

Urbanization Analysis of Lady Bird Lake Watershed

Austin, Texas

GIS & GPS Applications in Earth Science

Final Project Report

Sarah Alverson

Problem Formulation

In August of 2019, a Toxic Blue Green Algal bloom in Town Lake caused the death of 5 dogs. Blue Green Algae is very common and not all strains of it are toxic, but this is the first instance of toxin levels reaching a deadly level (a Harmful Algal Bloom, or HAB) in Town Lake. While we now have a toxin and risk monitoring system in place, we do not understand the main causes of the increased toxicity of the algal bloom. Some contributing factors to algal blooms in general are excess nutrients (either due to contaminated runoff or other sources such as zebra mussels), increased summer temperatures, and decreased flow rates due to climate change. Town Lake specifically experienced runoff from increased storms and flooding in the year prior to 2019 (recall the boil water notice of 2018), which could not be easily controlled, but an underlying trend of increased runoff due to urbanization of the watershed could contribute and is controlled by the City of Austin.

I am investigating the urbanization of the watershed surrounding the Lake to determine if there is any leverage point for intervention from the City of Austin to decrease the likelihood that we will encounter another HAB in Town Lake. *I predict that an urbanization analysis of the watershed for Town Lake (Lady Bird Lake) will demonstrate a trend of decreasing permeable areas over time (specifically between 2010 and 2020) as a proxy for increased runoff.*

To analyze the urbanization of the watershed, I used land use data and codes to identify permeable land within Lady Bird Lake watershed and added the park land to the permeable land parcels. I then compared the total area of permeable land between 2010 and 2020 as well as visualized the change over time. I found that while there were a few added permeable land parcels in 2020, there was an overall loss of about 20 acres. This indicates that increased runoff should be investigated as a potential driver in the HAB events and that increased permeability or runoff treatment could help decrease algal growth in Lady Bird Lake.

Data Collection

I used open data from the City of Austin open data portal (see Figures 1 and 2 for reference) because my study area was solely within Austin city limits. The portal website itself had the majority of the metadata and would not usually provide attached metadata in the shapefiles I downloaded. A notable metadata file was a .txt file that was stored separate from the 2010 land use data that provided a key for the land use codes. This was significant in determining what land codes represented permeable land use and I used it to create table 2. All other metadata is summarized in table 1 below.

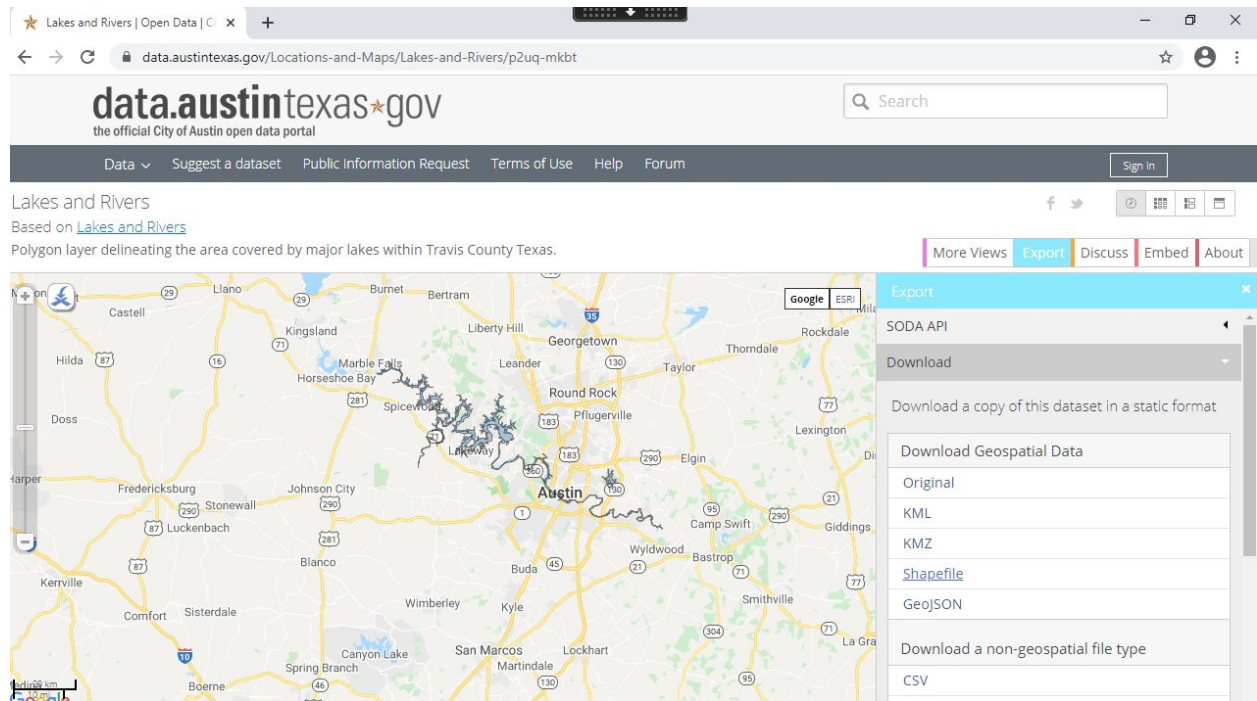
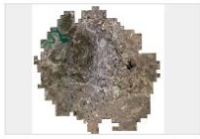


Figure 1: Open Data Portal for Austin, Texas Showing the Lakes and Rivers Data Download Options

2018 True Color Imagery

Overview



2018 Aerial Imagery

Tile Layer by CTM.Publisher

Created: Aug 25, 2018 Updated: Dec 2, 2020 View Count: 4,051

Description

An in-depth description of the item is not available.

Layers

[IMAGERYBASEMAPSEARTHCOVER.md_2018_01_6in_tc](#)

[Boundary](#)

[Footprint](#)

[Image](#)

[Boundary](#)

- Open in Map Viewer
- Open in Scene Viewer
- Open in ArcGIS Desktop
 - Open in ArcMap
 - Open in ArcGIS Pro

Details

Source: Map Service

Created from: 2018_tc_6in, Tile Package

Size: 112,119 MB

★★★★★



Share

Figure 2: Austin Texas Open data portal to access ArcGIS Online Files

Table 1: Metadata

Data	Source Name	URL	Spatial Reference	Currency	Features Represented
Land Use 2010	City of Austin Open Data portal - Planning and Development Review	https://data.austintexas.gov/Geodata/2010-Land-Use/uj-et-yfq2	West -98.026303 East -97.472847 North 30.522159 South 30.033282	Metadata Last Updated May 4, 2015 Date Created May 4, 2015	Polygons of parcels with attributes of their land use code
Land Use 2020	City of Austin Open Data portal - EGS Data Services - Planning and Zoning	https://data.austintexas.gov/Locations-and-Maps/Land-Use-Inventory-Detailed/fj9m-h5qy	West -98.019510 East -97.480345 North 30.516851 South 30.042994	created Nov 16, 2017 updated Dec 6, 2020	Polygons of parcels with attributes of their land use code
Lake Boundary	City of Austin Open Data portal - EGS Data Services - Watershed Protection & Development Review	https://data.austintexas.gov/Locations-and-Maps/Lakes-and-Rivers/p2uq-mkbt	West -97.788217 East -97.713528 North 30.294050 South 30.243509	created Mar 5, 2015 updated Dec 6, 2020	Polygons of lake and river areas
Park Boundary	City of Austin Open Data portal - EGS Data Services - City of Austin Parks Department	https://data.austintexas.gov/d/8f2b-a4q5?category=Locations-and-Maps&view_name=BOUNDARIES_city_of_austin_parks	West -97.922763 East -97.572346 North 30.516658 South 30.130341	created Nov 16, 2017 updated Dec 6, 2020	Polygons of park areas
Low Flow Watershed Boundary	City of Austin Open Data portal - Watershed Protection	https://data.austintexas.gov/Locations-and-Maps/Watershed-Boundary-Low-Flow/yfaf-uvsu	West -98.297353 East -97.356571 North 30.628657 South 29.923007	created Aug 9, 2015 updated Aug 28, 2020	Polygons of the watersheds in low flow conditions, have attributes of names and where the water in the

					watershed flows
2018 true Color Imagery	City of Austin - ArcGIS Online	http://www.arcgis.com/home/item.html?id=19cce9c2094c4f4dbca78a8b589c6657	West 3022404.9998 47 ft East 3201272.0000 52 ft North 10166805.999 938 ft South 9984065.9999 33 ft	Created: Aug 25, 2018 Updated: Dec 2, 2020	Satellite imagery of Austin for reference

Data Preprocessing

No data was preprocessed.

