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[Lancaster County Urban Growth Boundary]

Foreword

I followed every step of the assignment, but several parts were customized based on my own understanding to this assignment, including removing polygons in Step 5 and defining the density of buildings in Step 6, which may result in different outcomes of data. Thanks for different questions post on Piazza, I also got a lot of hints for procedures.

Coordinate system of map deliverables

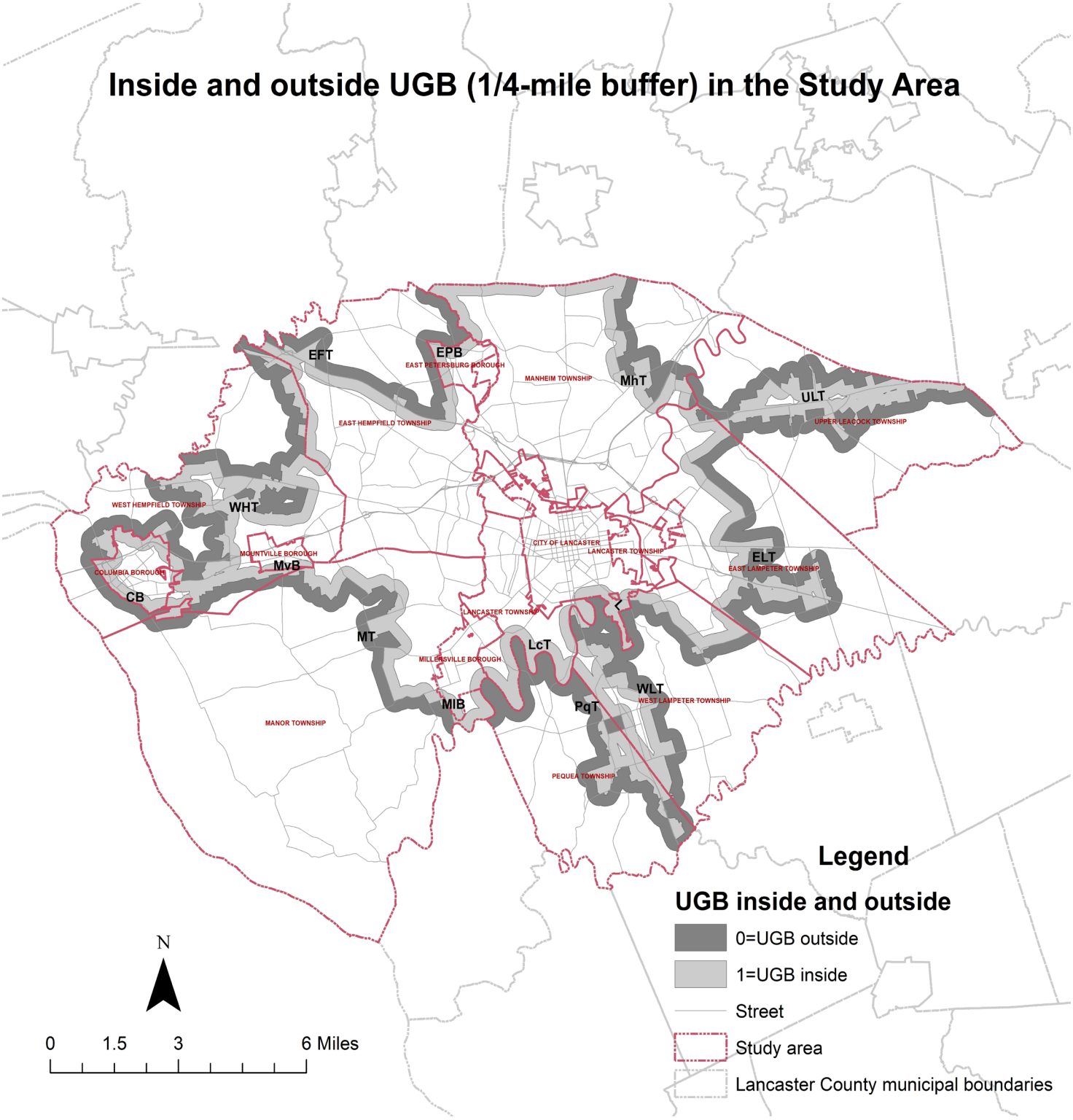
Projected coordinate system: NAD_1983_StatePlane_Pennsylvania_South_FIPS_3702_Feet

