11.205 – Intro to Spatial Analysis – Fall 2019

ArcMap Exercise

Week 4 – An Introduction to Geoprocessing: Objectives

I. Prepare Data for Geoprocessing
II. Learn to use the **Buffer Tool** to run a proximity analysis
III. Use the **Clip Tool** to Extract Features
IV. Use the **Dissolve Tool** to Calculate Areas
V. Create a Pie Chart in Excel
VI. Use the **Update Tool** to change data
VII. Combine Data using the **Intersect Tool**
VIII. Use the Proportional Split estimation method for population
IX. Use the Proportional Split estimation method for commuter data

INTRODUCING GEOPROCESSING

This week in lecture, we introduced **geoprocessing**: performing analytical operations on data layers. Geoprocessing involves combining layers in different ways to yield new information that can allow for insight or further analysis. In lab this week, we are going to explore some basic geoprocessing functions.

The MBTA, in collaboration with the City of Somerville and City of Medford, is planning an extension of the Green Line light rail transit line into the two cities. Somerville is investigating the impact of the proposed station locations. Specifically, they are interested in how the proposed Union Square station might affect land use and transit use. The city is seeking information on the area of each type of land use, the population, and the number of individuals that commute to work on transit within half a mile of the proposed Union Square Green Line station.

The following is a map of the proposed line, for reference, from the Boston Globe:

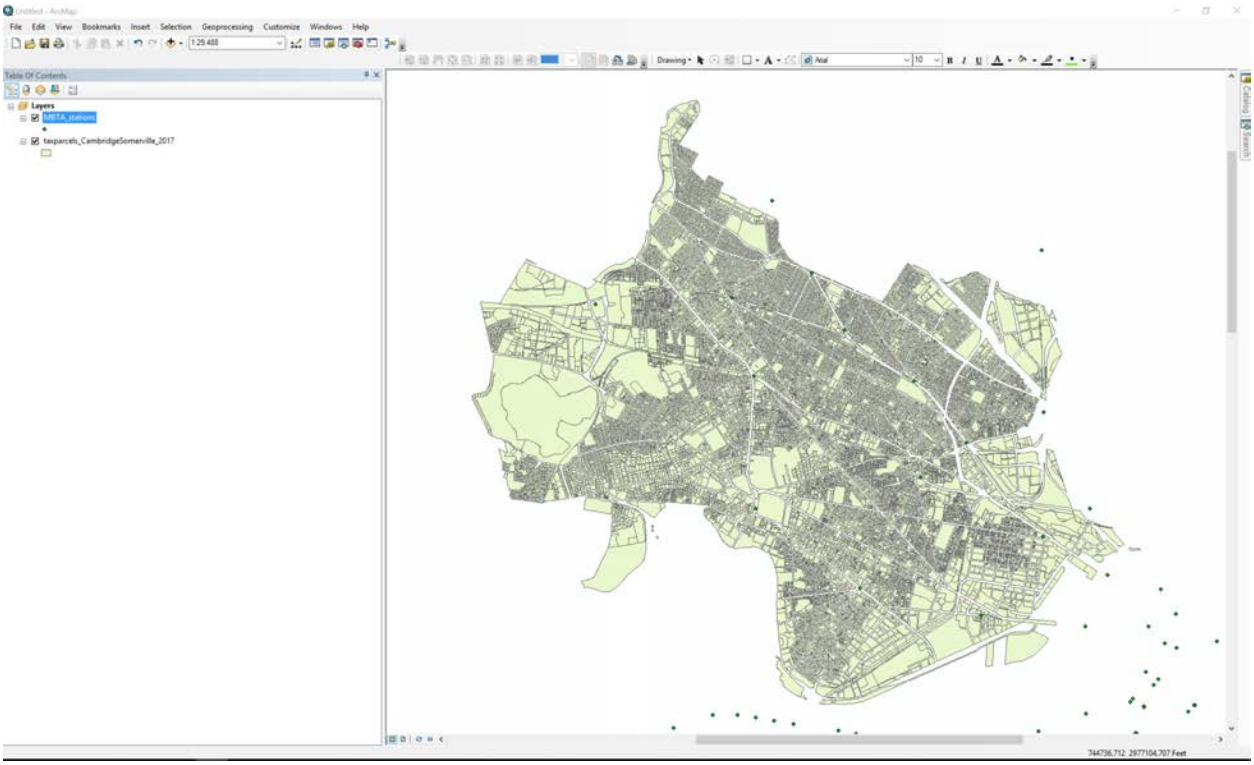
http://archive.boston.com/news/local/massachusetts/articles/2009/07/21/green_line_pop/

To conduct our analysis, we are going to use some basic geoprocessing techniques. Let's get started!

OBJECTIVE 1. PREPARE OUR DATA FOR ANALYSIS/SELECT STATIONS/VISUALIZE LAND USE DATA

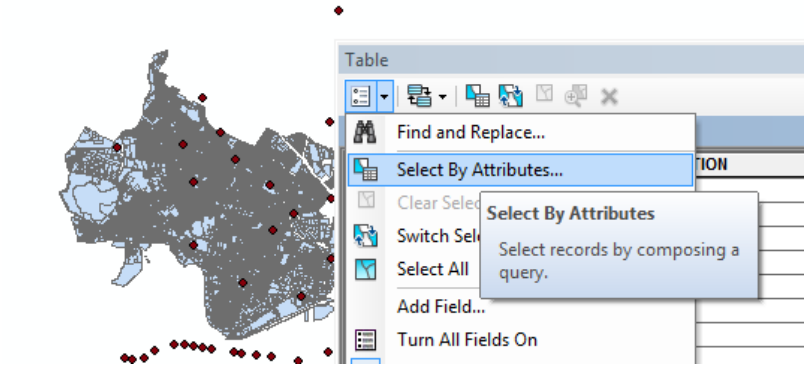
The first task is to load our data layers to prepare for analysis. In the class materials, you will find the two main shapefiles we need for our geoprocessing analysis, **taxParcels_CambridgeSomerville_2017.shp** and **MBTA_stations.shp.** These files, respectively, contain a parcel file merged to contain both Cambridge and Somerville, and a point file containing locations of all MBTA stations. The Union Square area is close to the Cambridge/Somerville city line, so your analysis will include parcels from both cities.

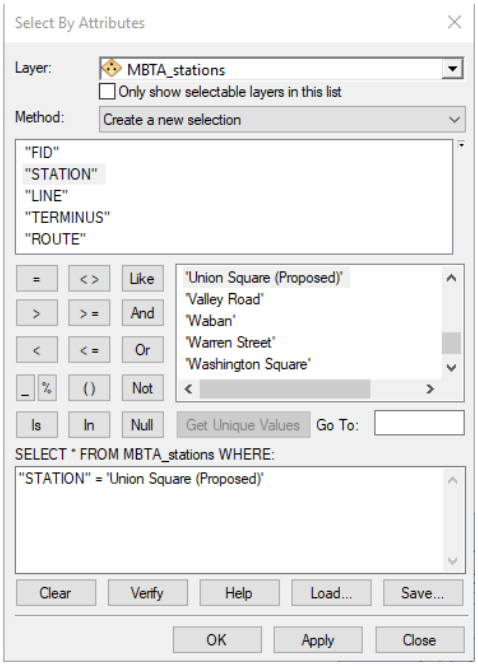
1. Open a new map document and add the two layers. Your map will look like the following.



2. Our analysis is going to focus on the proposed Union Square station. Open the attribute table of the MBTA data to see the fields and look at the data. You will see the MBTA stations layer contains all of the stations in the system, including the proposed ones. We are only concerned with the proposed Union Square station on the Green Line extension.

Navigate to the 'Select by Attribute' tool in the table options to query our **'MBTA_stations'** dataset.





When the **'Select by Attributes'** window appears, set the query method to **'Create a new selection.'**

Then, construct the query using the dialog window options. First, double click on the **"STATION"** field in the top window.

Type **'='** and then click the '**Get Unique Values'** button above the query field. This will show all the unique values in the **"STATION"** field.

The station we are looking for is **'Union Square (Proposed).'** Double click it.

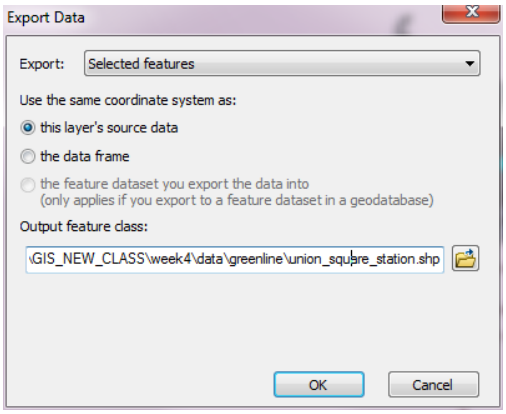
Your query will look like the following:

```
"STATION"='Union Square (Proposed)'
```

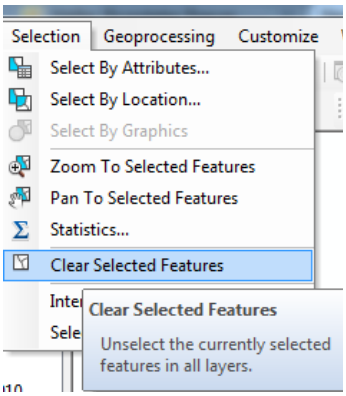
Click apply to run the query.

3. Return to the map. You will see one station highlighted, the proposed Union Square station.

4. Create a new shapefile from our selection by exporting the data. To do so, **right-click on MBTA_stations** and go to **Data -> Export Data**. In the Export Data dialog, make sure you are only exporting the features we have selected, not all features in the layer. Name the shapefile **union_square_station.shp**. Save it to your week's working space.



Add **union_square_station.shp** to your map document when the file is created.



Clear selections by going to the top of the page and using the "Selection" drop down menu. Select **"Clear Selected Features."** You can also click on the button.

