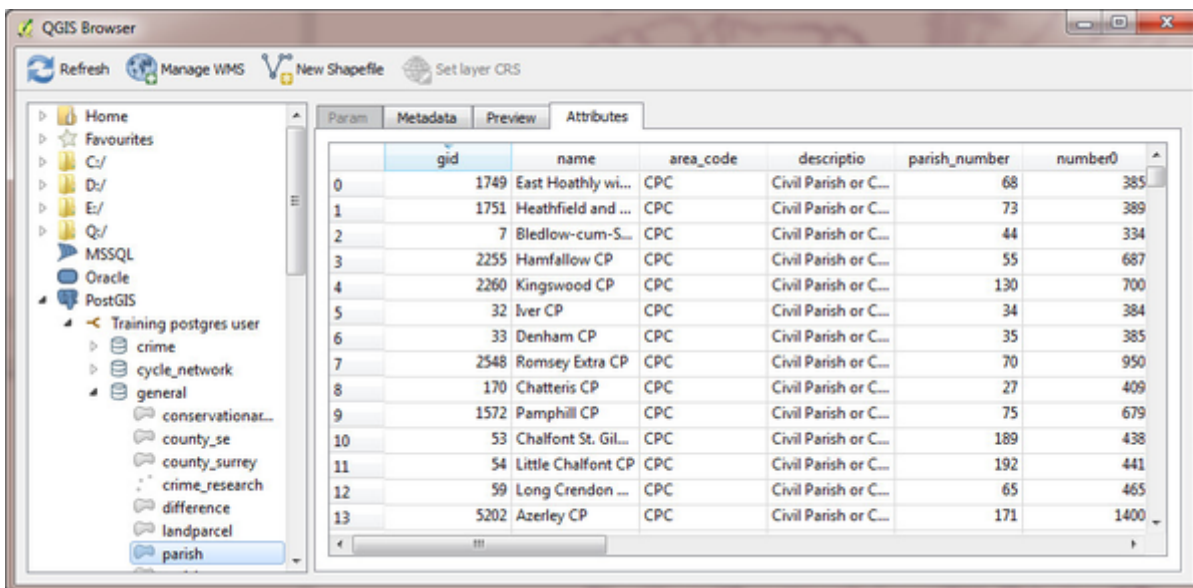
View metadata



Preview the map data



View and re-order attributes



You can also create shapefiles in the browser, and add web services layers.

You can drag files from the Browser to the main QGIS programme, but beyond that there is limited interaction between the two applications.

QGIS Browser Panel

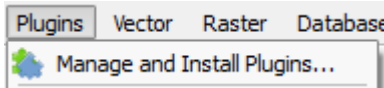
The **Browser Panel** in the main desktop programme is a useful way of interacting with data and bringing it into the map. A dataset in a database file can be dragged with the mouse from the **Browser Panel** to the map. The **Browser Panel** doesn't provide the preview capabilities found in the standalone version.

1.7. Plugins

Additional QGIS functionality is contained in plugins - tools that have been developed for QGIS to extend its scope or address specialist needs. There are two main types of plugins:

- Core plugins: installed by default
- Optional plugins: accessible in the **QGIS Official Plugin Repository**

To install, upgrade, uninstall and control plugins, use **Plugins > Manage and Install Plugins**.



Manage and Install Plugins

The Plugins dialogue can be used to:

- Find and install new plugins
- Activate and deactivate installed plugins
- Upgrade plugins
- Remove plugins

The quickest way of finding a plugin which meets your needs is to use the **Search** dialogue - this will search incrementally in plugin names and descriptions.

All

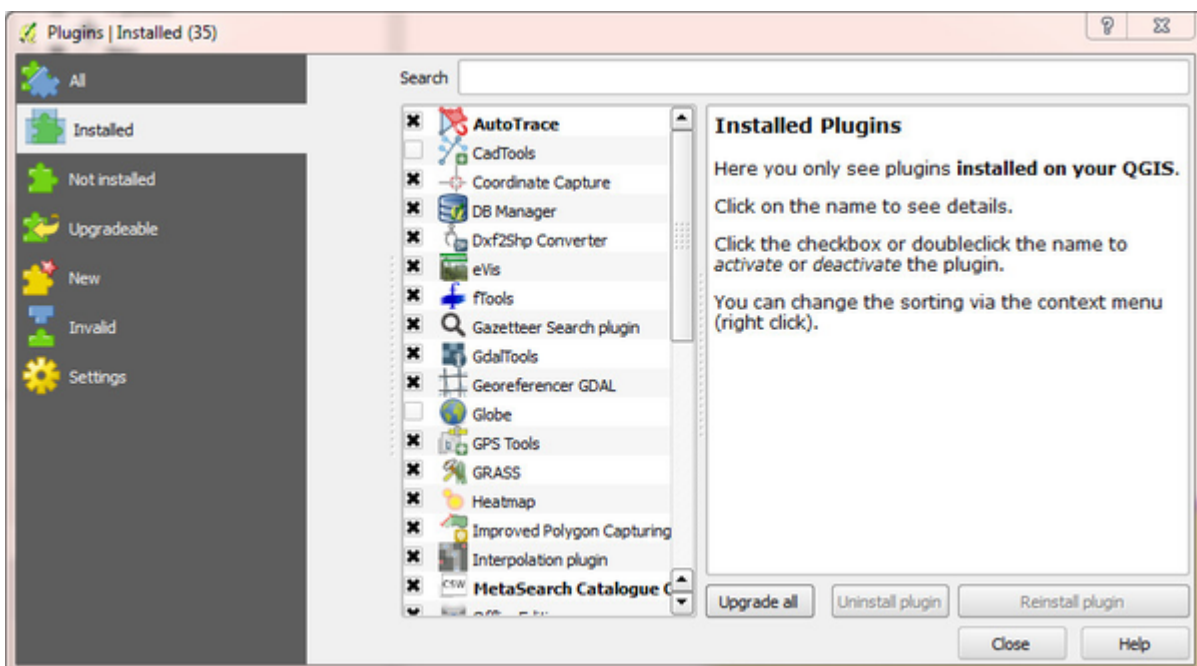
This tab shows all available plugins, including those installed. There will probably be around 500, but the number will change over time, and will vary according to the **Settings** - see below.

- Click on a name to see details.
- You can change the sort order by right-clicking on an plugin name
- To download and install a plugin, click on its name and click **Install plugin**

Installed

This tab shows a list of all plugins currently installed.

- This includes plugins will have been installed by QGIS, and those you have added
- To activate or deactivate a plugin, click its checkbox or double click its name
- Plugins in red are not loaded because there is a problem.
- Upgrade all installed plugins by clicking **Upgrade all**



Not Installed

This tab shows all plugins available in the repository but not installed.

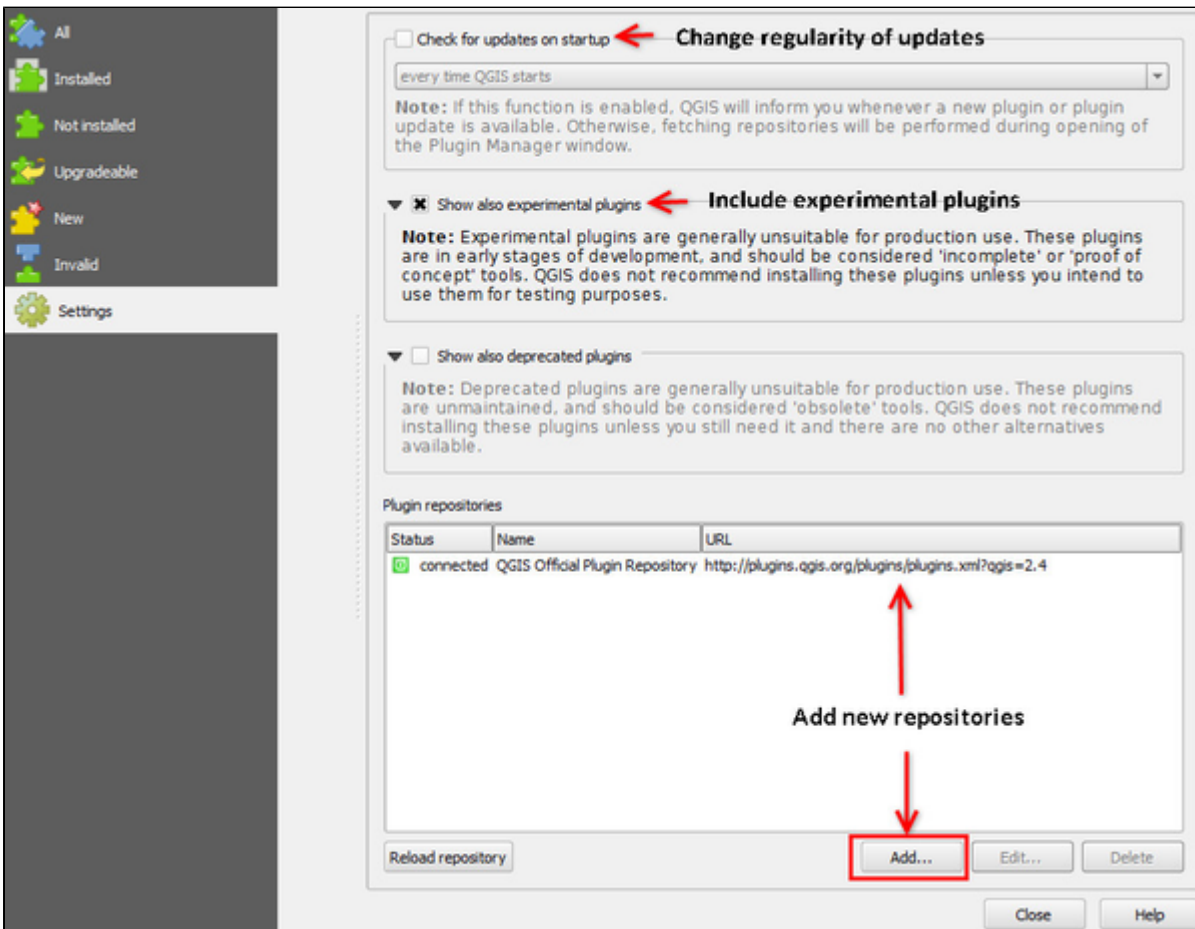
Upgradeable

This tab shows installed plugins where there is an upgrade available.

Settings

In the **Settings** tab, you can:

- Change the frequency of checks for updates
- Include experimental plugins (often useful, but may not be suitable for production use)
- Add additional repositories - there is an official repository, but there are also others



Recommended Plugins

A list of plugins you may find useful is included elsewhere in these notes (see Table of Contents).

2. Vector Data in QGIS

<ul style="list-style-type: none"> 2. Vector Data in QGIS <ul style="list-style-type: none"> 2.1. Introduction 2.2. File-Based Vector Data <ul style="list-style-type: none"> GeoPackage ESRI Shapefile MapInfo Other 2.3. Spreadsheet Data <ul style="list-style-type: none"> Excel Delimited Text Data (e.g. CSV) 2.4. Database Layers 2.5. Web Feature Service (WFS) Layers <ul style="list-style-type: none"> Create a new saved WFS Connection Connect to the WFS 2.6. Navigating Vector Layers <ul style="list-style-type: none"> View Layer Extents Attribute Table Manage the Layer List Group Layers Remove Layers 2.7. Joining Layers 2.8. Exporting Vector Data 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-02</td> </tr> <tr> <td>Title</td> <td>Vector Data in QGIS</td> </tr> <tr> <td>Description</td> <td>Load, join, and export vector data</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>09 Apr 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-02	Title	Vector Data in QGIS	Description	Load, join, and export vector data	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	09 Apr 2018	Updated by	Antony Scott	Status	In progress
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2.1. Introduction

QGIS can open around 50 file-based data formats (using the [OGR](#) library), including ESRI shapefile and MapInfo TAB, and can save around 20 of these. It can also connect to five spatial database sources natively, with others available using ODBC, and to [Web Feature Service \(WFS\)](#) data.

Since QGIS 3.0, the default file format is [OGC GeoPackage](#), and in effect (though not explicitly) for databases the default connection is to [PostgreSQL/PostGIS](#).

Most QGIS functionality is available for all vector data sources, though some can only be used in read-only mode and need to be saved to another format for editing.

2.2. File-Based Vector Data

GeoPackage

GeoPackage is relatively new - it was first published as an OGC standard in 2014, and the current version, 1.1, was published in 2016. It has a .gpkg file extension, and although it can be used for single layers, it is implemented using the SQLite database standard, so can hold multiple layers in a single file as well. It is supported by current versions of most desktop GIS packages, and although it has not been widely used until now, it should be set to take over from shapefile as the default file-based storage and interchange format across applications and platforms. It will hold raster as well as vector data.

To load a GeoPackage layer:



1. Click **Open Data Source Manager**
2. Browse to the .gpkg file you want to open (this will be in .../Data/Vector under root directory for the course)
3. Double-click or drag and drop to open the layer in QGIS

Layer metadata

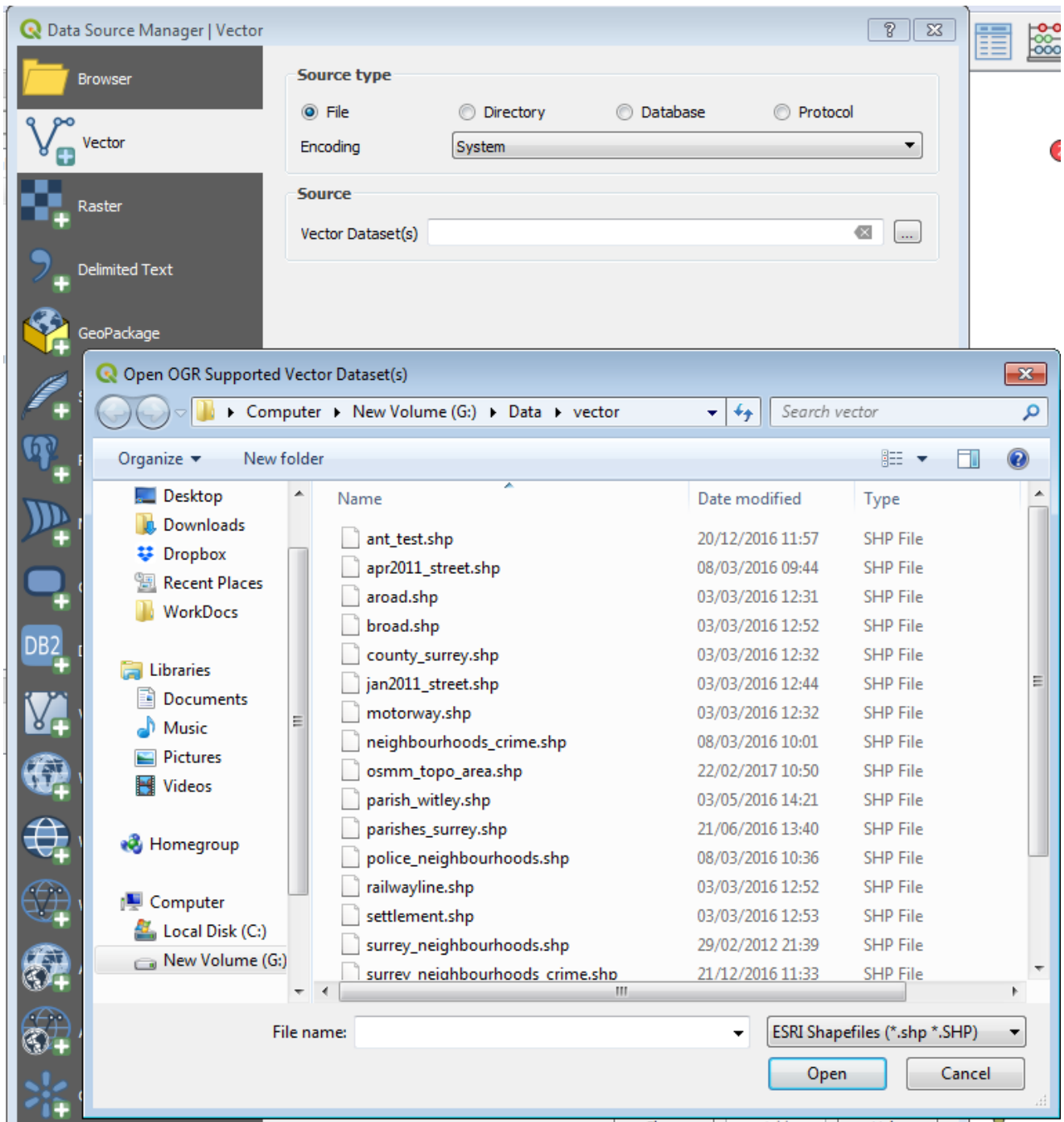
Right-click > Properties on the layer in the browser to see its metadata - CRS, number of features, fields and so on.

ESRI Shapefile

Until version 3.0, shapefile was the native format for QGIS, and it is still used by ESRI products (for example ArcGIS) and on many download sites. Shapefiles comprise four or more individual files on disk - all must be available for the file to open.

To filter directory listings to shapefile (or any file vector format):

1. Click **Open Data Source Manager**
2. Click the **Vector** tab on the left of the dialog



3. Click the three dots (...) to the right of the **Vector Dataset(s)** field, then use the dropdown to the right of the **File name:** field to filter to .shp
4. The list of files will be filtered to .shp only

MapInfo

QGIS can open both MIF and TAB files - these will appear in the browser with other file-based data. Note that MapInfo files can contain multiple geometry types, so QGIS may present a dialog with a choice of geometry types - i.e. line, polygon, point - to load. You can filter to MapInfo files in the same way as described for shapefiles above.

Editing MapInfo files

QGIS can edit .tab but not .mif files - if you need to edit these, you will need to save them to a different format (for example GeoPackage), then save back when you are finished.

Other

The process above can be used to load most vector data from file, including for example GML, GPX and GeoJSON. QGIS can also open ESRI GeoDatabases, though these will be read-only.

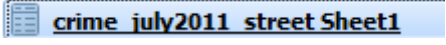
2.3. Spreadsheet Data

QGIS hasn't always worked well with native spreadsheet data (for example from Excel), but this has improved over time, and QGIS 3.0 will now open an Excel file, and for the most part correctly recognise data types (for example string, integer and so on). If the data includes coordinates, creating a geometry column which QGIS can use to represent the data spatially requires an extra step. In some cases, it's better to load the data as CSV rather than directly from Excel - you will need to see what works best with a particular dataset.

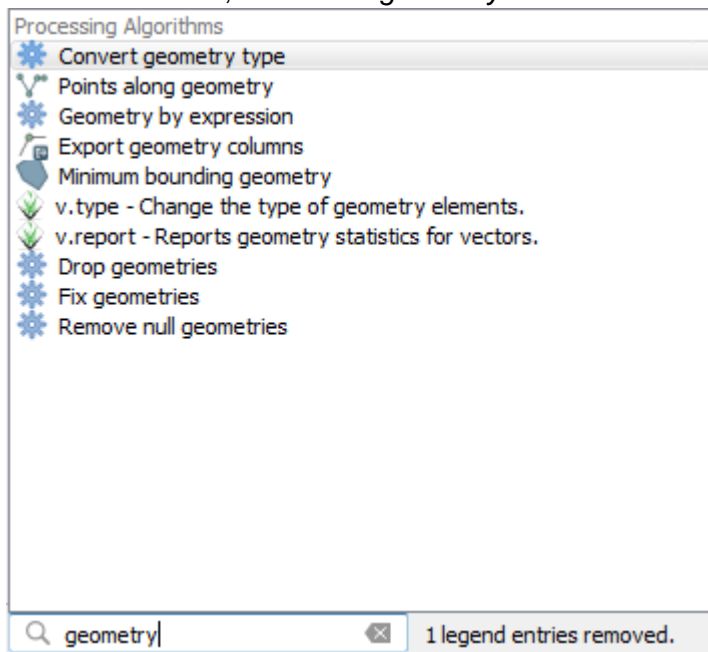
Excel

To load data from Excel:

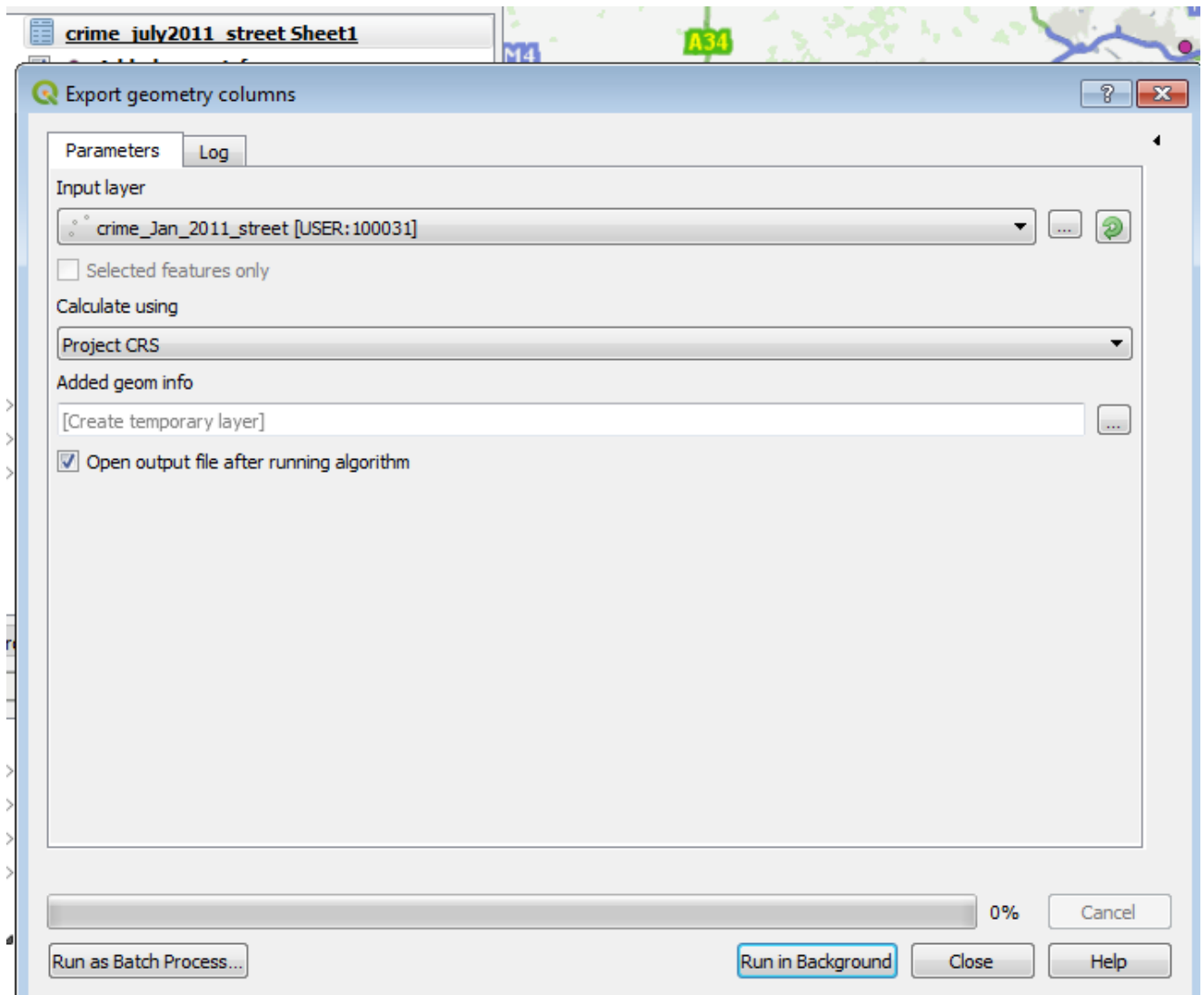
1. Click **Open Data Manager**
2. Browse to the Excel file
3. Double-click to add the layer to QGIS

At this stage, the layer will show in the **Layers** panel as a table , but it won't appear on the map. If the data doesn't contain coordinates, this may be what you want. However if the data represents points, and you have an x and y column, you will need to add a geometry column to the data so that QGIS can add it to the map.

1. Set the **Project CRS** to the CRS of the coordinates in your input data - you need to do this first, as you can't choose the CRS later
2. In the search bar, search for *geometry*



3. Double-click on **Export geometry columns**, and in the dialog, choose the appropriate layer and Project CRS



4. Click **Run in Background**
5. The layer will appear in the **Layers** panel as **Added geom info**, and the points will appear on the map

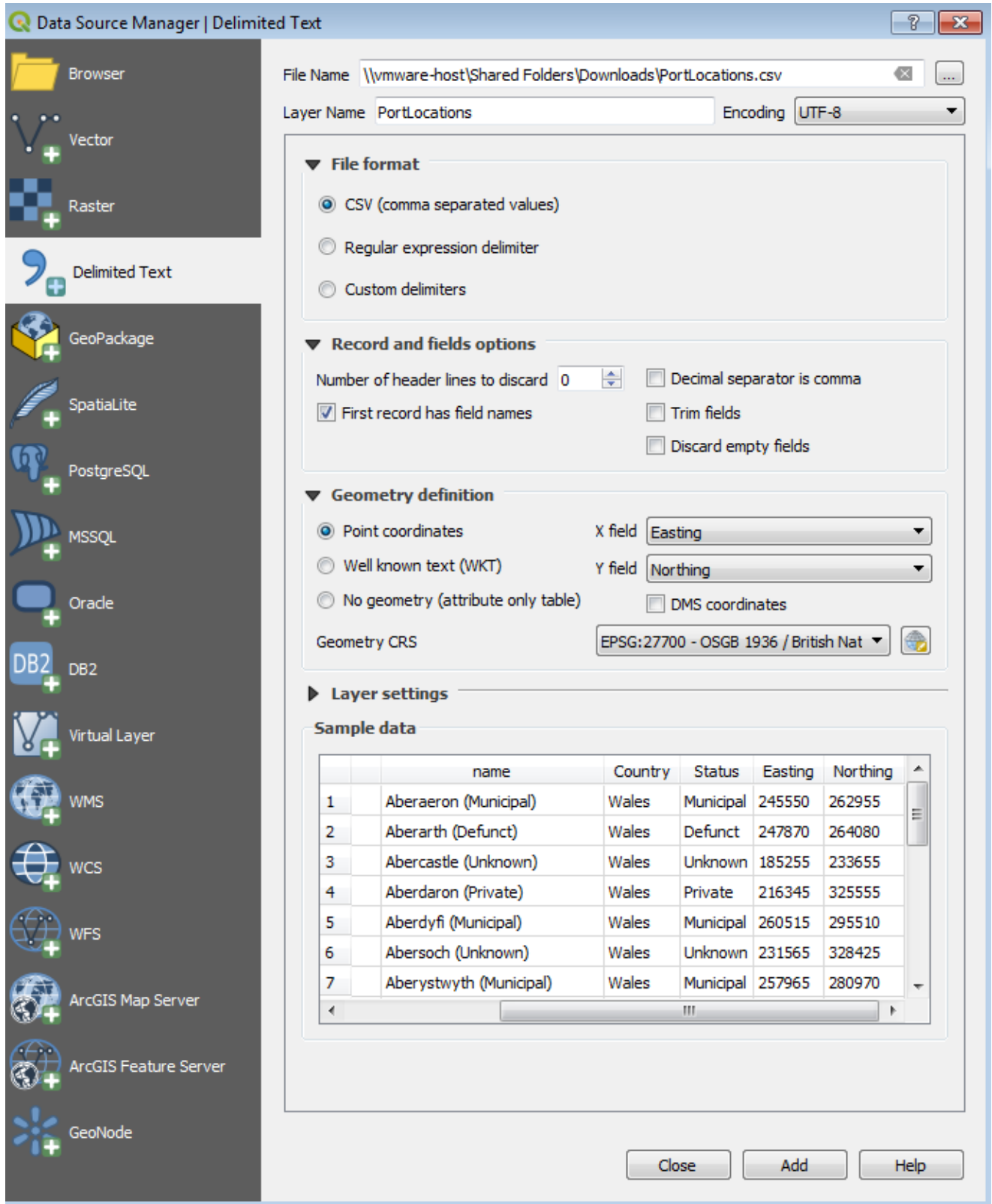
Adding geometry to Excel data

This approach will only work if the coordinates in the data are held in columns with names that QGIS will recognise - for example *easting* and *northing* for British National Grid data, or *lat long* for WGS84 data. If this isn't the case, you will need to save the Excel data as CSV, and follow the procedure below.

Delimited Text Data (e.g. CSV)

If you need more control over the process of loading spreadsheet data, or if it's already held in delimited text such as CSV, you can use the **Add delimited text layer** tool.

1. Click **Open Data Source Manager**
2. Select the **Delimited Text** tab to bring up the **Delimited Text** dialog
3. Adjust the settings shown below if necessary - note that in this instance, only the **Geometry CRS** setting was changed from the default - QGIS derived all other settings from the data



4. Click **Add** to add the layer to the map

Saving CSV in a vector format

At this point you may want to save the CSV as a standard vector format - there are some things which can't be done while it's still held as CSV. On the other hand, if you are using a CSV which is regularly updated from an external source, you may want to keep it as CSV, so that QGIS is always looking at the latest version of the data.

If the data has no coordinate data, and is just going to be used in QGIS as a table, check the **Geometry definition > No geometry** option in the dialog above. This is useful, for example, if there is a layer that needs to be joined.

If the file has a column containing [Well Known Text \(WKT\)](#) data (e.g. "SRID=27700;POINT(507417 163699)") instead of coordinates, check the **Geometry definition > Well known text** option.

2.4. Database Layers

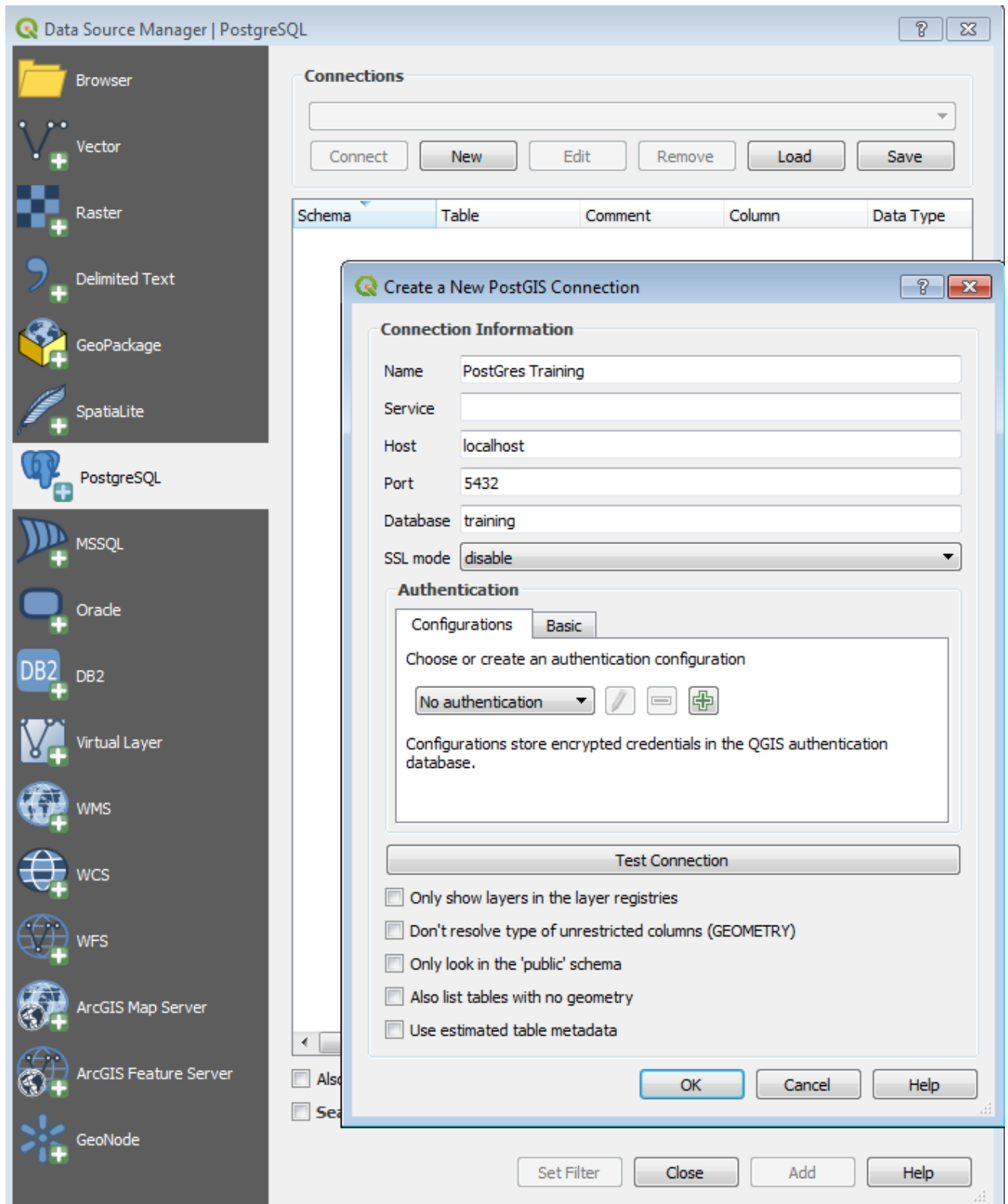
Loading database vector layers follows a slightly different process to loading a file-based layer, as you first need to establish a database connection. The process is similar for all databases, but in this example we will use data in a PostgreSQL database.

Database layers

You can load either spatial or non-spatial data from a database - the non-spatial data will be shown in QGIS as a table, which you can join to spatial data as shown below.

To load data from a PostgreSQL database:

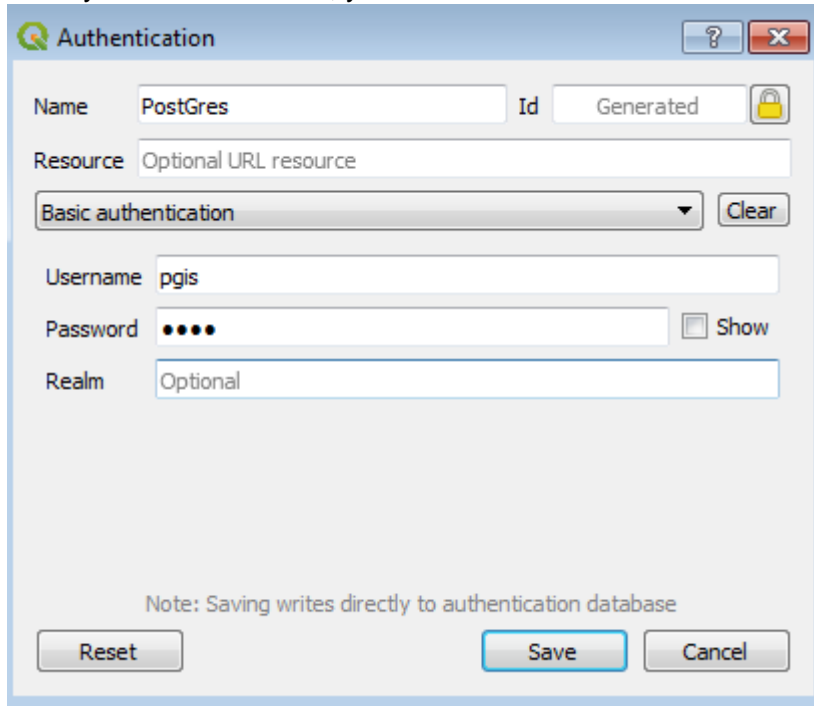
1. Click **Open Data Source Manger**
2. Click the **PostgreSQL** tab
3. If you haven't connected to the database before, click **New** to create a new database connection



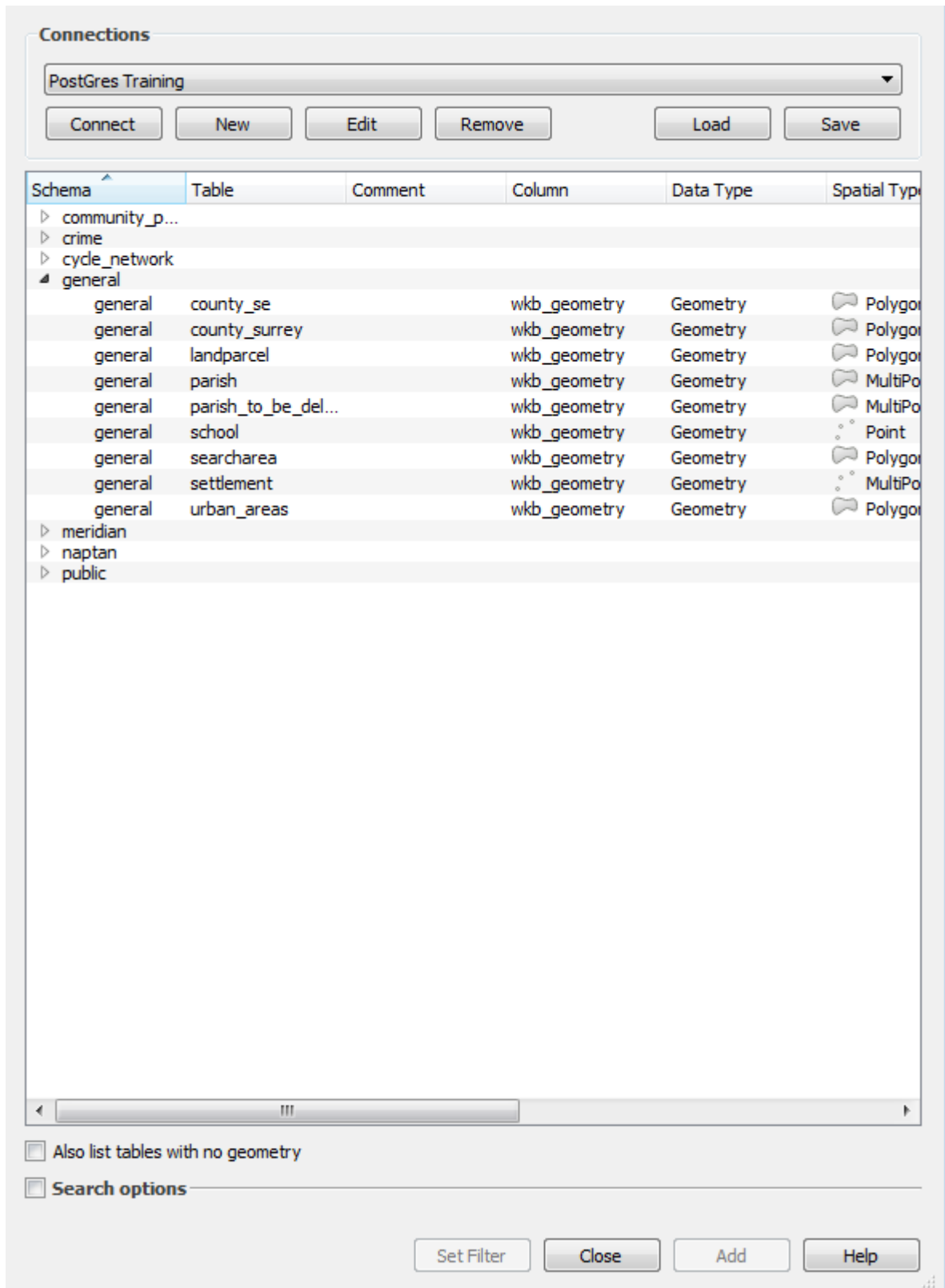
4. Complete the dialog:
 - a. **Name:** your name for the connection
 - b. **Host:** the name or IP address of the server the database is running on
 - c. **Port:** the port the database is running on - by default in PostGreSQL this is 5432, but it could be different
 - d. **Database:** the name of the database you want to connect to
5. Under **Authentication**, click the **Add** button to add your credentials
 - a. The first time you do this, you will be prompted for a **Master password** - *make sure this is*

something you can safely store or remember, as it cannot be retrieved later

- b. Once you have done this, you will be able to set the credentials for this connection:



- c. Click **Save** to save these credentials, then click **Test Connection** to make sure the connection is OK
- d. If all is well, click **OK**, then click **Connect** to establish the connection with the database



- e. Expand the database schemas, and select a table and click **Add** to add it to the map
- f. Check **Also list tables with no geometry** to view non-spatial data tables

Once the data is loaded in the **Layers** panel, it will behave in the same way as file-based vector layers. You only need to set up the connection once - after that, you can connect to the database from the PostgreSQL table in the **Data Source Manager**, or from the **Browser** tab.

2.5. Web Feature Service (WFS) Layers

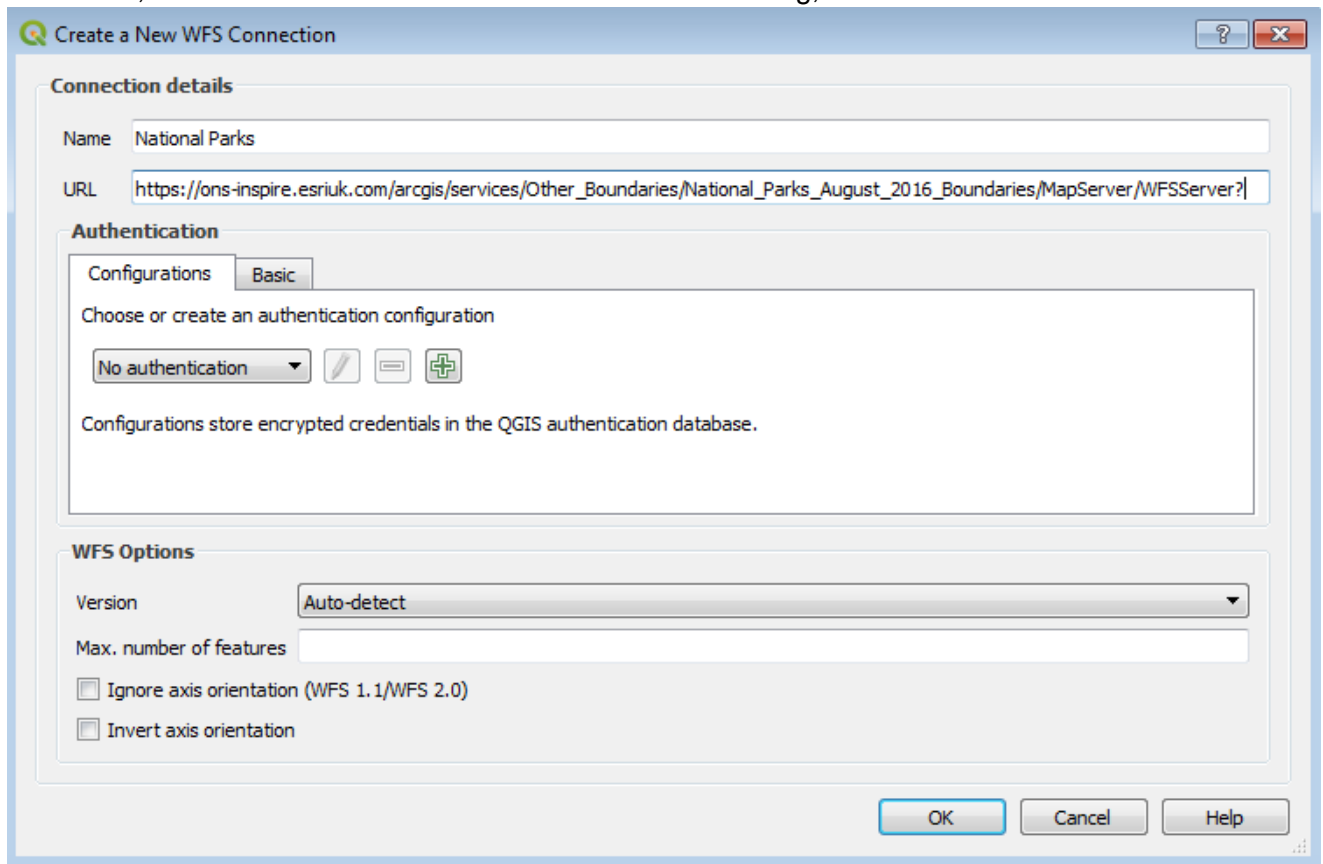
Data available in [OGC Web Feature Service \(WFS\)](#) format can be loaded in QGIS and used in a similar way to any other vector layer. However as the data is online, an Internet connection is required to use WFS data, although once the connection has been made it can be saved locally. WFS data is supplied as GML, and features can be selected, styled and queried in the same way as any other vector data.

To use a WFS, click the **Add WFS Layer** tool from the **Manage Layers** toolbar.

Create a new saved WFS Connection

The first time you have connect to a WFS source, you will need to create a connection:

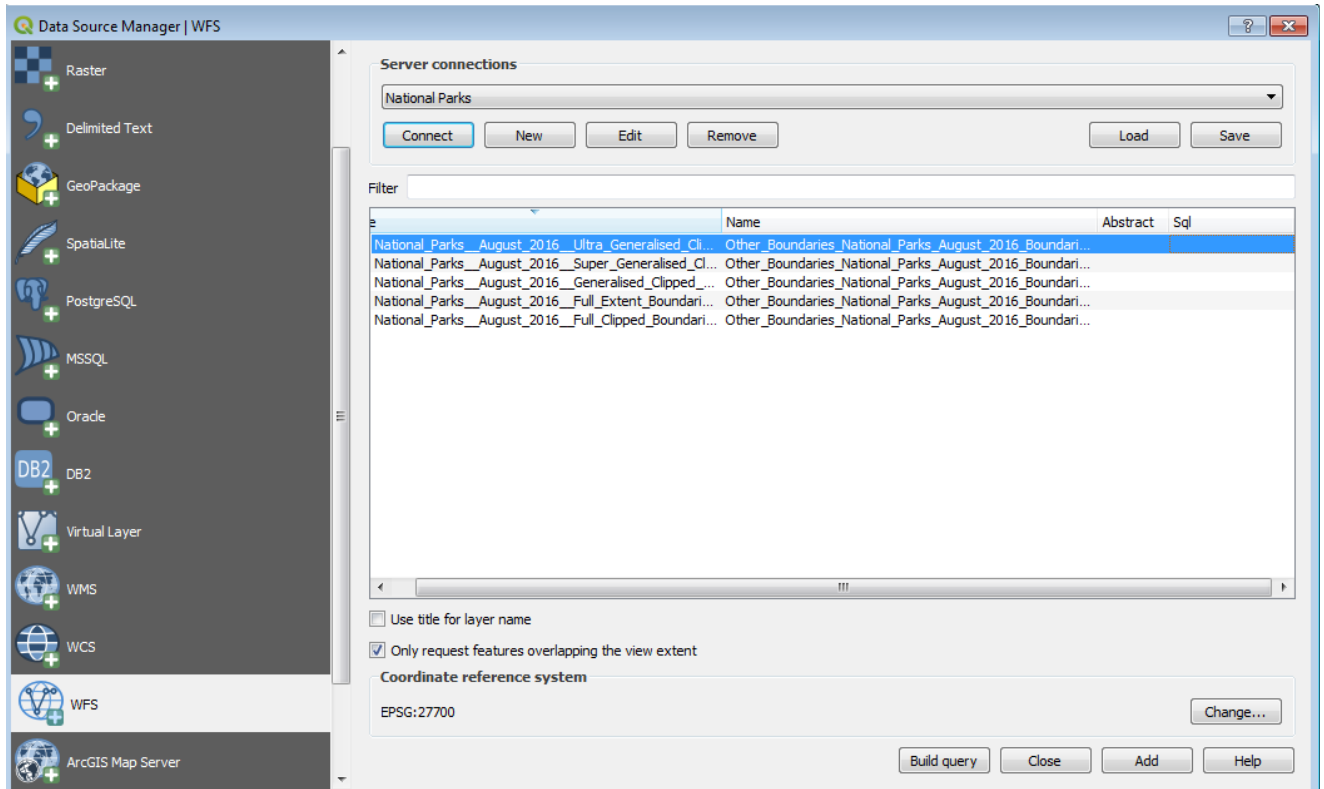
1. Click **Open Data Source Manager**, then the **WFS** tab
2. Click **New**, then in the **Create a New WFS Connection** dialog, add the connection details.



- a. **Name:** your name for the connection
 - b. **URL:** the URL of the WFS, for example https://ons-inspire.esriuk.com/arcgis/services/Other_Boundaries/National_Parks_August_2016_Boundaries/MapServer/WFSServer?
 - c. **Authentication:** complete as required
3. Click **OK**.

Connect to the WFS

1. Select the saved WFS
2. Click **Connect** to show the layers available in the WFS




3. Select the layer(s) required - you can select multiple layers
4. Click **Add** to load the layer(s) into the map
5. Note that with large datasets, it can take some time for the layers to load

WFS Queries

- By default, only features within the current view extent will be downloaded - uncheck **Only request features overlapping the view extent** to load all features from the source
- To load only a subset of features (other than by extent), click **Build query** to bring up the **SQL Query Composer**, and add a query to select the features you need

1. Click on the layer to select it
2. **Right-click > Zoom to Layer** (or click the icon on the toolbar)

Attribute Table


You can browse the attribute data for each layer by right-clicking on the layer and selecting **Open Attribute Table**, (or click the  icon in the toolbar).

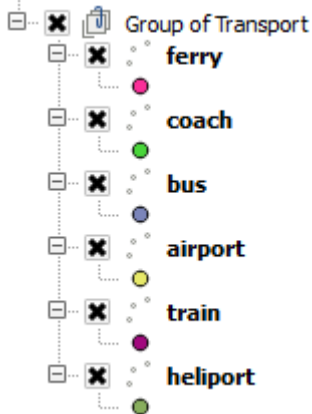
Manage the Layer List

Normally, layers at the top of the list in the **Layers** panel appear on the map in front of layers further down the list. You can change the order of layers in the list by dragging and dropping layers to a new position.

Group Layers

Layers can be grouped to create a hierarchical layer list, or table of contents.

1. Click the **Add Group** button at the top of the **Layers** panel 
2. Right-click and **Rename** the new group
3. Drag and drop layers into the group




Remove Layers

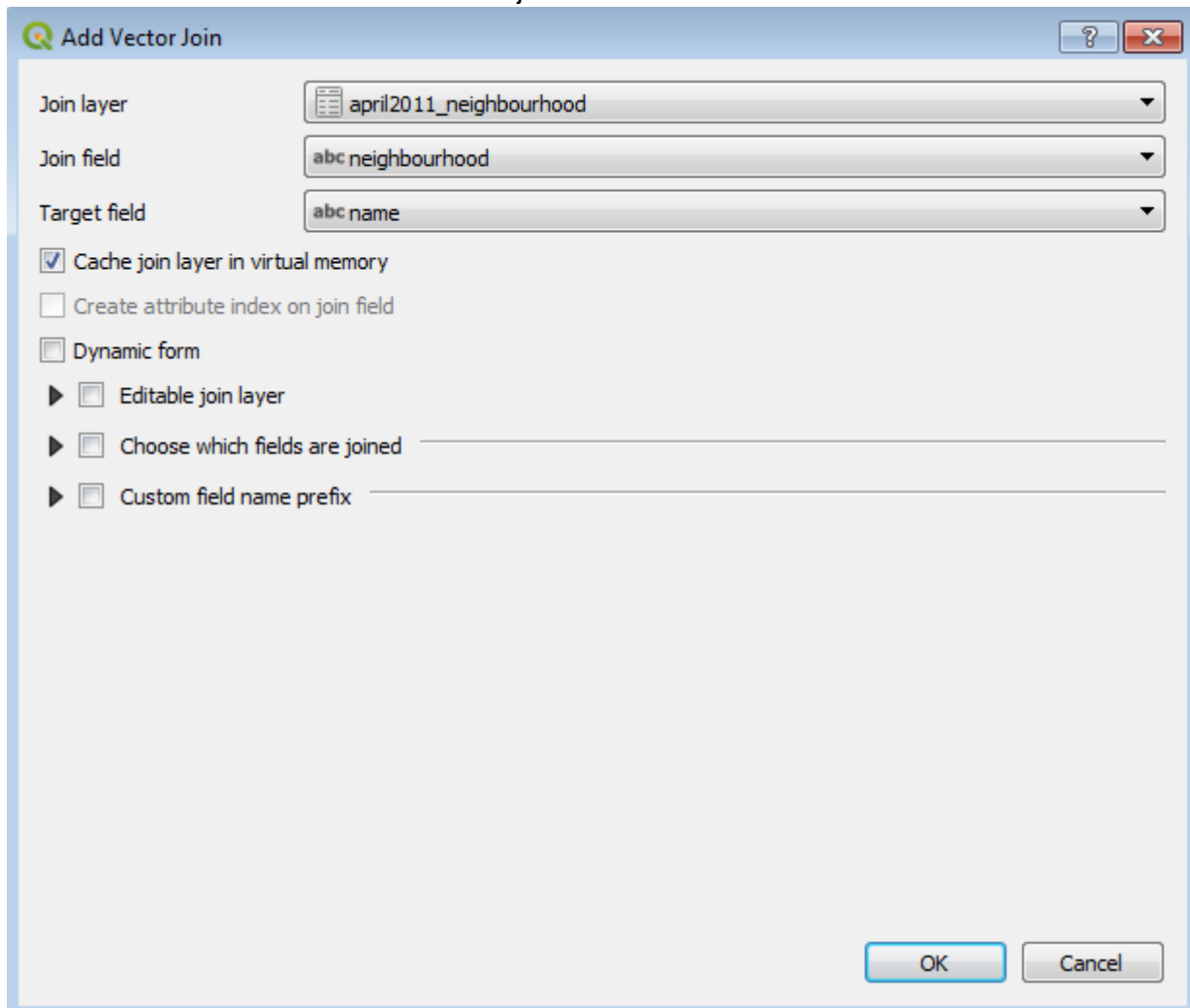
To remove a layer from the list, select the layer, then **Right-click > Remove**. This does not delete the data, just removes it from the map. However you will lose any styling or queries you have applied to the layer.

