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Introduction

Carlisle has a long history of flooding. The city is situated on the flood plain of the River Eden and three rivers meet in the city. There was a significant flood in 2005 in which 3 people died and more than 1800 properties were flooded.

The aim of this exercise is to use a selection of Ordnance Survey map data in ArcGIS, to analyse how many properties are at risk of flooding.

This exercise has been prepared using ArcMap 10.2.



Learning objectives

By the end of this exercise you will be able to:

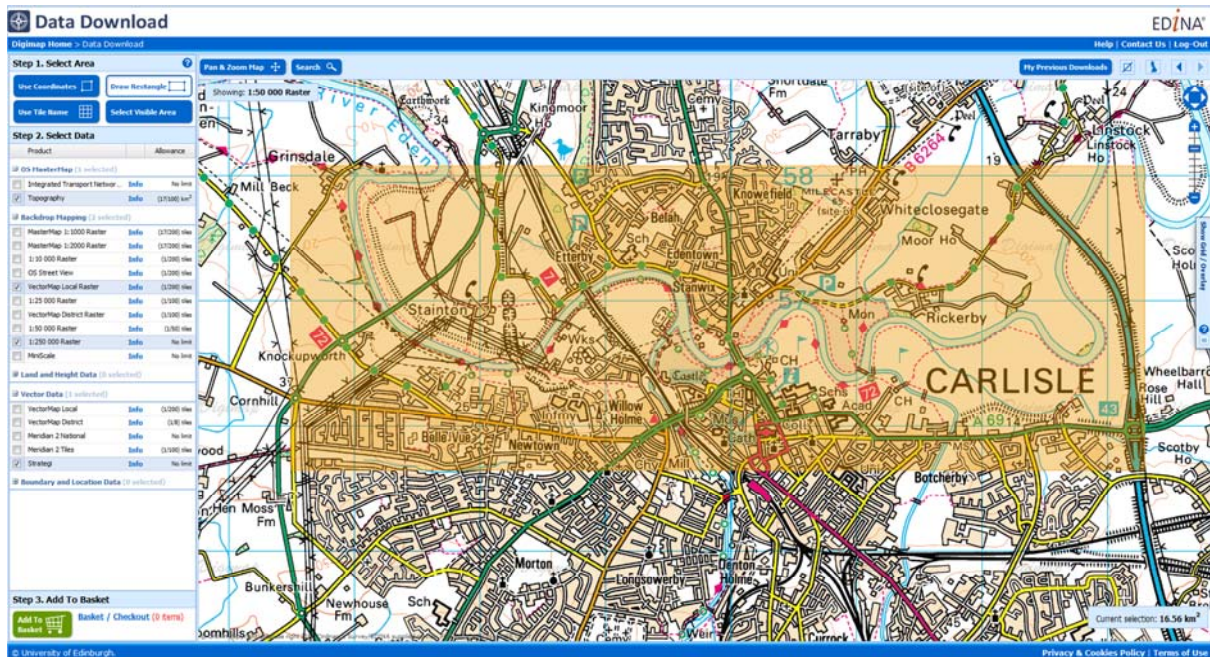
- download map data from Digimap Collections
- convert GML data to ArcGIS Personal Geodatabase format
- load data into ArcMap
- style map data
- create a buffer
- select features by attribute and save output
- select features by location and save output
- create effective print outputs

Download data from Digimap

Data Requirements

- Detailed vector data showing buildings.
- Vector data showing rivers.
- Raster maps for context, at 2 scales (1:250000 and 1:10000).

1. Go to Digimap:
2. <http://digimap.edina.ac.uk/digimap/home>
3. Login.
4. Select Ordnance Survey > **Data Download**.
5. **Search** for Carlisle.
6. Click **Draw Rectangle**.
7. Select an area on the map, similar to the image below.



8. Select map products, as shown in image below:
 - a. OS MasterMap topography.
 - b. VectorMap Local Raster.
 - c. 1:250000 Raster backdrop mapping.
 - d. Strategi.

Step 2. Select Data

Product	Allowance
OS MasterMap (1 selected)	
<input type="checkbox"/> Integrated Transport Networ...	Info No limit
<input checked="" type="checkbox"/> Topography	Info (17/100) km ²
Backdrop Mapping (2 selected)	
<input type="checkbox"/> MasterMap 1:1000 Raster	Info (17/200) tiles
<input type="checkbox"/> MasterMap 1:2000 Raster	Info (17/200) tiles
<input type="checkbox"/> 1:10 000 Raster	Info (1/200) tiles
<input type="checkbox"/> OS Street View	Info (1/200) tiles
<input checked="" type="checkbox"/> VectorMap Local Raster	Info (1/200) tiles
<input type="checkbox"/> 1:25 000 Raster	Info (1/100) tiles
<input type="checkbox"/> VectorMap District Raster	Info (1/100) tiles
<input type="checkbox"/> 1:50 000 Raster	Info (1/50) tiles
<input checked="" type="checkbox"/> 1:250 000 Raster	Info No limit
<input type="checkbox"/> MiniScale	Info No limit
Land and Height Data (0 selected)	
Vector Data (1 selected)	
<input type="checkbox"/> VectorMap Local	Info (1/200) tiles
<input type="checkbox"/> VectorMap District	Info (1/8) tiles
<input type="checkbox"/> Meridian 2 National	Info No limit
<input type="checkbox"/> Meridian 2 Tiles	Info (1/100) tiles
<input checked="" type="checkbox"/> Strategi	Info No limit
Boundary and Location Data (0 selected)	

9. Click **Add to Basket**.

Step 3. Add To Basket








Add To Basket  Basket /

10. Name your order Carlisle.

11. Click **Request Download**.

Basket ? ×

Select the **Version**, **Format** and **Layers** using the drop down menus (▼) where available.

Product Name	1. Version	2. Format	3. Layers	Preview	Remove
Strategi	January 2014 ▼	SHAPE ▼	N/A		
1:250 000 Raster	June 2014 ▼	TIFF	N/A		
VectorMap Local Raster	Full Colour July 201...	TIFF	N/A		
Topography	May 2014 ▼	GML2 ▼	All ▼		

Give this download a name:

Request Download

Email address your downloads are sent to:

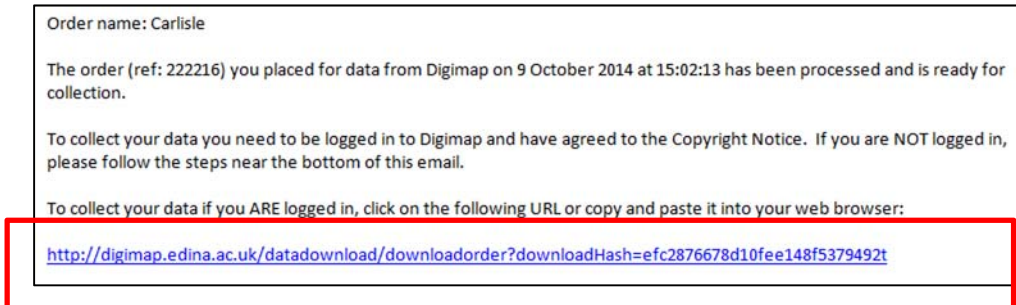
[\[Change email\]](#)

Add More Data **Clear Basket**

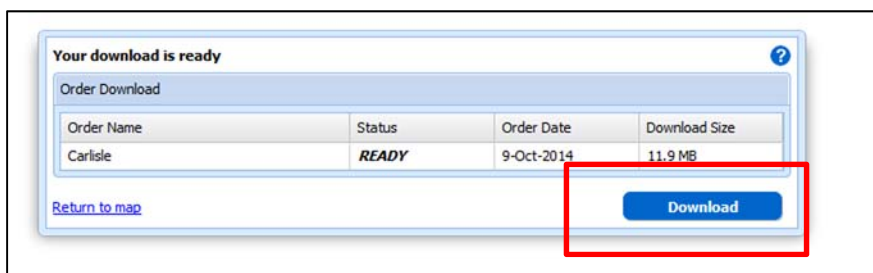
Download the data file

Now you will receive 2 emails.

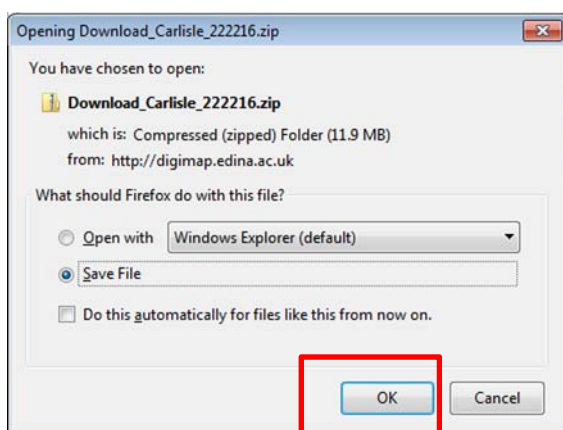
1. Click the link in the SECOND email:



2. Click the Download button:

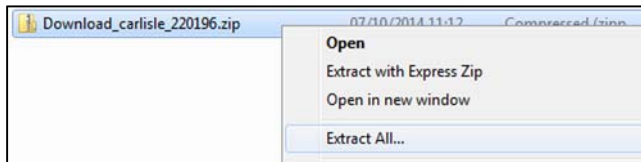


3. Save the file to your personal drive.
4. Click OK.



Unzip the data file

1. Open Windows Explorer.
2. Navigate to the Digimap download file.
3. Right click the file.
4. Select Unzip or Extract. Your options may be different to the image here:



5. Unzip the file to a new folder.

View download file contents

6. There is a sub-folder for each map product you downloaded.
7. Contents.txt – this details all the map products in your order, plus the coordinates of your download area.
8. Citations.txt – you can copy and paste the text in this file to your bibliography.

Name	Date modified	Type	Size
mastermap-topo_622764	13/10/2014 17:20	File folder	
raster-250k_622762	13/10/2014 17:21	File folder	
strategi_622761	13/10/2014 17:54	File folder	
vml-raster_622763	13/10/2014 17:06	File folder	
citations_orders_224553.txt	13/10/2014 16:59	Text Document	2 KB
contents_order_224553.txt	13/10/2014 16:59	Text Document	3 KB

Convert OS MasterMap data

The OS Master Map data we downloaded from Digimap is in GML format. We can import data in this format to ArcMap but the data will be much easier to work with if we convert it to an ArcGIS database.

We will use Productivity Suite. If your college or university has an ArcGIS licence, they can get Productivity Suite free of charge. Talk to your lecturers and IT staff to check if it's installed.

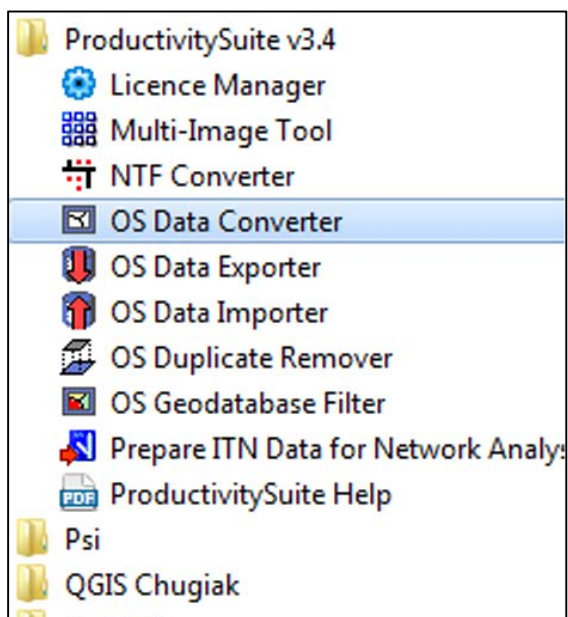
Alternatively, you can download a 30 day trial version, see link below.