ArcGIS Processing

Below is a step-by-step guide for the ArcGIS processing and analysis, first written out, then demonstrated with screenshots.

1. Find appropriate watershed
 - a. In lake boundary layer- selection by attribute for name of body of water = 'Lady Bird Lake', use to visually identify the watershed containing LBL
 - b. Delete all other polygons not selected
 - c. In watershed layer - selection by attribute for name of watershed = 'Lady Bird Lake' confirm that it encircles the lake
 - d. delete all other polygons not selected
2. Clip layers to watershed
 - a. Use analysis clip tool for park boundary, Land use 2010, and Land Use 2020 layers
3. Combine Land Use Codes
 - a. Create new "Permeable" field where 1=permeable and 0=impermeable for all layers to be dissolved or merged (a field with properties: float with a precision of 2)
 - b. Select by attribute (see table 1)
 - c. View selection in attribute table and change Permeable field value to 1
 - d. Use dissolve tool on 2020 and 2010 land use layers and select the permeable field
4. Merge park land to land used codes
 - a. *Created new "Permeable" field for Park layer in step 3a
 - b. Use merge data management tool to merge park and land use layers to create a total 2010 and total 2020 layer
 - c. Verified that the Merged layer area changes made sense and reported the area using the statistics option in the attribute table of the newly merged layers
 - d. Create new area field and recalculate the geometry if the area fields did not merge properly
5. Visualized the change in area
 - a. Opened imagery file from arcgis online and saved as a layer file for a basemap and visual reference
 - b. Used Intersect tool to visualize the area that was in both years
 - c. symbolize both 2010 and 2020 layers so that impermeable land is the same color as the intersection polygon and the 2010 permeable land is red and 2020 permeable land is green
 - d. Created layout highlighting the lost area in 2010 (red) and the gained area in 2020 (green)

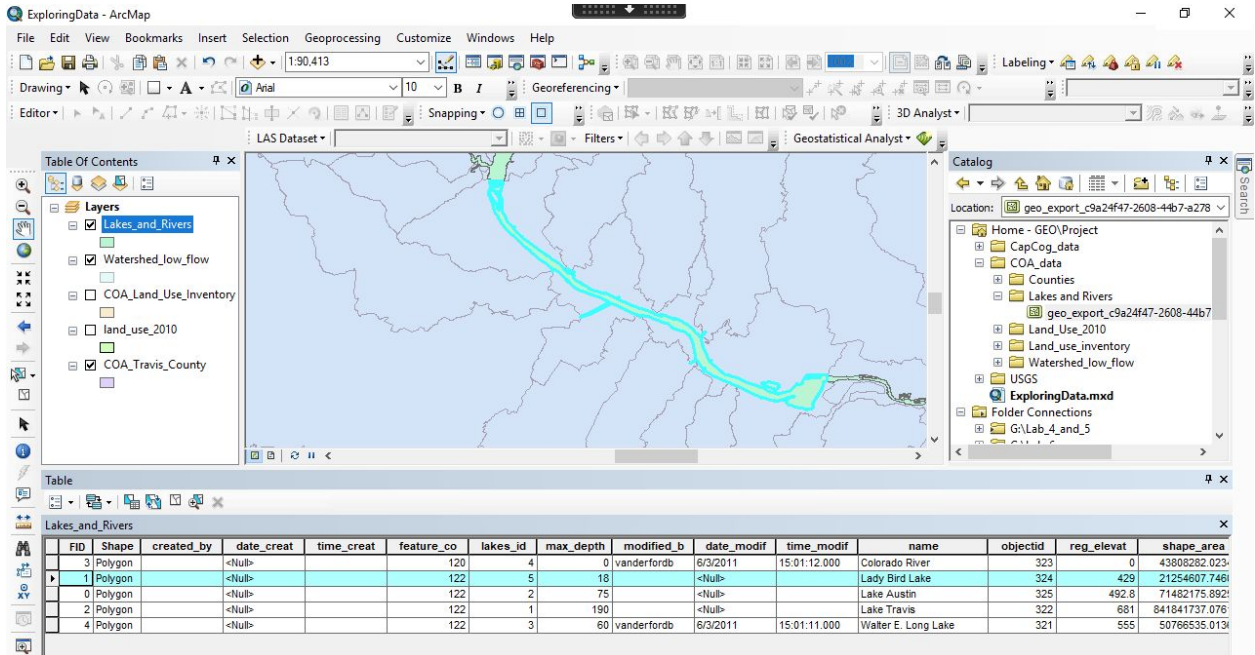


Figure 3. Step 1a: Selection by attribute for Lady Bird Lake

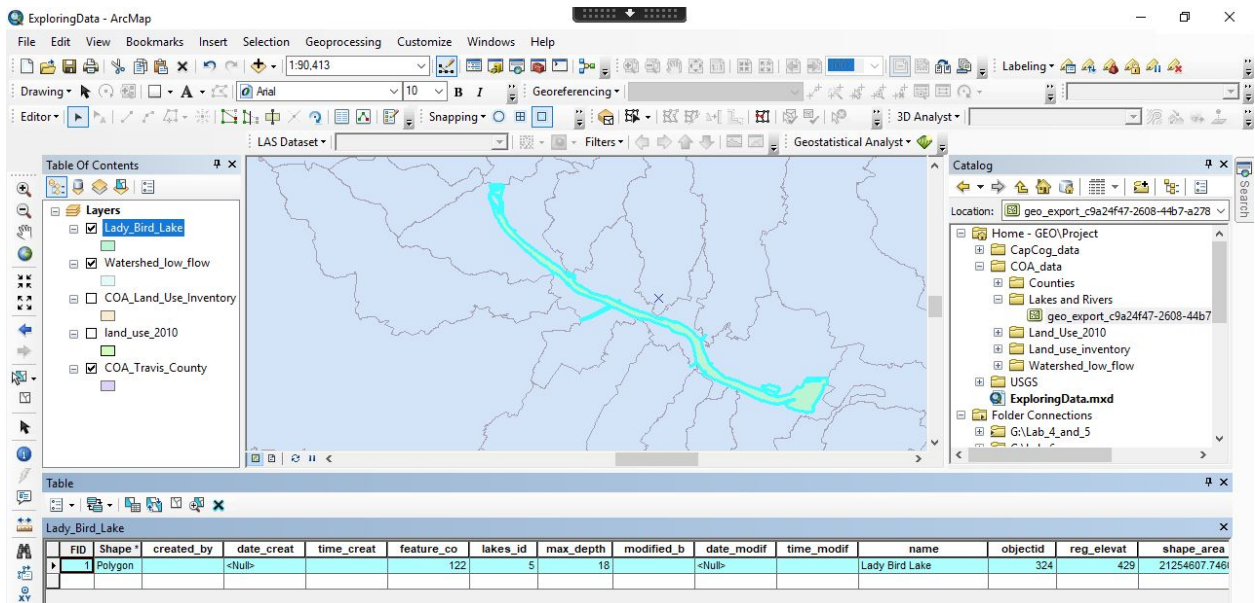


Figure 4. Step 1b: Delete all other polygons not selected to leave only the Lady Bird Lake polygon