2.7. Joining Layers

If you want to use data in your map which has no spatial references, you will need to *join* this to a corresponding spatial dataset. For example, you might have population data for census areas, and a polygon layer of the census areas themselves, and you want to join the two in order to show the population figures for each areas as a label.

1. Add the non-spatial data table, and the spatial layer you are joining it to, as described earlier
2. The new table will appear in the **Layers** panel, but not on the map
3. Double-click the spatial layer to bring up the **Properties** dialog, and select the **Joins** tab
4. Click the **Add** button bottom left to add a join 
5. In the **Add Vector Join** dialog, use the dropdowns to specify:

1. **Join layer:** the layer you want to join to the current one
2. **Join field:** the field in the target layer (the one you are joining to) that is going to be used for the join (this might be ID, for example, or name, or in the case below, neighbourhood)
3. **Target field:** the field in the current layer (the spatial one) which is going to be used for the join - this must contain the same data as the join field



6. Click **OK** and **OK** again, then check the attribute table of the spatial layer - it will have an expanded number of columns to include the data from the non-spatial table

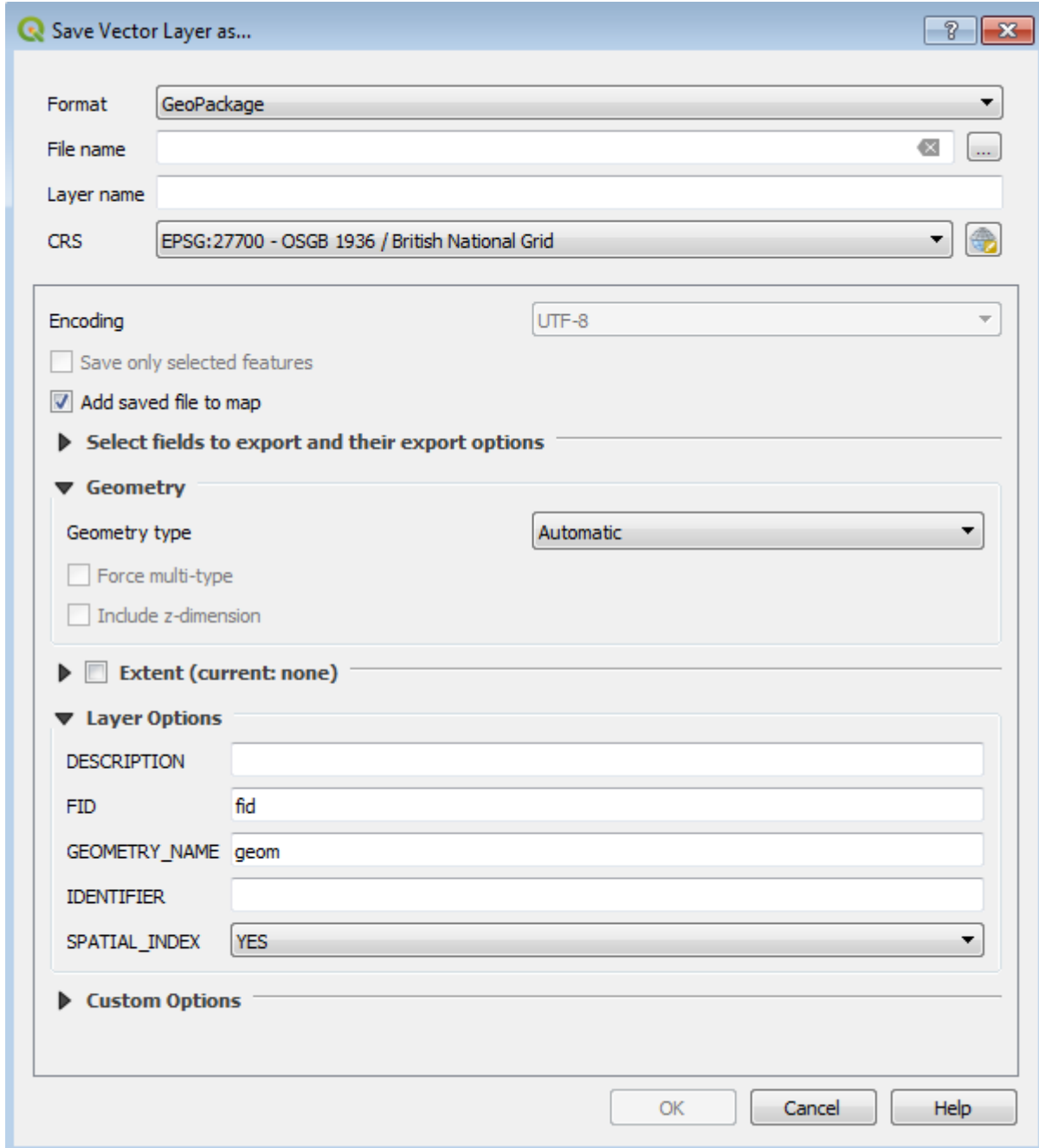
Join definition

The join definition is saved in memory, and is saved in the QGIS project - it does not affect the source data. It will therefore reflect the current data each time the project is loaded. You can edit the join after it has been created - for example to exclude fields from the joined data - in the same dialog you used to create it.

2.8. Exporting Vector Data

To export a layer or part of a layer:

1. **Right-click > Save as** from the layer



2. In the dialog, you can simply save the file as a different name - however you can also use other options:
1. **Format:** save the data in a different vector format
 2. **Save only selected features:** save a subset of the features
 3. **CRS:** reproject the data on save to a different CRS
 4. **Select fields to export:** save a subset of fields from the attribute table
 5. **Extent:** save only features visible in the current extent

Exporting a joined layer

If you export a layer with a join, the exported data will include the fields in the join - this is a way of creating a permanent new dataset from a joined layer.

3. Styling in QGIS

<ul style="list-style-type: none"> 3. Styling in QGIS <ul style="list-style-type: none"> 3.1. Introduction 3.2. The Style Dialog 3.3. Symbology Types <ul style="list-style-type: none"> Single Symbol Categorized Graduated 3.4. Re-using Styles 3.5. Images 3.6. Labels 	<p><i>An Astun Technology Training Module</i></p> <table border="1"> <tr> <td>Code</td> <td>QGIS-03</td> </tr> <tr> <td>Title</td> <td>Styling in QGIS</td> </tr> <tr> <td>Description</td> <td>Add styles and labels to layers</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Version</td> <td>1.0</td> </tr> <tr> <td>Updated</td> <td>27 Feb 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In development</td> </tr> </table>	Code	QGIS-03	Title	Styling in QGIS	Description	Add styles and labels to layers	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Version	1.0	Updated	27 Feb 2018	Updated by	Antony Scott	Status	In development
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Version	1.0																		
Updated	27 Feb 2018																		
Updated by	Antony Scott																		
Status	In development																		

3.1. Introduction


We need to add style to data to give it a useful representation on the map. Styles can be very simple (for example 'colour everything blue'), to highly complex with multiple rules and elements. This module covers some basic styling approaches and techniques, with some pointers to more advanced techniques.

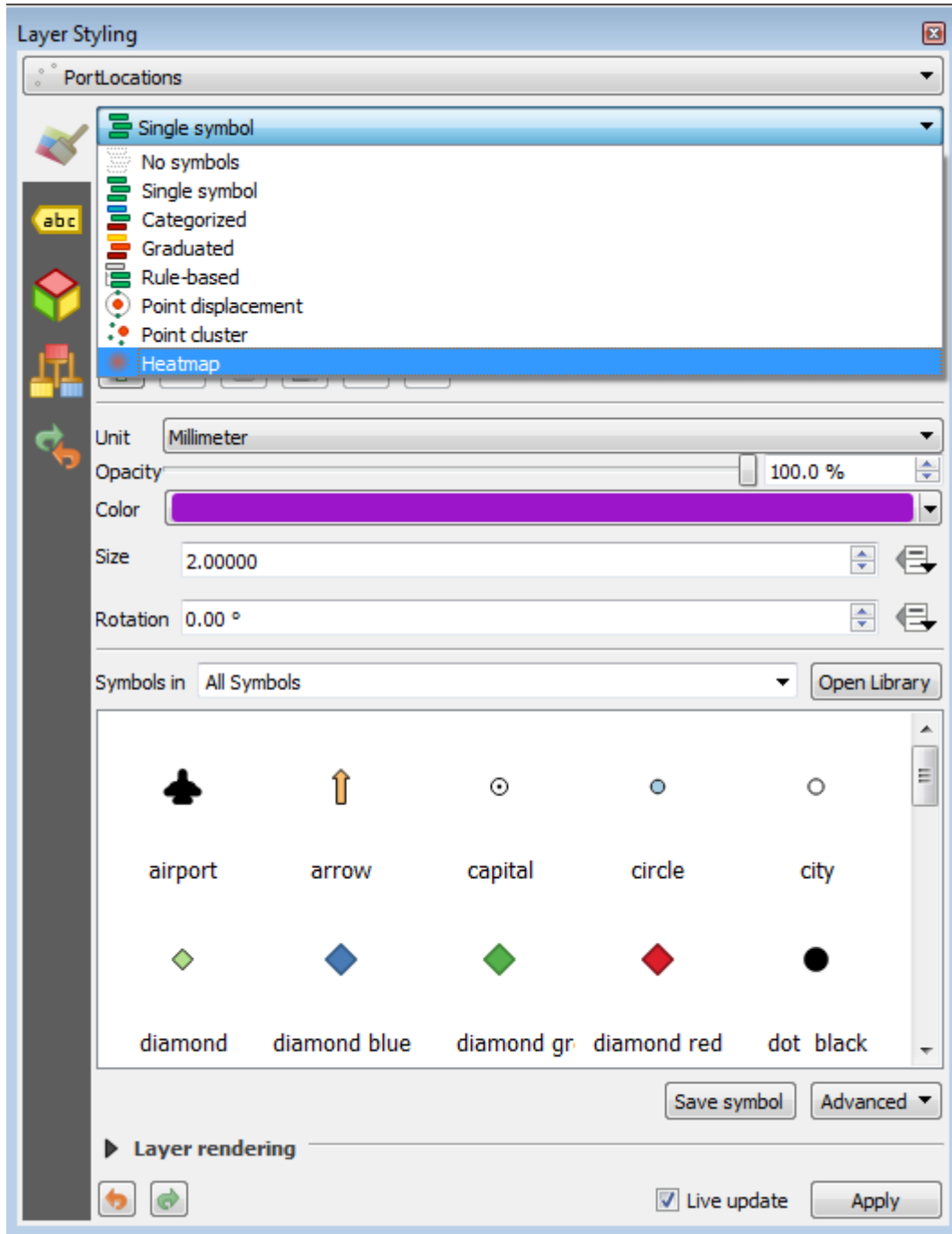
3.2. The Style Dialog

QGIS applies a default style to every layer when it is loaded (otherwise layers would not be visible). To set your own style, you can access **Symbology** for the layer in the **Layer Properties** dialog, but it's usually more convenient to use the style dock, which allows you to set styling for all layers from a dockable panel, and updates changes live on the map.

To use the style dock:



- Click the button at the top of the Layers panel , or hit **F7**
- Select the layer that you want to style from the first dropdown
- Select the type of symbology you want to apply from the second dropdown



The symbology options are as follows:

Symbology type	Description	Example	Comment
No symbols	The layer will not appear on the map.	Display the data using labels only	
Single symbol	The same symbology will be used for all features	Location of villages	Symbol can be sized proportionately to an attribute value - for example population

Categorized	A different symbology will be used for each unique value of an attribute	Crime types	Depending on values, each feature could have a unique style, or features could share the same style
Graduated	For numeric data only, values can be 'banded', with each band having a different style, usually using a graduated colour ramp	Voting patterns	Number, size and statistical composition of bands can be set by user
Rule-based	One or more rules (or queries) can be used to determine styling	Ordnance Survey MasterMap	Used to apply more complex logic to styling, for example where the content of more than one attribute is used to determine style
Point displacement	Move points slightly if they are in the same location, or within a set tolerance of each other, so that they are all visible	Crime locations	Where representation of numbers is more important than geographical accuracy
Point cluster	Coalesces points which are in the same location or within a set tolerance of each other into a single symbol, with a number showing the count of the points included	Crime locations	Where representation of numbers and geographical accuracy to a certain zoom level is required, with numbers of points coalesced changing with zoom level
Heat map	Continuous surface of varying colour and intensity based on point density	Bird nesting locations	Best used to visualise point locations over an homogenous area

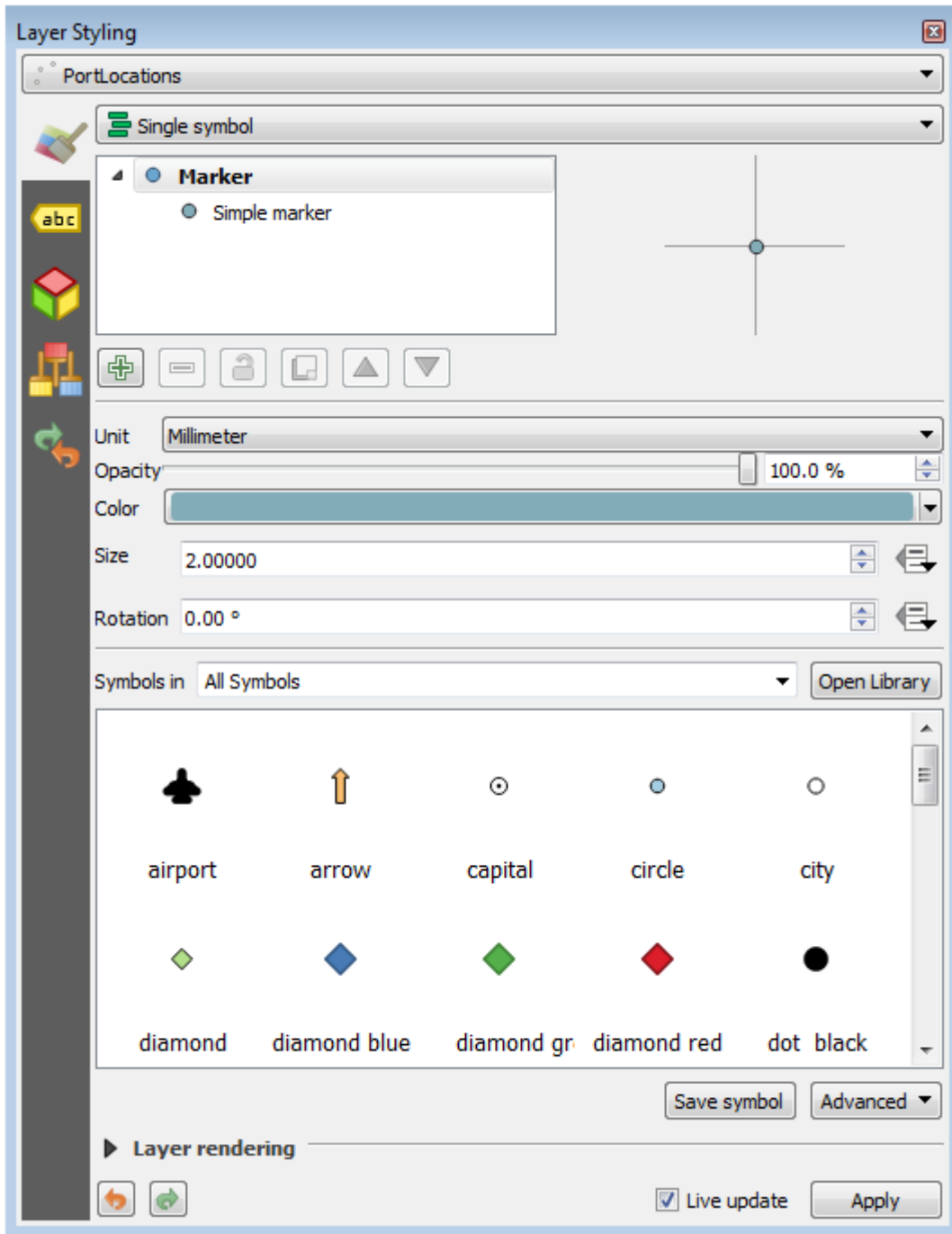
This module focuses on Single Symbol, Categorized and Graduated.

3.3. Symbology Types

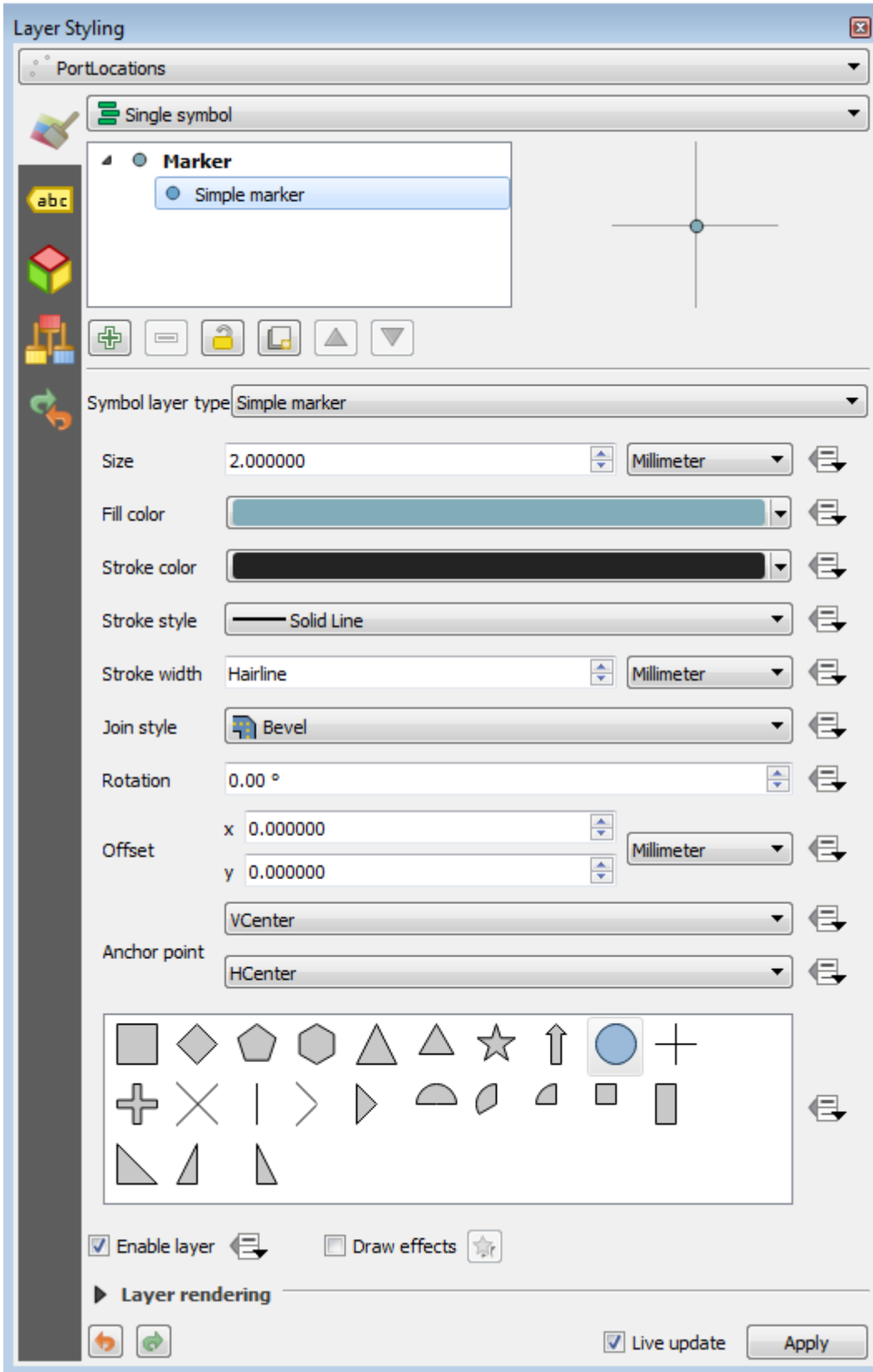
Single Symbol


Where a dataset is homogenous, and/or you want to represent all the features in the same way, use **Single symbol**. Despite the name, this style type can be used for lines and polygons as well as points, and the styling options will depend on which of these geometry types you are styling.

QGIS always provides some pre-packaged styles, so you can use these and amend them, or build your own from scratch. Styles can contain one or more elements - for example in the screenshot below there is a single **Simple marker**. Click on the existing styles to see how these are typically constructed.



To change a style, click on one of its components, for example the **Simple marker** in the screenshot above. This shows settings which are specific to that component - for example colour, size and stroke style.



Click the **add** button  to add components to the style, and use the up and down arrows to control which components are in front or behind.

Live update

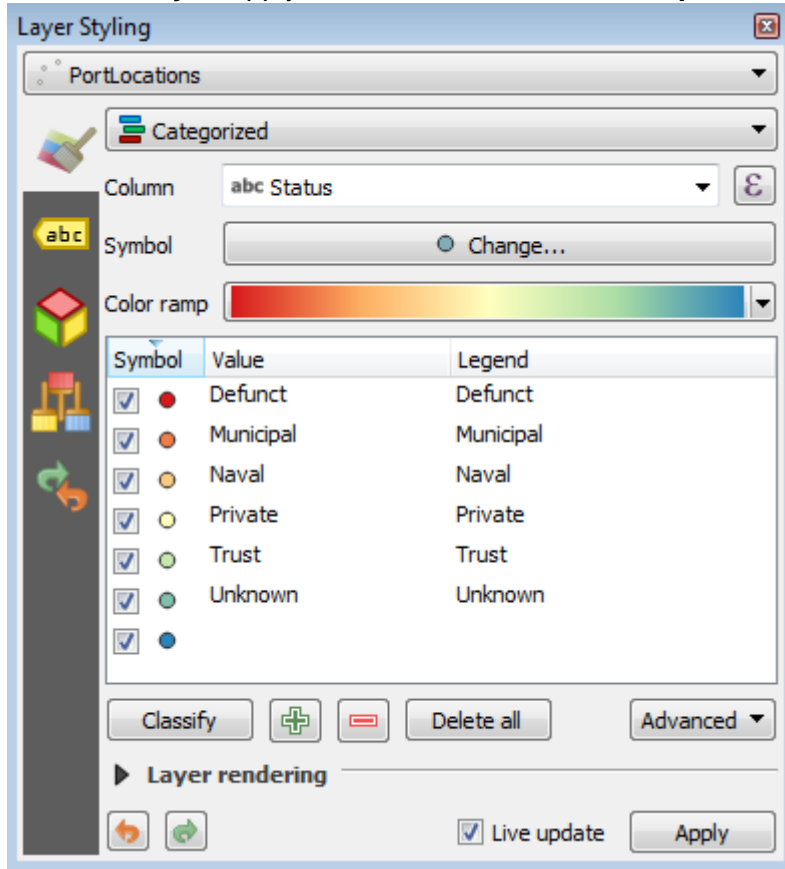
The **Live update** checkbox at the bottom right of the dialog keeps your style changes in synch with the map. If this is slowing things down too much, uncheck it and use the **Apply** button when you want to see the effect of your changes.

Categorized

A categorized style is used to classify the map based on unique attribute values in the dataset.

To apply a categorized style:

1. Select **Categorized** from the dropdown list
2. Select a **Column** to use for the categorization
3. Click **Classify** to apply the colours in the **Color ramp** to the values



You can edit the individual class styles:

- **Right-click** on one of the styles to get a limited set of options (e.g. colour, size, opacity)
- **Double-click** to see the full style dialog

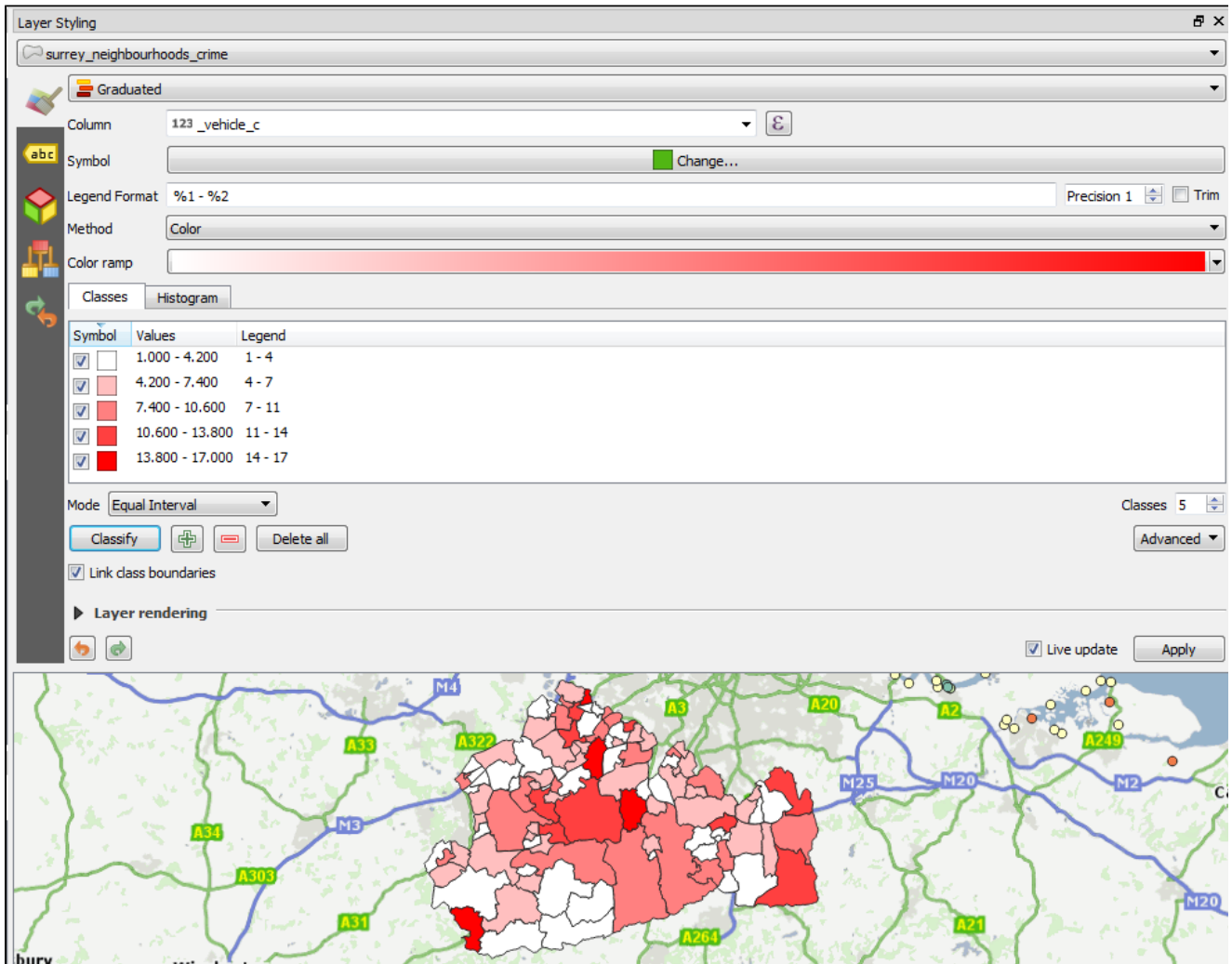
You can also double-click on the text under the **Legend** heading to change it.

Graduated

Graduated styling requires numeric attribute values, and places them within ranges, each of which will be styled differently. The example below uses neighbourhood crime data, showing the number of vehicle crimes in one month per neighbourhood.

To apply a graduated style:

1. Select **Graduated** from the dropdown list
2. Under **Column**, select the field with the relevant data that you want to represent
3. Click **Classify** to create the class bands and apply the **Color ramp**
4. Adjust the settings and click **Classify** again if required



3.4. Re-using Styles

There are a number of ways to re-use a style. You can:

- Copy/paste styles between layers: select the layer, **right-click > Copy** (or **Paste**)
- Save a style in the QGIS native file format, .qml, for importing to another project: **double-click the layer > Layer Properties > Symbology > Style > Save Style > QGIS Layer Style File**
- Save a style as an **SLD (Styled Layer Descriptor)**, for use in other applications which support it: **double-click the layer > Layer Properties > Symbology > Style > Save Style > SLD File**
- Load a style from QML or SLD: **double-click the layer > Layer Properties > Symbology > Style > Load Style**

QGIS and SLD

QGIS does not at the moment fully support the SLD standard in its export and import - there are some styles which will not be translated. You may also need to do some tweaking of the SLD file (which is in XML), depending on the application you are working with.

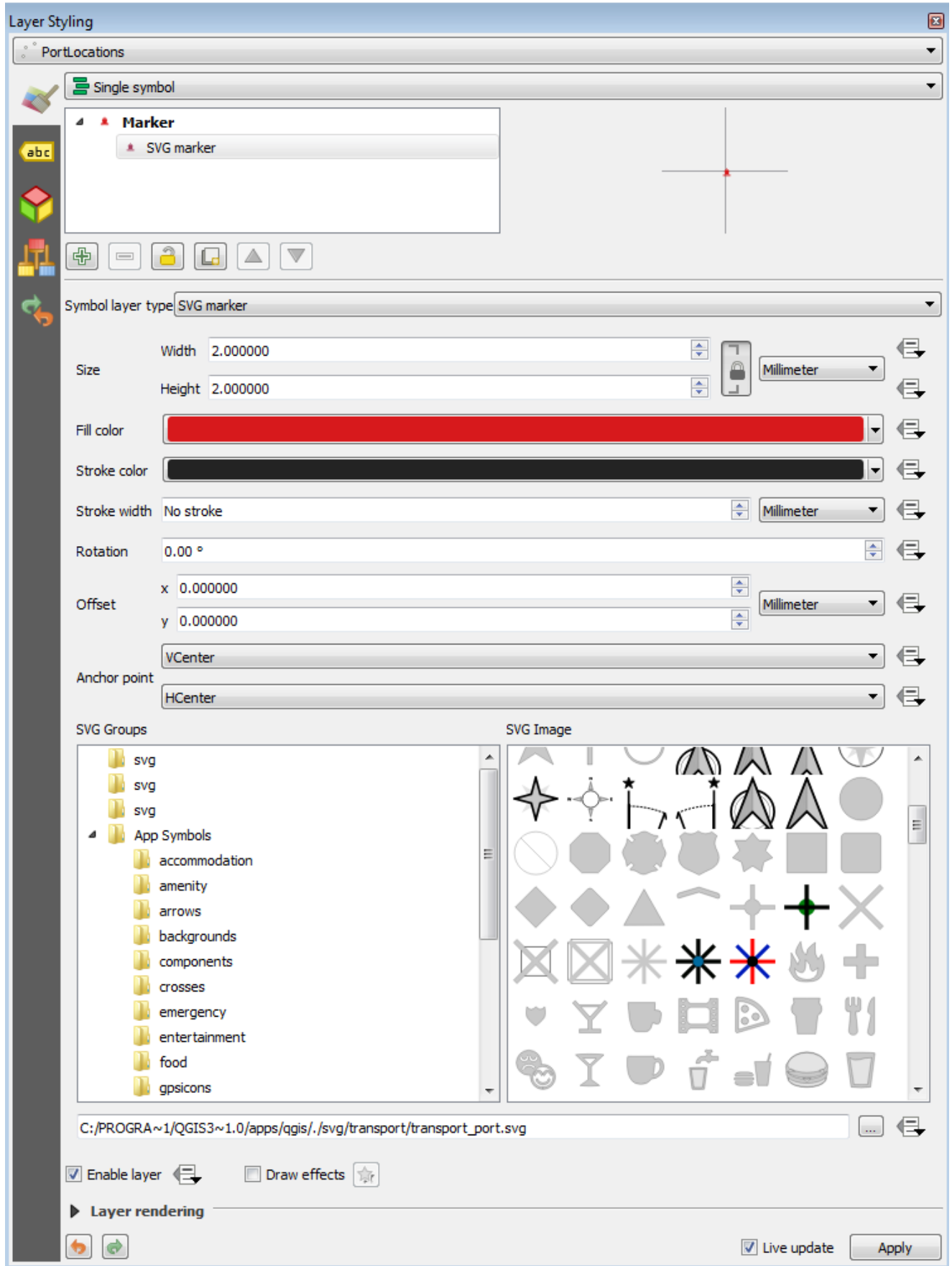
- Create and import style libraries (groups of styles) for example for corporate use: **Settings > Style Manager > Import / export**
- Set a style as a default, to be used when a layer is added to a project. This works well if the layers are stored in a PostgreSQL database, as the default styles are available to any user. File-based default styles are normally only be available to the local user: **double-click the layer > Layer**

3.5. Images

QGIS uses [Scalable Vector Graphic \(SVG\)](#) images as its native image format - other formats such as PNG and JPG can only be used if they are embedded in a SVG file. Graphics programs such as [InkScape](#) can be used to create SVG images. Images can be used in all geometry types - for point styles, for area fills, and for markers on a line. SVG images can be coloured and scaled, and combined to create composite images, so they are more versatile than some other formats.

To use an SVG image:


- In the **Symbol Selector** dialog (where a specific symbol is configured), from the **Symbol Layer Type** dropdown list select **SVG marker**

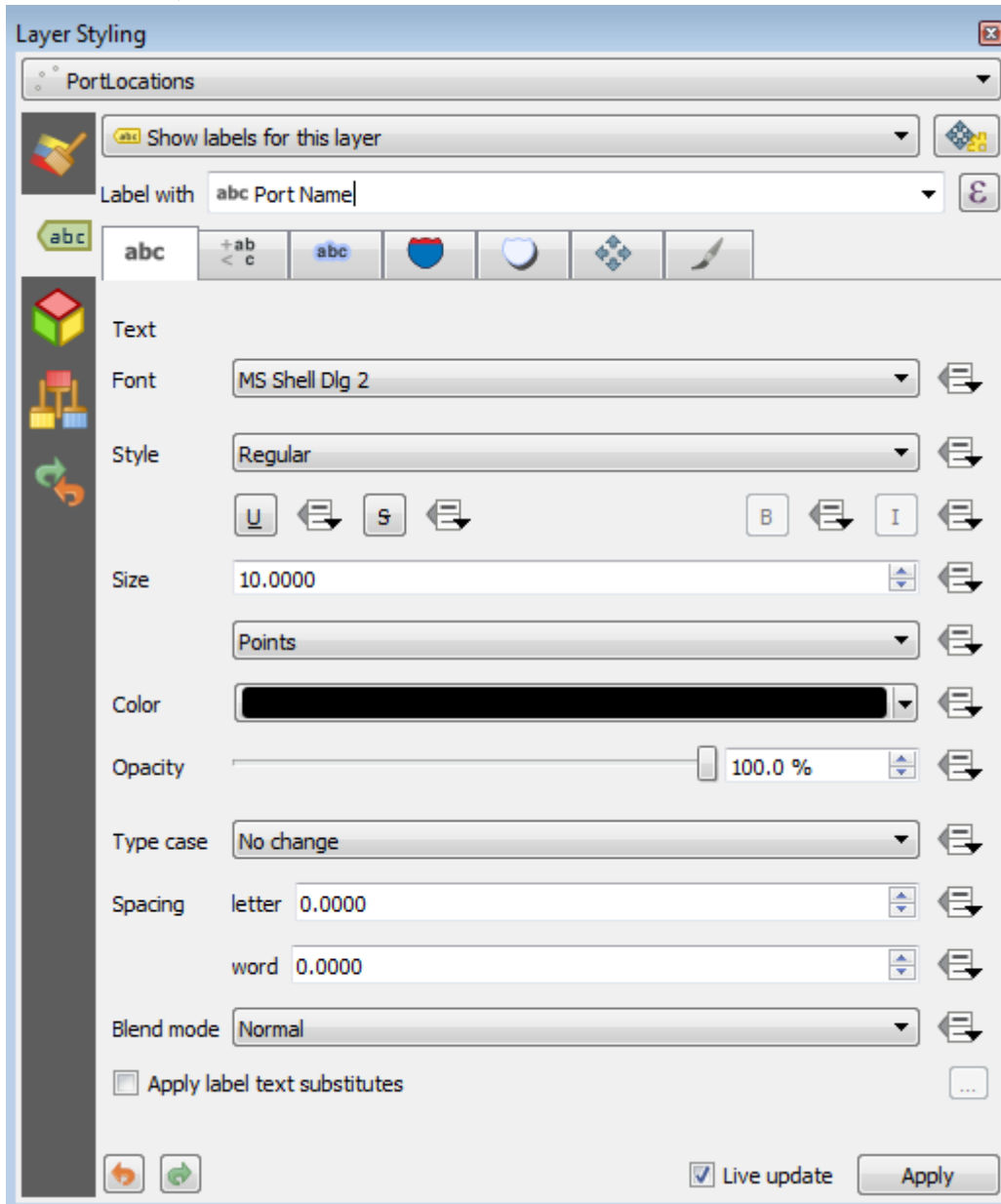


- Select the SVG marker to use from the library, or use the file manager view to browse to your own SVG image
- Adjust the settings such as size and colour to suit your needs

3.6. Labels



Labels are also configured from the **Layer Styling** dialog (the Style Dock). To activate the labels dialog:

- Click the button at the top of the Layers panel , or hit **F7**
- In the Layers dropdown, select **Show labels for this layer**
- In **Label with**, select the column to be used for labels




You can now adjust a range of settings for labels, including font, placement and formatting.

We are not going to cover label settings in detail, but here are a few pointers and tips:

- If some labels are not appearing on the map, this may be because they are conflicting with other labels and so have been removed. Use **Show all labels for this layer** in the **Rendering** tab  so you can see all labels
- Use the settings in the **Buffer** tab  to draw a buffer or halo round labels so they stand out

against a darker background


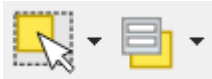
- Use the **Expression Builder** button  (next to the **Label with** field) to build labels with expressions - for example concatenating two or more attribute values, or creating a total of numeric values

4. Select and Filter in QGIS

<ul style="list-style-type: none"> 4. Select and Filter in QGIS <ul style="list-style-type: none"> 4.1. Introduction 4.2. Identify Features <ul style="list-style-type: none"> Derived Information Multiple Features Feature Attributes Identify Features from Multiple Layers 4.3. Selection <ul style="list-style-type: none"> Select Feature(s) Select Features by Polygon/Freehand/Radius Navigate and Remove Selection 4.4. Using the Attribute Table <ul style="list-style-type: none"> Attribute Table Views Toggle Attribute Views Attribute Table Field Filter Attribute Table Advanced Filter (Expression) 4.5. Filter (Layer) 4.6. Spatial Selections and Filters <ul style="list-style-type: none"> Select by Location Join Attributes by Location 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-04</td> </tr> <tr> <td>Title</td> <td>Select and Filter in QGIS</td> </tr> <tr> <td>Description</td> <td>Select, query, filter, expressions.</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>01 Mar 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In development</td> </tr> </table>	Code	QGIS-04	Title	Select and Filter in QGIS	Description	Select, query, filter, expressions.	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	01 Mar 2018	Updated by	Antony Scott	Status	In development
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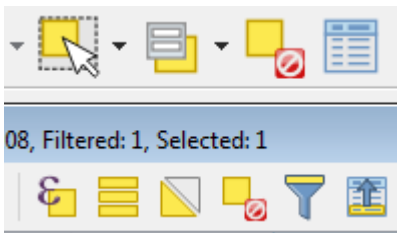
4.1. Introduction

QGIS provides a number of different ways of selecting, filtering and querying map layers. It's important to understand the terms that QGIS uses to describe these different techniques - they are summarised in this table.

Action	Result	How	Details
<i>Identify</i>	Show data (attribute values) for a single feature or group of features, and optionally show values in a form for viewing/editing. Attribute data is shown for each feature, along with derived data - e.g. length/area.		Click the Identify features button, then click on a feature.
<i>Select</i>	Create a subset of tagged (selected) features from one or more layers, while continuing to display all features. Selected features are highlighted in the map and attribute table. Further actions (e.g. save, processing) can be performed on the selection only.		Click on one of the Select buttons, or use their dropdowns, to make a selection.

<i>Filter (layer)</i>	Display only a subset of the features in a layer (including both map and attribute table), hiding the rest.	Layer > Filter	Write a query to filter features.
<i>Filter (attribute table)</i>	Display a subset of features in the attribute table, without changing the map.	Layer > Open Attribute Table > Field Filter or Advanced Filter (Expression)	Write a query to filter features.

The **Identify** and **Select** tools are grouped together in the **Attributes** toolbar, and additional tools are in the **Attribute Table** toolbar, shown in the second row below.



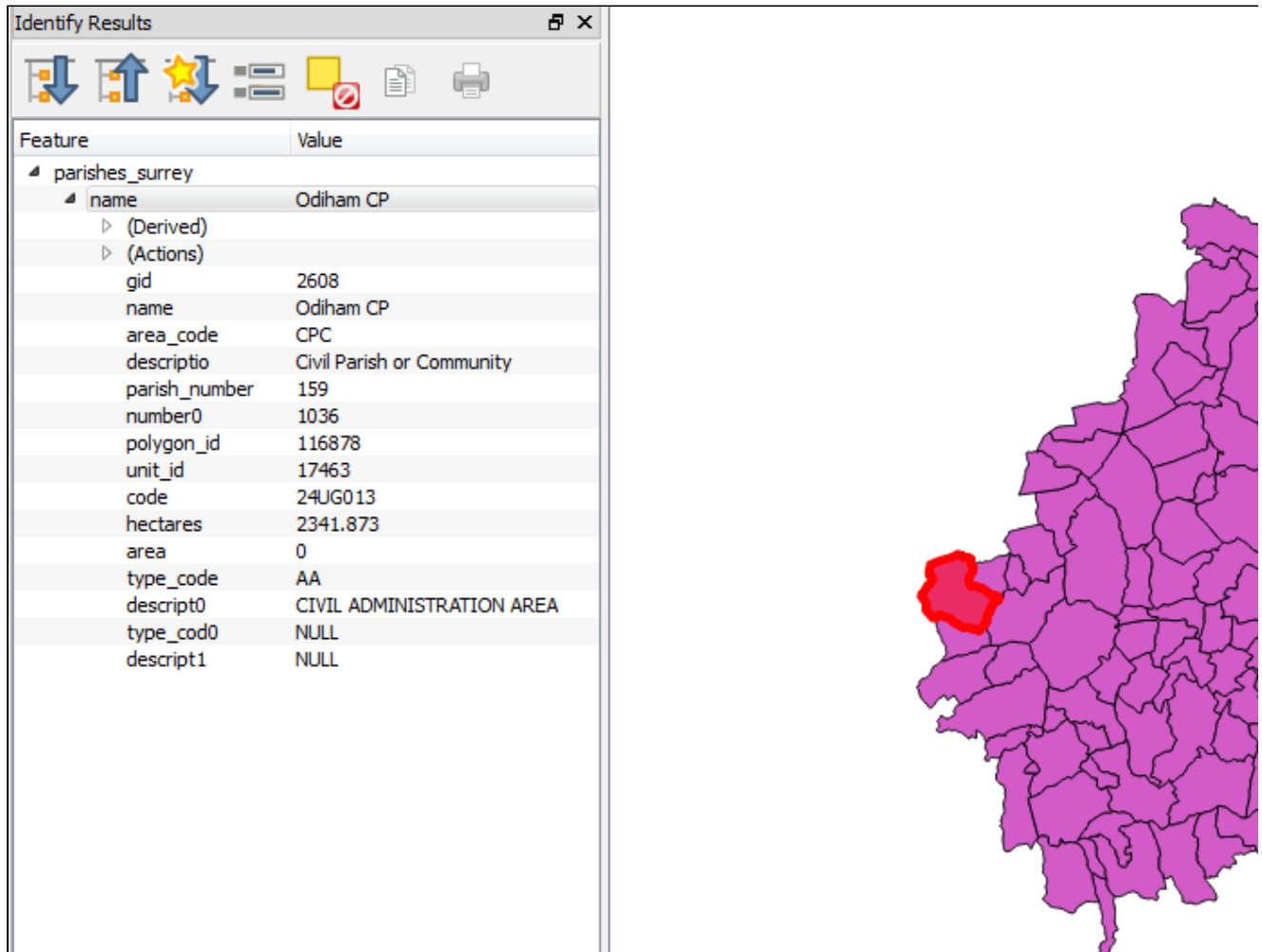
4.2. Identify Features

The **Identify Features** tool is used to display the attribute values, and some derived properties of a map feature.

1. Click the layer of interest in the layer list

2. Click the **Identify Features** button  - the cursor will change

3. Click on a map feature.



- The feature will be highlighted, and the **Identify Results** panel box will appear, showing the values of all the attributes for the feature

Derived Information


The **Derived** section in the panel includes measurements derived from the geometry of the feature such as length, area and perimeter (depending on the geometry type).

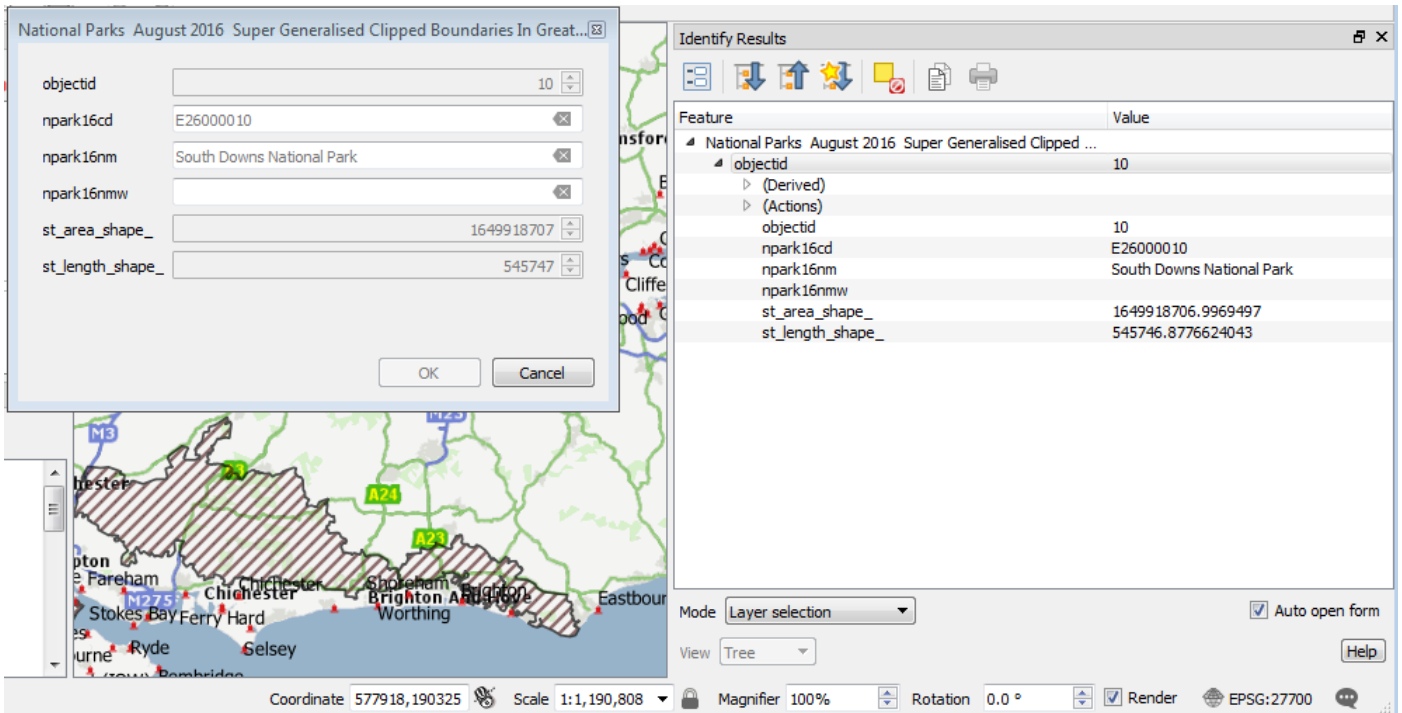
(Derived)	
(clicked coordinate X)	-0.9363
(clicked coordinate Y)	51.2429
Area	23.367 km ²
Closest vertex X	-0.9413
Closest vertex Y	51.2308
Closest vertex number	845
Perimeter	23.877 km
Vertices	932
feature id	53

Multiple Features

If you click close to feature boundaries, multiple features are identified, and these will be listed as separate items in the **Identify Results** hierarchy. Browse the tree to see the data for each feature.

Feature Attributes

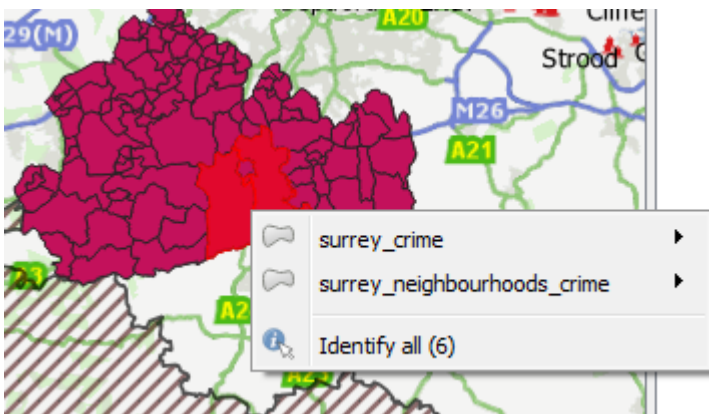
To view the attributes for a feature in a form dialog, click the **View feature form** button at the top of the **Identify Results** panel . This makes it easier to view the data, and if the layer is in edit mode, to edit it.



To open the form automatically whenever **Identify Results** is used, check the **Auto open form** box at the bottom of the panel.


Identify Features from Multiple Layers

If you click on a location where there are features from multiple layers, you will be able to choose which layers to use in populating the **Identify Results** panel (including all of them).



To show results for a single selected layer, select **Current layer** from the **Mode** dropdown at the bottom of the **Identify Results** panel.

Copy to clipboard

The **Copy Selected Feature to clipboard** button  copies the data from the clicked feature to the clipboard as tab delimited text - you can then paste it to a text editor or directly into a spreadsheet.

4.3. Selection

Selecting features 'tags' them for future use, highlighting them in the map and in the attribute table. It also creates a subset of the data that QGIS can use to apply specific functionality to - for example, once features have been selected, you can:

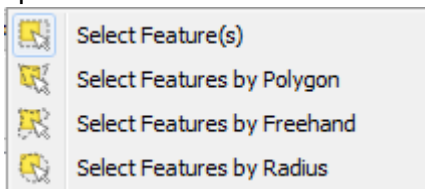
- save the selected features as a new layer
- run processing tasks on them
- invert the selection to select all features currently not selected.

Features can be selected:

- interactively in the map interface, for example by clicking or selecting by rectangle
- interactively in the attribute table, by clicking one or more rows
- by query, from the map or attribute table

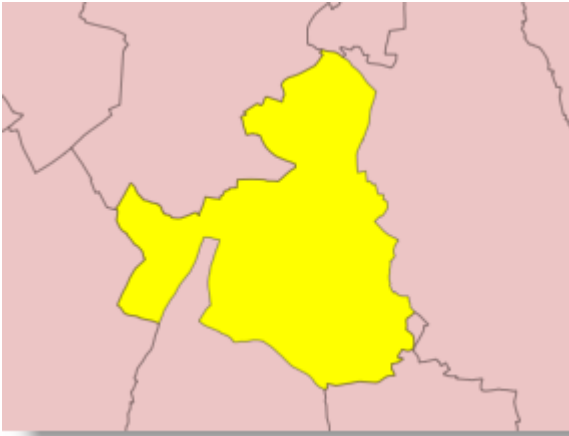
To select interactively from the map, click the dropdown (the black triangle) next to the **Select features by**

area or single click button in the toolbar . The menu which appears gives you a number of options:

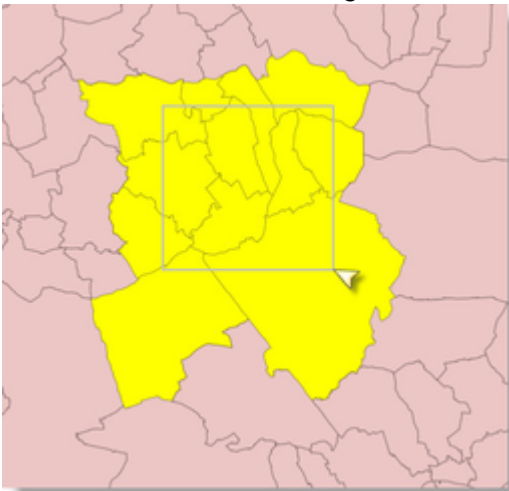


Select Feature(s)

Click **Select Feature(s)** (it's selected by default), then click on the map to select a single feature at that location. Use **Ctrl-click** to select multiple features.



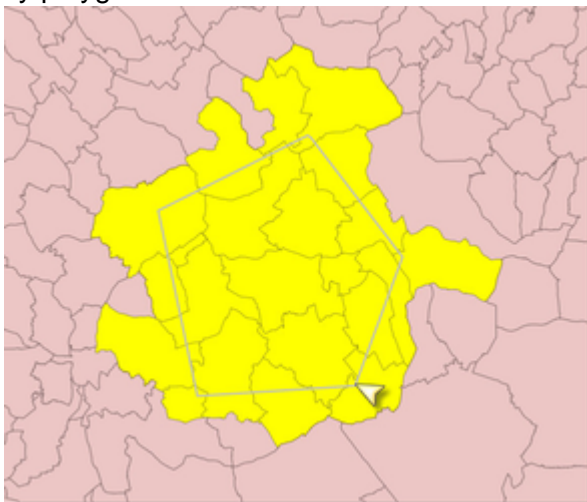
You can also click and drag a box over features to select all features that intersect the box.