1. Download and install the software from this link:

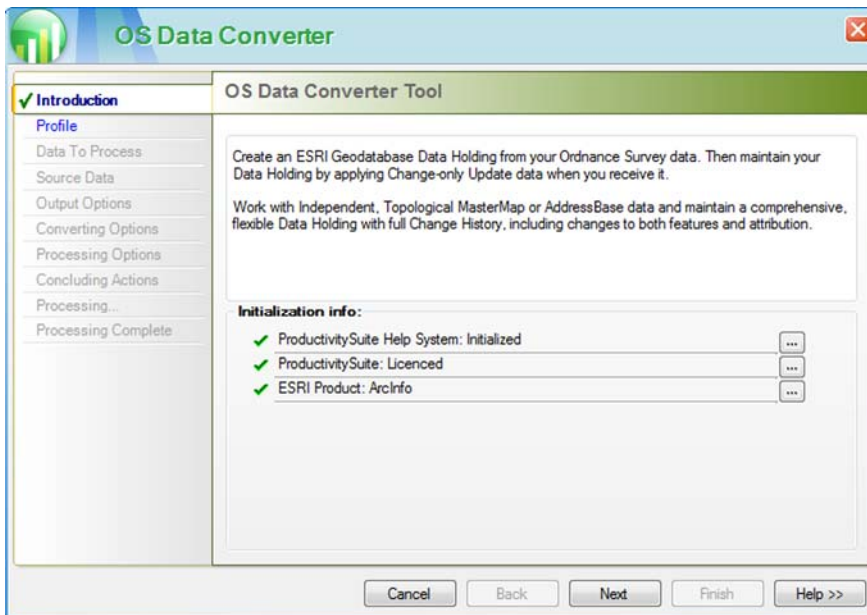
<http://www.esriuk.com/software/arcgis/productivitysuite/download>

This ESRI software has an OS Data Converter tool.

2. **Open Productivity Suite > OS Data Converter**, seen in this image:

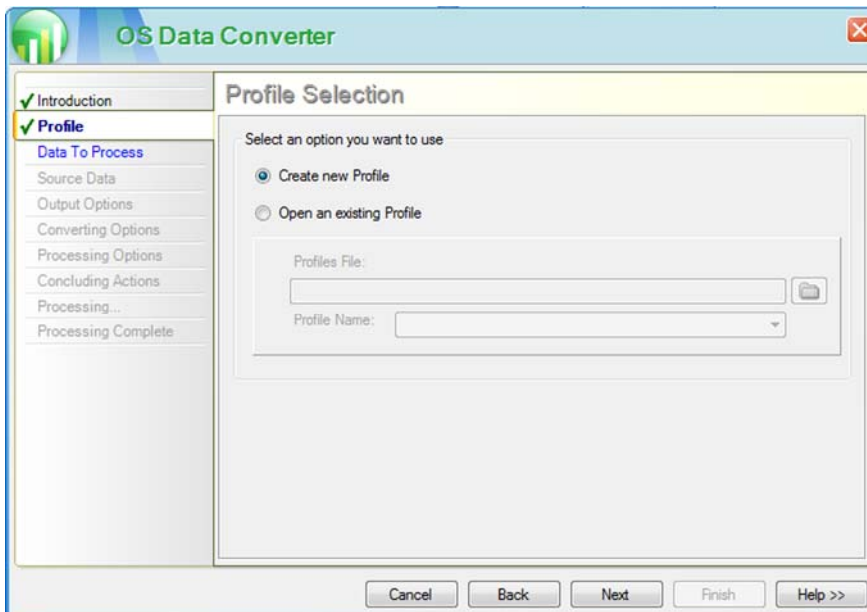


3. Introduction screen - Click **Next**.



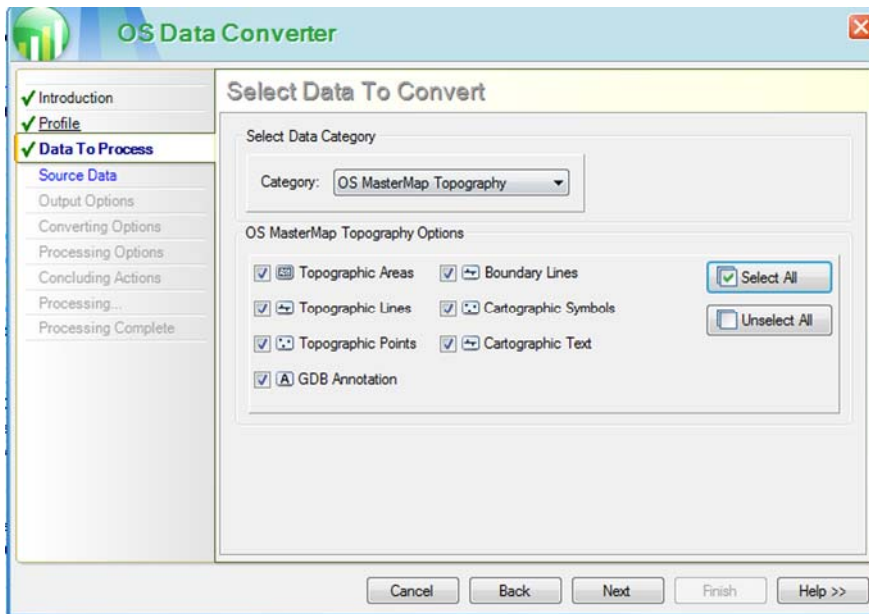
4. Profile Selection screen –leave Create New Profile selected.
5. Click **Next**.

At the end of the conversion process you can save the settings you have made as a profile to apply to future conversions, if you wish.



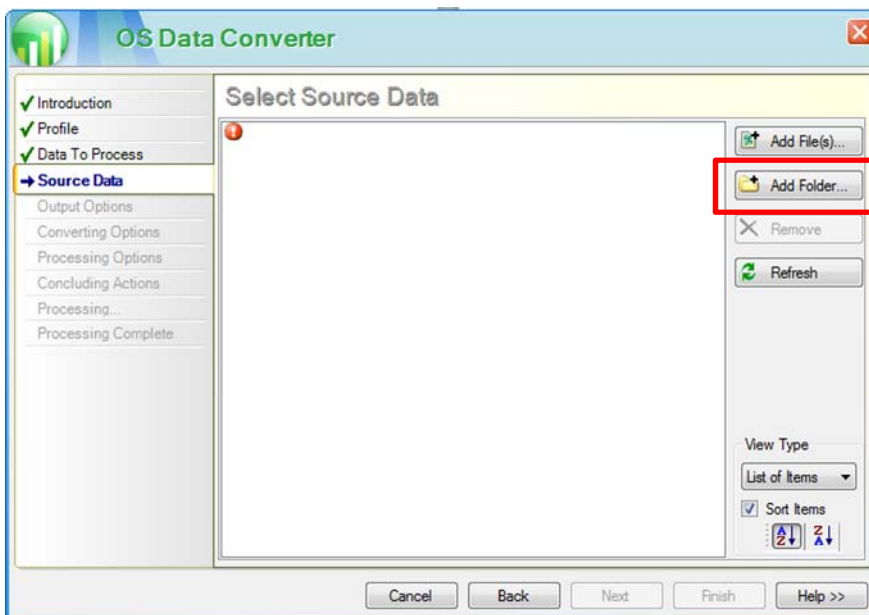
Select Data Screen – here we identify the type of data we will convert:

6. **OS MasterMap Topography** is the default product selection. Leave this selected. Note that there are other data options available (e.g. Vector Map Local data, available from Digimap).
7. Click **Select All**. The conversion will create a database feature class for each option checked.
8. Click **Next**.

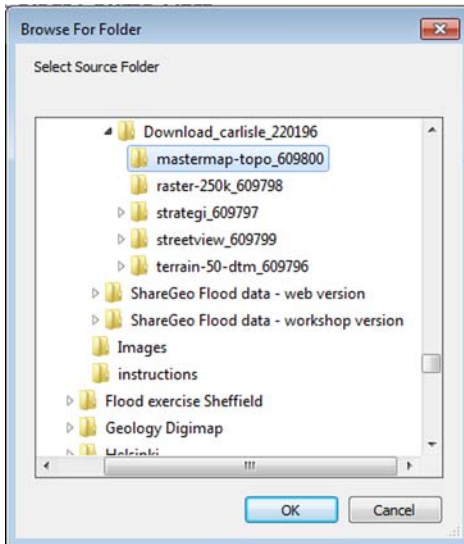


Select Source data - now we need to select our data file or folder.

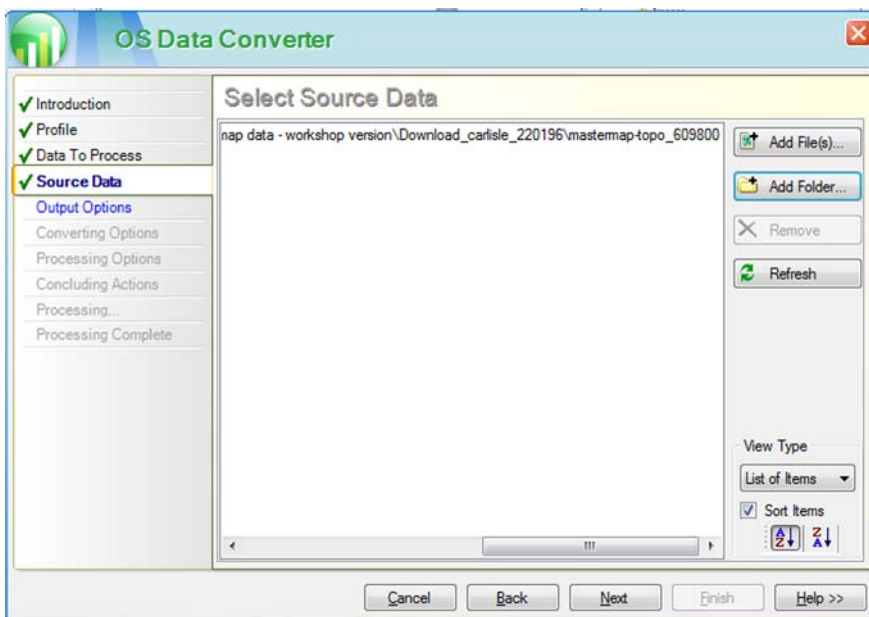
9. Click **Add Folder**. Our OS MasterMap download can consist of more than one GML file in the download folder, so Add Folder is the right option.



10. Navigate to your Digimap download file.
11. Click the **mastermap-topo** folder.
12. Click **OK**.

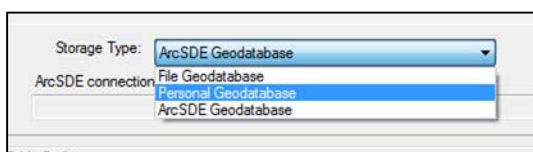


13. Check the right folder is listed in the Select Source Data window.
14. Click **Next**.



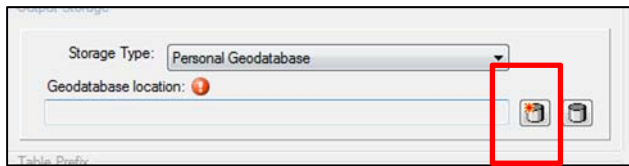
Output options – here we select the type of database we want and create our geodatabase.

