3.5 Bradford Chain of Lakes

This section presents the results from Tasks 1 through 3 for the Bradford Chain of Lakes. This includes an overview and history of the lakes and drainage basin, present impairment status, an overview of available data, a qualitative assessment of potential pollutant sources, and calculation of potential pollutant loads.

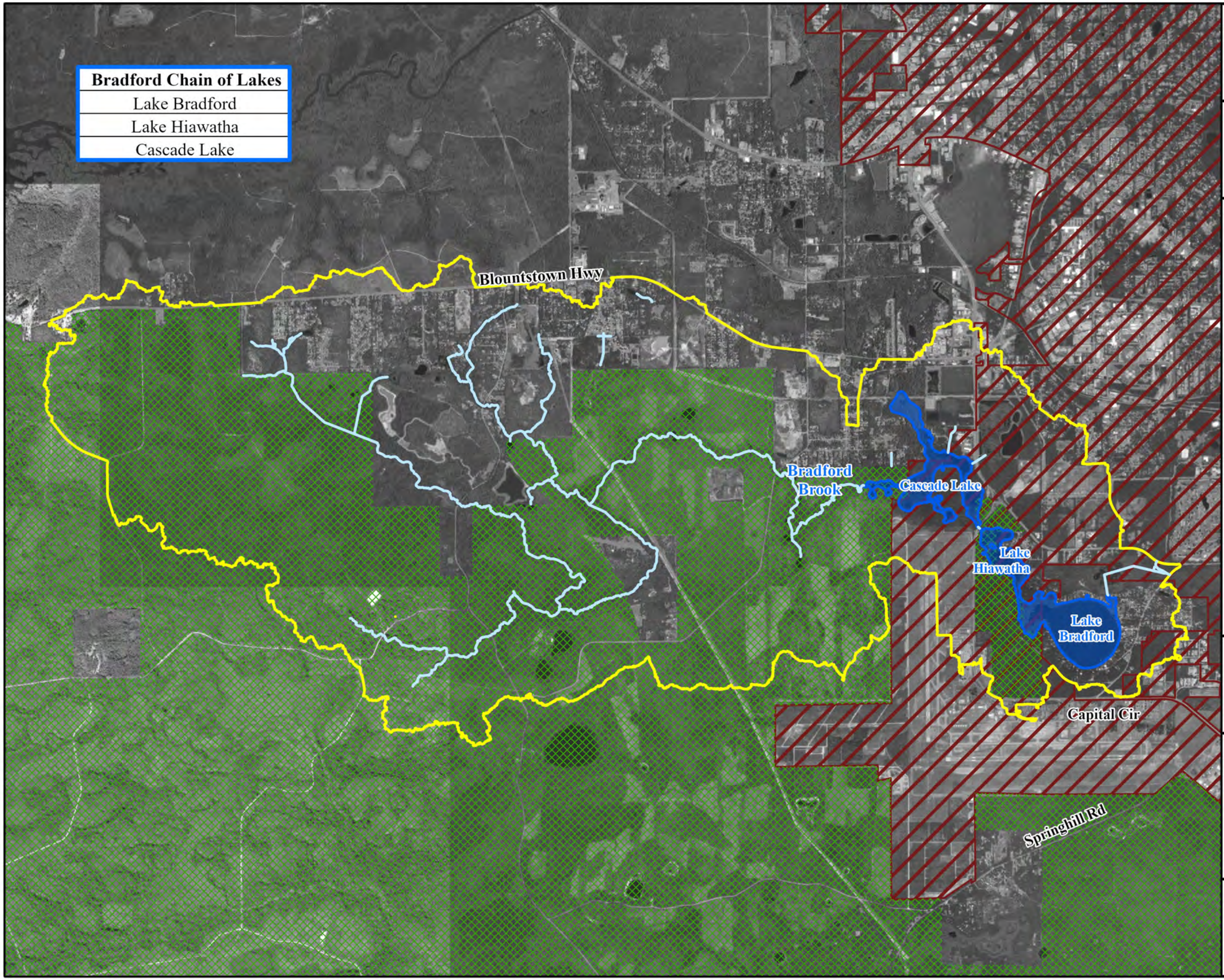
3.5.1 Overview and History

The Bradford Chain of Lakes consists of three interconnected waterbodies: Cascade Lake, Lake Hiawatha, and Lake Bradford (**Figure 3-46**). Bradford Creek, which drains the upper watershed for the Chain of Lakes, flows into Cascade Lake, which then flows into Lake Hiawatha and finally into Lake Bradford. Flow out of Lake Bradford goes into Grassy Lake before flowing into Munson Slough at the confluence with the West Drainage Ditch.