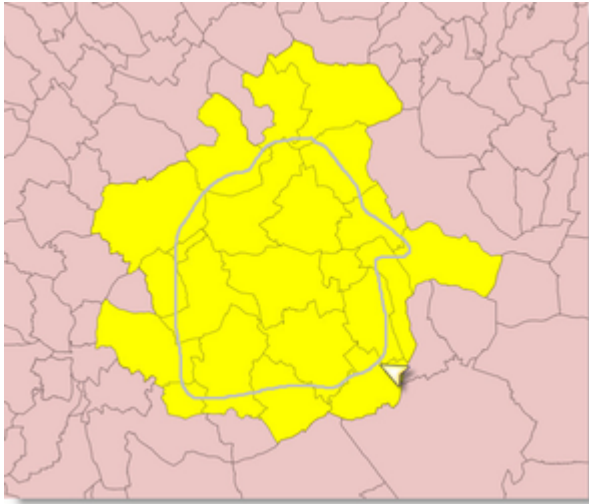
Select Features by Polygon/Freehand/Radius

Use these tools to select features by drawing a polygon, freehand line or radius:

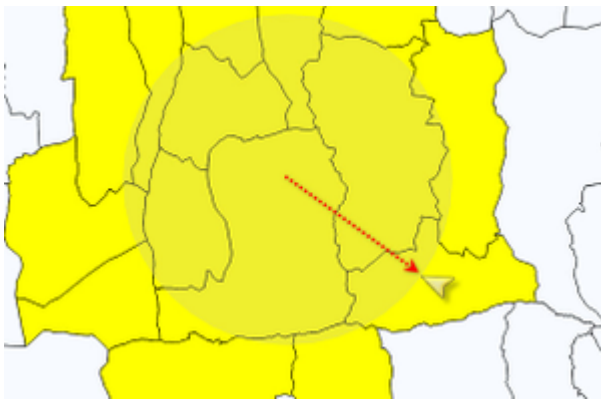
- by polygon



- freehand



- radius



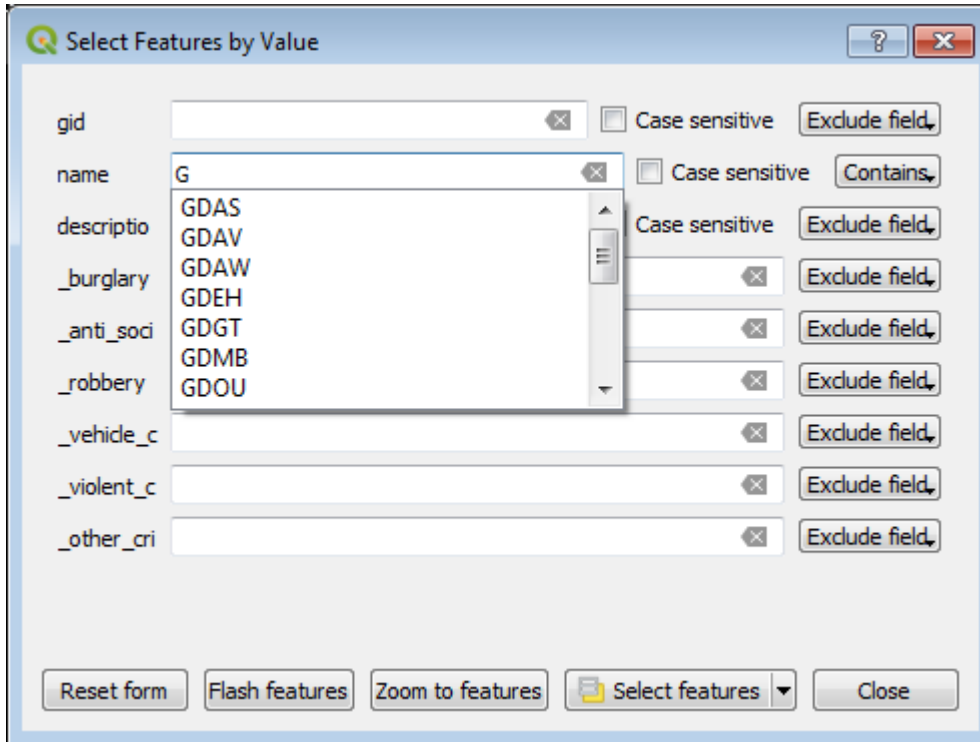
Select Features by Value or Expression

The tools on the **Select Features by Value** dropdown

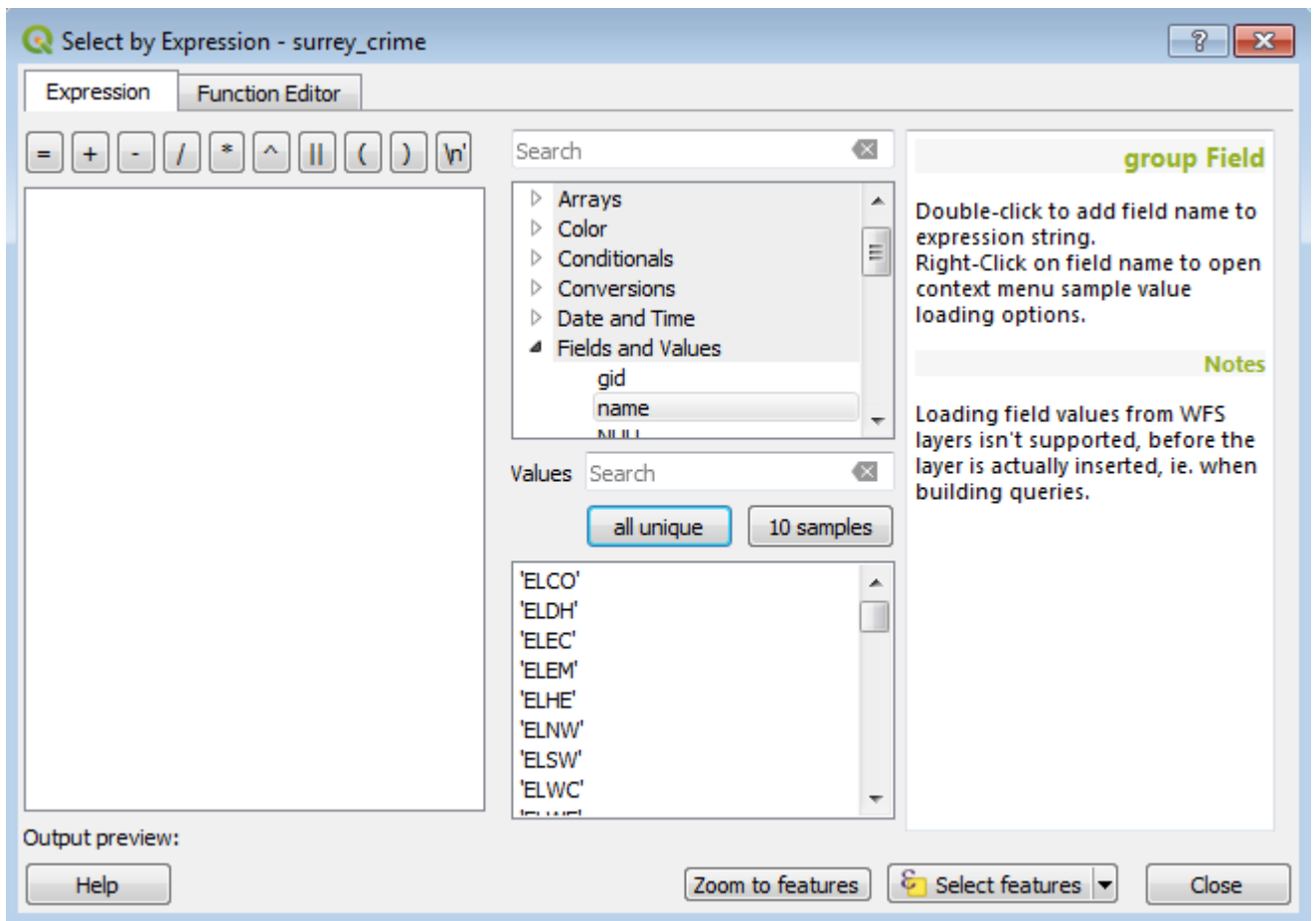


allow you to identify a selection by using a query, or by matching values against attributes.

- **Select Features by Value** displays a dialog where you can enter values to search for in the data - note that the search is interactive, so as soon as you start typing, matching values appear





- **Select by Expression** displays a dialog in which you can build a query by selecting fields, operators and functions. This dialog appears in a number of places in QGIS, and it will be explained in more detail below



Navigate and Remove Selection

Navigate to a selection in two ways:

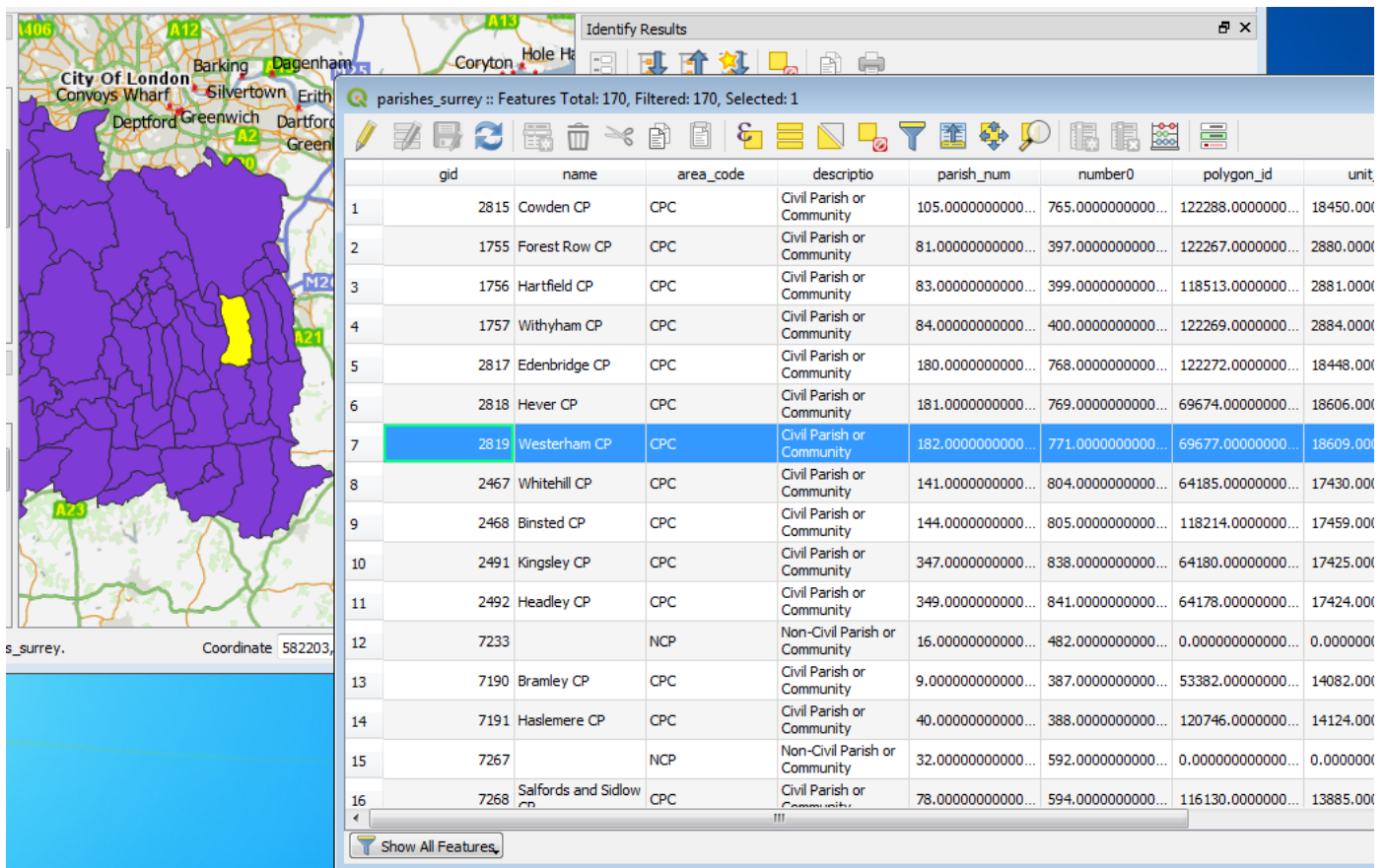
- **Pan Map to Selection** will centre the map on the feature 
- **Zoom to Selection** will set the map extents to match those of the feature 

To remove selections:

- **Deselect Features** to deselect features from all layers 

4.4. Using the Attribute Table

The attribute table holds data about all the features in the layer - you can use it to view, edit and query data. Open it from the **Attributes** toolbar, or by **right-click > Open Attribute table** from a layer in the layer list. Each row in the attribute table corresponds to a feature on the map, and selection is synchronised between the table and the map - if a feature is selected in the attribute table, it's also selected on the map.



gid	name	area_code	descriptio	parish_num	number0	polygon_id	unit
1	2815 Cowden CP	CPC	Civil Parish or Community	105.0000000000...	765.0000000000...	122288.00000000...	18450.000
2	1755 Forest Row CP	CPC	Civil Parish or Community	81.0000000000...	397.0000000000...	122267.00000000...	2880.000
3	1756 Hartfield CP	CPC	Civil Parish or Community	83.0000000000...	399.0000000000...	118513.00000000...	2881.000
4	1757 Withyham CP	CPC	Civil Parish or Community	84.0000000000...	400.0000000000...	122269.00000000...	2884.000
5	2817 Edenbridge CP	CPC	Civil Parish or Community	180.0000000000...	768.0000000000...	122272.00000000...	18448.000
6	2818 Hever CP	CPC	Civil Parish or Community	181.0000000000...	769.0000000000...	69674.00000000...	18606.000
7	2819 Westerham CP	CPC	Civil Parish or Community	182.0000000000...	771.0000000000...	69677.00000000...	18609.000
8	2467 Whitehill CP	CPC	Civil Parish or Community	141.0000000000...	804.0000000000...	64185.00000000...	17430.000
9	2468 Binsted CP	CPC	Civil Parish or Community	144.0000000000...	805.0000000000...	118214.00000000...	17459.000
10	2491 Kingsley CP	CPC	Civil Parish or Community	347.0000000000...	838.0000000000...	64180.00000000...	17425.000
11	2492 Headley CP	CPC	Civil Parish or Community	349.0000000000...	841.0000000000...	64178.00000000...	17424.000
12	7233	NCP	Non-Civil Parish or Community	16.0000000000...	482.0000000000...	0.000000000000...	0.0000000
13	7190 Bramley CP	CPC	Civil Parish or Community	9.0000000000...	387.0000000000...	53382.00000000...	14082.000
14	7191 Haslemere CP	CPC	Civil Parish or Community	40.0000000000...	388.0000000000...	120746.00000000...	14124.000
15	7267	NCP	Non-Civil Parish or Community	32.0000000000...	592.0000000000...	0.000000000000...	0.0000000
16	7268 Salfords and Sidlow CP	CPC	Civil Parish or Community	78.0000000000...	594.0000000000...	116130.00000000...	13885.000

Attribute Table Views

The **Show All Features** button at the bottom left of the attribute table is a button which has a dropdown with a number of options to control which features appear in the table:

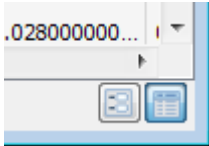
- **Show All Features:** Show all features in the data
- **Show Selected Features:** Only features selected in the map/table will be shown
- **Show Features Visible on Map:** Only features which can be seen in the current map window are shown
- **Show Edited and New Features:** During an editing session, this shows features which have been

created or edited but not yet saved

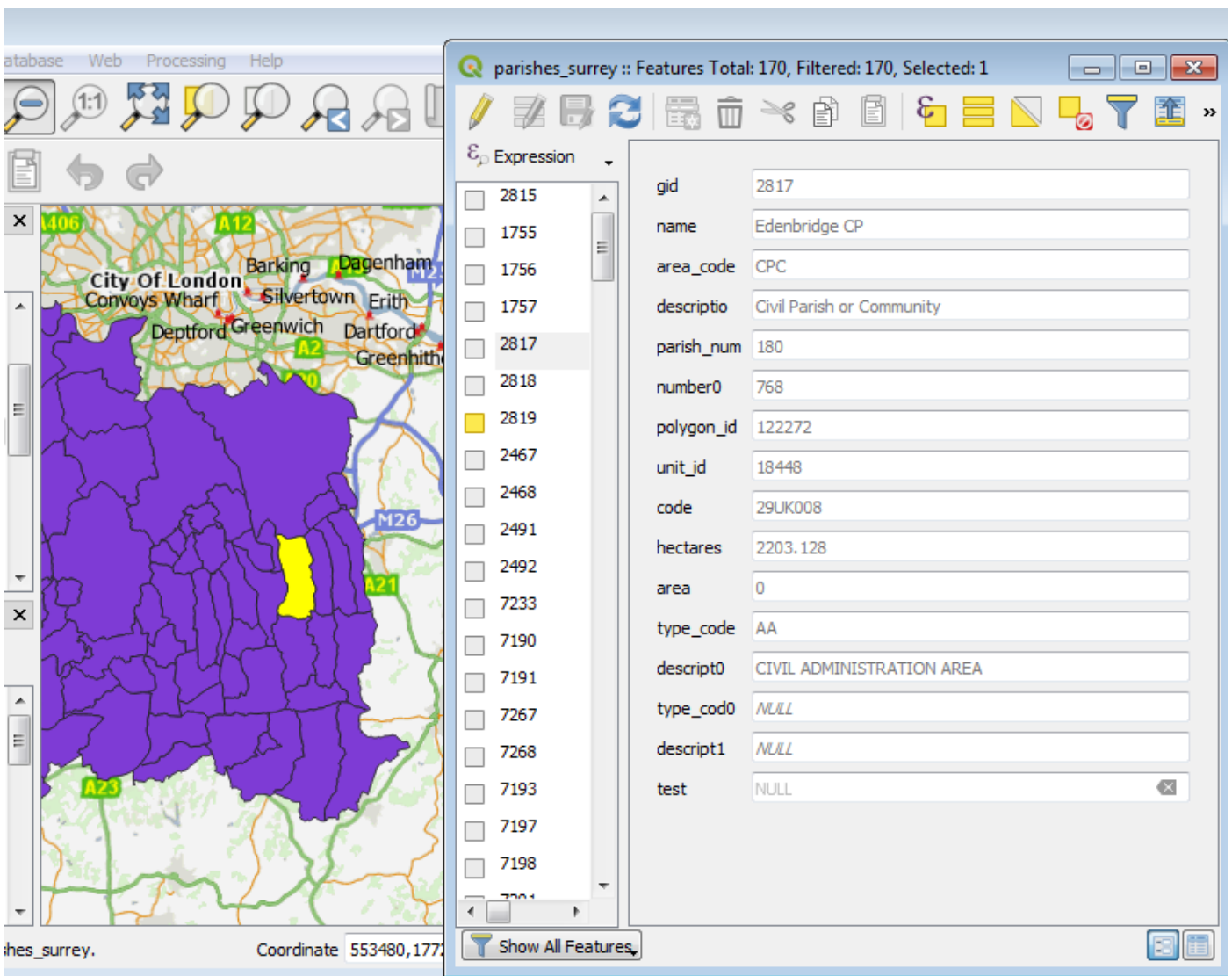
- **Field Filter:** filter the table by selecting a field and a search value
- **Advanced Filter (Expression):** filter the table by opening the **Expression based filter** dialog

Toggle Attribute Views

There are two possible views of the data within the attribute table - the default tabular or grid view, and the form view. Switch to the form view and back by using the buttons at the bottom right-hand side of the window.



The form view is similar to the form used in **Identify Results**, but includes a navigation panel on the left for moving between features. This can be more convenient for editing attribute values.



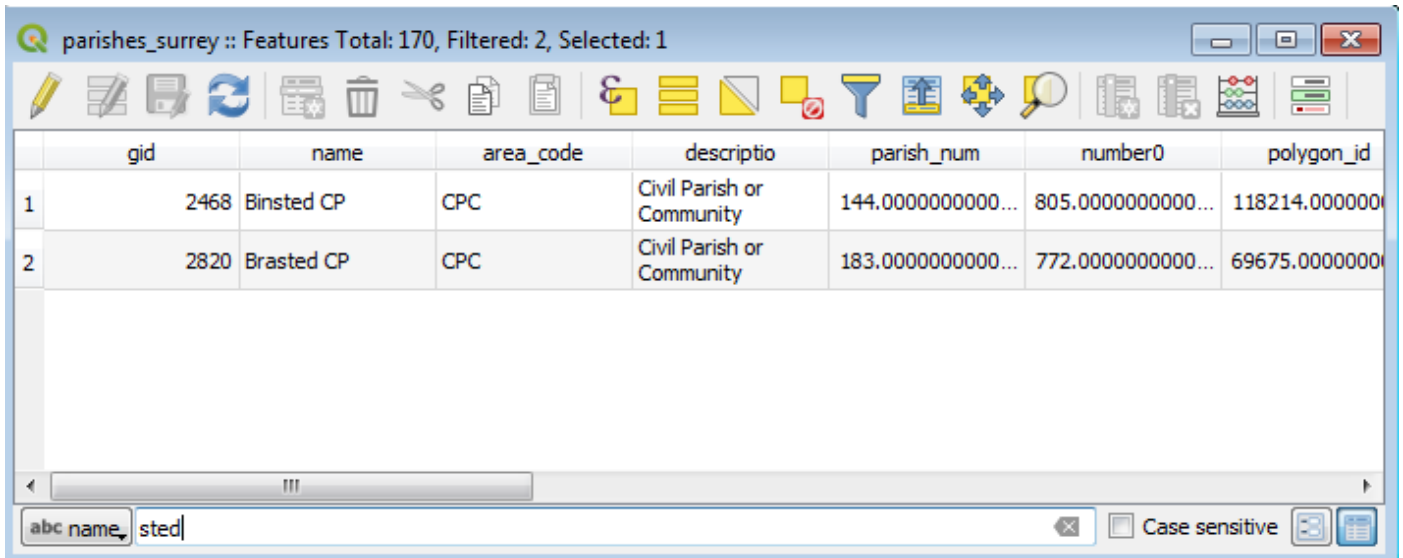
Form view

Select features in the form view of the attribute table by clicking the checkbox to the left of the feature list - once selected, the box for the feature will show yellow.

Attribute Table Field Filter

Run a simple search in the attribute table by selecting **Field Filter** from the menu in the bottom left of the attribute table dialog, then select the column name for the search. This is a simpler, single field version of the **Select by Values** tool described above, and it will show matching values interactively in the same way. To run the search, press **Enter**.

The attribute table will be filtered to show only the matching features.



Case sensitivity

Values are not case sensitive unless the **Case sensitive** box is checked, and the search is for a pattern within the string (for example **ming** will find **Birmingham**) so you don't need the exact value.

Datatypes

Here, and in many other field-specific locations, there is an indicator of datatype immediately before the field name. For example, **abc** means a text field, while **123** means numeric.

Attribute Table Advanced Filter (Expression)

Select **Advanced Filter (Expression)** from the dropdown at bottom left of the attribute table to open the **Expression Based Filter** dialog - this is the same one as opened from **Select Features by Expression** earlier. However the result of applying this expression will only filter features in the attribute table, not on the map.

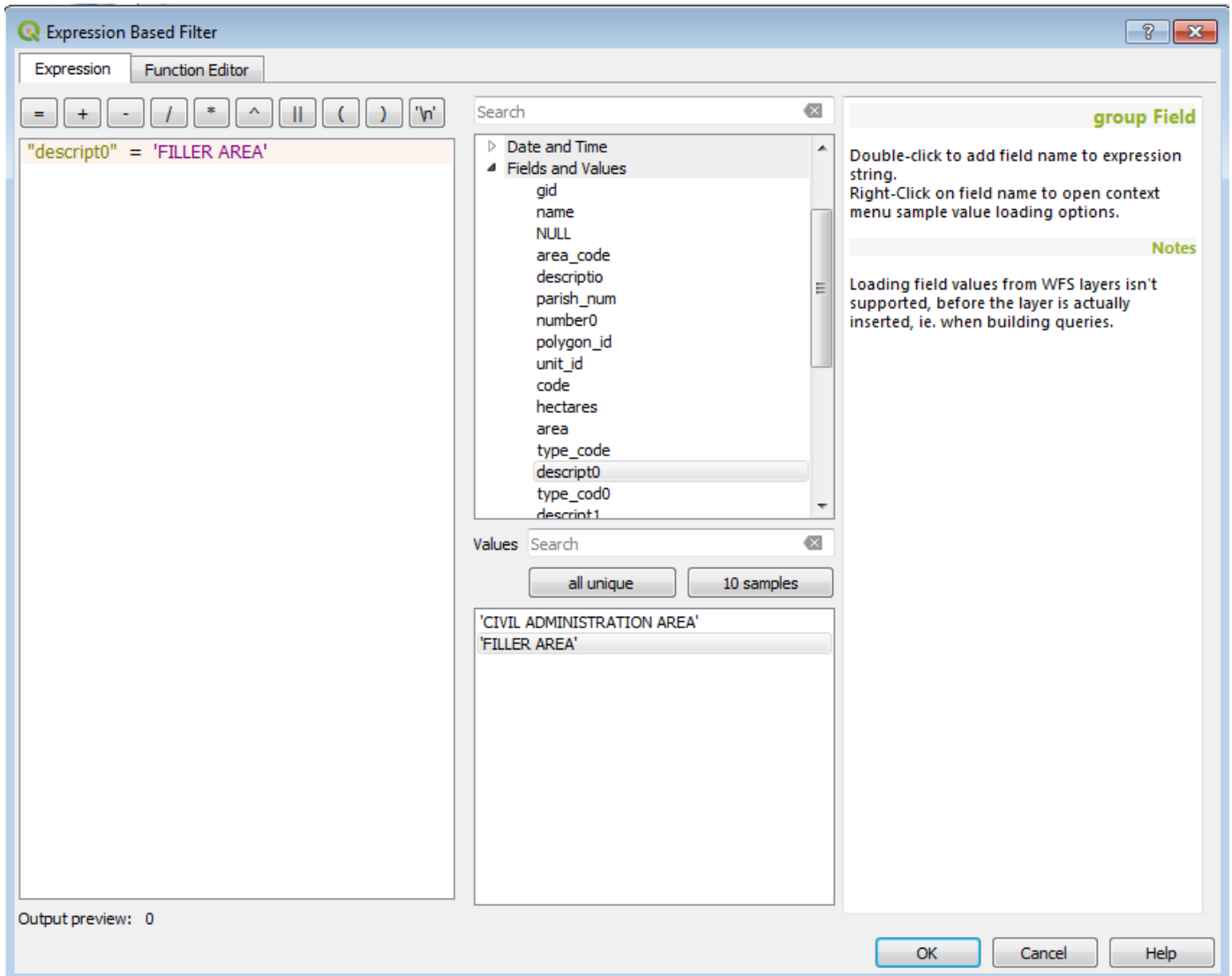
Queries can be built up in this dialog by selecting fields, operators, values and functions. For example, a simple query might be in the form:

[field] [operator] [value] - e.g. phase_of_education = 'Primary'

The example below builds a simple query to find all all parishes which are 'filler areas' - i.e. where there is no council.

1. In the **Expression Based Filter** dialog, navigate to **Fields and Values** in the central panel and select the relevant field (in this case **descript0**)
2. Double-click on the field to bring it into the **Expression** panel on the left
3. Click on the **=** operator in the **Expression** panel
4. In the **Values** panel, click **all unique** to show all the values of the field which appear in the data (or if there are a large number of values, click **10 samples**)

5. Double-click on the value you want to use for the filter (in this case 'FILLER AREA')
6. You should now have an expression in place which looks something like the screenshot below - click **OK** to apply the filter



Operators

The operators below are the most commonly used, but more are available in the dialog.

Operator	Meaning
=	Equal to
<>	Not equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to
LIKE	Case-sensitive string match

ILIKE	Case-insensitive string match
NOT	Combined with another operator to make it negative
%	Wildcard – include in the search string at the point of uncertainty
AND	Extends queries to apply more than one condition to a search
OR	Extends queries to search for different values and will be returned if either is true
	Join two values into a string

4.5. Filter (Layer)

When a layer is filtered, *only* the filtered features are visible - the user will not see any that do not meet the filter conditions, either on the map or in the attribute table.

To apply a filter:

1. Select the layer to be filtered
2. **Right-click > Filter**
3. In the **Query Builder** dialog, construct a query to show the features you need

The **Query Builder** dialog is similar but not identical to the **Expression Based Filter** dialog described above.

To reset the query in order to see all data, click **Clear** in the **Query Builder**.

4.6. Spatial Selections and Filters

The queries and expressions we have been looking at until now work by using the attribute values of layers rather than their geography. There are a number of options for running spatially-based queries in QGIS, addressing questions such as:

- Which points fall within this polygon?
- Which lines cross this boundary?
- What are the distances between features?

Two approaches are covered here:

- Selecting features based on location
- Join attributes by location

Spatial queries

There are many types of spatial queries - use the search box at the left of the information bar to look for others.

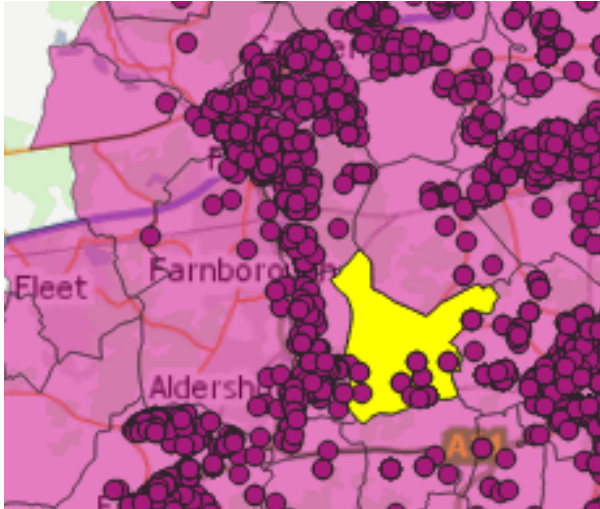
Select by Location

This tool creates a new selection of features in a layer, based on a spatial relationship between the layer and another layer (or even the same layer). For example you might want to use it to:

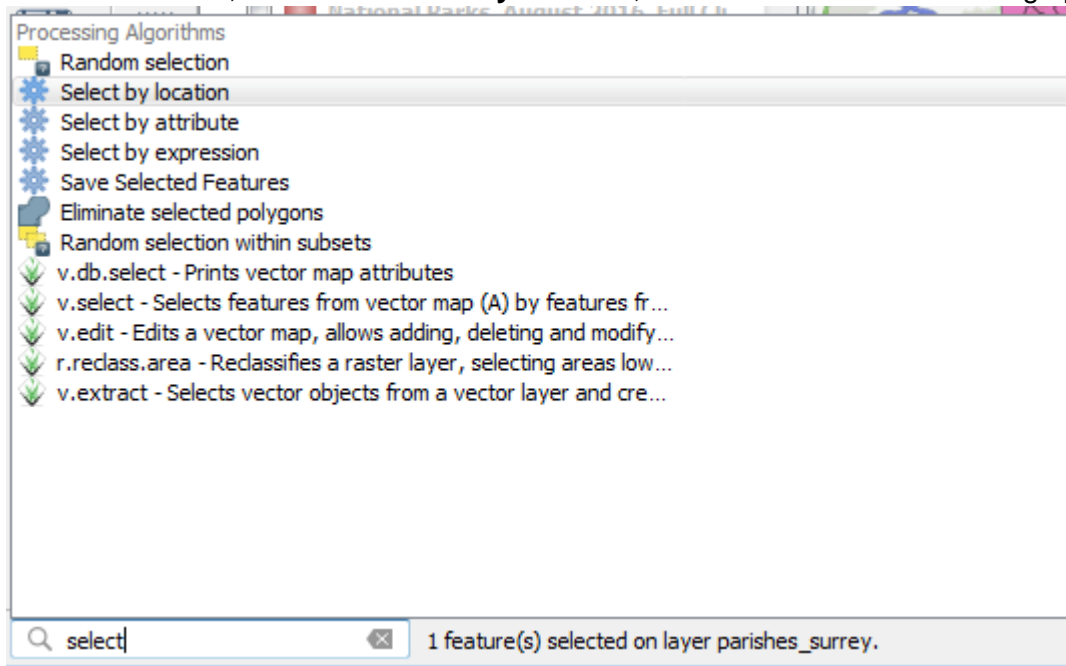
- select points in a polygon
- select lines which intersect a polygon
- select a polygon which contains a specific point.

To select points in a polygon:

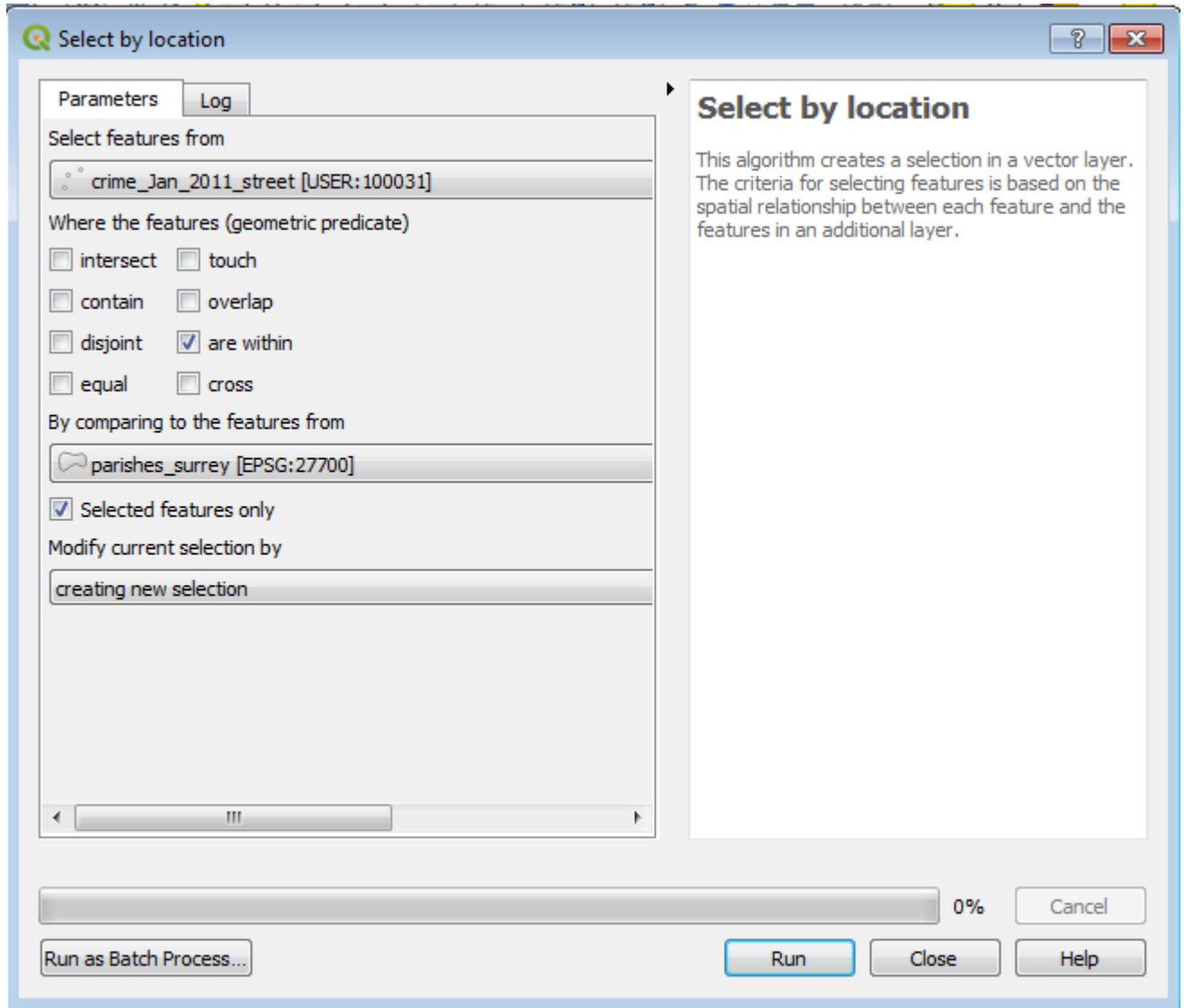
1. Select the polygon you want to make the selection within - in this instance we have selected a parish within which we want to identify crimes



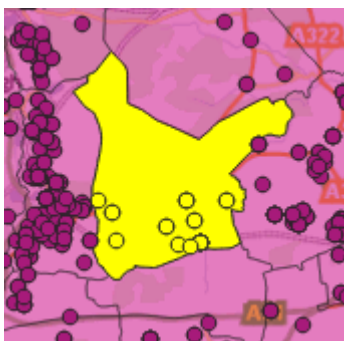
2. In the search box, search for **Select by location**, then double-click on it to bring up the dialog



3. In the **Select by location** dialog, complete the options in a similar way to the screenshot below



4. Note that:
 - a. The first layer should be the one which contains the things you want selected - e.g. *crimes*
 - b. The **predicate** determines the spatial relationship between the features in the two layers
 - c. The second layer is the one you are using to drive the selection - in this case *parishes*
 - d. The **Selected features only** checkbox specifies that only selected features in the second layer will be used to make the selection - in this case it's the single feature we selected in the first step
5. Click **OK** to run the selection - the result will be a map which looks something like this:

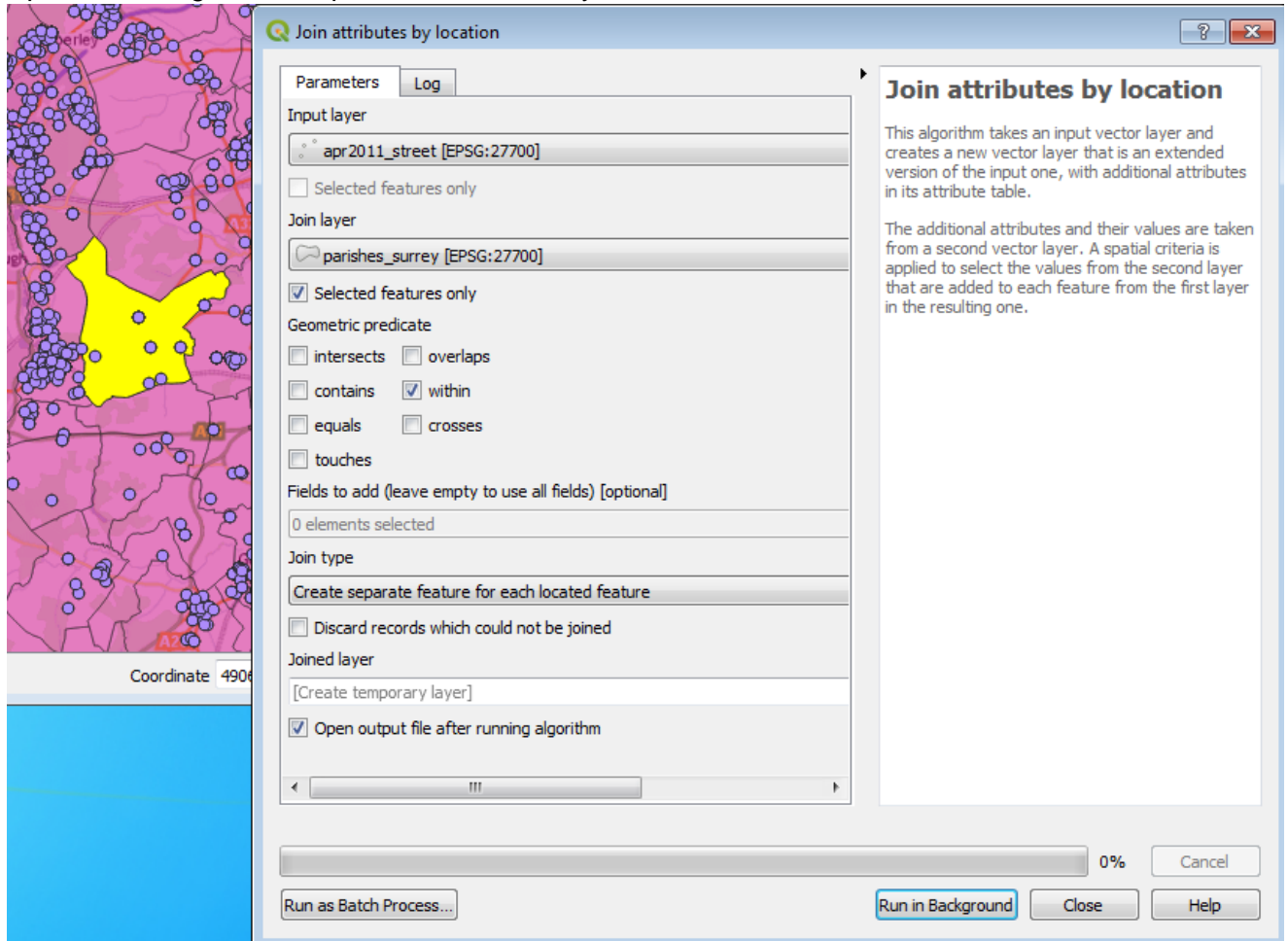


6. Note that only crimes *within* the selected parish have been selected

Join Attributes by Location

This tool carries out a similar operation to the one above, but instead of making the result a selection, it adds the attribute values of the second layer to the first, target layer, so that each feature which satisfies the criteria in the spatial analysis takes on the attributes of the feature it is within (in this case).

1. As in the previous example, select a polygon you want to make a selection with
2. In the search box, search for **Join attributes by location**
3. Open the dialog, and complete in a similar way to the screenshot below:



4. When the process is run a new **Joined layer** will be created and added to the map, comprising the original crime layer with, for each feature, the attributes from the parish it is within

Joined layer :: Features Total: 9675, Filtered: 9675, Selected: 0

	northing	location	crime_type	context	gid	name	area_code	descriptio	parish_num
1	152382.0000000...	On or near Pirbright Road	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
2	152382.0000000...	On or near Pirbright Road	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
3	151340.0000000...	On or near Manor Farm Close	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
4	152382.0000000...	On or near Pirbright Road	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
5	150222.0000000...	On or near The Paddocks	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
6	151008.0000000...	On or near Wyke Avenue	Anti-social behaviour	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
7	151345.0000000...	On or near Bailes Lane	Violent crime	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
8	152382.0000000...	On or near Pirbright Road	Other crime	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
9	151340.0000000...	On or near Manor Farm Close	Other crime	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
10	150066.0000000...	On or near Christ...	Other crime	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
11	151345.0000000...	On or near Bailes Lane	Violent crime	0	7246	Normandy CP	CPC	Civil Parish or Community	84.00000000000...
12	143969.0000000...	On or near Farnham Road	Burglary	0	NULL				NULL
13	148932.0000000...	On or near North Road	Vehicle crime	0	NULL				NULL
14	141892.0000000...	On or near New Farthingdale	Other crime	0	NULL				NULL

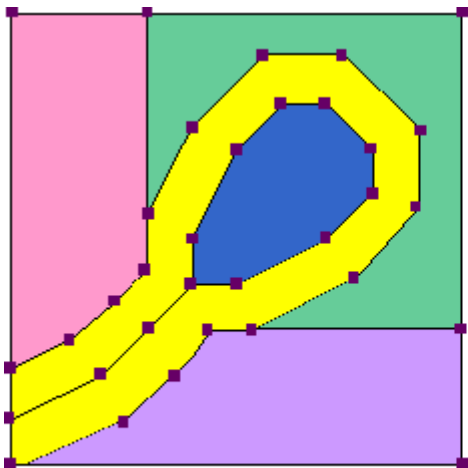
5. This layer can then be retained as a temporary layer in the project, or saved as a new layer

5. Raster Data in QGIS

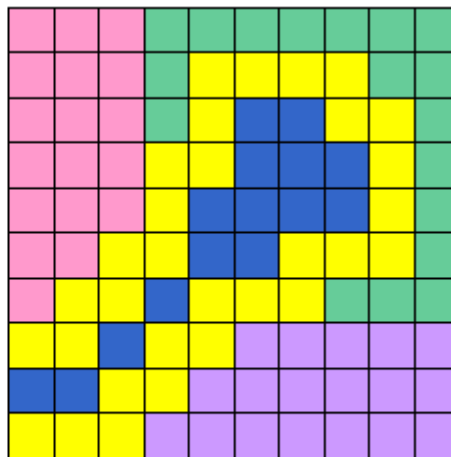
<ul style="list-style-type: none"> 5. Raster Data in QGIS <ul style="list-style-type: none"> 5.1. Introduction 5.2. File Types <ul style="list-style-type: none"> Georeference files 5.3. Loading Raster Images 5.4. Virtual Rasters 5.5. Web Map Services (WMS) <ul style="list-style-type: none"> Create a New WMS Connection Connect to the WMS 5.6. Raster Style 	<p style="text-align: center;">An Astun Technology QGIS Training Module</p> <table border="1" style="width: 100%;"> <tr> <td>Code</td> <td>QGIS-05</td> </tr> <tr> <td>Title</td> <td>Raster Data in QGIS</td> </tr> <tr> <td>Description</td> <td>Working with raster data</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>28 Mar 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-05	Title	Raster Data in QGIS	Description	Working with raster data	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	28 Mar 2018	Updated by	Antony Scott	Status	In progress
Code	QGIS-05																
Title	Raster Data in QGIS																
Description	Working with raster data																
Required Software	QGIS v 3.0 or later																
Target Audience	QGIS Desktop users																
Updated	28 Mar 2018																
Updated by	Antony Scott																
Status	In progress																

5.1. Introduction

Raster data is fundamentally different from vector data - whereas vector data has discrete features constructed from vertices, raster data is a digital image, where the shapes represented are constructed from cells or pixels, with a single numeric value per pixel (often represented as a colour) - they don't exist as separate selectable or queryable features.



Vector



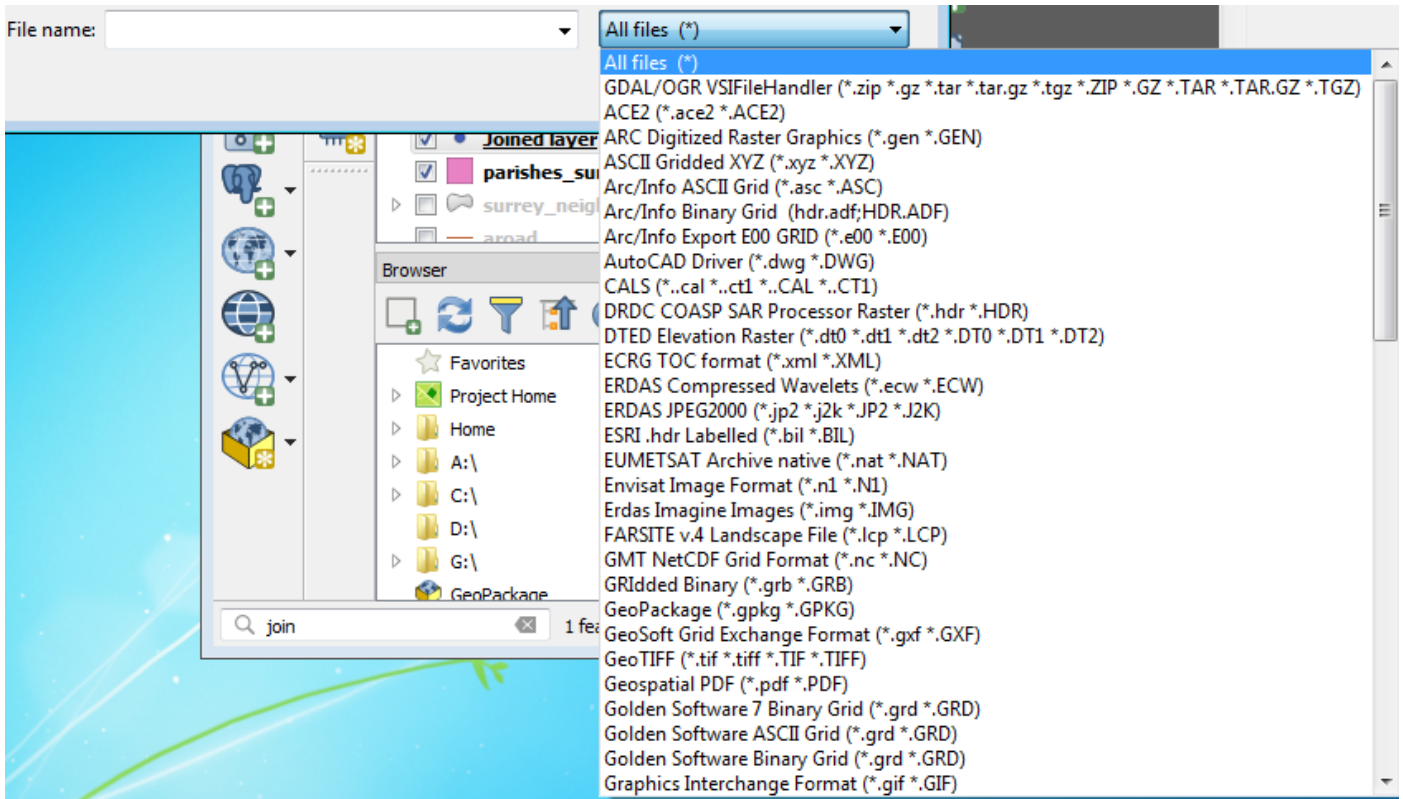
Raster

5.2. File Types

While it is possible to add most raster formats in QGIS, for images to be displayed at the correct location,

projection and location information is required. In some formats, such as GeoTIFF or ECW, this is included within the file. For other formats, a separate geo-referencing file is required for each image.

To see which raster formats are currently supported by QGIS, click **Open Data Manager**, then the **Raster** tab and browse. The file filter lists all possible raster formats (currently over 70) - QGIS uses GDAL for file conversion, so formats supported by GDAL are supported by QGIS.



Georeference files

Files which don't have georeferencing data embedded should have separate georeference files. These must have the same name as the image file, though the extension will be different, and be in the same folder as the image file.

Example georeference file formats are:

- TFW (ESRI World file)
- TAB (MapInfo file)

For Ordnance Survey tiled raster data files for example, both formats are supplied as a separate filesset, and need to be copied into the same folders as the images in order to be used. Other image suppliers provide similar files.

5.3. Loading Raster Images

To load a single raster image or a small number of files:

1. Click **Open Data Manager**, then **Raster**.
2. Browse to the file, using the file filter to show only files of a specific type if needed. Be sure to select the file itself, not the georeference file.

Multiple files

Use **Ctrl-click** or **Shift-click** to load multiple files at the same time.

- Once you have selected the file(s), click **Add** to load them as layers in the map.
- Check the layer list and the map to see that the tiles have loaded correctly.



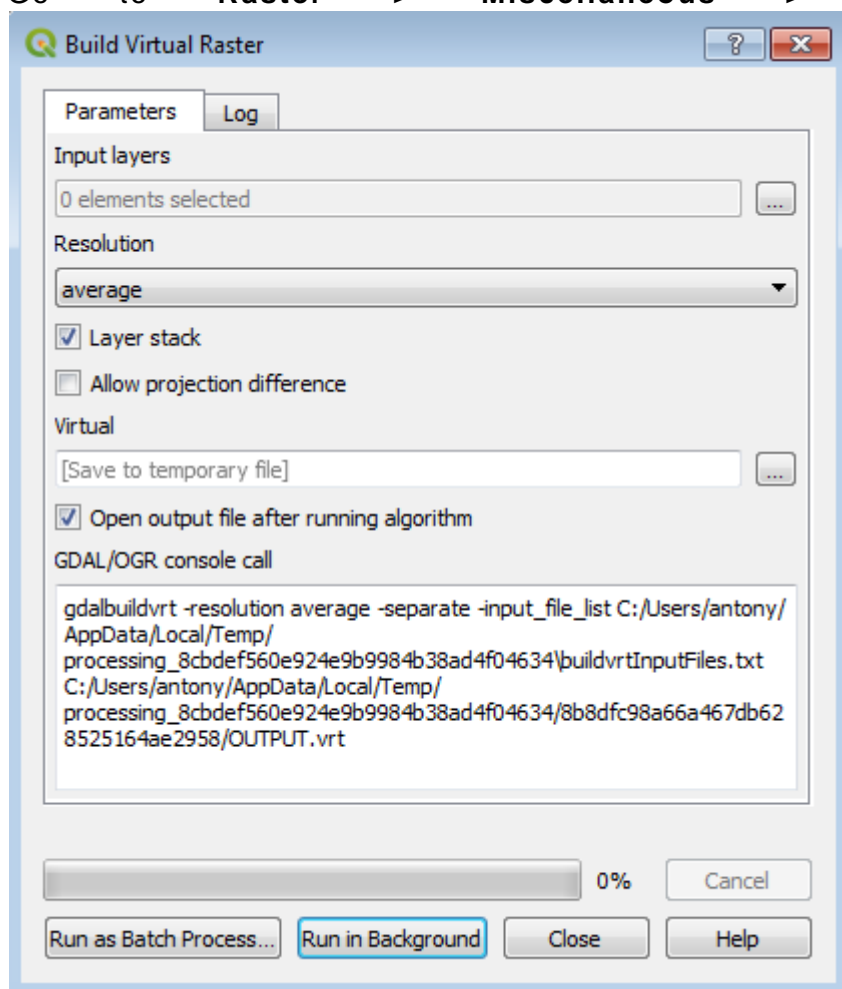
Note that each image loads as a separate layer. When there are a large number of images, you can make this easier to manage by either putting images in a group, or by creating a **Virtual Raster**.

5.4. Virtual Rasters

A virtual raster stitches raster images together so that they behave as though they were a single layer. For a set of images at the same scale which provide coverage of a defined area, this is usually the optimal format to use.