Geographic coordinate system: GCS_North_American_1983

Town names and abbreviation

City of Lancaster	L
Columbia Borough	CB
East Hempfield Township	EFT
East Lampeter Township	ELT
East Petersburg Borough	EPB
Lancaster Township	LcT
Manheim Township	MhT
Manor Township	MT
Millersville Borough	MIB
Mountville Borough	MvB
Pequea Township	PqT
Upper Leacock Township	ULT
West Hempfield Township	WHT
West Lampeter Township	WLT

I.Urban growth boundary (UGB) symbolized with the inside and outside categories and respective municipality



There are 14 municipalities in the study area. I removed the "island" polygons based on my own judgment, and I tried to keep the enclosed UGB and removed weired little UGBs in the center. Due to the limited space on map and to keep the layout clean, I abbreviated the town names for the respective municipalities of inside and outside UGB buffer, and removed duplicated labels. From the map, I noticed that not all the towns in the study area have buffered UGB both inside and outside.

2. Inside and outside UGB comparison table

Table 1. Mean square foot of buildings

	Mean square foot of buildings		
Municipality	Inside	Outside	Difference
CITY OF LANCASTER	1570.4	N/A	1570.4
COLUMBIA BOROUGH	2495.5	3575.0	-1079.4
EAST HEMPFIELD TOWNSHIP	5385.1	3083.0	2302.0
EAST LAMPETER TOWNSHIP	4108.4	3463.9	644.5
EAST PETERSBURG BOROUGH	2089.7	N/A	2089.7
LANCASTER TOWNSHIP	1926.2	N/A	1926.2
MANHEIM TOWNSHIP	2706.5	2804.8	-98.3
MANOR TOWNSHIP	2726.5	2438.3	288.2
PEQUEA TOWNSHIP	1866.6	1689.3	177.3
UPPER LEACOCK TOWNSHIP	4039.1	2582.5	1456.6
WEST HEMPFIELD TOWNSHIP	2091.1	2015.9	75.2
WEST LAMPETER TOWNSHIP	2262.7	3429.2	-1166.5

I omitted Millersvile Borough and Mountville Borough, because they both lack outside data, so in tables, there are 12 out of 14 towns left. The mean square foot of buildings is calculated by (total square footage of buildings / total number of buildings) for each municipality. There are also several "N/A"s in the table, it means that there is no building (no data) for UGB outside of the respective town. Thus, for the difference, I directly took the inside value, which means I regard "N/A" to be 0.

Table 2. Density of buildings

	Density of buildings (number/acre)			Density of buildings (total square footage/acre)		
Municipality	Inside	Outside	Difference	Inside	Outside	Difference
CITY OF LANCASTER	0.5	0	0.5	721.0	0.0	721.0
COLUMBIA BOROUGH	1.3	3.8	-2.5	3196.3	13742.6	-10546.3
EAST HEMPFIELD TOWNSHIP	0.7	0.3	0.4	3826.6	807.1	3019.5
EAST LAMPETER TOWNSHIP	1	0.3	0.7	4041.9	1162.1	2879.8
EAST PETERSBURG BOROUGH	2.1	0	2.1	4453.5	0.0	4453.5
LANCASTER TOWNSHIP	0.6	0	0.6	1158.6	0.0	1158.6
MANHEIM TOWNSHIP	0.8	0.2	0.6	2137.2	435.4	1701.8
MANOR TOWNSHIP	0.7	0.2	0.5	2028.9	572.4	1456.5
PEQUEA TOWNSHIP	1.2	0.4	0.8	2153.5	604.0	1549.5
UPPER LEACOCK TOWNSHIP	1.5	0.3	1.2	5995.7	680.5	5315.2
WEST HEMPFIELD TOWNSHIP	1.4	0.2	1.2	2962.6	412.7	2549.9
WEST LAMPETER TOWNSHIP	1.6	0.2	1.4	3530.7	564.9	2965.8