Photo 3-22 through **Photo 3-29** present aerial views of the lakes from 1937 through the present. Examination of the aerial photos shows that, overall, the structure of the chain of lakes has not changed significantly since 1937. The aerials show that the area of water changes over time, likely with dry versus wet conditions, especially in the upper reaches around Cascade Lake. Also observable is the conversion of prairie land to silviculture and then to protected forest, increases in nearby development, and the construction of Capital Circle and the airport, which first appear in the 1970 aerial (**Photo 3-22**).

Lake Bradford is a 149-acre high color lake and is the largest waterbody in the chain of lakes. **Photo 3-30** shows the northeast end of the lake. The bulk of the lake inflow is from Lake Hiawatha, which then flows through the lake and out to Grassy Lake. At times of significant rainfall, such as under storm events of 5-year return frequency or greater, flow historically reversed and flowed from Grassy Lake into Lake Bradford across Lakeview Drive. Under some conditions, backflow would also enter Lake Hiawatha (Leon County, 2019; City, 2019). Following a 2014 study, Lakeview Drive was elevated, piped conveyance was increased, and the outflow structure from Lake Bradford was updated by increasing the weir elevation and including a one-way valve to prevent backflow. **Photo 3-31** shows the present structure at the connection between Lake Bradford and Grassy Lake. The check valve can be seen in the photo. While the one-way valve prevents backflow from Grassy Lake to Lake Bradford under frequently occurring storm events, larger, less frequent storm events still have the potential to generate backflow from Grassy Lake when downstream water levels exceed the elevation of the weir. Even with the known backflow issues, Lake Bradford has been a healthy, well-balanced lake throughout its history. A recent issue within the lake is elevated lead levels, which is discussed in more detail in **Section 3.5.2**.

Lake Bradford also has a long history as a recreational resource for Leon County. Lake Bradford presently supports recreational activities including water skiing, sailing, kayaking, and fishing. The Tallahassee Museum of History and Natural Science (also known as the Junior Museum) was founded in 1957 and sits on the northwestern shoreline of the lake at the confluence with Lake Hiawatha (Lake Bradford Sector Plan, 2004). The museum has a number of historic buildings onsite including the former home of the Prince and Princess Murat. Additionally, the FSU Reservation, also known as Camp Flastacowa, is located on the lake and is a swimming and boating amenity for FSU and Leon County. **Photo 3-32** shows the FSU Reservation shoreline.



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Legend

- Bradford Chain of Lakes Draingage Basin
- Waterbodies in Study
- Watercourses
- Apalachicola National Forest
- Tallahassee Corporate Limits

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
Facilities: COT, 2020
Parks: COT-Leon County, 2023
City Limits: COT, 2022

Figure 3-46:
Bradford Chain of Lakes Basin Overview Map

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

Photo 3-22: Bradford Chain of Lakes Aerial (1937)