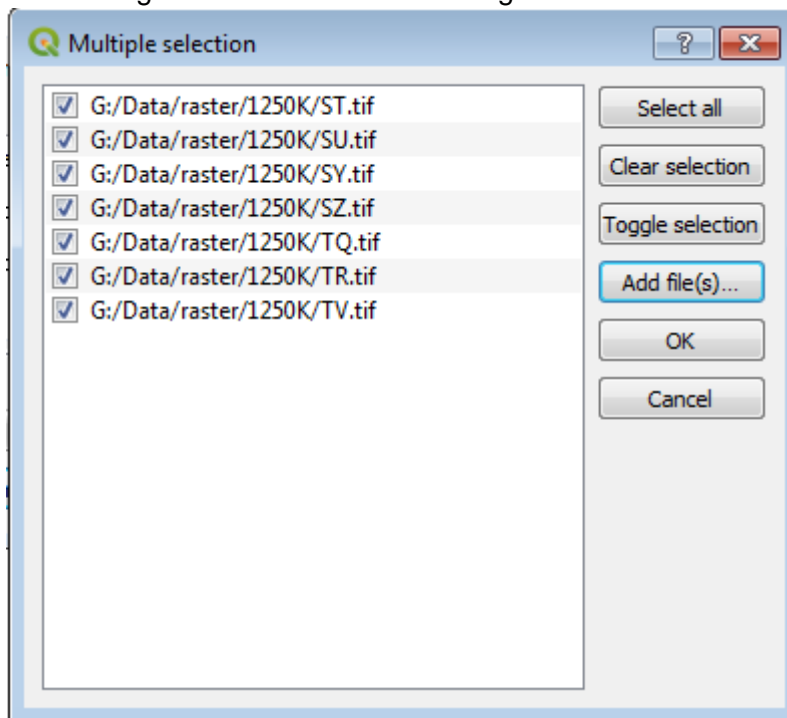
To create a virtual raster:

- Go to **Raster > Miscellaneous > Build Virtual Raster**.

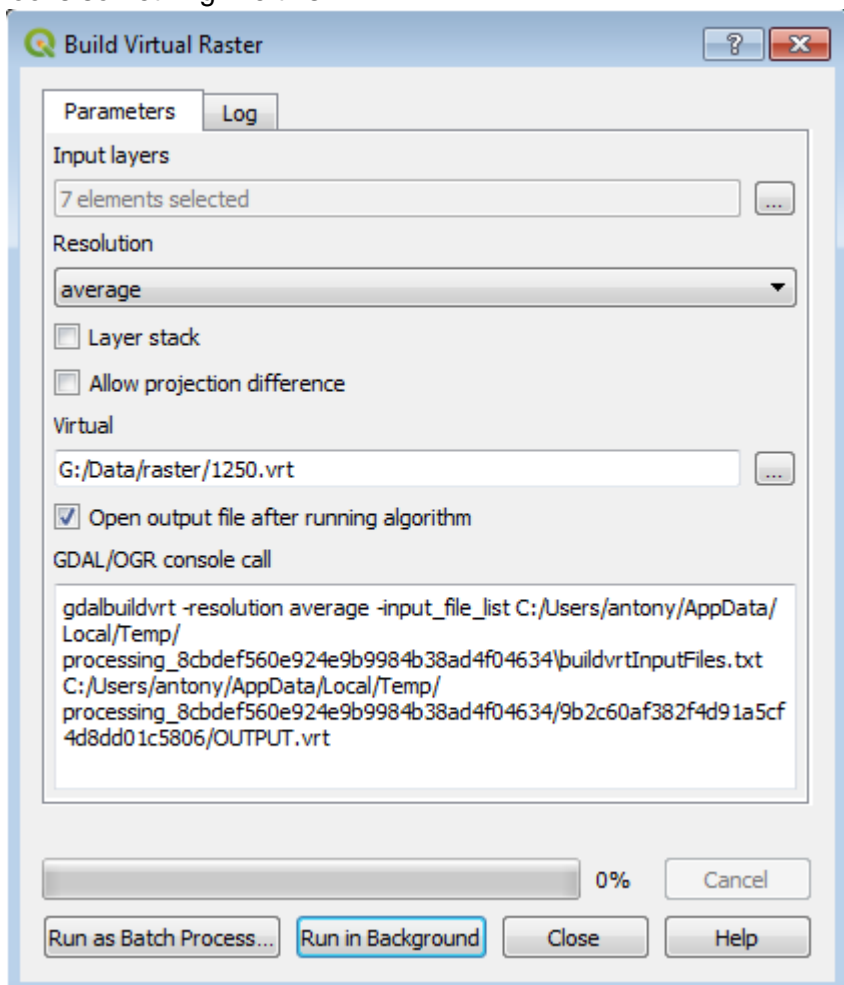


- Click the three dots under **Input layers** to select the files you want to include in the raster
- In the **Multiple selection** dialog, click **Add file(s)**, and browse to the location of the raster images you want to include
- Select all the images to be included - you may need to filter the view by type if there are georeferencing files in the folder

5. Your dialog should now look something like this



6. Click **OK**, uncheck **Layer stack** and set a location for the output file under **Virtual**, so your dialog looks something like this



7. Click **Run in Background** to create the virtual raster and load it into the map

The virtual raster layer will contain all the raster images in the directory, and once loaded it can be treated in the same way as other raster layers.

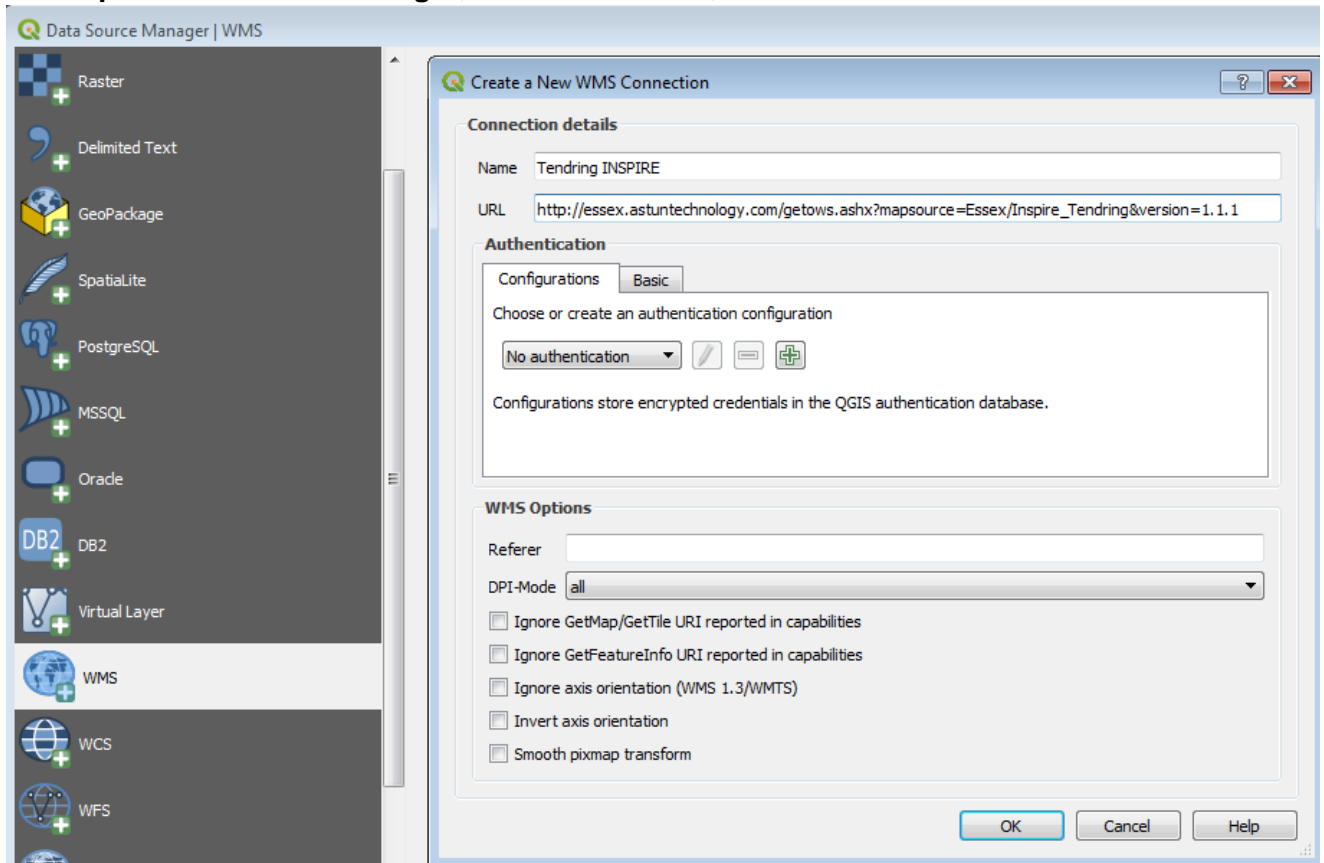
5.5. Web Map Services (WMS)

OGC Web Map Service (WMS) is a standard protocol for serving raster data (e.g. map and aerial images) over the Internet. Typically these will have been generated by map server software such as [GeoServer](#) or [MapServer](#). To use a WMS you will need to know the URL of the service, and if required, logon credentials.

Create a New WMS Connection

The first time you connect to a WMS, you will need to create a connection:

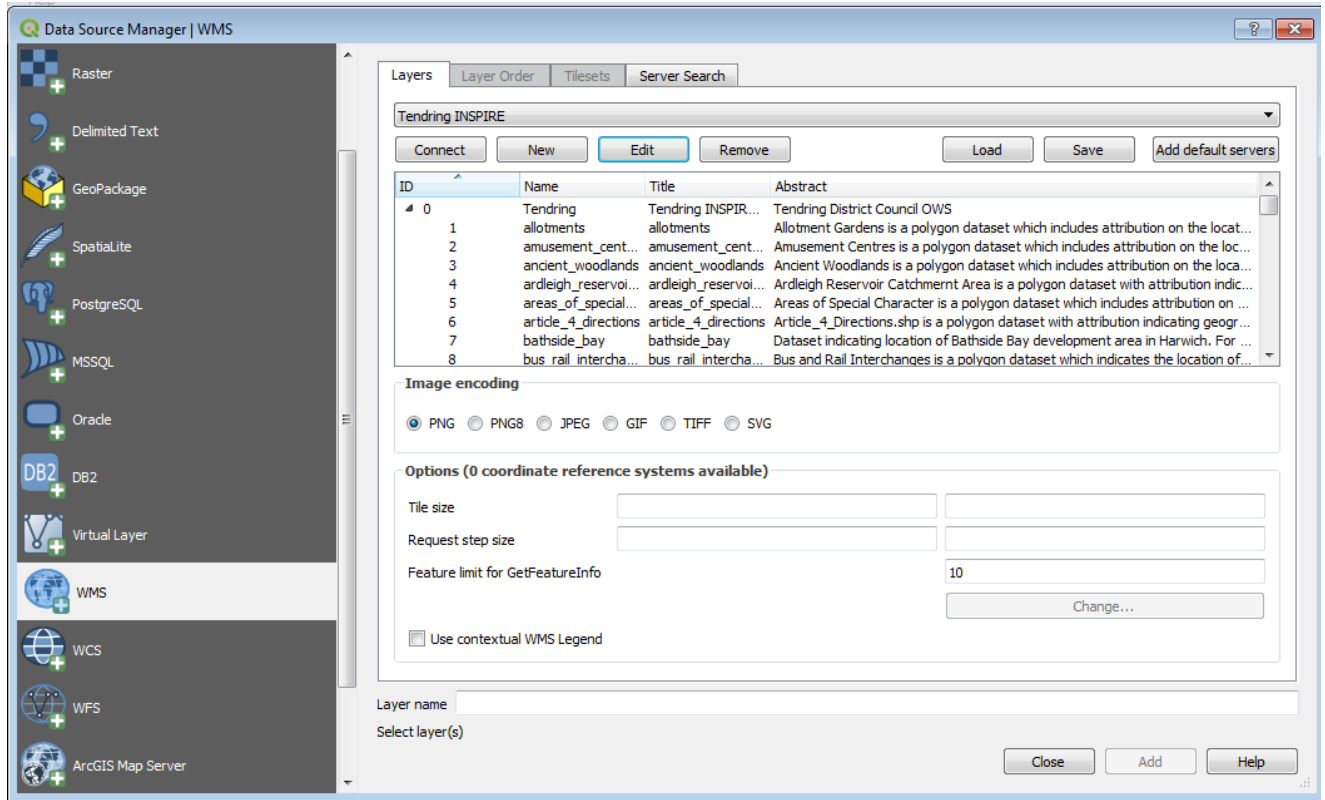
1. Click **Open Data Source Manager**, then the **WMS** tab, and **New** to create a new connection



2. In the **Create a new WMS connection** window, add the connection details:
 - a. **Name:** your name for the connection
 - b. **URL:** the URL of the WMS (e.g. http://essex.astuntechnology.com/getows.ashx?mapsource=Essex/Inspire_Tendingr&version=1.1.1)
 - c. **Authentication:** if required
3. Click **OK** - the connection uses the **GetCapabilities** service of the WMS, which returns a list of the available layers

Connect to the WMS

1. Select the required WMS and click **Connect**.



This connects to the WMS and lists the available layers

2. Select the layer required - note that these may be grouped hierarchically, you can select a layer, a group, or load everything by selecting the top level
3. Click **Add** to load WMS layers into the layer list

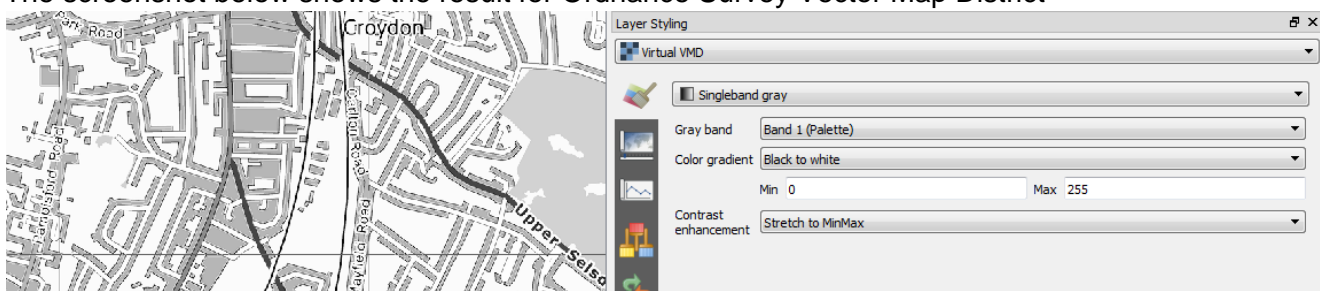
WMS Layer Order

Select multiple WMS layers by using **Ctrl-click** or **Shift-click** - layers will be loaded as a single combined layer. You can change the order in which the individual layers appear by selecting the **Layer Order** tab in the WMS dialog.

5.6. Raster Style

Most background raster images (such as the Ordnance Survey ones used in this course) are already styled. However you can amend the styling if required. For example, to change a raster to greyscale:

1. Open the **Layer Styling Dock** if it's not already open
2. Select the layer to be styled
3. In the second dropdown, select **Singleband gray**
4. If necessary, adjust other settings - for example **Color gradient**, **Contrast enhancement**, to improve the effect
5. The screenshot below shows the result for Ordnance Survey Vector Map District



6. Use the **Transparency** tab if required to set the transparency of the layer

6. QGIS Data Creation and Editing

<ul style="list-style-type: none"> 6. QGIS Data Creation and Editing <ul style="list-style-type: none"> 6.1. Introduction 6.2. Create a New Layer 6.3. Edit Layer Geometry <ul style="list-style-type: none"> Create Features Edit Feature Geometry Move a Feature Snapping Tracing 6.4. Edit Attribute Values <ul style="list-style-type: none"> The Field Calculator 6.5. Edit Field List 	<p><i>An Astun Technology Training Module</i></p> <table border="1"> <tr> <td>Code</td> <td>QGIS-06</td> </tr> <tr> <td>Title</td> <td>QGIS Data Creation and Editing</td> </tr> <tr> <td>Description</td> <td>Creating and editing data</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>03 Apr 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-06	Title	QGIS Data Creation and Editing	Description	Creating and editing data	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	03 Apr 2018	Updated by	Antony Scott	Status	In progress
Code	QGIS-06																
Title	QGIS Data Creation and Editing																
Description	Creating and editing data																
Required Software	QGIS v 3.0 or later																
Target Audience	QGIS Desktop users																
Updated	03 Apr 2018																
Updated by	Antony Scott																
Status	In progress																

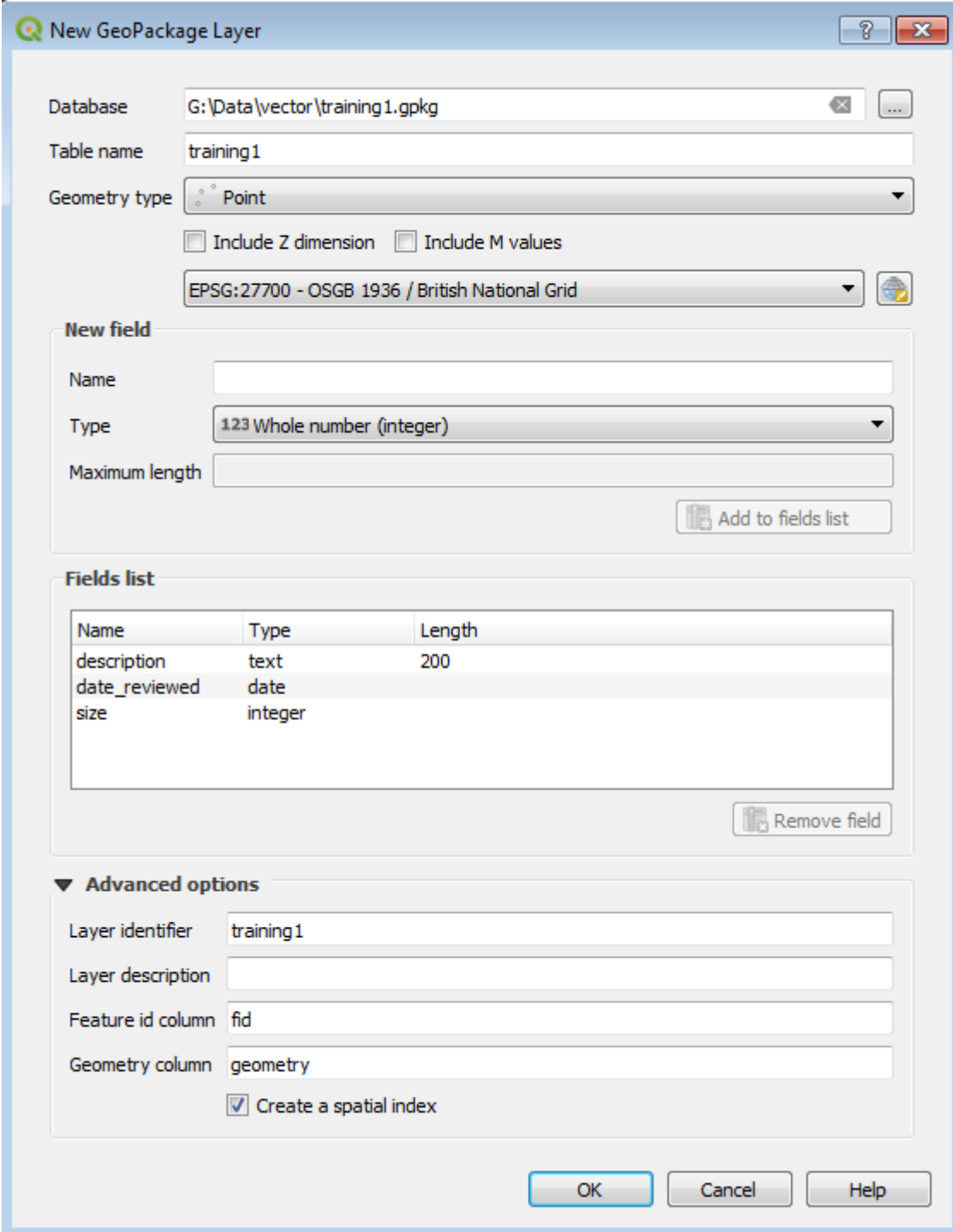
6.1. Introduction

This module looks at creating and editing vector data, including both editing geometry in the map window and editing attribute data in the attribute table and forms.

6.2. Create a New Layer

Before you can add data, you need to create a layer to put it in. The example below describes how to create a new GeoPackage layer - a file-based database format, which can hold more than one layer. However you can also create layers in other formats - for example shapefile.

1. Click **New GeoPackage layer** 
2. Complete the **New GeoPackage Layer** dialog:



New GeoPackage Layer

Database: G:\Data\vector\training1.gpkg

Table name: training1

Geometry type: Point

Include Z dimension Include M values

CRS: EPSG:27700 - OSGB 1936 / British National Grid

New field

Name: []

Type: 123 Whole number (integer)

Maximum length: []

Add to fields list

Fields list

Name	Type	Length
description	text	200
date_reviewed	date	
size	integer	

Remove field

Advanced options

Layer identifier: training1

Layer description: []

Feature id column: fid

Geometry column: geometry

Create a spatial index

OK Cancel Help

- Database:** browse using the three dots to the right of the field, and either choose an existing GeoPackage, or create a new one with an appropriate location and name
- Table name:** add a name for the layer (by default the name of the GeoPackage file) - this will appear in the layer list
- Geometry type:** set the appropriate type from the dropdown
- CRS:** select the coordinate reference system for the layer
- New field:** for each attribute in the layer, complete:
 - Name:** a name for the attribute
 - Type:** an appropriate type from the dropdown
 - Maximum length** (where required): in number of characters, at least as long as your longest value in the data
- Add to fields list:** when you have specified the details of each field (although you can add fields later)

3. Click **OK** to add the layer to the map

6.3. Edit Layer Geometry

To edit a layer, select it in the layer list, then **Right-click > Toggle Editing** or select the **Edit** tool from the **Digitizing** toolbar.

Note that edits are not saved to their source until you actively save them - use the **Save Layer** button to do this (you will be prompted to save when you use the **Toggle Editing** button to stop editing).

Undo

Ctrl-Z (undo) will reverse the last change you made, as long as you have not saved your edits.

Create Features

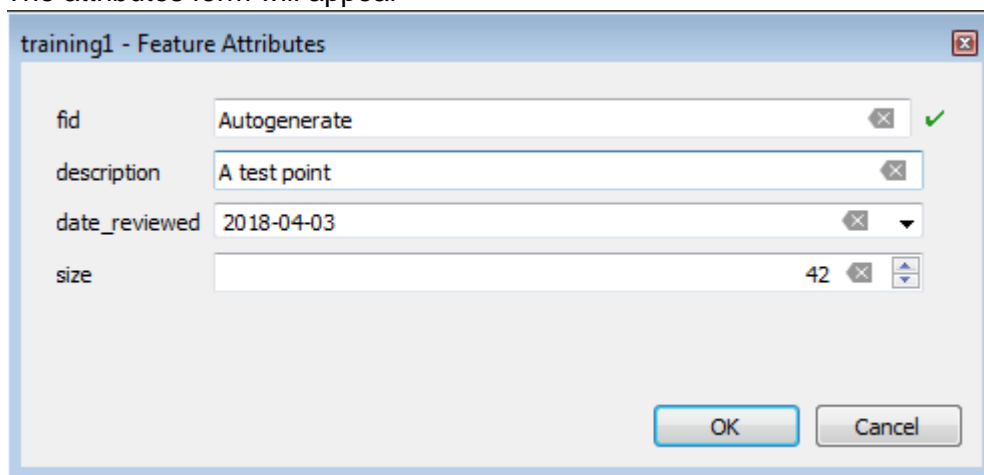
Create features in a layer using the **Add Feature** button in the **Digitizing** toolbar. This button varies according to the type of feature being created (e.g. points, lines or polygons) - in the screenshot below, the button (fourth from left) is for creating new polygon features.



The individual points which make up features are known as *vertices*.

Add Points to a Layer

1. Select or create a point layer, and turn on editing
2. Click **Add Point Feature** in the **Digitizing** toolbar, then move the cursor to required location and click
3. The attributes form will appear



4. Add the appropriate attribute values and click **OK** (values can be added later if you prefer)
5. The new point will appear on the map
6. Save edits and turn off editing

Adding Lines and Polygons to a Layer

The process for adding lines or polygons is similar to that for adding points, but for each feature you need to add a number of vertices.

1. In a line or polygon layer, click **Add Feature**
2. Click to add the first vertex

3. Continue clicking to add vertices
4. Right-click to complete the feature, and show the attributes dialog

Vertex tips

- To delete the last vertex you created, use **Backspace**
- If you double-click when digitising, two nodes will be created on top of each other – this is best avoided.

Edit Feature Geometry

To modify the geometry of a feature, edit individual vertices. This is fairly intuitive (and easier to do than to describe), but here are some instructions:

1. Turn on editing for the layer
2. Select the **Vertex Tool**
3. Hover over the vertex you want to edit, and:
 - a. **create a new vertex**: double-click on the X which appears between two existing vertices
 - b. **move a vertex**: click once on a vertex to select it, move the mouse to its new position, and click again
 - c. **delete a vertex**: click on the vertex to select it, then click **Delete**
 - d. **delete multiple vertices**: click and drag a rectangle over the nodes to be deleted, then click **Delete**
 - e. **move a segment of a line or polygon**: click the segment to select it, move the mouse to its new position, click again

Move a Feature

To move a feature to a new position (without changing its geometry):



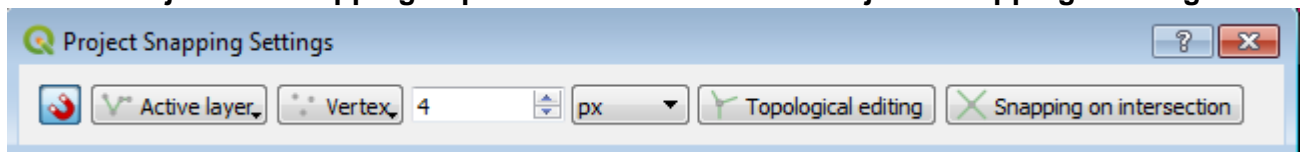
1. Click the **Move Feature** button
2. Click and drag the feature to a new position

Snapping

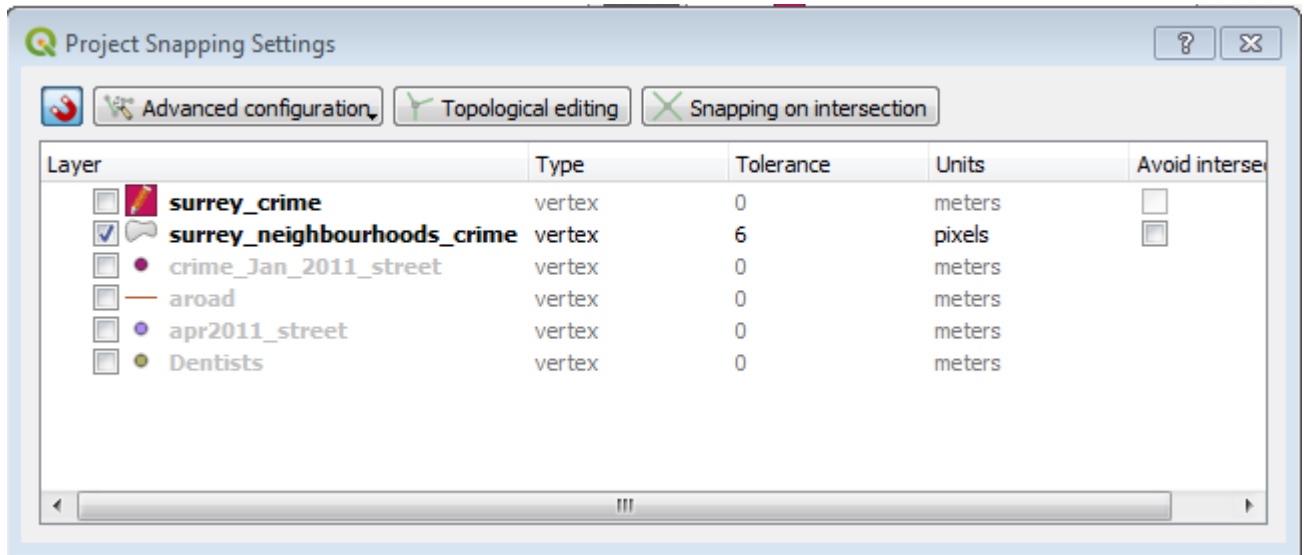
Snapping allows you to create new features, or move existing ones, to align exactly with the coordinates of another feature - for example to create a new boundary or building footprint which abutts or encloses an existing one. When snapping is activated, any new vertices you create will snap to the coordinates of an existing vertex in the target layer, if you click within the tolerance settings.

To turn on snapping and define options:

1. Go to **Project > Snapping Options** to activate the **Project Snapping Settings** dialog



2. Turn on snapping using the **toggle snapping button** on the left
3. Set the layer you want to *snap to* using the **Active layer** dropdown - if you want to snap to a specific layer, you will probably need to select **Advanced configuration** to select it



4. Select the appropriate layer(s), and set a **tolerance** value - this governs the distance your cursor needs to be from an existing vertex before you can snap to it.
5. Continue editing - when you move the cursor within the tolerance settings of an existing vertex, it shows a purple square, indicating that you are within snapping range

Snapping

Snapping setting stay in place until you change them.

Tracing

As well as snapping, you can go one step further and trace features - i.e. replicate some or all the points on a line or polygon in a new feature.

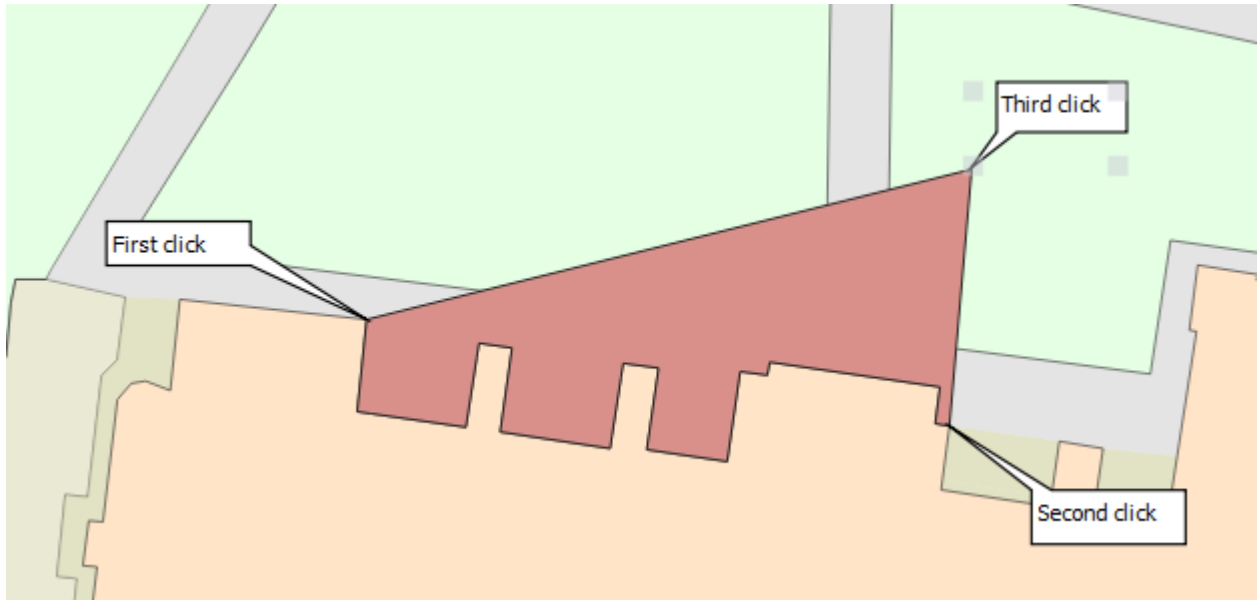
To turn on tracing, activate the **Snapping Toolbar**:



You need at least two layers: the one you are editing, and the one you are tracing, and you also need to turn on snapping - the tracing tool will only follow lines in layers which have snapping turned on.

To trace over a polygon:

1. In the **Snapping Toolbar**, click **Enable Tracing** (the right-hand button)
2. Move the cursor over the first vertex you want to trace, and click
3. Move the cursor over the last vertex of the section of the polygon you want to trace to, and click
4. All the points on the polygon in between your clicks will be digitised, and you can continue creating vertices to create your new polygon

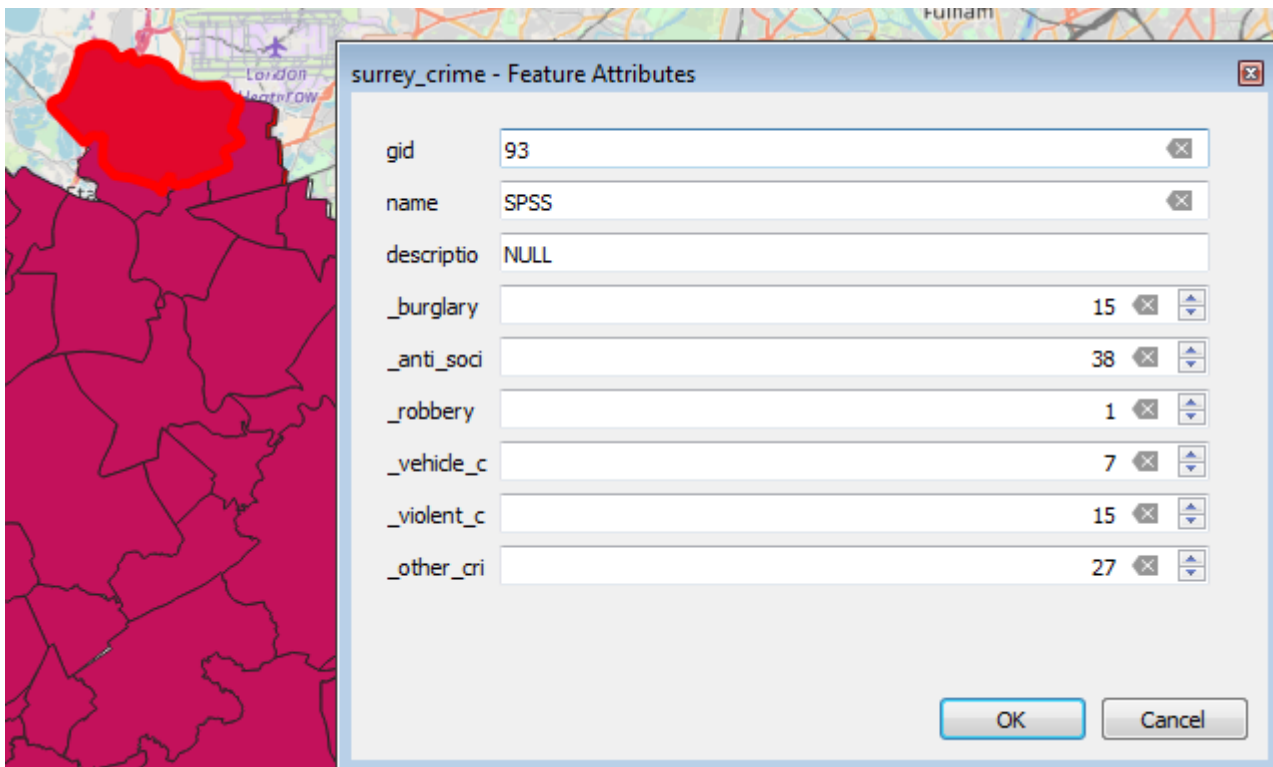


5. In this example, the darker polygon has been created with three clicks

6.4. Edit Attribute Values

Attribute values can be edited directly in the attribute table, as you would in a spreadsheet. You need to have editing turned on for the layer - this can be done in the attribute table itself.

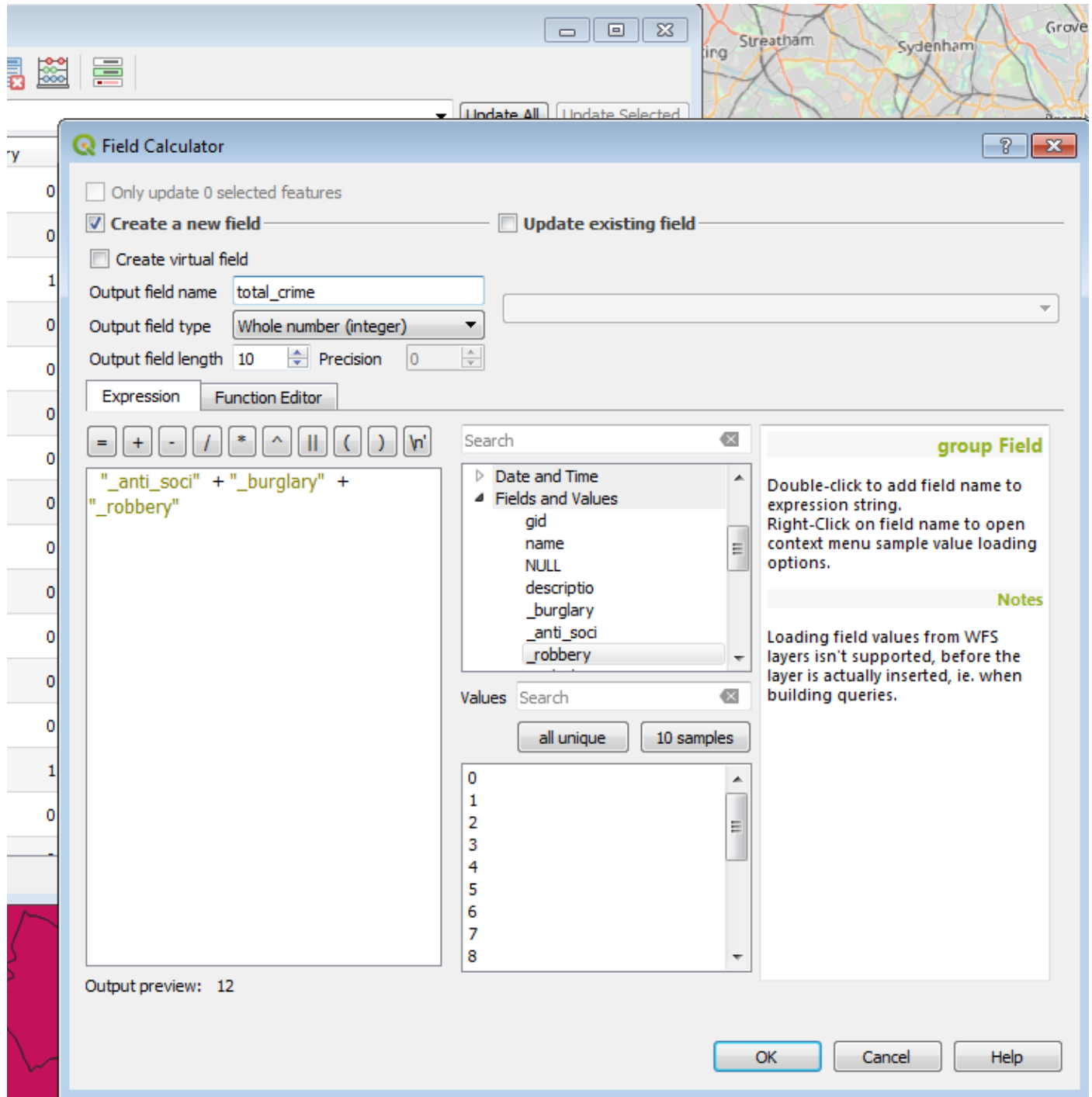
With editing on, you can also use **Identify Features** to select a feature and edit its attributes in a form.



The Field Calculator

The **Field Calculator** creates new fields, or amends the values of existing ones, by using expressions. For example, you could create a new field which totals the values of two existing fields.

Open **Field Calculator** by clicking the button in the attribute table toolbar.



Choose whether to create a new field or update an existing one, and use the expression builder to specify the contents of the target field - in the example above, the total of all crime types.

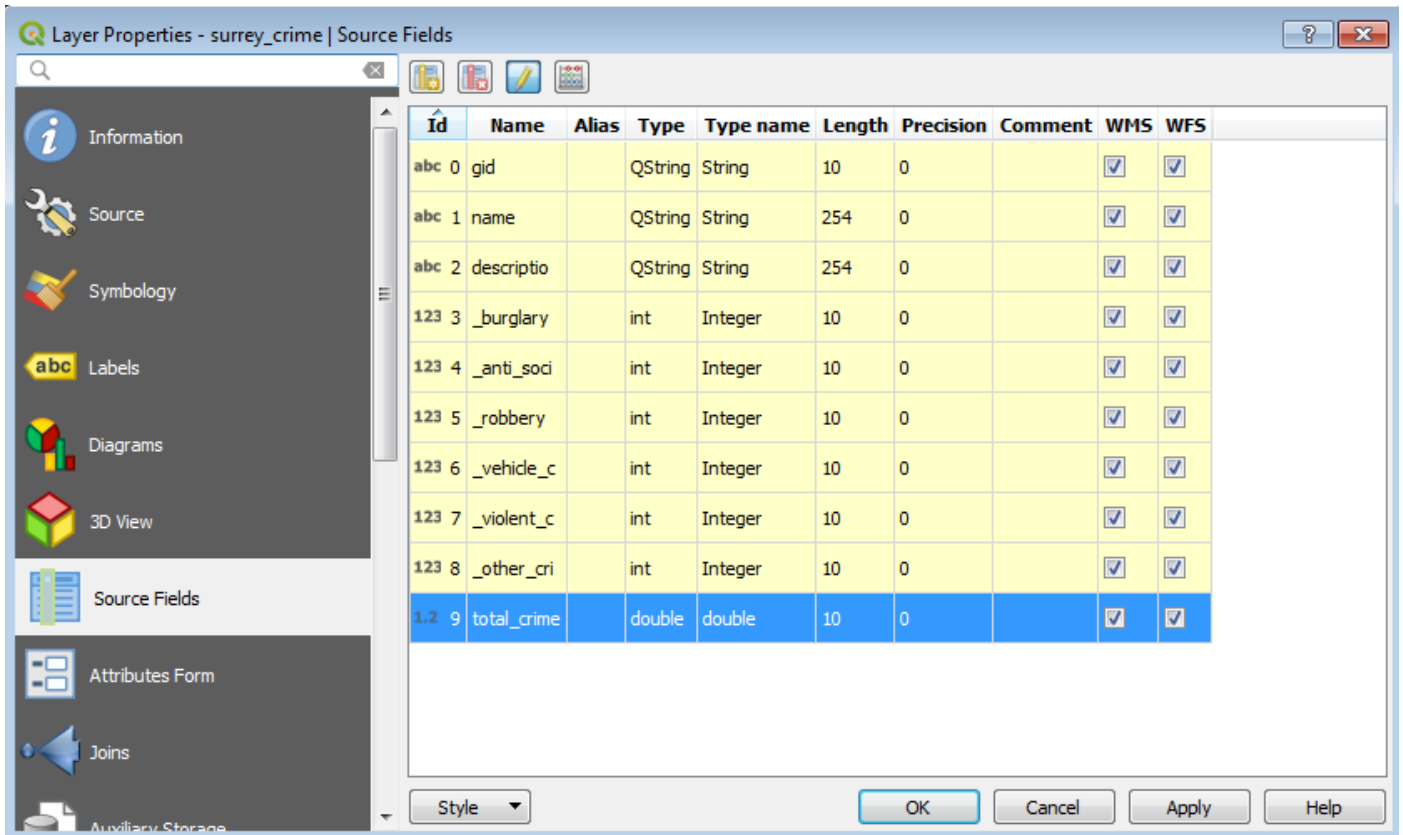
As examples, you can use the **Field Calculator** to:

- **Rename a field:** create a new field with the same type and length as the source field, with a new name, and populate the new field with data from the old field
- **Change data type:** use a data type conversion (under **Conversions**) such as **to_int** to change a data type from string to numeric, for example
- **Derive coordinates:** in the **Geometry** options, the **\$x** and **\$y** functions will return the coordinates of the points in a point layer

6.5. Edit Field List

Fields can be added to and deleted from a layer in the **Layer Properties** dialog.

Select the layer, then **Right-click > Properties > Source Fields**.



Use the toolbar buttons to add and delete fields, bearing in mind that editing needs to be turned on to do this.

Refactoring fields

You cannot change the name, type, alias or length of a field once it has been created, but you can use the **Refactor Fields** algorithm to create a new layer with any required field changes.

7. QGIS Geo Processing

<ul style="list-style-type: none"> 7. QGIS Geo Processing <ul style="list-style-type: none"> 7.1. Introduction 7.2. Geoprocessing Functions <ul style="list-style-type: none"> Fixed distance buffer Intersection Difference Union 7.3. Other Tools <ul style="list-style-type: none"> Polygon from Layer Extent Random points inside polygons Vector grid 7.4. Analysis Tools <ul style="list-style-type: none"> Distance Matrix Sum line lengths Count points in polygon 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-07</td> </tr> <tr> <td>Title</td> <td>QGIS Geo Processing</td> </tr> <tr> <td>Description</td> <td>Processing and analysing vector data.</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>04 Apr 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-07	Title	QGIS Geo Processing	Description	Processing and analysing vector data.	Required Software	QGIS v 3.0	Target Audience	QGIS Desktop users	Updated	04 Apr 2018	Updated by	Antony Scott	Status	In progress
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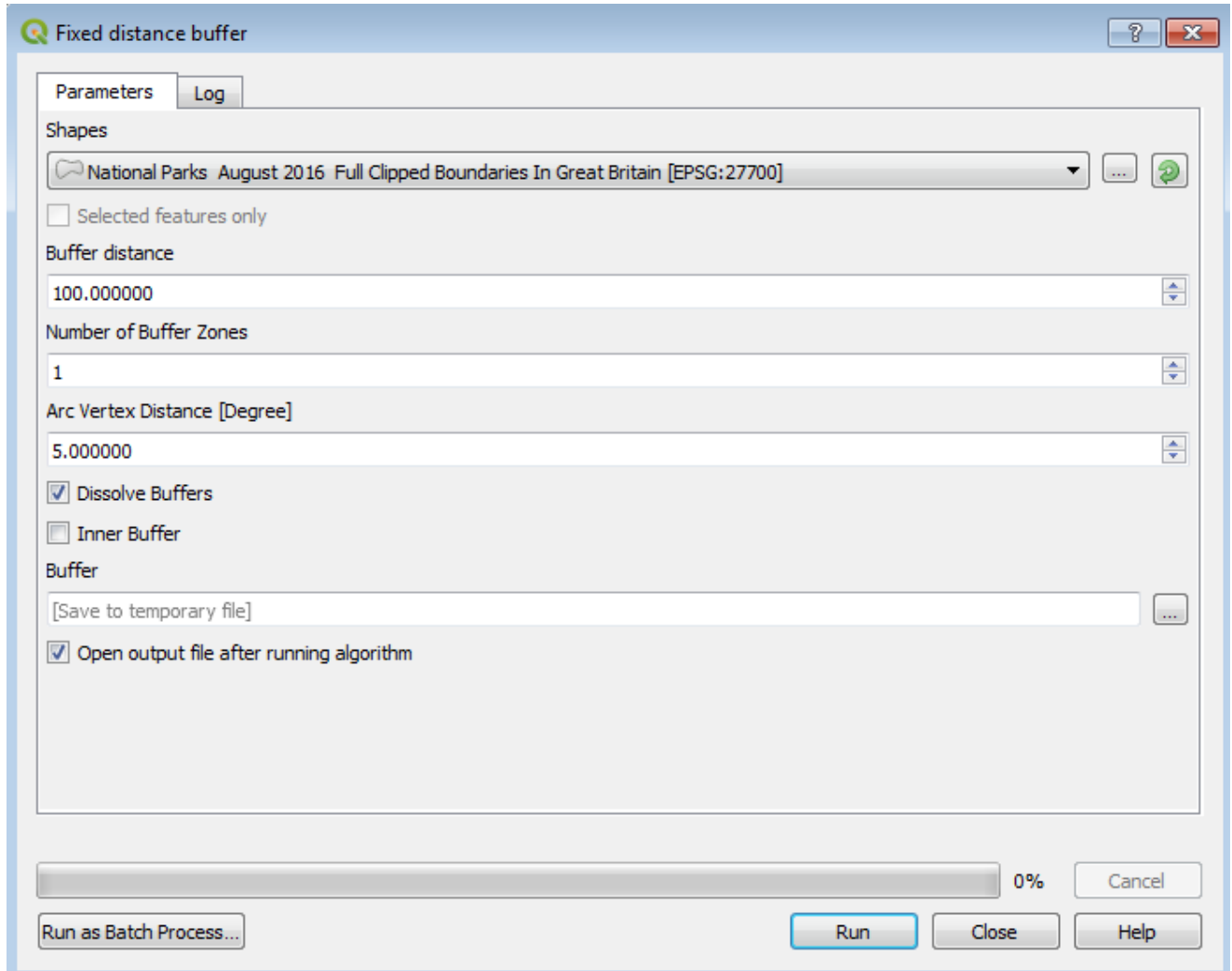
7.1. Introduction

This module introduces a few of the common QGIS vector processing functions. In most cases, functions take as input one or more vector layers and create a new vector layer as output. Many functions can be accessed either through menus or by navigating in the **Processing Toolbox** - however the instructions below use the search bar ('omnisearch') as the easiest way of finding them.

7.2. Geoprocessing Functions

Fixed distance buffer

1. In the search bar, type *buffer* and select **Fixed Distance Buffer**



2. Complete the dialog as follows:

- a. **Shapes:** the layer to be buffered - to buffer a layer not currently in the map, browse to it using the button to the right of the dropdown
- b. **Selected features only:** buffer only the features in the source layer which are selected
- c. **Buffer distance:** the distance in the units of the CRS of the layer (for example metres for British National Grid) that the buffer should be from the source features
- d. **Number of buffer zones:** increase this from one to create multiple buffers - i.e. to buffer the buffers
- e. **Arc Vertex Distance:** this controls the extent to which the buffer follows the shape of the source line or polygon (it has no effect for lines) - normally the default is adequate
- f. **Dissolve Buffers:** if checked, creates a single output multipolygon feature as shown below, with any overlapping boundaries dissolved - if unchecked, a polygon is created for each source feature

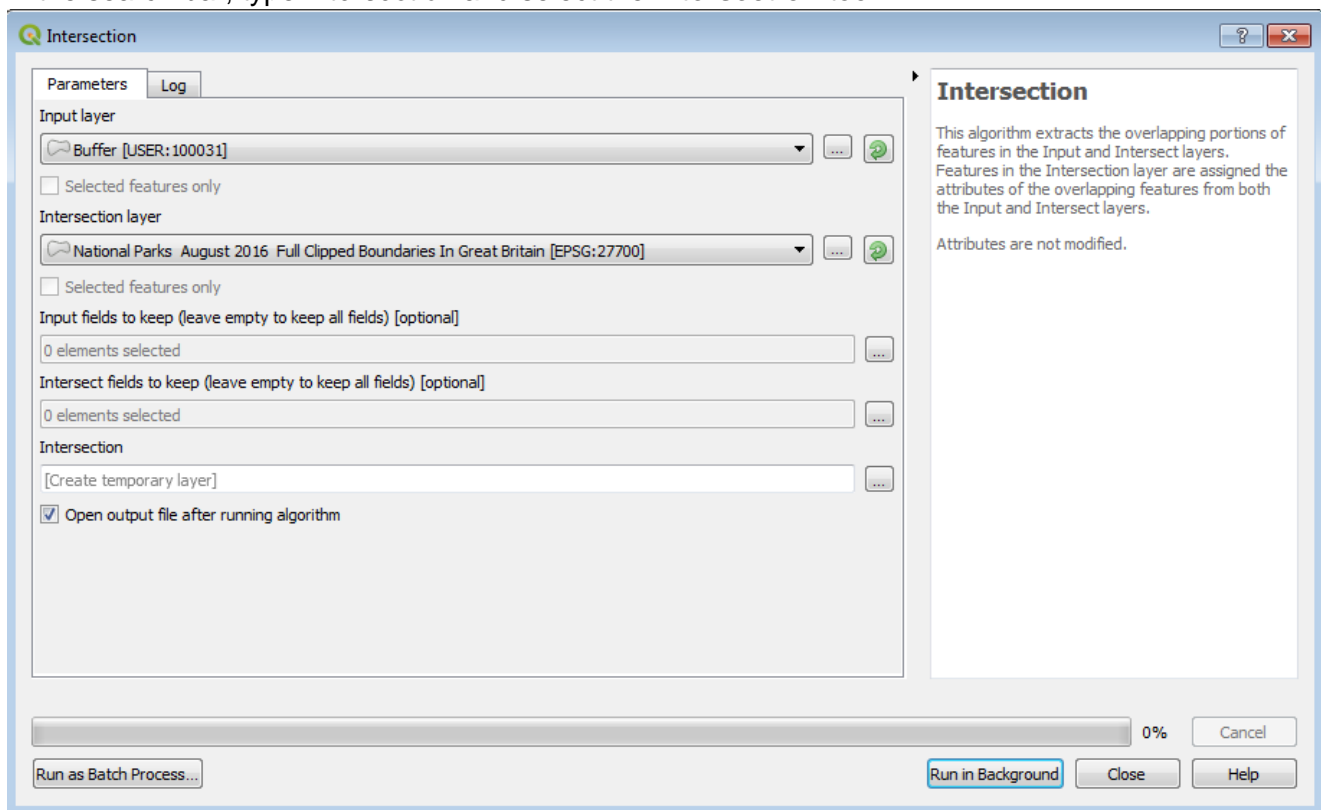


- g. **Inner Buffer:** for polygons, creates a buffer inside rather than outside the polygon - has no effect for lines and points
- h. **Buffer:** leave blank to create the output in memory, or browse to a location and enter a file name to save the output
- i. **Open output file after running algorithm:** load the buffer output into the map
- j. **Run as Batch Process:** run multiple buffer processes as a single job
- k. **Run:** create the buffer output

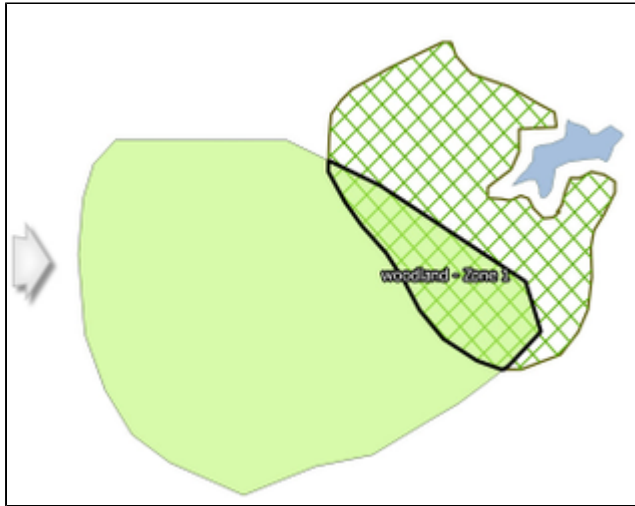
Intersection

This process creates an intersection of two sets of geometry - i.e. a new layer representing the shared areas of the input layers.

