

ArcGIS Pro

Module 4 - Data Analysis

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Last Updated: September 29, 2020

Goals

- Learn some basic geospatial analysis through the use of various tools
- Solve a basic spatial problem using GIS

Calculating Distances

1 - click on various segments of lines from the “bikeways” dataset

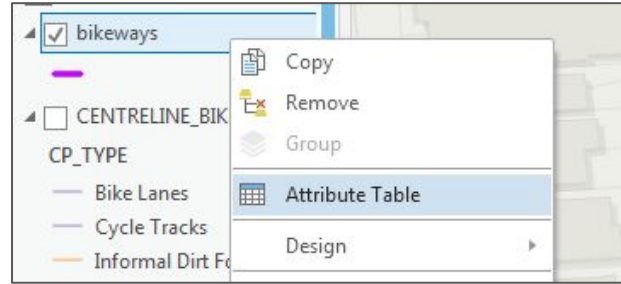
2 - notice the various attributes

The screenshot shows a GIS application interface. On the left is a legend with categories: 'bikeways' (checked), 'Toronto Roads', and 'NEIGHBORHOODS_WGS84'. The 'bikeways' legend lists various types like 'Bike Lanes', 'Cycle Tracks', etc. The map shows a street network with 'Annette St' highlighted in purple. A pop-up window titled 'Pop-up' is open over the purple segment, showing a table of attributes for 'bikeways - Annette St'. The status bar at the bottom shows coordinates and 'Selected Features: 2314'.

bikeways - Annette St	
OBJECTID_1	580
GEO_ID	14013997
LFN_ID	2890
LF_NAME	Annette St
ADDRESS_L	17-31
ADDRESS_R	
OE_FLAG_L	0
OE_FLAG_R	N
LONUML	17
HINUML	31
LONUMR	0
HINUMR	0
FNODE	14013999
TNODE	14013998
ONE_WAY_DI	0
DIR_CODE_D	Not One-Way
FCODE	201300
FCODE_DESC	Minor Arterial
JURIS_CODE	CITY OF TORONTO
OBJECTID	7774

Calculating Distances

1 - right-click on the “bikeways” layer in the “Contents” pane and select “Attribute Table”



A screenshot of the ArcGIS Pro Attribute Table for the 'bikeways' layer. The table displays 20 rows of data, each representing a polyline feature. The columns are: Shape, GEO_ID, LFN_ID, ADDRESS_L, ADDRESS_R, OBJECTID_1, Shape_Length, LF_NAME, OE_FLAG_L, OE_FLAG_R, LONUM_L, HINUM_L, and LONUM_R. The 'Shape_Length' column is highlighted in blue. The status bar at the bottom indicates '1 of 2313 selected' and 'Filters: 100%'.

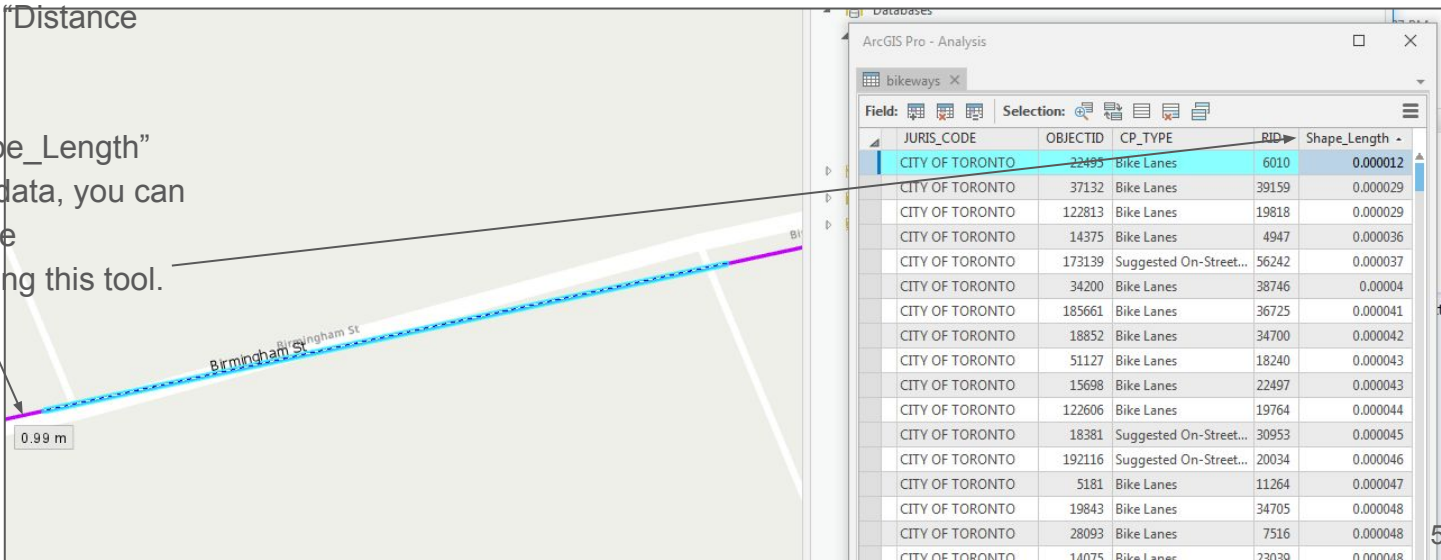
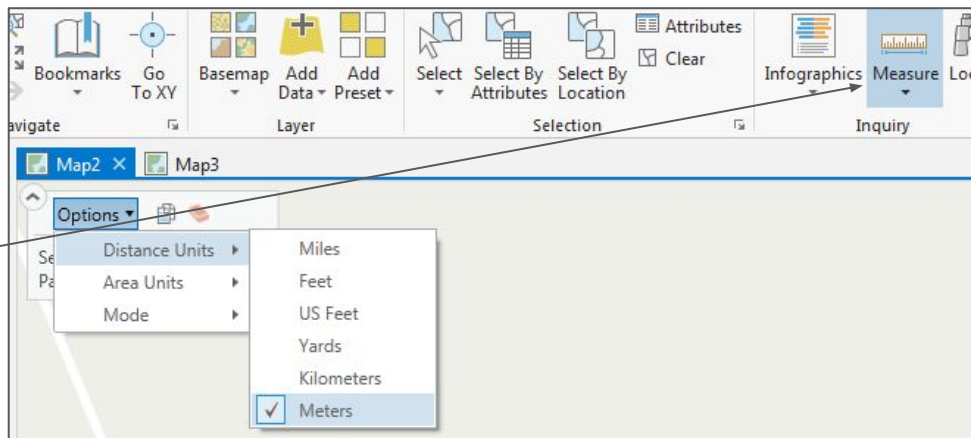
Shape	GEO_ID	LFN_ID	ADDRESS_L	ADDRESS_R	OBJECTID_1	Shape_Length	LF_NAME	OE_FLAG_L	OE_FLAG_R	LONUM_L	HINUM_L	LONUM_R
Polyline	20048136	1181			266	0.000012	Birmingham St	N	N	0	0	0
Polyline	20059683	181			1643	0.000029	Greenwood Ave	N	N	0	0	0
Polyline	14134996	11642			828	0.000029	Lower Simcoe St	N	N	0	0	0
Polyline	20047160	2413			220	0.000036	Royal York Rd	N	N	0	0	0
Polyline	30021218	10252			2100	0.000037	Old Finch Ave	N	N	0	0	0
Polyline	14677680	391			1632	0.00004	Woodbine Ave	N	N	0	0	0
Polyline	30076489	88			1491	0.000041	Dawes Rd	N	N	0	0	0
Polyline	1146472	4733			1373	0.000042	Yonge St	N	N	0	0	0
Polyline	20111833	4492			736	0.000043	Strachan Ave	N	N	0	0	0
Polyline	14015932	930			1009	0.000043	Vaughan Rd	N	N	0	0	0
Polyline	14134978	11642			823	0.000044	Lower Simcoe St	N	N	0	0	0
Polyline	20045914	5570			1268	0.000045	Faywood Blvd	N	N	0	0	0
Polyline	30082799	3704			835	0.000046	Howland Ave	N	N	0	0	0
Polyline	14042202	866			549	0.000047	Runnymede Rd	N	N	0	0	0
Polyline	1146468	4733			1374	0.000048	Yonge St	N	N	0	0	0
Polyline	20048142	2528			347	0.000048	Stephen Dr	N	N	0	0	0
Polyline	20010441	854			1043	0.000048	Roselawn Ave	N	N	0	0	0
Polyline	30071306	4392			1473	0.000053	Sherbourne St N	N	N	0	0	0
Polyline	30053054	4345			1060	0.000053	Russell Hill Rd	N	N	0	0	0
Polyline	30096655	3106			2180	0.000058	Cambridge Ave	N	N	0	0	0
Polyline	14024858	3752			1539	0.000062	Jones Ave	N	N	0	0	0

Calculating Distances

1 - Under the “Map” menu, select the “Measure” tool

2 - under the measure “Options” drop-down menu, select “Distance Units” → “Meters”

3 - while there is a “Shape_Length” column in your attribute data, you can see that it is not the same measurement we get using this tool.



Calculating Distance

1 - with the “bikeways” attribute table open, click on the “Add” button to create a new field

3 - name the field “LineLength” with the alias “Line Length”

4 - select “Double” as the “Data Type”

The screenshot shows the ArcGIS Pro interface with the 'bikeways' attribute table open. The 'Field:' tab is active, and the 'Add' button is highlighted. The 'Add Field' dialog box is open, prompting to 'Add a new field in this table.' The table below shows various fields with their data types and lengths. The 'LineLength' field is highlighted with a green background, and its data type is set to 'Double'.

Field Name	Alias	Data Type	Length
OE_FLAG_L	OE_FLAG_L	Text	
OE_FLAG_R	OE_FLAG_R	Text	
LONUML	LONUML	Long	
HINUML	HINUML	Long	
LONUMR	LONUMR	Long	
HINUMR	HINUMR	Long	
FNODE	FNODE	Long	
TNODE	TNODE	Long	
ONE_WAY_DI	ONE_WAY_DI	Short	
DIR_CODE_D	DIR_CODE_D	Text	20
FCODE	FCODE	Long	
FCODE_DESC	FCODE_DESC	Text	100
JURIS_CODE	JURIS_CODE	Text	20
OBJECTID	OBJECTID	Double	
CP_TYPE	CP_TYPE	Text	50
RID	RID	Double	
LineLength	Line Length	Double	

Calculating Distances

1 - right-click on the “Line Length” column and select “Calculate Geometry”

2 - in the “Geoprocessing” popup select “Length (geodesic)” in the “Property” column

3 - select “Kilometers” as the “Length Unit”

4 - click on “Run”

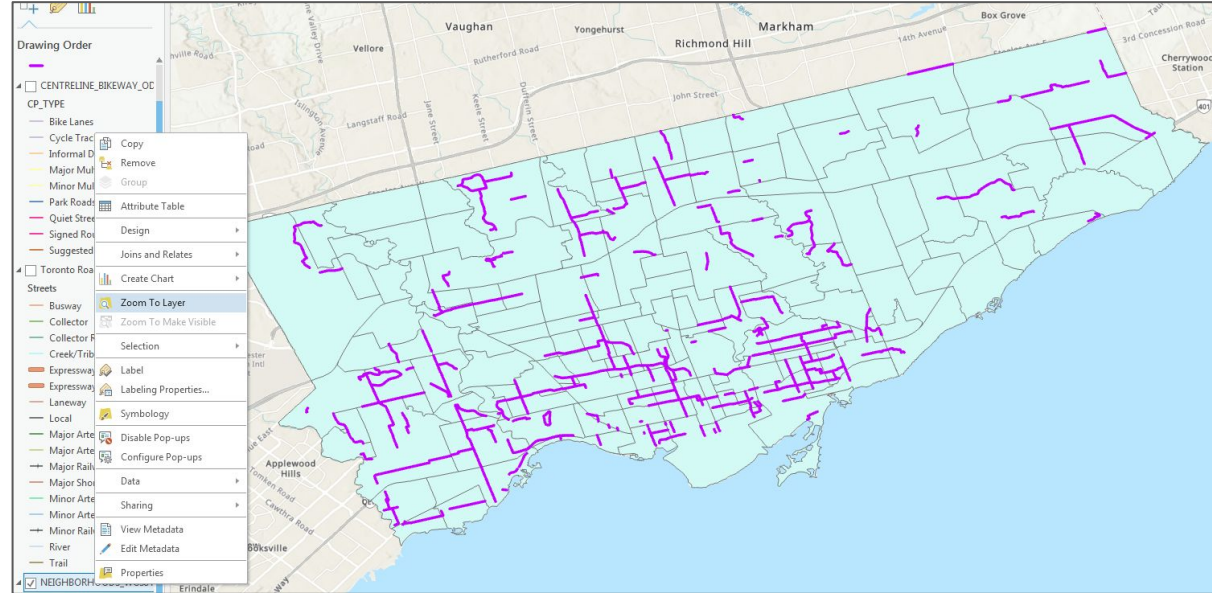
The column should now be populated with the line length of every segment of the bikeways layer.

The screenshot shows the ArcGIS Desktop interface. A context menu is open over the 'Line Length' column in a data table, with 'Calculate Geometry' selected. The 'Geoprocessing' window is open, showing the 'Calculate Geometry Attributes' tool. The 'Input Features' are 'bikeways'. The 'Target Field' is 'Line Length' and the 'Property' is 'Length (geodesic)'. The 'Length Unit' is 'Kilometers' and the 'Coordinate System' is 'Kilometers'. The 'Run' button is highlighted. A status bar at the bottom indicates 'Calculate Geometry Attributes Completed successfully'. On the right, a data table shows the results of the calculation.

JURS_CODE	OBJECTID	CP_TYPE	RID	Line Length
CITY OF TORONTO	22495	Bike Lanes	6010	0.00099
CITY OF TORONTO	37132	Bike Lanes	39159	0.003055
CITY OF TORONTO	122813	Bike Lanes	19818	0.003033
CITY OF TORONTO	14375	Bike Lanes	4947	0.003885
CITY OF TORONTO	173139	Suggested On-Street...	56242	0.003389
CITY OF TORONTO	34200	Bike Lanes	38746	0.0043
CITY OF TORONTO	185661	Bike Lanes	36725	0.00449
CITY OF TORONTO	18852	Bike Lanes	34700	0.004493
CITY OF TORONTO	51127	Bike Lanes	18240	0.004535
CITY OF TORONTO	15698	Bike Lanes	22497	0.004238
CITY OF TORONTO	122606	Bike Lanes	19764	0.004567
CITY OF TORONTO	18381	Suggested On-Street...	30953	0.004677
CITY OF TORONTO	192116	Suggested On-Street...	20034	0.004885
CITY OF TORONTO	5181	Bike Lanes	11264	0.005061
CITY OF TORONTO	19843	Bike Lanes	34705	0.005173
CITY OF TORONTO	28093	Bike Lanes	7516	0.00517
CITY OF TORONTO	14075	Bike Lanes	23039	0.003959
CITY OF TORONTO	180671	Bike Lanes	36435	0.00572
CITY OF TORONTO	129244	Bike Lanes	23994	0.005531
CITY OF TORONTO	207820	Suggested On-Street...	61561	0.005964
CITY OF TORONTO	187540	Bike Lanes	37379	0.006704

Spatial Joins

1 - right-click on the “Neighborhoods” layer and select “Zoom to Layer”



Spatial Joins

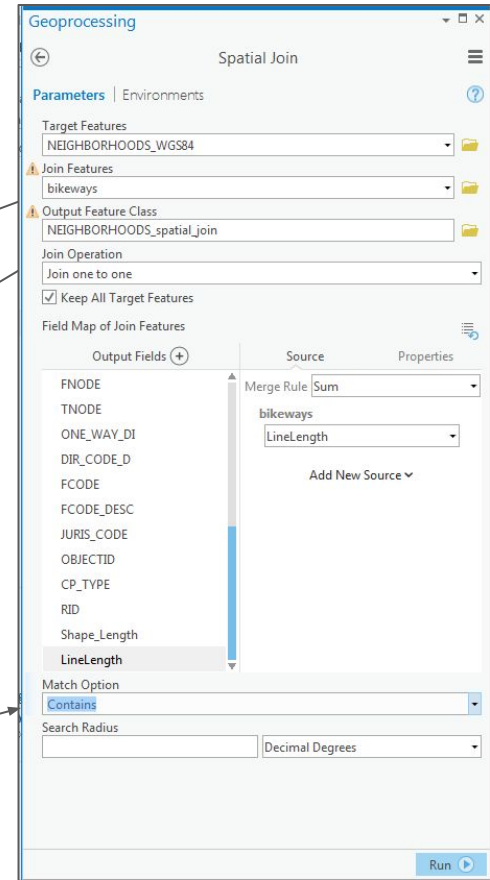
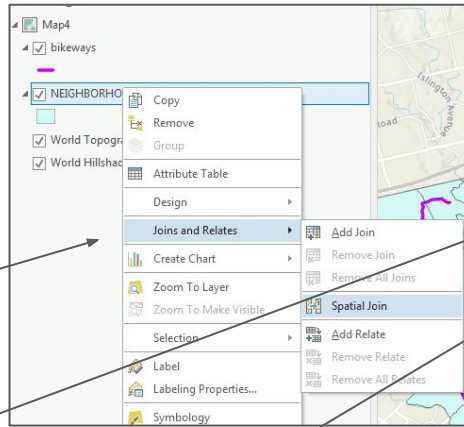
1 - right-click on the “Neighbourhoods” layer and select “Joins and Relates” → “Spatial Join”

2 - select “bikeways” in the “Join Features” option

3 - give the name “NEIGHBORHOODS_spatial_join” to the resulting joined layer

4 - highlight the “LineLength” field and select “Sum” as the “Merge Rule”

5 - select “Contains” as the “Match Option” and click on Run



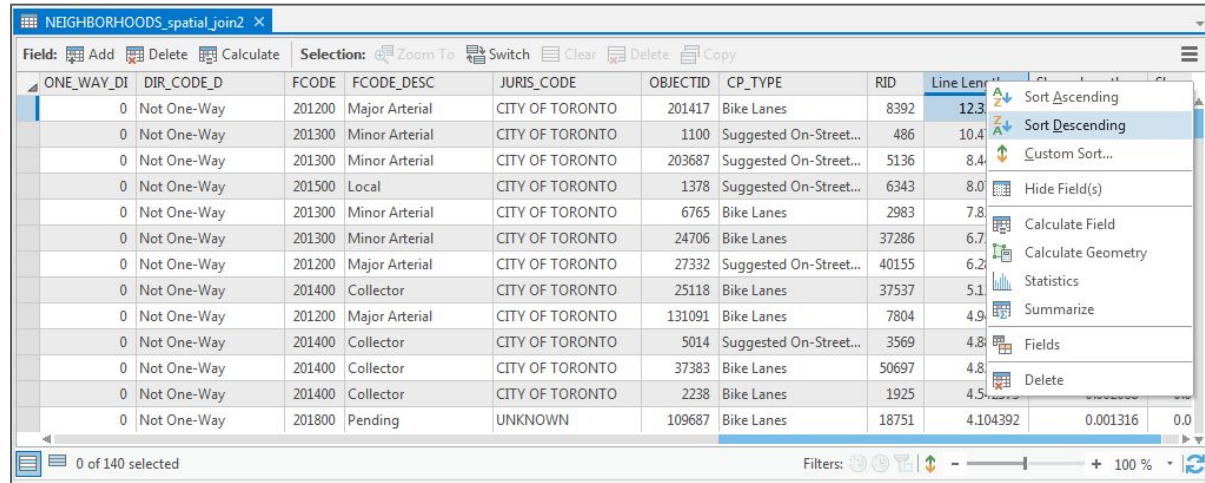
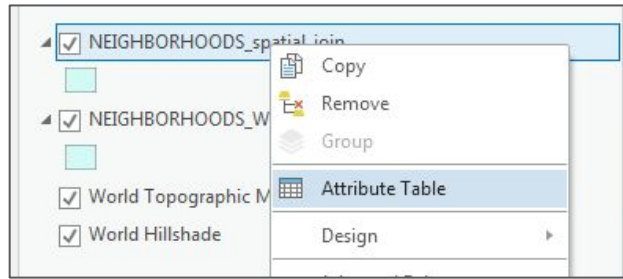
Spatial Joins

1 - right-click on the resulting “NEIGHBORHOODS_spatial_Join” layer in the “Contents” pane and select “Attribute Table”

2 - examine the “Join_Count” column (this is the number of bikeway segments are in each neighbourhood)