15. Click the drop down arrow.
16. Select **Personal Geodatabase**.

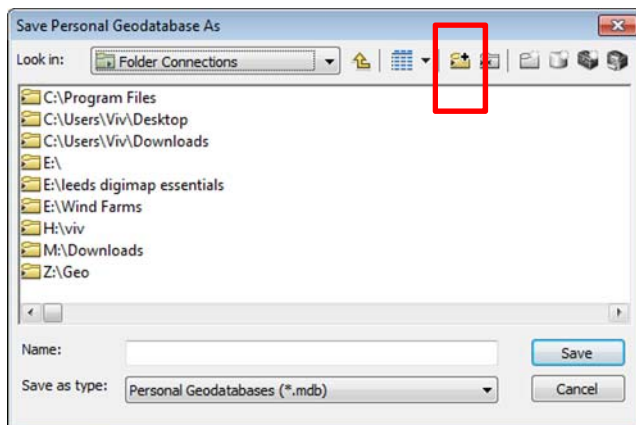


17. Now we need to create the geodatabase.

18. Click the container icon with the red star:



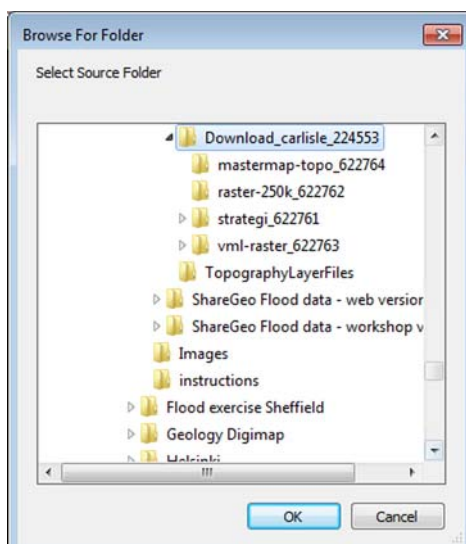
19. Click the yellow folder with the plus sign, to create a folder connection to your Digimap data folder.



20. Navigate to the Digimap data folder.

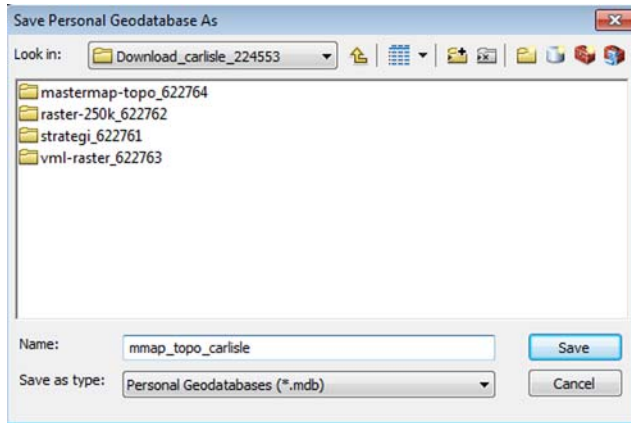
21. Click on the folder to select it.

22. Click **OK**.

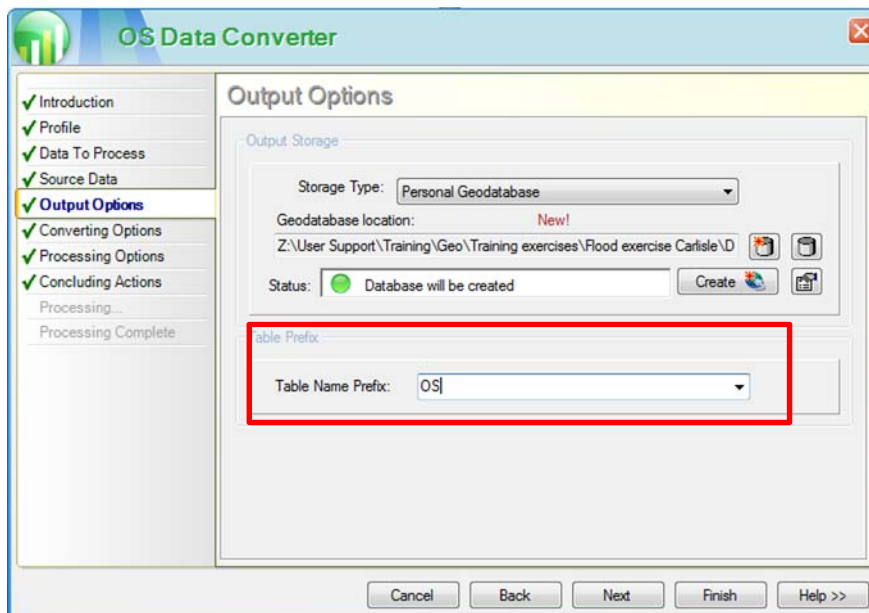


23. Type a name for your geodatabase in the file name – we suggest **mmap_topo_carlisle**.

24. Click **Save**.

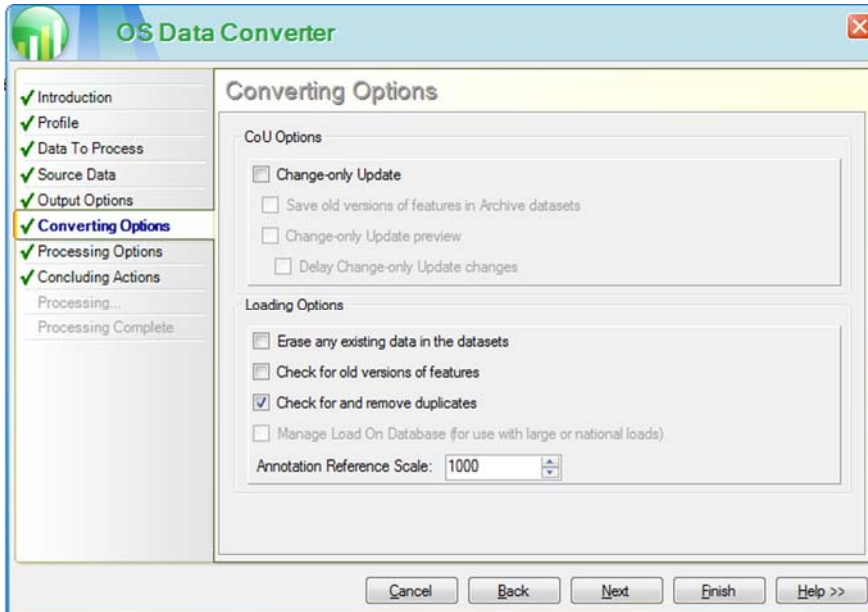


- 25. Prefix – type some letters as a prefix – it doesn't matter what.
- 26. Click Next.



Converting options screen:

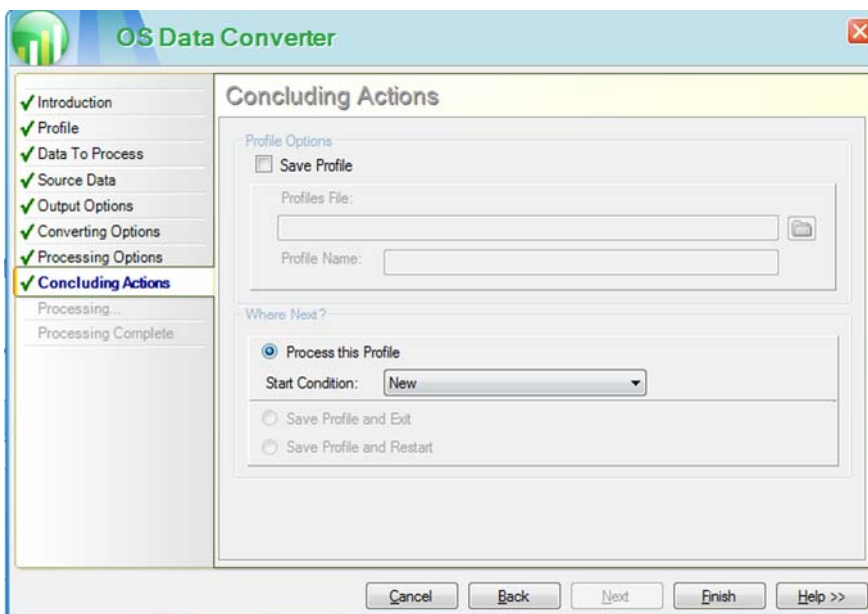
- 27. Click **Check for and remove duplicates**.
- 28. Click **Next**.



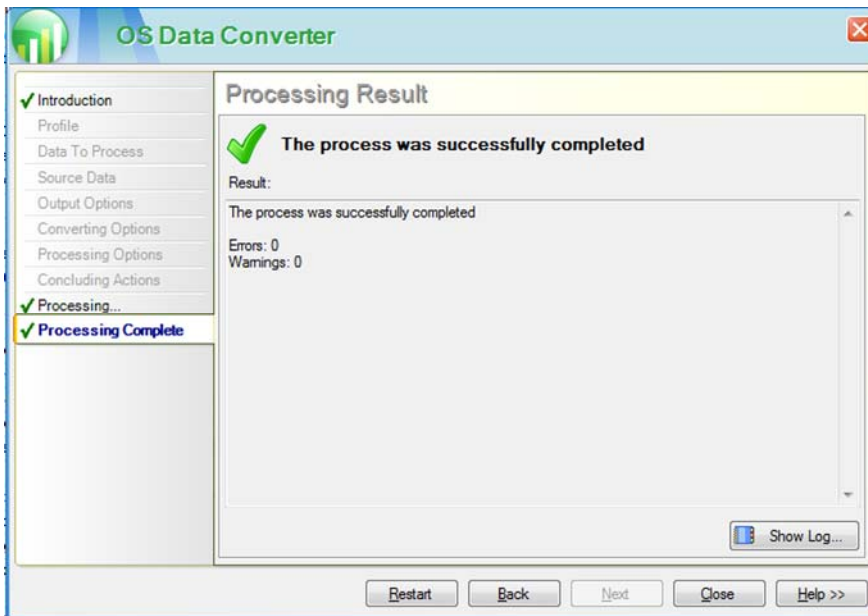
29. Processing options screen (no image shown) – click **Next**.

30. **Concluding actions** screen. If you wish you can save your profile to reuse it in future.

31. Click **Finish** to start the conversion.



32. You should receive a Processing Complete screen.



33. Click **Close** to exit Productivity Suite.

Locate your Geodatabase

1. Open Windows Explorer or My Computer.
2. Navigate to your Digimap data folder.
3. Check your geodatabase is there – it has a suffix of MDB:

Name	Date modified	Type	Size
mastermap-topo_609800	07/10/2014 11:50	File folder	
raster-250k_609798	07/10/2014 11:50	File folder	
strategi_609797	07/10/2014 11:50	File folder	
streetview_609799	07/10/2014 11:50	File folder	
terrain-50-dtm_609796	07/10/2014 11:50	File folder	
citations_orders_220196.txt	07/10/2014 11:07	Text Document	2 KB
contents_order_220196.txt	07/10/2014 11:07	Text Document	6 KB
mmap_topo_carlisle.mdb	09/10/2014 11:20	Microsoft Access ...	245,088 KB

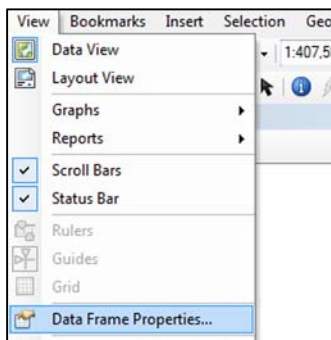
Load data into ArcMap

Let's start loading our data into ArcMap.