1. In the search bar, type *intersection* and select the **Intersection** tool



2. Complete the dialog, and click **Run in Background** to add the intersect layer to the map - the screenshot below shows (outlined in black) the intersect between the green and the hatched layer



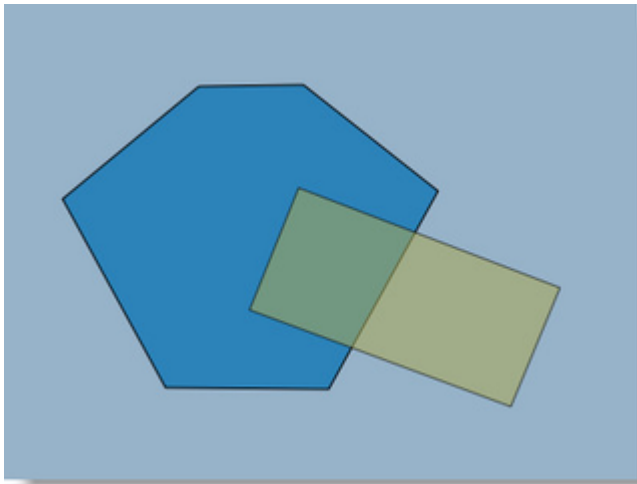
Difference

The difference between two vector layers is represented by the areas which are in one but not the other - in other words the inverse of intersection. The **Difference** tool has a similar dialog to the **Intersection** tool, with two input layers specified.

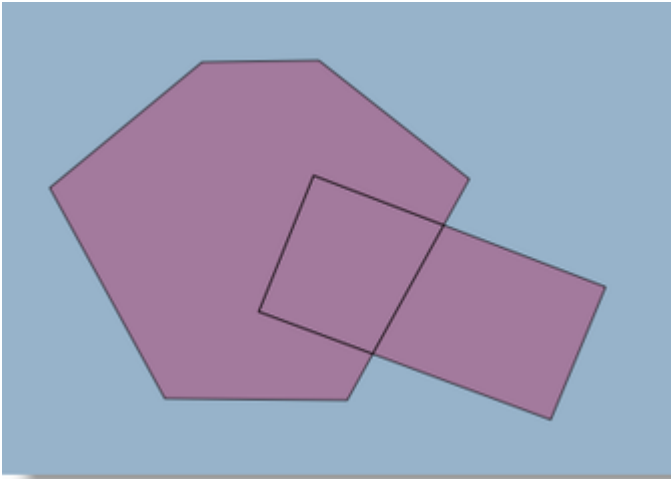
Union

The union tool merges the geometries from two layers into a single layer. Note that it does not dissolve boundaries between features or create multi-polygons, but rather creates features comprising all component parts from the two geometries. To use **Union**, search in the search bar.

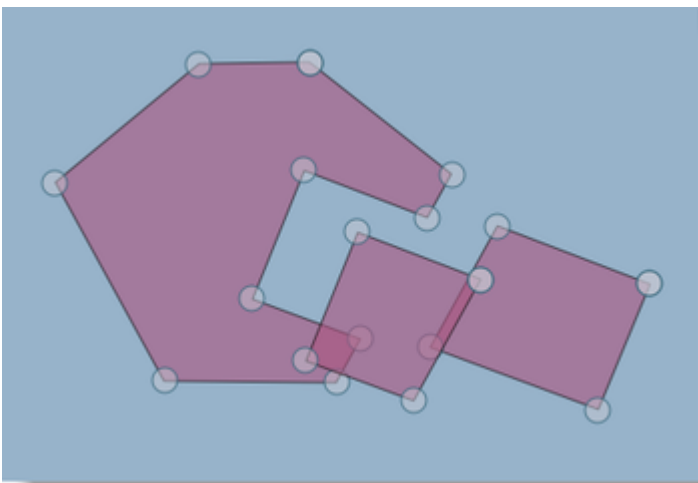
If these are the features to be unioned:



The result would be as follows:



Note that separate features have been created where there is an overlap - in the screenshot below they have been moved to demonstrate this:

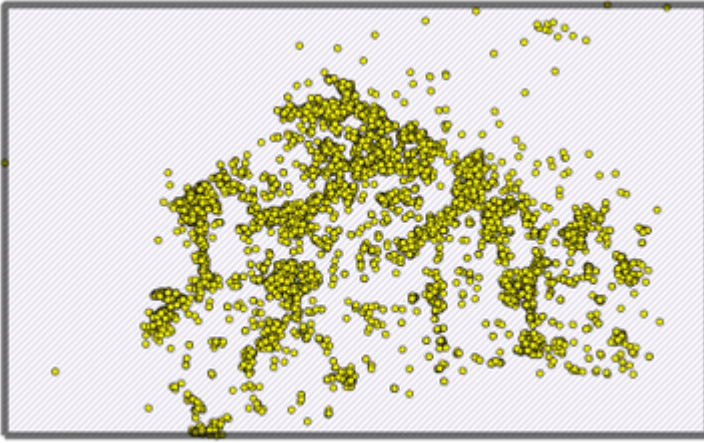


7.3. Other Tools

As well as 'standard' geoprocessing functions, QGIS includes a range of useful tools that can be used for research or other purposes - some examples are described here. In each case, use the search bar to load the dialog.

Polygon from Layer Extent

This creates a rectangle (in black) that represents the maximum extent of all the features in a layer.

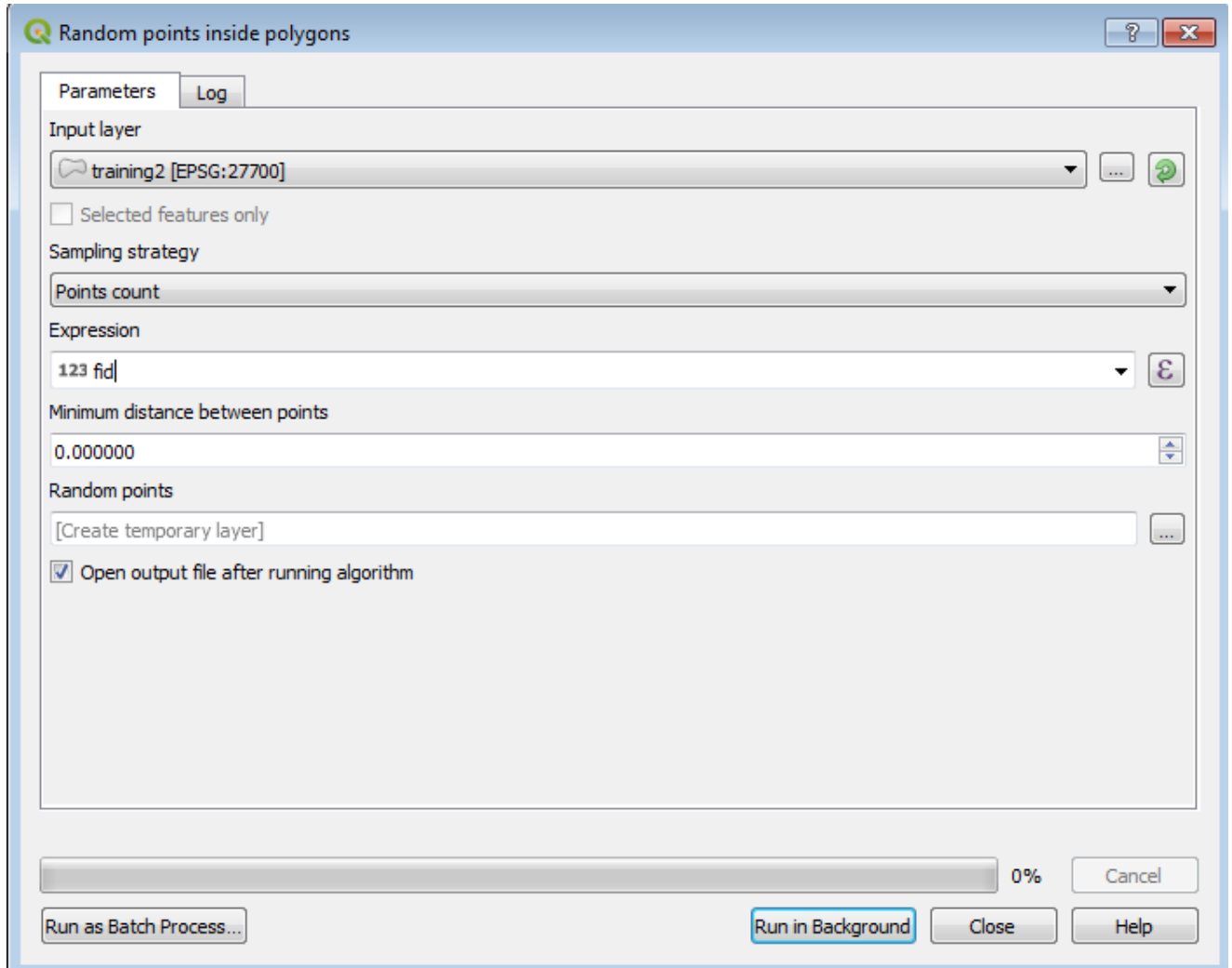


Random points inside polygons

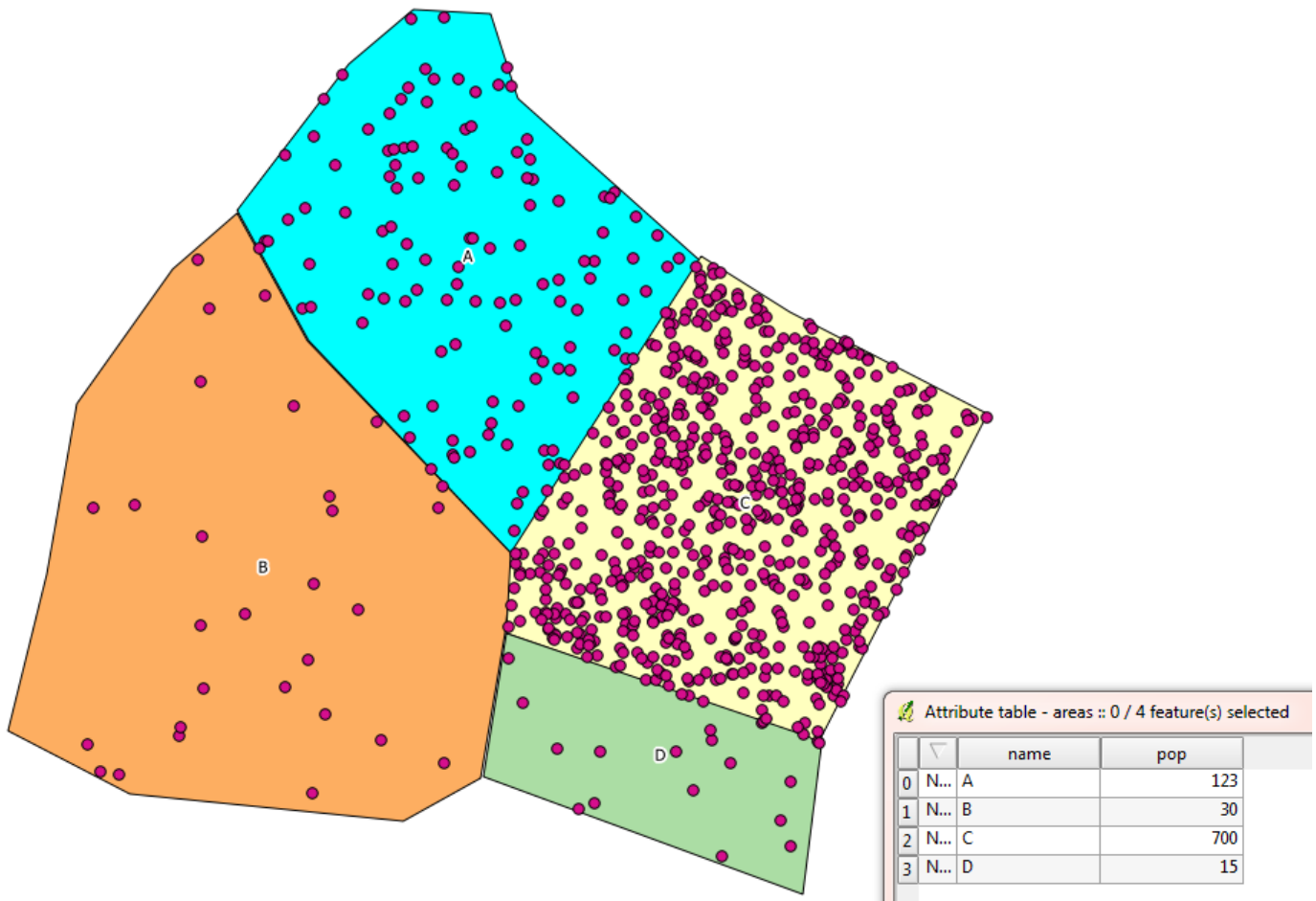
This is a sampling tool which creates randomly-located points in a new output dataset. This is commonly used to create dot density maps.

The tool requires as a minimum:

- an input polygon layer to define the area within which the points are created
- a setting for the number of points to be created per feature, using an attribute in the source polygon data - for example population



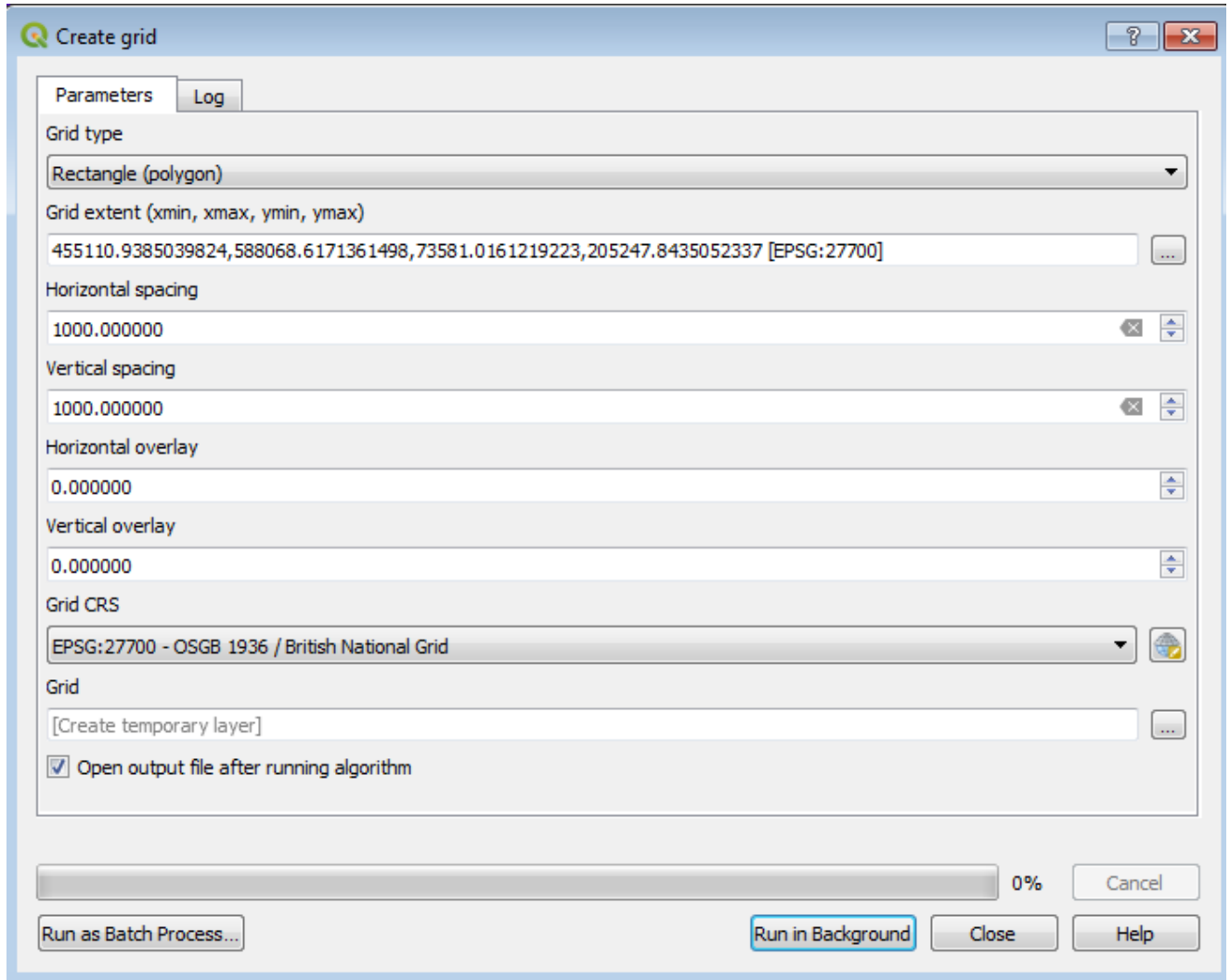
The result will be something like this, with the number of dots based on the population of each area:



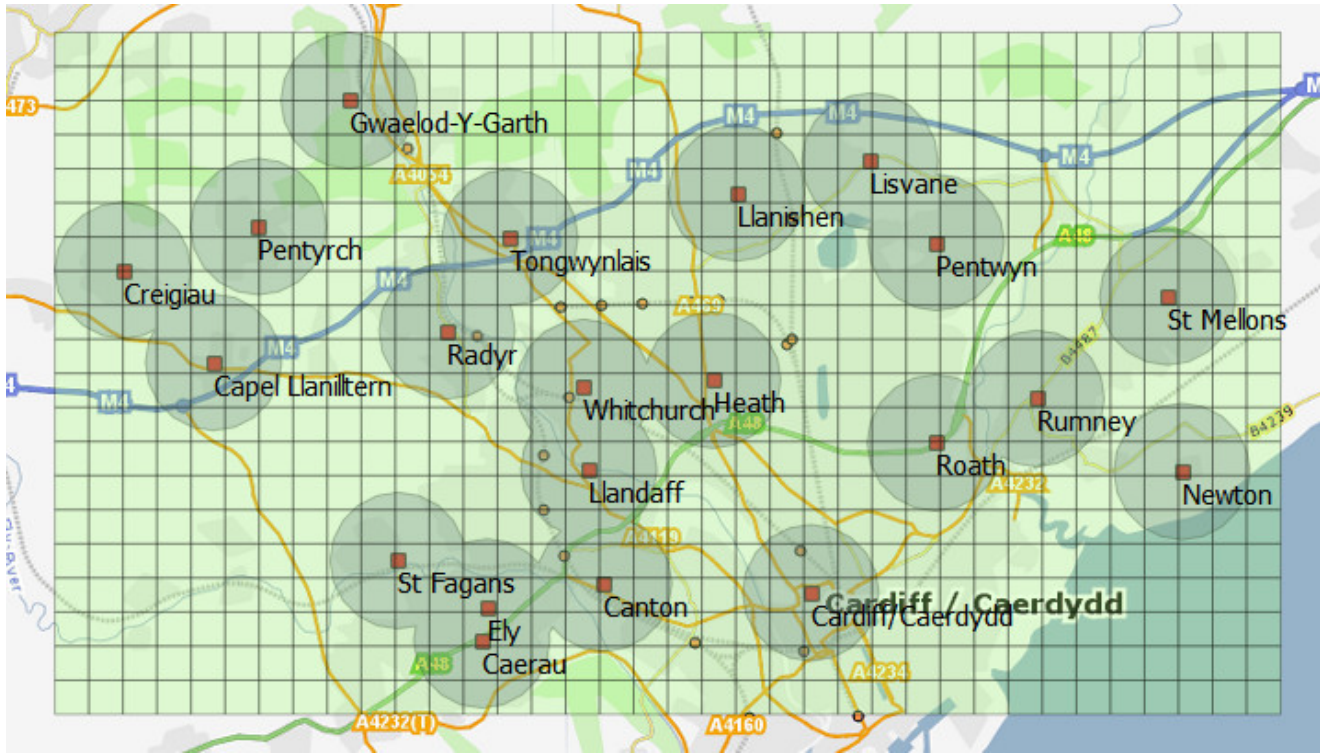
Vector grid

A vector grid overlaid on a map can be used in analysis, for example showing the density of points within grid squares, or for 'sectorising' an area.

1. Search for *create grid* and load the **Create grid** dialog



2. Complete the dialog in a similar way to the example above:
 - a. Select **Rectangle (polygon)** as the grid type
 - b. Use the three dots button to the right under **Grid extent** to set the extent to the current canvas
 - c. Set the spacing values in metres for BNG
 - d. Click **Run in Background** to create the grid
3. The grid will be loaded in the map - each square is a separate polygon



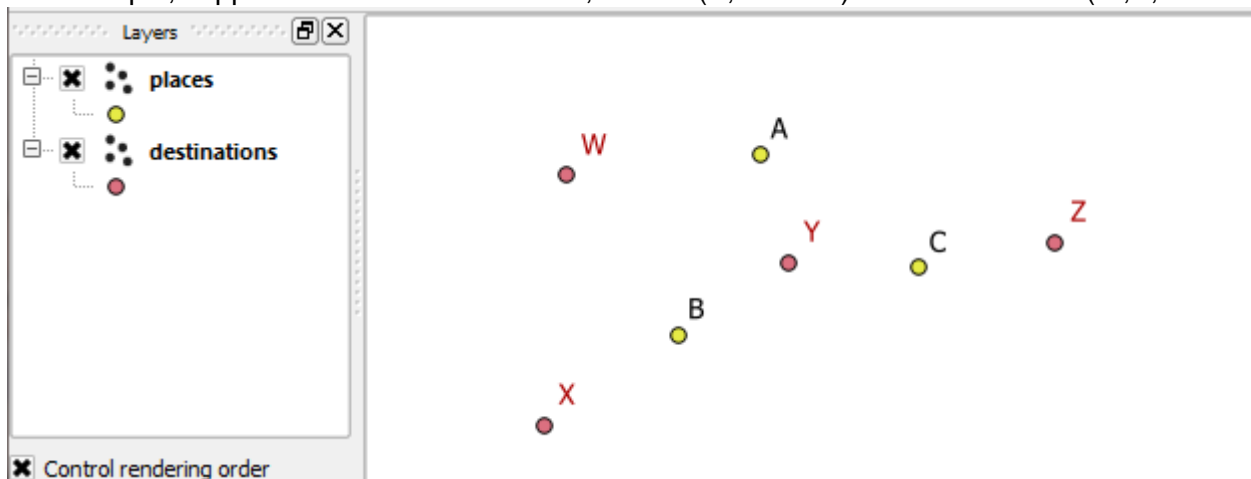
7.4. Analysis Tools

The tools in this section support data analysis, both spatial and non-spatial.

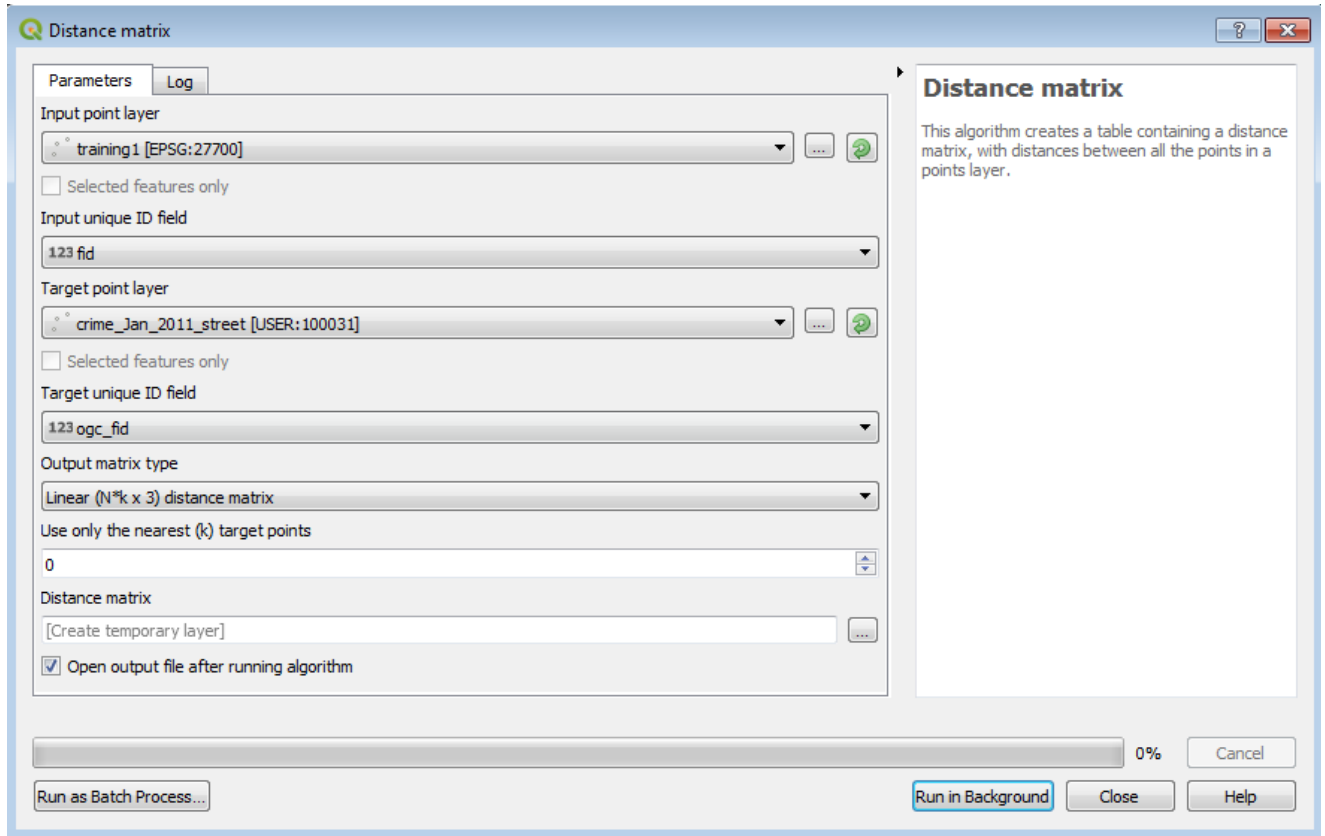
Distance Matrix

This tool calculates the distances between all the points in one dataset and all the points in another, and outputs the results to a new table.

For example, suppose we have two datasets, Places (A,B and C) and Destinations (W,X,Y and Z).



1. Search for *distance matrix* and open the **Distance matrix** dialog



2. Complete the dialog as appropriate, and click **Run in Background**
3. A table like the one below is created, showing distances between all points:

ID	Y	W	Z	X
A	2358.233	4142.397	6488.594	7331.113
B	2785.362	4098.12	8202.308	3426.17
C	2764.89	7712.791	2917.892	8609.382

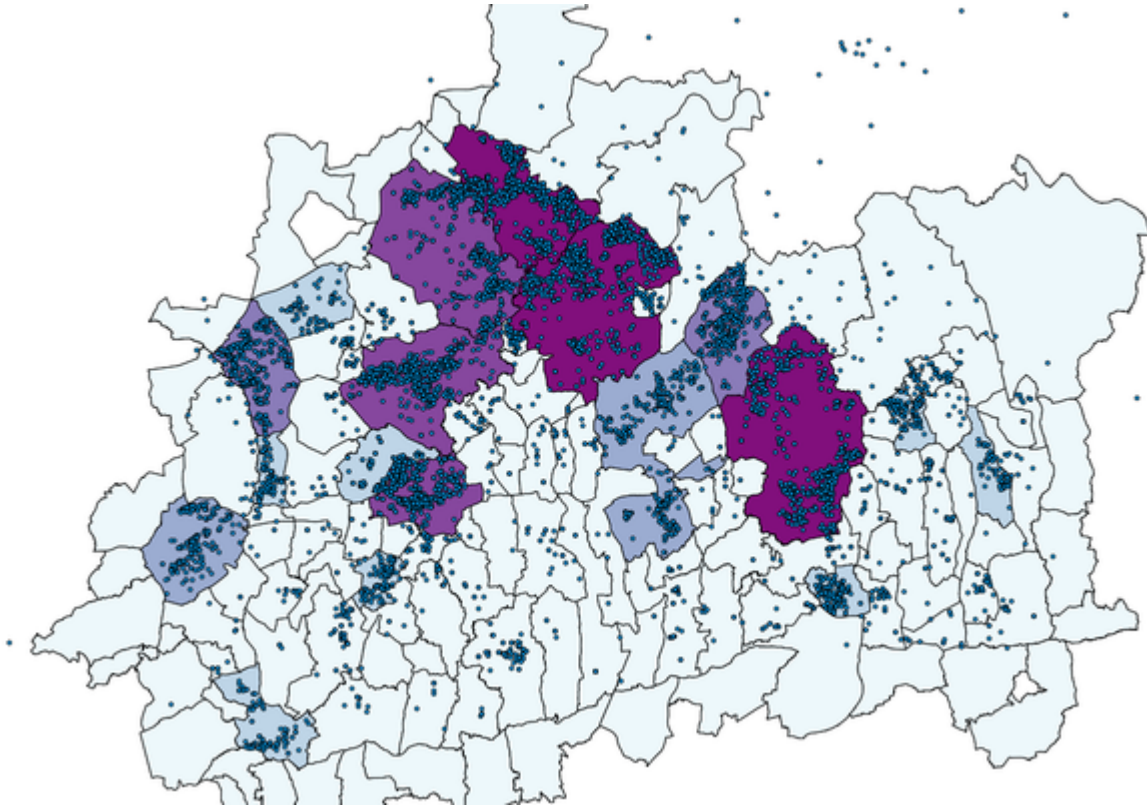
Sum line lengths

This tool calculates the total length of a line or line network within an area or multiple areas. Two input layers are required; one containing the lines to be calculated, and the other the areas within which the calculation will be made. The output will be a copy of the area layer, with the total line length within each area as a new attribute.

Count points in polygon

This calculates the number of points in a point layer that fall within each feature of a polygon layer. It requires two inputs; the point layer to be counted, and the polygon layer to count inside.

The output will be a copy of the polygon layer, with an additional attribute for each feature showing how many points are inside it. This attribute can be used with a graduated style to indicate the frequency of points in each feature.



8. PostGIS Data in QGIS

<ul style="list-style-type: none"> 8. PostGIS Data in QGIS <ul style="list-style-type: none"> 8.1. Introduction 8.2. Connecting to PostGIS 8.3. Load a PostGIS Layer 8.4. Load Vector Layers into PostGIS 	<p>An Astun Technology Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-08</td> </tr> <tr> <td>Title</td> <td>PostGIS Data in QGIS</td> </tr> <tr> <td>Description</td> <td>Loading and saving PostGIS data.</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>05 Apr 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-08	Title	PostGIS Data in QGIS	Description	Loading and saving PostGIS data.	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	05 Apr 2018	Updated by	Antony Scott	Status	In progress
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Updated by	Antony Scott																
Status	In progress																

8.1. Introduction

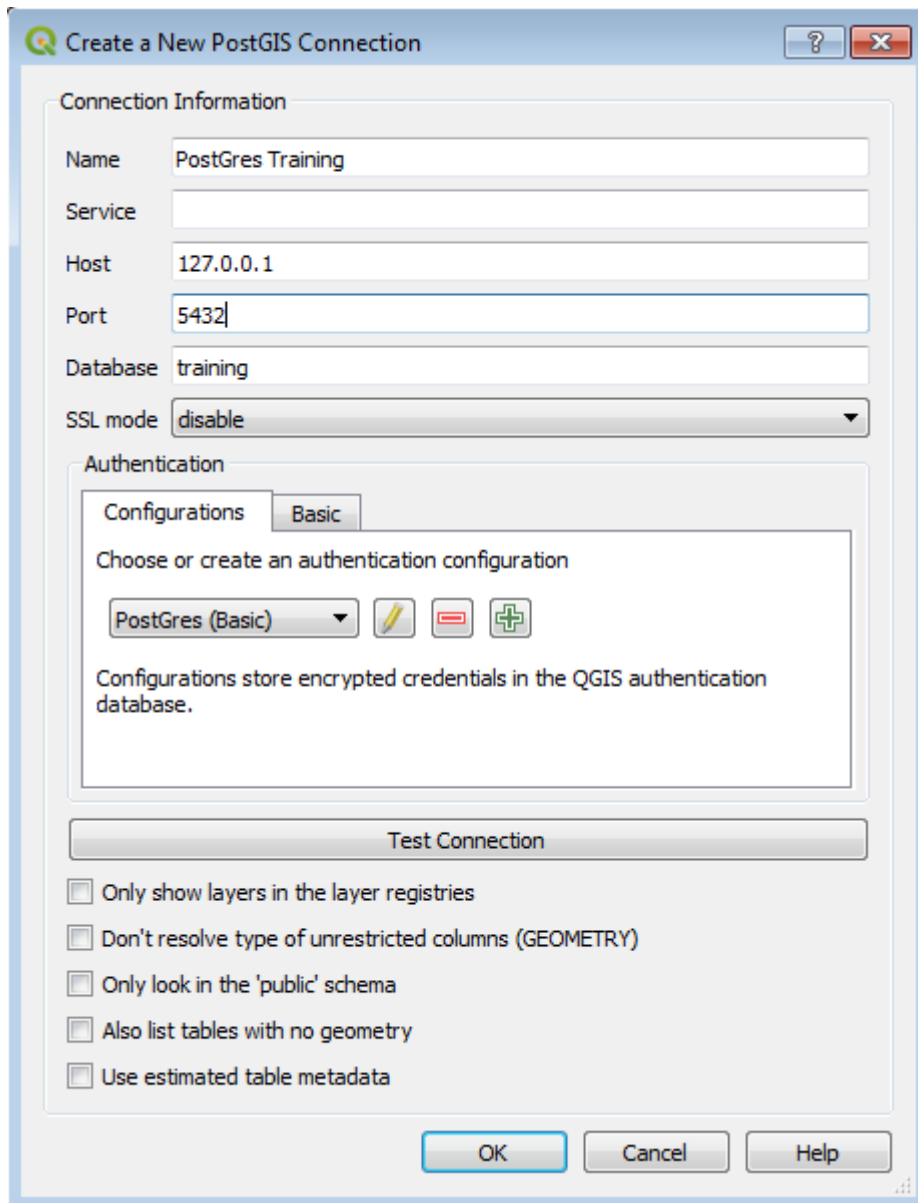
QGIS can use data in a number of database formats, both file-based (GeoPackage, SpatialLite), and client/server (MSSQL, Oracle, DB2). However it is particularly tightly integrated with [PostgreSQL/PostGIS](#), which is the focus of this module.

8.2. Connecting to PostGIS

PostGIS is a spatial extension to the PostgreSQL database. PostGIS supports spatial indexing, filtering, processing and query capabilities, so if data is in a PostGIS database, you can choose to process and manage it in the database itself, or through QGIS.

To use data from a Postgres database, first create a connection to it. You can do this from the **Data Source Manager**, but here we are going to use the **Browser**.

1. In the **Browser** panel, right-click on the **PostGIS** icon and click **New connection**



2. Populate the dialog using appropriate values as per the screenshot above:
 - a. **Name:** your name for the connection
 - b. **Service:** can be left blank
 - c. **Host:** the server name or IP address
 - d. **Port:** normally 5432
 - e. **Database:** the name of the database you are connecting to
 - f. **Authentication:** click the **plus** button to add details
3. Click **Test Connection** to see if the connection is working - note that the target PostGres instance will normally need to be configured to accept connections from your IP address
4. If successful, click **OK** to save the connection

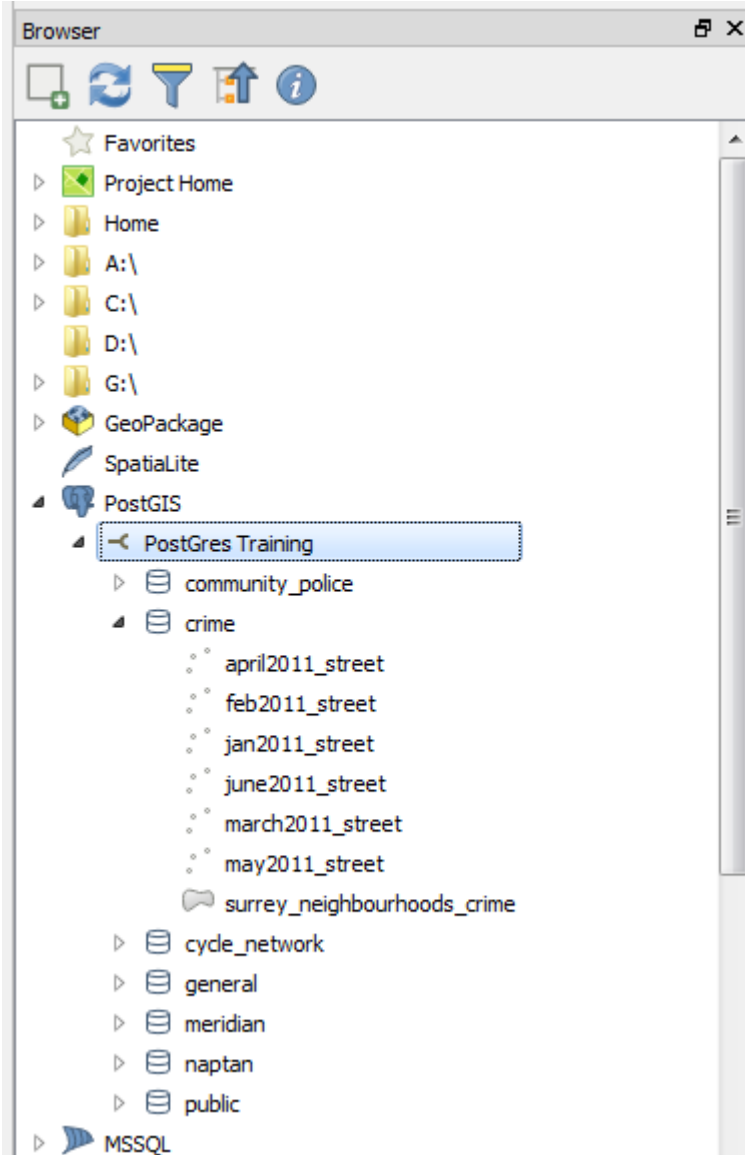
Connection options

- Check **Also list tables with no geometry** to show non-spatial tables
- If you have large tables and/or a large number of tables, speed up the processes of loading the table list by checking **Only show layers in the layer registries** and **Use estimated table metadata**

8.3. Load a PostGIS Layer

With a connection defined, you can load layers from the PostGIS database:

1. In the **Browser**, expand the **PostGIS** icon to view the content of the database

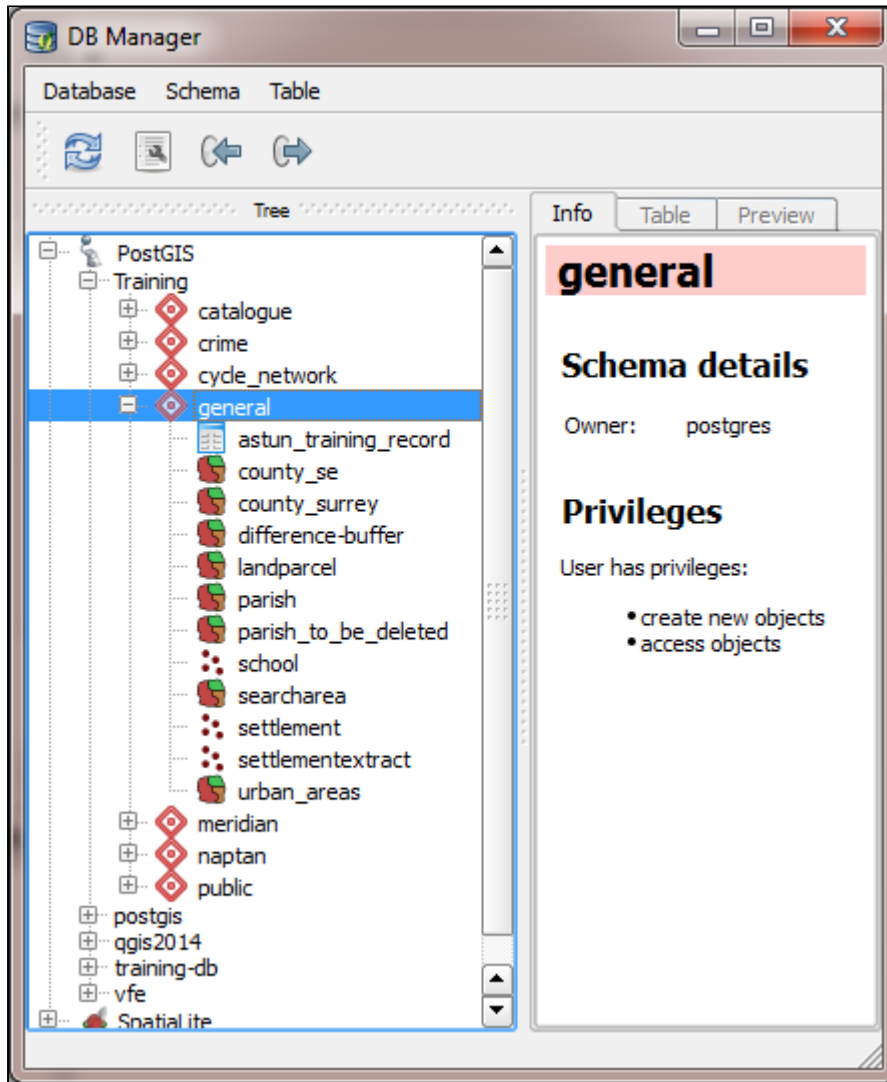


2. Double-click on a layer (or drag and drop) to add it to the map
3. Add multiple layers using **shift-click** or **Ctrl-click**

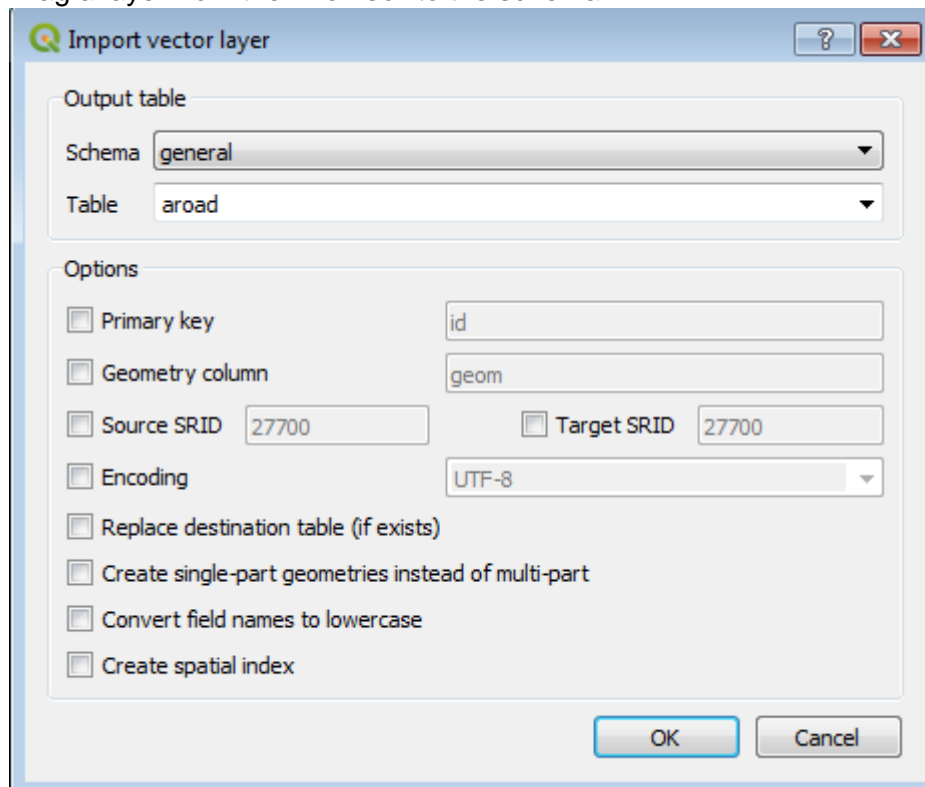
8.4. Load Vector Layers into PostGIS

Use the **DB Manager** to load vector layers into the PostGIS database.

1. Go to **Database > DB Manager > DB Manager**
2. Browse to the target PostGIS database, and open the schema where you want to put the data



3. Drag a layer from the **Browser** to the schema



4. In the **Import vector layer** dialog, usually defaults can be left in place - however the main

parameters are as follows:

1. **Schema:** change if required (note that if you want to put the data in a new schema, you will need to create it first)
 2. **Table:** enter a table name, or select from the dropdown to overwrite an existing table
 3. **Primary key:** specify a field in the source data - otherwise **id** will be created by default
 4. **Geometry column:** will be **geom** by default, but can be changed
 5. **Source/target SRID:** to use a CRS in the database which is different to the source, specify the EPSG SRID in the **Target SRID** field
 6. **Create spatial index:** check if spatial searches are going to be performed on the data
5. Click **OK** to load the layer into the database

9. QGIS Print Layouts

<ul style="list-style-type: none"> 9. QGIS Print Layouts <ul style="list-style-type: none"> 9.1. Introduction 9.2. Create a Layout <ul style="list-style-type: none"> Page Setup 9.3. Adding Layout Items <ul style="list-style-type: none"> Add a Map Add a Label Add an Image Add a Legend Add a Scalebar 9.4. Output 9.5. Managing Print Layouts <ul style="list-style-type: none"> Templates 	<p><i>An Astun Technology Training Module</i></p> <table border="1"> <tr> <td>Code</td> <td>QGIS-09</td> </tr> <tr> <td>Title</td> <td>QGIS Print Layouts</td> </tr> <tr> <td>Description</td> <td>Producing print-ready output using map layouts</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.0 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>04 Apr 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In progress</td> </tr> </table>	Code	QGIS-09	Title	QGIS Print Layouts	Description	Producing print-ready output using map layouts	Required Software	QGIS v 3.0 or later	Target Audience	QGIS Desktop users	Updated	04 Apr 2018	Updated by	Antony Scott	Status	In progress
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Updated by	Antony Scott																
Status	In progress																

9.1. Introduction

Print Layouts are a distinct program module within QGIS, used to create map layouts for printing or publication.

Be aware that:

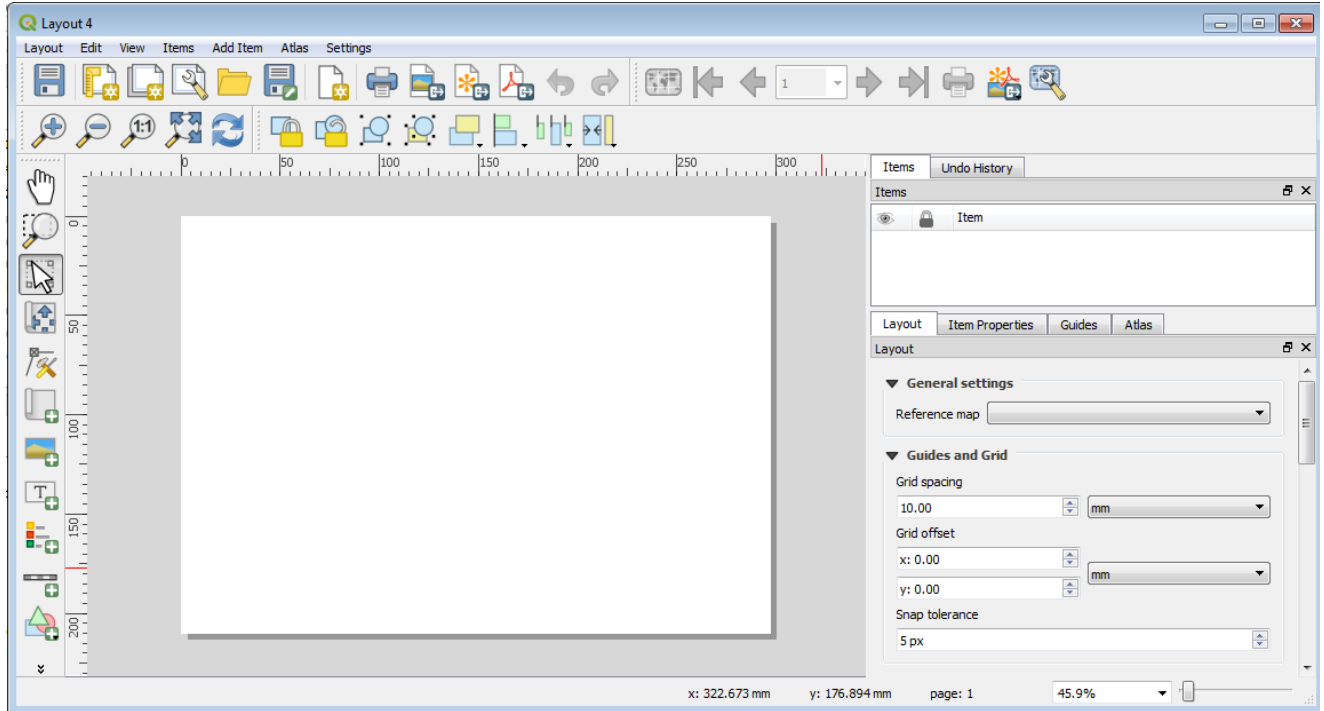
- Print layouts are saved to the QGIS project file (.qgs), so are directly linked to the project
- There can be many print layouts in a project
- Layouts can contain one or more items including:
 - Maps
 - Attribute tables
 - Text
 - Images
 - Legends
 - Scale bars
- Layouts can be saved as templates and reused in other projects

9.2. Create a Layout

To create a print layout:

1. Go to **Project > New Print Layout**

2. Choose a name for the layout
3. The layout window will open showing a blank page



Page Setup

Go to **Layout > Page Setup** to set paper size, orientation and margins. You can also use the settings in the **Layout** and **Guides** tabs in the right hand panel to create guides (visible lines) and grids (invisible lines) to help with layout. Grids can be set to snap to help keep items aligned.

Use the **View** menu to turn guides, grids, and snapping on and off.

9.3. Adding Layout Items

With the page setup in place, you can add items to the layout. You can add as many items as you need, and you can have more than one of each item type - for example you may want to add a main map and an overview map.

Below are instructions for adding and configuring each of the main layout items.

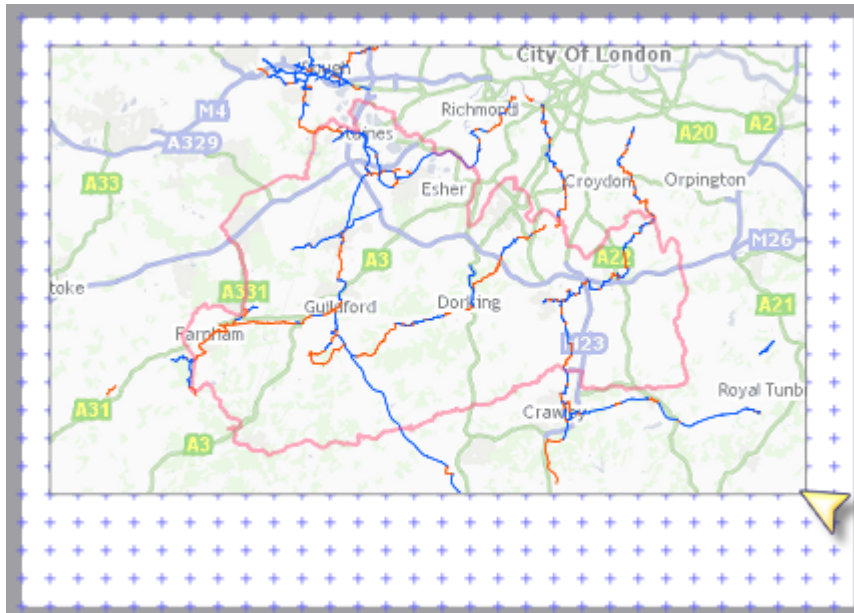
Add a Map

To add a map to the layout:

1. Set up the map in the main map window as you want it to appear in the output - it's a good idea to edit layer names at this stage so that they appear correctly in the legend

2. Click the **Add Map** button in the **Toolbox Toolbar** 



3. Drag a box over the page where you want the map to appear



4. The current view of the map from the main map window will appear

Change the Map

You can change the map in two ways:

- move the frame in which the map appears, by clicking and dragging on the frame, or dragging the corners: the map frame must be selected using the **Select/Move item** button 
- leaving the frame in place, but change the scale or positioning of the content: click the **Move item content** button first, then use the mouse or **Item Properties** tab to make changes 

Map Properties

With the map frame selected, the **Item Properties** tab controls configuration of the map - the main options are listed below.