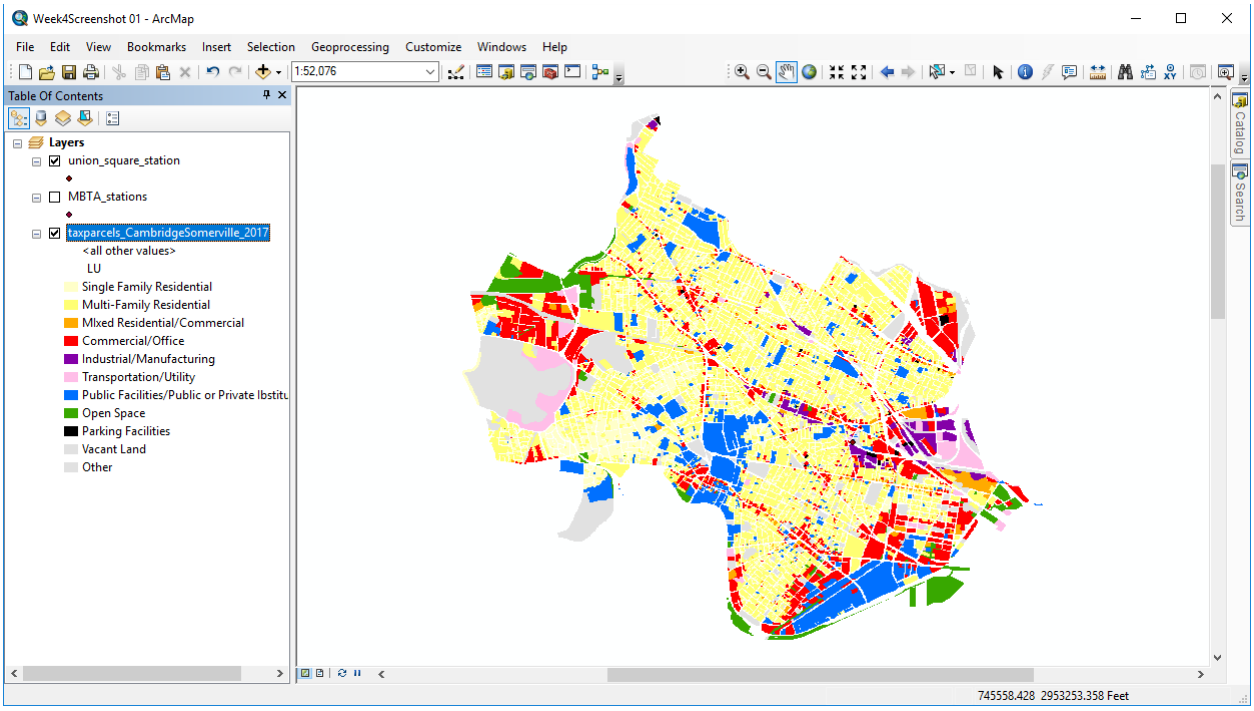
4. Next, you will visualize land use. The Massachusetts parcel datasets contain highly detailed land use codes. If you want to dig into them, you can find the official code book for the parcel dataset in your weekly materials as **"classificationcodebook_massachusetts.pdf."** For this exercise, we have simplified the land use codes for you. **You can find the simplified codes in the 'LU' field.** The fields will correspond to the following:

LU	Description
01	Single Family Residential
02	Multi-family Residential
03	Mixed Residential/Commercial
04	Commercial/Office
05	Industrial/Manufacturing
06	Transportation/Utility
07	Public Facilities/Public or Private Institutional
08	Open Space and Outdoor Recreation
09	Parking Facilities
10	Vacant Land
11	Other

Symbolize the land use data using traditional land use map colors (recall Week 2's exercise). Represent various categories within uses with several shades of the color. (i.e. single family residential is light yellow; multi-family residential is dark yellow -- or light blue is public facility; and dark blue is public or private institutional).

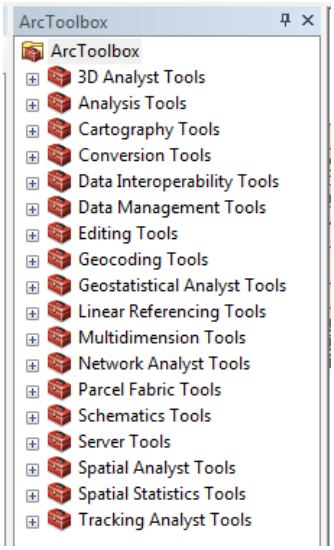
Color	Land Use
Yellow	Residential
Orange	Mixed Use (Residential/Commercial)
Red	Commercial/Office
Purple	Industrial/Manufacturing
Pink	Transportation/Utility
Gray	Vacant Land/Other
Blue	Public Facilities/ Public or Private Institutional
Green	Open Space and Outdoor Recreation
Black	Parking Facilities

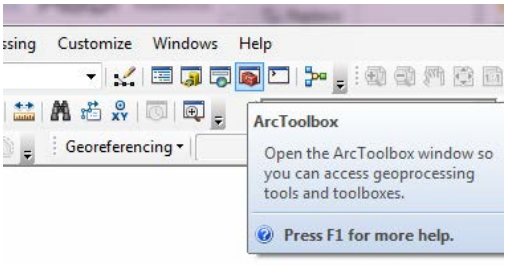
When symbolized, your map should look something like the following. **Save it as geoprocessing.mxd to your weekly working folder.**



OBJECTIVE 2: LEARN TO USE THE BUFFER TOOL

With our map document setup and the data visualized, we can begin our analytical process. In ArcGIS, most geoprocessing tools are accessed through ArcToolbox, an integrated feature that catalogs tools. To complete our tasks, we are going to begin by using a 'buffer' to create a polygon shapefile that contains all area within ½ mile of the proposed Union Square station.

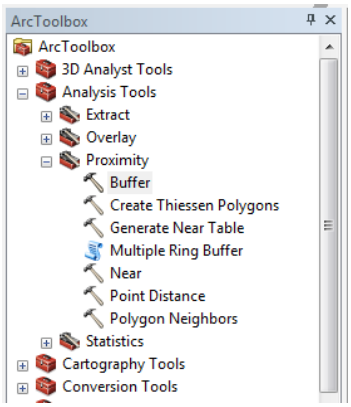




1. Open ArcToolbox by clicking the small red box at the top of the ArcGIS map document window, or by clicking on the Geoprocessing menu dropdown and selecting ArcToolbox.

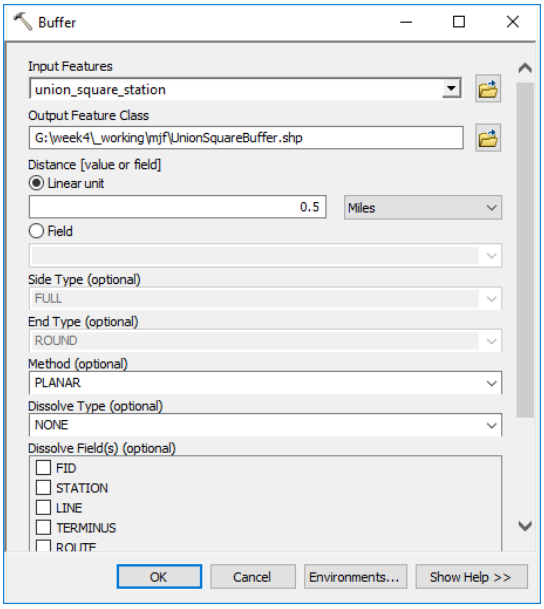
You can dock the ArcToolbox window to your map document by clicking and holding the title bar and dragging it to the arrows on the side of the window. A small pushpin button at the top right will keep it as a tab on the right side of your map window so that it can be easily expanded/collapsed.

Explore this window and the many geoprocessing options available in the ArcGIS software. There are other options for accessing tools, such as writing Python scripts and creating model builder models, but for this exercise, we are going to use ArcToolbox.

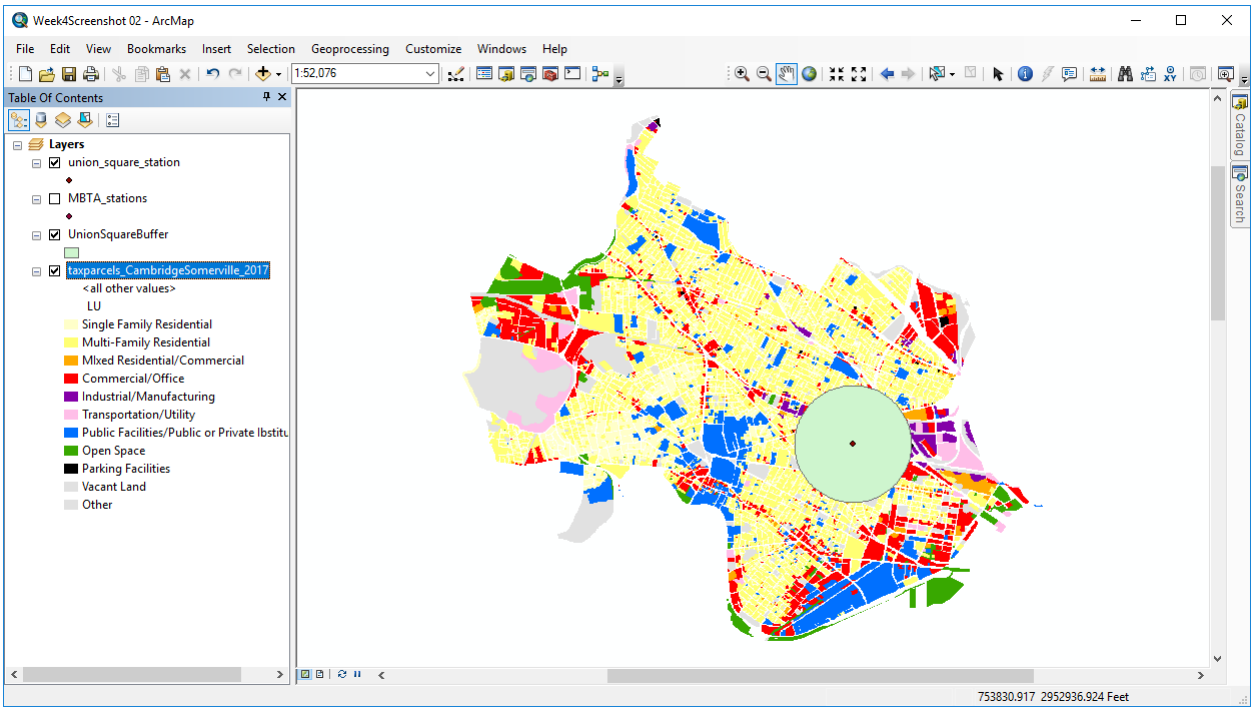


2. The Buffer tool is a Proximity Analysis tool. This means it can be found in the 'Analysis Tools' under a submenu called 'Proximity'. In ArcToolbox, navigate to the Buffer tool. Double click on it.

The Buffer dialog window will open. In it, we will set all the parameters of our buffer process. Use the **Union Square station layer as the input**, save the output in the weekly workspace as **UnionSquareBuffer.shp**. Set our **buffer distance to be ½ mile**. There are many other options you can use to fine tune your buffers. For now, leave the rest of the options as default. Once set, click OK to run the buffer tool.



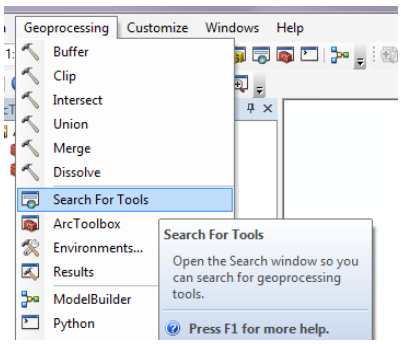
Your buffer will now look something like the following. You have created a new shapefile that contains a circular area with a radius of ½ mile around the proposed Union Square station.

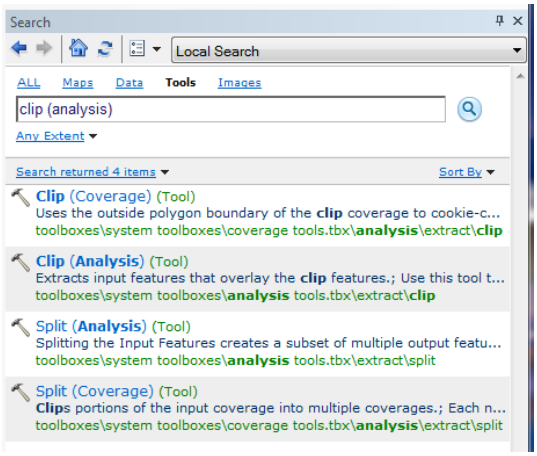


OBJECTIVE 3: USE THE CLIP TOOL TO EXTRACT LAND USE POLYGONS NEAR UNION SQUARE

We now have a polygon shapefile that contains a polygon of the area within ½ mile of the proposed Union Square station. We can use this polygon layer to extract information from our land use layer. We only want to look at the land uses in within ½ mile of the proposed Union Square station, so, we will create a new shapefile that contains only the parcels within the area of the buffer.