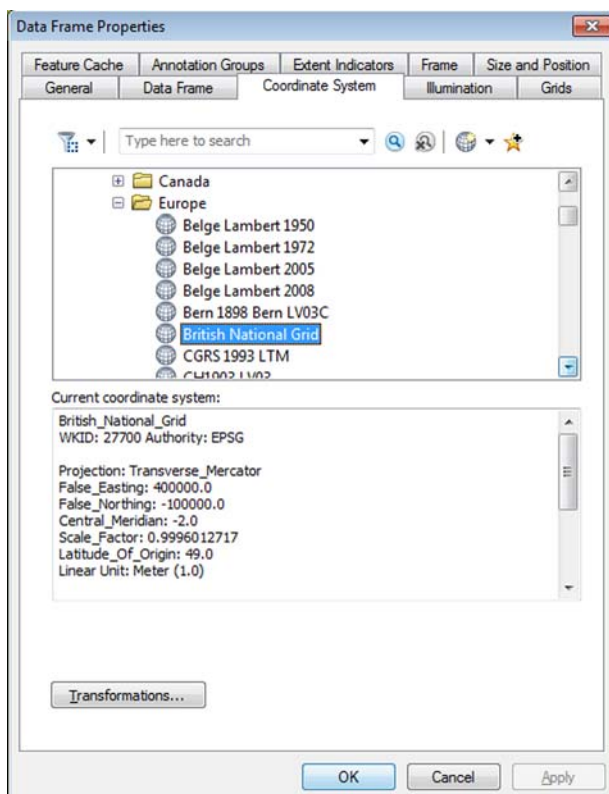
Set coordinate system

First, we should set our data frame coordinate system.

1. Open ArcMap.
2. Select New Maps > Blank Map > OK.
3. Select View on the toolbar.
4. Select **Data Frame Properties**.

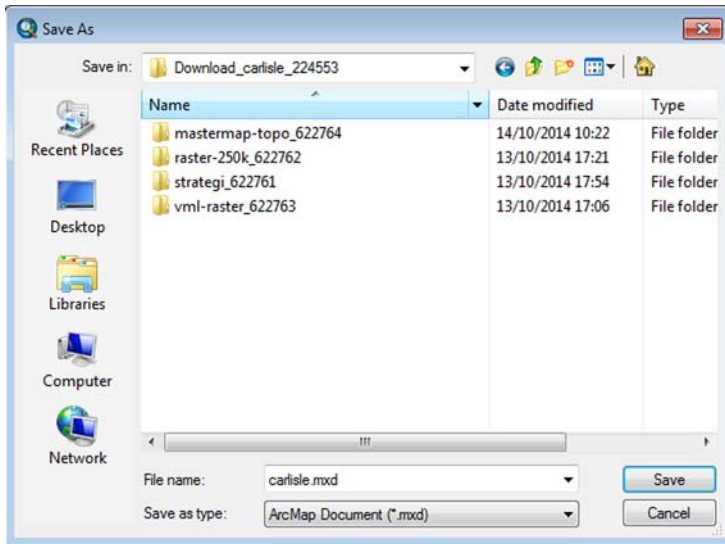


5. Click the **Coordinate System** tab.
6. Select Projected **Coordinate Systems** > **National Grids** > **Europe** > **British National Grid**.
7. Click **Apply**.
8. Click **OK**.





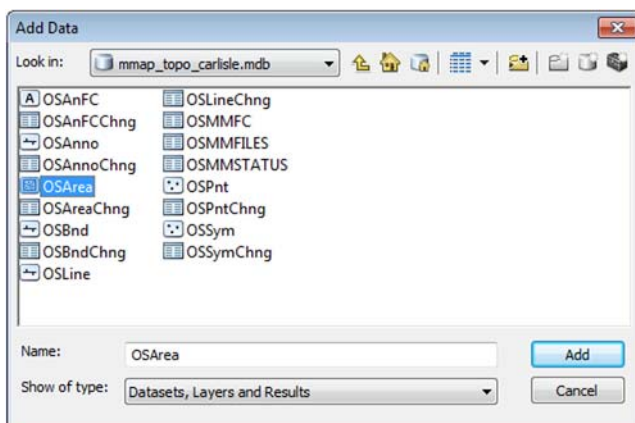
Save your ArcMap document

1. Click **File > Save**.
2. Choose a suitable folder.
3. Name your document.
4. Click **Save**.




Add OS MasterMap data

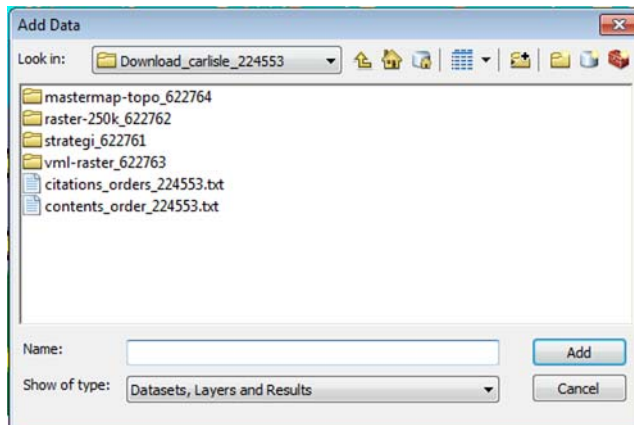
1. Click the **Add Data** button or **File > Add Data..** 
2. Navigate to your Digimap data folder.
3. You may need to connect to the folder. **Click the Connect to folder button** and select the **folder.** 
4. Double click the geodatabase you just created, **mmap_topo_carlisle.mdb**.
5. Select **OSArea** (you may have a different prefix, depending on what you added in conversion).
6. Click **Add**.



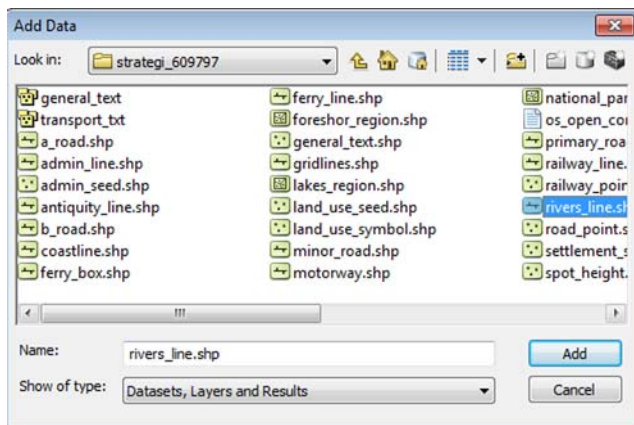
Add Strategi data

Now let's add some of the Strategi vector data – we only want the rivers.

7. Click **Add Data** 
8. Go back to the Digimap folder.
9. Double click the **Strategi** folder:




10. Click **rivers_line.shp**.
11. Click **Add**.

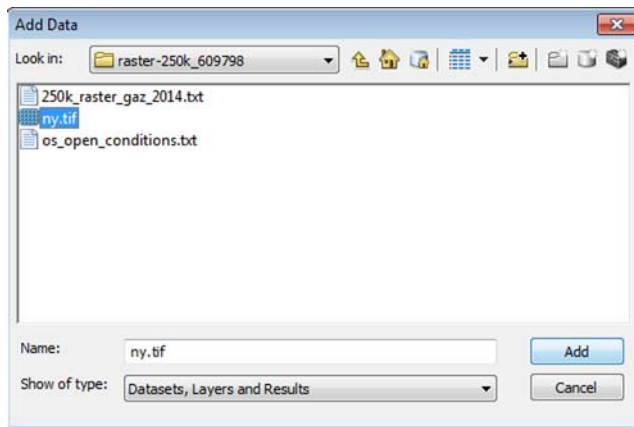


Add 1:250000 raster map

Next, let's add in a small scale raster map for context.

1. Click **Add Data** 
2. Go back to the Digimap folder.
3. Double click the **raster-250k** folder.
4. Select **ny.tif**.
5. Click **Add**.

6. If you get a **Build Pyramids** message – say **YES**.



Style data

Symbolise our OS MasterMap data

Our OS MasterMap data does not look as it does in Digimap, or on the OS website. ArcGIS loads data in random colours.

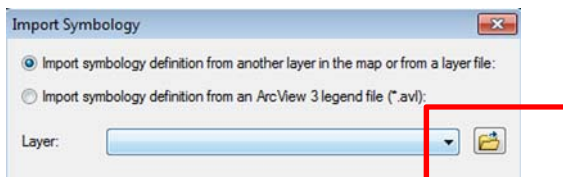
Productivity Suite supplies some layer files that will symbolise the map data to look more like the OS cartography. We have provided these files for you to use today.

Let's apply one to the Area layer.

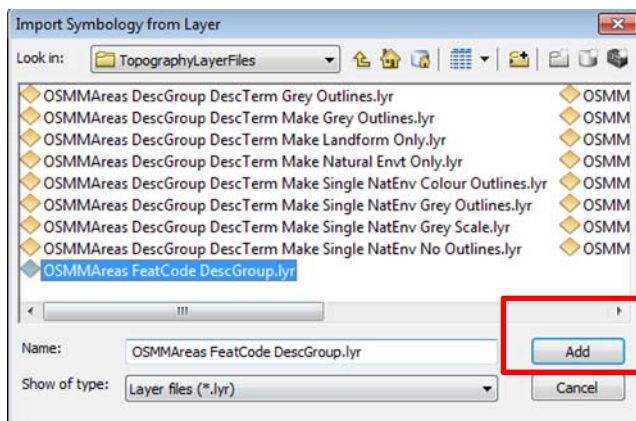
- Right click **OSArea** in the Table of Contents.
- Select **Properties**.
- Select the **Symbology** tab.
- Click the **Import** button at top right of the tab, as shown in the image below:



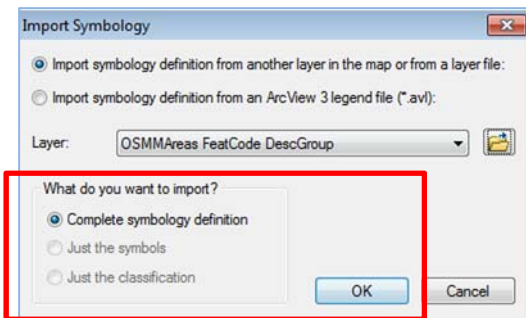
- Click the yellow folder icon next to Layer:



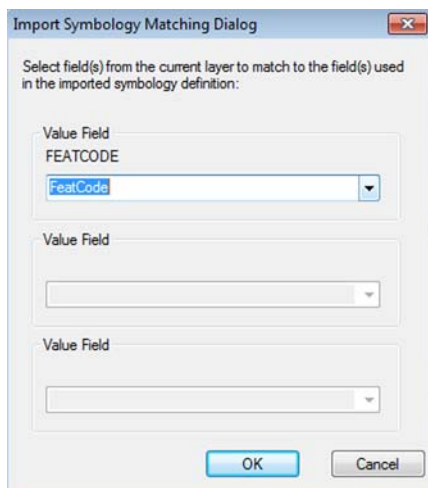
- Navigate to the folder **TopographyLayerFiles**.
- Double click on the folder.
- Click the file **OSMMAreas Feat Code Desc Group.lyr**.
- Click **Add**.