- **Main Properties > Scale:** sets the scale of the map to a value entered in the field
- **Layers > Lock layers:** freezes the layers in the map frame, even if the map is changed in the main map window - if this is unchecked, and changes are made to the main map, the Print Layout map will be updated with the changes
- **Layers > Lock styles:** with the layers locked, you can also choose to lock styles, so that style changes in the main map will not affect the Print Layout map
- **Grids:** add one or more grids or graticules, using the CRS of the project
- **Overviews:** where there is more than one map in the layout, an overview can be used to show the extent of one map in the other
- **Frame:** set properties for the map frame

Multiple Maps

A single layout can contain multiple maps: for example an overview or inset map. Maps are created in turn, use the **Lock layers** button to freeze each map as it is completed. Some items, for example scalebars, need to be set to reference the relevant map.

Where one map extent sits within the extent of another, it's useful to add an extent indicator in the

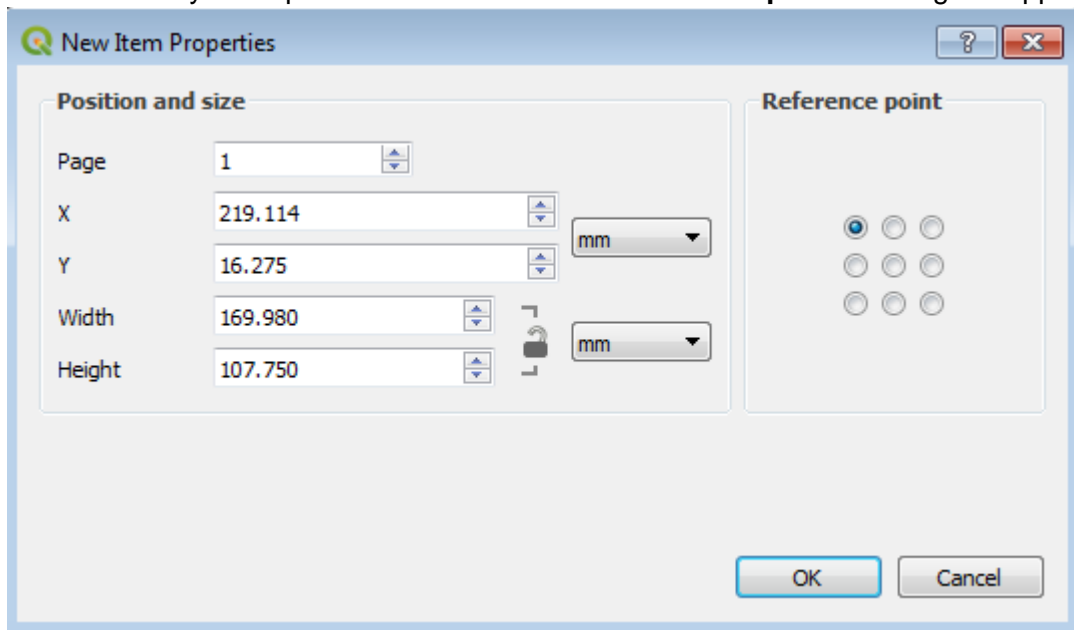
second map using the **Overviews** settings.

Add a Label

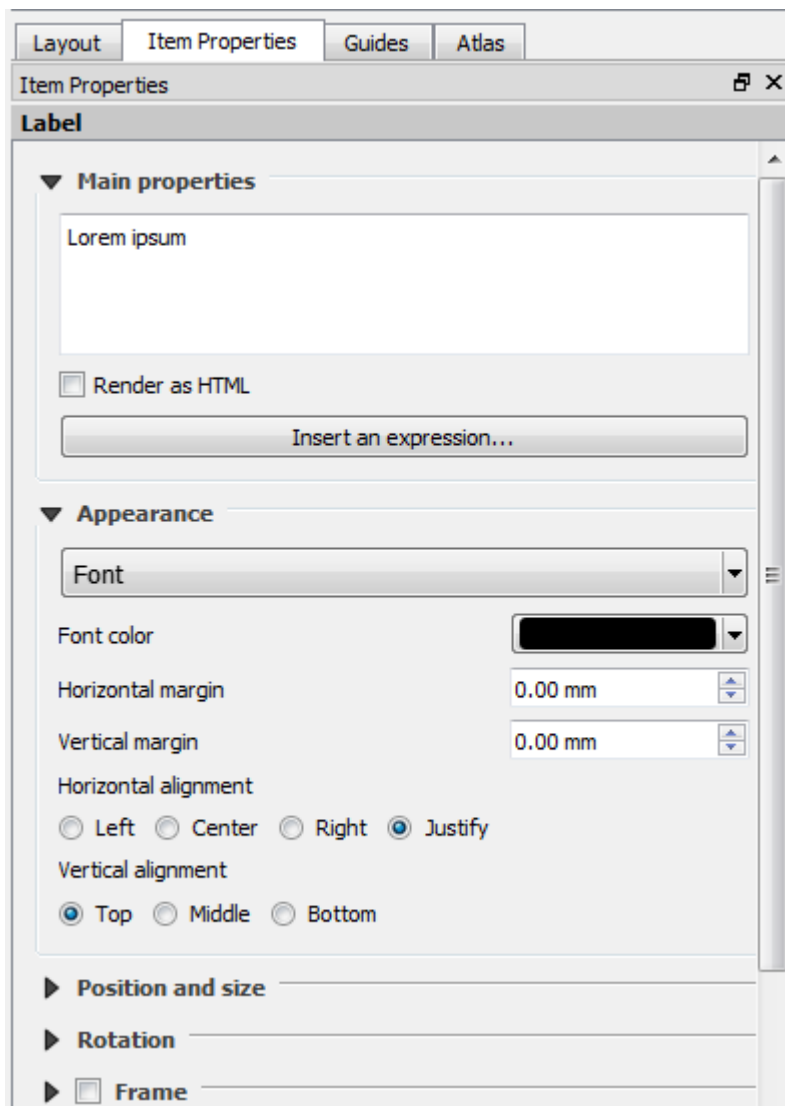
Labels (as text boxes are known in QGIS) are used to add text to the map: for example a title, description, or copyright statement.



1. Select the **Add label** tool from the toolbar on the menu
2. Click on the layout to position the label - the **New Item Properties** dialog will appear



3. Amend the settings as required, and click **OK** to add the label
4. A default label with default text will be created
5. Adjust the label size and location as required
6. Use the **Item properties** tab to configure the label, including:
 - a. Text content
 - b. Font
 - c. Colour
 - d. Alignment
 - e. Margins



Formatting and expressions

- To include formatting in the text box, check **Render as HTML**, then write or paste HTML into the panel.
- Use the **Insert an expression** button to use functions and variables in the box, using values from your data, or QGIS variables such as date and user.

It is common to use multiple text boxes to include map metadata such as date of creation, contact details, description, copyright and so on.

Add an Image

Any file-based image can be added to the Print Layout - for example a logo, a photograph, or any other image relevant to the map. You can also use this tool to add a north arrow to the map.



1. Click the **Add Image** tool from the toolbar
2. Click on the layout to position the label - the **New Item Properties** dialog will appear
3. In the **Item Properties** tab, browse to an image, or look in **Search directories** for SVG images shipped with QGIS.
4. Select an image to load it into the image frame, and resize the box to fit the size of the image

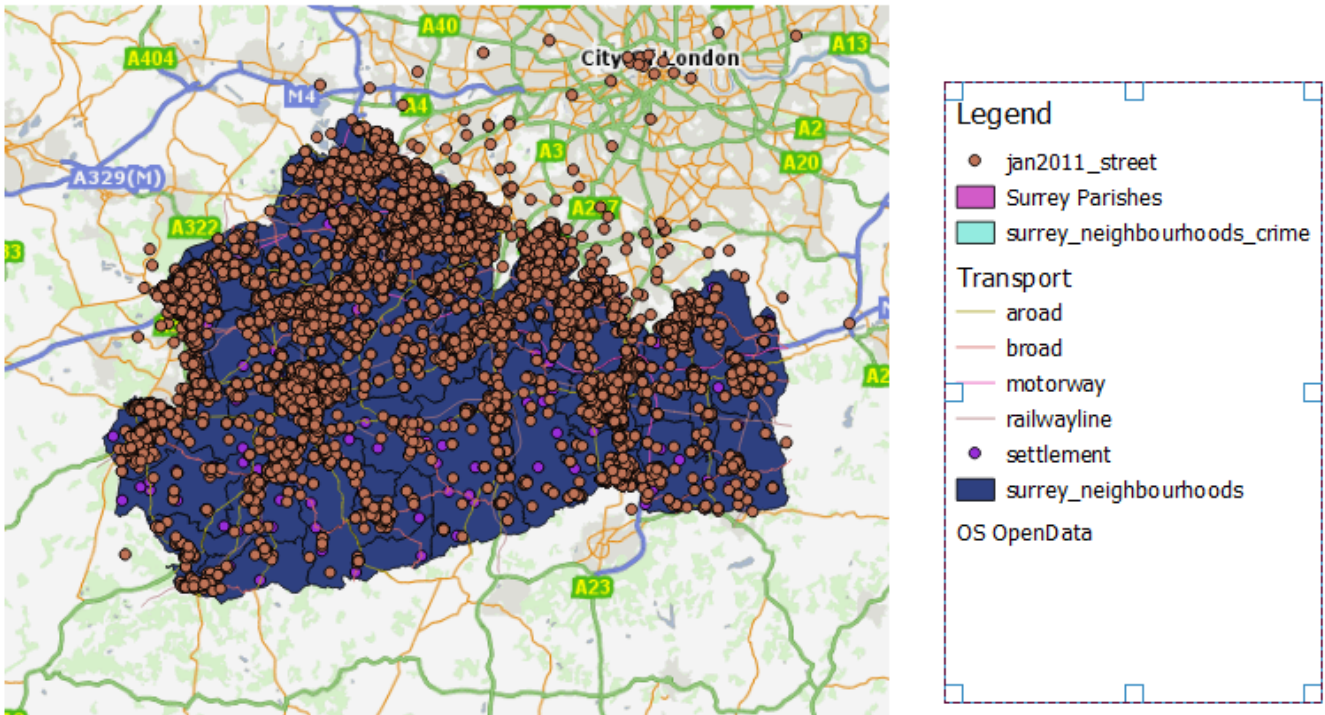
5. Use **Image rotation** if necessary to rotate the image

Add a Legend


To add a legend to the print layout:

1. Click **Add Legend** on the toolbar
2. Click on the map to position the legend - the **New Item Properties** dialog will appear
3. Click **OK** to generate the legend and add it to the map

The legend will require some configuration to bring to publication standard - the initial legend is a first draft.



By default, the size of the legend box is driven by its contents, and will include *all* items in the layer list, whether turned on or off. To change the size:

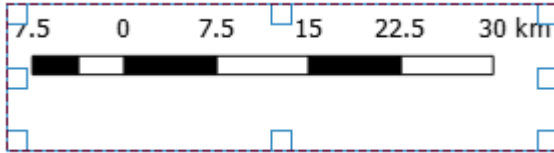
1. Remove any items in the layer list which aren't needed, or use the **Legend Items > Filter Legend by Map Content** button to show only layers which appear on the map 
2. In the **Item Properties** tab, adjust **Fonts**, **Spacing** and **Position and size**
3. Uncheck **Resize to fit content** - this allows you to change the size of the box, though it won't resize the legend items themselves
4. Set a blank **Title**
5. To edit the legend items directly in the Print Layout, uncheck the **Legend Items > Auto update** box - this activates the buttons below the list of legend items, and allows you to delete, edit and change the order of items. Note that once you have done this, changes in the main map won't be reflected here.

Add a Scalebar



1. Click **Add new Scale Bar** on the toolbar
2. Click on the map to position the scalebar, and click **OK** on **New Item Properties**

3. The scalebar will appear on the page







Use the **Item Properties** tab to customise the scalebar - the **Style** settings include pre-configured styles, including a numeric scale representation (e.g. 1:500,000).

Map reference

Use the **Map** setting if there is more than one map on the page - make sure the scalebar is pointing to the correct one.

9.4. Output

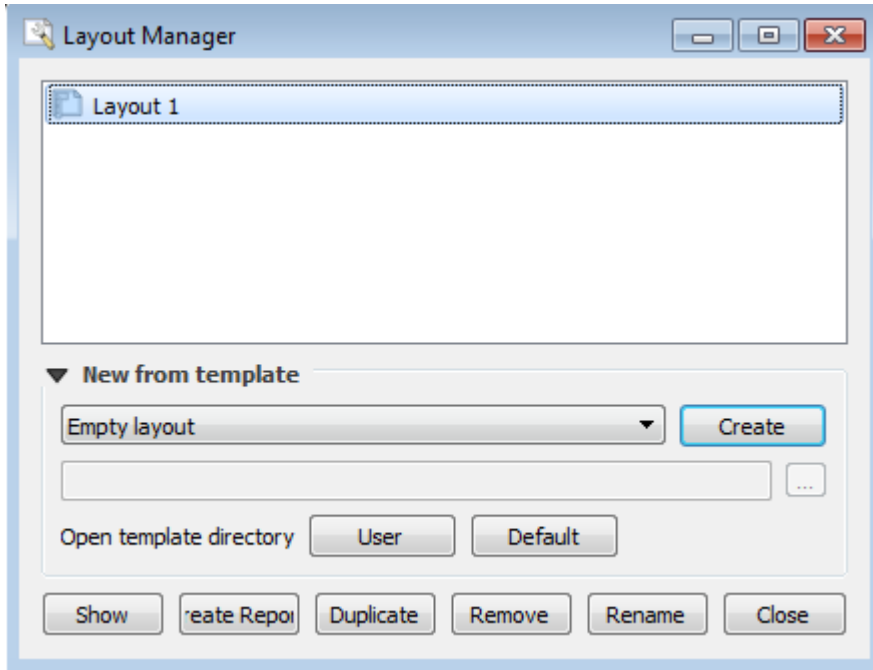
Print Layouts can be output:

- directly to a printer 
- to an image (in most common image formats) 
- to SVG (for example for embedding in a web page) 
- to PDF (for distribution, or for importing to graphics tools) 

9.5. Managing Print Layouts

Print Layouts can be managed in the **Layout manager**, from the **Project** menu in the main QGIS window

or the toolbar in a Print Layout. 



Use the dialog to:

- Create new blank layouts: **New from template > Empty layout > Create**
- **Rename** a layout
- **Duplicate** a layout
- **Remove** a layout
- View an existing project layouts: Select layout and click **Show**
- Create a layout from a template: **New from template > Specific > browse to template or click User or Default > Show**

Templates

Templates are used to save a Print Layout for reuse either by you or other users - for example for a corporate layout.

To save a layout as a template:

Go to **Layout > Save as template** and navigate to an appropriate location, and save under a descriptive filename - e.g. *astun_A3_landscape_2018.qpt*. The file format for templates is .qpt - as with QGIS project files, this is an XML file.

Template paths

In **Settings > Options > Layouts > Layout Paths** in the main QGIS menu, you can set search locations for templates - this would typically be a shared drive where corporate templates and other resources are stored.

10. QGIS Essentials: Exercises

- 10. QGIS Essentials: Exercises
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 - 10.7. GeoProcessing for Analysis
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 - 10.7.2. Create centroids and a distance matrix
 - 10.7.3. Create a hexagon grid and a point count
 - 10.8. Print Layouts

An Astun Technology QGIS Training Module

Code	QGIS-EX01
Title	QGIS Essentials - Exercises
Description	A set of exercises to support the QGIS Essentials course.
Required Software	QGIS v 3.0 or later
Target Audience	QGIS Desktop users
Updated	23 Aug 2018
Updated by	Antony Scott
Status	Complete

These exercises are designed to give you hands-on experience of the main techniques covered in the course notes and slides. Explore other features of QGIS, and don't hesitate to ask if you need help.

10.1. Getting Started

10.1.1. Objective

Get familiar with the QGIS interface, layer management, customisation and configuration, plugins.

10.1.2. Get started and tidy up

1. Start QGIS.
2. Arrange the toolbars and panels, switching off toolbars you don't need for now (keep **Attributes, Data Source Manager, Label, Map, Project**)
3. Go to **Settings > Options > General** and review the settings, making any changes which are helpful - ' e.g. icon sizes, paths, language
4. Go to **Settings > Options > CRS** and change **Default CRS for new projects** to **British National Grid**, and the **CRS for new layers** to **Use project CRS**

10.1.3. Open a project and arrange layers

1. Go to **Project > Open**, and open the project file **.../QGIS Training/Essentials 3/Projects/essentials_01_gettingstarted.qgs** and save with a new name - create a new folder under **Projects** for your own work
2. The project will open with a set of point, line and polygon layers
3. Rearrange the layers so that they are ordered in a way that they are all visible in the map
4. Create a group using the **Add Group** button in the **Layers** panel , and put some of the layers in it
5. Go to **Project > Properties > General** and give the project a title
6. **Right-click > Rename** to make layer names more readable
7. Zoom to a scale where the layers are all readable

10.1.4. Manage plugins

1. Go to **Plugins > Manage and Install Plugins**
2. In the **Settings** tab, check **Show also experimental plugins**
3. In the **All** tab, browse the plugins, and install **QuickMapServices**
4. Load this plugin (it should now be in the Web menu), for example by adding the **OSM Standard** layer
5. Install any other plugins which look useful

10.2. Working with Vector Data

10.2.1. Objective

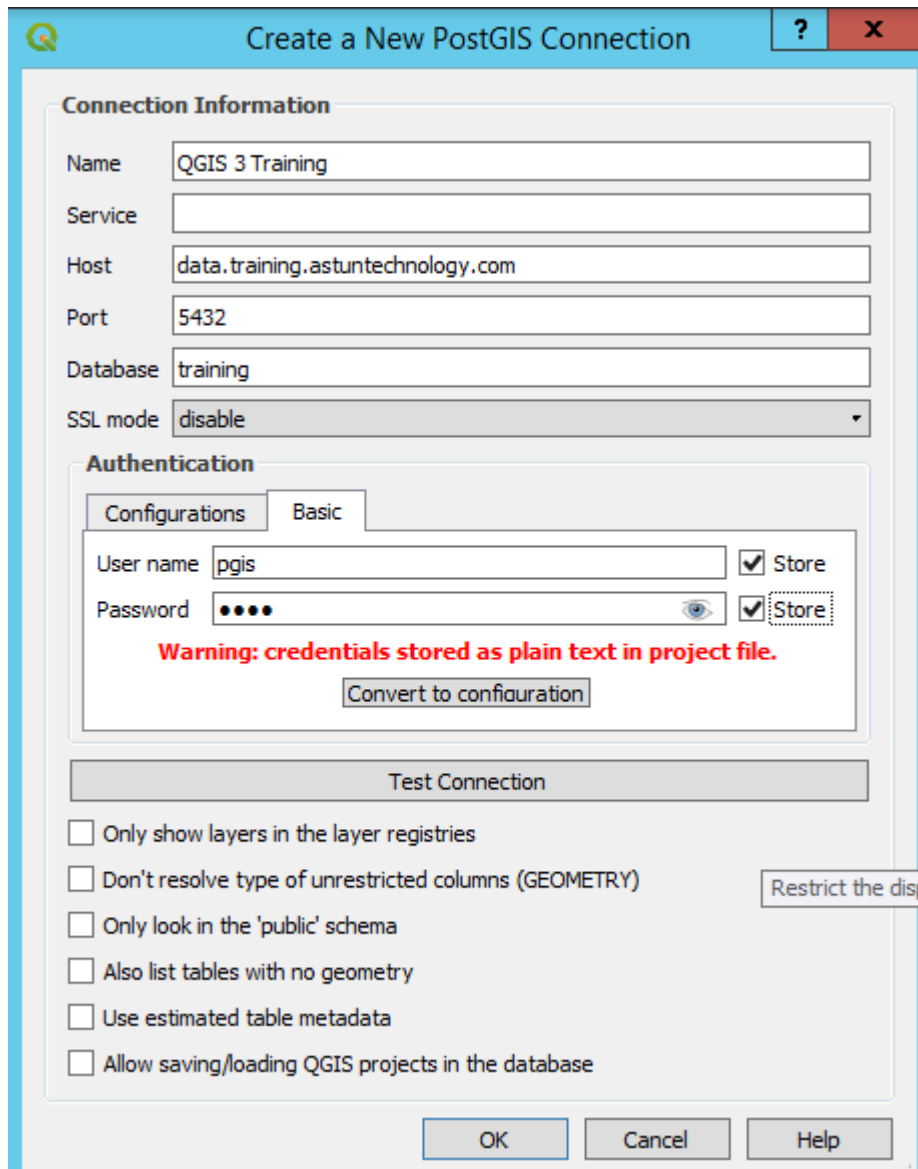
Load vector layers from various sources, create a table join with some non-spatial data.

10.2.2. Add Layers

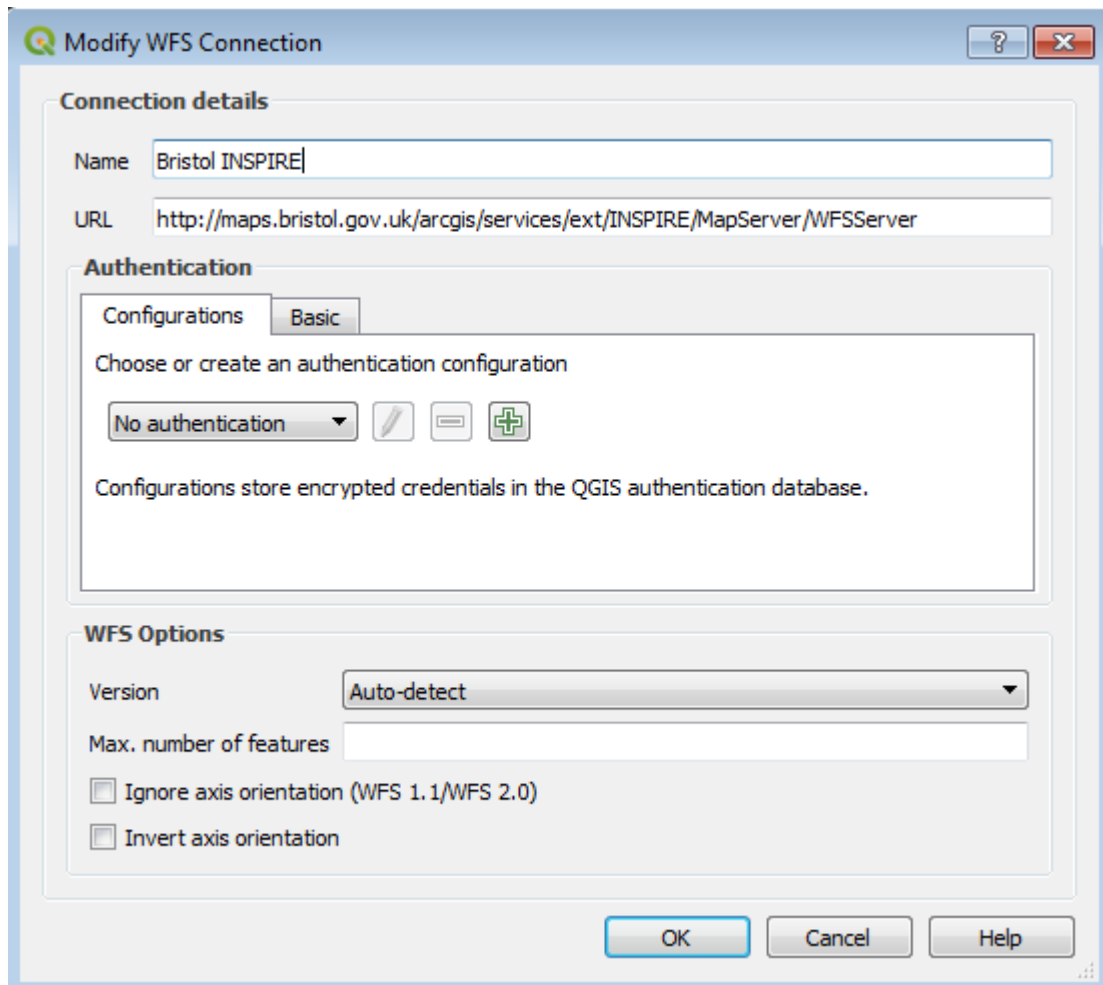
Data location

All vector data is in ...**QGIS Training\Essentials 3\Data\vector**. You may find it helps to use the file filter to look for only files of a certain type.

1. Open the project from the previous exercise
2. Using the **Data Source Manager**, add file-based data:
 1. Shapefile: add **wind_turbines_point.shp**
 2. MapInfo: add **aonb_wales.mif**
 3. CSV: add **playgroundsdata.csv** - note that this data is in WGS84
3. Add PostgreSQL data
 1. Create a connection to the database: **Data Source Manager > PostgreSQL > New**
 2. Complete the connection details as below, using the Basic tab under authentication - note the user credentials are **pgis/pgis**



3. Click Test Connection to make sure you can connect to the database - if successful, you will see a confirmation message
 4. Click **OK**, then **Connect** to open the connection
 5. Browse to **boundaryline > county_region** and click Add, then Close
4. Add WFS data
1. Create a WFS connection **Data Source Manager > WFS > New**
 2. Complete the credentials as below (you may find it easier to search for the link on <http://data.gov.uk>)



3. Click **OK** then **Connect**
4. Click on the layer you want to load, then **Add** and **Close**

10.2.3. Attribute Tables

1. Open the attribute tables for some of the layers, and see how the data in the attribute tables relates to the features on the map
2. Select an item in the attribute table by clicking on the row number - it will also be selected on the map
3. Click on the column headers to sort the table using that column

10.2.4. Add Non-spatial Tables and Create a Join

1. Go to **Data Source Manager > Delimited Text**
2. Browse to **Index_of_Multiple_Deprivation_December_2015_Lookup_in_England.csv** and load it - you will need to set the Geometry Definition to **No geometry**
3. Go to **Data Source Manager > GeoPackage > New**
4. Select **LLSOA_Dec_2011_England_Wales.gpkg**
5. Click **Connect**, then select the table and **Add**
6. Open the attribute tables for both **Index_of_Multiple_Deprivation_December_2015_Lookup_in_England** and **LLSOA_Dec_2011_England_Wales** - notice that **LSOA11CD** in the former has a one-to-one relationship to **Isoa11cd** in the latter
7. Follow the course notes to create a join between these two layers
8. Check the attributes of **LLSOA_Dec_2011_England_Wales** to ensure the data has been joined correctly

9. Save the project

10.3. Styling Maps

10.3.1. Objective

Add styling to the data you have been working with, replacing the QGIS default styling, and add some annotations and labels.

Use the project you created in the last exercise, or if you don't have it, open **essentials_03_styling.qgs** and save it with a new name.

10.3.2. Styling the Map

1. Create a **Single symbol** style for the **canal_crt** layer- use and amend one of the QGIS styles, or create your own from scratch
2. Create a **Single symbol** style for the **wind_turbines_point** layer, using a **SVG** or **Font** marker
3. Create a **Categorized style** for **aonb_wales**, with a suitable fill - use transparency or hatching to make the layers underneath visible
4. Create symbols and name labels for the **railway_naptan** layer
5. Create a **Graduated style** for the **LLSOA_Dec2011_England_wales** layer, using the **IMD15** field

10.3.3. Add Annotations

Add two or three text annotations to your map, indicating some points of interest from the OS OpenData layer, with appropriate text. Edit the formatting, and choose a different symbol for each annotation.

10.3.4. Loading a Style

This section covers the use of a ready-made style - for this you are going to use OS MasterMap, and load a saved style from a qml file.

1. Load the **osmm_topo_area** shapefile
2. Zoom to extents, noting the sample covers the city of Exeter
3. Load the style for MasterMap **osmmstyle.qml**
4. Have a look at the style, and how it is constructed

10.3.5. Additional Tasks

1. Apply a **Categorized** style to **wind_turbines_point**, using the **STATUS** field for example
2. Look at some of the fill styles for polygons under **Symbol** layer type - for example **Centroid fill**, **Sha**
peburst fill
3. For a line or point, create a symbol with multiple components

10.4. Selecting and Querying

In this exercise, you will work on selecting features, and writing and running queries to filter layers.

You can work with the same project as you were using for the previous exercise, or load a fresh version of it from **essentials_03_styling.qgs** and save it under a new name in your **Documents** folder.

10.4.1. Identify Features

1. Use the **Identify Features** tool to look at attribute values on some of your layers
2. Have a look at the **Derived** section, and use the **Auto open form** option to see a forms dialog

Forms

Note that this dialog will only appear if you have selected a single feature - you may need to zoom in to do this.

10.4.2. Manual Selection

1. Use the selection tools to create some manual selections on the map, and compare the results in the attribute table for the layer
2. Make manual selections in the attribute table, and use the **Zoom map** and **Pan map** tools to view them in the map

10.4.3. Selection using an Expression

1. In the attribute table for **LLSOA_Dec_2011_England_Wales**, select the 100 LLSOAs with the highest Index of Multiple Deprivation - note that the **IMD15** field is a ranking, so the lowest number represents the highest IMD
2. Save the selection as a new GeoPackage file in your **Documents** folder
3. Using the new layer of top 100 LLSOAs, select those where the area is less than 100,000 hectares
4. Select all the LLSOAs in Tower Hamlets, using **ILIKE** (for a case-insensitive search) and the **%** wildcard character

10.4.4. Field Calculator

1. Create a new field which contains the name without the code at the end - i.e. omitting the last five characters
2. You may want to do this in two steps - either by creating two columns, or by nesting the operators:
 1. Using the **String** operator **length** to get the length of each name
 2. Create a new field of datatype **string**, with a length which is five characters less than the original, using the **left** operator

10.4.5. Spatial Queries

1. In **LLSOA_Dec_2011_England_Wales**, use **Select Features by Value** on the **Attributes** toolbar to select LLSOAs in Tower Hamlets (you can use **Starts with** from the **Exclude field** dropdown on the right)
2. Use **Select by location** in the **Processing Toolbox** to find all railway stations which fall within these LLSOAs

3. Use **Join attributes by location** to add the attributes of the containing LLSOA features to each of the the railway stations you have found in Tower Hamlets

10.4.6. Filter Layers

1. Use one of the queries you have already created - or create a new one - and apply to one of the layers on the map
2. Apply the same query as an attribute table filter

10.5. Loading Raster Data

This exercise shows you how to add raster background mapping layers, and to add a set of raster images from a folder.

10.5.1. Load individual rasters

1. Create a new project file and save it in your **Documents** folder
2. Click **Open Data Source Manager**, then **Raster**
3. Browse to and open the .tiff files in **Data/raster/1250K** (use Ctrl-click to select multiple files)
4. Create a group, and put these images in it

10.5.2. Create a Virtual Raster

Virtual Raster

Note that this exercise takes several minutes to run in the AppStream environment - you will need to wait for the processing to complete.

1. Go to **Raster > Miscellaneous > Build Virtual Raster**
2. Select the files you want to include in the raster - use the files in **Data/raster/VMD**
3. Uncheck **Place each input file into a separate band**, and set a location for the output file
4. Click **Run in Background** to create the virtual raster and load it into the map - this will take several minutes to complete
5. Set scale dependencies on the raster layers you now have loaded, so they appear at appropriate scales

10.5.3. Load WMS layers

1. Go to <http://data.gov.uk> (or another site with WMS data sources if you prefer)
2. Search the site for a WMS layer, and copy the link
3. Use the **Data Source Manager** to create the connection, and load layers from the site

10.6. Data Creation and Editing

This exercise covers creating and editing vector data, both in the map and in the attribute table.

10.6.1. Create features

1. Create a new GeoPackage layer in your **Documents** folder. Ensure that it is a polygon type, and has the following attributes:
 1. **name** (text)
 2. **date** (date)
 3. **reference** (integer).
 4. Specify the CRS as **EPSG:27700**
2. Create two or three new features in the layer, populating the attributes when prompted
3. When this is done, open the attribute table for the layer, and make further edits

10.6.2. Edit features

1. Open one of the layers you have been using, and amend the geometry of some of the existing features, including lines, points and polygons
2. Use **Copy/Paste** to create new features
3. Use the tools in the **Advanced Digitizing** toolbar to amend the geometry, including
 - a. **Split Features**: draw a line across a feature to split it into two
 - b. **Extend Features**: draw an extension to a feature
 - c. **Rotate Features**: turn features round
 - d. **Add part**: add a new part to a multipart features

10.6.3. Snapping and tracing

1. Turn on the **Snapping Toolbar**, and activate snapping
2. Use the second button to go to **Snapping Options**, and set snapping to one of the layers - for example **railways_naptan** - with a tolerance of 50 metres
3. Create a new line layer, and draw lines between railway stations to create a representational map of part of the railway network, with vertices snapping to existing stations
4. Turn on **Enable Tracing** in the toolbar, and create a new AONB, which adjoins one of the existing AONBs, using tracing to make part of the boundary coincide
5. Turn on **Enable Topological Editing** in the toolbar, and adjust one of the common boundaries in a polygon layer, for example in **LLSOA_Dec_2011_England_Wales**

10.7. GeoProcessing for Analysis

This exercise uses a combination of geo processing techniques to address some spatially-related questions.

10.7.1. Buffer and select points in polygon

1. Create a new project and save it
2. Open the **nat_parks_england** and **railway_naptan** layers
3. Create a 10km buffer round the Lake District National park
4. Use **Select by location** to find out how many railway stations are within 10km of the park

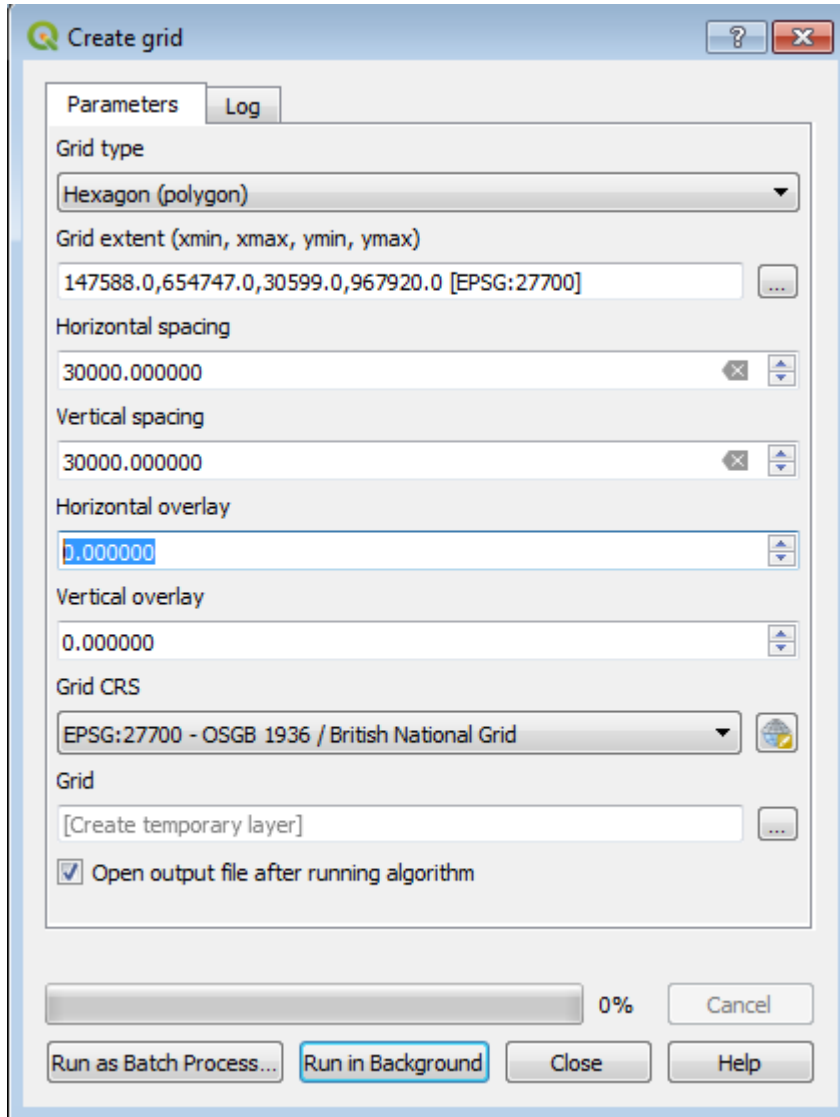
10.7.2. Create centroids and a distance matrix

1. Open the **county_region_england** layer
2. Use the **Centroids** process to create a layer of the centroid of each county
3. Use a **Distance Matrix** to find the three nearest railway stations to each centroid

10.7.3. Create a hexagon grid and a point count

This stage visualises the density of railway stations across Great Britain.

1. Using the **Create grid** tool, create a hexagon grid to cover the extent of the railway stations layer
 - a. Zoom to the extents of the railway stations layer
 - b. Create a 30km hex grid for the extents of the layer, with settings something like:



- b. Use **Count points in polygon** with the grid as the polygon layer, and the railway stations as the points layer
- c. Create a style to visualise the results, using the field name specified in **Count field name** in the previous step (e.g. **NUMPOINTS**)

10.8. Print Layouts

Use a project file from an exercise of your choice to create a Print Composer page. Use as many of the tools and features as possible, as covered in the course notes, including:

- **Legend:** including editing the legend in the Print Composer
- **Scalebar:** including adjusting settings
- **Image:** of your choice
- **Text:** try using some HTML, and/or an expression
- **Table:** change the settings to include a subset of the attributes
- **Overview map:** with an extent indicator on the main map, formatted as a red outline

When you have loaded all the elements onto the page, if you have time, fine-tune the layout to improve the quality and usability for the reader.

When you have finished, save the result as a PDF and also as a PNG image into a suitable location, with your name as part of the filename - we will review some of the final maps together.

1. QGIS Atlas

<ul style="list-style-type: none"> 1. QGIS Atlas <ul style="list-style-type: none"> 1.1. Introduction 1.2. Setting up the Atlas 1.3. Review the results 1.4. Add further elements 1.5. Use a hidden layer 1.6. Set styling to highlight the layer in focus 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-A01</td> </tr> <tr> <td>Title</td> <td>QGIS Atlas</td> </tr> <tr> <td>Description</td> <td>Using Atlas to create data-driven maps</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.2 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>23 May 2019</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>Complete</td> </tr> </table>	Code	QGIS-A01	Title	QGIS Atlas	Description	Using Atlas to create data-driven maps	Required Software	QGIS v 3.2 or later	Target Audience	QGIS Desktop users	Updated	23 May 2019	Updated by	Antony Scott	Status	Complete
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1.1. Introduction

Atlas is a component of Print Layouts which allows multiple output pages to be automatically generated from a single Layout, driven by an attribute of the data, with a page for each feature. This is commonly used to produce, for example, a single map for each feature in an administrative boundary layer, for example wards or counties.

Various settings are available, and as well as the map itself being dynamic, other items in the Layout such as titles can be dynamically generated, with attribute values drawn from the current feature.

1.2. Setting up the Atlas

Open the QGIS project ...**Advanced\Projects3\atlasgeneration**

There are three layers

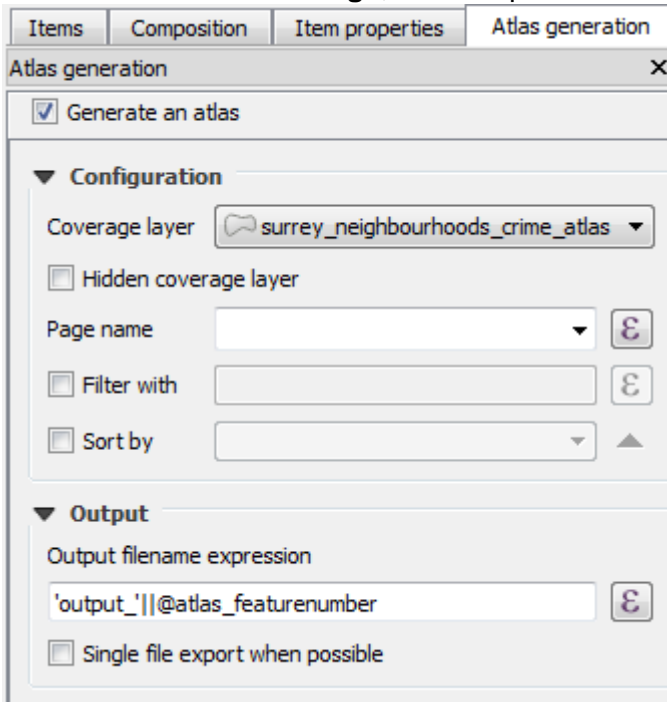
- **april2011_street** (individual crime incidents)
- **surrey_neighbourhoods_crime_atlas**
- **OS Opendata WMS**

The task is to create an atlas with one page for each neighbourhood, displaying all the data available.

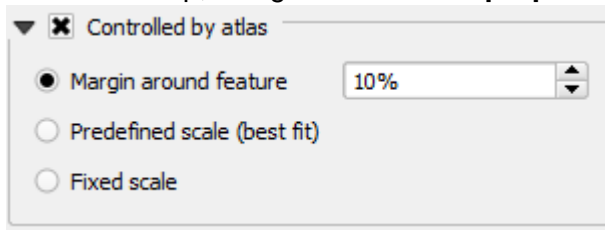
To do this:

1. Go to **Project > New Print Layout**
2. Enter an appropriate name, e.g. *Epsom neighbourhoods*
3. Add a map, legend, scalebar and label

4. Go to **Atlas > Atlas Settings**, and complete according to the screenshot below:

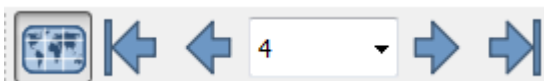


5. Select the map, navigate to the **Item properties** tab and complete as follows:



1.3. Review the results

Use the Atlas toolbar controls to review the maps - first click on **Preview Atlas** (the right-hand button on the Atlas toolbar) to activate the tools.

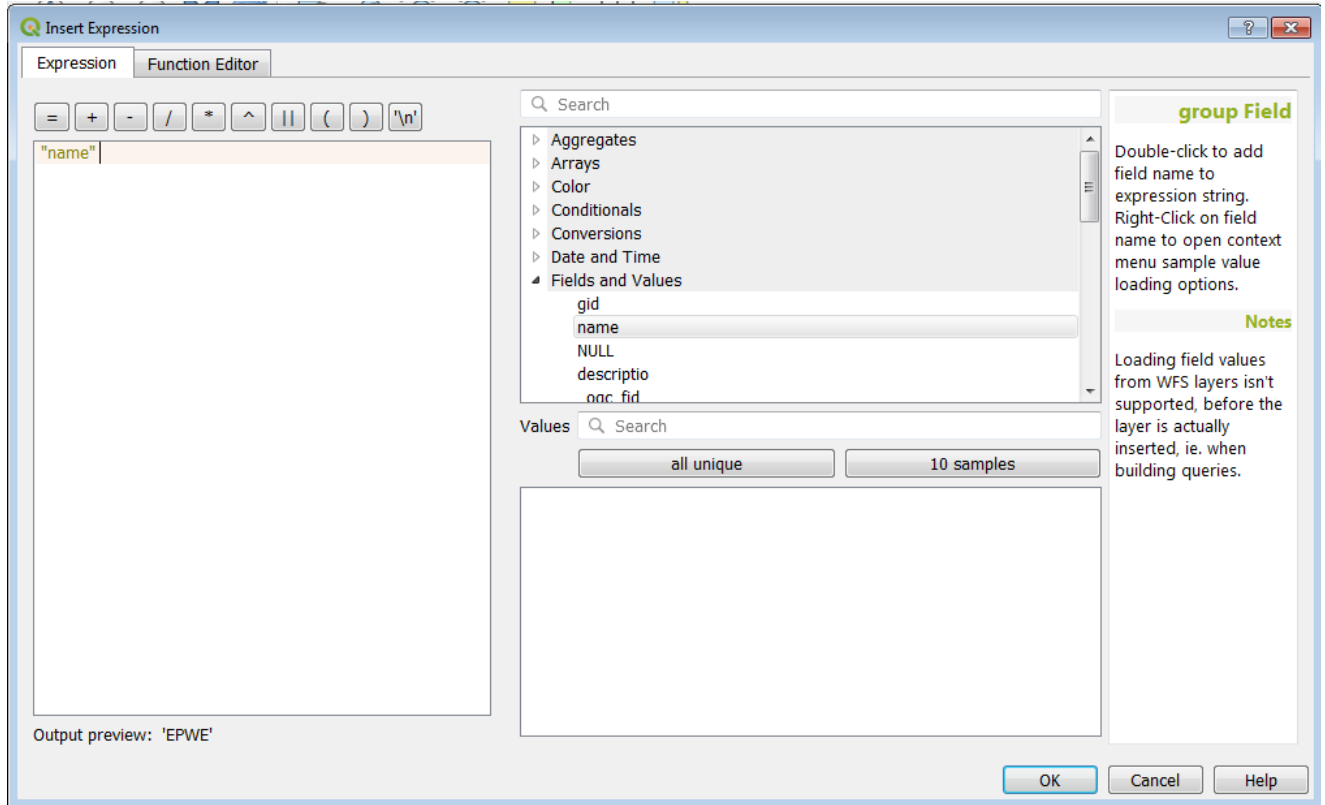


Use the left and right arrows to scroll through the Atlas pages.

1.4. Add further elements

1. In the label box, use **Insert an expression** to add a dynamic title to the map pages - so that the result is something like:
Crime Incidents for Neighbourhood EPWE: map 3 of 10

Note that you will need to find the correct expression to produce this result - look under Fields and Values and **Variables** in the **Expression Builder** dialogue.

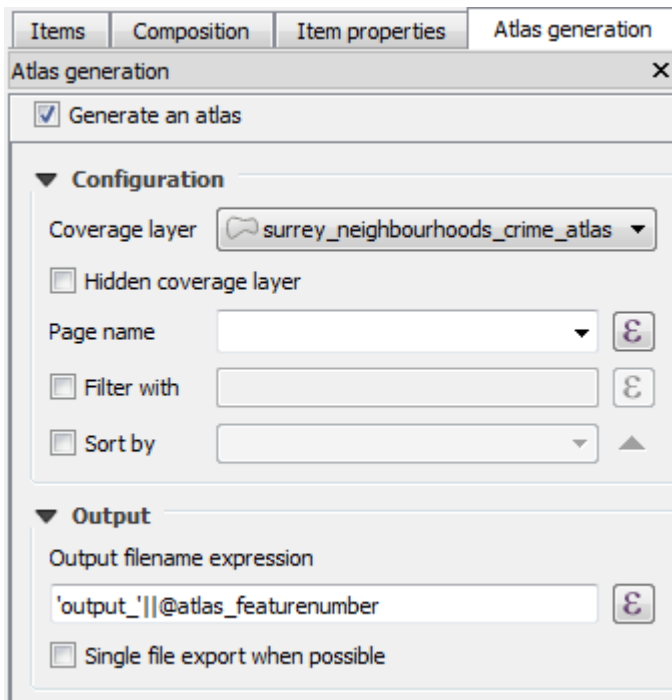


2. Add any other features to the map you think might be useful, and any other fields or variables.
3. Review the updated output pages in the preview.
4. Change the scale settings for the map, and review the results.

When you have created an atlas which is ready to produce, export the results.

1. Go to the **Atlas** menu and export as PDF
2. Choose folder **...\Advanced\Atlas\output**
3. On completion, open the PDF output and review, then revise and regenerate the output if necessary.

The output can be produced as a single PDF multi-page file, or as a series of single PDFs, one for each feature. To produce single pages, ensure **Single file export where possible** is unchecked in the **Atlas** tab, and edit the **Output filename expression** value using the expression builder, to use an attribute value from the feature in the filename.



1.5. Use a hidden layer

You can use a coverage layer which is not visible in the map to drive the Atlas - check the **Hidden coverage layer** box to do this.

This could be a grid layer for example, or a layer with polygons for specific areas of interest. If you have time, try using this approach, creating an appropriate layer.

1.6. Set styling to highlight the layer in focus

You may want your styling to differentiate between the feature which is the focus of the map, and the other features, so that it stands out. To do this, you will need to add a rule-based style for every layer which you want to change.

In the **Symbology** tab for the layer:

1. Select **Rule-based** from the style drop-down at the top
2. Click the **+** button at the bottom of the dialog to add a new rule
3. Expand the **Edit Rule** dialog so you can see all the controls
4. Enter 'Feature in focus' for the **Label**, to remind you that this new rule will only apply to the current Atlas feature
5. Open the expression builder dialog, and in the search box enter 'id'
6. Use the results to create the expression **\$id = @atlas_featureid** - this will apply the style in the rule only to the current Atlas feature
7. Set the styling for this rule, and for the other default rule as you wish - for example you may want to change colours and transparency
8. Preview the Atlas pages in the Print Layout to see the results

If you want to make the styling of features other than those in the coverage layer dynamic, you'll need to use an expression which determines, for example whether they are inside the current feature:

```
within($geometry, @atlas_geometry)
```

You may also want to use other Geometry functions such as **intersects**, or **overlaps**.

4. QGIS Georeferencing

<ul style="list-style-type: none"> 4. QGIS Georeferencing <ul style="list-style-type: none"> 4.1. Introduction 4.2. Open the project and load the Georeferencer 4.3. Load the source data 4.4. Create GCPs 4.5. Run the Georeferencer 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-A04</td> </tr> <tr> <td>Title</td> <td>QGIS Georeferencing</td> </tr> <tr> <td>Description</td> <td>Using the georeferencing tool to use unreferenced raster images.</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.2 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Pre-requisites</td> <td></td> </tr> <tr> <td>Updated</td> <td>01 Aug 2018</td> </tr> <tr> <td>Updated by</td> <td>Ian Turton</td> </tr> <tr> <td>Status</td> <td>Complete</td> </tr> </table>	Code	QGIS-A04	Title	QGIS Georeferencing	Description	Using the georeferencing tool to use unreferenced raster images.	Required Software	QGIS v 3.2 or later	Target Audience	QGIS Desktop users	Pre-requisites		Updated	01 Aug 2018	Updated by	Ian Turton	Status	Complete
Code	QGIS-A04																		
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Target Audience	QGIS Desktop users																		
Pre-requisites																			
Updated	01 Aug 2018																		
Updated by	Ian Turton																		
Status	Complete																		

4.1. Introduction

Georeferencing is used when raster data is not referenced to a CRS. The process adds coordinate references to a raster image so that it can be used in QGIS alongside other layers.

4.2. Open the project and load the Georeferencer

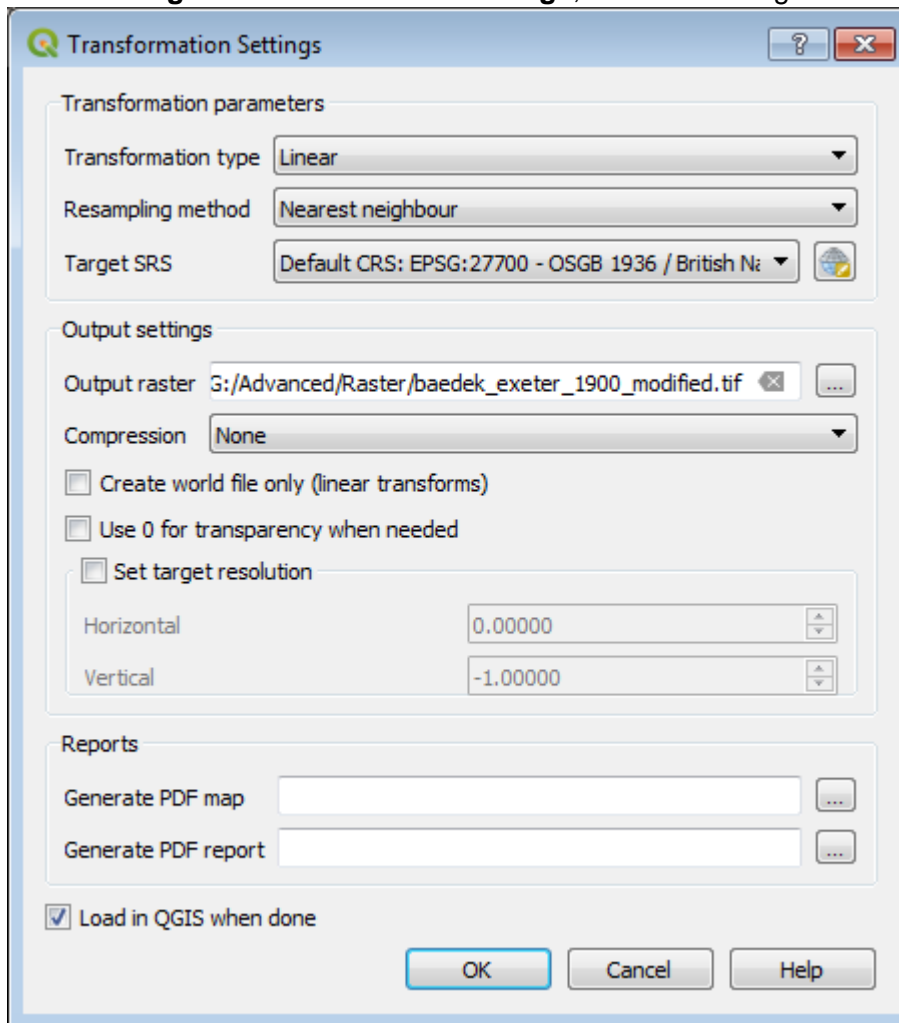
1. Open project ...**\Advanced\Projects\Georeferencing.qgz**
The map shows an area of Exeter, including a MasterMap layer and the OS open data WMS. You may want to load the style file for MasterMap from the earlier exercises.
2. Go to **Raster > Georeferencer** (if you don't see this in the menu, go to the **Plugin Manager** and enable the **Georeferencer GDAL** plugin).