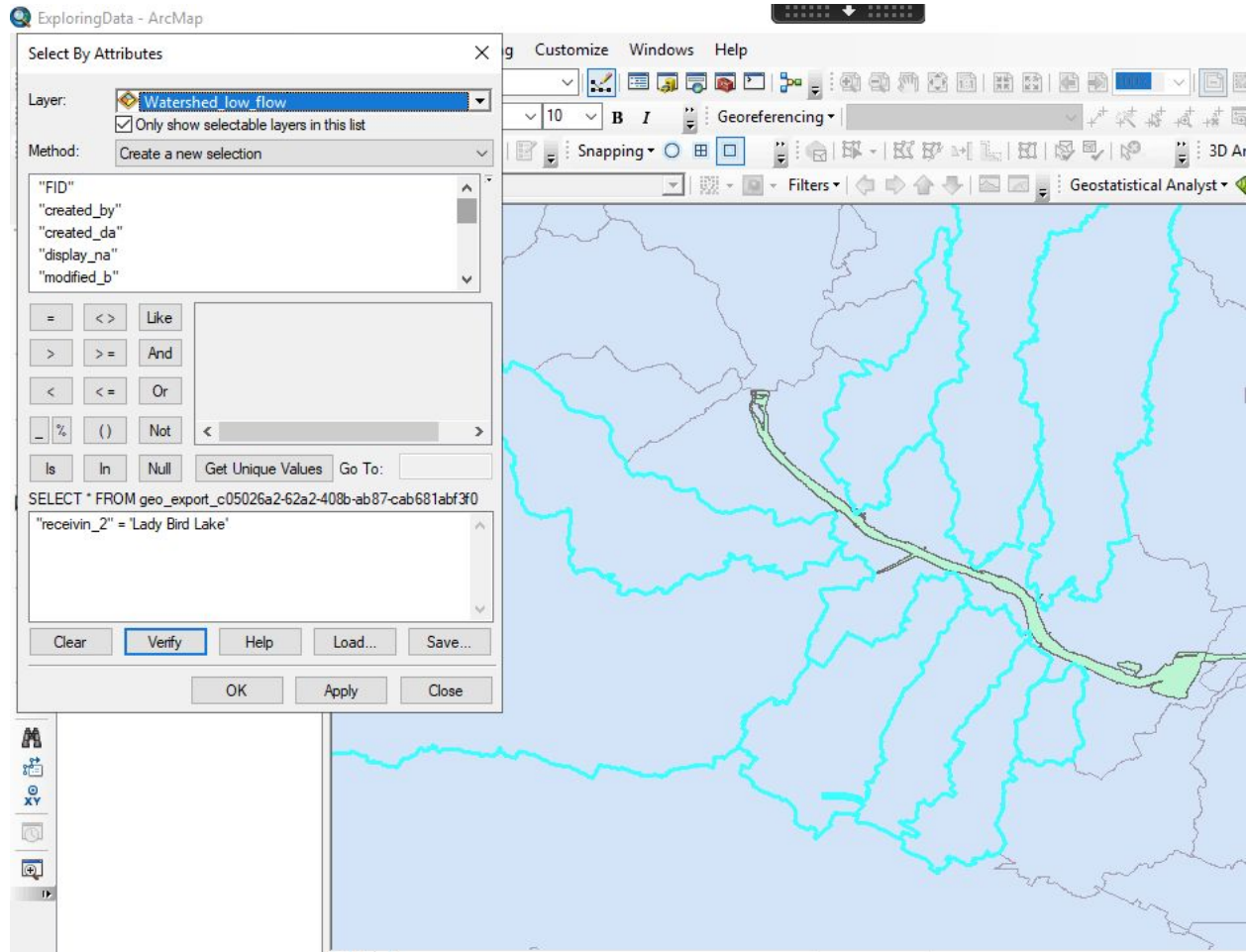


Figure 5. Step 1c: Discovering that receivin_2 is not the attribute I should be looking for - final selection query is "display_na" = 'Lady Bird Lake'

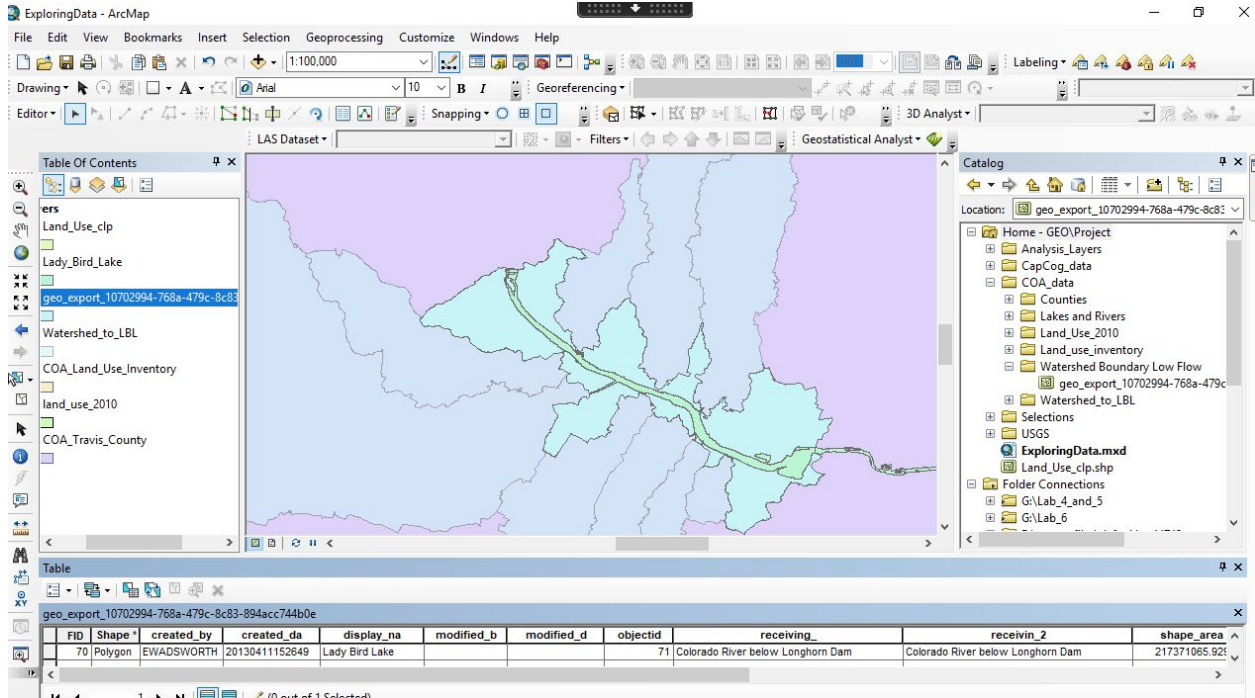


Figure 6: Step 1d: Final product of only selecting “display_na” = ‘Lady Bird Lake’ and deleting all other polygons