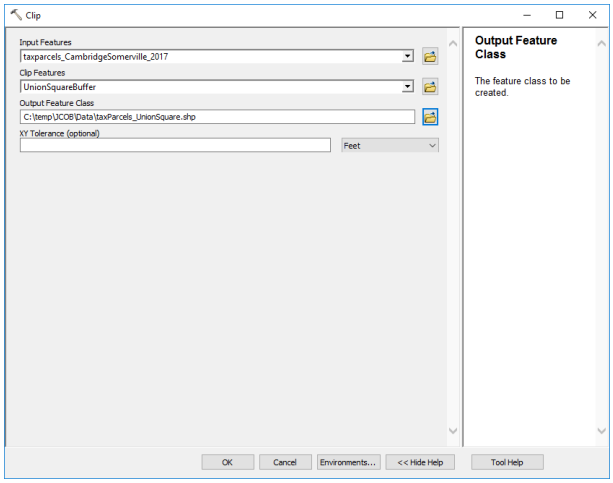
1. To create our new layer, we will use the Clip tool. The Clip tool is in the Analysis toolbox, under the Extract submenu. But to find it, we are going to use the Search feature. There are many tools in ArcToolbox and navigating the folder structure can be tedious. If you are unsure where to find the tool you are looking for, this is the best way to do so.

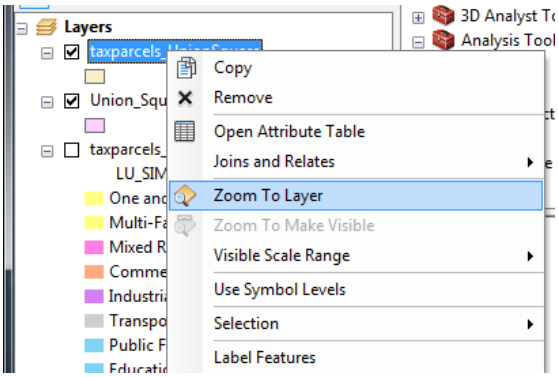




Under the Geoprocessing dropdown menu at the top of the ArcGIS interface, select Search for Tools. Type in "**Clip**". A couple of options will appear. Select the Clip (Analysis) option from the search window.

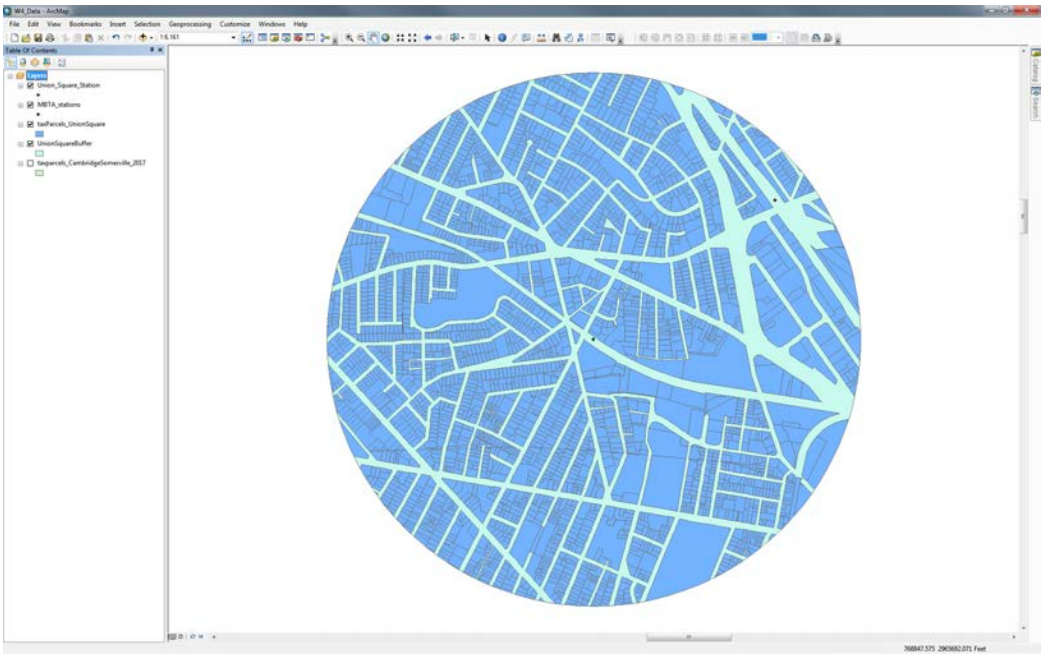
The Clip dialog will appear. Here we will set the parameters for our clip function. We want to clip the land use layer. Set **taxparcels_CambridgeSomerville_2017** to be the input features and **UnionSquareBuffer** to be the clip features. Name the output **taxParcels_UnionSquare.shp** and save it to your weekly workspace. The dialog will look like the following. Click OK and add the new layer to your map document.





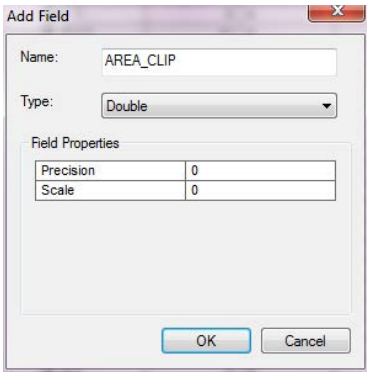
2. Turn off visibility on **taxParcels_CambridgeSomerville_2017** and zoom to the **taxparcels _UnionSquare layer**. You do this by right clicking on the **taxparcels_UnionSquare** and selecting the "Zoom to Layer" option.

At this stage in the process, your map document should look similar to the following. Note that our Parcels layer has been 'clipped' to the buffer layer, and that only intersecting features are included.



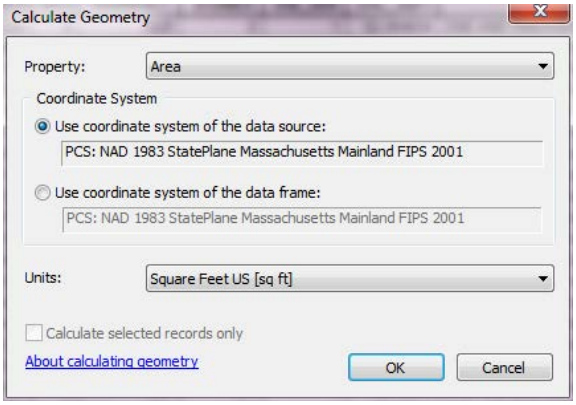
Taking a look at the attribute table for **taxParcels_UnionSquare**, you will only see the tax parcels within the clipped extent in our output clipped shapefile.

When looking at the geometry of **taxParcels_UnionSquare**, you will notice some of the parcels get cut in half by the edge of the ½ mile buffer and the geometry has changed. When you perform a Clip, you are creating a new shapefile that has new geometry. **This geometric change is not represented in the attribute table, and no fields are updated along with the geometry. In other words, if you have an Area field in your attribute table and you run a clip, the Area is not automatically updated.** This matters because some of the parcels were cut during the clip process.



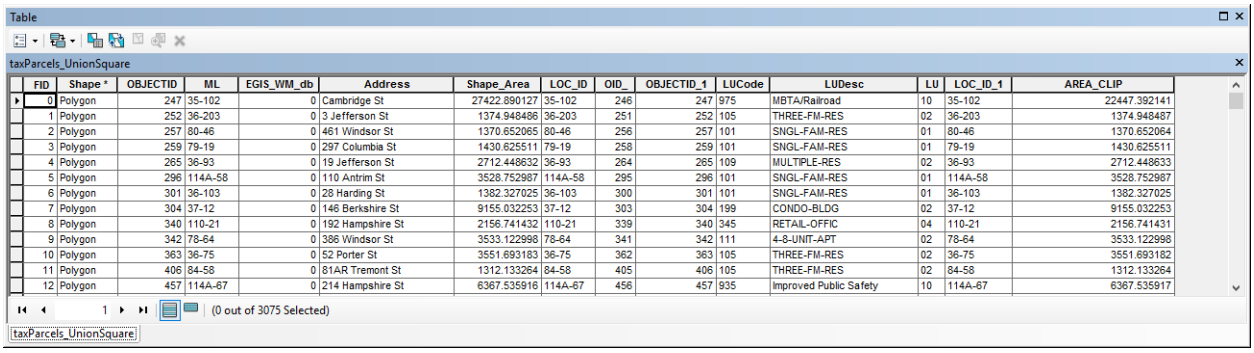
3. We need to add a new field and populate it with the new area of each polygon. Open the **taxparcels_UnionSquare** attribute table. In the attribute table, navigate to table options, and select **Add Field**. Name the field **'AREA_CLIP'** and give it the type of '**Double'**. It is important to keep field names short (either less than 8 or 13 characters) as long names can sometimes cause problems down the road.

4. Right-click on the Area field you just created in the attribute table. Select **Calculate Geometry** from the dropdown that appears. (Click **Yes** to the warning box, we will address this at a later date.) In the dialog box that appears, indicate that you want to calculate **Area**, and select **Square Feet** as the unit of measurement. Ignore the coordinate system radio buttons for now.



Click OK once you have your options selected (and "yes" to the warning if it appears). The Area field will now populate with the area of each polygon measured in Square Feet.

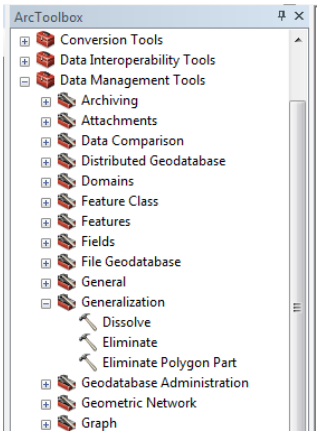
Looking at your table you will see something like the following:



FID	Shape *	OBJECTID	ML	EGIS_WM_db	Address	Shape_Area	LOC_ID	OID_	OBJECTID_1	LUCode	LUDesc	LU	LOC_ID_1	AREA_CLIP
0	Polygon	247	35-102	0	Cambridge St	27422.890127	35-102	246	247	975	MBTA/Railroad	10	35-102	22447.392141
1	Polygon	252	36-203	0	3 Jefferson St	1374.948486	36-203	251	252	105	THREE-FM-RES	02	36-203	1374.948487
2	Polygon	257	80-46	0	461 Windsor St	1370.652065	80-46	256	257	101	SNGL-FAM-RES	01	80-46	1370.652064
3	Polygon	259	79-19	0	297 Columbia St	1430.625511	79-19	258	259	101	SNGL-FAM-RES	01	79-19	1430.625511
4	Polygon	265	36-93	0	19 Jefferson St	2712.448632	36-93	264	265	109	MULTIPLE-RES	02	36-93	2712.448633
5	Polygon	296	114A-58	0	110 Antrim St	3528.752987	114A-58	295	296	101	SNGL-FAM-RES	01	114A-58	3528.752987
6	Polygon	301	36-103	0	28 Harding St	1382.327025	36-103	300	301	101	SNGL-FAM-RES	01	36-103	1382.327025
7	Polygon	304	37-12	0	146 Berkshire St	9155.032253	37-12	303	304	199	CONDO-BLDG	02	37-12	9155.032253
8	Polygon	340	110-21	0	192 Hampshire St	2156.741432	110-21	339	340	345	RETAIL-OFFIC	04	110-21	2156.741431
9	Polygon	342	78-64	0	386 Windsor St	3533.122998	78-64	341	342	111	4-8-UNIT-APT	02	78-64	3533.122998
10	Polygon	363	36-75	0	52 Porter St	3551.693183	36-75	362	363	105	THREE-FM-RES	02	36-75	3551.693182
11	Polygon	406	84-58	0	81AR Tremont St	1312.133264	84-58	405	406	105	THREE-FM-RES	02	84-58	1312.133264
12	Polygon	457	114A-67	0	214 Hampshire St	6367.535916	114A-67	456	457	935	Improved Public Safety	10	114A-67	6367.535917

Save early and save often! Save your map document (geoprocessing.mxd).