You are going to use the Georeferencer tool to open a non spatially-referenced image of a map, and reference it to the QGIS layers based on coordinates and common features across the maps.

4.3. Load the source data

1. Click the **Open raster** button in the Georeferencer. 
2. Navigate to and open ...**\Advanced\Data\Raster\baedek_exeter_1900.jpg** (from http://freepages.nealogy.rootsweb.ancestry.com/~genmaps/genfiles/COU_files/ENG/DEV/baedek_exeter_1900.htm)

3. Go to **Settings > Transformation Settings**, and add settings as in the screenshot below:



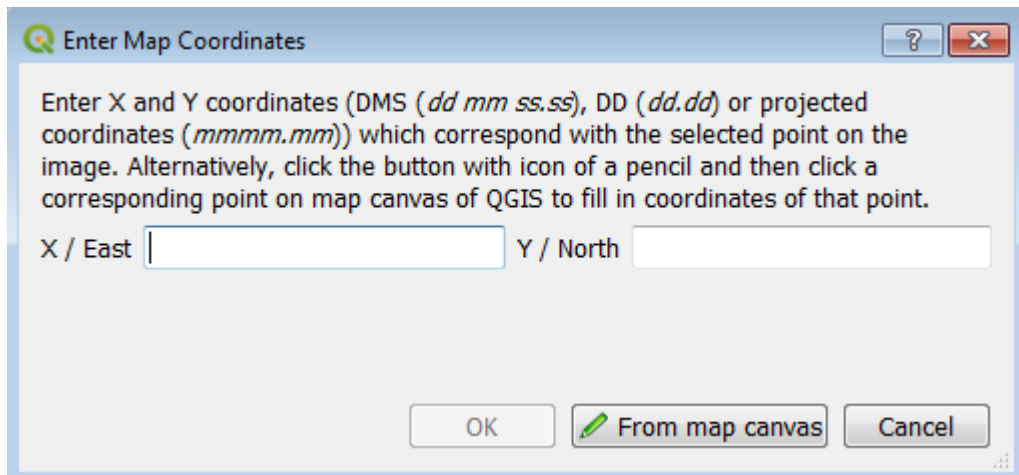
Look at the image alongside the QGIS map to understand how it relates to the other layers. You will need to identify features in common such as road junctions, or railway stations - you will need at least four of these, well spread out across the map. These are called Ground Control Points (GCPs).

You will see that the graphic contains two maps, each at a different scale - if possible, you should georeference both of these (create a copy of the original JPEG to create the second).

4.4. Create GCPs




1. Create your first control point by selecting the **Add point** tool
2. Click on the map image on a feature you will be able to identify on the QGIS map - for example the main railway station.
3. On the dialogue that appears, click **From map canvas**



4. Identify and click on the same feature in the QGIS map
5. Click **OK** - a point will appear on the map, with a corresponding reference in the table below.
6. Complete this task at least a further three times at different locations on the map where features can be identified, ensuring they are well distributed. This might take some time - use zoom controls to be as accurate as possible.
7. Use the **Move GCP point** tool if necessary to correct point locations, or to delete points and recreate.

4.5. Run the Georeferencer

1. When you are happy with the GCPs you have collected, click the **Start georeferencing** button 
2. Minimise the Georeferencer to see the results.
3. Your map should now be in the main QGIS map window, lined up with the MasterMap data.
4. If you are not happy with georeferencing, go back to the georeferencer and try again.

When you have completed this, repeat the exercise using the second map on the graphic, making a copy of the original JPEG to use as your source.

5. QGIS Raster Analysis

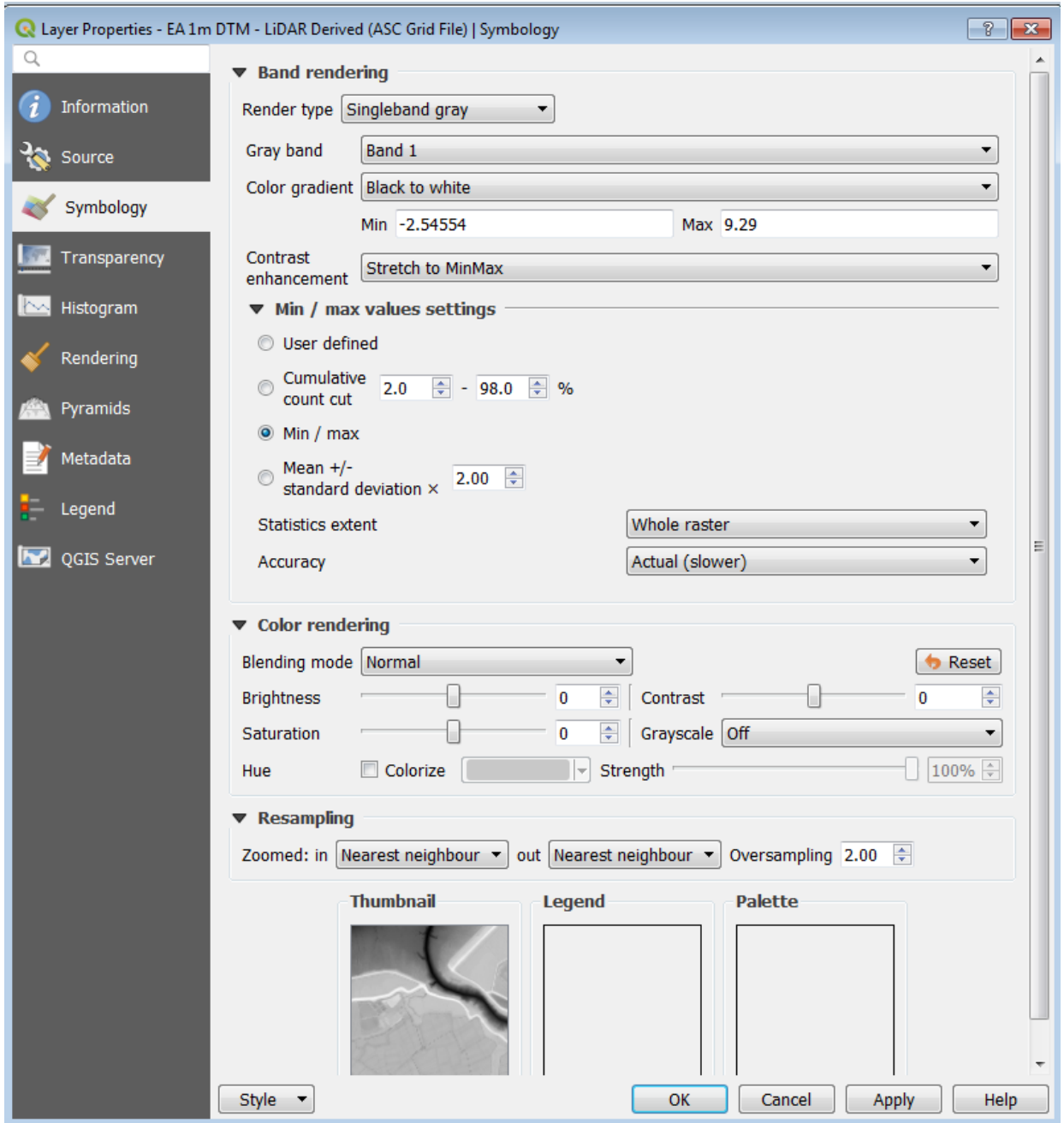
<ul style="list-style-type: none"> 5. QGIS Raster Analysis <ul style="list-style-type: none"> 5.1. Introduction 5.2. Open Raster Data 5.3. Create a hill-shaded image 5.4. Aspect, Slope and Raster calculations <ul style="list-style-type: none"> Create Aspect image Create Slope image Raster Calculations 5.5. 3D Viewing 	<p><i>An Astun Technology QGIS Training Module</i></p> <table border="1"> <tr> <td>Code</td> <td>QGIS-A05</td> </tr> <tr> <td>Title</td> <td>QGIS Raster Analysis</td> </tr> <tr> <td>Description</td> <td>Raster analysis</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.2 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>03 Sep 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>Complete</td> </tr> </table>	Code	QGIS-A05	Title	QGIS Raster Analysis	Description	Raster analysis	Required Software	QGIS v 3.2 or later	Target Audience	QGIS Desktop users	Updated	03 Sep 2018	Updated by	Antony Scott	Status	Complete
Code	QGIS-A05																
Title	QGIS Raster Analysis																
Description	Raster analysis																
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Target Audience	QGIS Desktop users																
Updated	03 Sep 2018																
Updated by	Antony Scott																
Status	Complete																

5.1. Introduction

Raster data is a wide field of analysis, so in these exercises we will introduce some common techniques and tools, and work with some specialist raster processing plugins. We are going to use some UK Environment Agency LIDAR data as our example.

5.2. Open Raster Data

1. Open the project ...**\Advanced\Projects\Rasteranalysis.qgz**
2. Add the following raster image:
...**\Advanced\Data\raster\EA_1m_\EA_1m_DTM\EA 1m DTM - LiDAR Derived (ASC Grid File).asc**
3. Go to **Layer > Properties > Style** and under the **Band rendering** section set the values as follows if they aren't set already:
 1. Set the **Render type** to **Singleband gray**
 2. Set **Contrast enhancement** to **Stretch to MinMax**
 3. Set the **Accuracy** under **Load min / max values** to **Actual (slower)**



4. Click **OK**.

The result will look like the image below - a LiDAR image of an area of land at the mouth of the Congresbury Yeo river in Somerset, UK.



5.3. Create a hill-shaded image

To give a more meaningful representation of relief, we are going to add some hill shading to the image.

1. Go to **Raster > Analysis > Hillshade**
2. In the dialogue, make sure the settings are as follows:
 - a. Input layer: **EA 1m DTM – LiDAR etc...**
 - b. Band number: **Bnad 1**
 - c. Output layer: **...\Data\Raster\Output\hillshade300.tif**
 - d. Z factor: **1**
 - e. Check **Open output file after running algorithm**
- c. Click **Run in background**

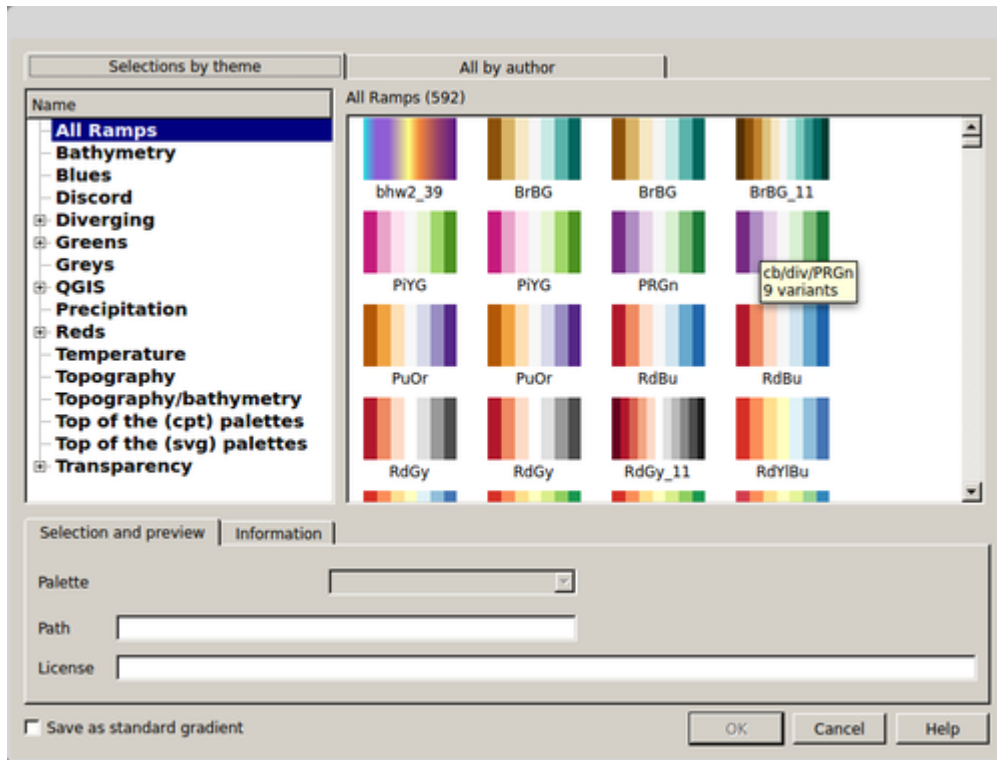
The data will be processed, and the new image added to the map. The image will be in standard greyscale, and you should be able to visually identify features.

To improve the appearance, use a psuedo-colour ramp.

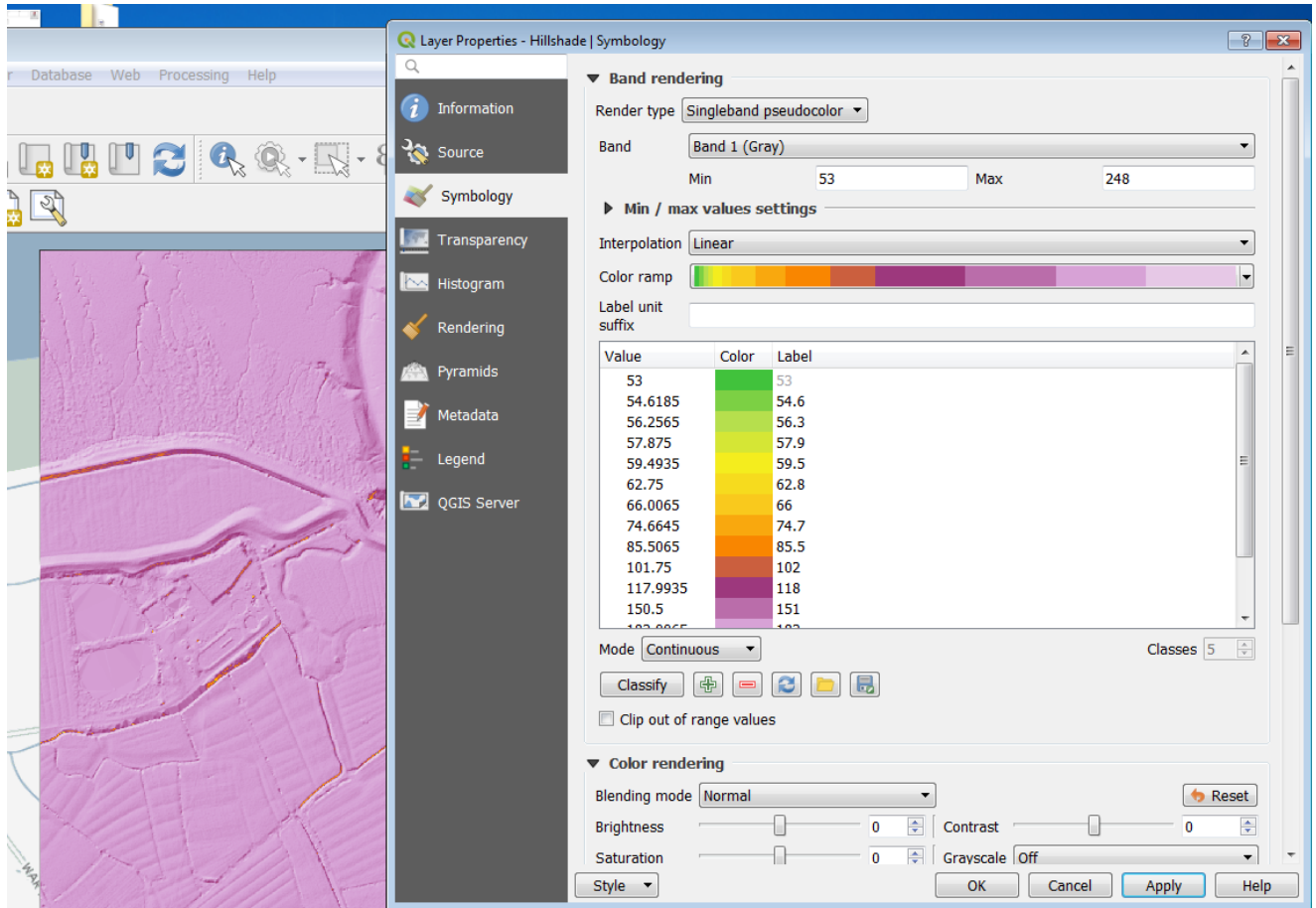
1. Go to **Symbology** for the new hillshade layer and set the **Render type** to **Singleband pseudocolor**
2. Under **Color ramp**, choose an appropriate color map from those available in the drop down list (eg **Pi**

YG), then click **Apply**

- For a more terrain-like colour scheme, scroll to the bottom of the color ramp list and choose **New color ramp...**, then in the dropdown select **cpt-city** which includes a variety of categorised colour ramps



- Select a colour ramp and click OK
- The result should be similar to the following:



6. Click **OK**.
7. Review the results in the map window.

Create an additional hill-shaded image, changing **Azimuth** to 210 degrees and call the file **hillshade210**. Examine the differences between the two images you have created to see how changing light source affects the clarity of the different features on images.

5.4. Aspect, Slope and Raster calculations

The next exercise includes several parts, using different tools to create a map of areas identified for development.

You need to identify areas for development that meet some specific criteria:

- The area needs to have a south-facing aspect
- The area should have a slope of less than 3 degrees.

Create Aspect image

First determine the aspect.

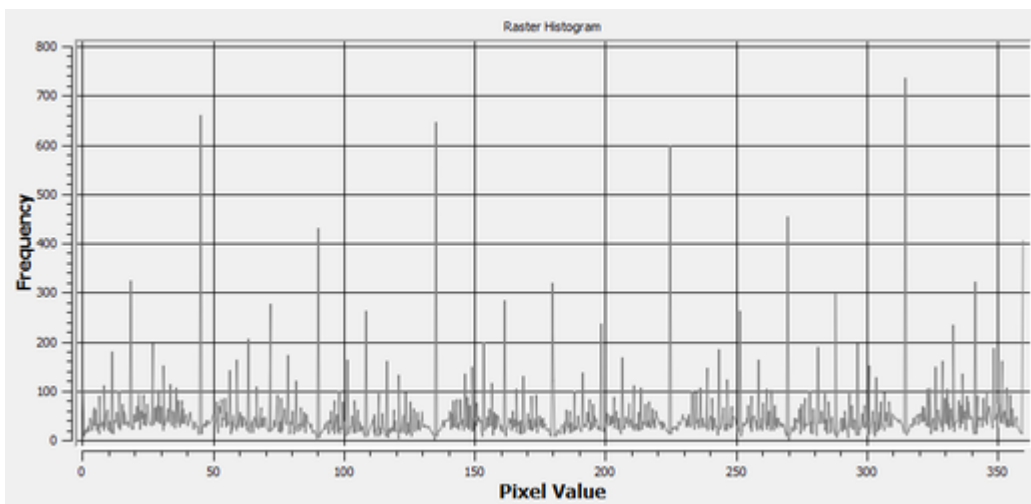
1. Select **Raster > Analysis > Aspect**
2. **Enter details as below:**
 - a. Elevation layer: **EA 1m DTM – LiDAR etc...**
 - b. Output layer: **...\\Advanced\\Data\\raster\\Raster\\Output\\aspect.tiff**
 - c. Click **Run in Background**

The image will be created and loaded with a singleband grey, looking similar to this.



Examine the image, and change the Style settings to experiment with different visualisations. Using the Identify tool, click locations in the image to identify the pixel values - note that each value is in degrees between 0 to 360, indicating the aspect of the slope.

For more information about the range of pixel values, go to the Properties for the layer and click the Histogram tab.



Leave the aspect layer for now - you will make use of it after the next section.

Create Slope image

To determine the degree of slope across the terrain:

1. Select **Raster > Analysis > Slope**
2. Enter details as below:
 - a. Elevation layer: **EA 1m DTM – LiDAR etc...**
 - b. Output layer: **C:\Users\PhotonUser\My Files\Home Folder\Documents\QGIS**

Training\Data\raster\Data\Raster\Output\slope.tiff

c. Click **Run in Background**

The image will be created and loaded as singleband grey, looking similar to the following:



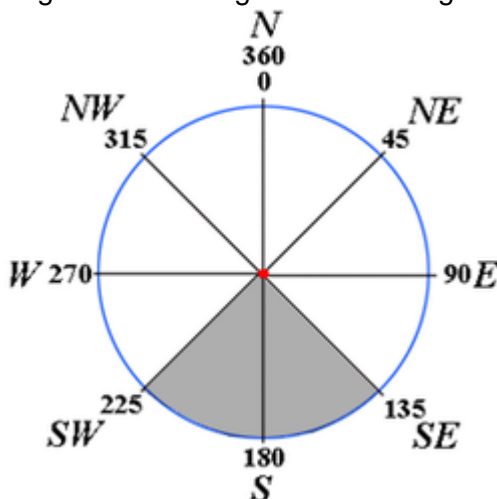
Examine the image, and change the Style settings to experiment with different visualisations. Using the **Identify** tool, click locations in the image to identify the pixel values - note each value is in degrees indicating the steepness of the slope.

As with the previous image, check the histogram to get an understanding of the type of terrain in the area.

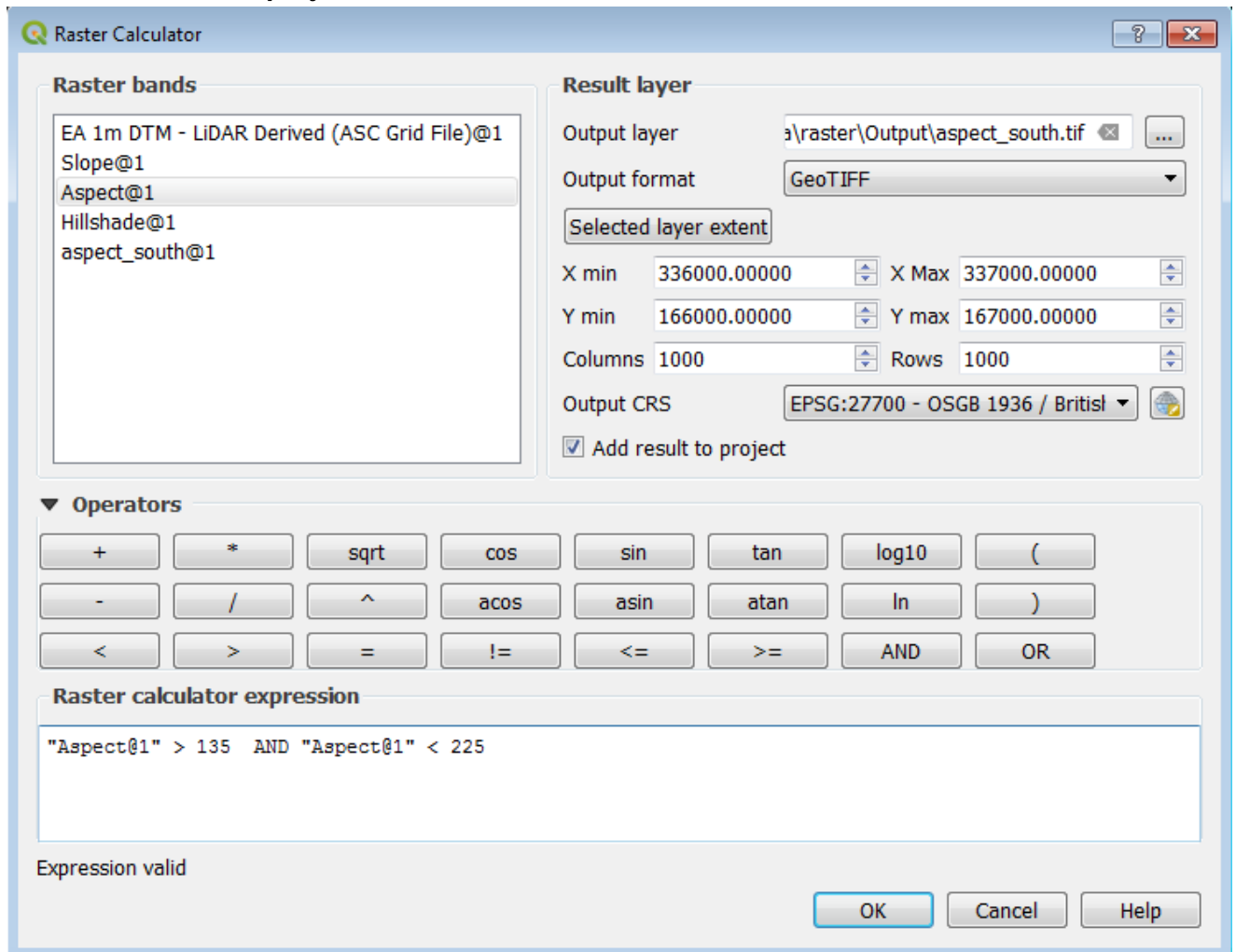
Raster Calculations

Having created the images for slope and aspect, you are going to perform three calculations using the raster calculator which will identify pixel values and hence areas that meet your selection criteria.

The first will identify all areas where the aspect is south facing - for this you are looking for aspects that range from 135 degrees to 225 degrees.



1. Go to **Raster > Raster calculator**
 2. Create the expression below using your own aspect layer names in the expression box
 3. Enter an **Output layer** name such as **aspect_south.tif**
1. Check **Add result to project**



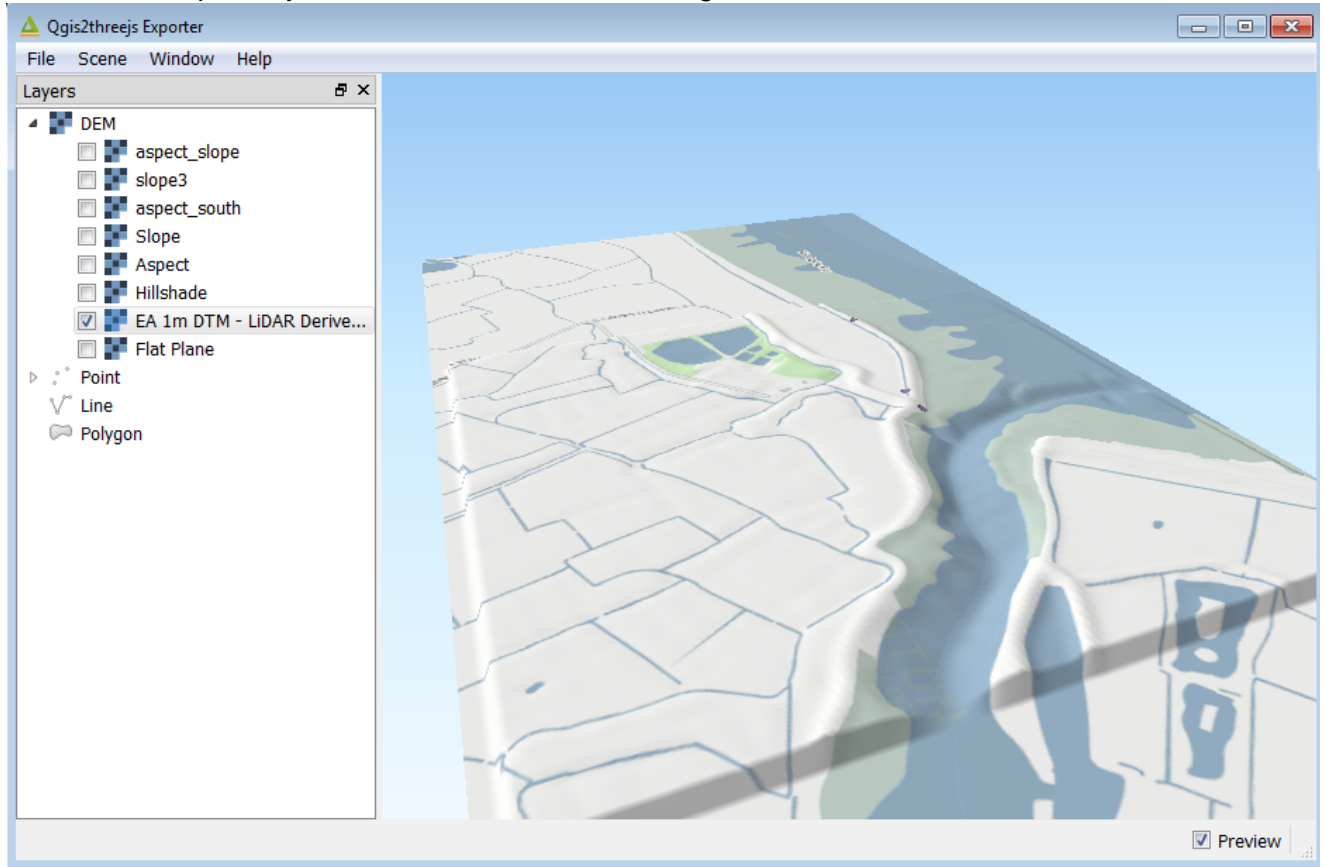
2. Click **OK**
The image should be created and loaded as a grey rectangle.
3. Examine the image on the map. The values used are a Boolean dataset, with 1 representing areas that meet your criteria.
4. Repeat the same steps for slope, using the following formula with your layer name, to determine slope less than three degrees, saving the layer as slope_3.tif:
slope@1 < 3
5. You can now use the 1 and 0 values in both layers to calculate the area that meets both criteria.
6. Open the raster calculator, and this time use the formula (with your layer names) as follows:
aspect_south@1 = 1 AND slope3@1 = 1
7. Set Color ramp settings on the resulting layer (if necessary) and view the results.

5.5. 3D Viewing

We can visualize the data in 3D using the QGIS plugin **Qgis2threejs** plugin.

1. Install the **Qgis2threejs** plugin

2. Turn off all layers apart from the LIDAR data and the OS Premium WMS layer, and ensure that the OS Premium layer is above the LIDAR in the layer list.
3. Go to **Web > Qgis2threejs > Qgis2threejs Exporter**
4. In the **DEM** section, turn on the LIDAR layer as the DEM Layer
5. In **File > World Settings**, set **Vertical exaggeration** to 3
6. In the Preview panel, you will see a zoomable 3D image



The scene can be exported to a website, although you will probably only be able to view the site from the file system in Firefox.

1. Go to **File > Export to Web**, then click **Export**
2. If Firefox is not your default browser, copy and paste the URL and view it in Firefox, or set the browser path to Firefox in **File > Exporter Settings**

You can include vector layers in the view as well.

1. Add a point vector layer to the project, select the layer in the Exporter and **Right-click > Properties** to set height and style options.

6. QGIS Graphical Modeler

<ul style="list-style-type: none"> 6. QGIS Graphical Modeler 6.1. Introduction 6.2. Summary 6.3. Create a point layer from CSV 6.4. Convert the Price field to an integer 6.5. Add a vector grid to use for analysis 6.6. Join the house price points to the grid polygons and summarise 6.7. Results 6.8. Add some styling 6.9. Working with the model 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-A06</td> </tr> <tr> <td>Title</td> <td>QGIS Graphical Modeler</td> </tr> <tr> <td>Description</td> <td>Automating processing tasks using the Processing Toolbox and Graphical Modeler</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.2 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop advanced users</td> </tr> <tr> <td>Updated</td> <td>04 Sep 2018</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>Complete</td> </tr> </table>	Code	QGIS-A06	Title	QGIS Graphical Modeler	Description	Automating processing tasks using the Processing Toolbox and Graphical Modeler	Required Software	QGIS v 3.2 or later	Target Audience	QGIS Desktop advanced users	Updated	04 Sep 2018	Updated by	Antony Scott	Status	Complete
Code	QGIS-A06																
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Status	Complete																

6.1. Introduction

This module covers the **Graphical Modeler**, which allows you to build and save process models containing one or more steps using a graphical interface.

Once a model has been built, it can be:

- Run from within QGIS, with different inputs
- Run as a standalone process using Python, for example from a batch file
- Made available as a shared resources

The Modeler can make use of any processes in the **Processing Toolbox**, so it's a useful tool for automating most things that QGIS can do.

6.2. Summary

The module shows you how to build a short workflow, so that it can be stored, repeated and shared.

The aim of the example is to take house price data from Bath in the UK, and represent it as a choropleth-styled map based on a grid.

The steps in the process are:

- Load CSV file of house sale prices
- Process the data to convert the **Price** field from a string to an integer
- Create a vector grid

- Join the house price data with a grid layer, summarising the individual price data as part of the process

Once these steps have been completed, you should have both a point layer of all house sales, and summary house price data for each cell in a grid overlay.

To get started:

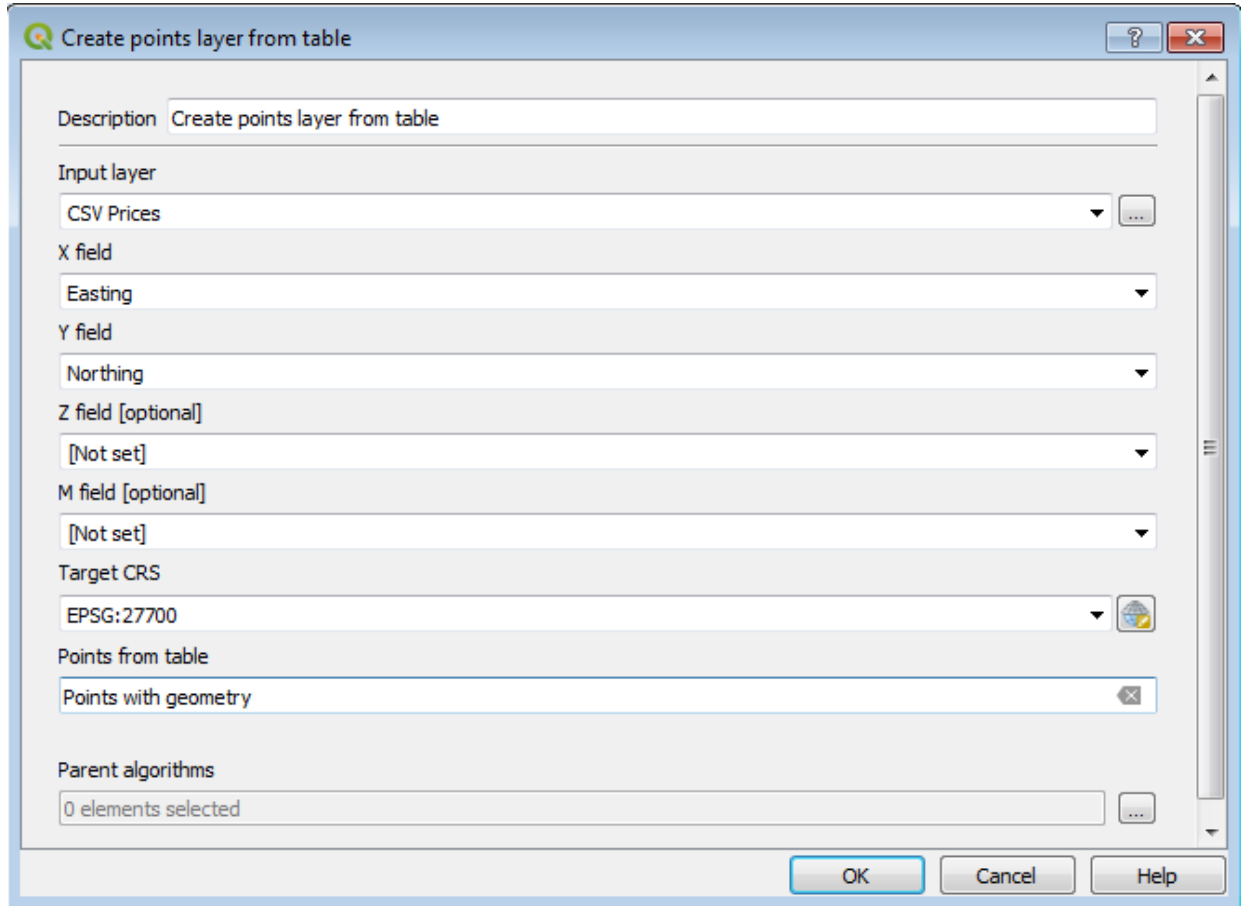
1. Open a new project in QGIS
2. In the Data Source Manager, use the **Delimited Text** option to load **Advanced/Data/Vector/House_Price_Paid_Bath_Land_Registry.csv**, setting the **Geometry definition** to **No geometry**
3. Ensure the project CRS is set to EPSG: 27700
4. **Save** the project in a suitable location (e.g. */Advanced/Projects/graphicalmodeler.qgz*)

6.3. Create a point layer from CSV

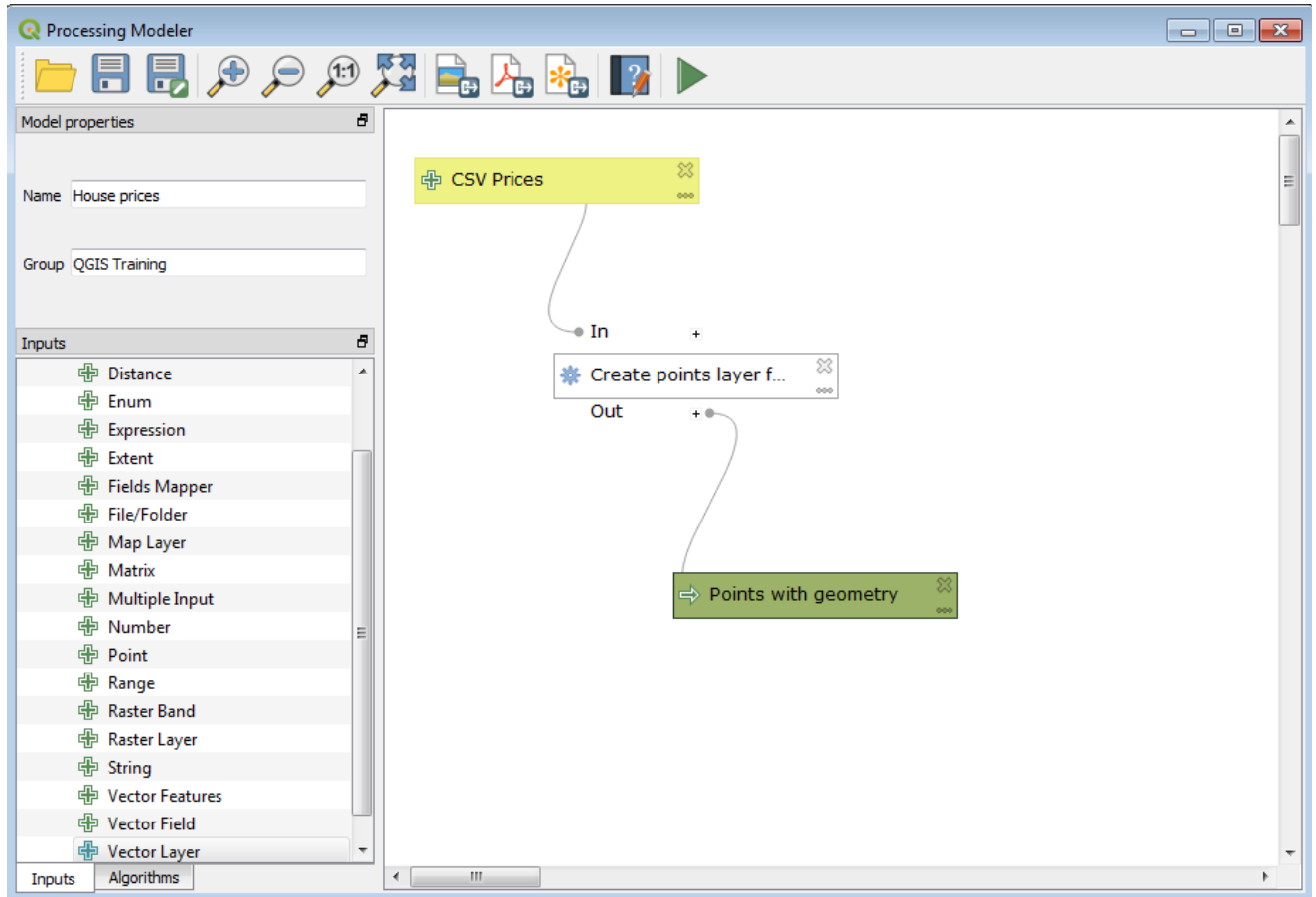
We'll now create a model to do the processing.

1. Go to **Processing > Graphical Modeler**
2. In Model Properties, complete the Name and Group fields with appropriate names (e.g. *House prices and QGIS Training*)
3. Create a placeholder for the the input layer
 - a. In the **Inputs** tab, double-click on **Vector Feature**, and in **Parameter Name** enter **CSV Prices** and click **OK**
4. Select a processing tool
 - a. In the **Algorithms** tab, search for points layer
 - b. Select the QGIS algorithm **Create points layer from table**
 - c. Complete the dialogue as shown below to create a points layer from the CSV
Note that because at this point you haven't specified an input file, only a placeholder, you will

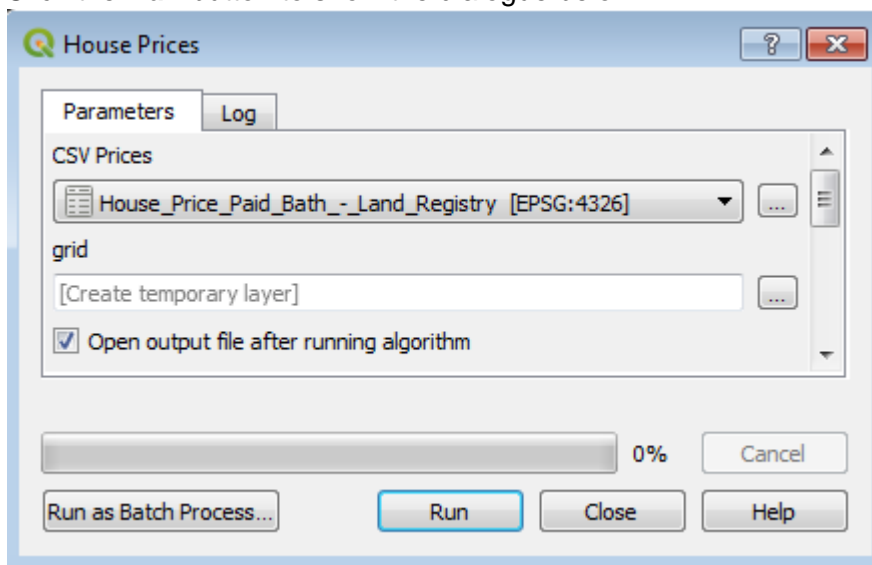
need to type in the values for X field and Y field rather than use the drop-downs. You should also set the CRS to EPSG:27700.



5. **Save** the model to your Documents folder with an appropriate name (e.g. *houseprices*) - you should have something like this:



6. Click the **Run** button to show the dialogue below:



7. Check the settings, and click **Run** to run the model
Make sure that whenever you run the model, the original input file (House_Price_Paid_Bath) is selected under CSV Prices
8. You should see a new layer on the map, **Points with geometry** - look at the layer to see that it's correct.
9. **Right-click > Remove** on the new layer to clean up

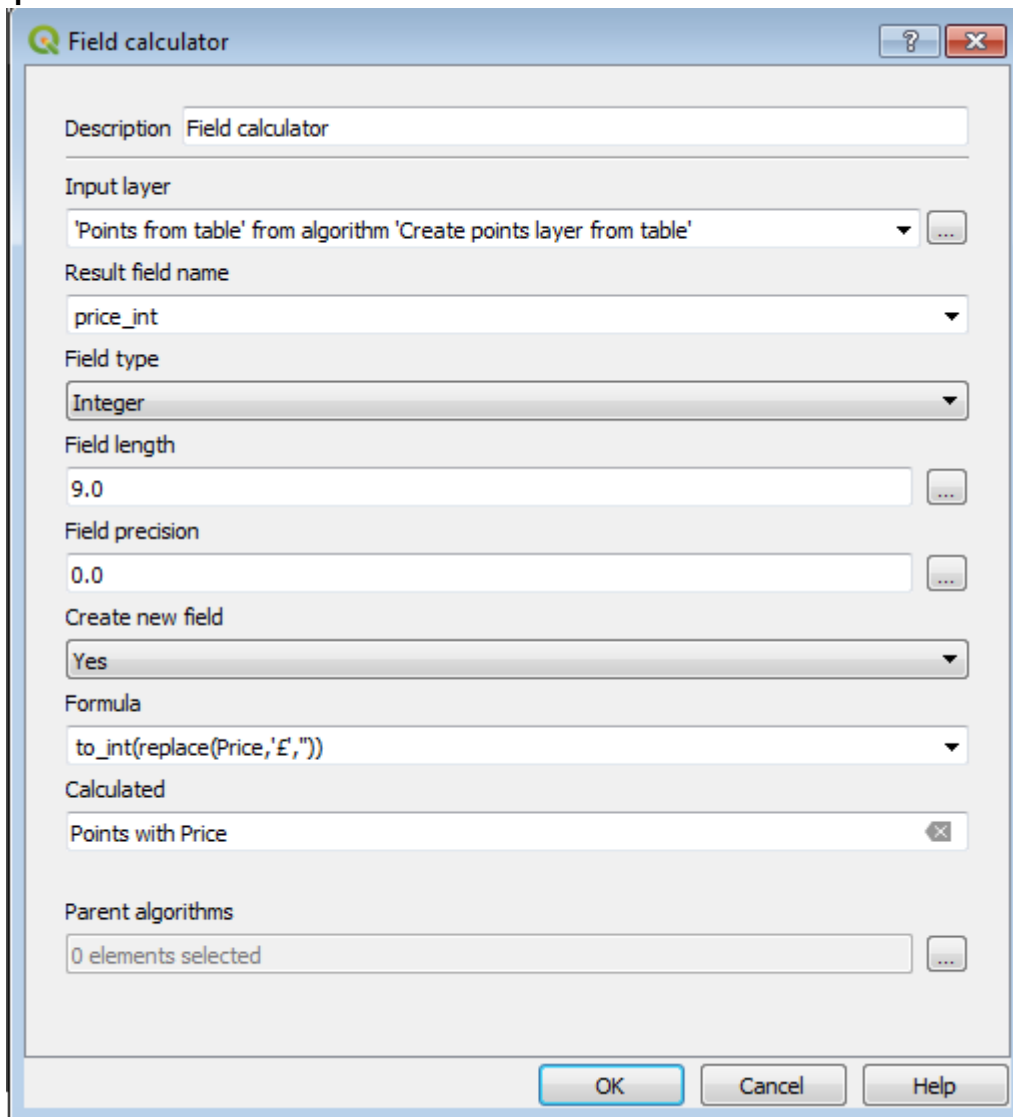
6.4. Convert the Price field to an integer

In this step, you will need to convert the **Price** field to an integer in order to work with it - it's currently a string, and has a '£' sign at the beginning. We'll use the field calculator to do this, but running it from the **Graphical Modeler** instead of the usual dialogue.

1. In the **Algorithms** tab, search for **field calculator**
2. Double click on Field Calculator, and complete the dialogue as the screenshot below
The formula you need to enter is below - it uses `replace()` to remove the £ sign from the string, and `to_int()` to convert the string to an integer

```
to_int(replace(Price,'£',''))
```

Note that the characters before the two last brackets are two single quotes, not a double quote.

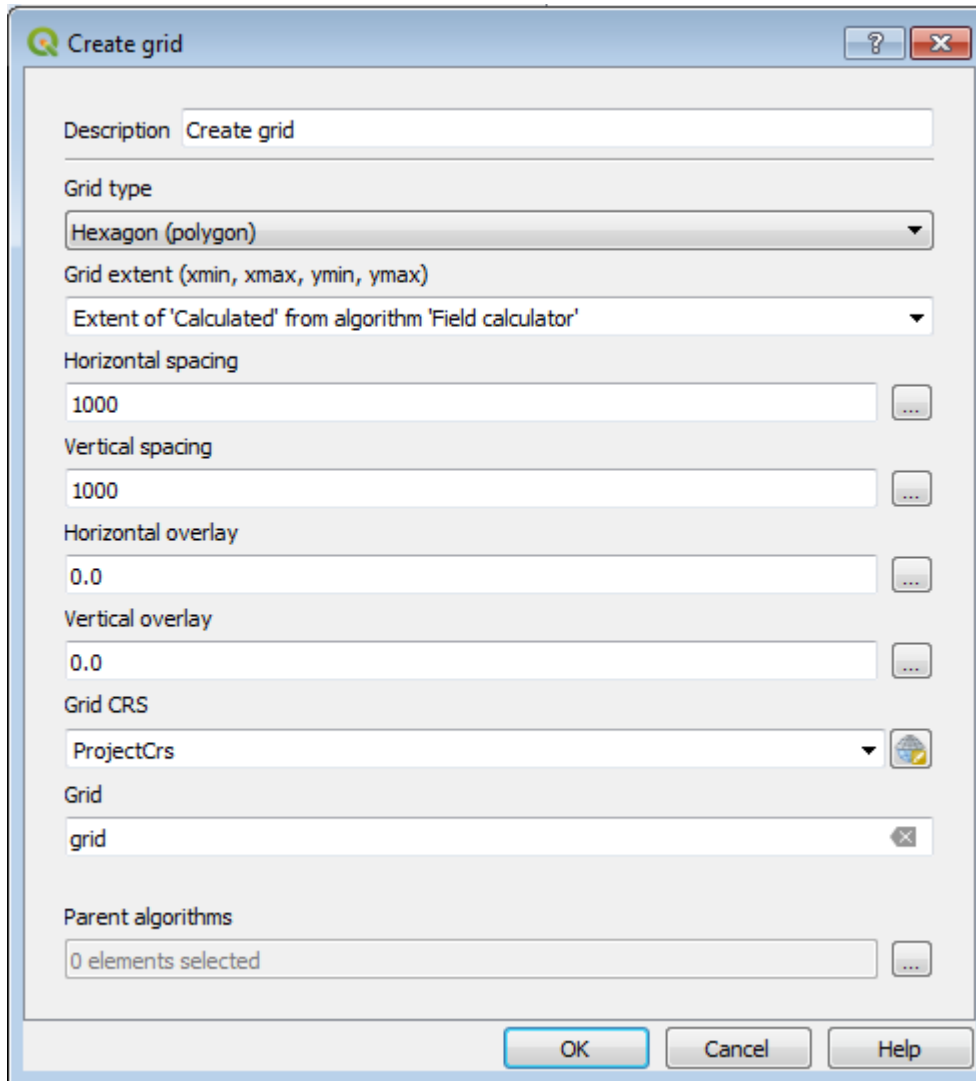


3. Click **OK**, then save and run the model
4. You should now have an additional point layer, with a new field **price_int** - check that this is correct.

6.5. Add a vector grid to use for analysis

We'll now overlay a vector grid which we can use to analyse the point vector data.