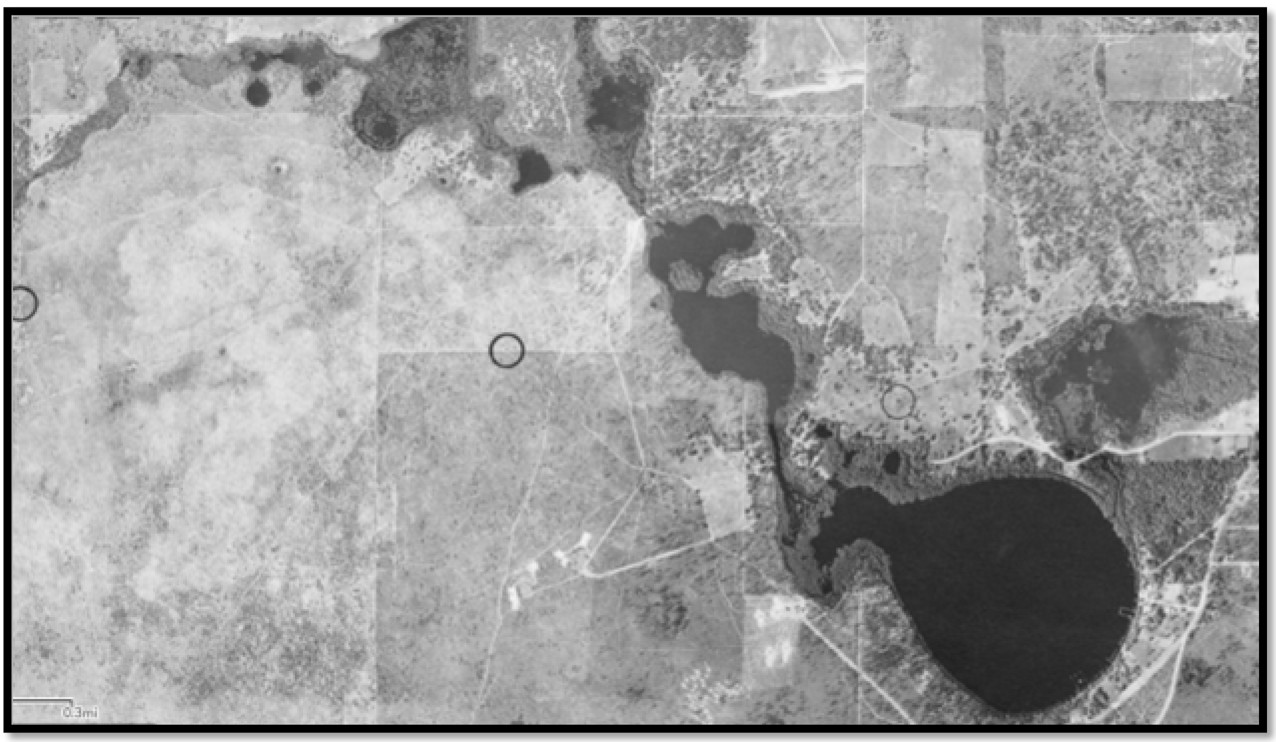


Photo 3-23: Bradford Chain of Lakes Aerial (1949)

Photo 3-24: Bradford Chain of Lakes Aerial (1954)

Photo 3-25: Bradford Chain of Lakes Aerial (1970)

Photo 3-26: Bradford Chain of Lakes Aerial (1983)

Photo 3-27: Bradford Chain of Lakes Aerial (1996)

Photo 3-28: Bradford Chain of Lakes Aerial (2007)

Photo 3-29: Bradford Chain of Lakes Aerial (2020)

Photo 3-30: Northeast Side of Lake Bradford (2013)