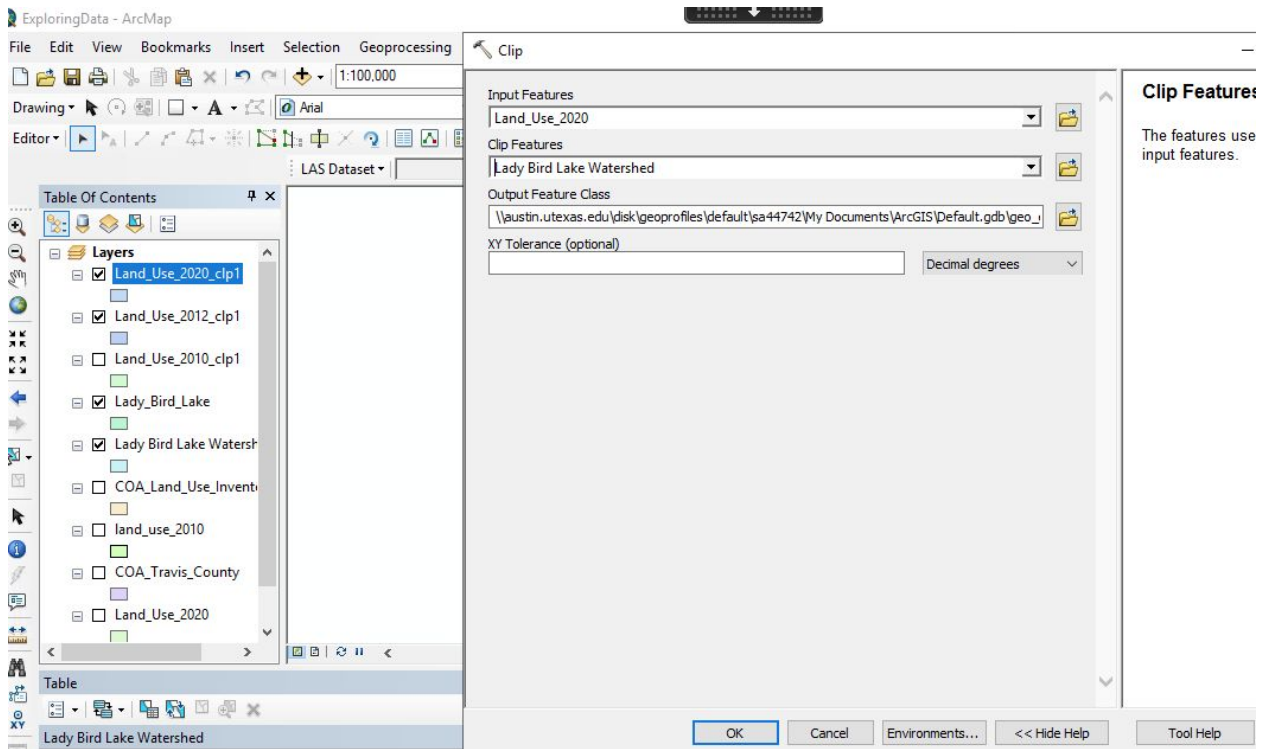


Figure 7: Step 2a: Using Clip tool to clip the Land_Use_2020 polygons to the Lady Bird Lake Watershed Polygon

The screenshot shows the ArcMap interface with the 'Select By Attributes' dialog box open. The dialog box is set to 'Layer: Land_Use_2020_clp1' and 'Method: Create a new selection'. The SQL query is: `SELECT * FROM Land_Use_2020_clp1 WHERE: "land_use" = 670 OR "land_use" = 710 OR "land_use" = 720 OR "land_use" = 740 OR "land_use" = 750 OR "land_use" = 900`. Below the dialog box, a data table is visible with the following columns: land_use_i, modified_b, date_modif, time_modif, objectid, parcel_id, property_i, shape_area, shape_leng, and Permeable. The Permeable column contains zeros for all rows.

land_use_i	modified_b	date_modif	time_modif	objectid	parcel_id	property_i	shape_area	shape_leng	Permeable
106259	<Null>			106259	0205102501	193482	5814.78125	348.604081	0
106232	<Null>			106232	0205100808	193395	5753.435547	345.738979	0
106005	<Null>			106005	0205100302	193318	5743.384766	345.45939	0
106215	<Null>			106215	0202110110	189590	7370.871094	398.659404	0
106190	<Null>			106190	0203041016	191015	6316.146484	366.606377	0
106250	<Null>			106250	0202110308	189621	5160.882813	362.331222	0
106187	<Null>			106187	0203040904	190981	6322.59375	370.218023	0
106219	<Null>			106219	0202110210	189606	7432.960938	399.131173	0
106231	<Null>			106231	0205100806	193393	5709.478516	344.570707	0
106227	<Null>			106227	0205101709	193552	6088.152344	353.812133	0
106253	<Null>			106253	0202110417	189650	5170.314453	359.358122	0
106252	<Null>			106252	0202110420	189653	6985.658203	447.303621	0
106185	<Null>			106185	0202050102	188638	5018.40625	300.546782	0
106222	<Null>			106222	0204100512	192066	7523.615234	417.135091	0

Figure 8: Step 3b: Select by attribute to identify the polygons with land use codes that are considered permeable, Note: Permeable field is created but not yet filled

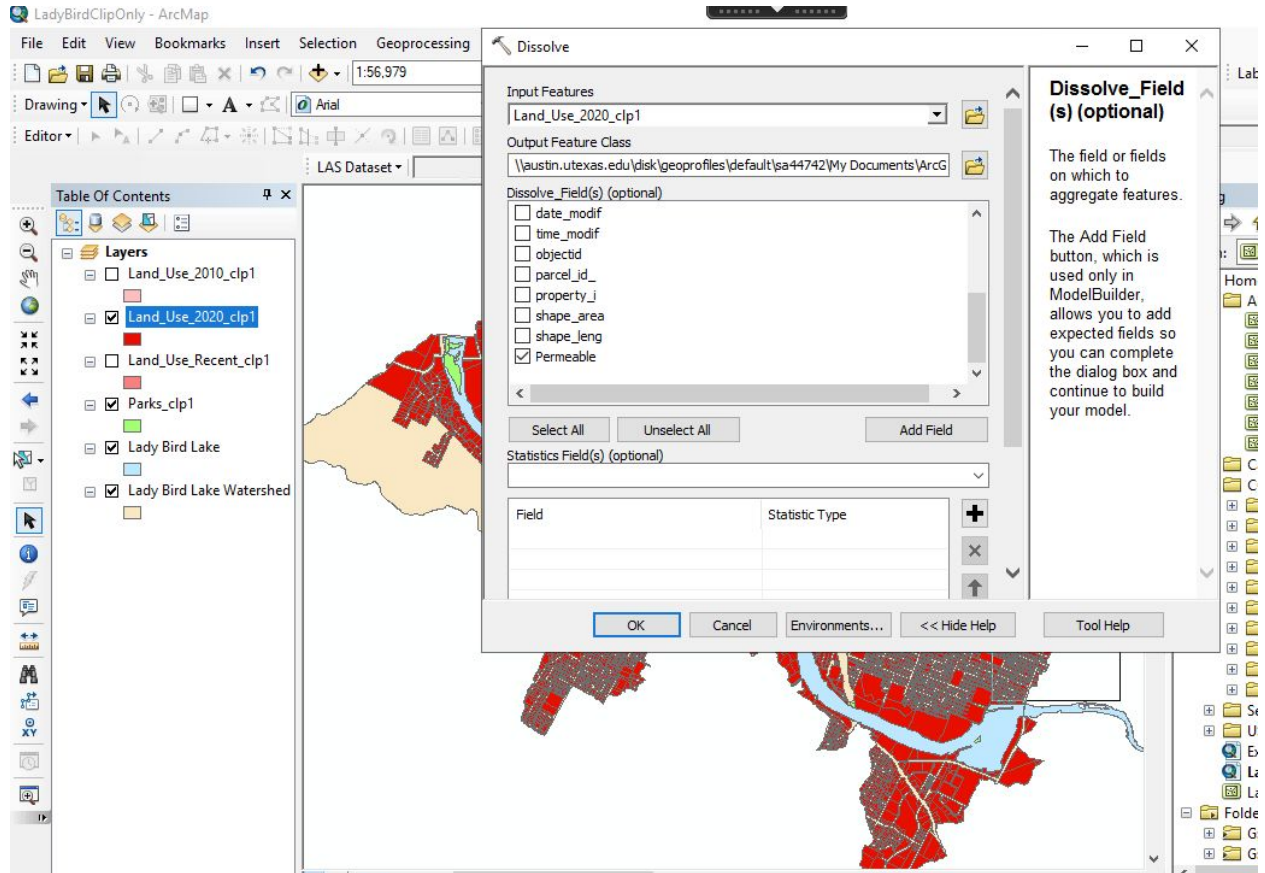


Figure 9: Step 3d: Dissolve tool used to combine all Permeable/Impermeable polygons within the clipped Land_Use_2020 shapefile