Thanks for Eugene Chong's idea on Piazza. I took 2 ways for calculating the density of buildings: 1) density of buildings = total number of buildings / acre, 2) density of buildings = total square footage of buildings / acre. Because currently I don't know if there are more single-family housing or multi-family housing in the study area, I would like to see both the number of buildings per acre and the square footage of buildings per acre. Finally, most difference values are positive for both methods, except Columbia Borough, which shows inside UGB, the buildings normally share a higher density than outside UGB.

Table 3. Travel and parking

	Sum of daily vehicle miles traveled			Mean square foot of parking lots		
Municipality	**Inside**	**Outside**	**Difference**	**Inside**	**Outside**	**Difference**
CITY OF LANCASTER	22725	0	22725	11341.0	N/A	11341.0
COLUMBIA BOROUGH	373400	2563	370837	30142.7	N/A	30142.7
EAST HEMPFIELD TOWNSHIP	480358	243091	237267	70258.3	103400.2	-33141.9
EAST LAMPETER TOWNSHIP	303235	174032	129203	61617.3	90746.9	-29129.7
EAST PETERSBURG BOROUGH	77155	55459	21696	15670.0	65111.0	-49441.0
LANCASTER TOWNSHIP	53954	15942	38012	17791.9	N/A	17791.9
MANHEIM TOWNSHIP	314456	409475	-95019	23207.8	78875.9	-55668.1
MANOR TOWNSHIP	67169	80963	-13794	8157.5	42706.0	-34548.5
PEQUEA TOWNSHIP	101010	129299	-28289	28881.0	27672.0	1209.0
UPPER LEACOCK TOWNSHIP	190785	134128	56657	55498.3	95737.6	-40239.3
WEST HEMPFIELD TOWNSHIP	682454	660694	21760	47151.0	56220.8	-9069.8
WEST LAMPETER TOWNSHIP	176114	147049	29065	27213.4	25352.2	1861.2