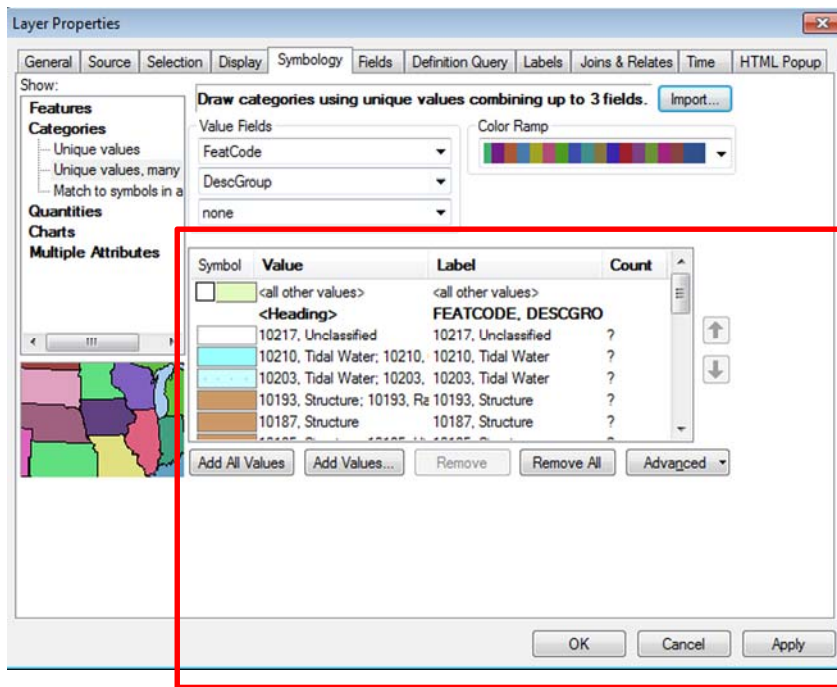
- What do you want to import? **Complete Symbology definition.**
- Click **OK.**



- Check Value Field is **FEATCODE.**
- Click **OK.**



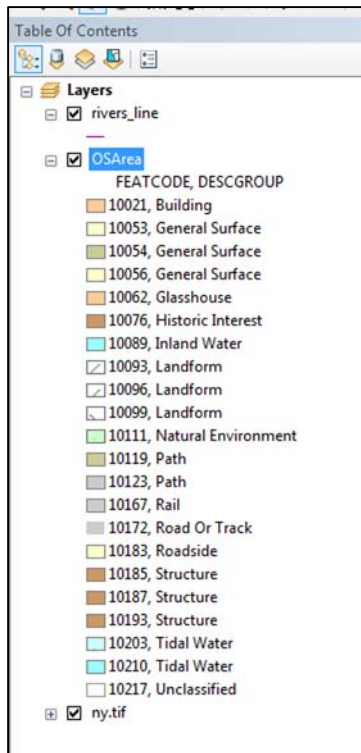
- You should now see the box on the Symbology tab populated with different symbols for different types of Area feature.
- Click **Apply.**
- Click **OK.**



- Right click the OS Area layer.
- Select **Zoom to Layer**.
- Your map data should be symbolised, for example see the image below. NOTE: to add building numbers/names, we would need to add our Annotations layer from our Personal Geodatabase. You don't need to do that now.



- Click on the plus sign next to OSArea in the Table of Contents, to open and view the legend.



Next, we will look at our rivers data.

- We will select a smaller area of the rivers map data and create a new file of that selection.
- We will also style our rivers data.

Select smaller rivers area

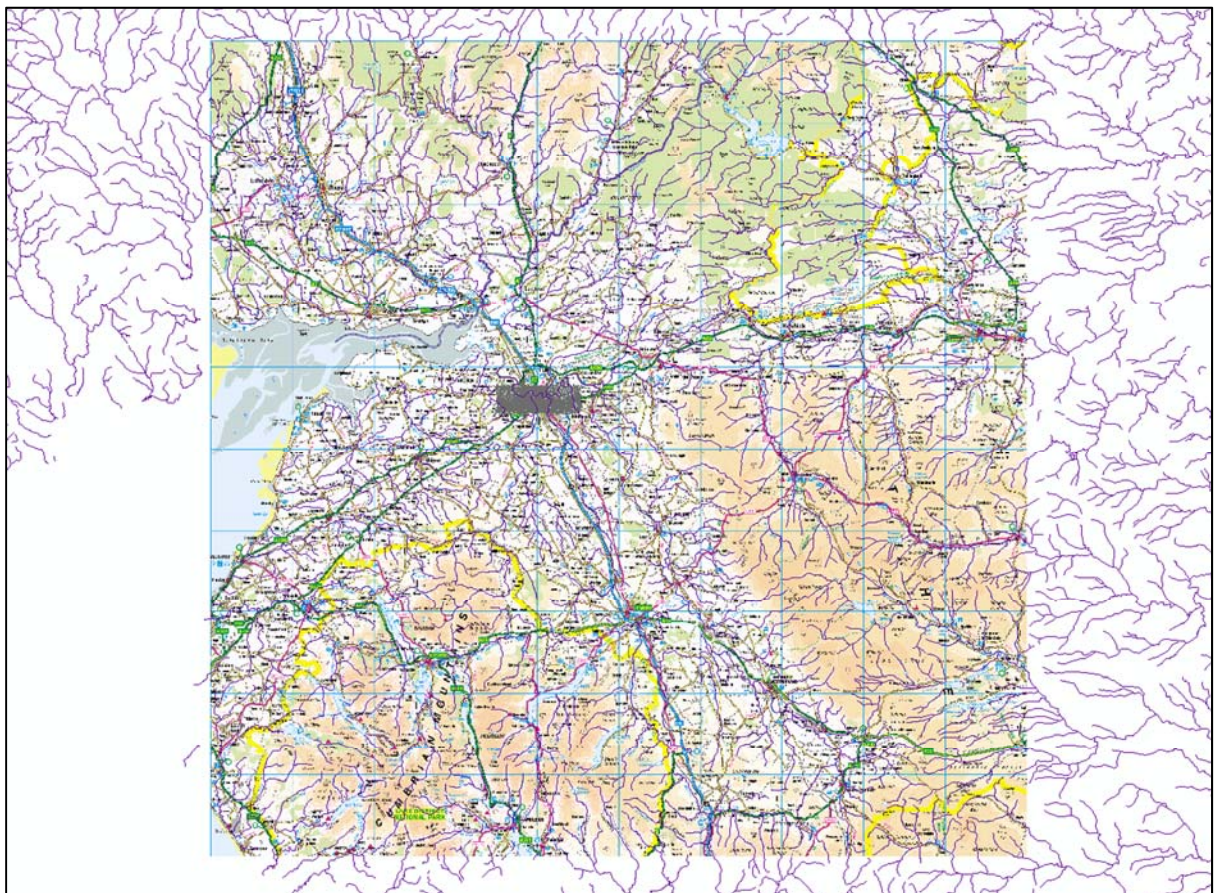
Our rivers layer covers all of Great Britain. Remember the rivers are Strategi data – this is always provided for the whole of GB from Digimap.

Let's select a smaller area of the rivers layer. Our map will draw faster with a smaller area.

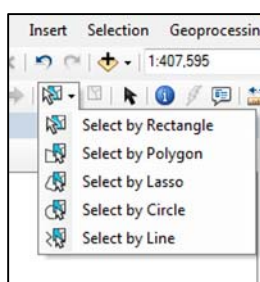
1. First, right click on **ny.tif** in the Table of Contents.
2. Select **Zoom to Layer**.

We will use the **ny.tif** layer as a guide for selecting the rivers.

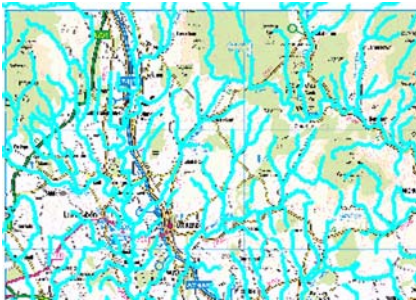
Your map window should look similar to this image – you can see the ny.tif file, the rivers around it and the small area of OS MasterMap data in the centre.



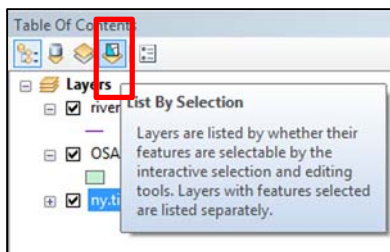
3. Click **Selection** on the toolbar.
4. Click **Select by Rectangle**.



5. Click on your map window.
6. Draw a box over **ny.tif**.
7. You should see all the data within that box highlighted in blue on your map, like this image:

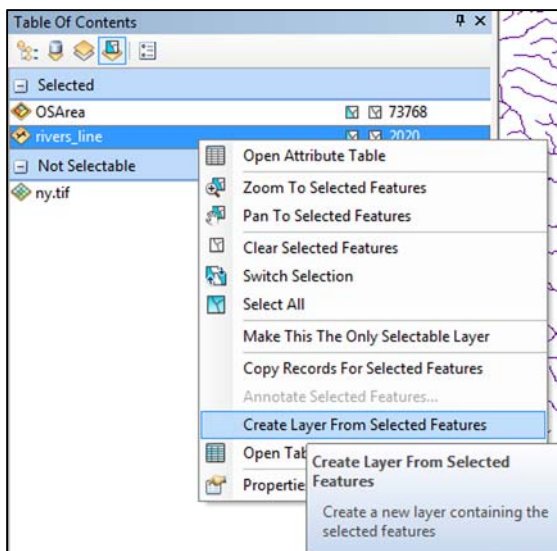


8. Now click **List By Selection** in the Table of Contents.

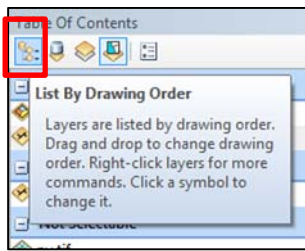


You will see that features have been selected from rivers AND OS MasterMap.

9. Right click **rivers_line**.
10. Click **Create layer from selected features**.



11. Now click **List by Drawing Order** in the Table of Contents:

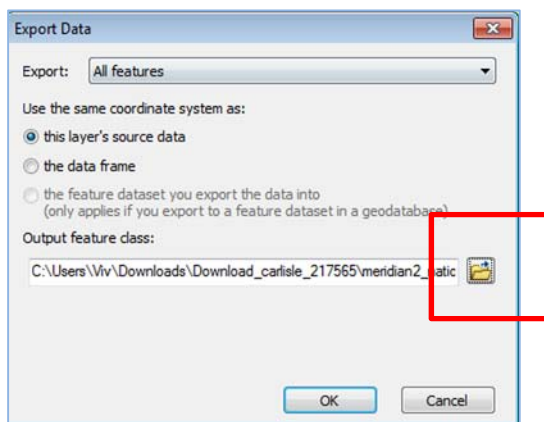


12. You will see a new layer in the Table of Contents – rivers line selection.

13. Right click **rivers line selection**.

14. Click **Data > Export data** – we will save the selection as a new file.

15. Click the yellow folder icon.

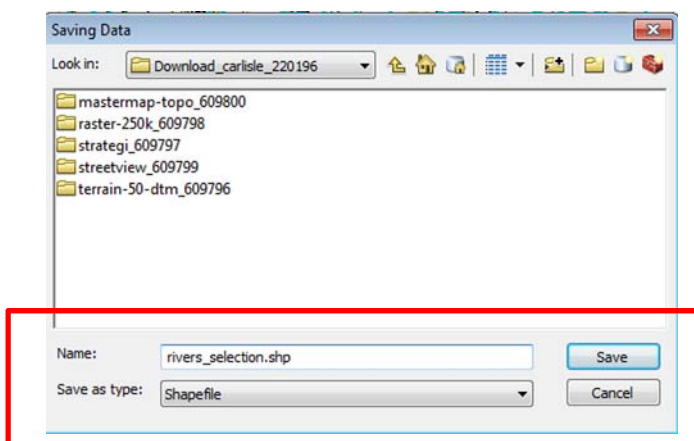


16. Choose a folder to save the new file.

17. Name the new file, for example **rivers_selection**.

18. Ensure that the **file type is Shapefile**.

19. Click **Save**.

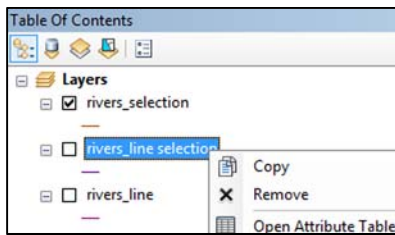


20. Click **OK**.

21. Add exported map data as a layer? Say **Yes**.

You will have a new rivers layer in your map.