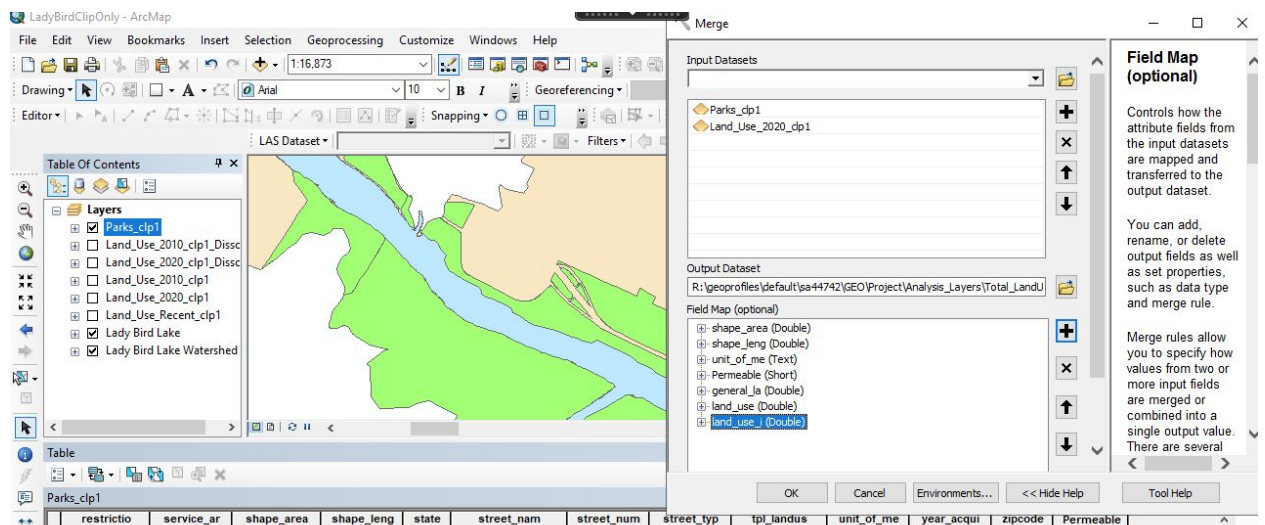


Figure 10: Step 3b: Merging the clipped park (permeable) areas with Land Use 2020 layer

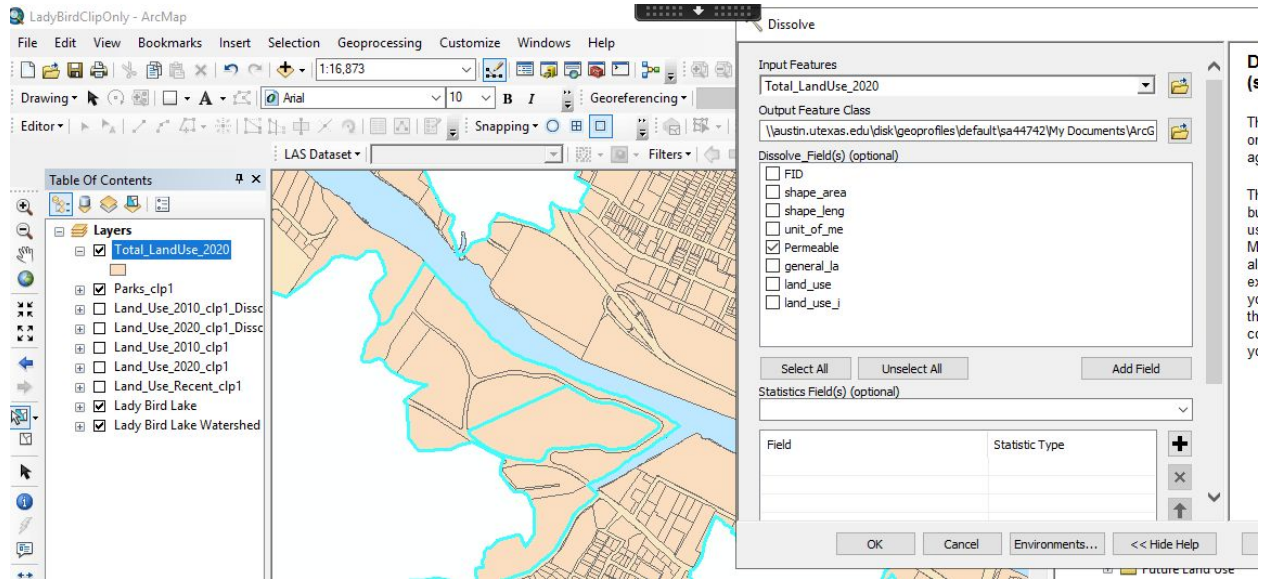


Figure 11: Step not in final processDissolving Total Land Use 2020 (contains park areas) by the permeable attribute (this failed and I ended up using the less clean merged layer for analysis and visualization)**