3 - slide along the table until you find the “Line Length” field

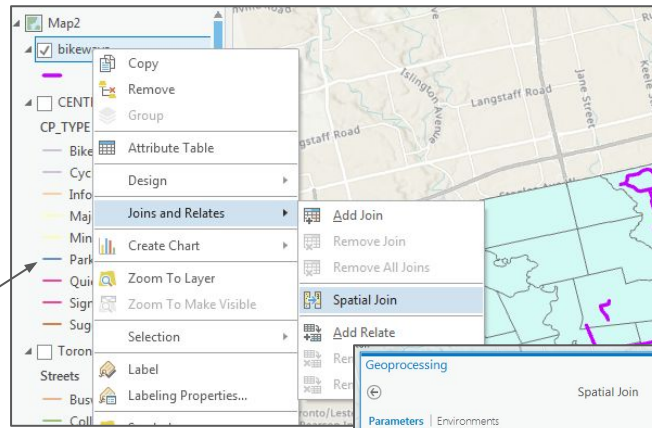
4 - right-click on the column and select “Sort Descending”



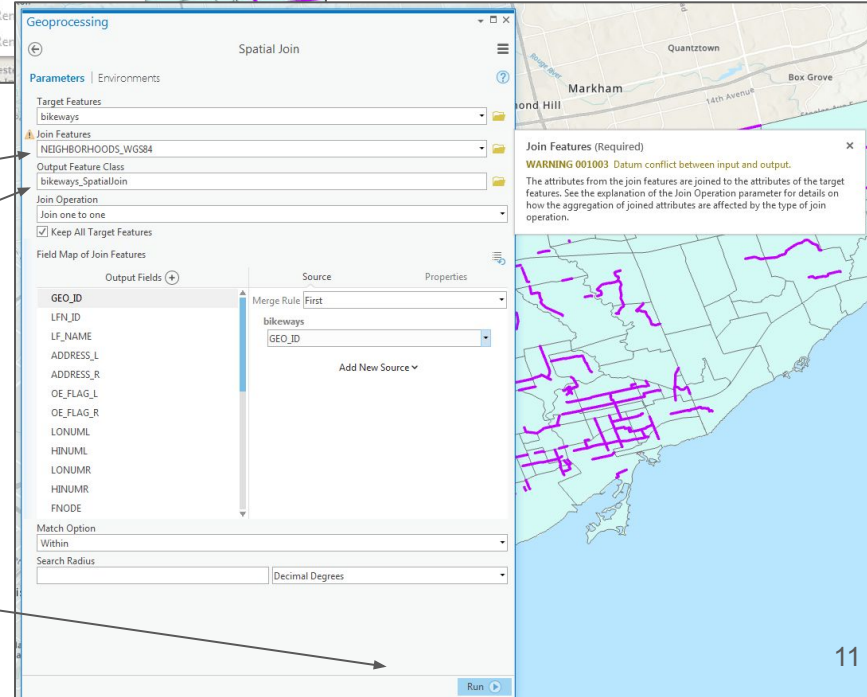
Field:	Add	Delete	Calculate	Selection:	Zoom To	Switch	Clear	Delete	Copy	
ONE_WAY_DI	DIR_CODE_D	FCODE	FCODE_DESC	JURIS_CODE	OBJECTID	CP_TYPE	RID	Line Length	Sort Ascending	
0	Not One-Way	201200	Major Arterial	CITY OF TORONTO	201417	Bike Lanes	8392	12.3	Sort Descending	
0	Not One-Way	201300	Minor Arterial	CITY OF TORONTO	1100	Suggested On-Street...	486	10.4	Custom Sort...	
0	Not One-Way	201300	Minor Arterial	CITY OF TORONTO	203687	Suggested On-Street...	5136	8.4	Hide Field(s)	
0	Not One-Way	201500	Local	CITY OF TORONTO	1378	Suggested On-Street...	6343	8.0	Calculate Field	
0	Not One-Way	201300	Minor Arterial	CITY OF TORONTO	6765	Bike Lanes	2983	7.8	Calculate Geometry	
0	Not One-Way	201300	Minor Arterial	CITY OF TORONTO	24706	Bike Lanes	37286	6.7	Statistics	
0	Not One-Way	201200	Major Arterial	CITY OF TORONTO	27332	Suggested On-Street...	40155	6.2	Summarize	
0	Not One-Way	201400	Collector	CITY OF TORONTO	25118	Bike Lanes	37537	5.1	Fields	
0	Not One-Way	201200	Major Arterial	CITY OF TORONTO	131091	Bike Lanes	7804	4.9	Delete	
0	Not One-Way	201400	Collector	CITY OF TORONTO	5014	Suggested On-Street...	3569	4.8		
0	Not One-Way	201400	Collector	CITY OF TORONTO	37383	Bike Lanes	50697	4.8		
0	Not One-Way	201400	Collector	CITY OF TORONTO	2238	Bike Lanes	1925	4.5		
0	Not One-Way	201800	Pending	UNKNOWN	109687	Bike Lanes	18751	4.104392		

Spatial Joins method II

1 - right-click on the “bikeways” layer and select “Joins and Relates” → “Spatial Join”



2 - in the “Geoprocessing” popup, select “NEIGHBORHOODS_WGS84” in the “Join Features” option



3 - give the name “bikeways_SpatiaJoin” to the resulting joined layer

4 - click “Run”

Spatial Joins method II

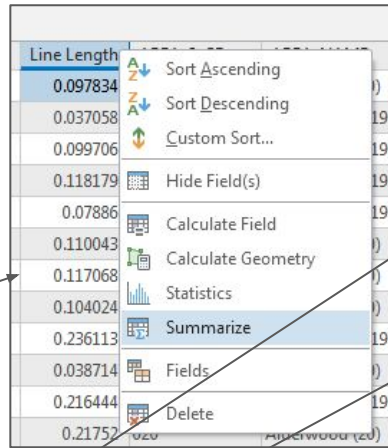
1 - right-click on the new joined layer
"bikeways_SpatialJoin" and select
"Attribute Table"

Examine the attribute data. You will
notice that the city wards data are now
attached to each bike lane

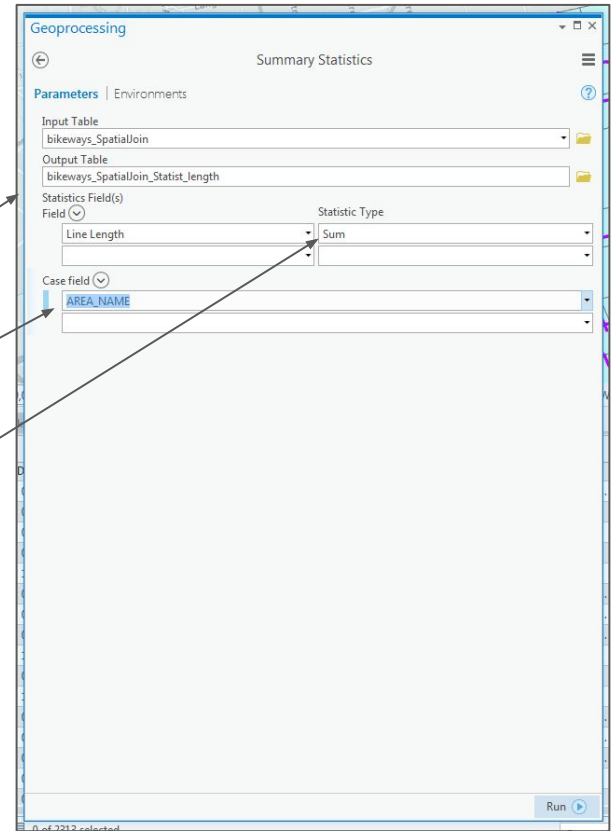
FCODE	FCODE_DESC	JURIS_CODE	OBJECTID	CP_TYPE	RID	Line Length	AREA_S_CD	AREA_NAME	Name	ID	Shape_Length
201500	Local	CITY OF TORONTO	97	Suggested On-Street...	16	0.097634	020	Alderwood (20)	Alderwood	20	0.000915
201200	Major Arterial	CITY OF TORONTO	278	Bike Lanes	73	0.037058	019	Long Branch (19)	Long Branch	19	0.000448
201200	Major Arterial	CITY OF TORONTO	279	Bike Lanes	74	0.099706	019	Long Branch (19)	Long Branch	19	0.00121
201200	Major Arterial	CITY OF TORONTO	372	Bike Lanes	76	0.118179	019	Long Branch (19)	Long Branch	19	0.00143
201200	Major Arterial	CITY OF TORONTO	168934	Bike Lanes	115	0.07886	019	Long Branch (19)	Long Branch	19	0.000966
201500	Local	CITY OF TORONTO	55300	Suggested On-Street...	124	0.110043	020	Alderwood (20)	Alderwood	20	0.001303
201500	Local	CITY OF TORONTO	185276	Suggested On-Street...	127	0.117068	020	Alderwood (20)	Alderwood	20	0.001097
201500	Local	CITY OF TORONTO	185263	Suggested On-Street...	144	0.104024	020	Alderwood (20)	Alderwood	20	0.001192
201200	Major Arterial	CITY OF TORONTO	168936	Bike Lanes	155	0.236113	019	Long Branch (19)	Long Branch	19	0.002443
201200	Major Arterial	CITY OF TORONTO	115	Bike Lanes	156	0.038714	020	Alderwood (20)	Alderwood	20	0.000354
201200	Major Arterial	CITY OF TORONTO	168935	Bike Lanes	203	0.216444	019	Long Branch (19)	Long Branch	19	0.002437
201500	Local	CITY OF TORONTO	99	Suggested On-Street...	215	0.21752	020	Alderwood (20)	Alderwood	20	0.002035
0	Not One-Way										
201500	Local	CITY OF TORONTO	249	Suggested On-Street...	217	0.20368	020	Alderwood (20)	Alderwood	20	0.001908
201400	Collector	CITY OF TORONTO	120611	Suggested On-Street...	234	0.136858	012	Markland Wood (12)	Markland Wood	12	0.001659
0	Not One-Way										
201400	Collector	CITY OF TORONTO	189065	Bike Lanes	394	0.24334	013	Etobicoke West Mall...	Etobicoke West Mall	13	0.002482
0	Not One-Way										
201400	Collector	CITY OF TORONTO	189060	Bike Lanes	395	0.008617	013	Etobicoke West Mall...	Etobicoke West Mall	13	0.000105

Summarizing statistics

1 - in the new “bikeways_SpatialJoin” attribute table, right-click on the “Line Length” column and select “Summarize”



2 - in the Geoprocessing popup, name your summary table “bikeways_SpatialJoin_Statist_length”



3 - in the “Case field” option, select “AREA_NAME”

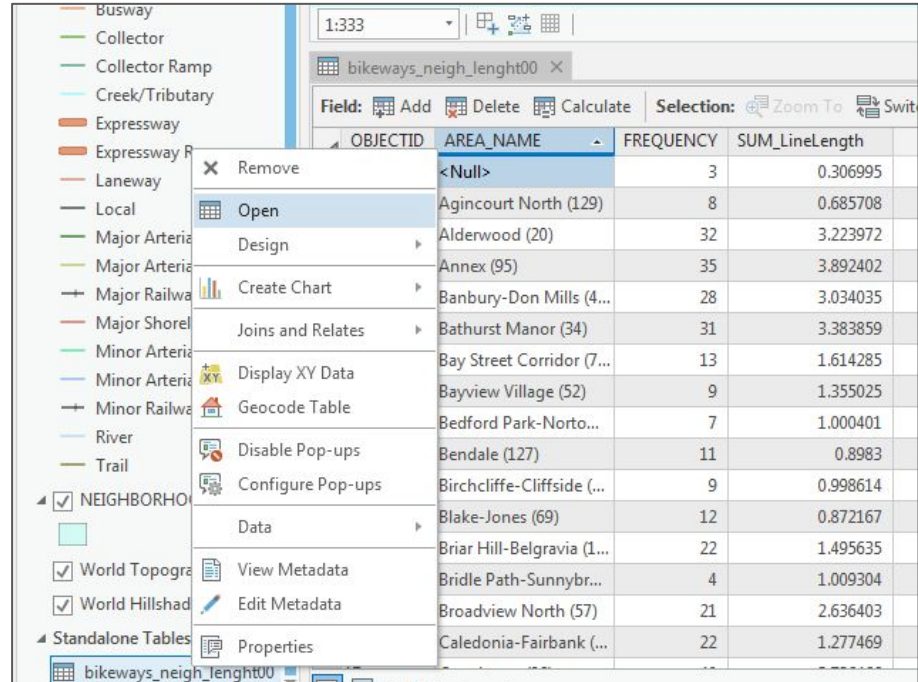
4 - in the “Statistic Type”, select “Sum”

5 - note the name of the “Output Table”

Summarizing statistics

1 - right-click on the resulting table in the “Contents” pane and select “Open”

This table has one entry for each Toronto Neighbourhood. Each entry has the number of “bikeways” segments (FREQUENCY) within the Neighbourhood and a “SUM_LineLength”, which is the total amount of Kilometres of “bikeways” are in that neighbourhood.

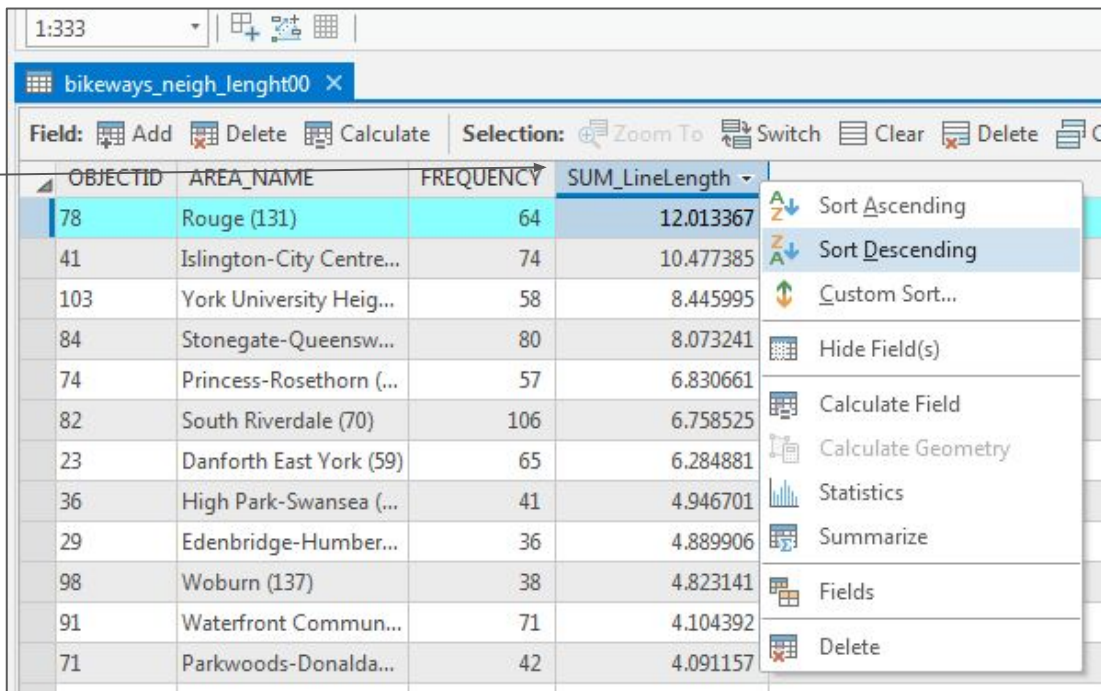


OBJECTID	AREA_NAME	FREQUENCY	SUM_LineLength
<Null>	<Null>	3	0.306995
	Agincourt North (129)	8	0.685708
	Alderwood (20)	32	3.223972
	Annex (95)	35	3.892402
	Banbury-Don Mills (4...)	28	3.034035
	Bathurst Manor (34)	31	3.383859
	Bay Street Corridor (7...)	13	1.614285
	Bayview Village (52)	9	1.355025
	Bedford Park-Norto...	7	1.000401
	Bendale (127)	11	0.8983
	Birchcliffe-Cliffside (...)	9	0.998614
	Blake-Jones (69)	12	0.872167
	Briar Hill-Belgravia (1...)	22	1.495635
	Bridle Path-Sunnybr...	4	1.009304
	Broadview North (57)	21	2.636403
	Caledonia-Fairbank (...)	22	1.277469

Summarizing statistics

1 - right-click on the “SUM_LineLength” column and select “Sort Descending”

You can see that the “Rouge (131)” neighbourhood has the most kilometres of bikeways in Toronto



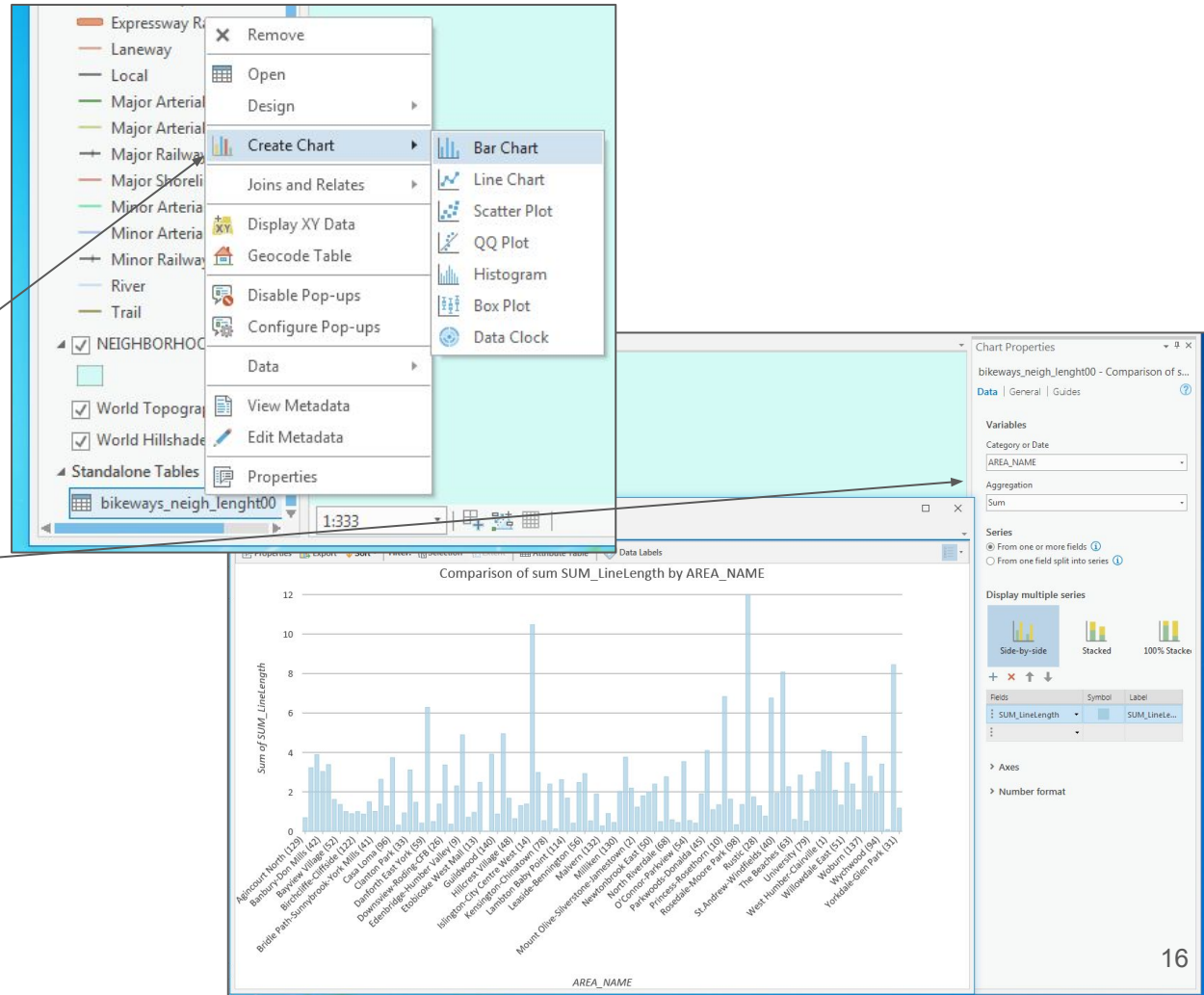
The screenshot shows a data table with the following columns: OBJECTID, AREA_NAME, FREQUENCY, and SUM_LineLength. The table is sorted by SUM_LineLength in descending order. A context menu is open over the SUM_LineLength column, with 'Sort Descending' selected. The table data is as follows:

OBJECTID	AREA_NAME	FREQUENCY	SUM_LineLength
78	Rouge (131)	64	12.013367
41	Islington-City Centre...	74	10.477385
103	York University Heig...	58	8.445995
84	Stonegate-Queensw...	80	8.073241
74	Princess-Rosethorn (...)	57	6.830661
82	South Riverdale (70)	106	6.758525
23	Danforth East York (59)	65	6.284881
36	High Park-Swansea (...)	41	4.946701
29	Edenbridge-Humber...	36	4.889906
98	Woburn (137)	38	4.823141
91	Waterfront Commun...	71	4.104392
71	Parkwoods-Donalda...	42	4.091157

Charts

1 - right-click on the new summary table once again in the “Contents” pane and select “Create Chart” → “Bar Chart”

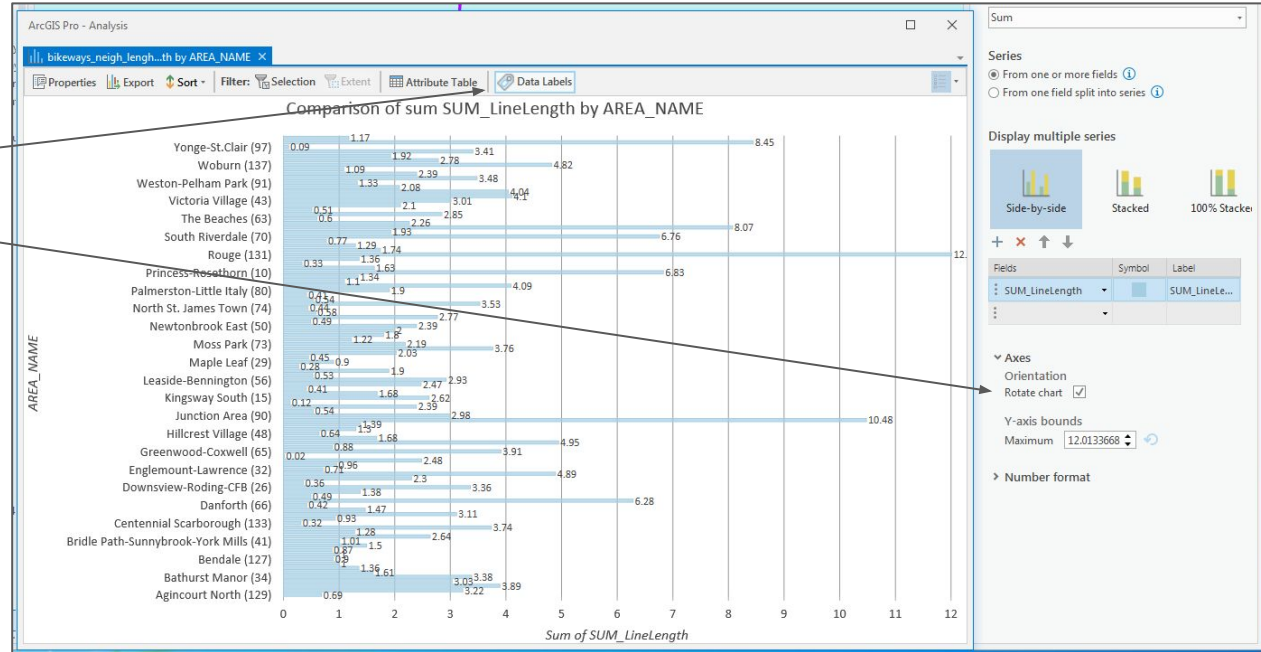
2 - under “Category or Date”, select “AREA_NAME” and under “Aggregation”, select “Sum”



Charts

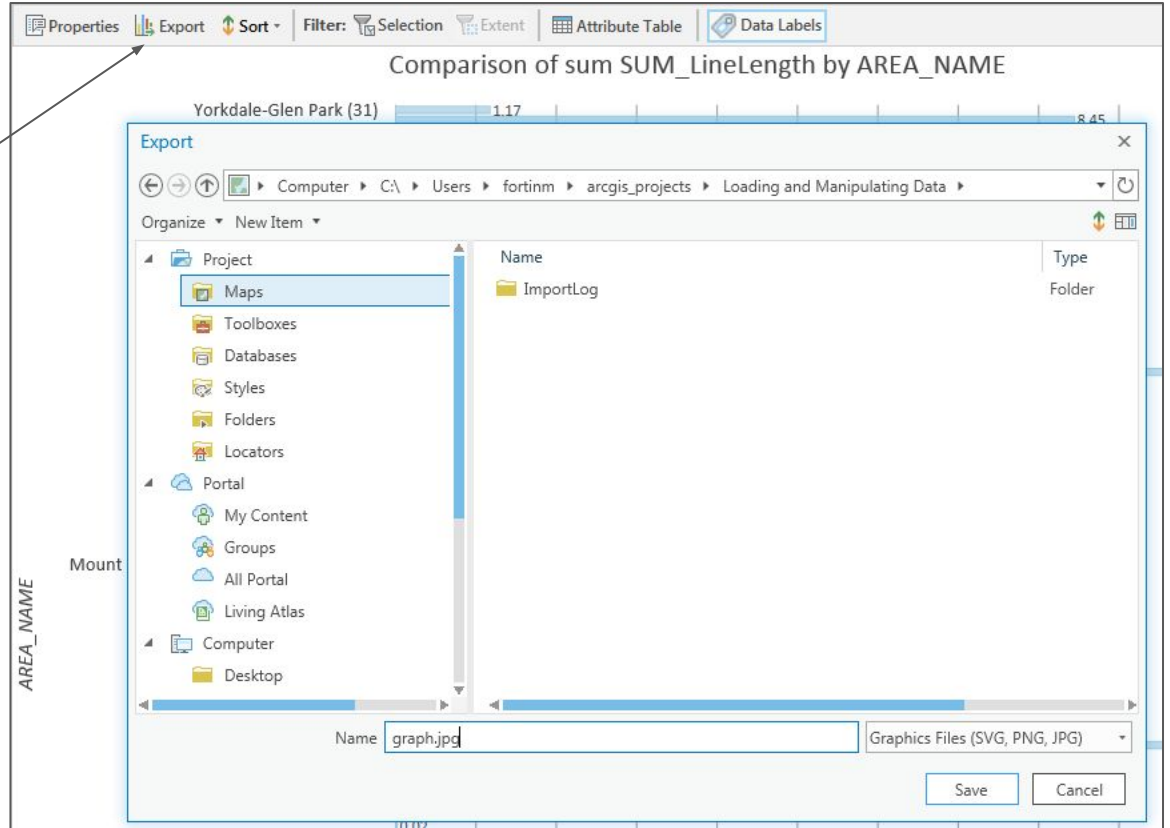
1 - click on “Data Labels”

2 - in the newly created chart, click on the “Axes” option and select “Rotate chart”



Charts

1 - click on "Export" and save your chart

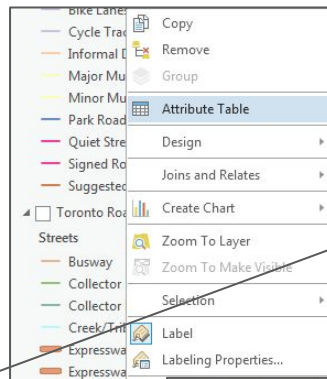


Attribute Joins

1 - in Windows, navigate to the “ArcGISWorkshop” → “data” → “Neighbourhood_Profiles” folder and double-click on the file “2016_neighbourhood_profiles.csv”

2 - right-click on the “NEIGHBORHOODS_WGS84” layer in the “Contents” pane and select “Attribute Table”

3 - compare the two. What might be some of the issues here?*



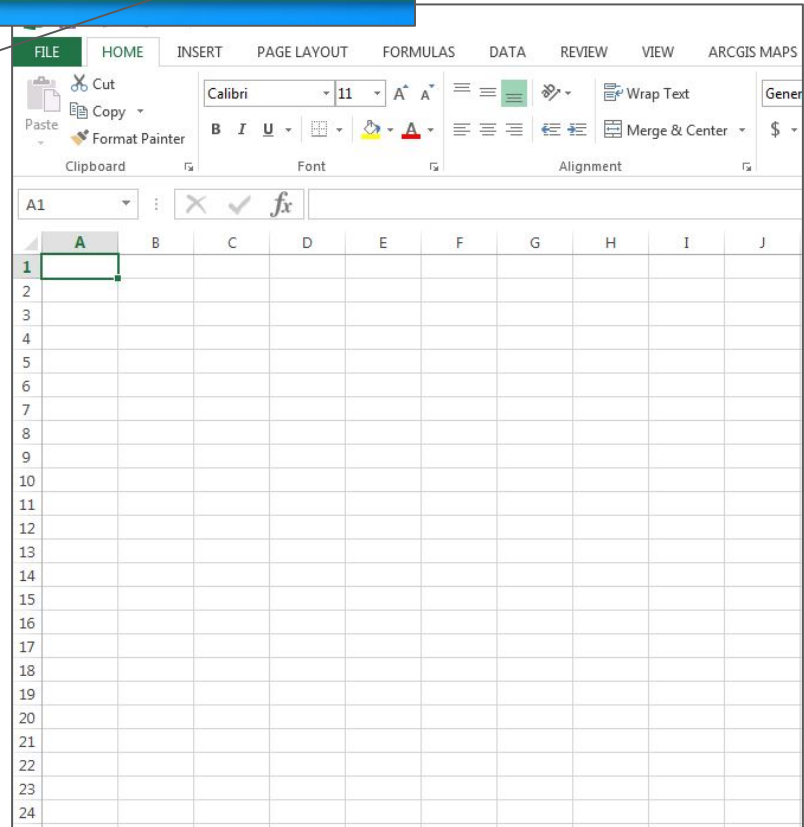
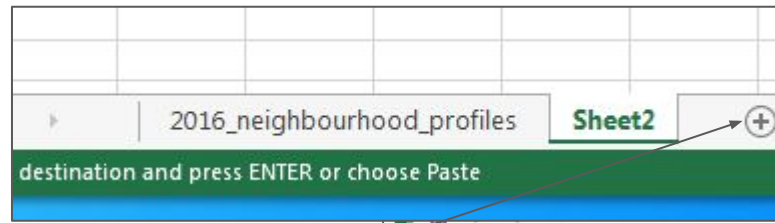
FID	Shape	AREA_S_CD	AREA_NAME	Name
79	Polygon	129	Agincourt North (129)	Agincourt North
80	Polygon	128	Agincourt South-Mal...	Agincourt South-Mal...
86	Polygon	020	Alderwood (20)	Alderwood
56	Polygon	095	Annex (95)	Annex
84	Polygon	042	Banbury-Don Mills (4...	Banbury-Don Mills
85	Polygon	034	Bathurst Manor (34)	Bathurst Manor
93	Polygon	076	Bay Street Corridor (7...	Bay Street Corridor
113	Polygon	052	Bayview Village (52)	Bayview Village
45	Polygon	049	Bayview Woods-Ste...	Bayview Woods-Ste...
114	Polygon	039	Bedford Park-Norto...	Bedford Park-Nortown
68	Polygon	112	Beechborough-Gree...	Beechborough-Gree...
88	Polygon	127	Bendale (127)	Bendale
89	Polygon	122	Birchcliffe-Cliffside (...)	Birchcliffe-Cliffside
94	Polygon	024	Black Creek (24)	Black Creek
102	Polygon	069	Blake-Jones (69)	Blake-Jones
139	Polygon	108	Briar Hill-Belgravia (1...	Briar Hill-Belgravia
116	Polygon	041	Bridle Path-Sunnybr...	Bridle Path-Sunnybr...
29	Polygon	057	Broadview North (57)	Broadview North
120	Polygon	030	Brookhaven-Amesbu...	Brookhaven-Amesbu...
99	Polygon	071	Cabbagetown-South...	Cabbagetown-South...
57	Polygon	109	Caledonia-Fairbank (...)	Caledonia-Fairbank
50	Polygon	096	Casa Loma (96)	Casa Loma
21	Polygon	133	Centennial Scarboro...	Centennial Scarboro...

*Hint - the spreadsheet file has the neighbourhoods listed in individual columns. The GIS file has the neighbourhoods all in one column

Attribute Joins

1 - to begin formatting the spreadsheet in a matching fashion, add a new tab to your spreadsheet by clicking on the “+” icon

2 - return to the “2016_neighbourhood_profiles” tab

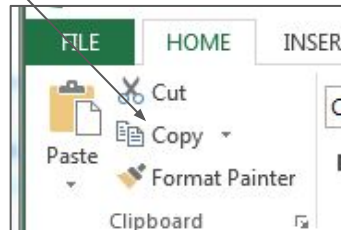
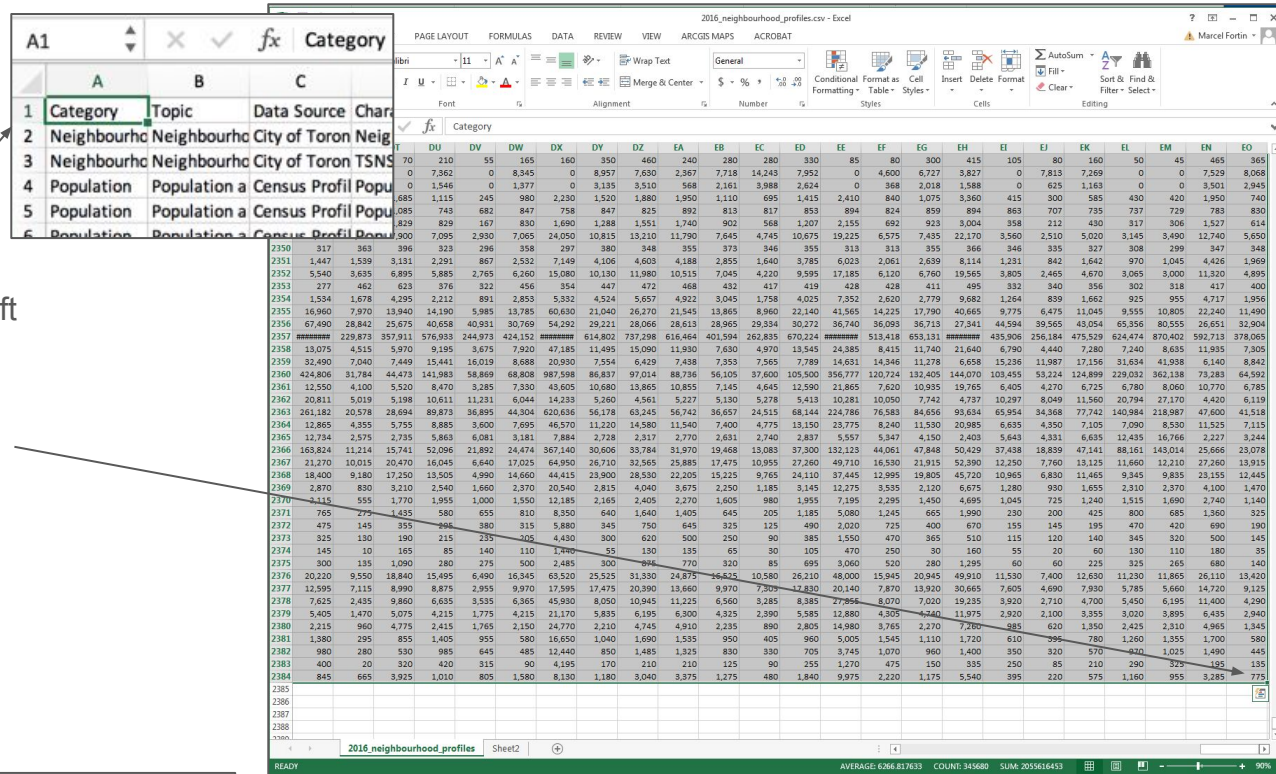


Attribute Joins

1 - click the first cell (A1) at the top-left of the table

2 - while holding down the shift key, click the last cell (EO2384)

3 - click on "Copy"

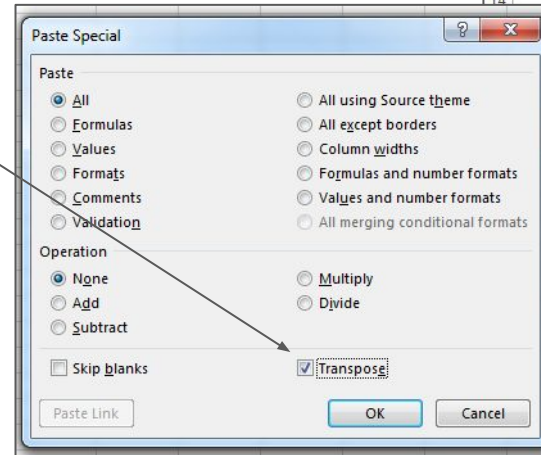
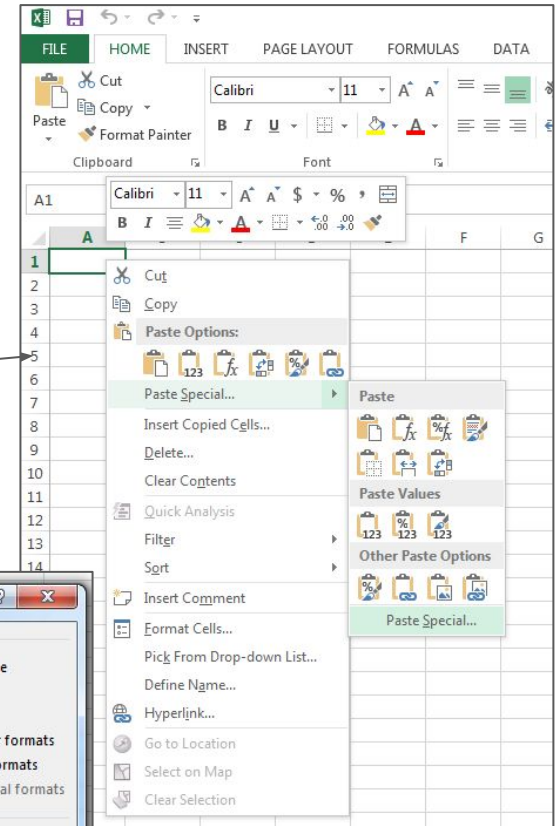
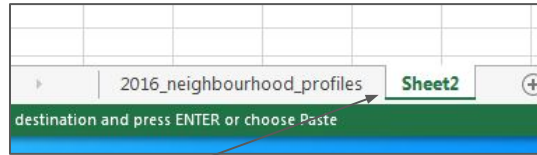


Attribute Joins

1 - click on the “Sheet2” tab

2 - right-click in the top-left (A1) cell, select “Paste Special...” → “Paste Special...”