22. You can remove or uncheck the other rivers layers.



Finally, we still have features selected. Let's clear them.

23. Click **Selection** on the top toolbar.

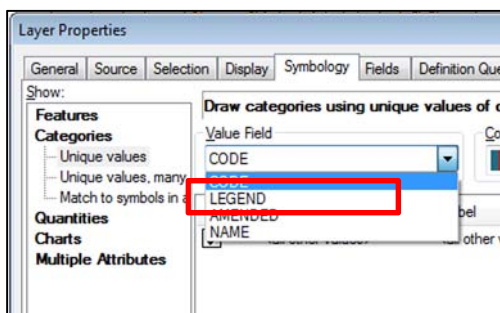
24. Click **Clear Selected Features**.

Style our rivers data

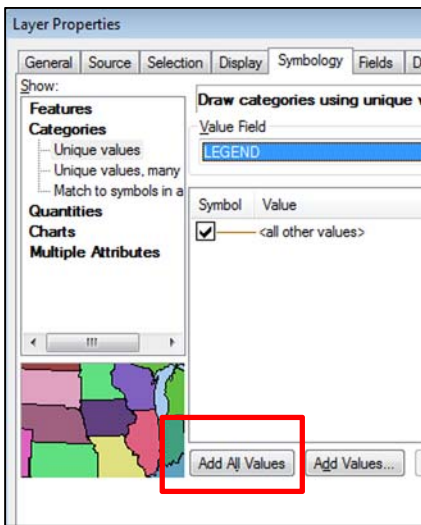
We could go to the Digimap help pages and try and find a layer file for our Strategi rivers data (remember we used a layer file to style our OS MasterMap Area). Or the Ordnance Survey website might have one.

Alternatively, we can use the layer's attribute data to quickly style this layer. Let's try that.

1. Right click **rivers_selection**.
2. Select **Open Attribute Table**.
3. Look at the **Legend** field. It gives the type of river, e.g. main, minor, secondary. We can use these entries to create a different style for each type of river.
4. **Close** the Attribute table.
5. Right click **rivers_selection**.
6. Select **Properties > Symbology**.
7. On the left, select **Categories > Unique Values**.
8. Click on **Value Field** drop down.
9. Select **LEGEND**.

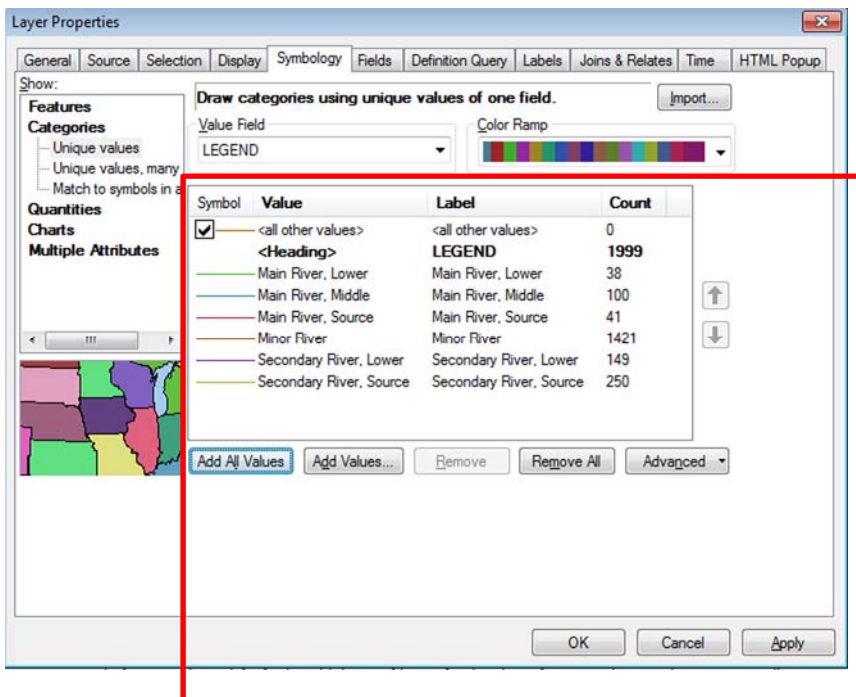


10. Now click **Add all values**, under the box.



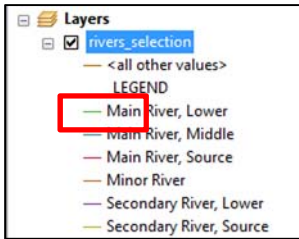
11. The box should be populated with different symbols for different river types, as shown in the image below.

12. Click **Apply > OK**.

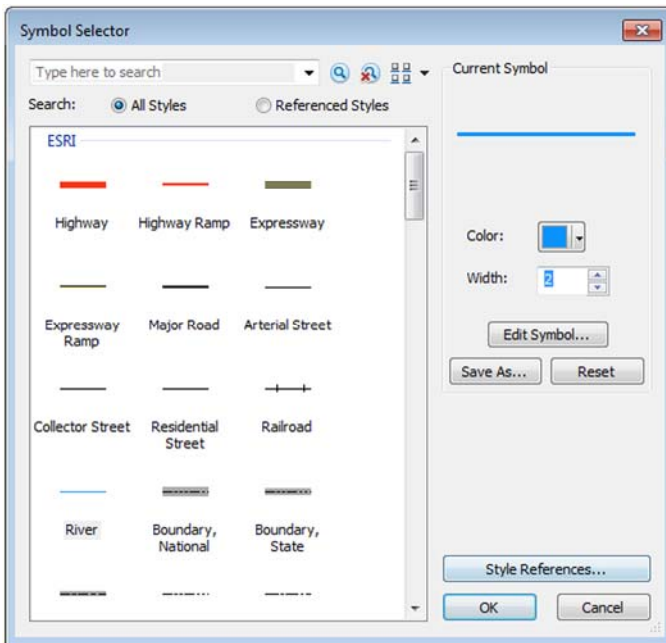


13. Unhappy with the styles? For example you may want to make the main rivers a thicker line.

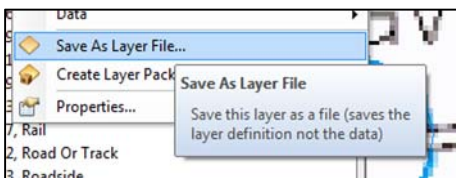
14. Click any symbol next to an entry in the Table of Contents – try **Main River, Lower**.



15. The **Symbol Selector** box should appear.
16. Select a colour and a line thickness, for example blue and width of 2.
17. Click **OK**.



18. Repeat with other layers until you are happy with the map.
19. Right click **rivers selection** in the Table of Contents.
20. Select **Save As Layer File**.
21. Save the LYR file in the Digimap data folder – you can use the layer file in the future to apply the same style to Strategii data – note the layer file contains the style, not the actual data.



Query our data

Question: How many buildings in Carlisle are at risk of flooding?

To answer this, we need to:

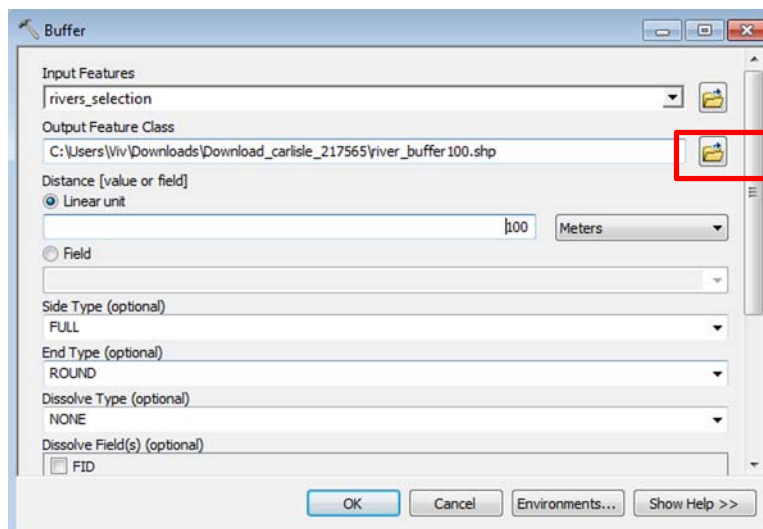
1. **Define an AT RISK area** around the rivers, within which buildings could potentially flood.
2. Query **how many buildings lie within the AT RISK area.**

1. Buffer the river centreline

Let's say that any property within 100m of the river will be considered "AT RISK" from flooding.

We can use the river centreline and create a 100m buffer around it.

1. We will use our **rivers selection** layer.
2. Open the Buffer tool
 - a. **Geoprocessing** → **Buffer** (note: this function can also be found in ArcToolbox → Analysis Tools → Proximity → Buffer).
 - b. Set the input features to **rivers selection** (your file name might be different).
 - c. **Output Feature Class** – click the yellow folder next to this.
 - d. Save the new buffer file in your Digimap data folder.
 - e. Name it **river_buffer100**.
 - f. Set the Linear Unit to **100** and the units to Meters.
 - g. Click **OK**.

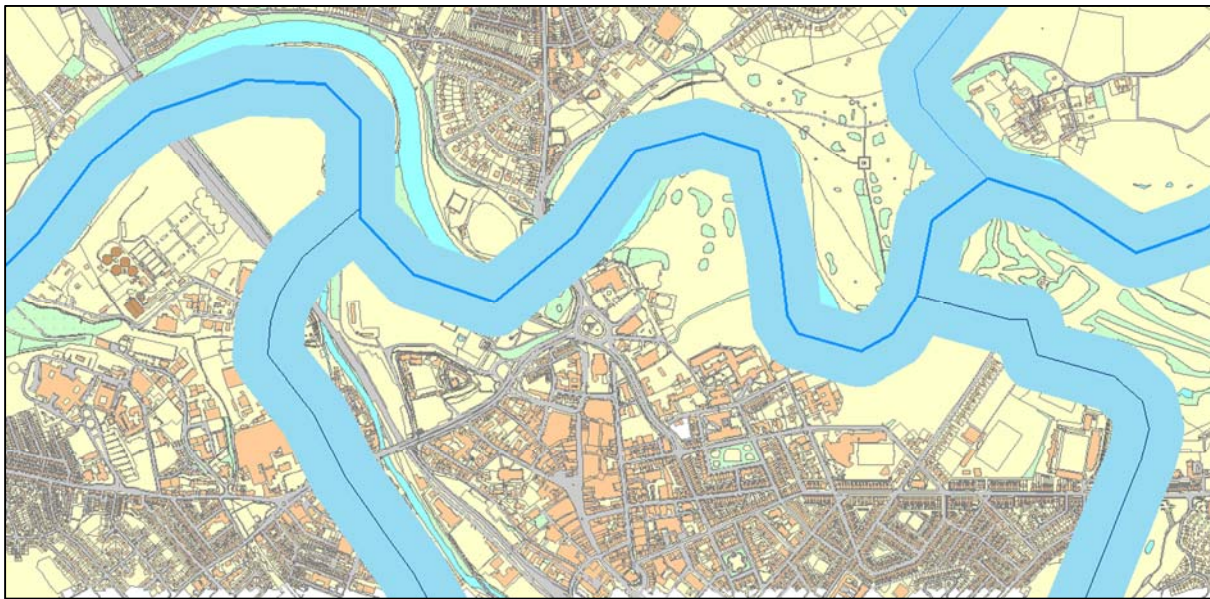


3. A new layer will be created and added to your map.

Let's zoom in to the city centre.

4. Right click the layer **OSArea**.
5. Click **Zoom to Layer**.
6. Uncheck **ny.tif** in the Table of Contents.

- You should be able to see a buffer zone around all the rivers, similar to this image.