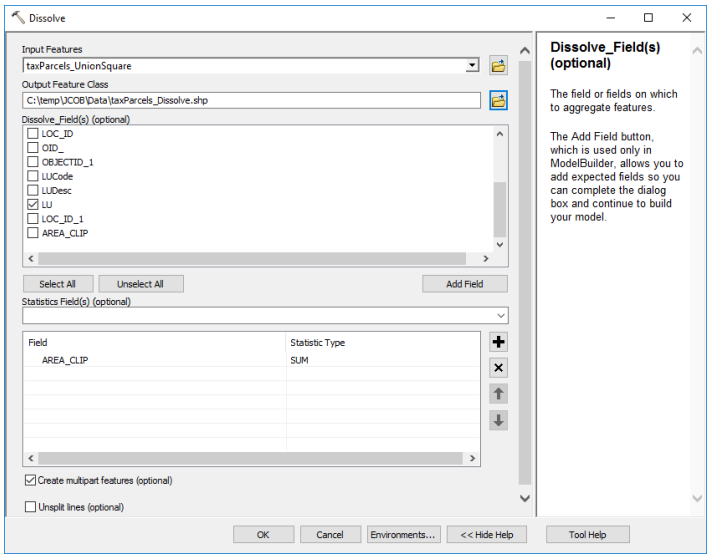
OBJECTIVE 4. USING THE DISSOLVE TOOL



We can now sum the area for each land use type. There is a **shortcut to calculating the area for each parcel rather than adding it up one by one**. **Dissolve** takes multiple features and combines them into one continuous feature based on common attributes. In our case, it will be polygons based on each land use type.

1. The *Dissolve tool*, like the Buffer tool, is located in ArcToolbox. Dissolve is a Generalization tool, meaning it 'generalizes' or simplifies data. It can be found in **Data Management Tools -> Generalization -> Dissolve**. Navigate to the Dissolve tool and double click. The Dissolve dialog window will open. In the Dissolve dialog, set our input features as **taxParcels_UnionSquare.shp** to dissolve our multiple polygons into one.

a. Call the output **taxParcel_Dissolve.shp**, and save it to your weekly workspace.



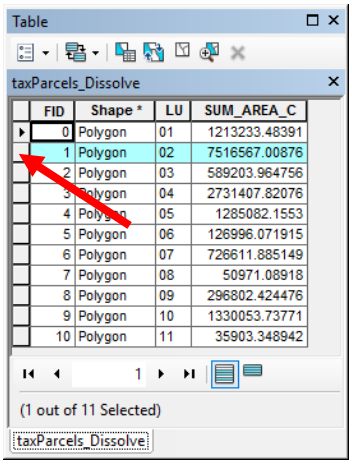
b. Set the **Dissolve Field to be LU**. This will create a shapefile with one feature for each value of LU. There are 11 values for LU, so the new shapefile will have 11 rows. The output will be multipart polygon, meaning that each single feature can have multiple parts.

c. The last part of the dialog is the **statistics field**. This will run basic statistics on our file when we dissolve it. We just calculated the area in the **AREA_CLIP** field. Select this from the dropdown, and then set the statistic type to **SUM**. This will add the areas for each feature and give us a total sum for each land use type.

Click OK to run the tool.

Add your new layer to the map. Right-click on the layer in the Table of Contents and open the attribute table. Notice you have fewer features. This is because we dissolved each land use type into one feature. Also notice the field called **SUM_AREA_C.** This is the total area for each type of land use. The **SUM_AREA_C** field is in Square Feet.

To illustrate what Dissolve is doing, your old buffers should look like those on the left, your new dissolved buffers should look like those on the right.



Your attribute table should look like the following. In the attribute table, you will see one feature for each LU value. Select the first row by clicking to the left of the row to highlight that row in the table and on the map.

You will see the feature, which represents all of the parcels that share a particular land use type selected. Deselect the feature to move forward by going to **Selection -> Clear Selected Feature**.

OBJECTIVE 5: EXPORT THE TABLE TO EXCEL AND CREATE A PIE CHART

We can now export this table to Excel and create a pie chart showing the total area of each land use type within ½ mile of the Union Square station.

1. Export the table. To export the attribute table, go to Table Options and choose Export. Save the table as type '**dBASE table'**, not a File or Personal Geodatabase Table, and name it **UnionSquare_LandUses.dbf**. Save it in your weekly working directory. When you click OK, ArcMap will ask you if you want to add the table to the map. Select No. If we add the table, ArcGIS will place a lock on the table that will not allow us to edit it in another software until we remove it from our map or close ArcGIS.

2. Open Excel. Go to File -> Open. You may not see the DBF file in your directory, so tell Excel to see **All Files** in the folder.

3. Add a new column called DESCRIPTIONS with the textual description of the Land Uses (LU) for our chart. Again, here are the land use code descriptions.

LU	Description
01	Single Family Residential
02	Multi-family Residential
03	Mixed Residential/Commercial
04	Commercial/Office
05	Industrial/Manufacturing
06	Transportation/Utility
07	Public Facilities/Public or Private Institutional
08	Open Space and Outdoor Recreation
09	Parking Facilities
10	Vacant Land
11	Other

4. In Excel, use the =SUM( ) function in cell E2 to sum the areas of each land use. Your Excel function should look like the following:

=SUM(C2:C12)

5. In Excel, add a column to hold the percentage of each land use. Call it PERCENTAGE. We will show this on our chart to help the reader make better sense of the data. Populate PERCENTAGE with the sum of each area divided by the total sum. Use the '$' in Excel to hold the sum field. The function will look like the following:

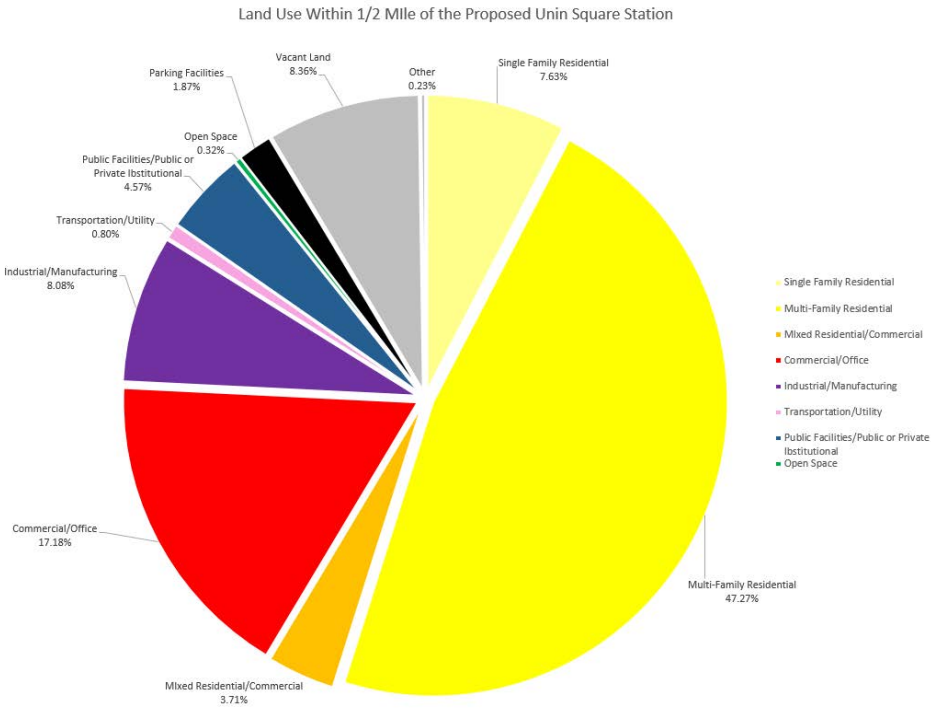
=C2/E2

Fill out the field.

6. Change the field format to percentage. Your table will look like the following:

	A	B	C	D	E
1	LU	DESCRIPTIONS	SUM_AREA_C		
2	1	Single Family Residential	1213233.48391000000	7.63%	15902832.99085860000
3	2	Multi-Family Residential	7516567.00876000000	47.27%	
4	3	MIxed Residential/Commercial	589203.96475600000	3.71%	
5	4	Commercial/Office	2731407.82076000000	17.18%	
6	5	Industrial/Manufacturing	1285082.15530000000	8.08%	
7	6	Transportation/Utility	126996.07191500000	0.80%	
8	7	Public Facilities/Public or Private Ibstitutional	726611.88514900000	4.57%	
9	8	Open Space	50971.08918030000	0.32%	
10	9	Parking Facilities	296802.42447600000	1.87%	
11	10	Vacant Land	1330053.73771000000	8.36%	
12	11	Other	35903.34894230000	0.23%	
13					
14					

7. You can now make a pie chart that will include percentages. Use the same colors for the pie chart categories as for your land use map. This will allow you to use the same legend as you use for the map and create consistency for your reader. To create the pie chart, use the Insert -> Charts -> Pie or Donut Chart feature in Excel. Your final pie chart should look something like the following.



(*Mind you, Excel can make some fantastically bad graphs. Feel free to edit them or bring them into your graphics editor of choice (ie Adobe Illustrator or Inkscape))*

Creating charts and graphs using Excel and ArcGIS in conjunction with one another is a very powerful workflow and can be used to create very compelling data driven arguments.

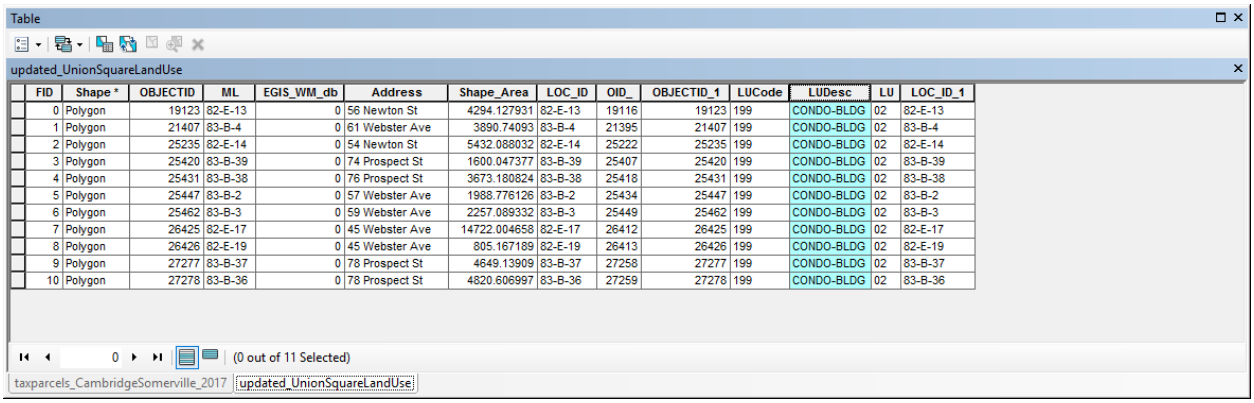
OBJECTIVE 6: USE THE UPDATE TOOL TO CHANGE A DATASET

The City of Somerville, in preparation for the construction of the station, has been updating most recent land use data near the proposed Union Square station. They have a shapefile of 11 parcels that contain new land use codes near the proposed station. Using the Update Tool, we can modify the tax parcel shapefile to reflect the changes in Land Use Codes. The Update Tool will update a feature class based on common attributes from another feature class.