3 - in the pop-up click to turn on the “Transpose” option and click “OK”



Attribute Joins

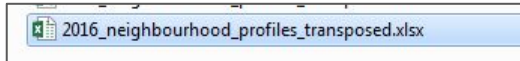
1 - delete the first three lines, and the fifth line of the spreadsheet

2 - you will notice that our spreadsheet now has the neighbourhood identifiers in columns

3 - close the spreadsheet (you can save it if you wish, but a saved version has already been created for you in the same folder called "2016_neighbourhood_profiles_transposed.xlsx"

Category	Neighbourhood	Neighbourhood	Population	Population	Population	Population	Population	Population	Population	Population	Population	Population
City of Toronto	TSNS2020	Population	Population	Population	Total priv	Private dv	Population	Land area	Children (Youth (15-19)	Age chara	Age chara	Age chara
n/a	2,731,571	2,615,060	4.50%	1,179,057	1,112,929	4,334	630.2	398,135	340,270	1,2		
No Design	29,113	30,279	-3.90%	9,371	9,120	3,929	7.41	3,840	3,705			
No Design	23,757	21,988	8.00%	8,535	8,136	3,034	7.83	3,075	3,360			
No Design	12,054	11,904	1.30%	4,732	4,616	2,435	4.95	1,760	1,235			
No Design	30,526	29,177	4.60%	18,109	15,934	10,863	2.81	2,360	3,750			
No Design	27,695	26,918	2.90%	12,473	12,124	2,775	9.98	3,605	2,730			
No Design	15,873	15,434	2.80%	6,418	6,089	3,377	4.7	2,325	1,940			
No Design	25,797	19,348	33.30%	18,436	15,074	14,097	1.83	1,695	6,860			
No Design	21,396	17,671	21.10%	10,111	9,532	4,195	5.1	2,415	2,505			
No Design	13,154	13,530	-2.80%	4,895	4,698	3,240	4.06	1,515	1,635			
No Design	23,236	23,185	0.20%	9,052	8,607	4,209	5.52	4,555	3,210			
NIA	6,577	6,488	1.40%	2,796	2,650	3,614	1.82	1,120	855			

FID	Shape	AREA_S_CD	AREA_NAME	Name
79	Polygon 129		Agincourt North (129)	Agincourt North
80	Polygon 128		Agincourt South-Malvern West	Agincourt South-Malvern West
86	Polygon 020		Alderwood (20)	Alderwood
56	Polygon 095		Annex (95)	Annex
84	Polygon 042		Banbury-Don Mills (42)	Banbury-Don Mills
85	Polygon 034		Bathurst Manor (34)	Bathurst Manor
93	Polygon 076		Bay Street Corridor (76)	Bay Street Corridor
113	Polygon 052		Bayview Village (52)	Bayview Village
45	Polygon 049		Bayview Woods-Steeles	Bayview Woods-Steeles
114	Polygon 039		Bedford Park-Nortown	Bedford Park-Nortown
68	Polygon 112		Beechborough-Greenbrook	Beechborough-Greenbrook
88	Polygon 127		Bendale (127)	Bendale
89	Polygon 122		Birchcliffe-Cliffside	Birchcliffe-Cliffside
94	Polygon 024		Black Creek (24)	Black Creek
102	Polygon 069		Blake-Jones (69)	Blake-Jones
139	Polygon 108		Briar Hill-Belgravia	Briar Hill-Belgravia
116	Polygon 041		Bridle Path-Sunnybrook	Bridle Path-Sunnybrook
29	Polygon 057		Broadview North (57)	Broadview North
120	Polygon 030		Brookhaven-Amesbury	Brookhaven-Amesbury
99	Polygon 071		Cabbagetown-South	Cabbagetown-South
57	Polygon 109		Caledonia-Fairbank	Caledonia-Fairbank
50	Polygon 096		Casa Loma (96)	Casa Loma
21	Polygon 133		Centennial Scarborough	Centennial Scarborough



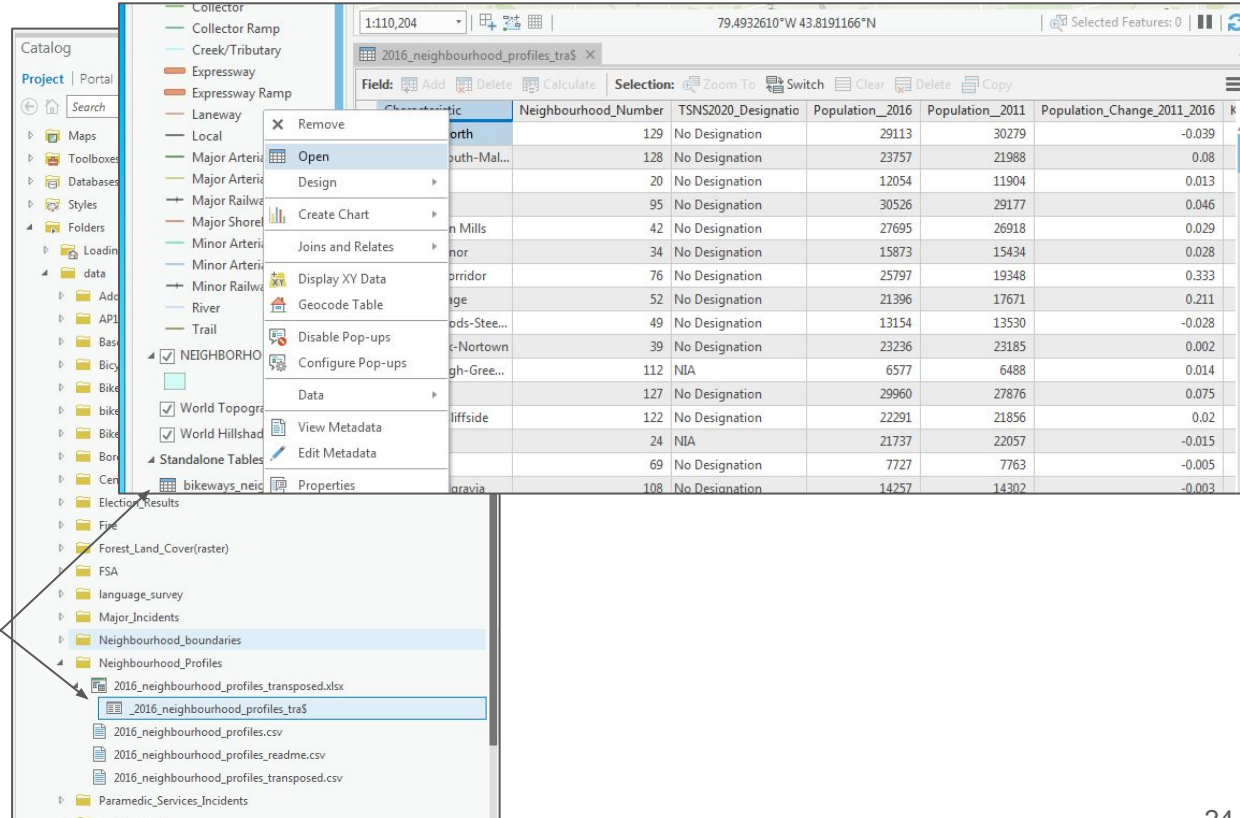
Attribute Joins

1 - In ArcGIS Pro, turn on the “Catalog” pane under the “View” menu

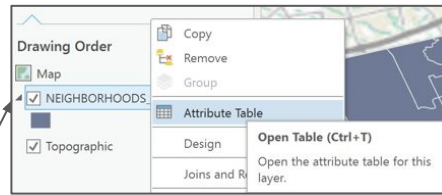
2 - in the “Catalog” pane, navigate to the “Neighbourhood_Profiles” folder

3 - expand the “2016_neighbourhood_profiles_transposed.xlsx” spreadsheet and select and drag into the map, the tab named “_2016_neighbourhood_profiles_tra\$”

4 - right-click on “_2016_neighbourhood_profiles_tra\$” in the “Contents” pane and click on “Open”



Attribute Joins



1 - right-click on the “NEIGHBORHOODS_WGS84” layer and select “Attribute Table” and compare the geography columns between this table and the spreadsheet

Field:	Add	Delete	Calculate	Selection:	Zoom To	Switch
FID	Shape	AREA_S_CD	AREA_NAME			
41	Polygon	001	West Humber-Clairville (1)			
98	Polygon	002	Mount Olive-Silverstone-Jamestown (2)			
7	Polygon	003	Thistletown-Beaumont Heights (3)			
103	Polygon	004	Rexdale-Kipling (4)			
78	Polygon	005	Elms-Old Rexdale (5)			
44	Polygon	006	Kingsview Village-The Westway (6)			
110	Polygon	007	Willowridge-Martingrove-Richview (7)			
58	Polygon	008	Humber Heights-Westmount (8)			
64	Polygon	009	Edenbridge-Humber Valley (9)			
30	Polygon	010	Princess-Rosethorn (10)			
82	Polygon	011	Eringate-Centennial-West Deane (11)			
125	Polygon	012	Markland Wood (12)			

2 - notice that there are similar fields, but no common fields. “AREA_S_CD” in the boundary file is a text field. “Neighbourhood_Number” in the spreadsheet is a number field. ArcGIS Pro will not match these together despite having the same number. The column with the names of the neighbourhoods would not work either because they are not written the same way

Field:	Add	Delete	Calculate	Selection:	Zoom To	Switch
Characteristic	Neighbourhood	TSNS2020_Designation				
West Humber-Clairville	1	No Designation				
Mount Olive-Silverstone-Jamestown	2	NIA				
Thistletown-Beaumont Heights	3	NIA				
Rexdale-Kipling	4	No Designation				
Elms-Old Rexdale	5	NIA				
Kingsview Village-The Westway	6	NIA				
Willowridge-Martingrove-Richview	7	No Designation				
Humber Heights-Westmount	8	Emerging Neighbourhood				
Edenbridge-Humber Valley	9	No Designation				
Princess-Rosethorn	10	No Designation				
Eringate-Centennial-West Deane	11	No Designation				
Markland Wood	12	No Designation				
Etobicoke West Mall	13	No Designation				
Islington-City Centre West	14	No Designation				
Kingsway South	15	No Designation				
Stonegate-Queensway	16	No Designation				

Attribute Joins

There are many ways to tackle this problem, but in this case we will create a new numeric field for our neighbourhood ID in our shapefile

1 - in the "NEIGHBORHOODS_WGS84" attribute table, click on the "Add Field" icon

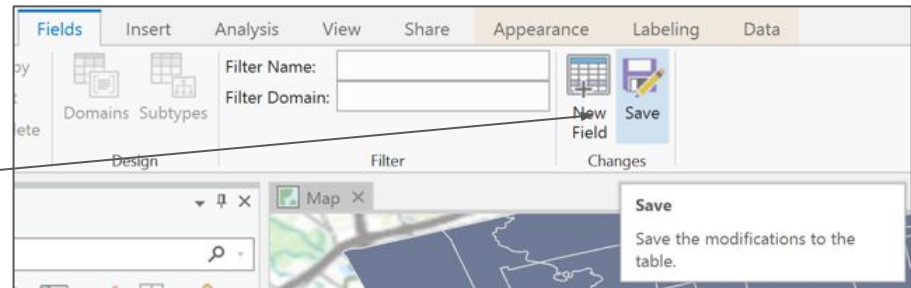


Current Layer		NEIGHBORHOODS_WGS84			
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Field Name	Alias	Data Type	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	FID	FID	Object ID	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Shape	Shape	Geometry	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	AREA_S_CD	AREA_S_CD	Text	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	AREA_NAME	AREA_NAME	Text	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	ID		Double	

Click here to add a new field.

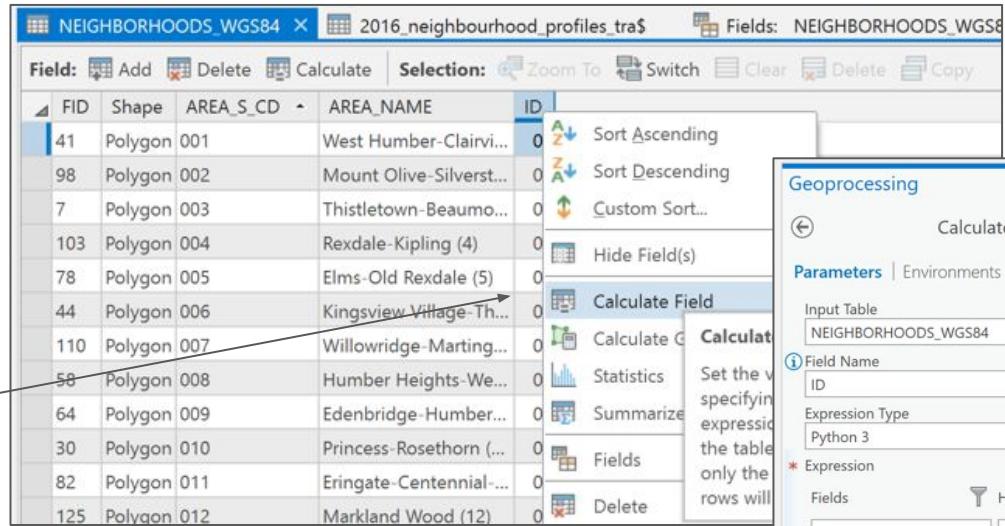
2 - name your field "ID" and select "Double" as the "Data Type"

3 - under the "Fields" menu, click on "Save"

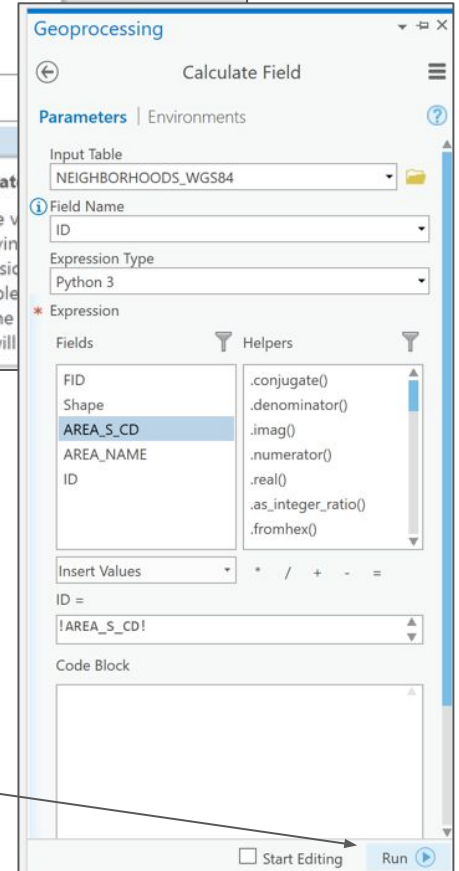


Attribute Joins

1 - go back to the "NEIGHBORHOODS_WGS84" attribute table and right-click on the new "ID" column and select "Calculate Field"



2 - double-click on the "AREA_S_CD" field to populate the "ID =" box to read "!AREA_S_CD!" This operation will convert our text field to a numeric field.



3 - click on Run

Attribute Joins

Our two tables now contain matching columns and we can now join the two layers.

FID	Shape	AREA_S_CD	AREA_NAME	Name	ID
41	Polygon	001	West Humber-Clairvi...	West Humber-Clairvi...	1
98	Polygon	002	Mount Olive-Silverst...	Mount Olive-Silverst...	2
7	Polygon	003	Thistletown-Beaumo...	Thistletown-Beaumo...	3
103	Polygon	004	Rexdale-Kipling (4)	Rexdale-Kipling	4
78	Polygon	005	Elms-Old Rexdale (5)	Elms-Old Rexdale	5
44	Polygon	006	Kingsview Village-Th...	Kingsview Village-Th...	6
110	Polygon	007	Willowridge-Marting...	Willowridge-Marting...	7
58	Polygon	008	Humber Heights-We...	Humber Heights-We...	8
64	Polygon	009	Edenbridge-Humber...	Edenbridge-Humber...	9
30	Polygon	010	Princess-Rosethorn (...)	Princess-Rosethorn	10
82	Polygon	011	Eringate-Centennial-...	Eringate-Centennial-...	11
125	Polygon	012	Markland Wood (12)	Markland Wood	12
32	Polygon	013	Etobicoke West Mall...	Etobicoke West Mall	13
11	Polygon	014	Islington-City Centre...	Islington-City Centre...	14
52	Polygon	015	Kingsway South (15)	Kingsway South	15
4	Polygon	016	Stonegate-Queensw...	Stonegate-Queensway	16

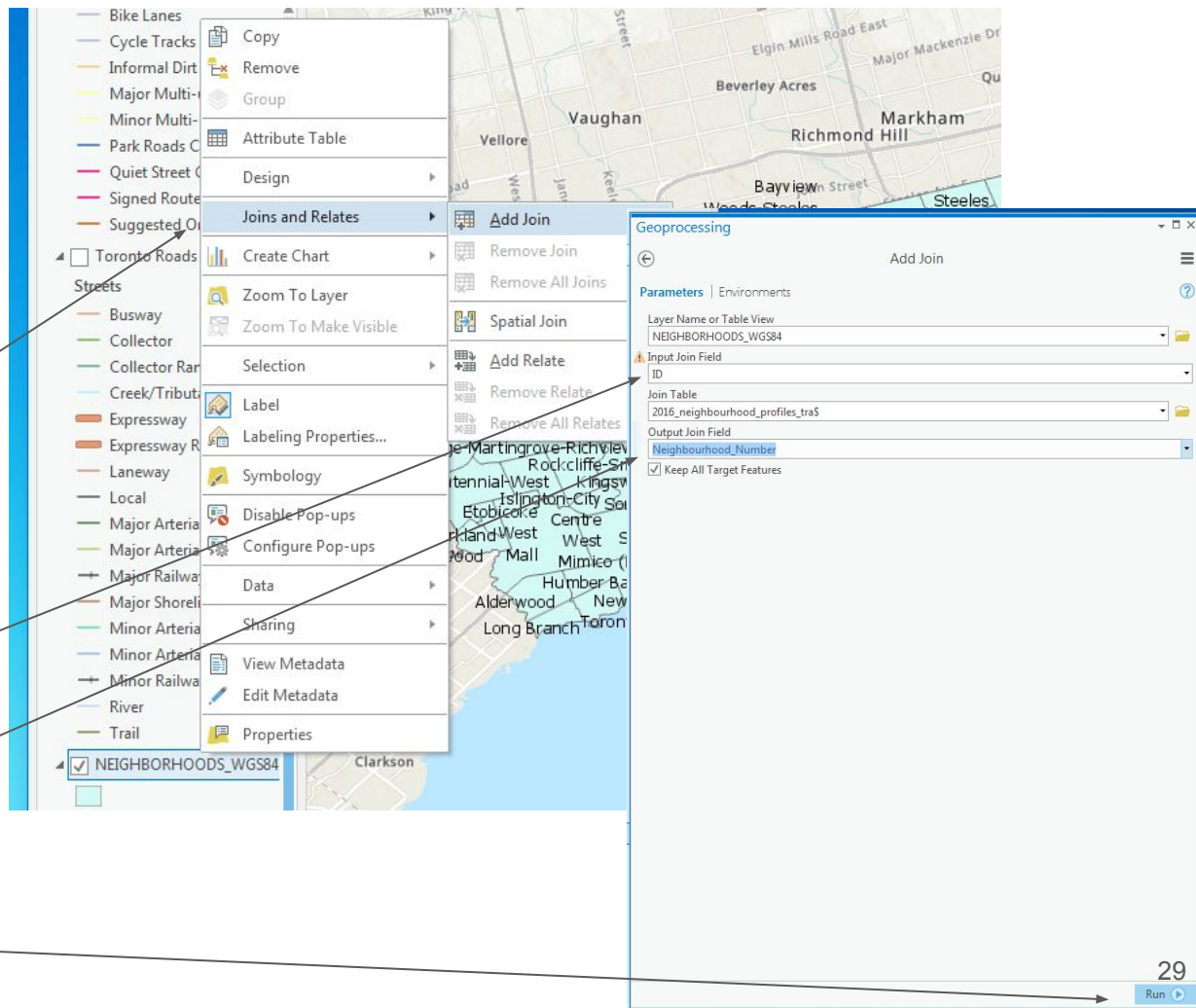
Characteristic	Neighbourhood_Number	TSNS2020_Designati	Population_2016
West Humber-Clairville	1	No Designation	33312
Mount Olive-Silverstone-Jamestown	2	NIA	32954
Thistletown-Beaumont Heights	3	NIA	10360
Rexdale-Kipling	4	No Designation	10529
Elms-Old Rexdale	5	NIA	9456
Kingsview Village-The Westway	6	NIA	22000
Willowridge-Martingrove-Richview	7	No Designation	22156
Humber Heights-Westmount	8	Emerging Neighbour...	10948
Edenbridge-Humber Valley	9	No Designation	15535
Princess-Rosethorn	10	No Designation	11051
Eringate-Centennial-West Deane	11	No Designation	18588
Markland Wood	12	No Designation	10554
Etobicoke West Mall	13	No Designation	11848
Islington-City Centre West	14	No Designation	43965
Kingsway South	15	No Designation	9271
Stonegate-Queensway	16	No Designation	25051

Attribute Joins

1 - right-click on the “NEIGHBORHOODS_WGS84” layer in the “Contents” pane and select “Joins and Relates” → “Add Join”

2 - select “ID” field as the “Input Join Field” from the “NEIGHBORHOODS_WGS84” table, and select the “Neighbourhood_Number” from the “Join Table”, “2016_neighbourhood_profiles_tra\$”

3 - Click on “Run”



Attribute Joins

1 - open the “NEIGHBORHOODS_WGS84” “Attribute Table”. You will notice that now all the data from the spreadsheet are now available for each of the Toronto neighbourhoods.

Now let’s map some of these variables.

2 - right-click on the “NEIGHBORHOODS_WGS84” layer and select “Symbology”

The screenshot displays the QGIS interface. The top panel shows a map of Toronto with various neighbourhoods labeled. The middle panel shows the Attribute Table for the 'NEIGHBORHOODS_WGS84' layer, which is selected in the layer list on the left. The table contains the following data:

Neighbourhood_Number	TSNS2020_Designatio	Population_2016	Population_2011	Population_Change_2011_2016	Knowledge_of
133	No Designation	13362	13093	0.021	
75	No Designation	31340	28349	0.106	
120	No Designation	26984	24770	0.089	
123	No Designation	15935	15703	0.015	
44	NIA	21933	22168	-0.011	
92	No Designation	14133	13743	0.028	
125 N					
90 N					
57 N					
10 N					
68 N					
13 N					

The bottom panel shows the Symbology panel for the 'NEIGHBORHOODS_WGS84' layer, which is currently set to 'Properties'. The Symbology panel includes options for 'Symbology', 'Disable Pop-ups', 'Configure Pop-ups', 'Data', 'Sharing', 'View Metadata', 'Edit Metadata', and 'Properties'. The 'NEIGHBORHOODS_WGS84' layer is highlighted in the layer list on the left.