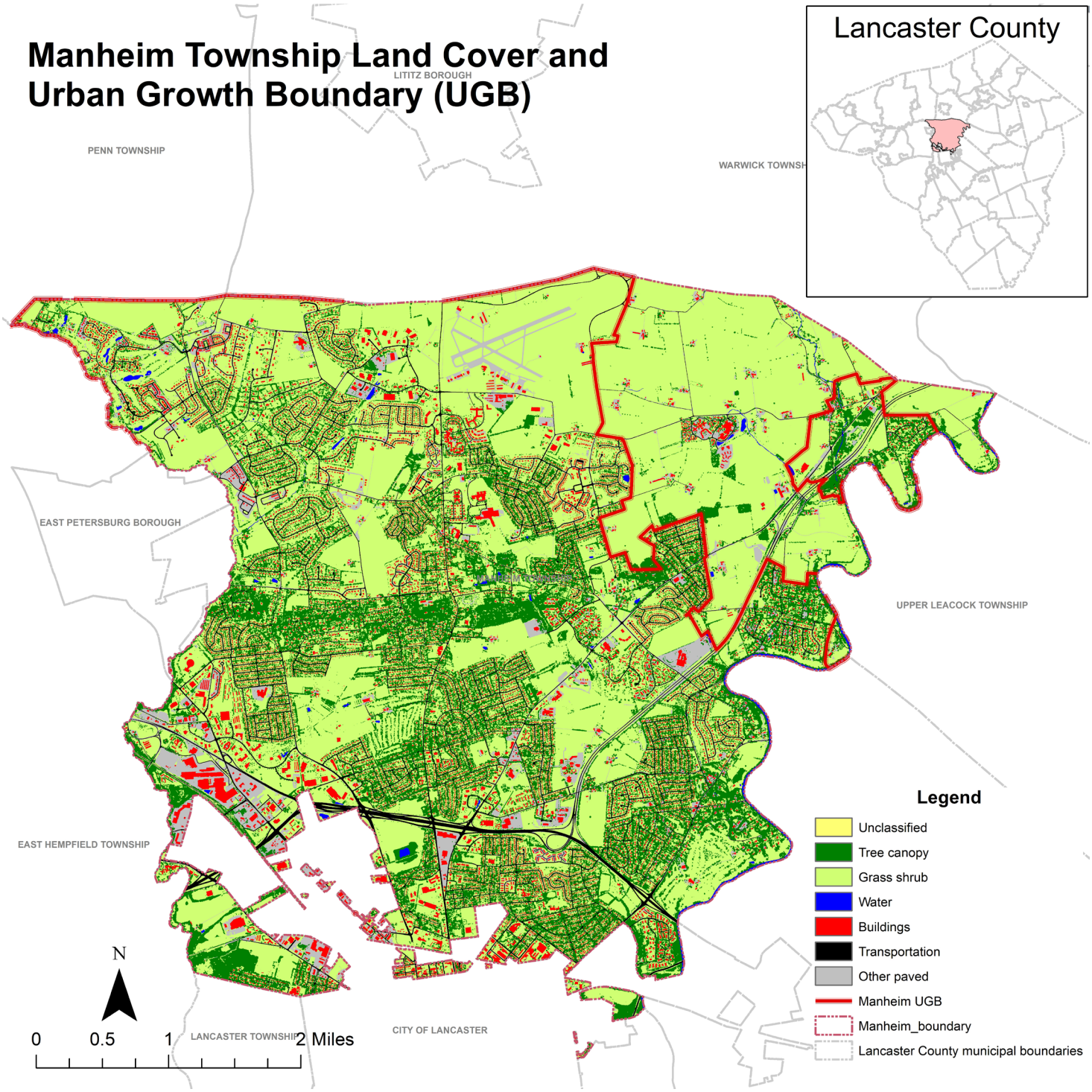
Similarly, there are also several "N/A"s in the table for mean square foot of parking lots, it means that there is no parking lots (no data) for UGB outside of the respective town as well.

Table 4. Grass shrub land in proposed UGB extension

Municipality	Grass shrub land in proposed UGB extension (Acres)	Proposed UGB extension area (Acres)	%Grass shrub land in proposed UGB extension
CITY OF LANCASTER	0.01	0.12	8.9%
COLUMBIA BOROUGH	0.03	0.52	5.2%
EAST HEMPFIELD TOWNSHIP	1365.05	1585.29	86.1%
EAST LAMPETER TOWNSHIP	1867.52	2229.49	83.8%
EAST PETERSBURG BOROUGH	0.93	2.42	38.2%
LANCASTER TOWNSHIP	N/A	0.01	N/A
MANHEIM TOWNSHIP	714.77	843.96	84.7%
MANOR TOWNSHIP	1374.24	1703.96	80.6%
PEQUEA TOWNSHIP	1424.64	2321.57	61.4%
UPPER LEACOCK TOWNSHIP	2334.38	2599.68	89.8%
WEST HEMPFIELD TOWNSHIP	2408.64	3932.06	61.3%
WEST LAMPETER TOWNSHIP	1520.34	2203.60	69.0%

I calculated the acres of grass shrub land in the outside buffer of UGB, but only Lancaster Township doesn't have data. In order to see the proportion of grass shrub land in the proposed UGB extension, I also calculated the acres of proposed UGB extension for each municipality, which is just the area of the outside 1/4-mile buffer of UGB. From the result, we can see the proportion of grass shrub land ranges from about 5% to almost 90%.