1. Returning to ArcMap, reopen the geoprocessing.mxd we have been working with. In the Data folder>boston, you will see a shapefile named **updated_UnionSquareLandUse.shp.** Add it your map document.

2. Open the attribute table of **updated_UnionSquareLandUse**. You will see it contains 11 parcels. The attributes follow the exact same schema, but the only difference is the lands use information (i.e. LUCode, LUDesc and LU) has been changed. We can use **Update** to apply these changes to our tax parcel file and create a new updated file.

The attribute table for updated_UnionSquareLandUse looks like the following, with the LU field highlighted.



Table

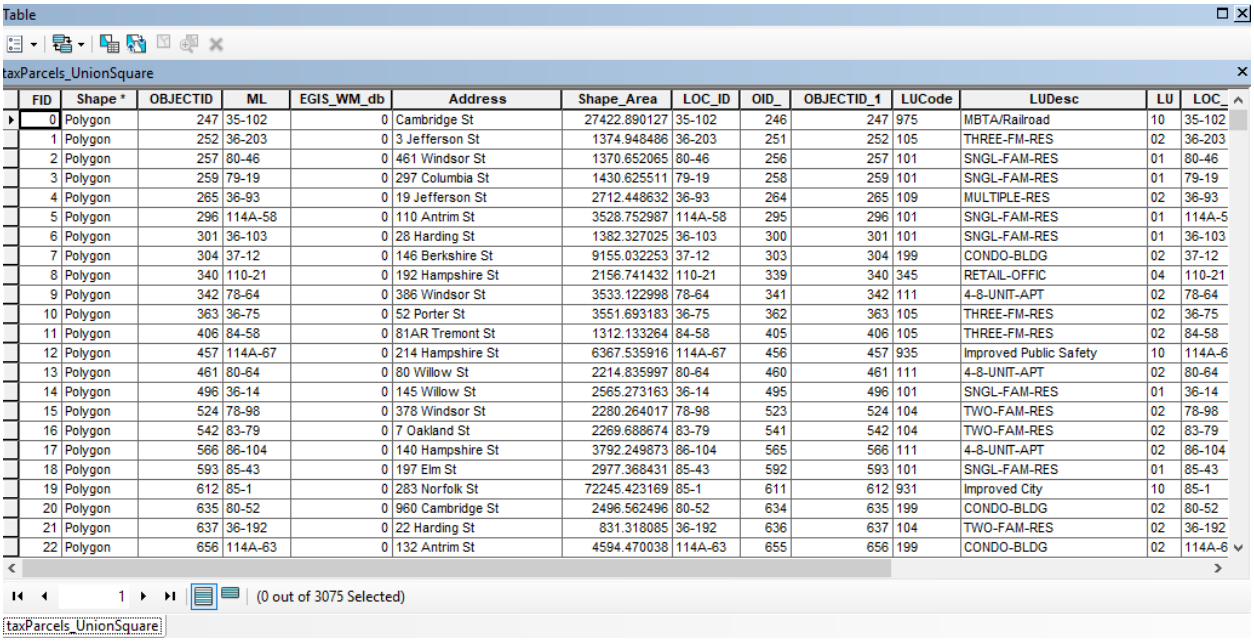
updated_UnionSquareLandUse

FID	Shape *	OBJECTID	ML	EGIS_WM_db	Address	Shape_Area	LOC_ID	OID_	OBJECTID_1	LUCode	LUDesc	LU	LOC_ID_1
0	Polygon	19123	82-E-13	0	56 Newton St	4294.127931	82-E-13	19116	19123	199	CONDO-BLDG	02	82-E-13
1	Polygon	21407	83-B-4	0	61 Webster Ave	3890.74093	83-B-4	21395	21407	199	CONDO-BLDG	02	83-B-4
2	Polygon	25235	82-E-14	0	54 Newton St	5432.088032	82-E-14	25222	25235	199	CONDO-BLDG	02	82-E-14
3	Polygon	25420	83-B-39	0	74 Prospect St	1600.047377	83-B-39	25407	25420	199	CONDO-BLDG	02	83-B-39
4	Polygon	25431	83-B-38	0	76 Prospect St	3673.180824	83-B-38	25418	25431	199	CONDO-BLDG	02	83-B-38
5	Polygon	25447	83-B-2	0	57 Webster Ave	1988.776126	83-B-2	25434	25447	199	CONDO-BLDG	02	83-B-2
6	Polygon	25462	83-B-3	0	59 Webster Ave	2257.089332	83-B-3	25449	25462	199	CONDO-BLDG	02	83-B-3
7	Polygon	26425	82-E-17	0	45 Webster Ave	14722.004658	82-E-17	26412	26425	199	CONDO-BLDG	02	82-E-17
8	Polygon	26426	82-E-19	0	45 Webster Ave	805.167189	82-E-19	26413	26426	199	CONDO-BLDG	02	82-E-19
9	Polygon	27277	83-B-37	0	78 Prospect St	4649.13909	83-B-37	27258	27277	199	CONDO-BLDG	02	83-B-37
10	Polygon	27278	83-B-36	0	78 Prospect St	4820.606997	83-B-36	27259	27278	199	CONDO-BLDG	02	83-B-36

0 (0 out of 11 Selected)

taxparcels_CambridgeSomerville_2017 updated_UnionSquareLandUse

The taxParcels_UnionSquare layer attribute table, for the same parcels, looks like the following.



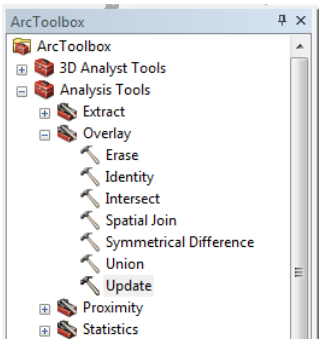
Table

taxParcels_UnionSquare

FID	Shape *	OBJECTID	ML	EGIS_WM_db	Address	Shape_Area	LOC_ID	OID_	OBJECTID_1	LUCode	LUDesc	LU	LOC_
0	Polygon	247	35-102	0	Cambridge St	27422.890127	35-102	246	247	975	MBTA/Railroad	10	35-102
1	Polygon	252	36-203	0	3 Jefferson St	1374.948486	36-203	251	252	105	THREE-FM-RES	02	36-203
2	Polygon	257	80-46	0	461 Windsor St	1370.652065	80-46	256	257	101	SNGL-FAM-RES	01	80-46
3	Polygon	259	79-19	0	297 Columbia St	1430.625511	79-19	258	259	101	SNGL-FAM-RES	01	79-19
4	Polygon	265	36-93	0	19 Jefferson St	2712.448632	36-93	264	265	109	MULTIPLE-RES	02	36-93
5	Polygon	296	114A-58	0	110 Antrim St	3528.752987	114A-58	295	296	101	SNGL-FAM-RES	01	114A-5
6	Polygon	301	36-103	0	28 Harding St	1382.327025	36-103	300	301	101	SNGL-FAM-RES	01	36-103
7	Polygon	304	37-12	0	146 Berkshire St	9155.032253	37-12	303	304	199	CONDO-BLDG	02	37-12
8	Polygon	340	110-21	0	192 Hampshire St	2156.741432	110-21	339	340	345	RETAIL-OFFIC	04	110-21
9	Polygon	342	78-64	0	386 Windsor St	3533.122998	78-64	341	342	111	4-8-UNIT-APT	02	78-64
10	Polygon	363	36-75	0	52 Porter St	3551.693183	36-75	362	363	105	THREE-FM-RES	02	36-75
11	Polygon	406	84-58	0	81AR Tremont St	1312.133264	84-58	405	406	105	THREE-FM-RES	02	84-58
12	Polygon	457	114A-67	0	214 Hampshire St	6367.535916	114A-67	456	457	935	Improved Public Safety	10	114A-6
13	Polygon	461	80-64	0	80 Willow St	2214.835997	80-64	460	461	111	4-8-UNIT-APT	02	80-64
14	Polygon	496	36-14	0	145 Willow St	2565.273163	36-14	495	496	101	SNGL-FAM-RES	01	36-14
15	Polygon	524	78-98	0	378 Windsor St	2280.264017	78-98	523	524	104	TWO-FAM-RES	02	78-98
16	Polygon	542	83-79	0	7 Oakland St	2269.688674	83-79	541	542	104	TWO-FAM-RES	02	83-79
17	Polygon	566	86-104	0	140 Hampshire St	3792.249873	86-104	565	566	111	4-8-UNIT-APT	02	86-104
18	Polygon	593	85-43	0	197 Elm St	2977.368431	85-43	592	593	101	SNGL-FAM-RES	01	85-43
19	Polygon	612	85-1	0	283 Norfolk St	72245.423169	85-1	611	612	931	Improved City	10	85-1
20	Polygon	635	80-52	0	960 Cambridge St	2496.562496	80-52	634	635	199	CONDO-BLDG	02	80-52
21	Polygon	637	36-192	0	22 Harding St	831.318085	36-192	636	637	104	TWO-FAM-RES	02	36-192
22	Polygon	656	114A-63	0	132 Antrim St	4594.470038	114A-63	655	656	199	CONDO-BLDG	02	114A-6

1 (0 out of 3075 Selected)