Choropleth Mapping

1 - in the “Symbology” popup window, select “Graduated Colors” under “Primary symbology”

2 - select “Population_2016” as the “Field”

3 - select “Natural Breaks (Jenks)” as “Method”

4 - choose a “Color scheme”

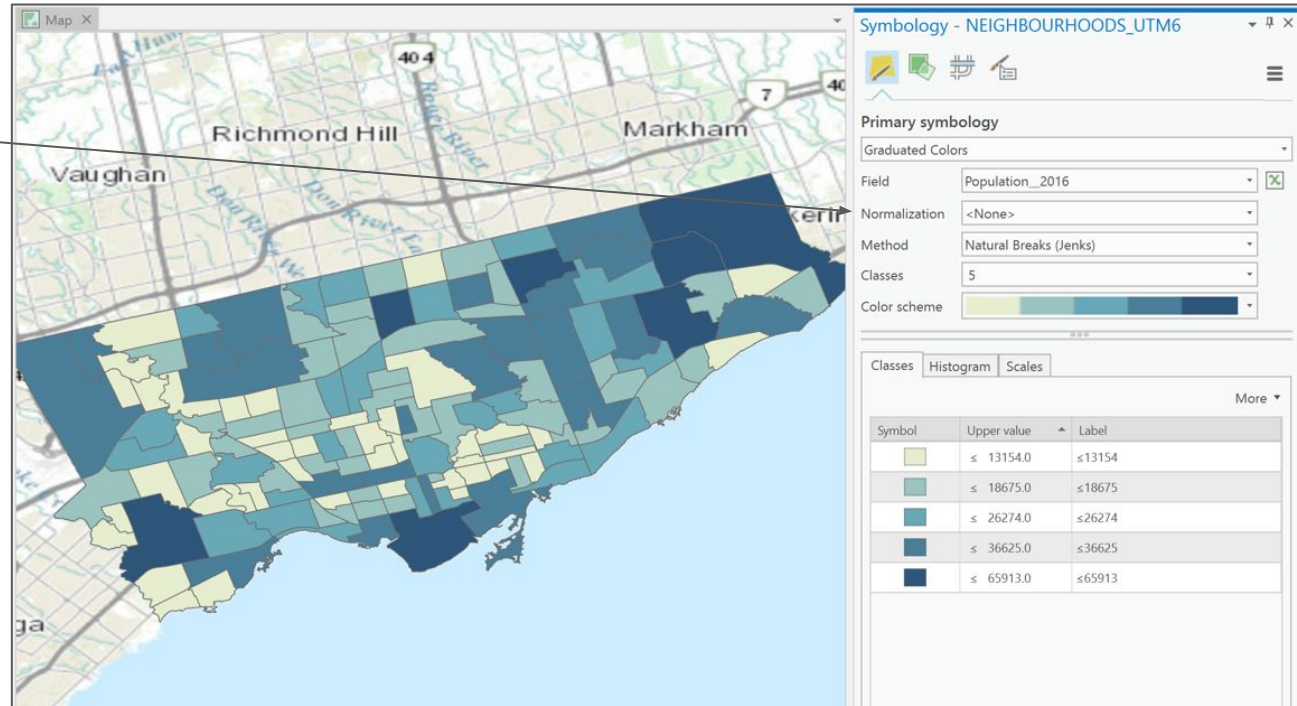
5 - Examine the resulting map

The screenshot shows the Symbology popup window for a layer named 'NEIGHBOURHOODS_UTM6'. The 'Primary symbology' is set to 'Graduated Colors'. The 'Field' is 'Population_2016', 'Normalization' is '<None>', 'Method' is 'Natural Breaks (Jenks)', and 'Classes' is '5'. A color scheme is selected, and a 'Classes' table is visible at the bottom.

Symbol	Upper value	Label
	≤ 13154.0	≤13154
	≤ 18675.0	≤18675
	≤ 26274.0	≤26274
	≤ 36625.0	≤36625
	≤ 65913.0	≤65913

Choropleth Mapping

Since we have not “normalized” our data, what does this map really expressing since we are comparing just population numbers?

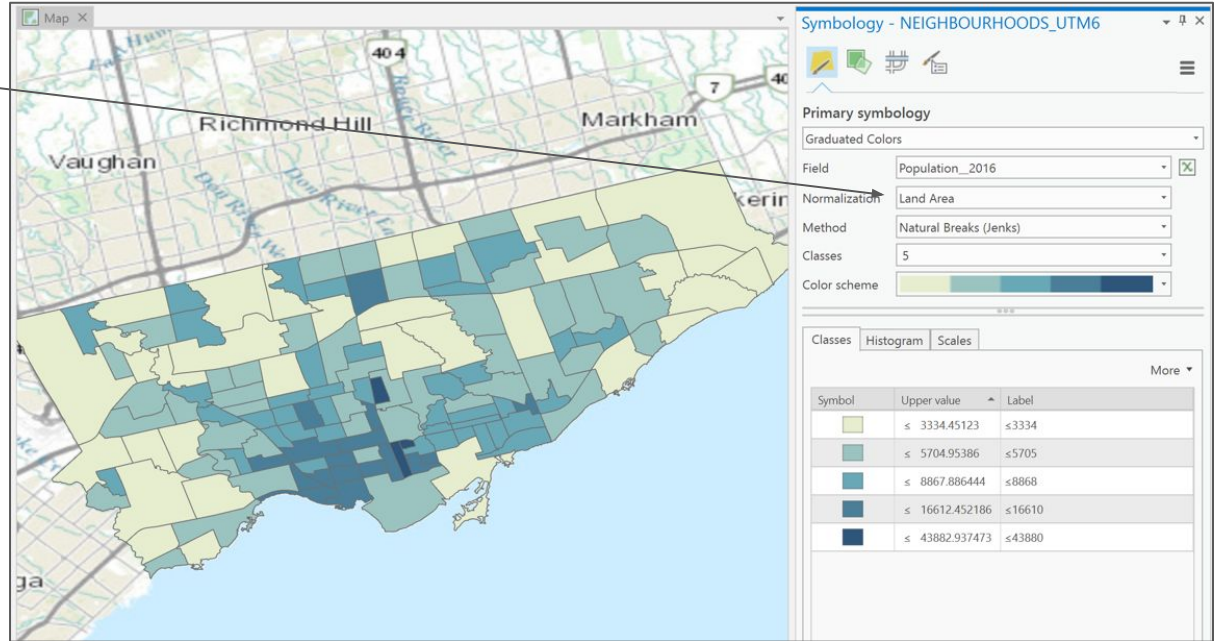


Choropleth Mapping

1 - Normalize your data using the field “Land Area”

2 - This now gives us population density

3 - “Natural Breaks” group data into natural groups within the data range. Using this method, features are divided into classes where there are relatively large differences in values. Since the least populated neighbourhood in Toronto is about 10% of the most populated one, this is a good starting point to classify our data.

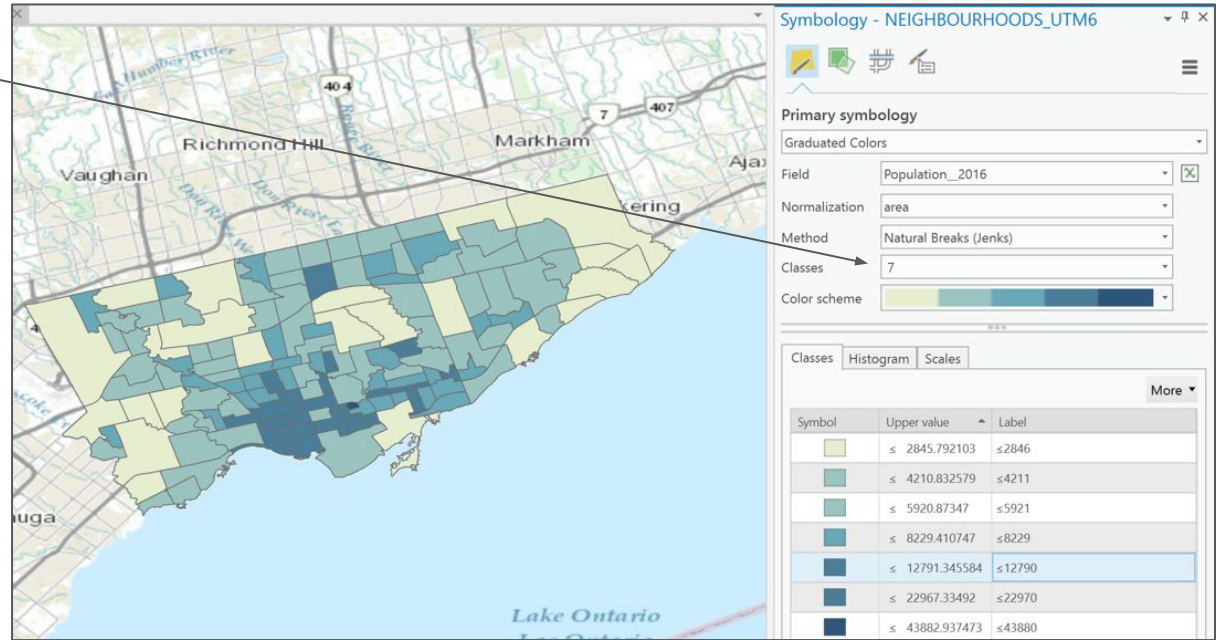


Choropleth Mapping

1 - change the number of “Classes” to “7”

You can see that this provides a little more precision to demonstrate where the highest densities are located.

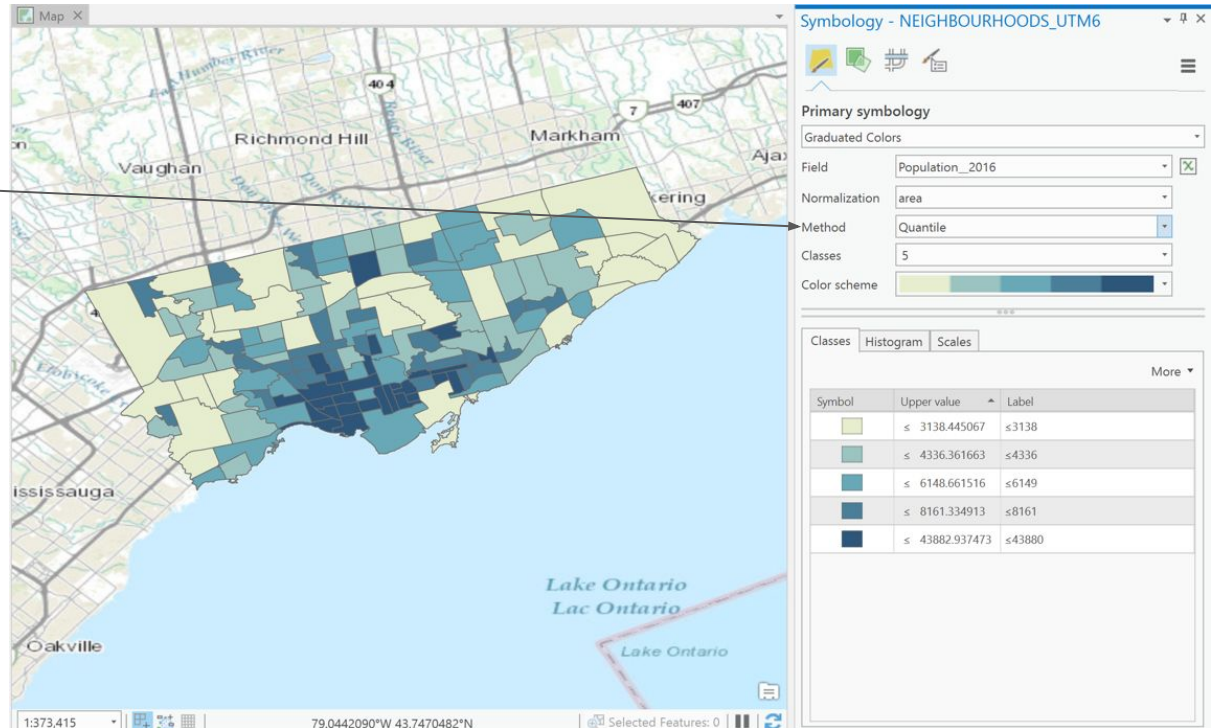
2 - Return the “Classes” to “5”



Choropleth Mapping

1 - Change the “Method” for classification to “[Quantile](#)”

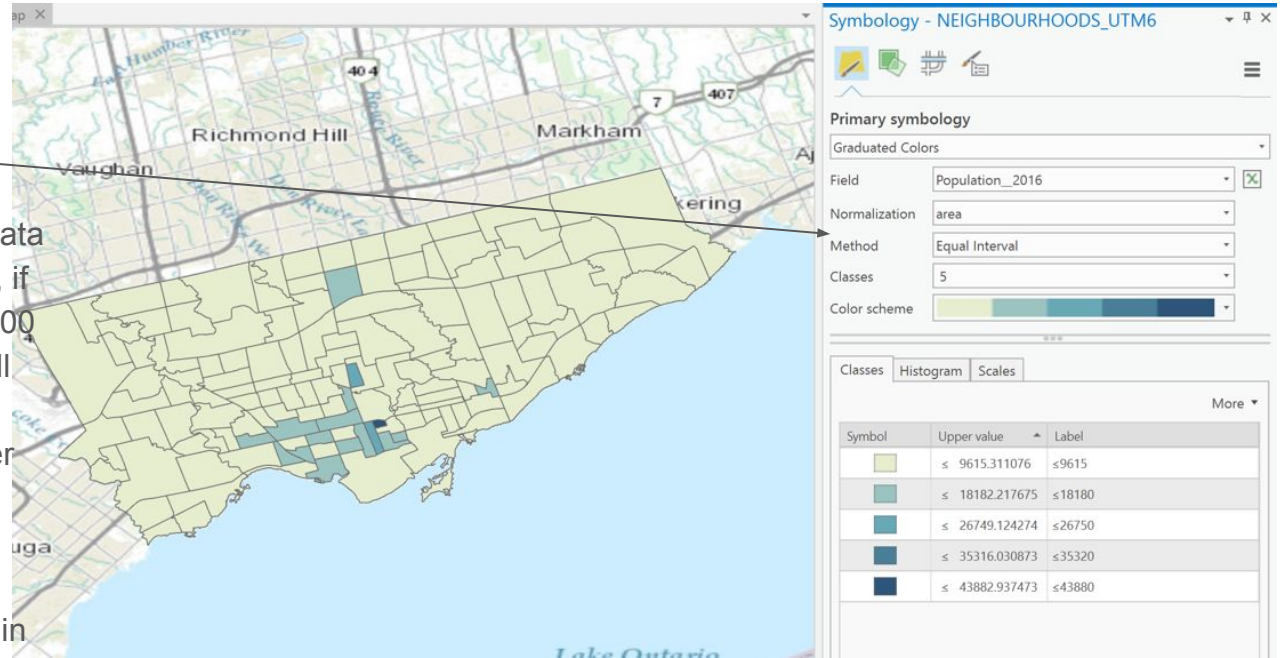
Quantile distributes evenly the number of features (or entries in the attribute table) within the number of classes regardless of the jumps in values. Best suited for linear data, this is not a particularly good choice for Toronto’s big differences in population and density across all of its geography.



Choropleth Mapping

1 - Change the “Method” for classification to “[Equal Interval](#)”

Equal Interval divides the attribute data into equal sub-ranges. For example, if you have values ranging from 0 to 100 and you specify 5 ranges, values will vary from 0-25, 26-50, 51-75 and 76-100. Unlike quantiles, the number of features within a class will differ. Because the density of Toronto’s population is mostly in the southern core, most values end up displayed in few classification colours.



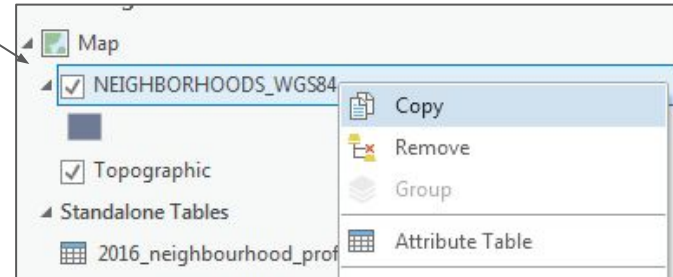
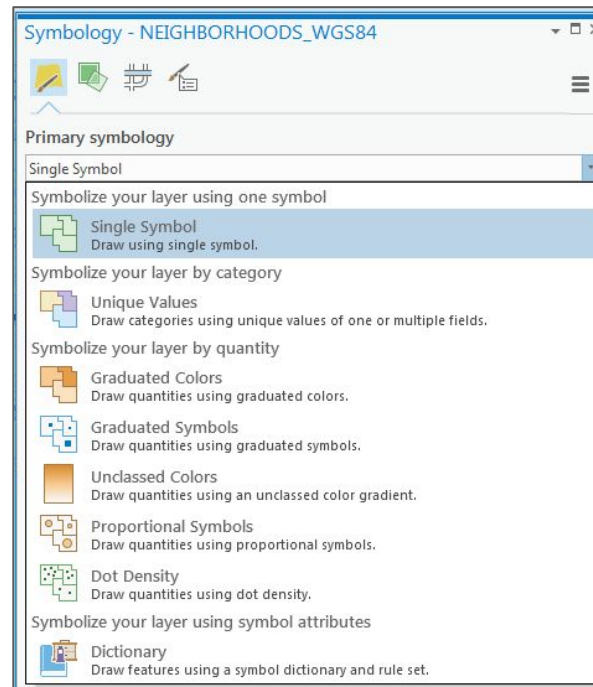
Graduated Symbols

1 - return your map to “Single Symbol” classification under the “Primary symbology” option

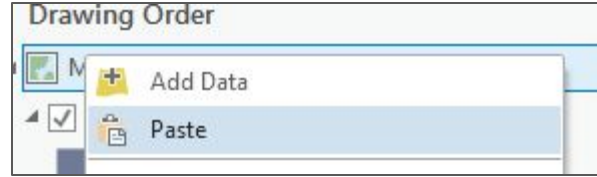
2 - right-click on the “NEIGHBORHOODS_WGS84” layer in the “Contents” pane and select “Copy”

Graduated symbols show quantitative differences between mapped features by varying the size of symbols. Data are classified into ranges that are each assigned a symbol size to represent the range. See

<https://pro.arcgis.com/en/pro-app/help/mapping/layer-properties/graduated-symbols.htm>

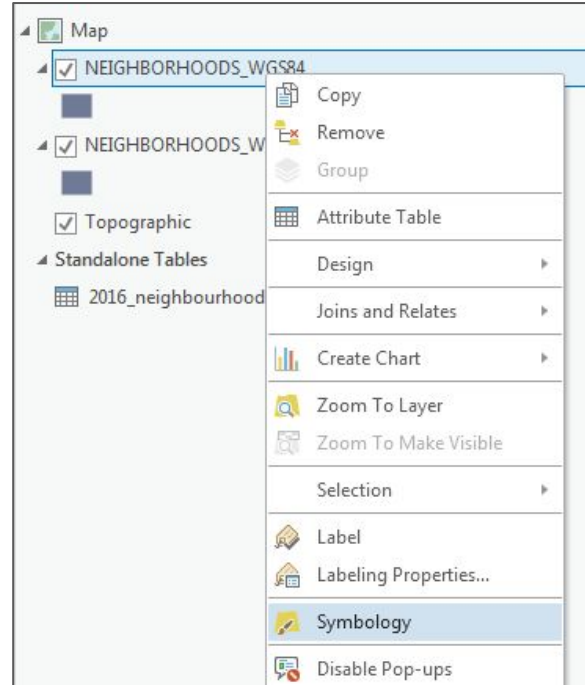


Graduated Symbols



1 - right-click on the "Map" in the "Contents" pane and select "Paste"

2 - right-click on the top-resulting "NEIGHBORHOODS_WGS84" layer in the "Contents" pane and select "Symbology"

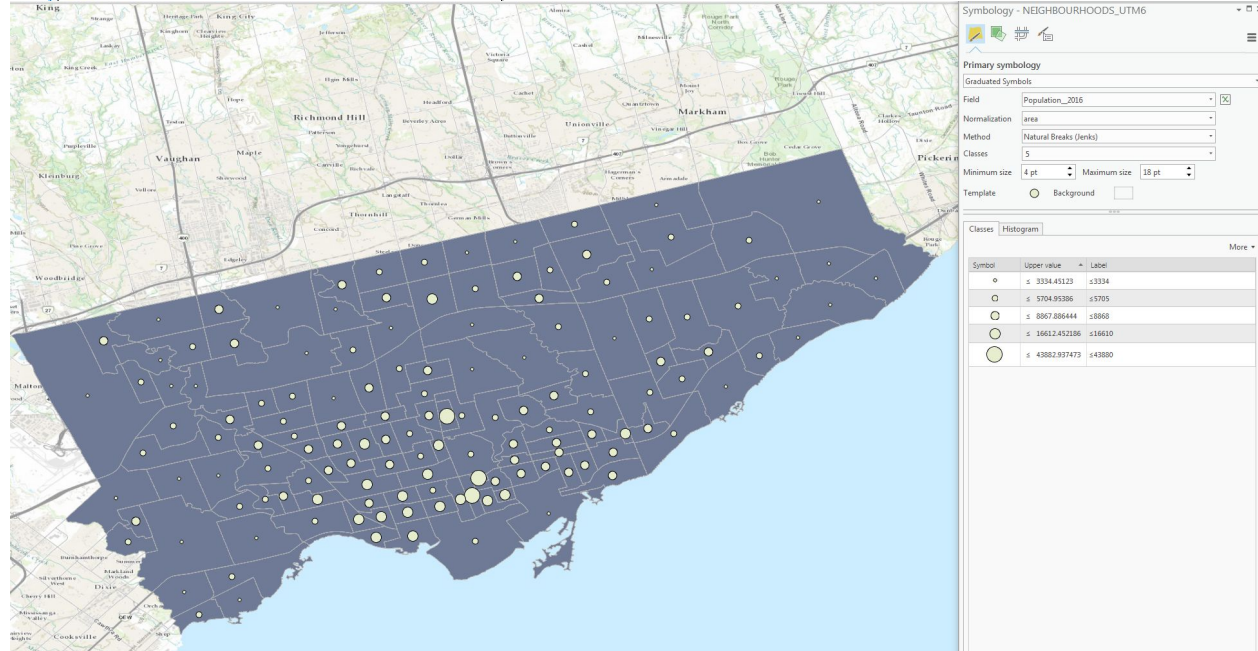
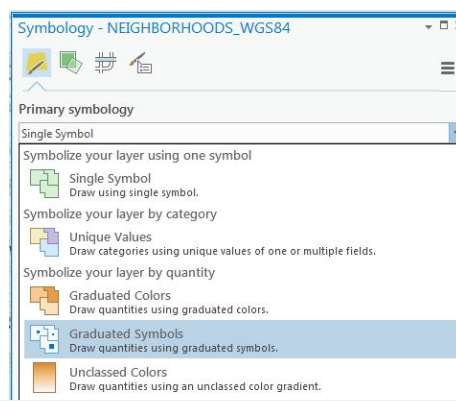


Graduated Symbols

1 - in the “Symbology” popup window, select “Graduated Symbols”.