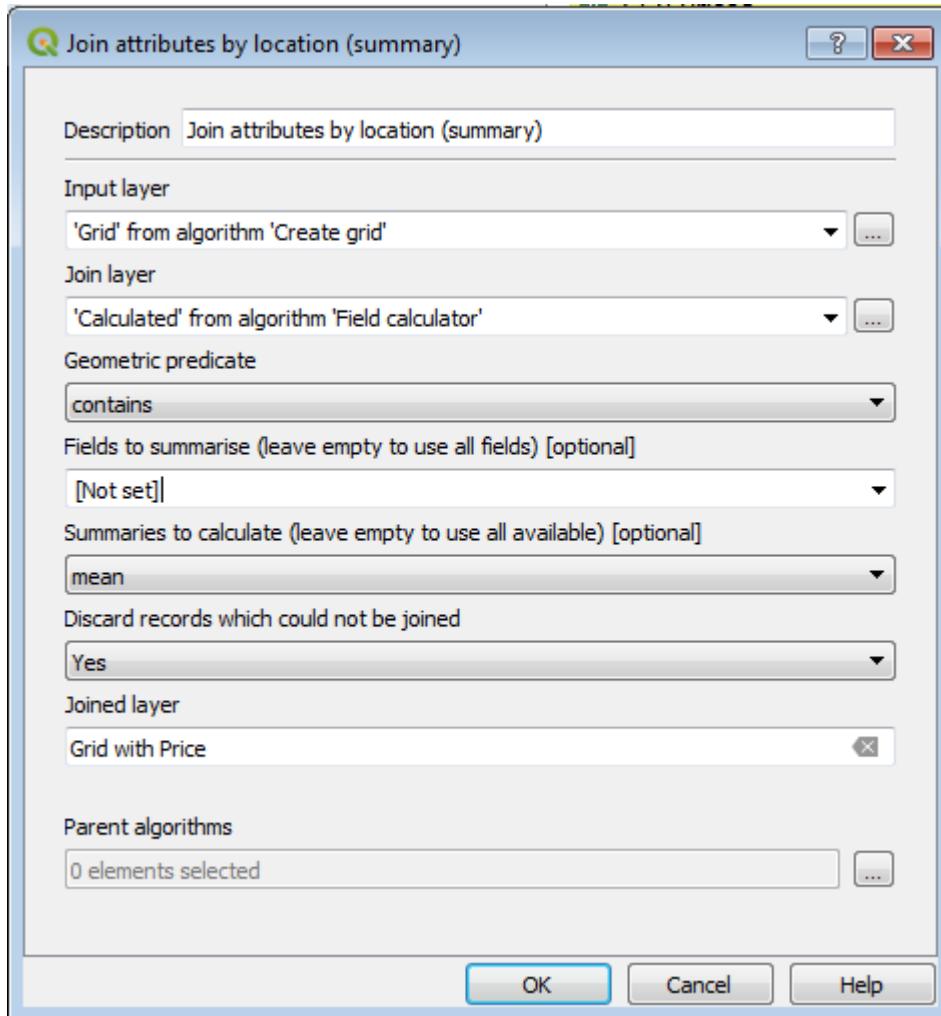
1. In the **Algorithms** tab, search for grid and select **Create grid**
2. Complete the dialogue as shown below - this will create a grid of 1km squares which covers the extent of the point layer



3. Save and re-run the model
4. You should now have a 1km polygon hex grid overlaying the point layers
5. Remove all the layers except the original CSV, and save the model

6.6. Join the house price points to the grid polygons and summarise

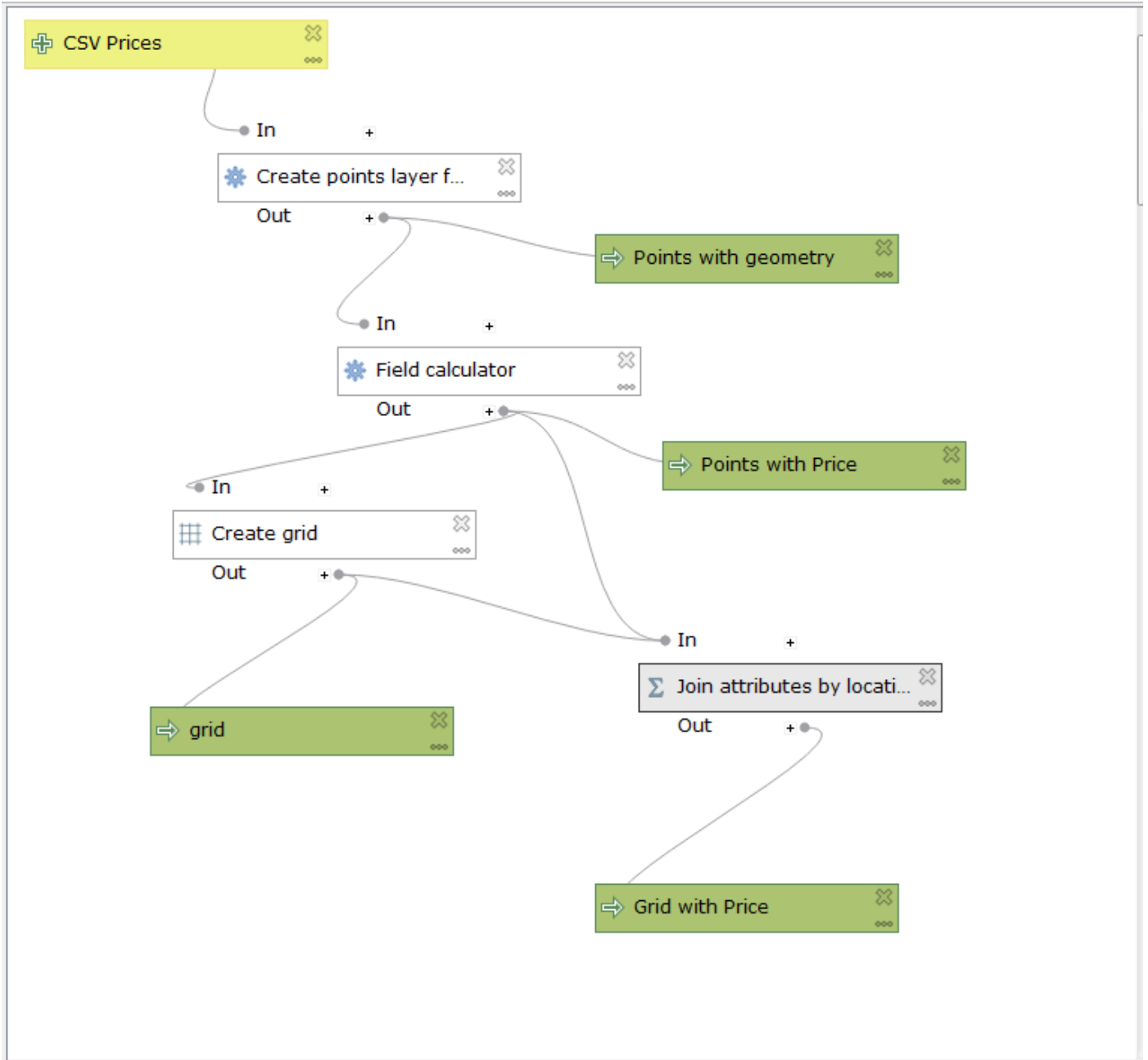
1. In the **Algorithms** tab, search for **join**
2. Double click on **Join attributes by location (summary)**
3. Complete the dialogue as below



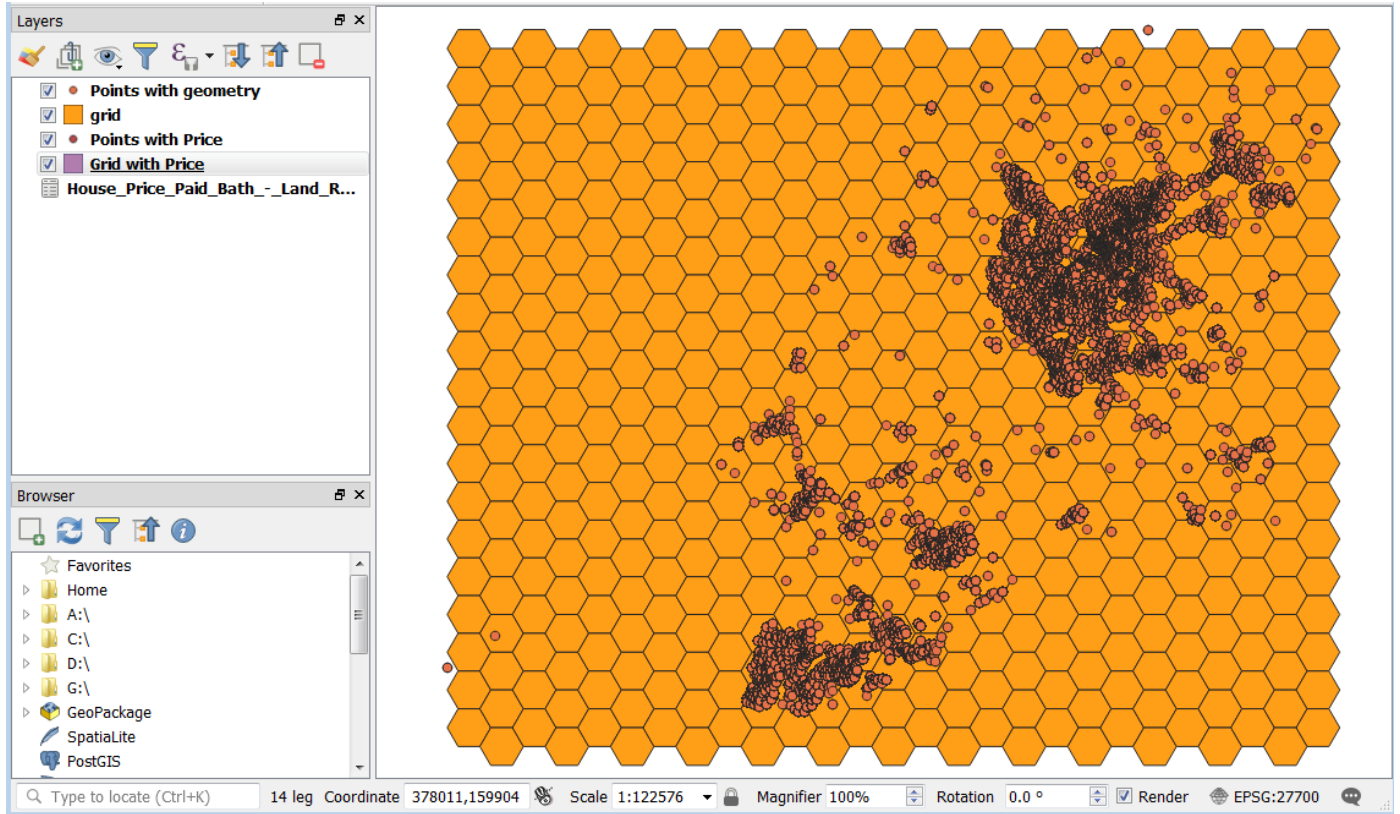
4. Save and run the model
5. You should see a new grid layer, with the a mean attribute for the house prices in each grid unit

6.7. Results

By this time, you should have a model which looks like this:



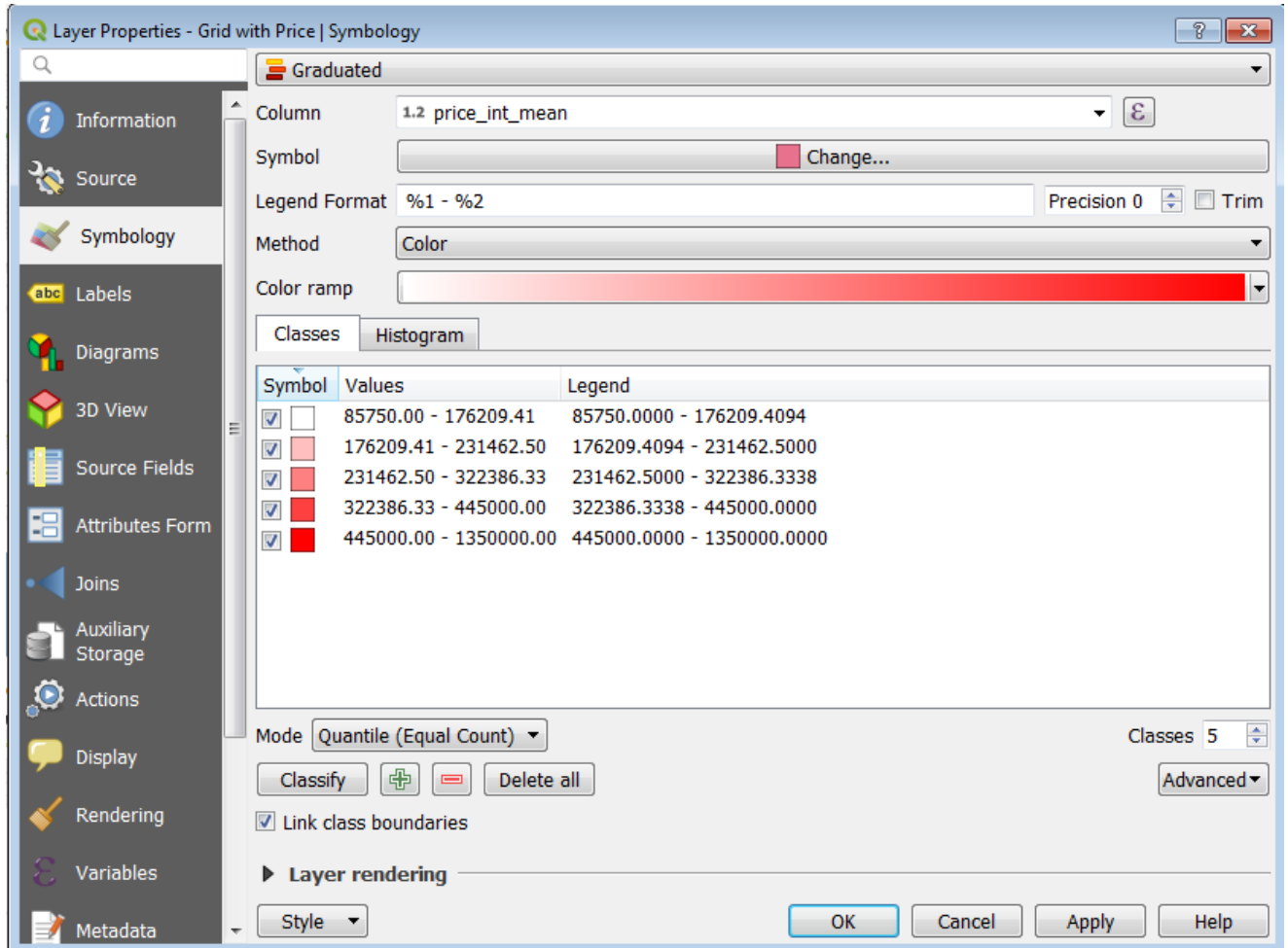
and your main QGIS interface should look something like this:



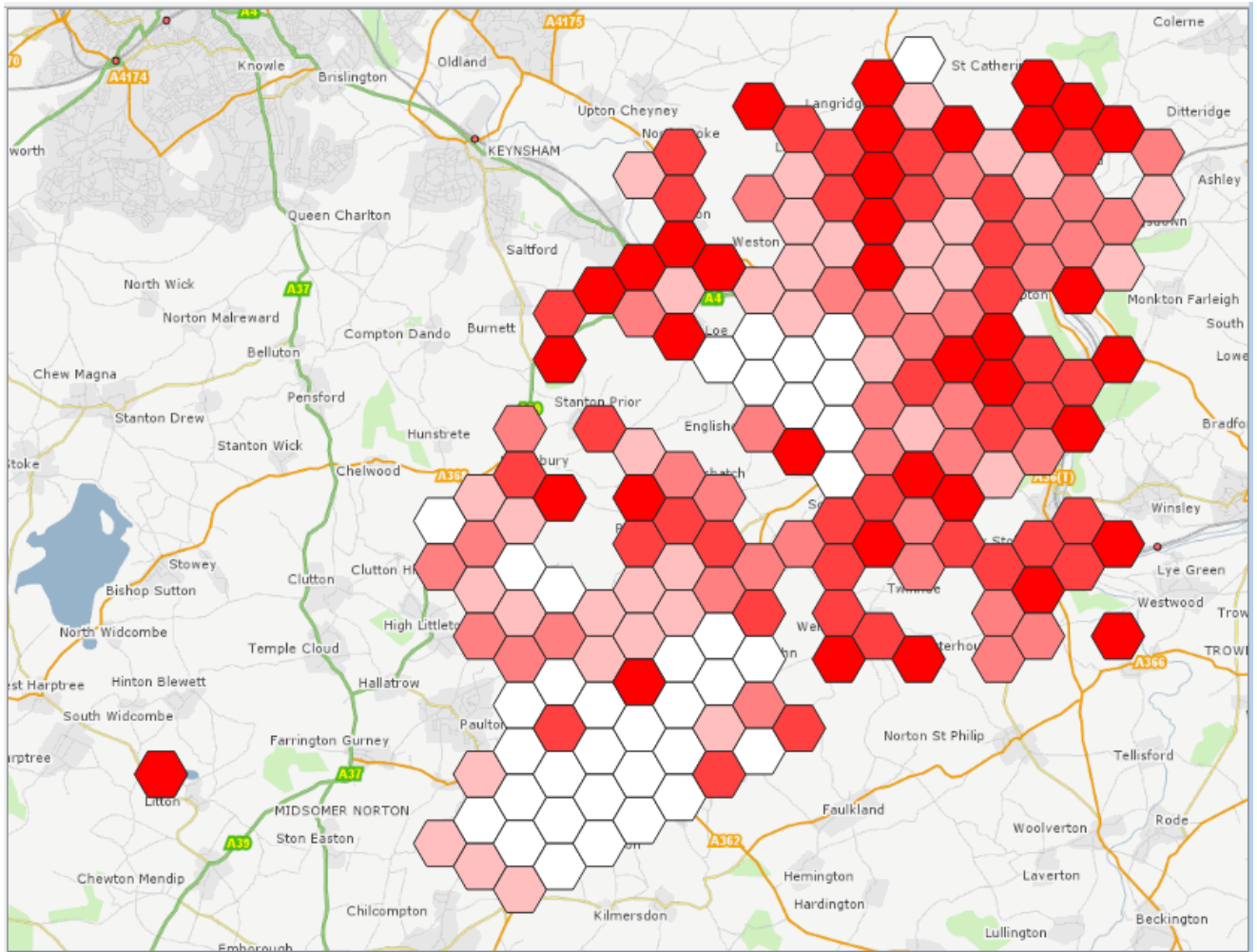
6.8. Add some styling

We've now got a process which creates a hex grid containing summary statistics on house prices for each hexagon square, so to make it useful we can add some styling.

1. Add a WMS layer of background mapping - for example ADS OS Premium
2. Right click on the new **house_prices_grid** layer and go to **Properties > Style**, then select a **Graduated** style and use the **price_int_mean** column, with **Mode** set to **Quantile (Equal Count)**.



3. With the style applied, you should see a map something like this



4. Once you have created the styling, save the project

6.9. Working with the model

Once the model has been created, it can be:

- run manually
- shared with other users
- run as a standalone programme using Python, allowing it to be scheduled

7. QGIS Time Manager

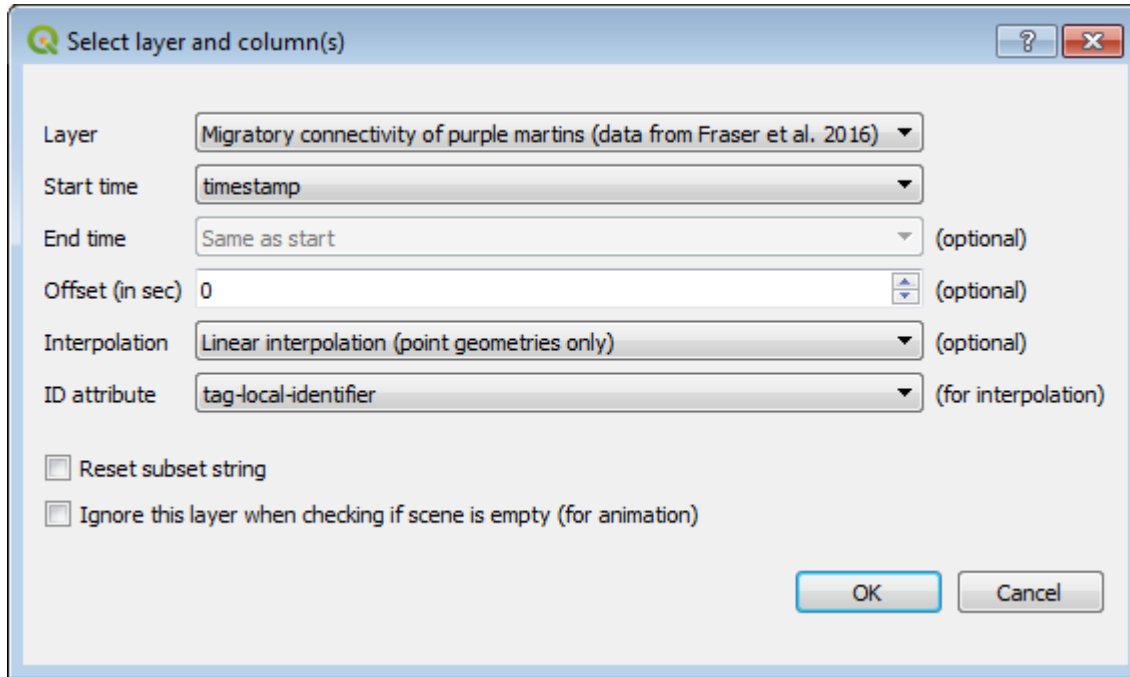
<p>7. QGIS Time Manager</p> <p>7.1. Introduction</p> <p>7.2. Steps</p>	An Astun Technology QGIS Training Module	
	Code	QGIS-A07
	Title	QGIS Time Manager
	Description	Using the QGIS Time Manager plugin to create animations
	Required Software	QGIS v 3.2 or later
	Target Audience	QGIS Desktop users
	Updated	04 Sep 2018
	Updated by	Antony Scott
	Status	Complete

7.1. Introduction

This module describes how to create animations using the Time Manager plugin, for viewing in QGIS or to create a video.

7.2. Steps


1. Install the **TimeManager** plugin
2. Go to **Open Data Source Manager > Delimited Text**, and load the source data **../Advanced/Data/Vector/Migratory connectivity of purple martins (data from Fraser et al. 2016).csv** - you will need to use the **location-long** and **location-lat** fields as **x** and **y**, and **EPSG:4326 - WGS 84** as the CRS
3. In the **Time Manager** dialogue, click **Settings > Add Layer**
4. Complete the settings as in the screenshot below

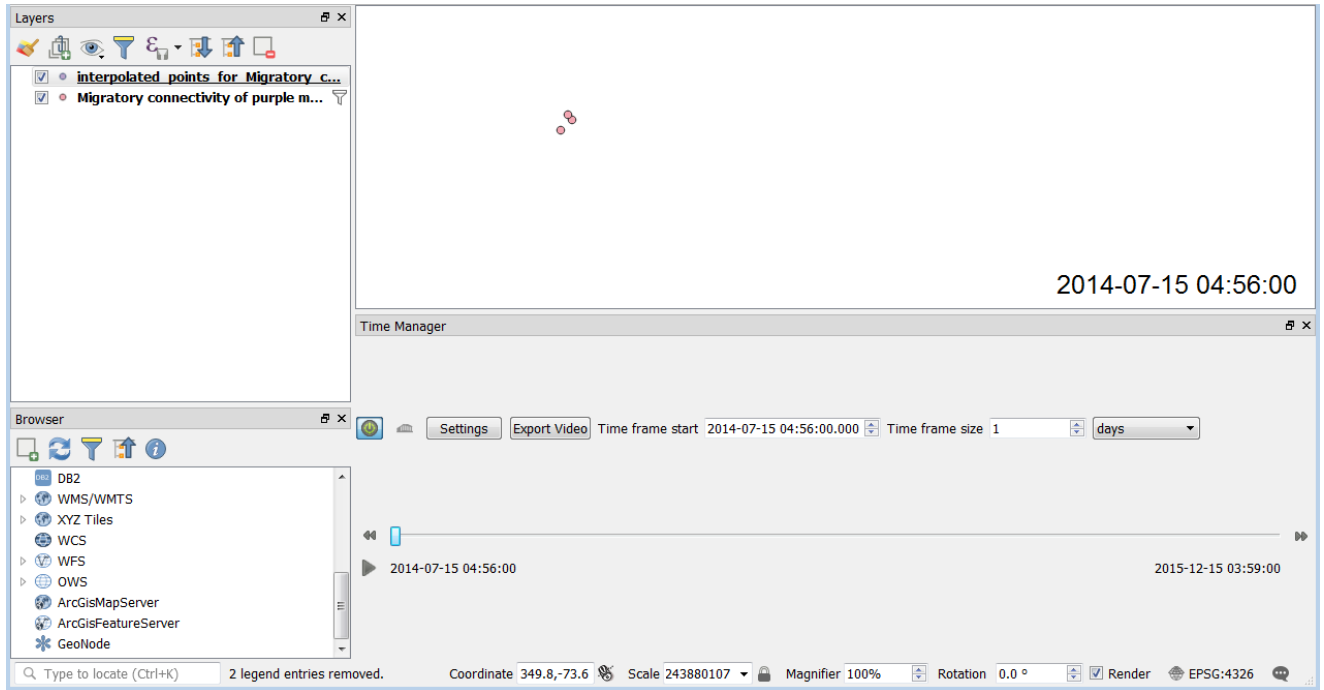



5. If you find that the ID attribute field is greyed out, enter the value tag-local-identifier (which identifies the individual bird) manually in the main Time Manger dialog after clicking OK, in the ID column for the layer

Note that:

- a. The date in the **Start time** selection *must* be in one of the formats listed in the Time Manager help on the previous dialogue (though it need not be in date format in QGIS)
- b. Interpolation will fill in any gaps in the data - i.e. dates for which no data exists. You will need to complete the ID attribute selection to indicate the item or object of focus to which dates need to be added - in this case individual tagged birds

6. Click **OK** and **OK** again to return to the main QGIS screen
7. In the Time Manager dialogue, set the appropriate time for the gap between each frame - for this data we will start with 1 day
8. If it is not already activated (green), click the button to activate the animation 
9. Your screen should now look something like this



10. Click the play button to run the animation  - this button is sometimes not visible, but it is to the left of the timestamp as in the screenshot above, so if you click there, the animation should run.

Once the animation is working, you can go back and change the settings to see how this affects the results. Note that you can also style the source layers (though you will have to remove them from the Time Manager settings first), and you may want to add a WMS background layer to show some context.

Source data

For the animation to work correctly, the source data must be fully normalised - i.e. there must be row in the attribute table for each item to be animated for each time stamp. You may need to prepare the data in an external programme such as a spreadsheet in order for this to be the case.

When you are happy with the animation, you can use the Export Video button to export the frame into a folder. In Windows, you will then need to use a video editor to produce a video.

8. QGIS Point Cluster Styling

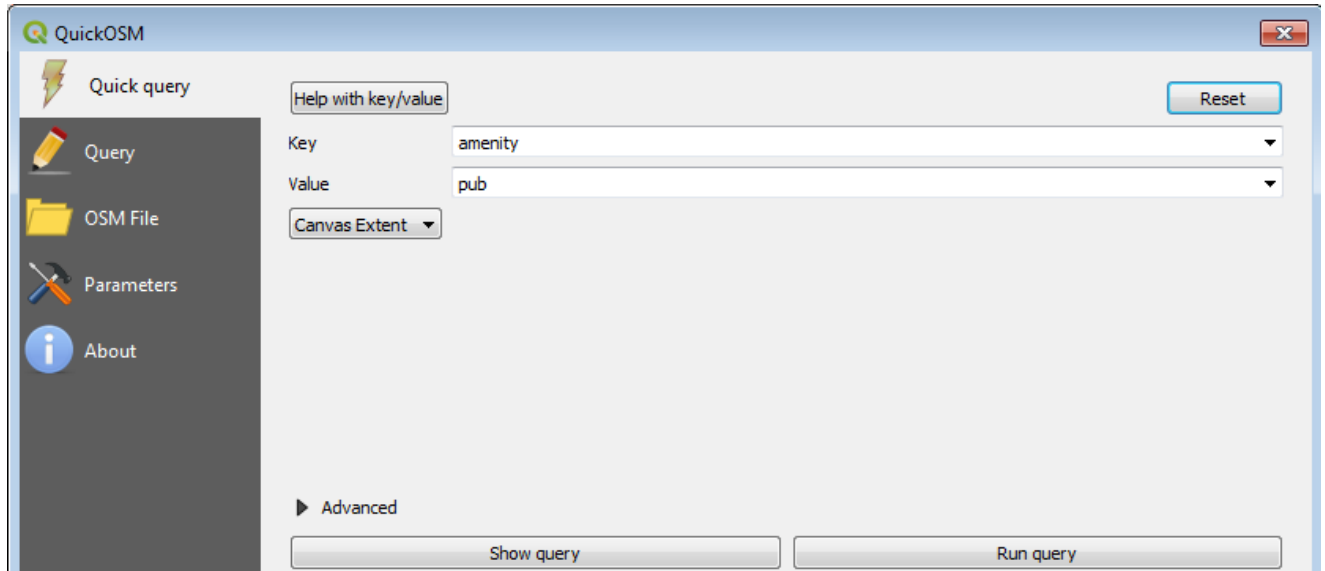
<ul style="list-style-type: none"> 8. QGIS Point Cluster Styling <ul style="list-style-type: none"> 8.1. Introduction 8.2. Load data 8.3. Set initial styling 8.4. Add point clustering 8.5. Add data dependency to symbol size 8.6. Using geometry generators 	<p>An Astun Technology QGIS Training Module</p> <table border="1"> <tr> <td>Code</td> <td>QGIS-A08</td> </tr> <tr> <td>Title</td> <td>QGIS Point Cluster Styling</td> </tr> <tr> <td>Description</td> <td>Using point cluster styling in QGIS</td> </tr> <tr> <td>Required Software</td> <td>QGIS v 3.4 or later</td> </tr> <tr> <td>Target Audience</td> <td>QGIS Desktop users</td> </tr> <tr> <td>Updated</td> <td>11 Sep 2019</td> </tr> <tr> <td>Updated by</td> <td>Antony Scott</td> </tr> <tr> <td>Status</td> <td>In development</td> </tr> </table>	Code	QGIS-A08	Title	QGIS Point Cluster Styling	Description	Using point cluster styling in QGIS	Required Software	QGIS v 3.4 or later	Target Audience	QGIS Desktop users	Updated	11 Sep 2019	Updated by	Antony Scott	Status	In development
Code	QGIS-A08																
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Description	Using point cluster styling in QGIS																
Required Software	QGIS v 3.4 or later																
Target Audience	QGIS Desktop users																
Updated	11 Sep 2019																
Updated by	Antony Scott																
Status	In development																

8.1. Introduction

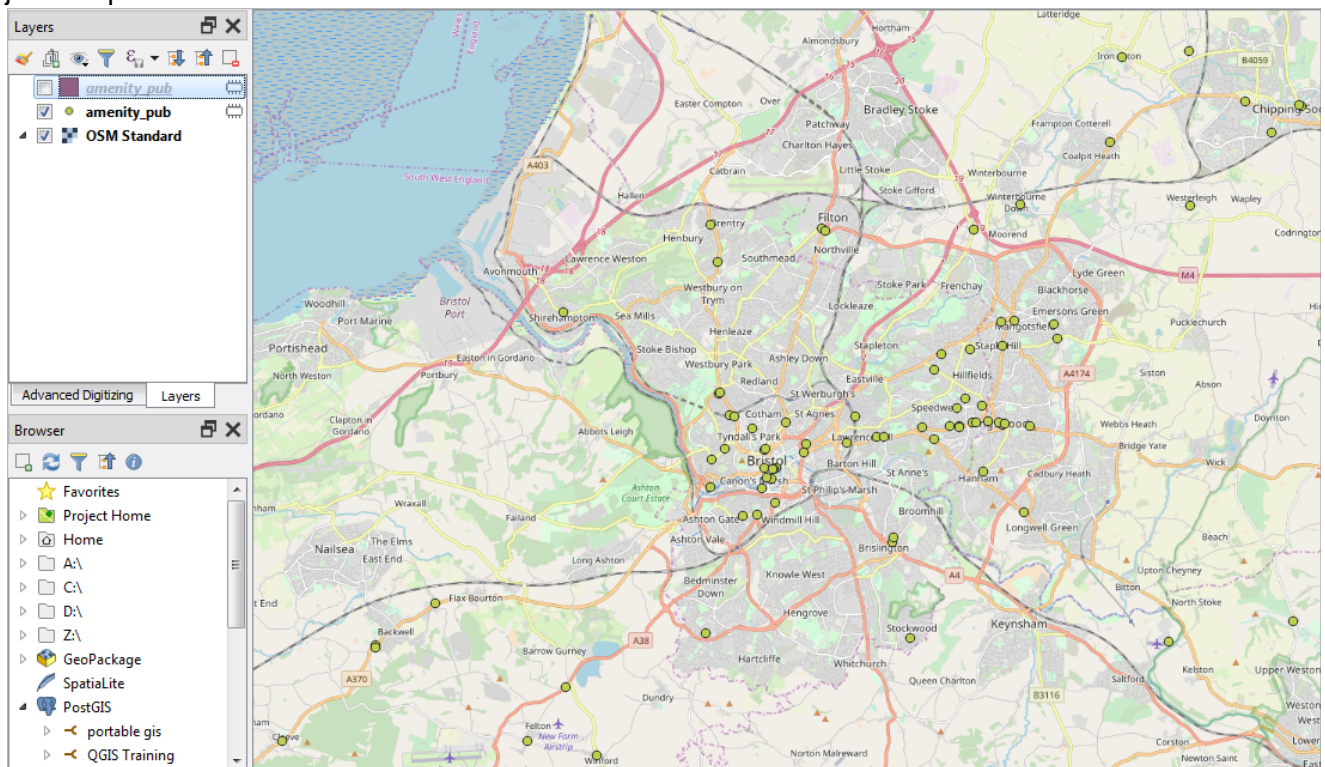
This module shows how densely populated point data can be styled using clustering, with OpenStreetMap data being used as an example.

8.2. Load data

1. Install the **QuickOSM** plugin - this will allow us to download OpenStreetMap data
2. Open a **QuickMapServices** base map (for example OSM Standard) and navigate to a large city in the UK
3. Go to **Vector > QuickOSM > QuickOSM** to open the **QuickOSM** dialog, from which you can run queries to download OSM data
4. Complete the dialog as per the screenshot below, and click **Run query**

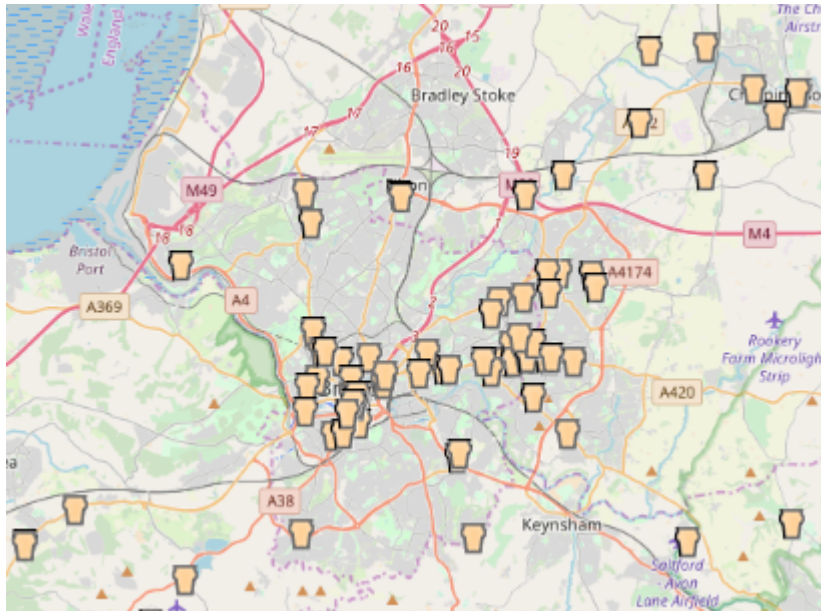


5. New layers will be added to the map, showing data for pubs in the area you have selected
6. Depending on the area, you may get polygon and line data as well as points - turn these off, leaving just the points



8.3. Set initial styling

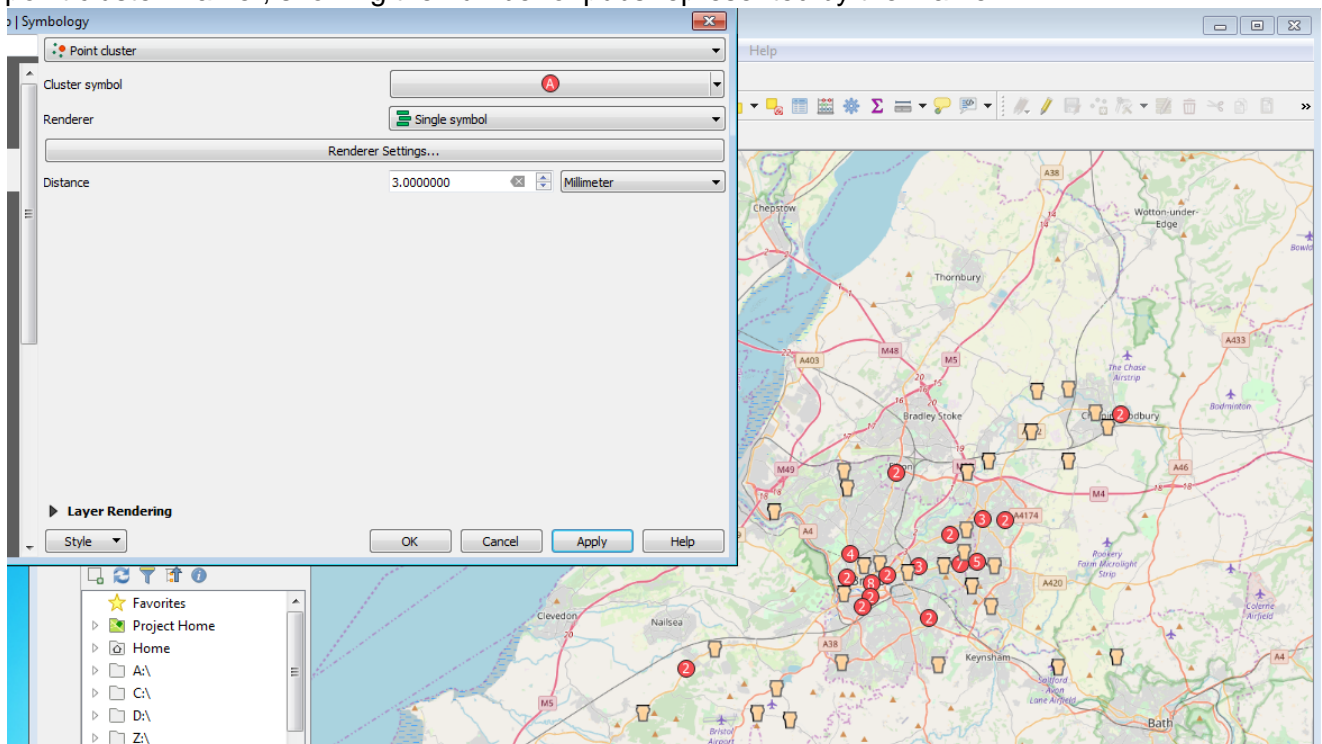
1. Add a **Simple style** to the data, using an appropriate SVG symbol
2. Adjust the settings on the symbol from the default, and experiment with the **Draw effects** at the bottom of the dialog to create a reasonable-looking symbol



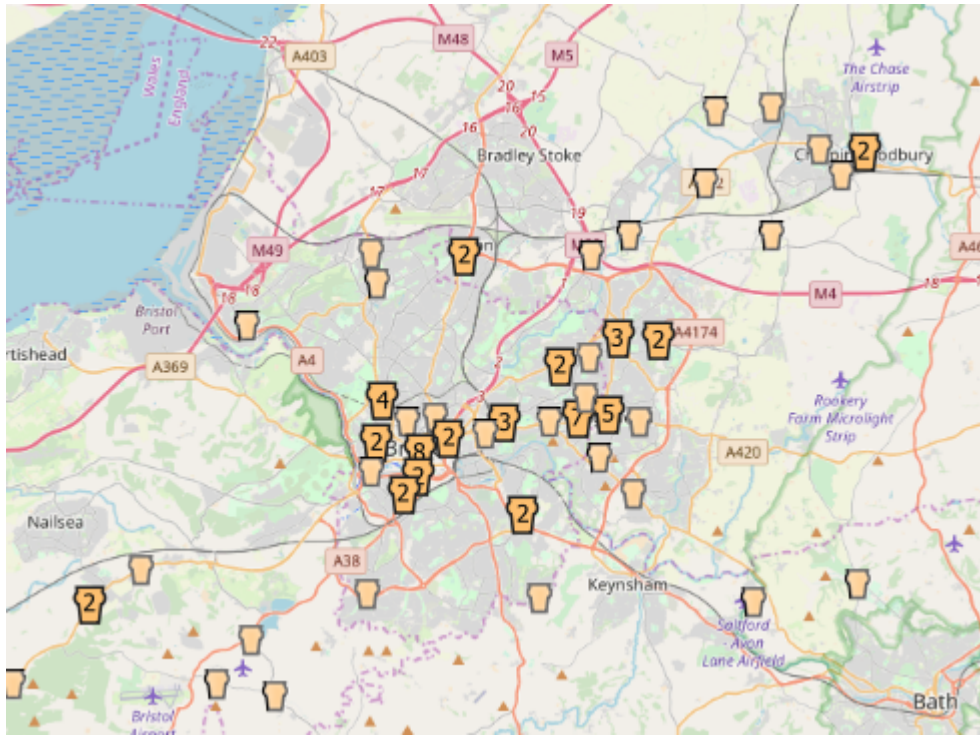
3. You should now have a representation of pubs in the city, though some of the points will probably overlap - we are going to address this using point clustering

8.4. Add point clustering

1. Go back to **Symbology**, and choose **Point cluster** as the type, then **Apply**
2. You will see that where pubs are within a certain distance of each other, the points are replaced by a point cluster marker, showing the number of pubs represented by the marker



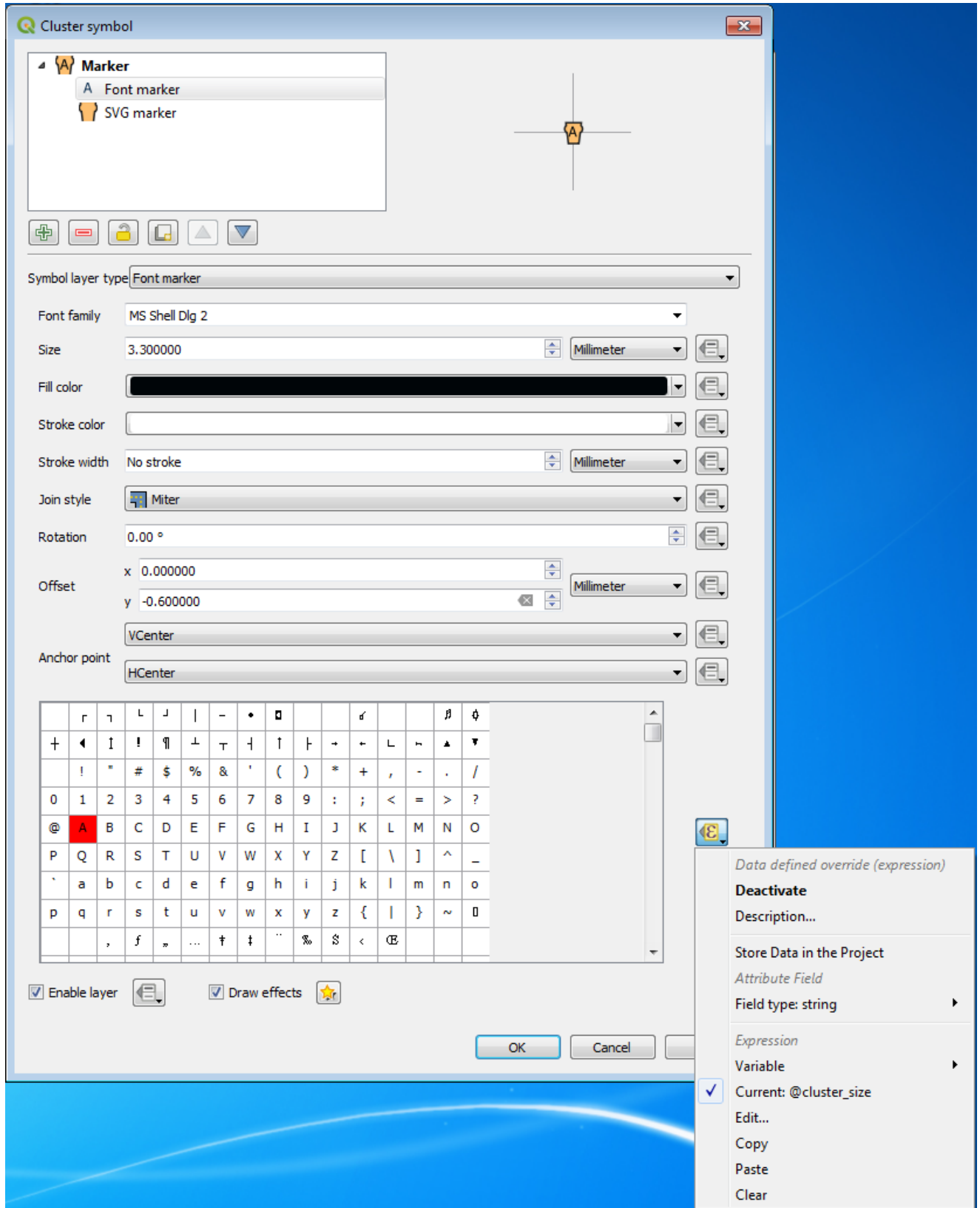
3. This is useful, but it would be better to use our custom symbol rather than the default red symbol
4. Click on the **Cluster symbol** button, and change the **Simple marker** to an **SVG marker**, using the same settings as for your original marker
5. You may need to change the size of the marker or the font to ensure that the numbers are visible
6. Your map should now look something like this




8.5. Add data dependency to symbol size

The map might be more useful if we could make the size of the symbols dependent on the number of pubs in the cluster.

1. In the **Cluster symbol** dialog, click on the **Font marker**, and notice that the symbol to the right of the font characters is highlighted in yellow - this means that a data dependency has been set
2. Click on the symbol - it shows that the `@cluster_size` function is being used to generate a number to show in the symbol

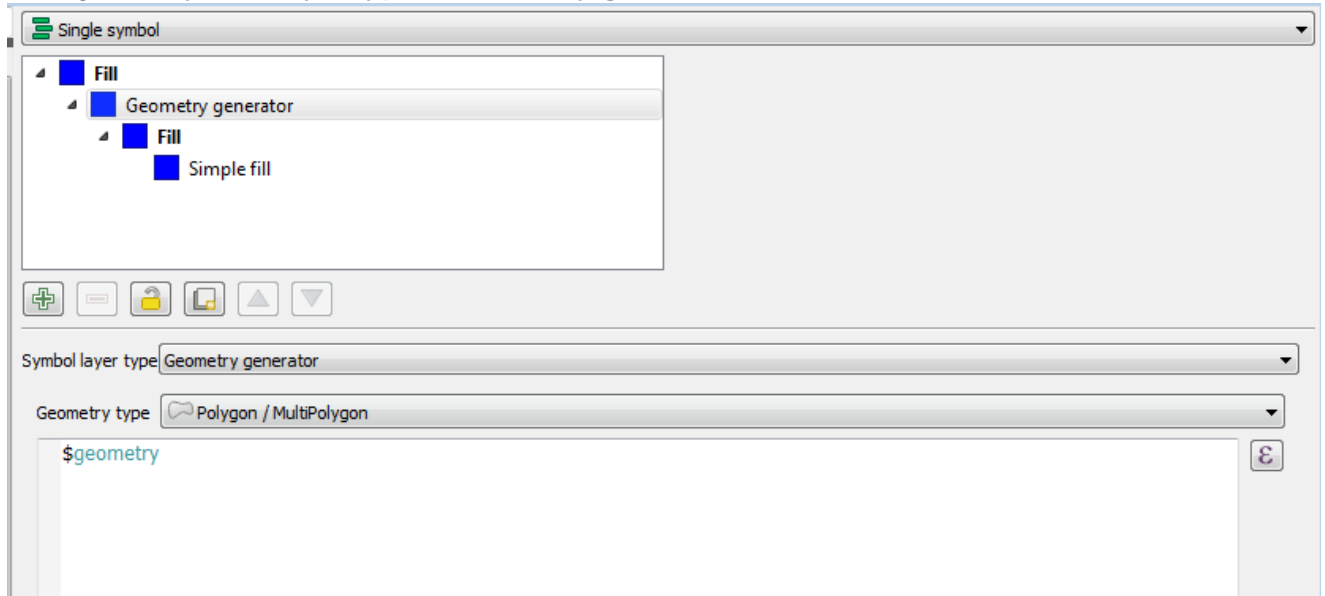


3. We can use this function to drive the symbol size - click on the **SVG marker**
4. Click on the **Data defined override** button  to the right of **Width**, and select **Edit** from the menu (note that you may have to resize the window to see this button)
5. In the **Expression** dialog, type **@cluster_size**
6. When you apply the style, the marker size will vary depending on the size of the cluster
7. Adjust the size of the marker and the font, using a multiplier on the **@cluster_size** function if necessary, until you have a style you are happy with

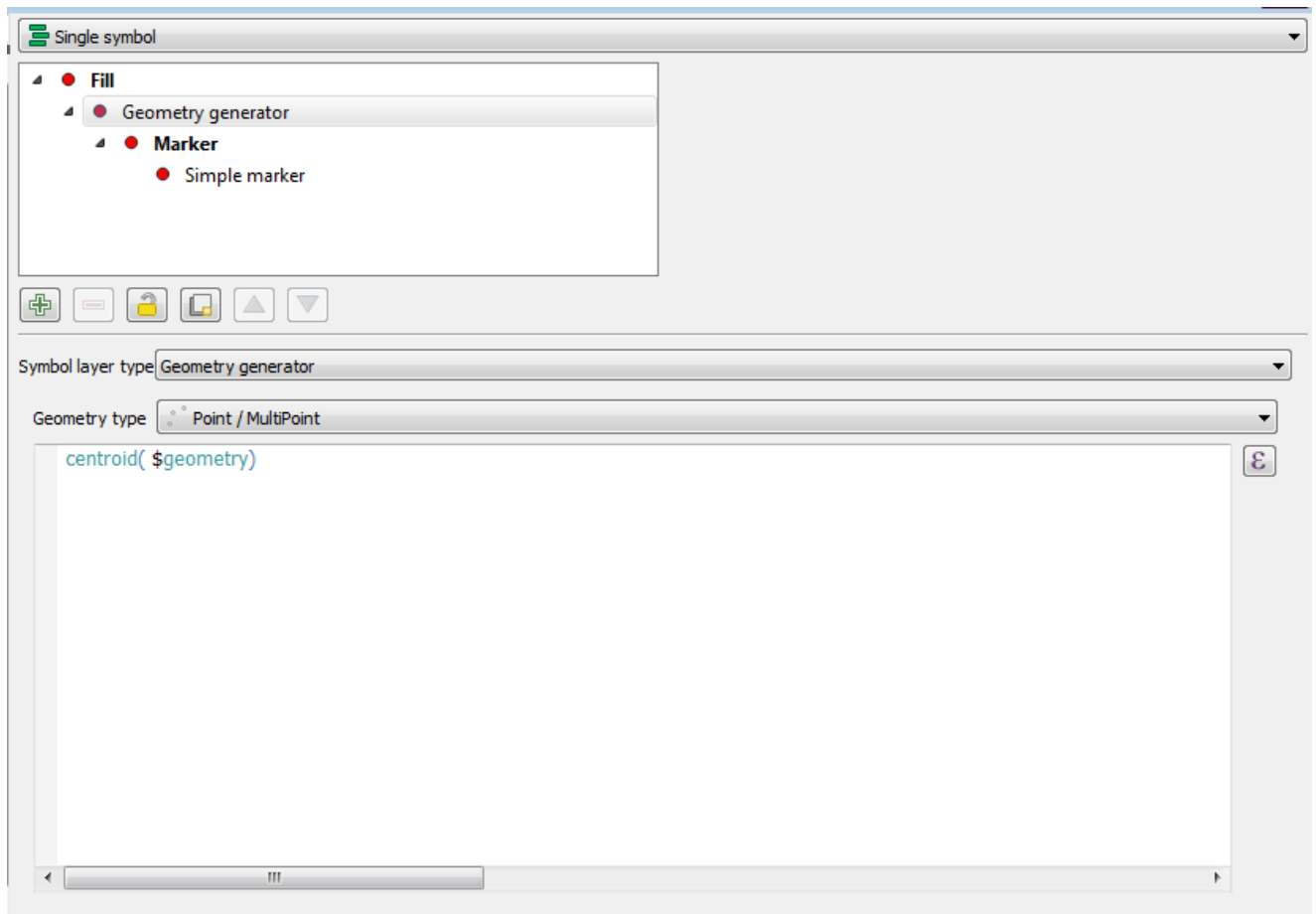
8.6. Using geometry generators

There are QGIS styles which support geometry transformations, such as buffering and centroids, on the fly. We can use these, for example, to show as points the pubs which are represented as polygons.

1. Turn on the polygon pubs layer
2. In **Symbology**, select **Single symbol** and click on **Simple fill**
3. Change the **Symbol layer type** to **Geometry generator**



4. Click on the expression icon on the right, and search for *centroid* - you can then use this to create an expression **centroid(\$geometry)** to show the polygons as centroids
5. Note that you will also need to set the correct output **Geometry type** (in this case Point/MultiPoint), so your dialog should now look like this



6. Add appropriate styling and apply
7. Experiment with other geometry generators - for example buffers to show the areas within a certain distance of a pub

11. QGIS Plugins

11. QGIS Plugins	An Astun Technology QGIS Training Module	
	Code	QGIS-P01
	Title	QGIS Plugins
	Description	A review of selected plugins.
	Required Software	QGIS v 3.0 or later
	Target Audience	QGIS Desktop users
	Updated	23 Aug 2018
	Updated by	Antony Scott
	Status	Complete

Name	Description Ease of Use (1 = easy, 5 = hard)		Comments
autoSaver	Saves project and data files at a specified interval.	1	QGIS has no native functionality which does this.
Data Plotly	Add a linked graph to your map or print layout.	2	
Discovery	Provides search / gazetteer functionality in QGIS using PostGIS-based data	1	Works on PostGIS data only.
go2streetview	Adds a drag and drop cursor which opens Google StreetView.	1	Requires Google Maps API key.
Memory Layer Saver	Saves any current scratch layers alongside the project file, so they are available to the project next time it is opened.	1	Data saved as .mldata.
MetaSearch Catalog Client	Interacts with metadata catalogue services, supporting the OGC Catalogue Service for the Web (CSW) standard, and allowing CSW catalogues to be accessed from within QGIS.	2	

mmqgis	Vector layer manipulation tools.	1	Duplicates much of existing QGIS functionality, but sometimes provides useful additions/alternatives.
OS Translator II	Loads GML-based datasets into PostGIS and performs post-processing tasks.	2	Specifically developed for Ordnance Survey GML data.
Qgis2threejs	Generates a 3D interactive model of raster DEM data, including in-browser controls. Also allows 3D representation of vector data.	3	Needs configuration, but models can be produced and regenerated very quickly.
qgis2web	Allows generation of an OpenLayers or Leaflet web map from the current project.	1	Produces output set which can be published directly to the web or loaded in a local browser.
QuickMapServices	Provides a menu and search for WMS services for background mapping, including for example Google, Bing and OpenStreetMap.	1	
QuickOSM	GUI query for OpenStreetMap data selection and download.	1	
QuickWKT	Allows you to paste in data in WKT format (e.g. from PostGIS or other programs) and see it on the map	2	
Spreadsheet Layers	Allows a spreadsheet layer to be loaded with datatype selection, using coordinates to set geometry.	1	Allows point data with coordinates to be loaded as spatial layer without loading to CSV.
TimeManager	Creates a video based on data with a time component.	4	A fair amount of config needed, and a video-editing application may also be required to produce the final outputs.
zoomtopaste	Zoom to a set of coordinates pasted from the clipboard.	1	