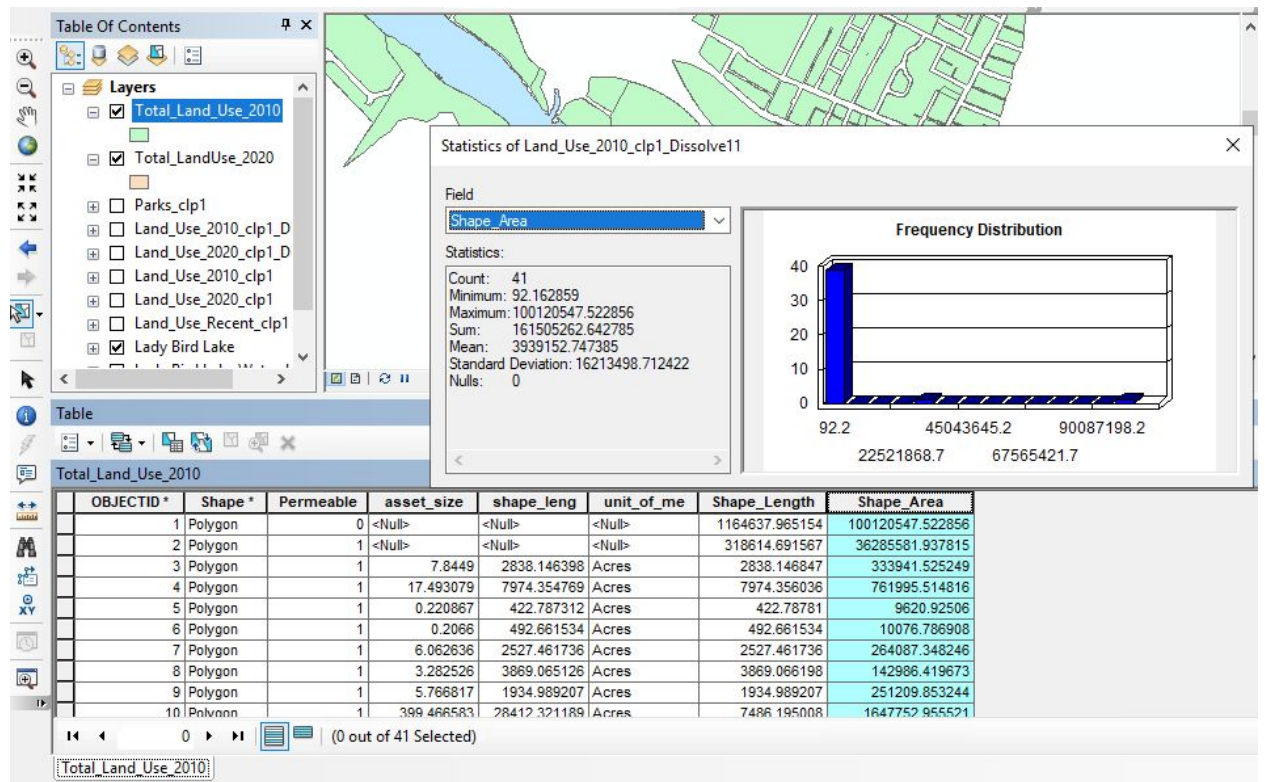


Figure 12: Step 4c: Finding the total land area for Total Land Use 2010

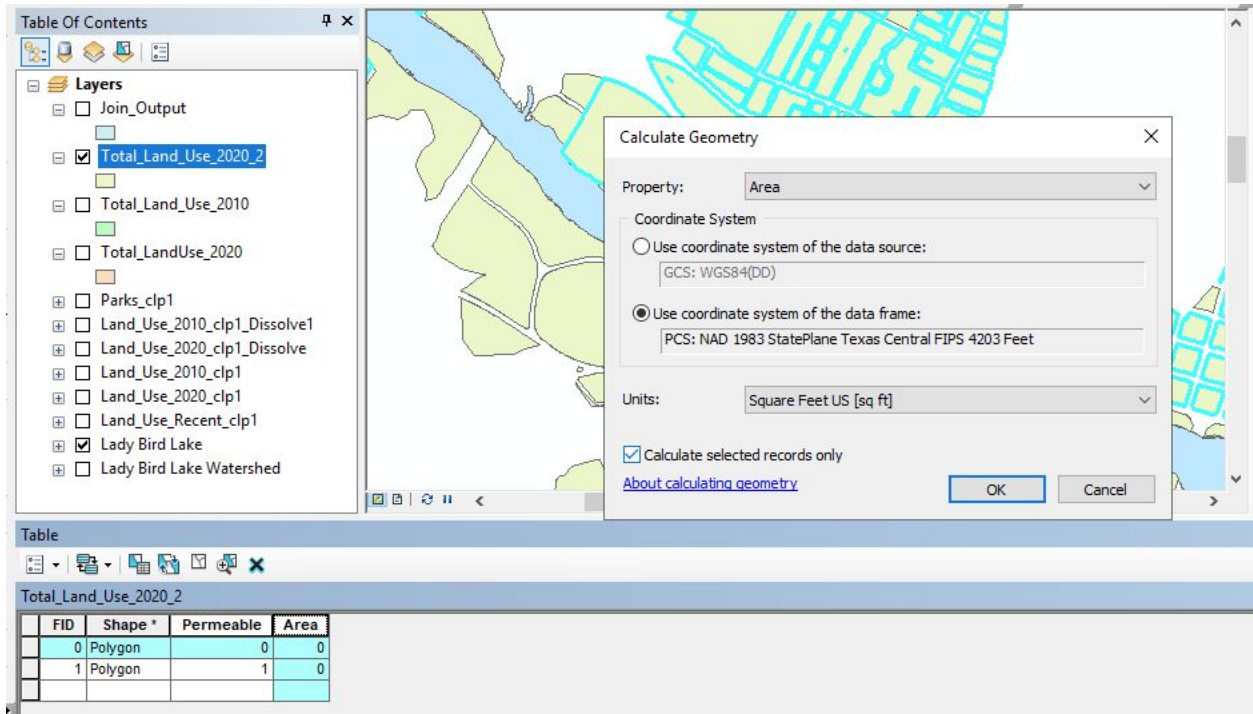


Figure 13: Step 4d: Fixing the Total Land Use 2020 layer (lost the area field after merging) by adding a new field and editing to calculate the geometry of the permeable and impermeable polygons

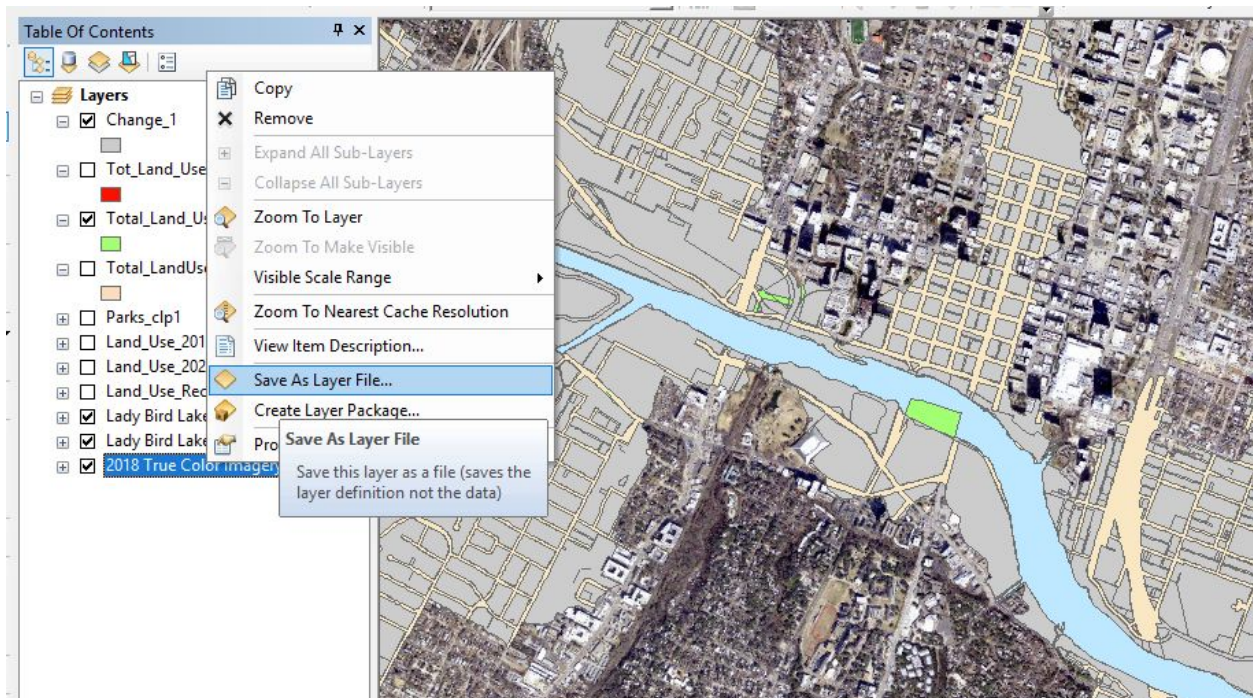


Figure 14. Step 5a: Saving imagery from ArcGIS online as a layer file (see Figure 2 for downloading screenshot)

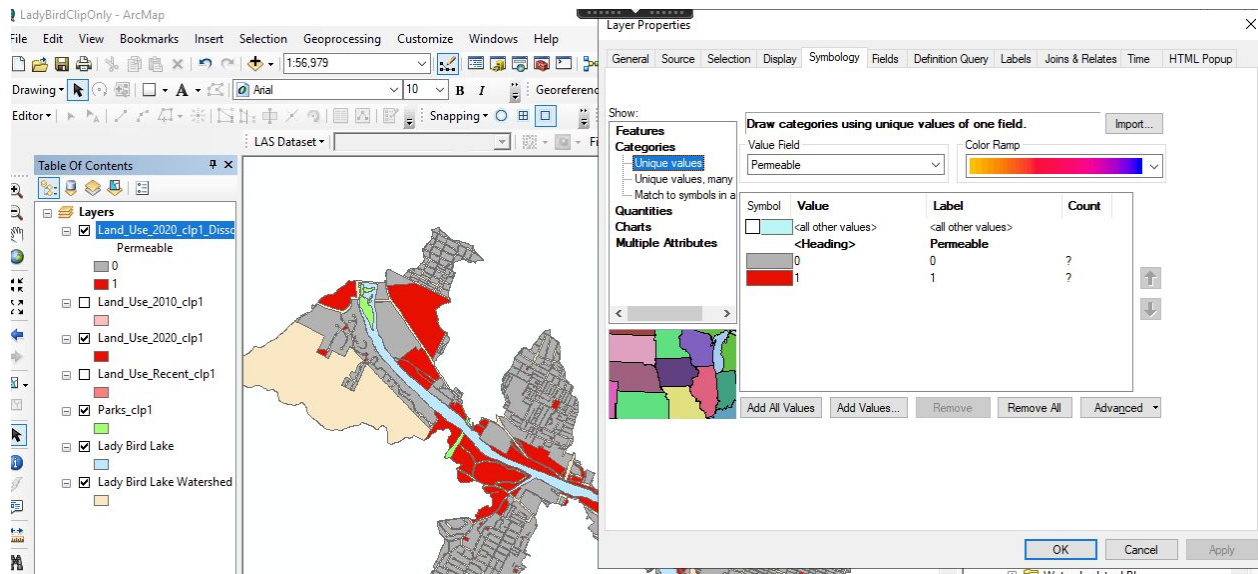


Figure 15: Step 5b: Visualizing the Permeable and Impermeable Land Use for 2020 Dissolved Layer