3. Manheim Township



I choose Manheim Township as the best qualified town to receive the new development permits. From Lancaster County map, Manheim Township is located at the center of the county, north of City of Lancaster. Manheim Township has 15,421.6 acres. From the land use, grass shrub and tree canopy occupy a considerable amount of land in Manheim Township.

Why did I choose Manheim Township?

I read news about the Portland metro area urban growth boundary. In 2008, metro staff have officially recommended expanding the UGB in four cities. The recommended expansion nearly of 2,200 acres is largely aimed at increasing the available land for single-family housing—with approximately 6,100 of the 9,200 new housing units projected to be single-family residences. The main drive to extend the urban growth boundary for Portland is the inadequate land for increasing housing. Therefore, I customized the criteria for choosing the most suitable town to extend its UGB with a primary focus on housing:

NO.1. Housing/building characteristics
NO.2. Land availability
NO.3. Parking lot characteristics

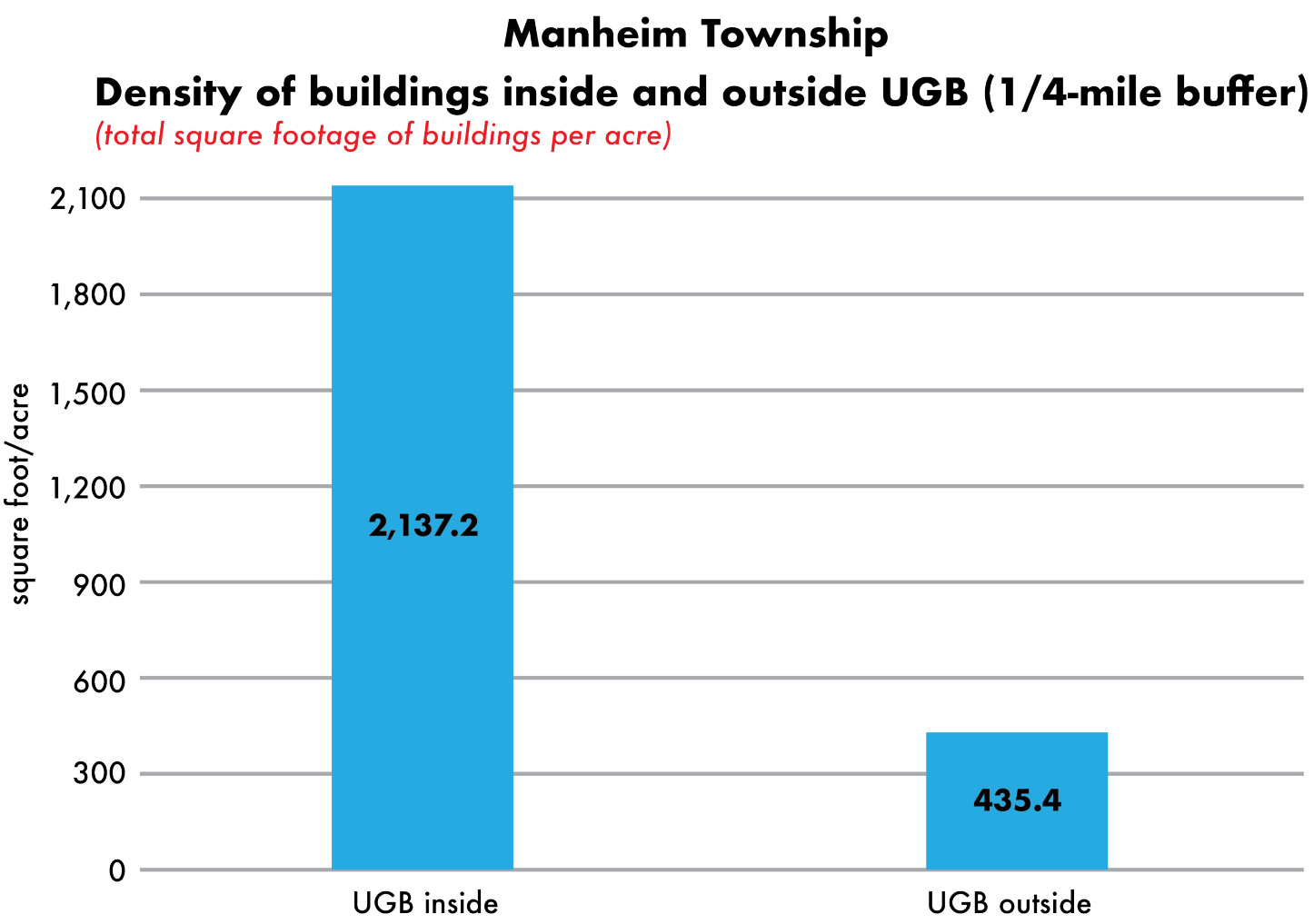
My selection is only based on the data of UGB comparison tables. I disregarded vehicle miles travelled (VMT) because I don't think it is very important for UGB, instead, I think VMT is more significant to study jobs-housing balance.