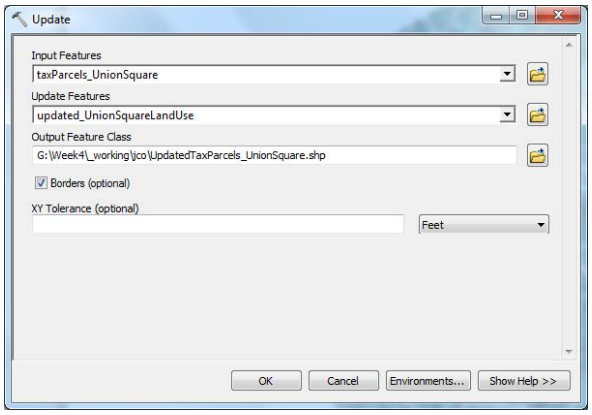
taxParcels_UnionSquare



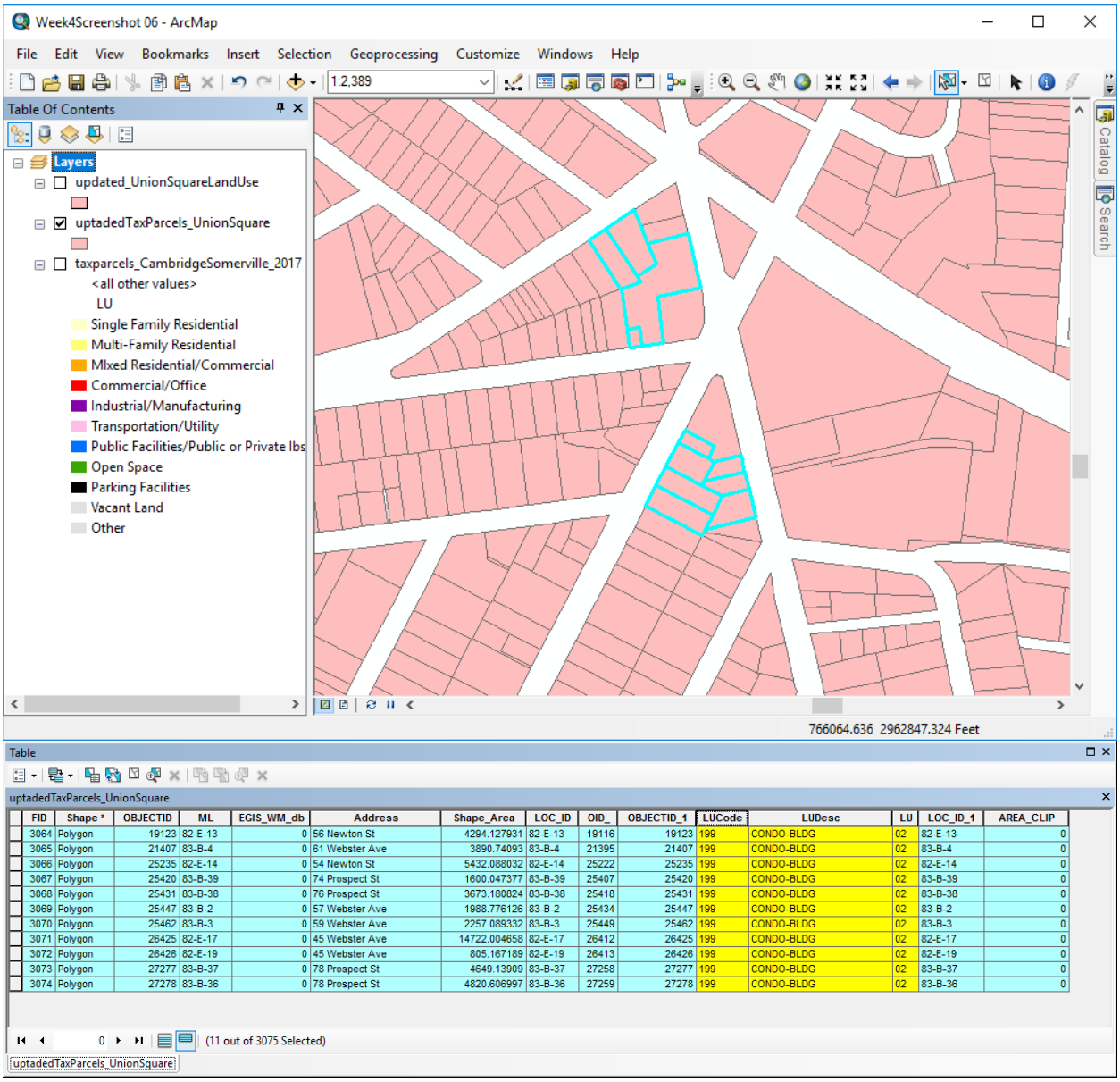
3. Before updating the file, we want to make sure we are using the whole file. **Go to Selection -> Clear Selected Features** in your map document to make sure nothing is selected in our document.

4. Updating the file creates a new output that contains a geometric intersection of the Input Features and Update Features. It will update both the geometry and the attributes, with the features from the update layer taking precedence over features from the input layer. Search or navigate to Analysis Tools -> Overlay -> **Update**. Double click on it and the Update dialog will open.

In the Update dialog, set the Input Features to **taxParcels_UnionSquare**, the update features to **updated_UnionSquareLandUse**, and name the output **updatedTaxParcels_UnionSquare**, saving it to your weekly working space. Once the dialog is set, click OK.



5. Once the Update Tool has completed running, add the **updatedTaxParcels_UnionSquare** layer to your map. Click on one of the parcels we updated to select it and open the attribute table. You will see that the land use information for all of the parcels was brought into our new file. For example, the selected parcels, which previously had different LUDesc codes among them, now all have LUDesc values of CONDO-BLDG. The attribute table, map, and document will look like the following.

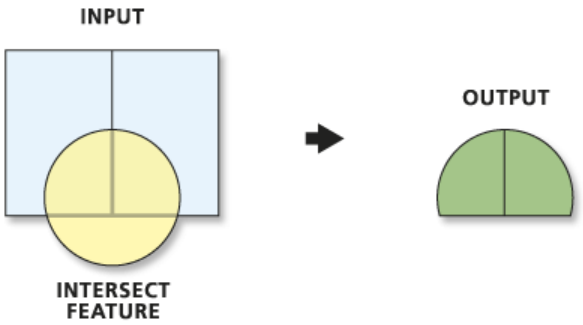


FID	Shape *	OBJECTID	ML	EGIS_WM_db	Address	Shape_Area	LOC_ID	OID_	OBJECTID_1	LUCode	LUDesc	LU	LOC_ID_1	AREA_CLIP
3064	Polygon	19123	82-E-13	0	56 Newton St	4294.127931	82-E-13	19116	19123	199	CONDO-BLDG	02	82-E-13	0
3065	Polygon	21407	83-B-4	0	61 Webster Ave	3890.74093	83-B-4	21395	21407	199	CONDO-BLDG	02	83-B-4	0
3066	Polygon	25235	82-E-14	0	54 Newton St	5432.088032	82-E-14	25222	25235	199	CONDO-BLDG	02	82-E-14	0
3067	Polygon	25420	83-B-39	0	74 Prospect St	1600.047377	83-B-39	25407	25420	199	CONDO-BLDG	02	83-B-39	0
3068	Polygon	25431	83-B-38	0	76 Prospect St	3673.180824	83-B-38	25418	25431	199	CONDO-BLDG	02	83-B-38	0
3069	Polygon	25447	83-B-2	0	57 Webster Ave	1988.776126	83-B-2	25434	25447	199	CONDO-BLDG	02	83-B-2	0
3070	Polygon	25462	83-B-3	0	59 Webster Ave	2257.089332	83-B-3	25449	25462	199	CONDO-BLDG	02	83-B-3	0
3071	Polygon	26425	82-E-17	0	45 Webster Ave	14722.004658	82-E-17	26412	26425	199	CONDO-BLDG	02	82-E-17	0
3072	Polygon	26426	82-E-19	0	45 Webster Ave	805.167189	82-E-19	26413	26426	199	CONDO-BLDG	02	82-E-19	0
3073	Polygon	27277	83-B-37	0	78 Prospect St	4649.13909	83-B-37	27258	27277	199	CONDO-BLDG	02	83-B-37	0
3074	Polygon	27278	83-B-36	0	78 Prospect St	4820.606997	83-B-36	27259	27278	199	CONDO-BLDG	02	83-B-36	0

Using the update tool is one method of overlay analysis that allows you to combine a file with multiple differences to an original file in order to modify and update it.

OBJECTIVE 7: COMBINE DATA USING THE INTERSECT TOOL

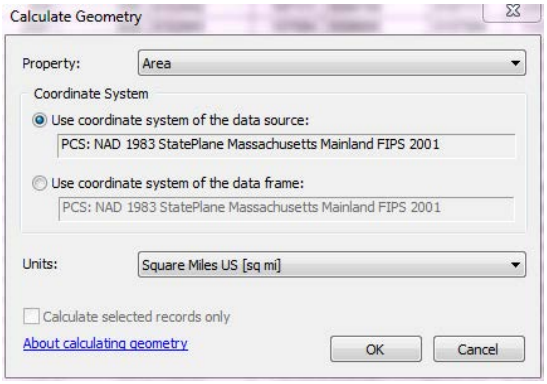
Our next task is to find an estimate of population within ½ mile of the proposed Union Square station. To complete this task, we are going to use the Intersect tool and the block group level data that contains the 2013-2017 ACS population estimate (in the block group shapefile as POP15). The Intersect tool takes two layers, and creates a new shapefile that contains areas that are included in both shapefiles. When the Intersect tool is run, each individual feature that is in this congruent area will be brought to the new file, and the attributes will transfer with it.



We are going create a new polygon shapefile that contains all of the areas that are both within a Cambridge or Somerville block group and within ½ mile of the proposed station site.

First, save your geoprocessing.mxd map document to preserve it, then go to File -> Save as… and save the file as **geoprocessing_part2.mxd** in your weekly workspace. We will now do some census data work. From your weekly materials, add **CambridgeSomerville_blkgrps_2017.shp** to your map document.

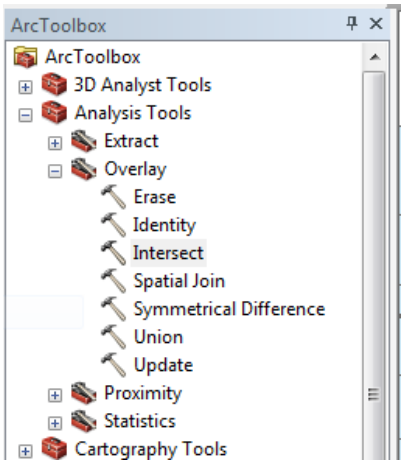
We will start by adding an Area column to our block group shapefile.

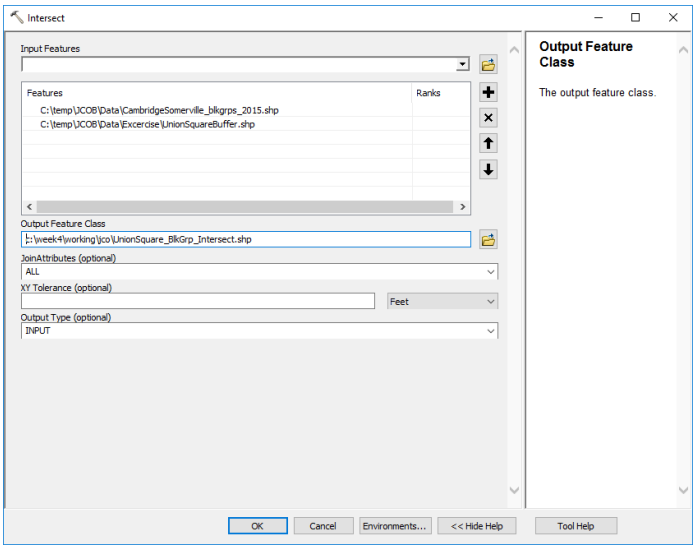


1. Add a field to the attribute table of the CambridgeSomerville_blkgrps_2017 file. We will call this field ***AREA_SQMI*.** Make the field's data type Double.

2. Calculate the area of each block group by right-clicking the field and choosing **Calculate Geometry.** In the dialog box that appears, select that you want to calculate the area in square miles.

3. With the area now populated in our block group table, we are now ready to perform the intersection. In ArcToolbox, navigate to the Intersect tool. It is in the Analysis toolbox nested within the Overlay tools. Double-click Intersect.