[Graduated Symbols](#) show quantitative differences between features by varying the size of the symbols.

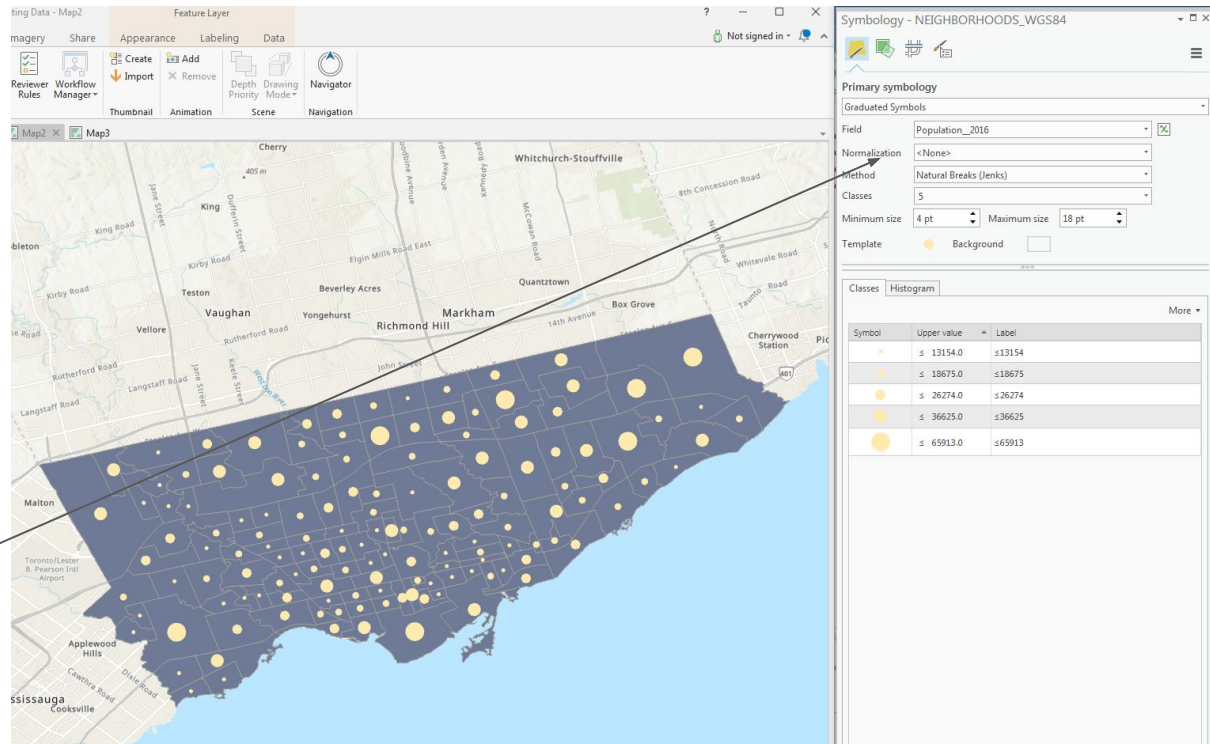
2 - use “Population_2016 for the “Field” and normalize by “area” and play around with different classification “Methods”; “Natural Breaks”, “Quantile” and “Equal Interval” and with different “Classes” 5, 6 or 7.



Graduated Symbols

Graduate colors do not work well with raw population numbers. However, graduated symbols do work well with raw populations.

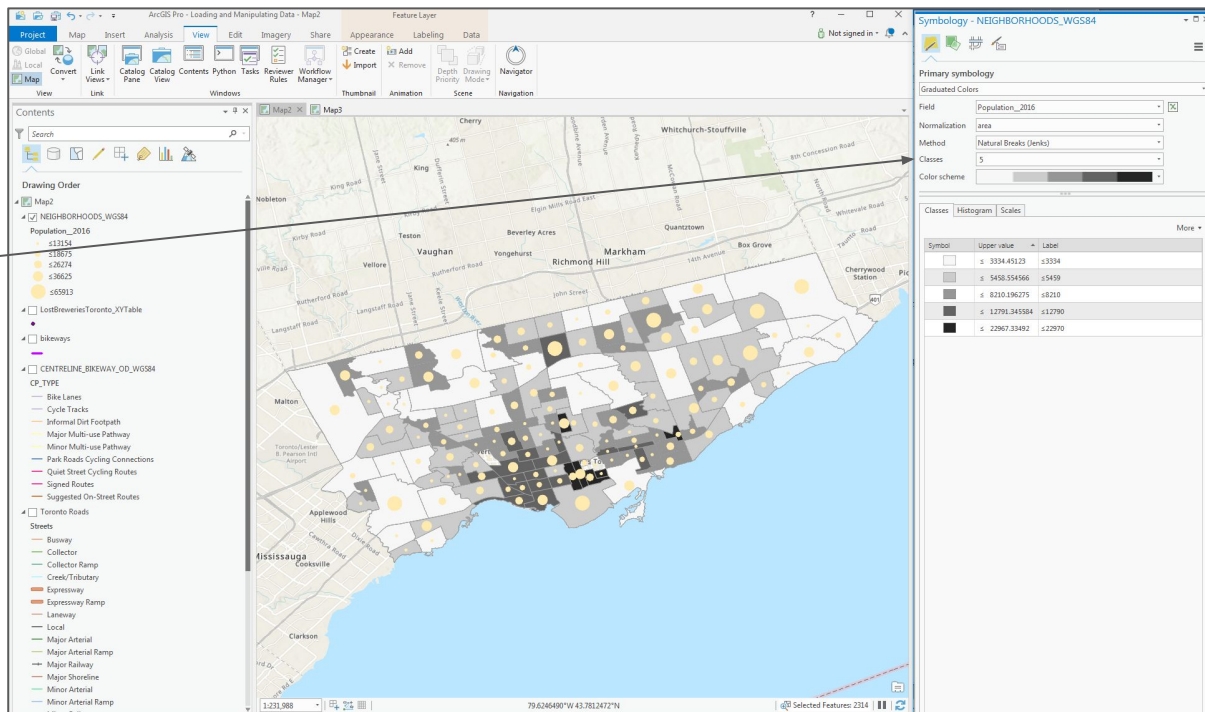
1 - change the “Normalization” to your symbology for your “Graduated Symbols” to “<None>”



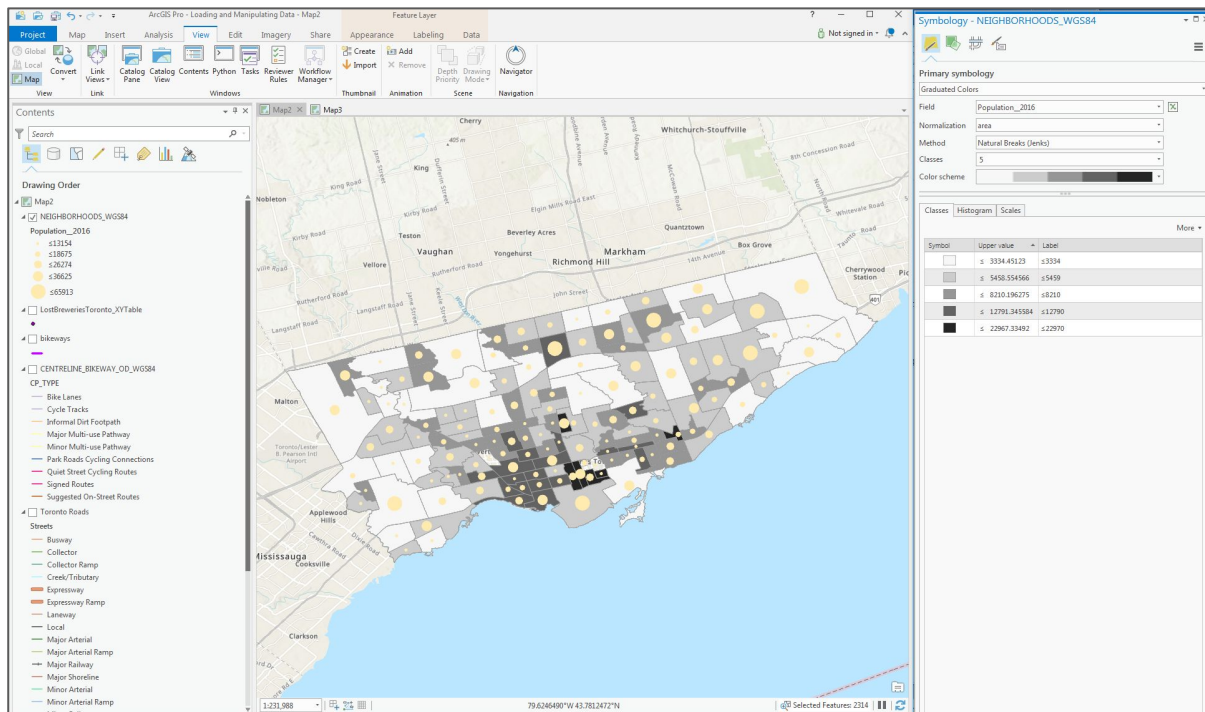
Graduated Symbols

1 - change the “Symbology” of the second copy of “NEIGHBORHOODS_WGS84” to “Graduated Colors” with the 2016 population normalized by area using the “Natural Breaks (Jenks)” “Method”

Our resulting map is interesting because it allows for displaying both full population numbers and the population density at the same time.



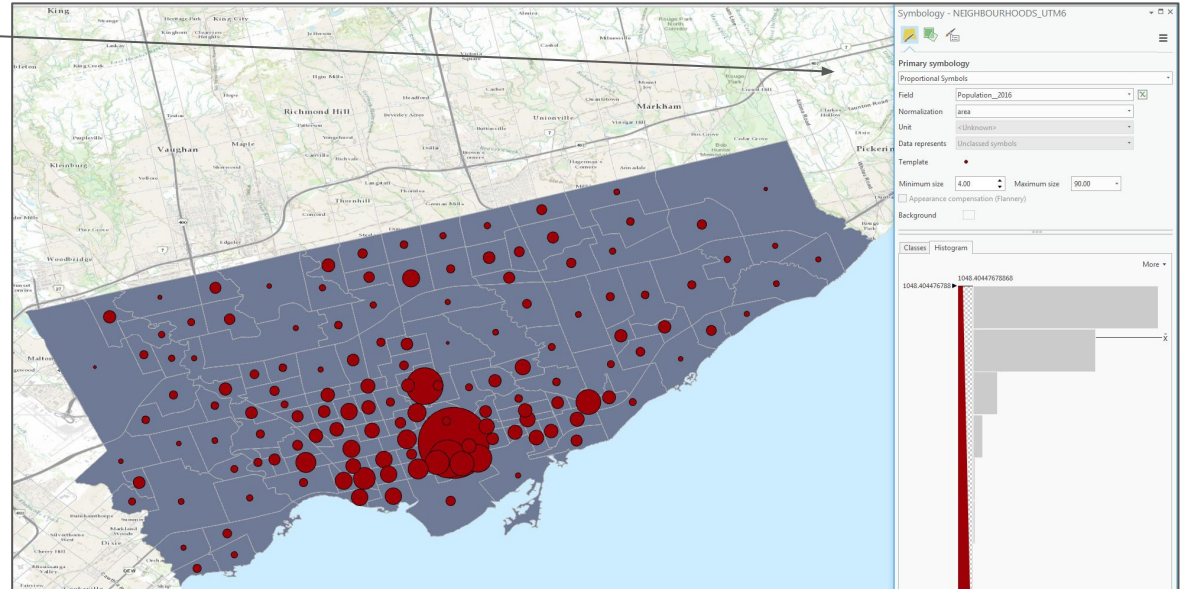
Graduated Symbols



Proportional Symbols

1 - Return to “Single Symbol” for the second neighbourhood layer and change the “Primary symbology” to “Proportional Symbols” on the other

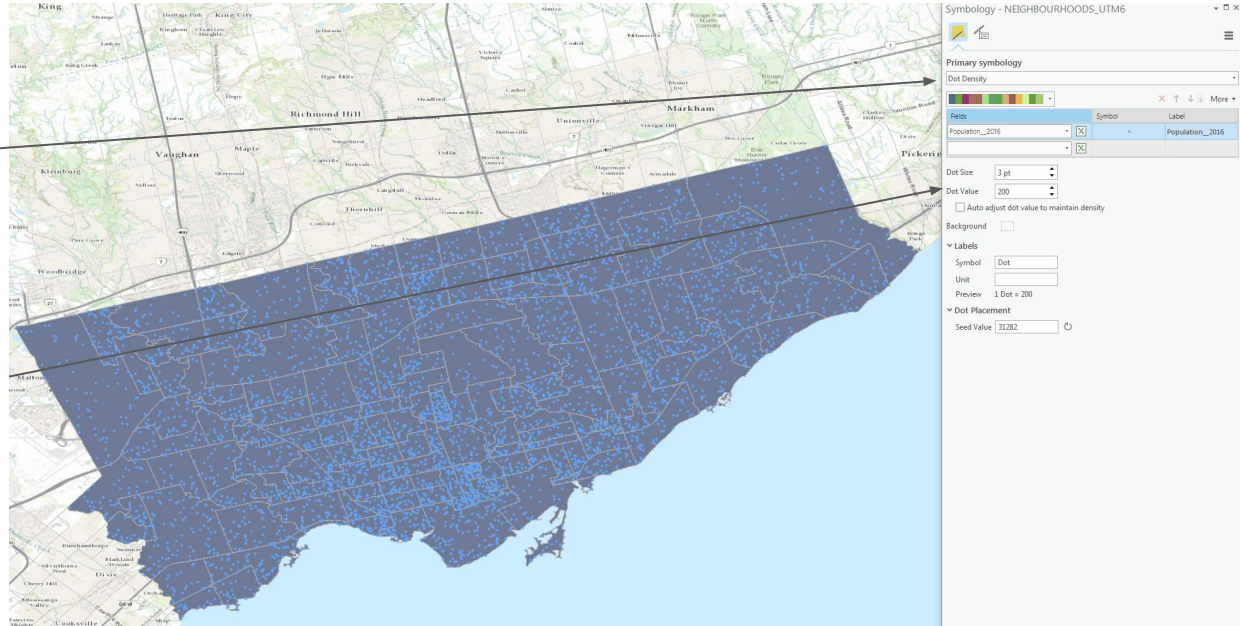
Proportional Symbols are used to show relative differences in quantities among features. Unlike graduated symbols, proportional symbols represent quantitative values as a series of unclassed symbols, sized according to each specific value.



Dot Density

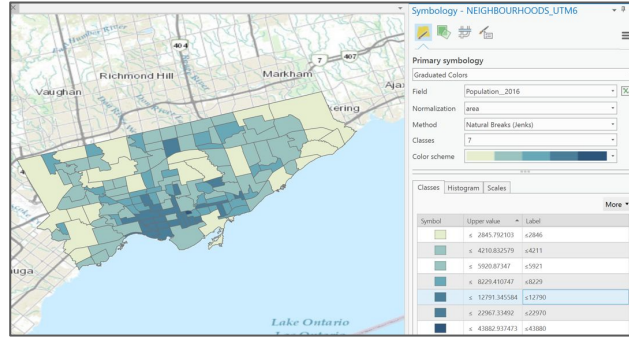
1 - change the “Primary Symbology” to “Dot Density” and select “Population_2016” as the Field to represent

2 - Change around the values for the “Dot Size” and the “Dot Value”. “Dot Value” in this case means the number of people the dots represent.

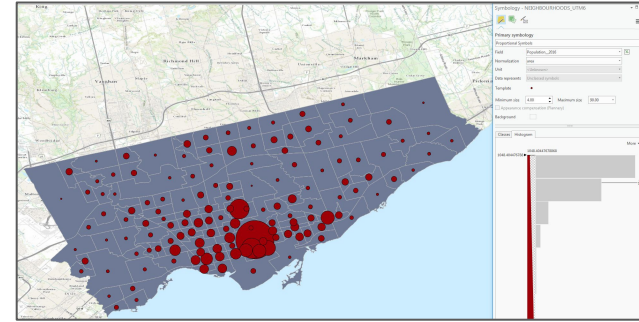


Discussion

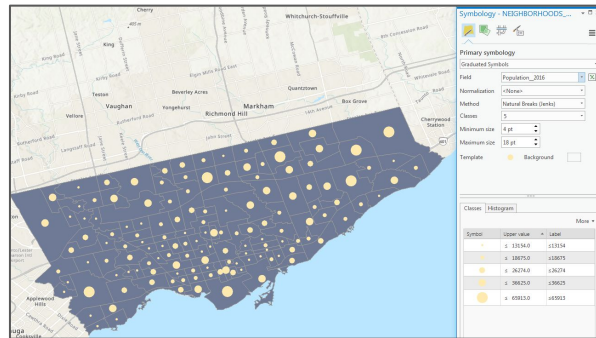
In your estimation, which better represents the population density of the City of Toronto? Graduated Colours, Graduated Symbols, Proportional Symbols or Dot Density?