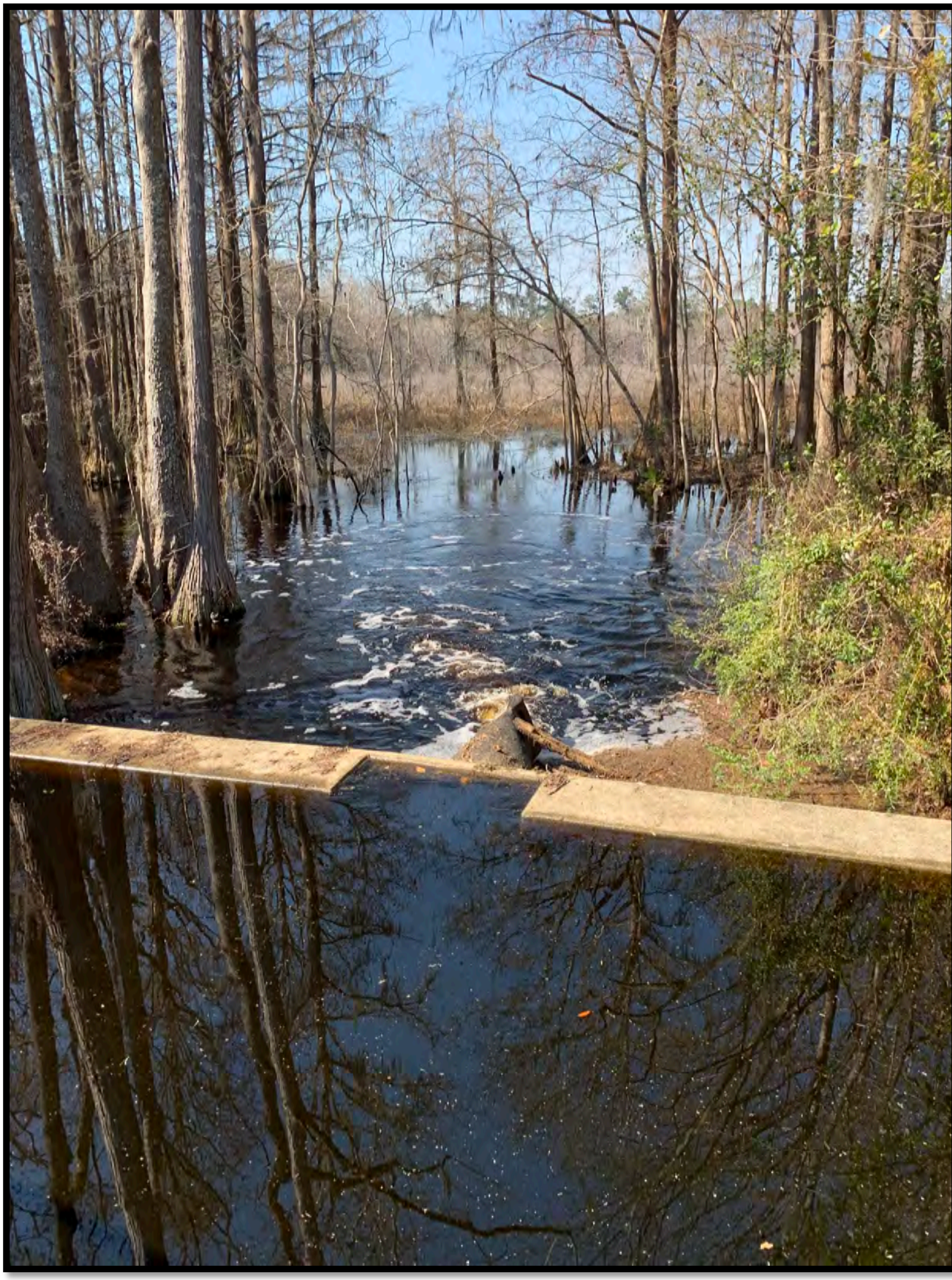


Photo 3-31: Flow through the Structure Connecting Lake Bradford and Grassy Lake (2021)

Photo 3-32: FSU Reservation on Lake Bradford (2021)

Lake Hiawatha is a 40-acre high color lake located immediately upstream of Lake Bradford. Color levels in the lake are so high that light cannot penetrate the water column thus not allowing submerged aquatic vegetative growth (City, 2019; Leon County, 2019). Lake inflow is primarily through a culvert beneath Capital Circle Southwest at the northeastern end of the airport property. Lake outflow enters the northeast end of Lake Bradford. However, as previously discussed, at times system flows will reverse. Unlike Lake Bradford, which generally maintains its permanent pool, Lake Hiawatha can dry out at times. **Photo 3-33** shows the lake in 2021 when water levels were high. **Photo 3-34** shows the lake during a dry-down period in 2011. Lake Hiawatha has been a healthy, well-balanced lake throughout its history. Like Lake Bradford, a recent issue within the lake is elevated lead levels, which is discussed in more detail in **Section 3.5.2**.

Cascade Lake is the most upstream of the sister lakes and is a 109-acre high color lake located immediately upstream of Lake Hiawatha and has been identified as a “pristine” waterbody (Lake Bradford Sector Plan, 2004). Lake inflow comes from Bradford Brook, which drains part of the Apalachicola National Forest. The lake has a sandy bottom along with an active sink and is the most prone to drying out of the chain of lakes. **Photo 3-35** shows the lake in 2021 when water levels were relatively high. **Photo 3-36** shows the lake in January of 2020 during a dry-down period. Cascade Lake has been a healthy, well-balanced lake throughout its history. Like its sister lakes, a recent issue within the lake is elevated lead levels, which is discussed in more detail in **Section 3.5.2**.