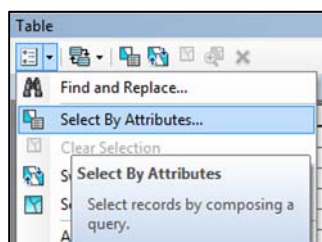


2. Calculate the number of buildings in the buffer

Now let's calculate the number of buildings that lie within the buffer we have just created.

This is a 2 stage process.

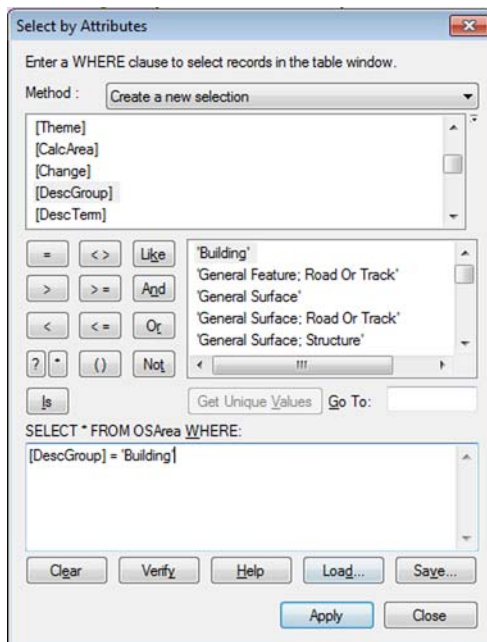
- First we will select all the features that are buildings, in our OSArea layer.
- Right click **OS Area**.
- Select **Open Attribute Table**.
- Scroll along until you find the field DescGroup. Scroll down and you will see features described as Building.
- Now let's select all those features.
- Click the arrow at the top left.
- Click **Select by Attribute**.



- Double click **DescGroup** – it is added to our query in the bottom box.
- Single Click = **the equal sign**.
- Single click **Get Unique Values**.
- Double click **Building**.

We now have a query that we can run.

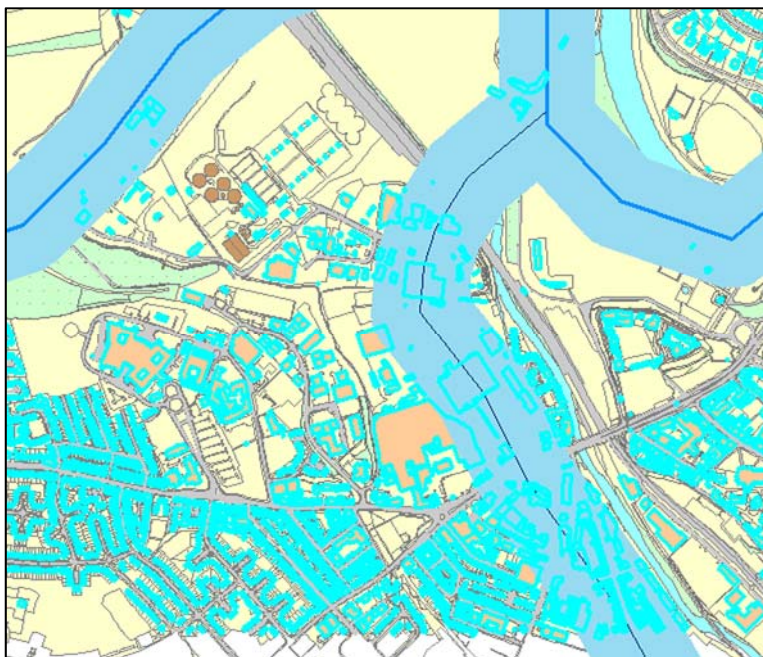
12. Click **Apply**.
13. **Close** the Select by Attributes query box.



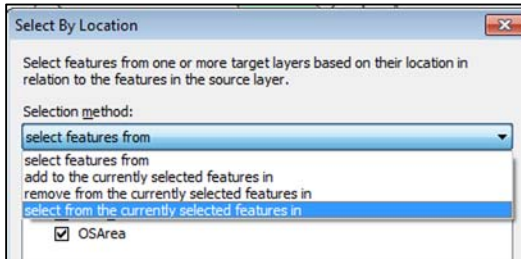
14. **Close** the Attribute Table.

You should see some building features highlighted in blue on your map to show they are selected.

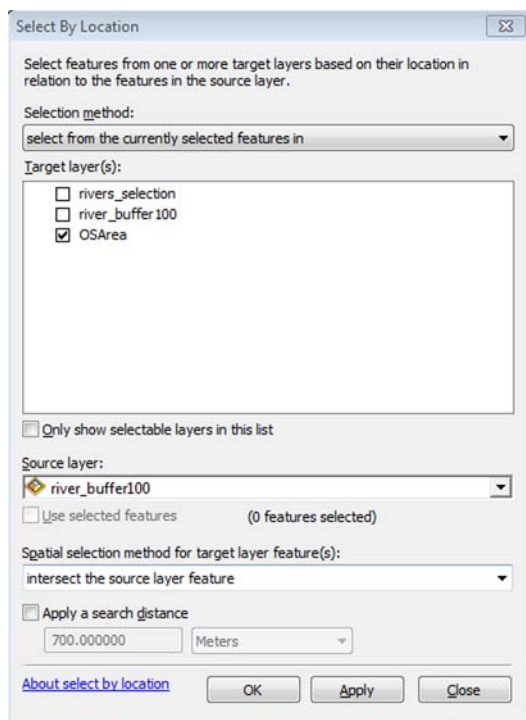
If you zoom in, you should be able to see that some of your buildings lie within the buffer, as seen in this image. We want to know how many.



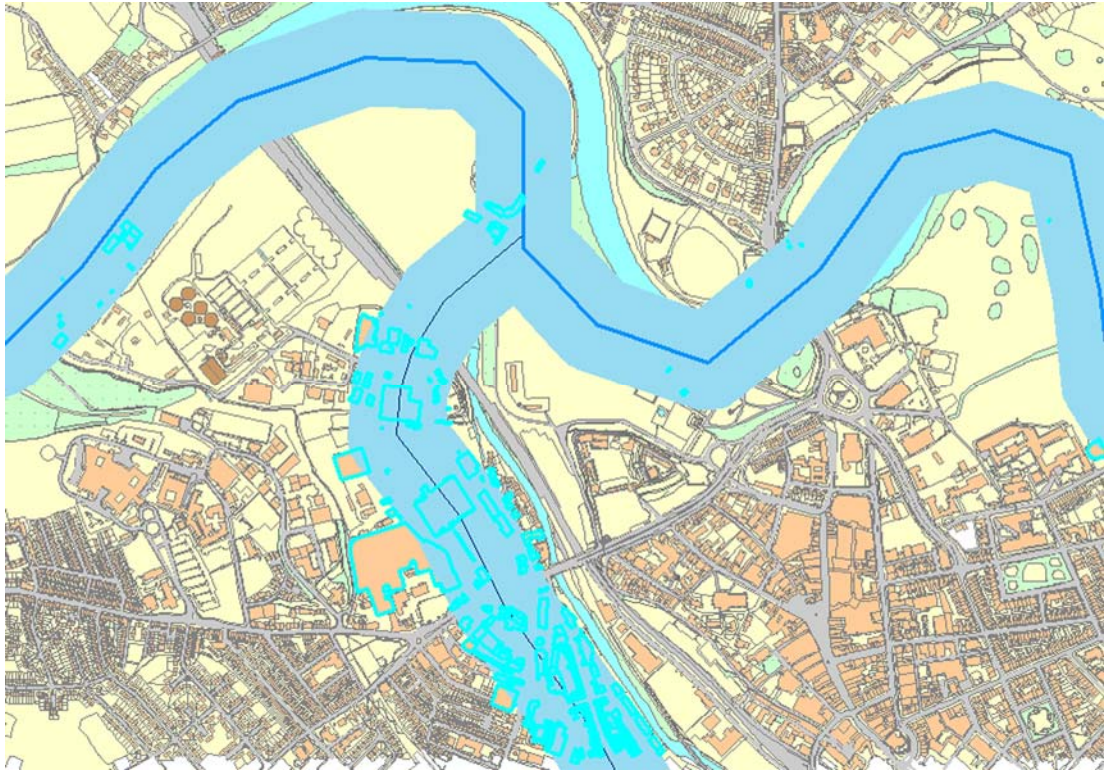
15. Choose **Selection > Select by Location** from the top toolbar.
16. Selection method – choose **select from the currently selected features in**:



17. Target Layer - Select **OSArea**.
18. Set source layer to **riverbuffer100** (this is our outline feature - we want to see what is within it).
19. Set Spatial Selection Method: **intersect the source layer feature**.
20. Press **Apply > OK**.

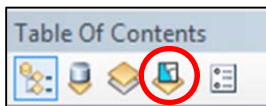


21. The features that match our search criteria will now have been selected and will appear blue on the map.

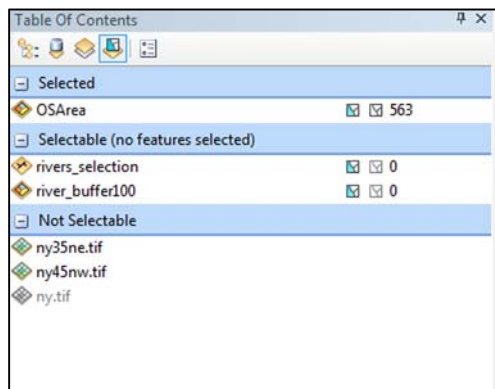


Let's save our selected features as a **Shapefile**.

1. Switch table of contents to **List by Selection**.

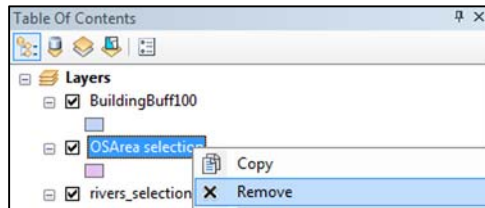


2. In our map, 563 features are selected –**NOTE**: you will probably have a different number, as you will not have downloaded exactly the same area of OS MasterMap data.

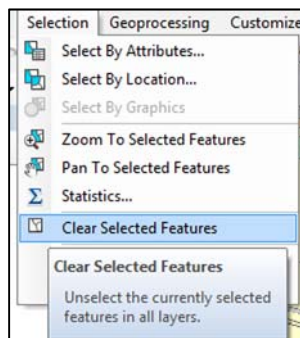


3. **Right click** the OSArea layer.
4. Click **Create layer from Selected Features**.
5. Return to List by Drawing order – we should have an extra layer called **OSArea selection**.

6. Right click **OSArea selection**.
7. Select **Data > Export Data**.
8. Export **All features**.
9. Select the same coordinate system as the layer's source data.
10. Save the data in our Digimap data folder with the name **BuildingBuff100**.
11. Ensure you select **Shapefile** as the file type.
12. Add data to the map as a layer when prompted.
13. Remove the other layer, OS Area selection:



14. Clear the selected features (they are still selected in memory): **Selection > Clear Selected Features**.



Export your map

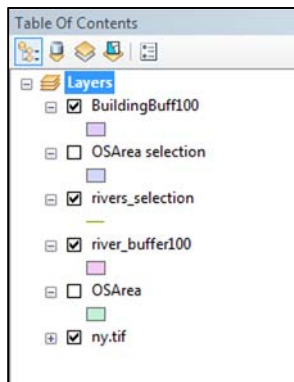
We have done some basic analysis. Let's make a map that we can export and include in a document, to represent the houses that are at risk of flooding in Carlisle.