Table 2: Permeable and Impermeable Land Use Codes

Permeable Surfaces	Non-Permeable Surfaces
Park Land (from Park Boundaries)	100: Single Family
670: Cemetery	113: Mobile Homes
710: Parks/Greenbelts	150: Duplexes
720: Golf Courses	160: Large-Lot Single Family
730: Camp Grounds	210: Three/Fourplex
740: Common Areas	220: Apartment/Condo
750: Preserves	230: Group Quarters
900: Undeveloped	240: Retirement Housing
910: Agricultural	300: Commercial
940: Water	330: Mixed Use
	400: Office
	510: Manufacturing
	520: Warehousing
	530: Miscellaneous Industrial
	560: Resource Extraction (Mining)
	570: Landfills
	610: Semi-institutional Housing
	620: Hospital
	630: Government Services
	640: Educational
	650: Meeting and Assembly
	680: Cultural Services
	810: Railroad Facilities
	820: Transportation Facilities
	830: Aviation Facilities
	840: Marinas
	850: Parking
	860: Streets and Roads
	870: Utilities
	999: Unknown

Data Presentation

My study found that there was urbanization occurring within the Lady Bird Lake watershed and that there was a loss of 20.6 acres of permeable land between 2010 and 2020. From the summary statistics of the 2010 and 2020 polygon areas, Figure 16 summarizes the changes in both permeable and impermeable land area. I had to first convert the area from ft² (because the layers were in State Plane coordinates) to acres.

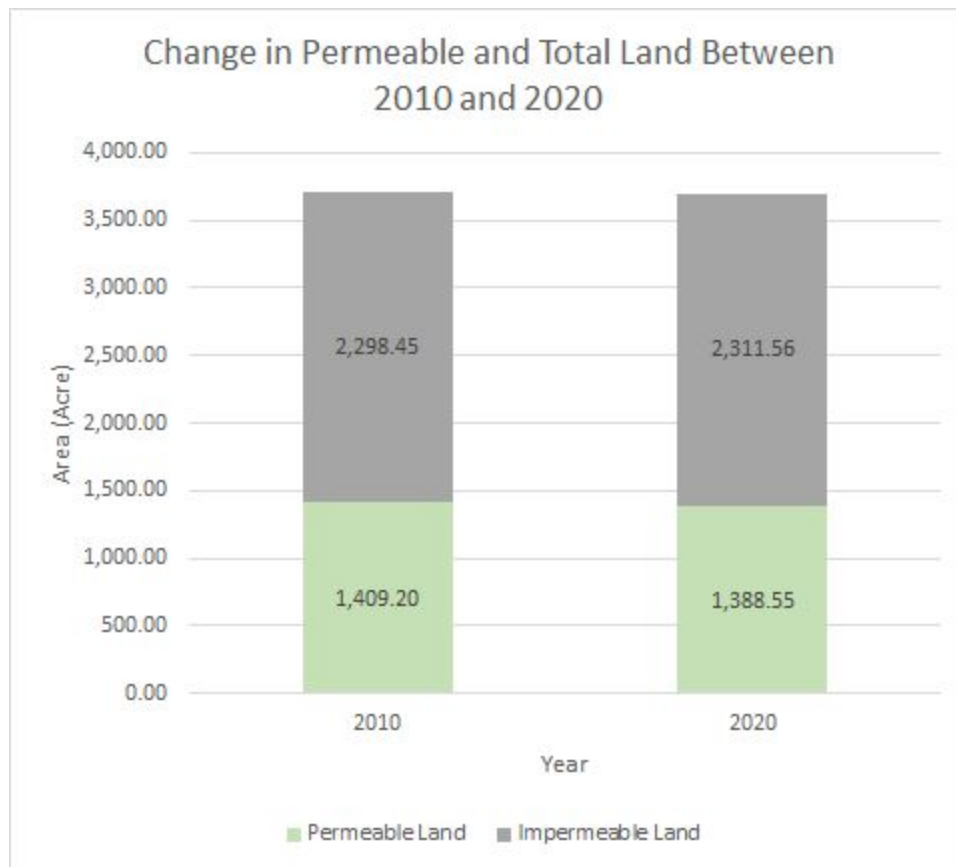


Figure 16. Bar plot of land use area

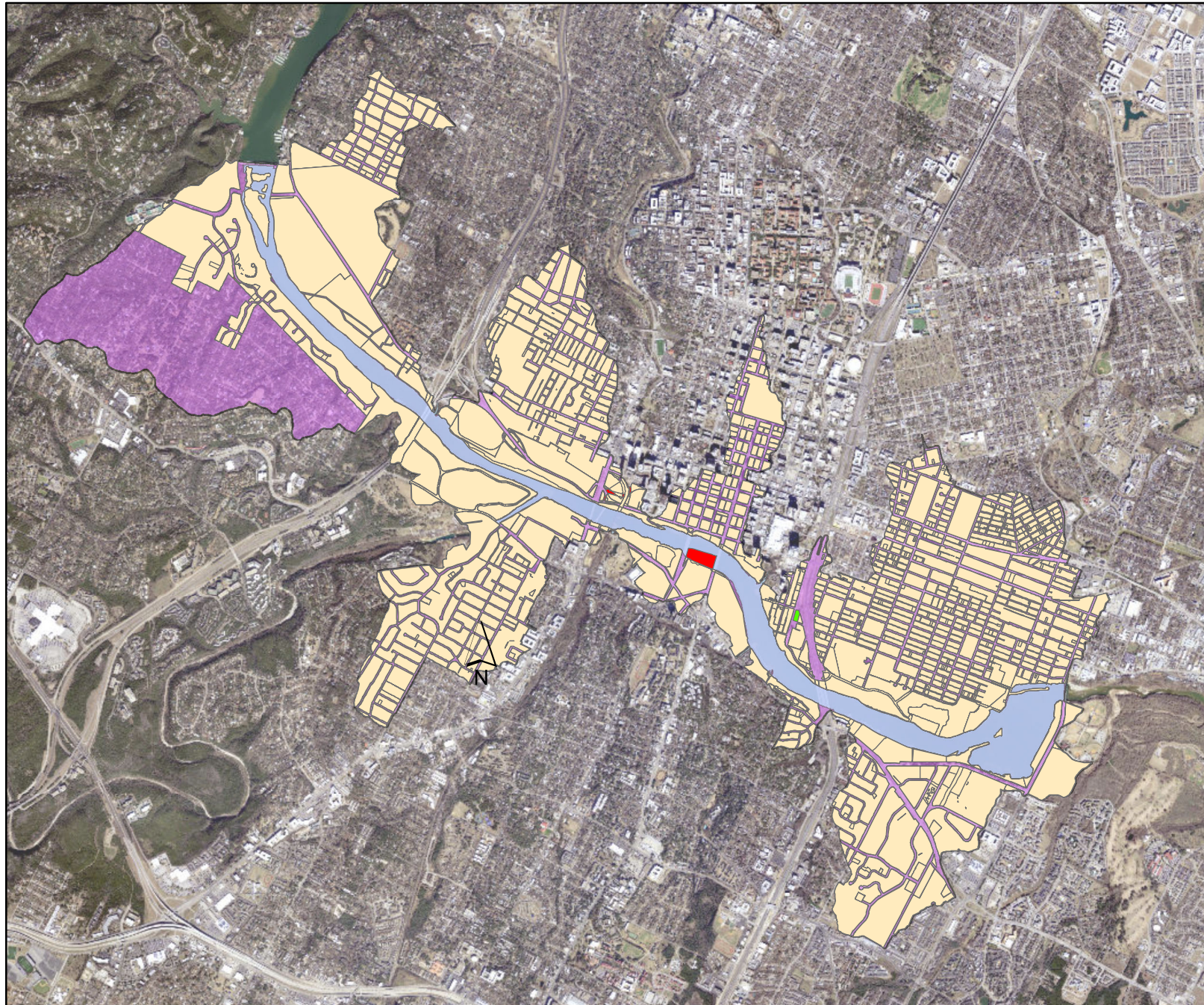
The final map is attached at the end.