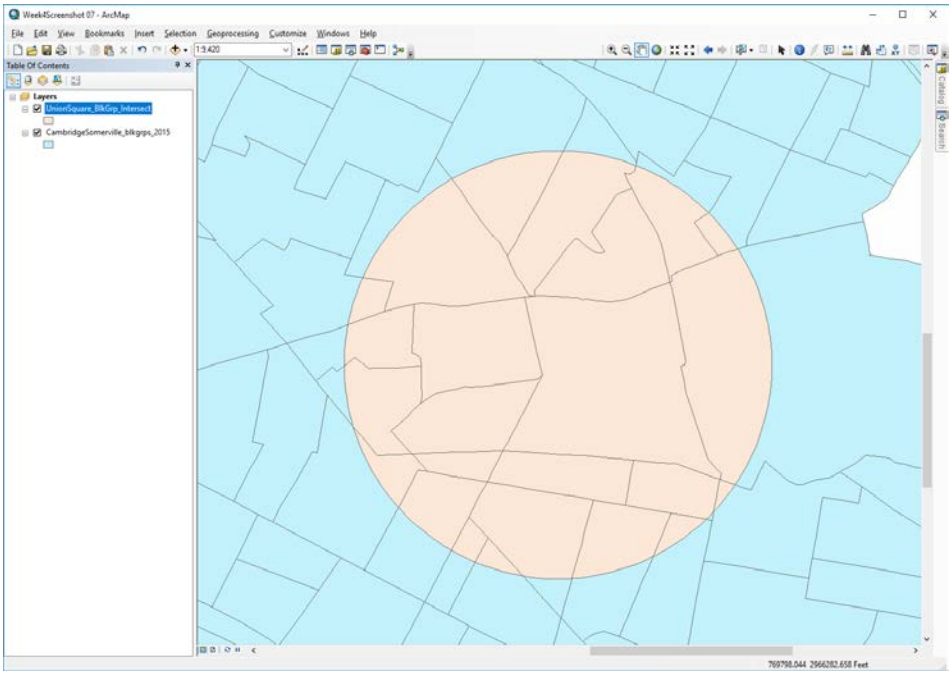




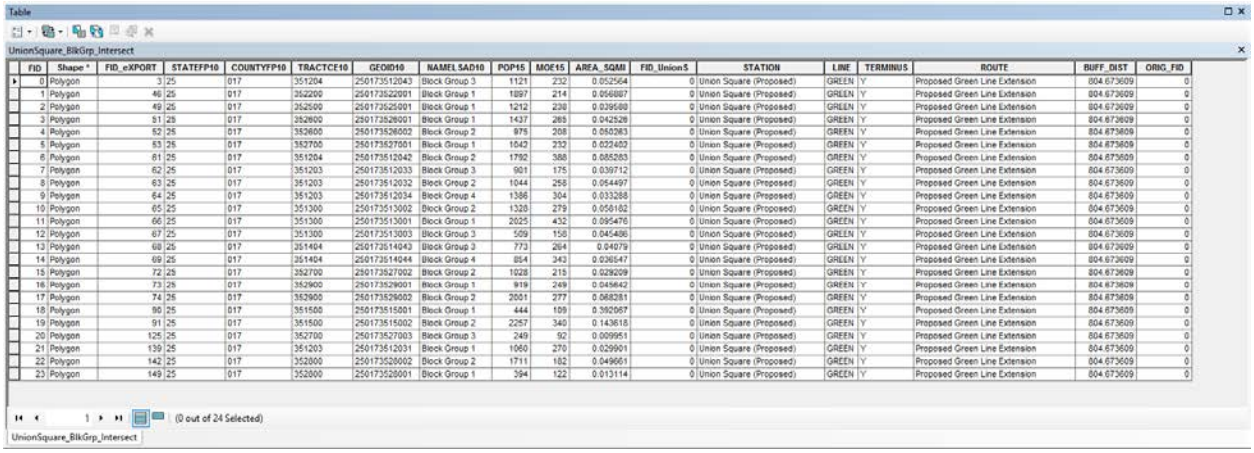
4. The Intersect dialog will appear. Add the two layers we want to intersect. Name the file **UnionSquare_BlkGrp_Intersect.shp** and save it to your weekly working space. JoinAttributes represents the attributes from each layer, make sure it is marked as ALL and leave the defaults for the rest.

Click OK to run the Intersect.

5. Your output should look like the following. Notice that only the areas that were overlapping in the two shapefiles are in our output shapefile.



At first, this looks a lot like a clip, but open the attribute table. You will see that, unlike doing a clip, taking the intersect also applied the attributes of each layer to our output intersected file.



FID	Shape *	FID_eXPORT	STATEFP10	COUNTYFP10	TRACTCE10	GEOID10	NAMELSAD10	POP15	MOE15	AREA_SQMI	FID_UnionS	STATION	LINE	TERMINUS	ROUTE	BUFF_DIST	ORIG_FID
0	Polygon	3	25	017	351204	250173512043	Block Group 3	1121	232	0.052564	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
1	Polygon	46	25	017	352200	250173522001	Block Group 1	1897	214	0.056887	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
2	Polygon	49	25	017	352500	250173525001	Block Group 1	1212	230	0.039580	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
3	Polygon	51	25	017	352600	250173526001	Block Group 1	1437	265	0.042526	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
4	Polygon	52	25	017	352600	250173526002	Block Group 2	975	208	0.050283	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
5	Polygon	53	25	017	352700	250173527001	Block Group 1	1043	232	0.022403	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
6	Polygon	61	25	017	351204	250173512042	Block Group 2	1792	388	0.085283	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
7	Polygon	62	25	017	351203	250173512033	Block Group 3	901	175	0.039712	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
8	Polygon	63	25	017	351203	250173512032	Block Group 2	1044	258	0.054497	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
9	Polygon	64	25	017	351203	250173512034	Block Group 4	1386	304	0.033288	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
10	Polygon	65	25	017	351300	250173513002	Block Group 2	1328	279	0.050182	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
11	Polygon	66	25	017	351300	250173513001	Block Group 1	2025	432	0.095476	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
12	Polygon	67	25	017	351300	250173513003	Block Group 3	509	158	0.045486	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
13	Polygon	68	25	017	351404	250173514043	Block Group 3	773	264	0.04079	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
14	Polygon	69	25	017	351404	250173514044	Block Group 4	854	342	0.036547	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
15	Polygon	72	25	017	352700	250173527002	Block Group 2	1028	215	0.029209	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
16	Polygon	73	25	017	352900	250173529001	Block Group 1	919	249	0.045642	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
17	Polygon	74	25	017	352900	250173529002	Block Group 2	2001	277	0.068281	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
18	Polygon	90	25	017	351500	250173515001	Block Group 1	444	109	0.392067	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
19	Polygon	91	25	017	351500	250173515002	Block Group 2	2257	340	0.143618	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
20	Polygon	125	25	017	352700	250173527003	Block Group 3	249	92	0.009951	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
21	Polygon	139	25	017	351203	250173512031	Block Group 1	1060	270	0.029901	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
22	Polygon	142	25	017	352600	250173526002	Block Group 2	1711	182	0.049661	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0
23	Polygon	149	25	017	352600	250173526001	Block Group 1	394	122	0.013114	0	Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0

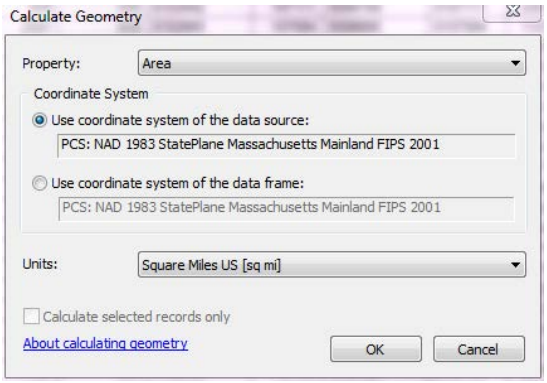
As with many tasks in ArcGIS, there are many ways to get to the same result. Think of what other methods you could use to get only the areas of the block groups that are within ½ mile of the proposed Union Square station location.

OBJECTIVE 8: USE THE PROPORTIONAL SPLIT ESTIMATION METHOD TO GET POPULATION

As we covered in class, there are a number of methods that can be employed to estimate values over geographic areas. In this case, we are going to use the **Proportional Split method**. When we intersected the block group and buffer files in the last step, we ended up with a file that contains a 'portion' of the block groups. The proportional split method involves taking a value, such as population, and multiplying it by the proportion of area that falls within our criteria, for example, within ½ mile of the proposed Union Square Green Line station. In the following steps, let's calculate the population within ½ mile. Our file contains a 2013-2017 five year ACS estimate for population.

1. Open the attribute table for **UnionSquare_BlkGrp_Intersect**. You will see the AREA_SQMI field we created in the last step. This represents the entire area of the block group. We need to add a new field that holds the area of the current intersected or clipped polygon. Add a new field, name it **PROP_SQMI**, and give it type Double. It will add on to the end of the fields in your attribute table.

2. Calculate the values for **PROP_SQMI** using the Calculate Geometry tool. This will populate the field with the new size of each polygon. Remember to change the units to square miles.

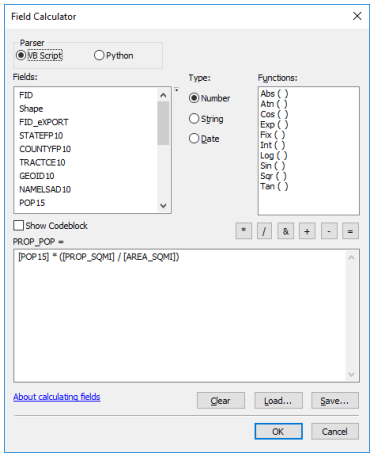


3. Add another field to hold our proportional population value. We will use the field calculator to populate this field with the estimated population within ½ mile of the proposed station site. To do this, we will take the total population for the block group, and multiply it by the percentage product of PROP_SQMI divided AREA_SQMI. Add a new field, call it PROP_POP, and give it data type Double.

Right-click on the header of PROP_POP and go to the Field Calculator. Our field calculation will look like the following:

PROP_POP = [POP17] * ([PROP_SQMI] / [AREA_SQMI])

Your field calculator window will look like the following. Once filled, click OK.



PROP_POP will fill with the value of our proportional split estimation. Our table will look like the following:

Table

UnionSquare_BlkGrp_Intersect

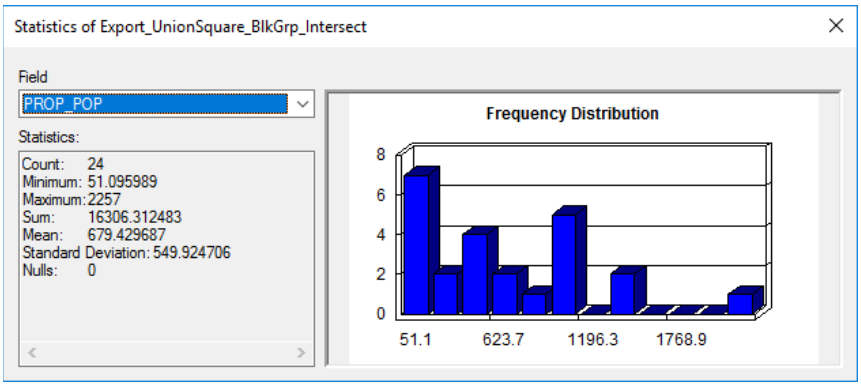
STATION	LINE	TERMINUS	ROUTE	BUFF_DIST	ORIG_FID	PROP_SQMI	PROP_POP	PROF
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.007005	149.388418	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.001532	51.095989	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.003991	122.180586	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.00499	168.622028	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.027285	529.268452	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.022257	1035.267324	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.067384	1415.893462	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.039712	901	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.054497	1044	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.028397	1182.356072	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.04693	1071.15905	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.031549	669.14846	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.045486	509	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.004635	87.829273	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.025699	600.505207	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.029209	1028	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.02241	451.23137	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.01044	305.942211	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.089251	101.072944	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.143618	2257	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.009951	249	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.019641	696.274879	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.044628	1537.583588	
Union Square (Proposed)	GREEN	Y	Proposed Green Line Extension	804.673609	0	0.004776	143.493168	

0 (0 out of 24 Selected)

UnionSquare_BlkGrp_Intersect

PROP_POP now contains an estimation of the proportion of population that lives within ½ mile of the proposed station site.