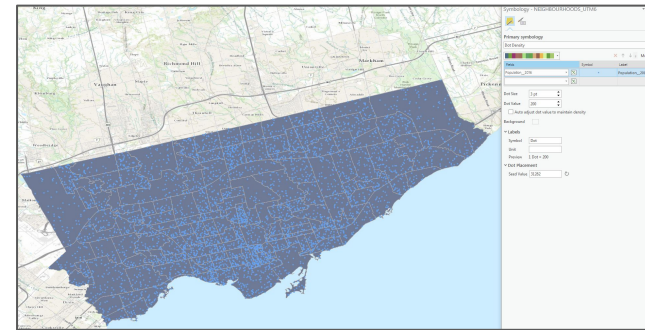
Graduated Colours



Proportional Symbols



Graduated Symbols

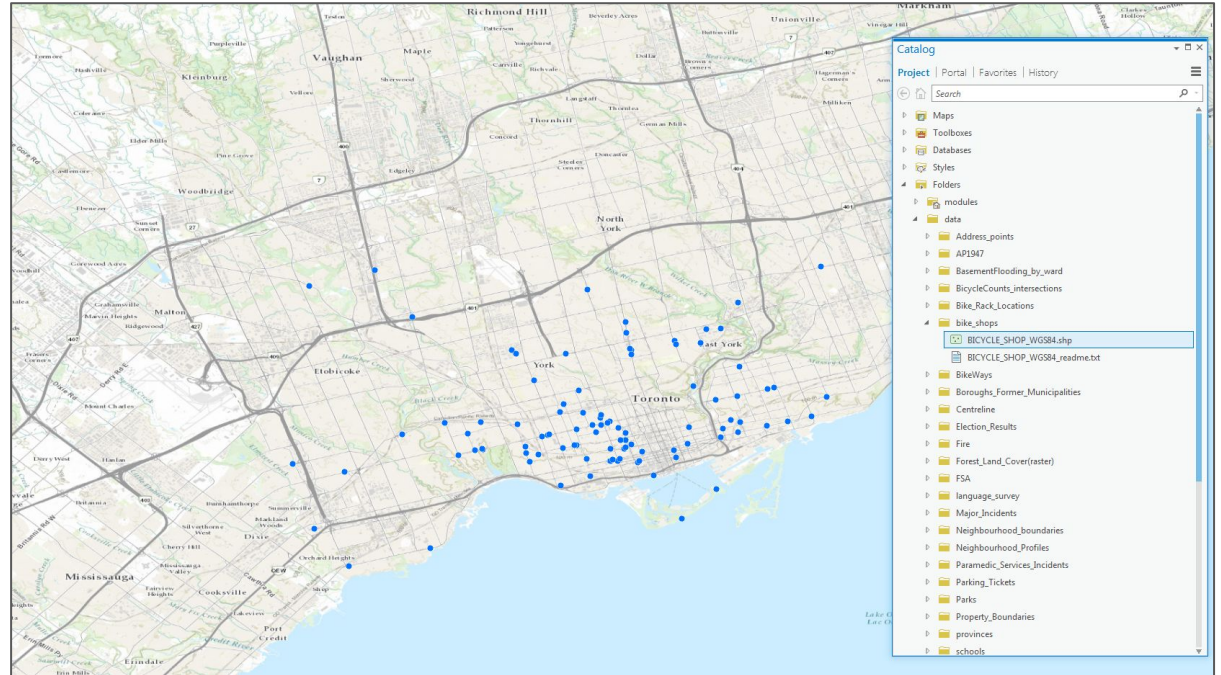


Dot Density

Solving Problems with GIS

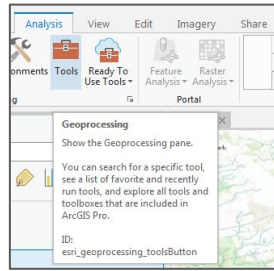
Problem: how do we find an ideal location to set up a new bicycle shop in Toronto where there are no established stores, but within a short distance of bicycle traffic in Toronto?

1 - In a new map, start by loading the “BICYCLE_SHOP_WGS84.shp” shapefile from the “bike_shops” folder

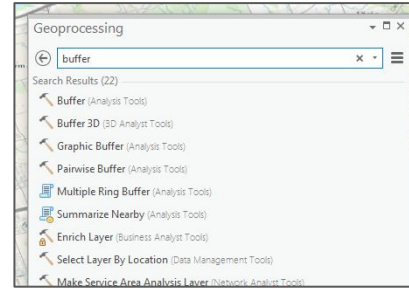


Buffering

1 - using the “Analysis” menu, click on “Tools”

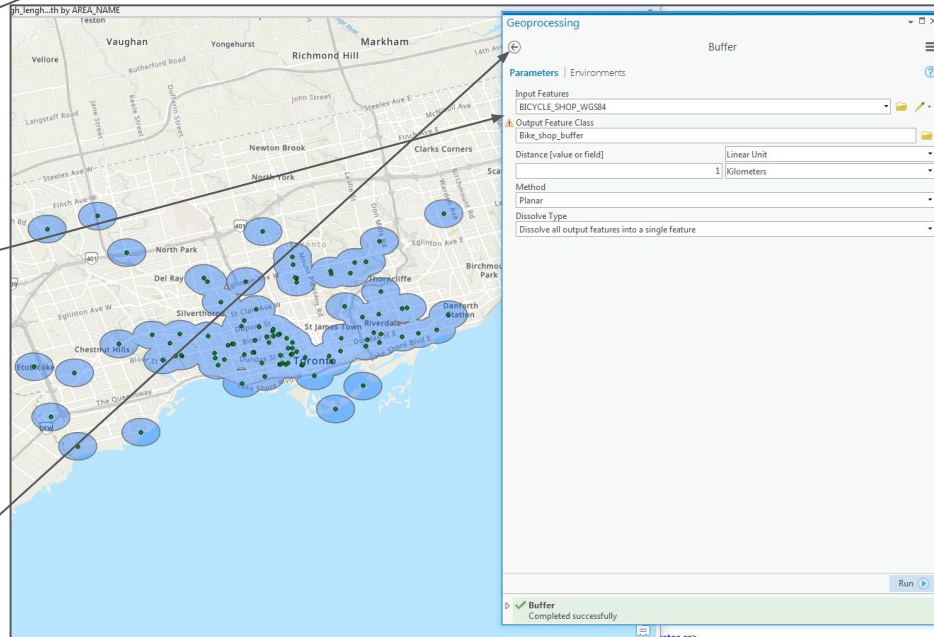


2 - in the “Geoprocessing” popup, type in “buffer” to find the “Buffer” tools



3 - click on “Buffer (Analysis Tools)”

4 - provide a name to the resulting buffer layer “Bike_shop_buffer” select a distance of 1 KM buffer and select “Dissolve all output features into a single feature” option for the “Dissolve Type”



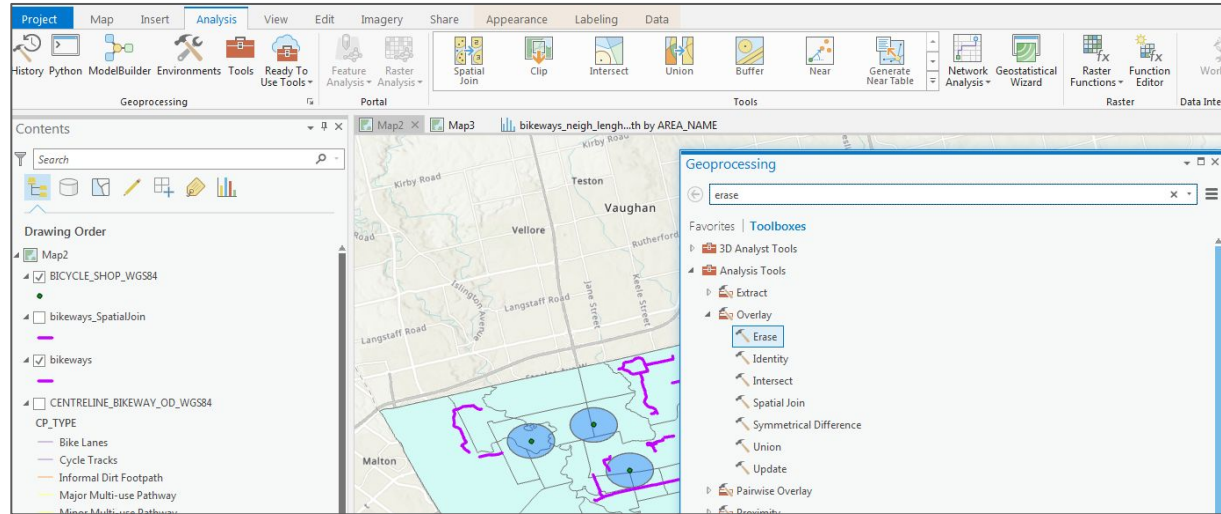
5 - click on “Run” and return to the main “Geoprocessing” window by clicking on the back arrow

Erase

Our buffer represents areas we do not want to build a new bike shop in since the areas are already serviced. We need to “erase” these from our possible locations.

1 - in the “Geoprocessing” window search box, type “erase”

2 - click on the “Erase” toolbox

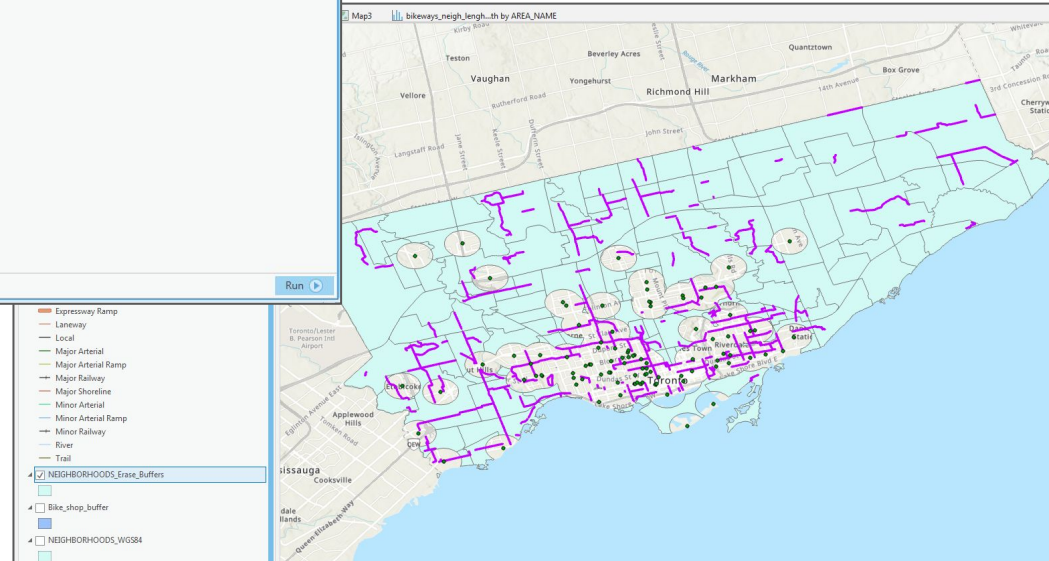
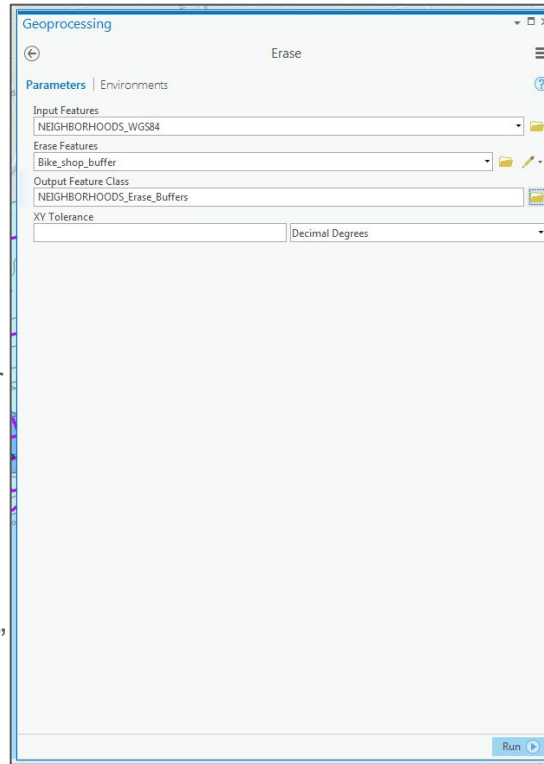


Erase

1 - your “Input Features” are the “NEIGHBOURHOODS_WGS84” layer from which we want to erase the buffer we just created “Bike_shop_buffer”

2 - provide a name from the resulting neighbourhoods “Output Feature Class” “NEIGHBOURHOODS_Erase_Buffers”

3 - click on “Run”

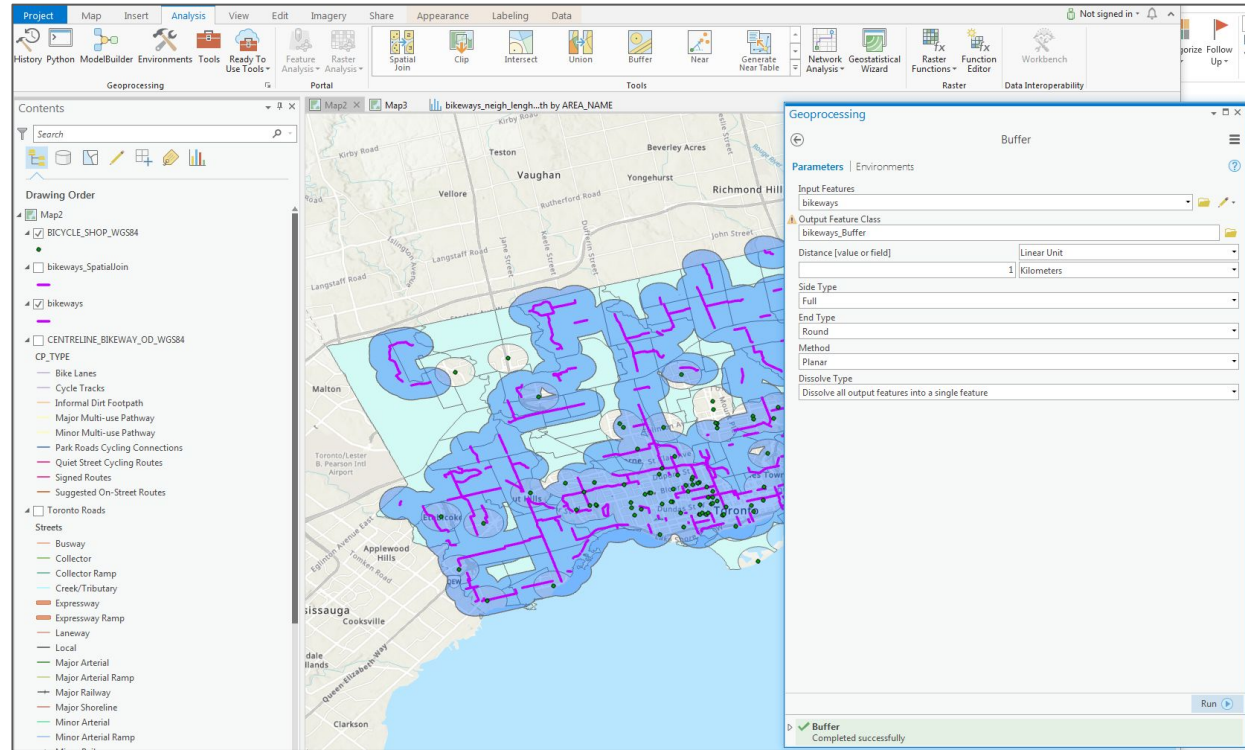


Buffering Lines

We now want to find areas that are within 1KM of our “bikeways” features created earlier. To accomplish this, we will create a new buffer, but we will not delete from this one, we will instead “clip” out our city layer from our resulting buffer.

1 - in the “Geoprocessing” popup, search for the “buffer” tool again, but this time build a buffer of 1 km around all bikeways features

2 - name your “Output Feature Class”, “bikeways_Buffer”



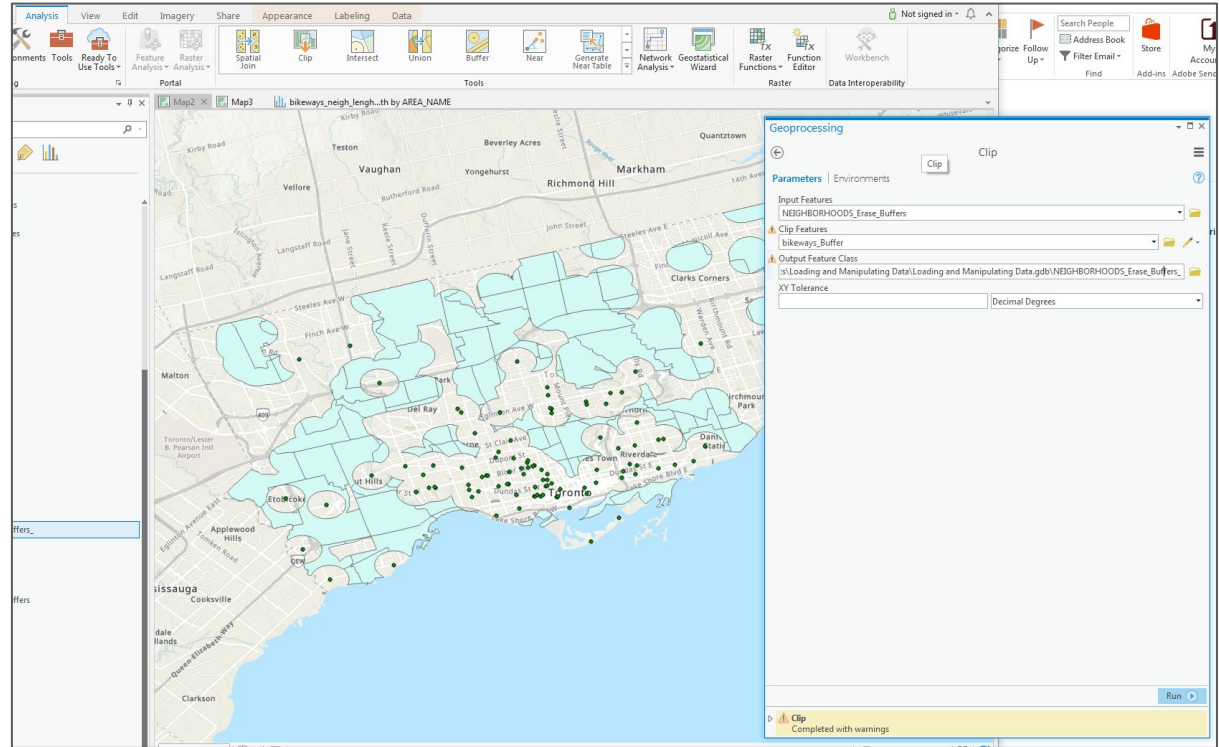
Clipping

Our new buffer represents areas that are of good potential because they are close to bikeways. But we need to combine these results with what we erased earlier so we can get closer precision to finding potential sites.

1 - search for the “Clip” tool

2 - clip out of the “NEIGHBOURHOOD_Erase_Buffers” layer, the new “bikeways_Buffer”

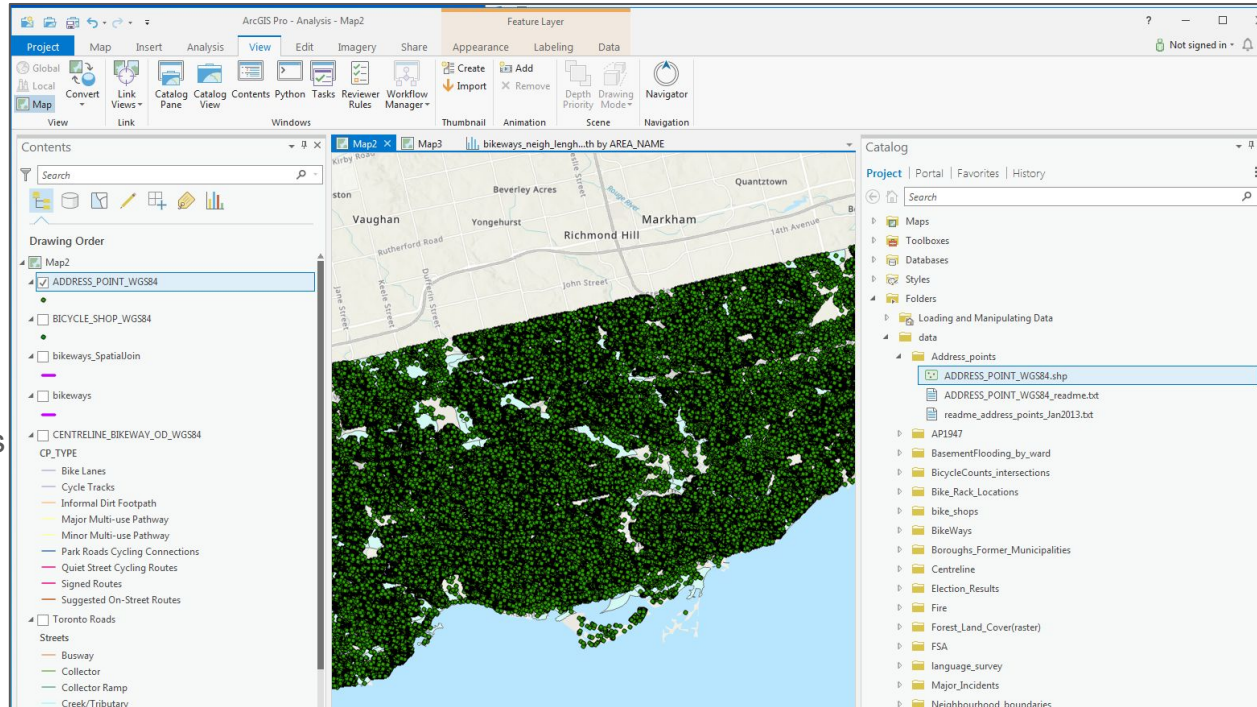
The results now show areas that do not have a bike shop within 1km but that are within 1km of a bikeway feature.