Firstly, I think the difference of mean square foot of buildings should be negative, with a positive difference of building densities between inside and outside, so that the buildings inside UGB seem to be more packed in size and density. This criteria mainly drives UGB extension because more land is needed to accommodate more buildings with more space. This criteria only brings Manheim Township and West Lampeter Township.

Secondly, I would like to see the land availability by focusing on grass shrub area outside UGB. If there is a higher proportion of grass shrub, it means that more land can be exploited and the grass shrub can be turned into land for buildings. Outside UGB and within the a quarter mile buffer, Manheim Township has 84.7% land with grass shrub, and West Lampeter has 69%. Both proportions are relatively high. Then I went to the third criteria, the mean square footage of parking lots.

Thirdly, I think the difference of mean square foot of parking lots should be negative as well. If the parking lots inside UGB are much smaller than the parking lots outside UGB, the quantity and the size of parking lots may not be enough, and from the statistics, there are actually more parking lots inside UGB. Therefore, beside building characteristics, parking lots can also represent development. In this criteria, only Manheim Township has a negative value of the difference of mean square foot of parking lots between inside and outside. So finally, at this last step, I choose Manheim Township to receive the new development permits.

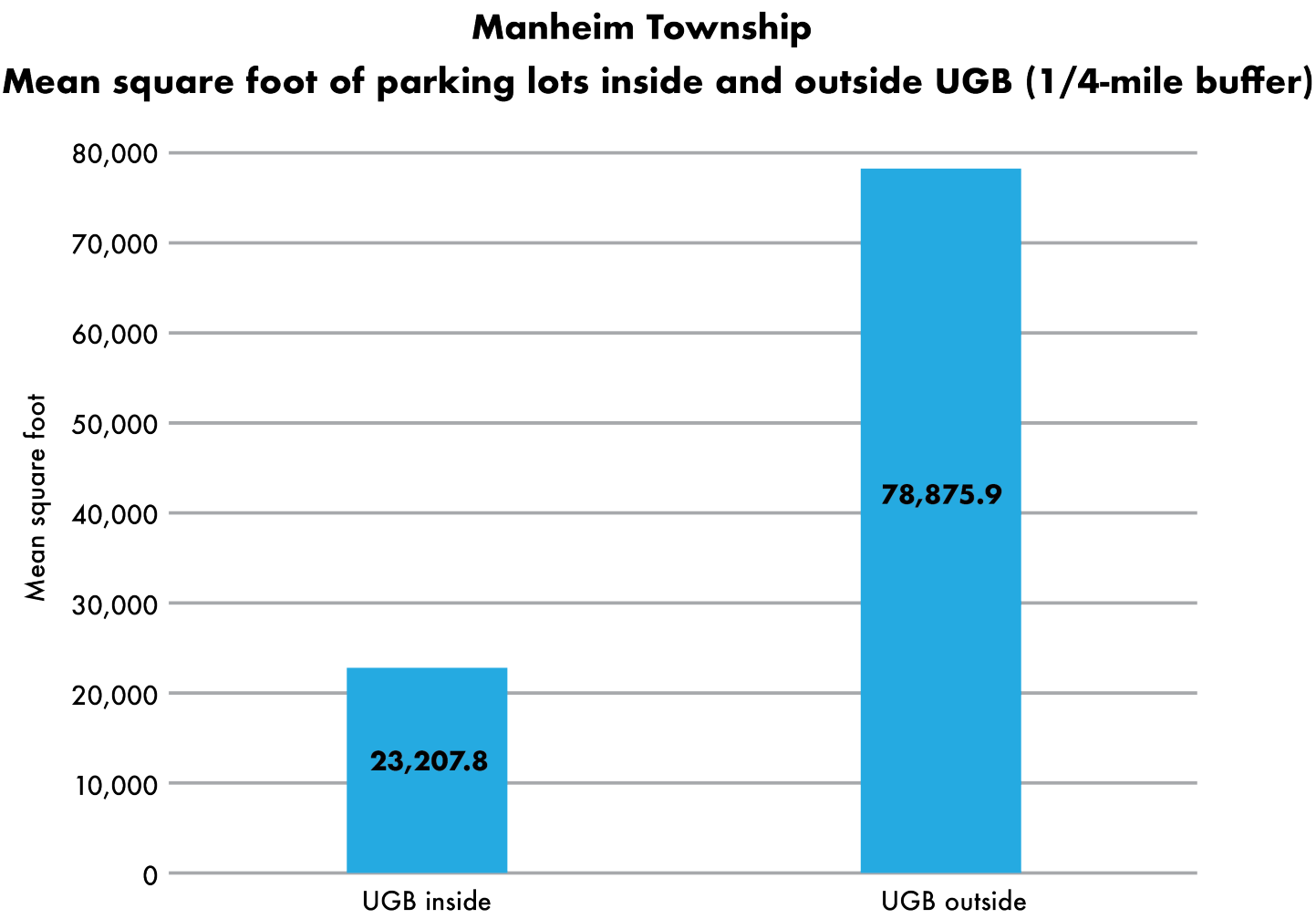
Figure 1. Difference of density of buildings inside and outside UGB



Following the selection criteria, as a part of the NO.1 criteria, the density of buildings inside and outside UGB can evaluate the adequacy of land to accomodate more housing and people. Compared with the mean square foot of buildings, I think the density of buildings is more significant and representative to look at UGB extension, because density emphasizes the compactness of buildings more.