Discussion

While my study did accomplish what I set out to find, there are still notable factors that should be considered when viewing the results.

1. The data was only between 2010 and 2020, further analysis of older land use surveys and future plans should be conducted to confirm a large scale trend in urbanization.
2. Limited data affects the results. I used the only available park boundary shapefile and assumed that the park area did not change significantly over the 10 years. So both the 2010 and 2020 have been merged with the same parkland. This may have minimized the change in permeable area.
3. I simplified my question by only looking at the Lady Bird Lake watershed. There are many watersheds which drain to creeks that directly drain to Lady Bird Lake which would affect the inflow of nutrients. For this study I assumed that because the algal bloom does not occur in the upstream region of Barton Creek, the creeks are not significant contributors.

Urbanization of Lady Bird Lake Watershed in Austin, Texas



Legend

Intersection of 2010 and 2020

2020 Land Use

Permeable

0

1

2020 Land Use

Permeable

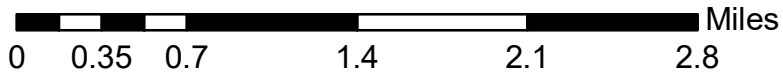
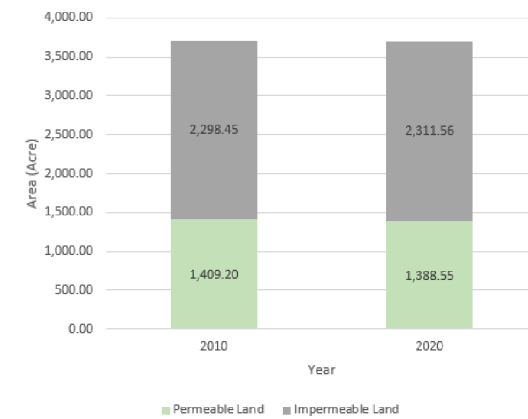
0

1

Lady Bird Lake

Lady Bird Lake Watershed

Change in Permeable and Total Land Between 2010 and 2020



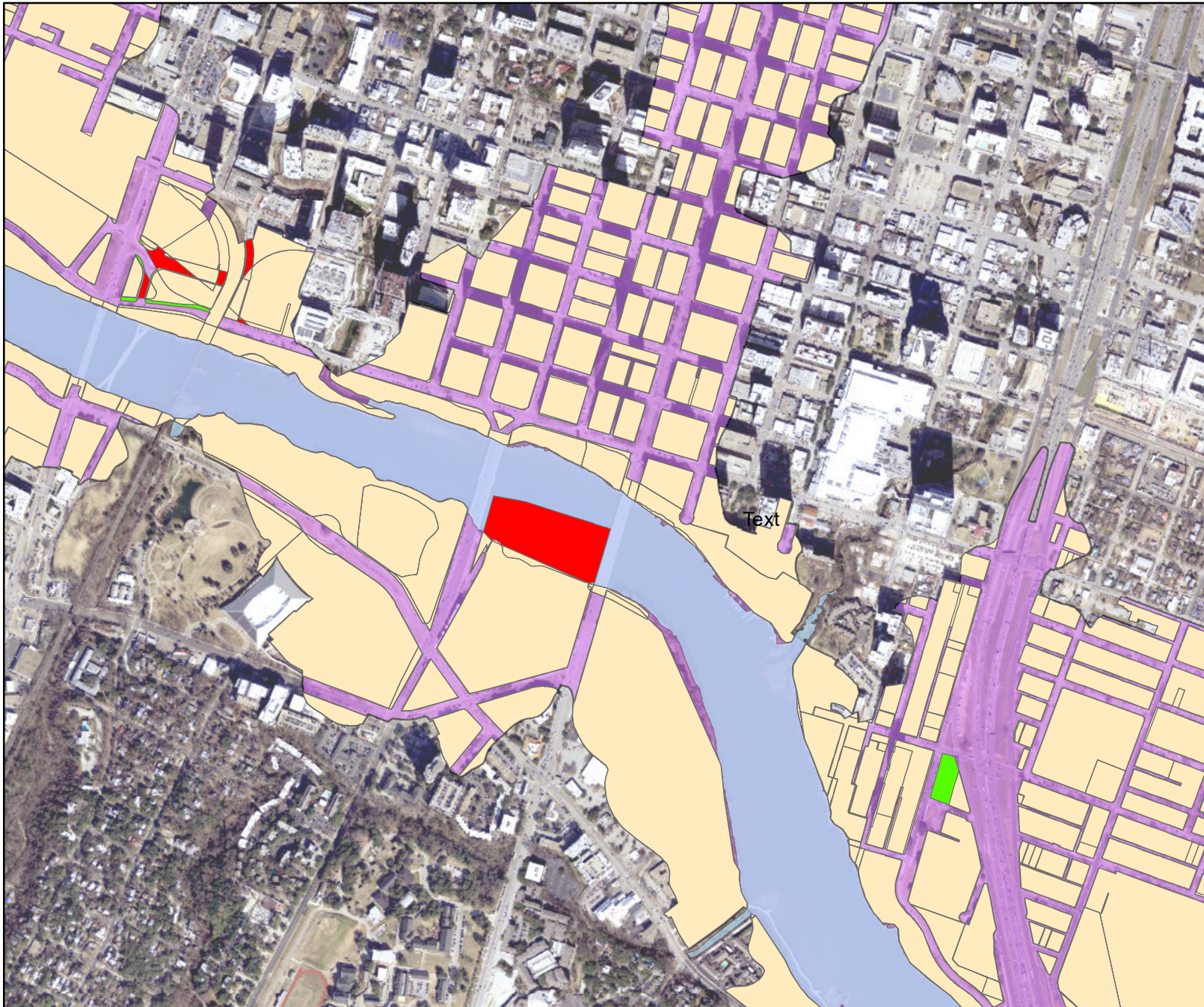
1:50,000

Author: Sarah Alverson

Date: 12/7/2020

Urbanization of Lady Bird Lake Watershed In Austin, Texas

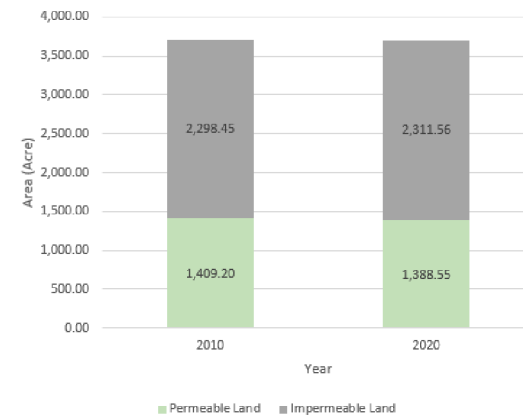
Highlighted Change in Land Use



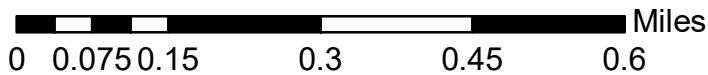
Legend

- Intersection of 2010 and 2020
- 2020 Land Use**
- Permeable**
- 0
- 1
- 2020 Land Use**
- Permeable**
- 0
- 1
- Lady Bird Lake
- Lady Bird Lake Watershed

Change in Permeable and Total Land Between 2010 and 2020



Total Loss of Permeable Area = 20.6 ac



1:12,000

Author: Sarah Alverson

Date: 12/7/2020