To get the total, right click the PROP_POP field and click Statistics. A dialog will appear that will give us Summary Statistics of the PROP_POP field. The Sum value, 16,306 persons, represents the count of persons in the area based on our proportional split method and based on the 2013-2017 ACS population estimate counts.

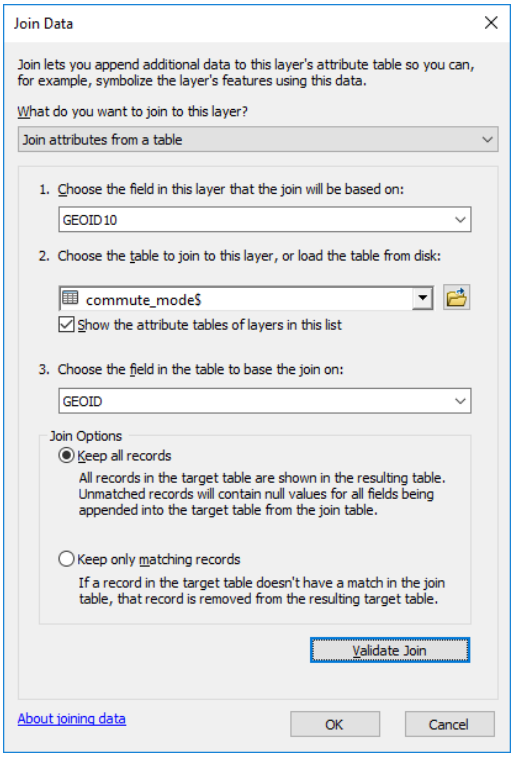


To get a percentage of the total population, go to the original Cambridge and Somerville block group layer and summarize the population field.

OBJECTIVE 9: USE THE PROPORTIONAL SPLIT ESTIMATION METHOD TO GET COMMUTER %

In objective 8, we calculated an estimate of population based on the Proportional Split disaggregation method. The next objective is similar, except we are going to look at the percentage of commuters 16 years old and over that commute to work by car within ½ mile of the proposed Union Square stop. The

American Community Survey collects commuter data. You can download it at Social Explorer—it is Table 128: Means of Transportation to Work for Workers 16 Years and Over. But for this exercise we have downloaded it and placed it in the Data folder for the week in a CSV called CambridgeSomerville_Commuters_2017.csv. The file is based on an extract of the most current American Community Survey available from 2013-2017. Use this data to find the number of car commuters near Union Square.



1. Add the commute_mode.xls file to your document, the sheet is also called **commute_mode**.

2. Click on the **UnionSquare_BlkGrp_Intersect** file that contains the block groups intersected with our Union Square buffer, and the area calculations we have completed in the previous steps. Join the **commute_mode spreadsheet** to this dataset based on the **GEOID** primary key. Your join window should look like the dialog to the left. Once set, click OK.

3. Your attribute table for **UnionSquare_BlkGrp_Intersect** will now have the commute data joined to the block groups. **Export the joined layer as a new SHP called UnionSq_Block_Commute.shp** and add it to your map.

We will now calculate the proportional split to determine the number of car and truck commuters in each block group within ½ mile of the proposed station.

Add three fields to the attribute table, make them all type DOUBLE – and name them **PROP_WORK** (for the proportion of the total number of workers 16 years and over), **PROP_CAR** (for the proportion of the total number of car and truck commuters 16 years and over), and **PERC_CAR** (for the percentage of workers that commute by car or truck in each block group). Your table should look like the following.

Table

UnionSquare_BlkGrp_Intersect

CAR_TRUCK	PUBLIC_TRA	MOTORCYCLE	BICYCLE	WALK	OTHER	WORK_AT_HO	PROP_WORK	PROP_CAR_1	PERC_CAR
199	168	0	85	187	0	51	0	0	0
224	283	0	83	294	0	36	0	0	0
363	192	0	11	126	9	33	0	0	0
548	279	0	115	221	0	8	0	0	0
157	46	0	72	72	0	0	0	0	0
219	184	0	24	125	0	41	0	0	0
444	323	0	141	207	0	56	0	0	0
366	195	0	17	170	0	17	0	0	0
152	103	0	63	156	0	22	0	0	0
264	190	0	116	250	16	6	0	0	0
345	169	0	66	71	0	107	0	0	0
666	353	0	80	114	0	35	0	0	0
229	44	0	73	41	8	72	0	0	0
172	71	0	13	33	0	0	0	0	0
316	158	0	35	29	65	40	0	0	0
263	200	0	43	109	0	0	0	0	0
187	33	0	109	140	9	19	0	0	0

(0 out of 24 Selected)

UnionSquare_BlkGrp_Intersect

4. Right click on the PROP_WORK field and go to field calculator. Here find the proportional split estimate of workers aged 16 years and over. Use the following fields and equation.

```
[WKRS_16PLU]*( [PROP_SQMI]/ [AREA_SQMI])
```

Click OK to calculate. Right click and get statistics on the field, the total number of workers 16 and over is approximately 10,207 persons.

5. Right click on the PROP_CAR field and go the field calculator. Here find the proportional split estimate of workers 16 years and over that commute by car or truck to work. Use the following fields and equation.

```
[CAR_TRUCK] *( [PROP_SQMI]/ [AREA_SQMI])
```

Click OK to calculate. Right click and get statistics on the field, the total number of workers 16 and over that commute by car is approximately 4,233 persons.

6. Finally, lets calculate the percentage. Right click on PERC_CAR and go to the field calculator. Here find the percentage of workers who commute by car or truck compared to the total percentage of commuting workers aged 16 years and over. Use the following equation.

```
[PROP_CAR] / [PROP_WORK]
```

Note: Total numbers will not affect percentage, so we can use either our proportional populations or total populations. Click OK to calculate. Your final table should look like the following.

Table

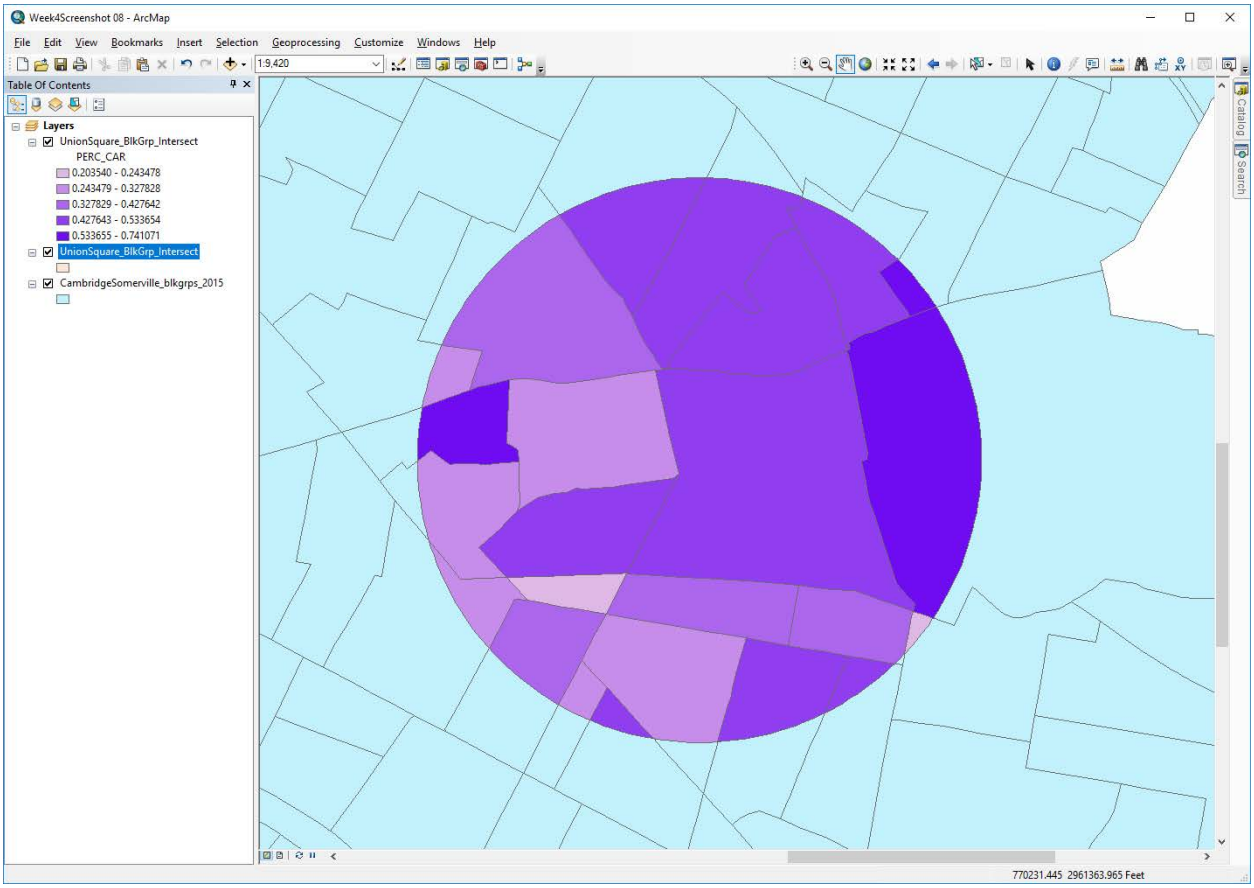
UnionSquare_BlkGrp_Intersect

CAR_TRUCK	PUBLIC_TRA	MOTORCYCLE	BICYCLE	WALK	OTHER	WORK_AT_HO	PROP_WORK	PROP_CAR_1	PERC_CAR
199	168	0	85	187	0	51	91.951836	26.519443	0.288406
224	283	0	83	294	0	36	24.780342	6.033475	0.243478
363	192	0	11	126	9	33	73.993853	36.59369	0.49455
548	279	0	115	221	0	8	137.408764	64.304016	0.467976
157	46	0	72	72	0	0	188.365285	85.225792	0.45245
219	184	0	24	125	0	41	589.168449	217.584975	0.369309
444	323	0	141	207	0	56	925.229489	350.812889	0.379163
366	195	0	17	170	0	17	765	366	0.478431
152	103	0	63	156	0	22	496	152	0.306452
264	190	0	116	250	16	6	718.285579	225.21068	0.313539
345	169	0	66	71	0	107	611.399518	278.275506	0.455145
666	353	0	80	114	0	35	412.393718	220.075494	0.533654
229	44	0	73	41	8	72	467	229	0.490364
172	71	0	13	33	0	0	32.836559	19.542865	0.595156
316	158	0	35	29	65	40	452.136825	222.20099	0.491446
263	200	0	43	109	0	0	615	263	0.427642
187	33	0	109	140	9	19	244.028282	91.817482	0.376258

0 (0 out of 24 Selected)

UnionSquare_BlkGrp_Intersect

7. Symbolize the map based on the percentage of workers who commute by car. My map document, when complete, appears the like the following. Save your map document.



11.205 Introduction to Spatial Analysis

Fall 2019