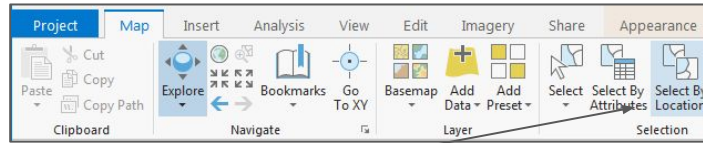
Select by Location

1 - add the
“ADDRESS_POINT_WGS84.shp”
shapefile to your map

This layer represents all address locations in the city. The addresses contain “land use” categories for each location. Let’s search for commercial locations that fall within our ideal areas identified.



Select by location



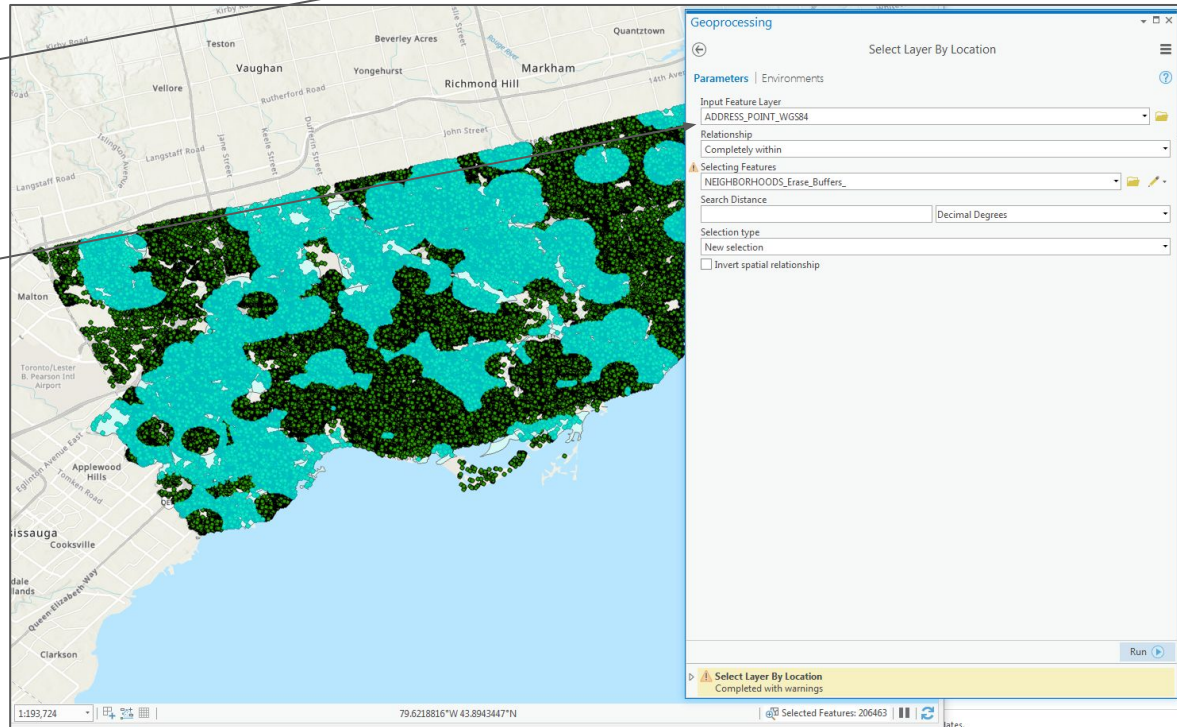
1 - under the “Map” menu, click “Select by Location”

2 - in the “Geoprocessing” popup, make sure your “Input Feature Layer” is set to “ADDRESS_POINT_WGS84”

3 - select “Completely within” under the “Relationship”

3 - under “Selecting Features” select “NEIGHBORHOODS_Erase_Buffers_”

This query will be looking for addresses that fall complete within our buffered, erased, and clipped layer “NEIGHBORHOODS_Erase_Buffers_”

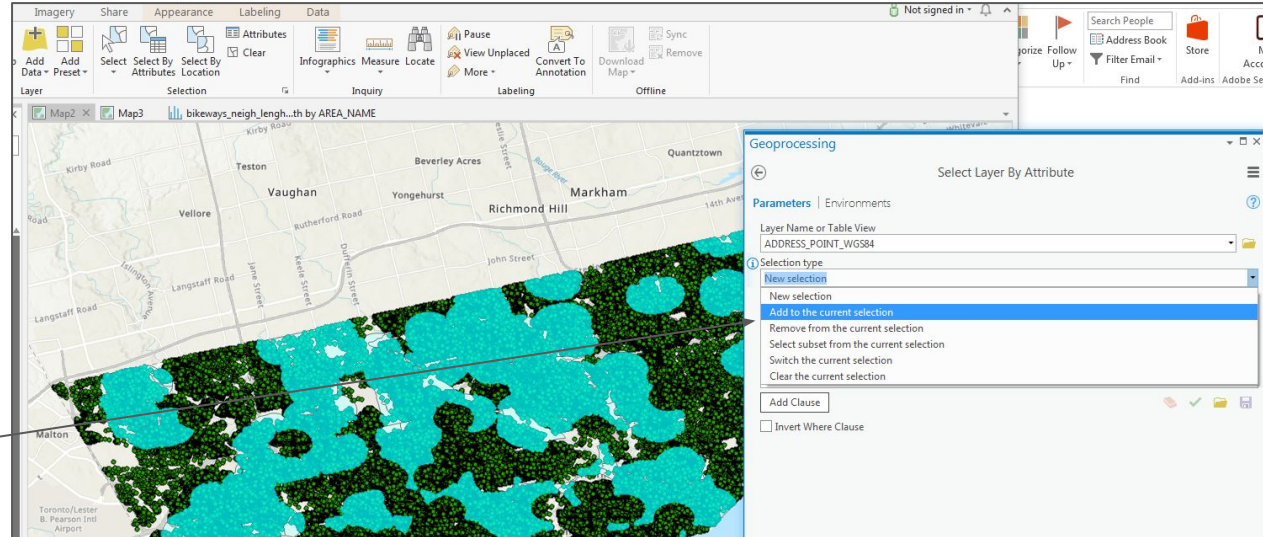


Select by Attribute

Now we want to find only
“Commercial” locations within the
addresses found within our ideal area.

1 - Under the “Map” menu, click on
“Select by Attributes”

2 - in the “Geoprocessing” popup,
make sure you are querying the
“ADDRESS_POINT_WGS84” layer
and that your “Selection Type” is “Add
to the current selection”



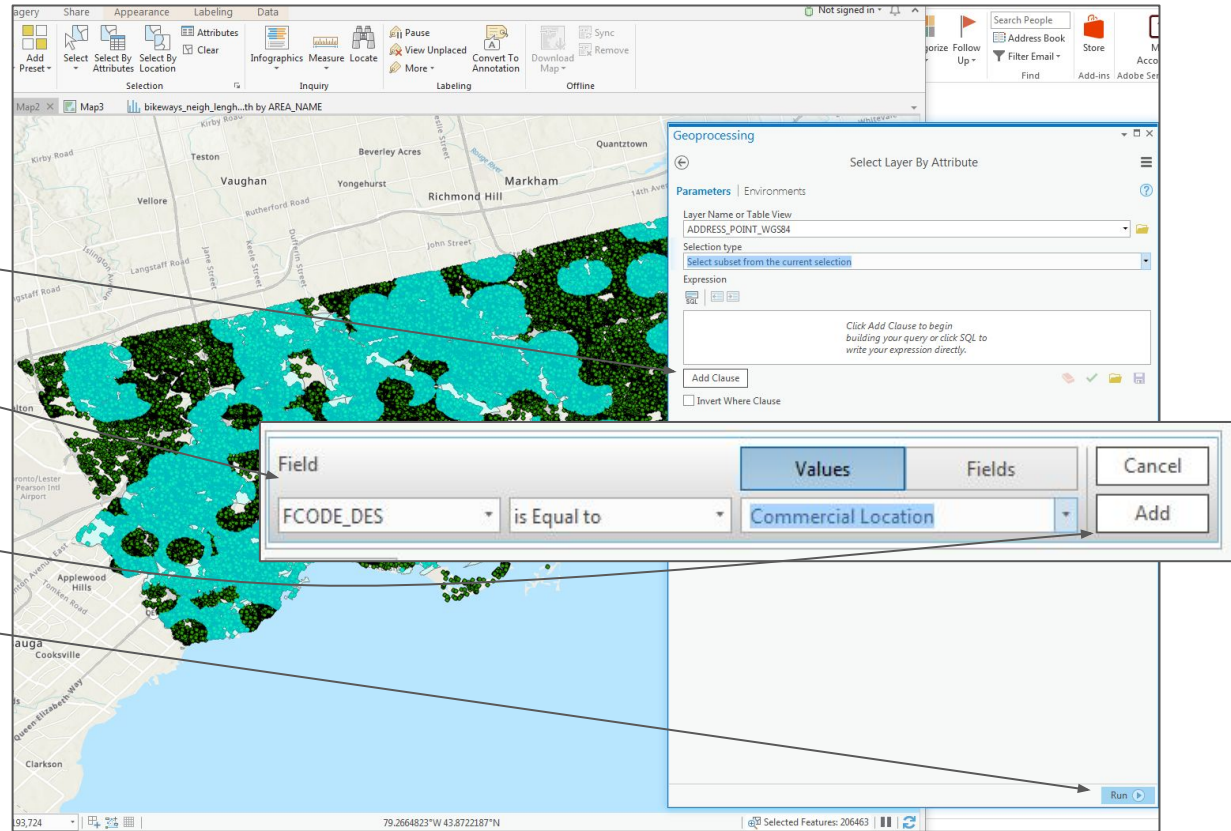
Select by attributes

1 - click on “Add Clause”

2 - in the resulting clause query tool, select the “Field” “FCODE_DES” “is Equal to” “Commercial Location”

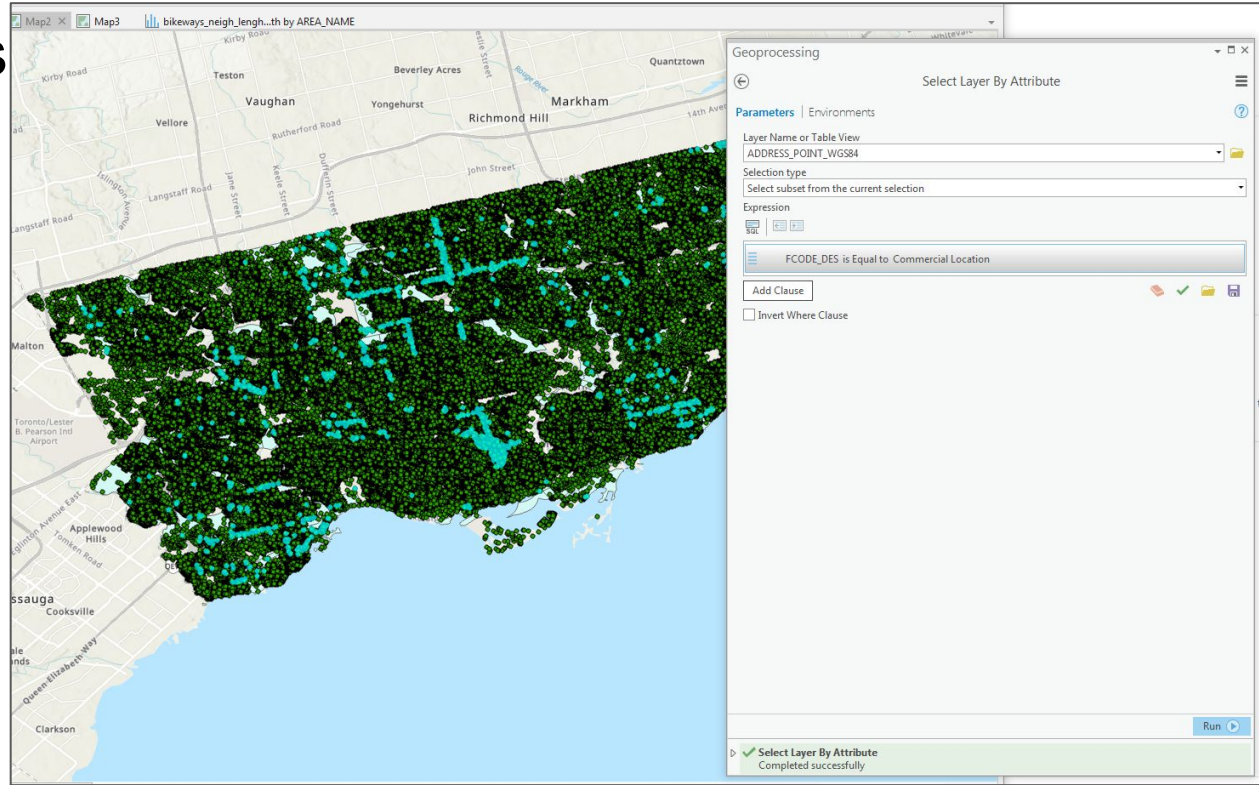
3 - click on “Add”

4 - click on “Run”



Select by Attributes

Let's create a new layer from these results.



Site Selection

1 - right-click on the “ADDRESS_POINT_WGS84” layer, select “Data” → “Export Features”

2 - provide a name for the resulting export feature

The screenshot displays the ArcGIS Desktop interface. On the left, the 'Drawing Order' pane shows a list of layers, with 'ADDRESS_POINT_WGS84' selected. A context menu is open over this layer, with 'Data' > 'Export Features' highlighted. The main map area shows a street network with green dots representing the exported features. A 'Geoprocessing' window is open in the bottom right, showing the 'Copy Features' tool with the following parameters:

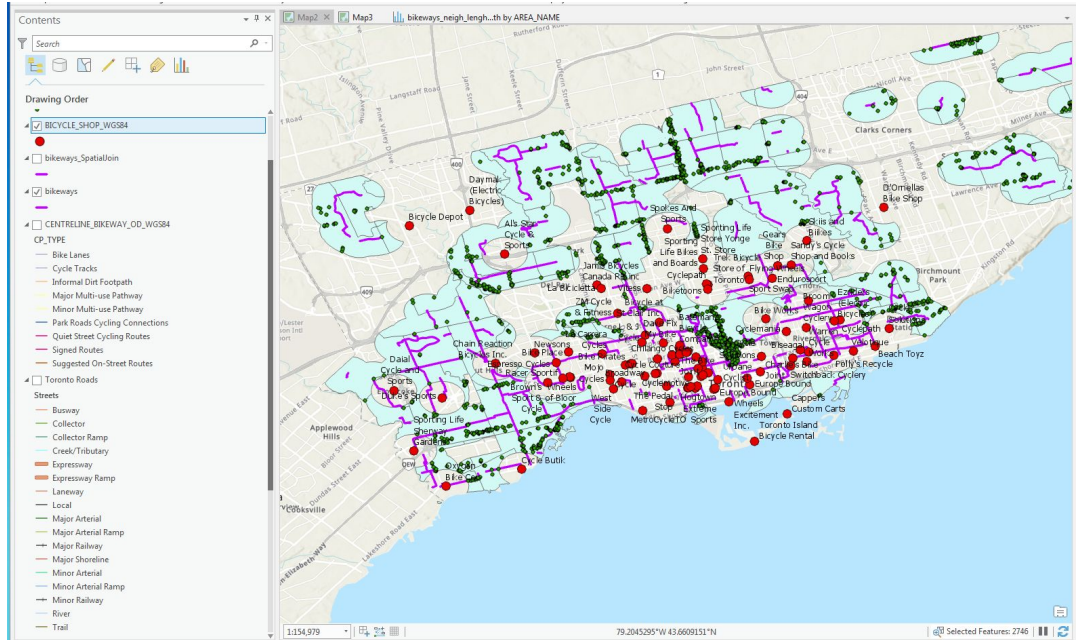
- Input Features: ADDRESS_POINT_WGS84
- Output Feature Class: New_possible_bike_shop_locations

The status bar at the bottom right indicates 'Copy Features Completed successfully' and the page number '57'.

Site locations

1 - label your current bicycle shops by right-clicking the layer in the “Contents” pane and selecting “Label”

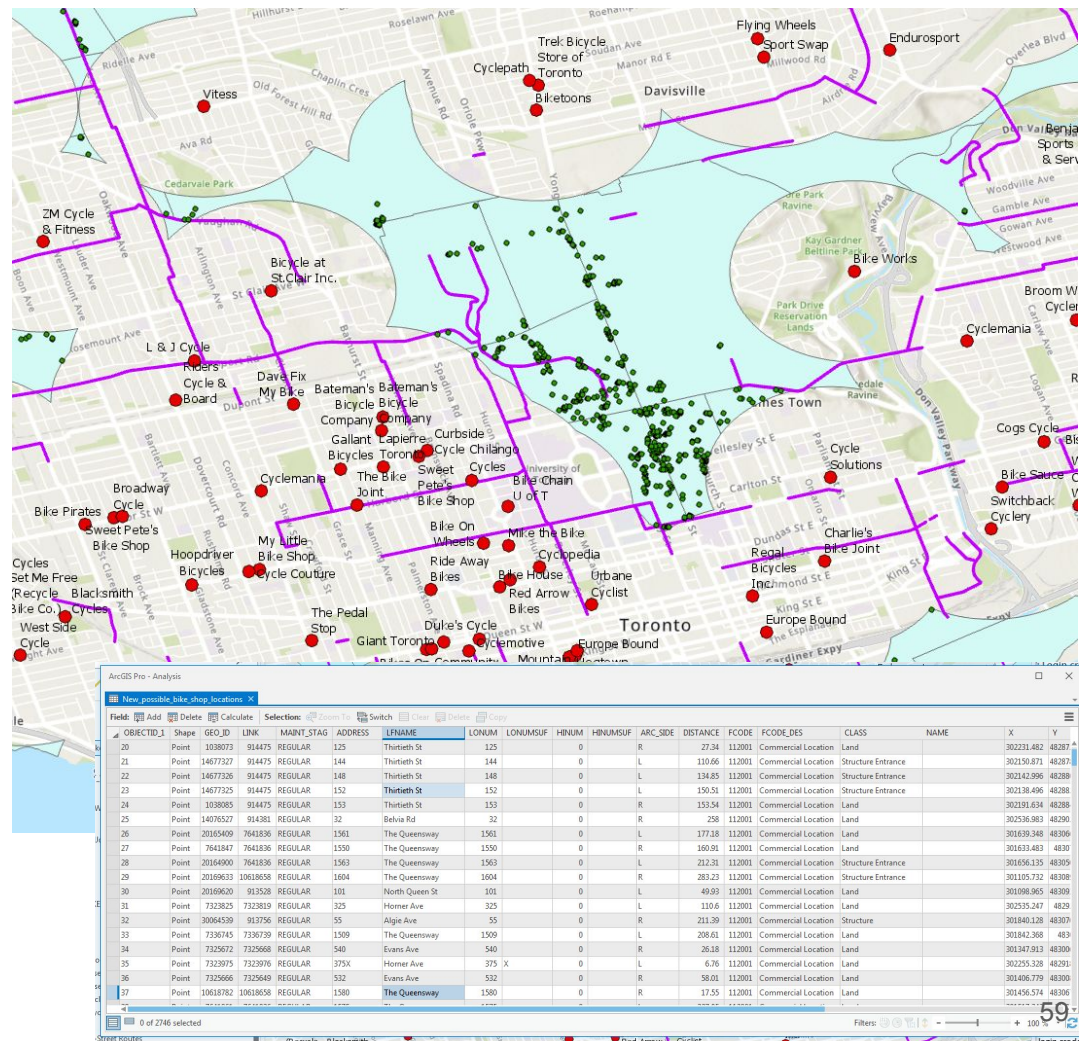
2 - zoom into your map



Site selection

Now it's just a matter of refining your searches by finding out which of these locations are for rent or for sale!

One could of course add new queries into the equation by looking at population numbers and income ranges, bike rack locations (available from the city) etc.



End of Module 4

Workshop evaluation:

<http://maps.library.utoronto.ca/feedback.html>