Our map needs to show:

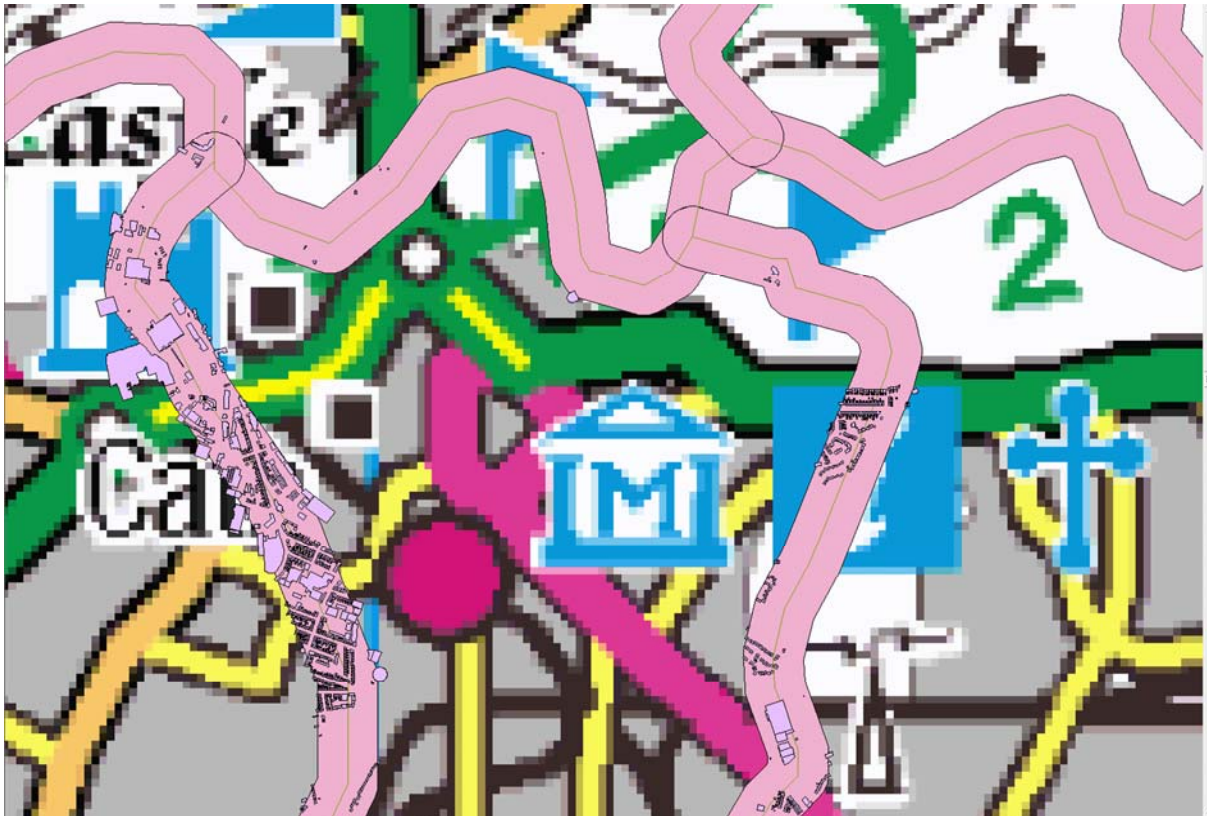
- River line
- River buffer
- The buildings within the buffer
- Background mapping for context


Display the right data

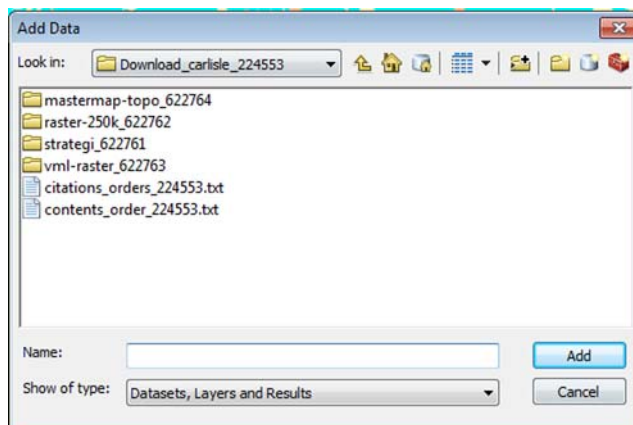
1. Zoom to a scale of 1:10000.
2. Check these boxes in the Table of Contents:
 - BuildingBuff100.
 - Rivers_selection.
 - River_buffer100.
 - Ny.tif – the 1:250000 raster data.
3. Uncheck everything else in the Table of Contents.



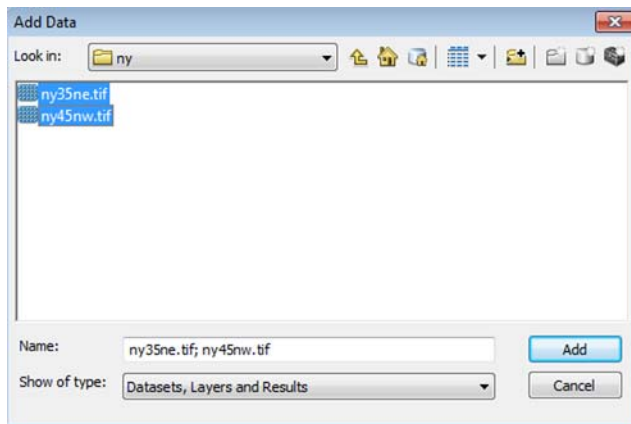
How does our map look? It should look similar to the image below.



1. Problem - our background raster map (1:250000 raster, ny.tif) is too small a scale – we need a more detailed map.
2. Click **Add Data** 
3. Go back to the Digimap folder.
4. Double click the **VML-Raster** folder:



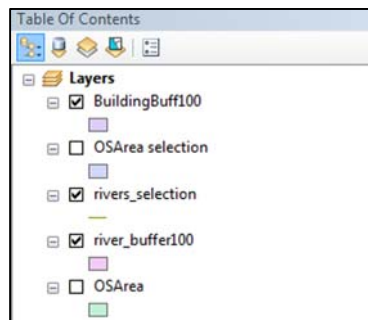
5. Double click the NY folder.
6. Ctrl-click to select the TIF files.
7. Click **Add**.
8. Say **YES to Build Pyramids**.



9. Uncheck ny.tif (the smaller scale, 1:250000 data) in the Table of Contents.

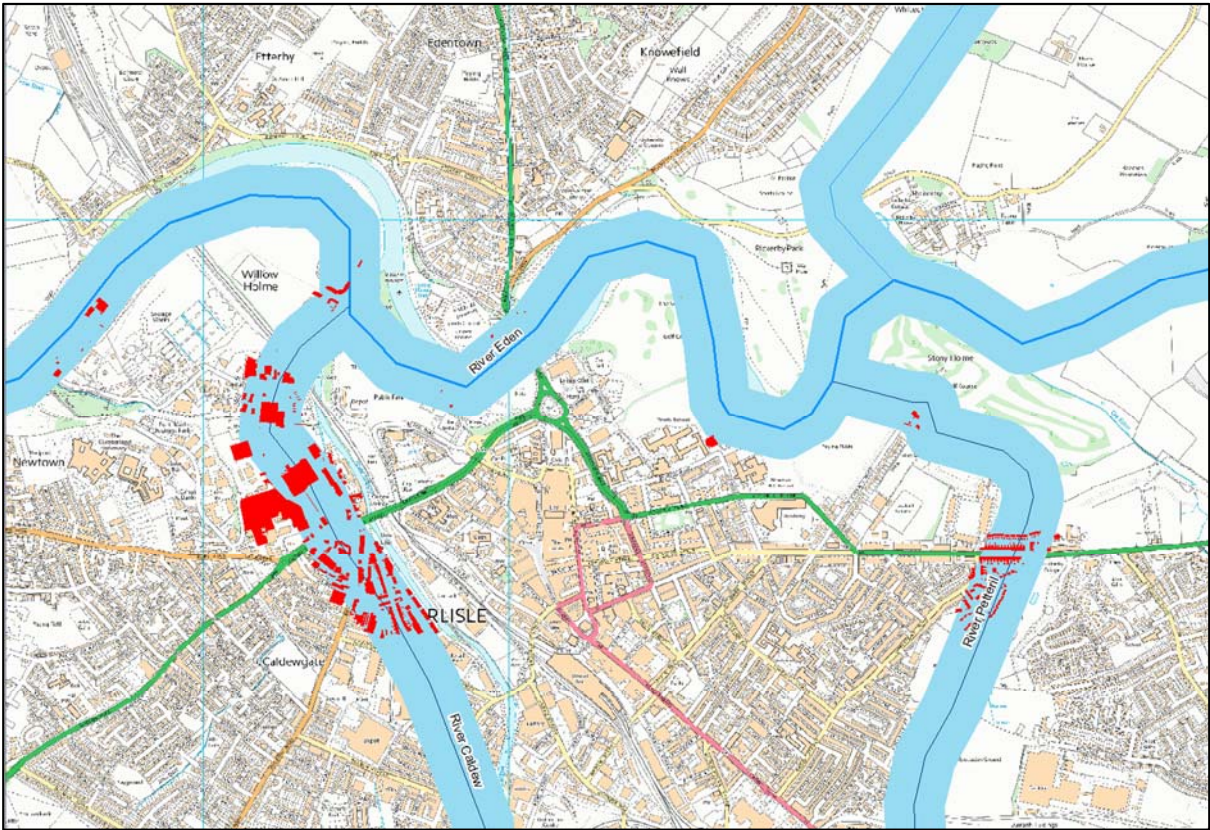
Styling

1. River_buffer100 – we could change the colour to blue.
2. Click the symbol under river_buffer100 in the Table of Contents.



3. The Symbol Selector box will open.
4. Select a blue colour.
5. Click OK.
6. Now let's make the buildings stand out more.
7. Repeat the steps above to change the symbol for BuildingBuff100 – choose a bright colour, for example red.
8. Finally, let's try labelling the rivers_selection layer.
9. Right click rivers_selection.
10. Click Label features.
11. You should be able to see a label on the River Eden. To change the size, right click and select Properties > Labels and play around with the options.

Our new map is clearer.

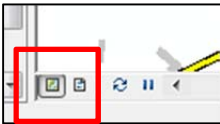


Export your map

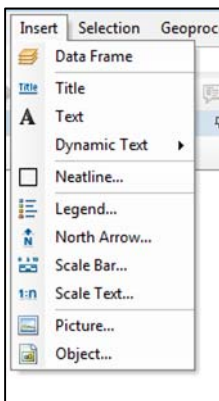
You can export your map in various formats, including image formats (jpg/tiff/png) or a pdf.

Layout view

ArcMap has 2 views, Data and Layout. To produce a print map, we must switch to the Layout view. The buttons are in the bottom left hand corner of the map window.



1. Switch to Layout View.
2. Click the Insert menu on the toolbar:



3. Insert a Legend, North Arrow, Title and Scale Bar.
4. Click **File > Export Map**.
5. Click **Save as Type** and select a format – try TIF.
6. For guidance with formats and output options, see this ArcGIS help page:

<http://resources.arcgis.com/en/help/main/10.1/index.html#//00sm00000004000000>

Data View

In **Data View**, then the legend, scale bar etc will not be printed. You will just get a snapshot of the visible map.

In this view you get the option to create a World file. This can be useful as it contains the geographic coordinates of your map.

A World file allows you to add the image back into ArcMap and it will appear in the correct geographical position.

Further steps

What else could you do with this project?

1. Create or look for more accurate flooding data, perhaps from the Environment Agency.
2. Download and add Digital Terrain Model data to your map to get a clearer understanding of the terrain.
3. Download and add Environment Land Cover data, to get a picture of activity in surrounding areas.