Here I chose "total square footage of buildings per acre" as the density for the bar graph. Although the inside-outside difference for "number of buildings per acre" is 0.6, it is more explicit to show a large difference in total square footage of buildings per acre. From the graph, the square footage of buildings per acre inside is 2137, while outside is only 435, resulting in about 1702 square foot difference.

Figure 2. Difference of mean square foot of parking lots inside and outside UGB



As the second most important variable, the size of parking lots complements the density of buildings in demonstrating the compactness of buildings and the population. Cars are essential in the country, the average number of cars per household is about 2. According to the statistics, there are more parking lots inside the UGB than outside, but the mean square foot of parking lots inside the UGB is significantly smaller than outside. Therefore, as the population grows, the difficulty for parking will increase inside the UGB, because the size of parking lots is limited. Meanwhile, the town should increase more parking lots, but obviously, it requires more land. On the other hand, outside UGB are fewer parking lots with larger sizes, such imbalance of parking lots is an opportunity for Manheim for new development and extending its UGB to accomodate more population and their vehicles, also make full use of the parking lots outside UGB.

The difference of mean square foot of parking lots inside and outside UGB for Manheim is -55,688, which means in average, the parking lots outside UGB is 55,688 square feet larger than the parking lots inside UGB. The difference is also the biggest one among municipalities in the study area.