Photo 3-33: Lake Hiawatha During Higher Water Conditions (2021)

Photo 3-34: Lake Hiawatha During Low Water Conditions (2011)

Photo 3-35: Cascade Lake During Higher Water Conditions (2021)

Photo 3-36: Cascade Lake During Low Water Conditions (2020)

The drainage basin for the Bradford Chain of Lakes covers an area of approximately 12,650 acres (**Figure 3-46**). The majority of the drainage area is located within the Apalachicola National Forest so anthropogenic stormwater inflows are relatively minimal. The only significant developed areas within the drainage basin are in the immediate vicinity of the Chain of Lakes or along the northern boundary of the basin near Blountstown Highway (State Road 20).

The 2004 Lake Bradford Sector Plan identified as its Priority Issue 1 the environmental protection of the Chain of Lakes (Lake Bradford Sector Plan, 2004). The plan recognized the pristine nature of the lakes and their cultural, socioeconomic and environmental benefit to the area. The plan provided a series of recommendations to maintain the water quality conditions, which included the following:

- Continue to monitor the Chain of Lakes by both the City and Leon County, and the volunteer efforts led by Florida LAKEWATCH,
- Extend sewer lines, thereby discontinuing the use of septic systems in areas with high water table,
- Install a gate to prevent backflow from Grassy Lake to Lake Bradford,
- Maintain the current low-density residential characteristics of the area, and
- Acquire nearby parcels of land with environmental benefits to the Chain of Lakes to provide buffer areas.

3.5.2 Regulatory Status

Exhibit 3-2 presented the verified impaired waters within the overall Lake Munson basin. Lake Bradford is presently verified impaired for lead. Within the latest assessment period (2015 to 2022), 11 of 15 samples exceeded the criteria. Cascade Lake is also presently verified impaired for lead. In the last assessment cycle, 5 of 10 samples exceeded the criteria. Lake Hiawatha, while not verified impaired, did have violations of the lead criteria. No other impairments exist within the three waterbodies or the upstream tributaries.

Leon County has identified potential relict sources of lead that include a former shooting range and the former Dale Mabry airfield (Leon County, 2019). The only apparent potential current source is the Tallahassee Regional Airport (aviation fuel). Increased lead levels are likely the result of elevated lead concentrations in the lake sediments and the acidic nature of these lakes, which enhances the solubility of lead.

3.5.3 Waterbody Data Review and Summary

This section presents an overview of available data and data sources for the Bradford Chain of Lakes basin, including, bathymetry, land use, soils, septic systems, hydrologic measurements, surface water quality, groundwater quality, biological, stormwater treatment facilities, and atmospheric deposition.

3.5.3.1 Bathymetry

Figure 3-47 presents a map showing bathymetry within Lake Bradford and Lake Hiawatha from LAKEWATCH. Since the depth contours are not defined to a specific datum, they are best considered as general informational only. The contours suggest depths up to 10 ft within Lake Bradford, with average depths around 6 ft, while Lake Hiawatha has maximum depths on the order of 4 ft, with average depths around 2 ft.

While no bathymetric charts were available for Cascade Lake, prior literature states maximum depths of around 8 ft with average depths generally less than 5 ft (City, 2019). However, during relatively frequent dry-down conditions those depths are significantly reduced.

3.5.3.2 Land Use

Figure 3-48 presents a map of the Level 2 land uses within the Bradford Chain of Lakes basin. A table is provided to show the overall acreages and percent cover for the various levels. Tables are provided for both the Level 2 and grouped Level 1 land uses. The largest land use type by far within the Bradford Chain of Lakes drainage basin per the grouped Level 1 categories is Upland Forest (48 percent). The Upland Forest areas extend throughout the central, southern and western portions of the basin where it drains the Apalachicola National Forest. The next highest categories are wetlands (19 percent) followed by Urban and Built Up (16 percent). The Urban and Built Up land uses are located along the northern edge along Blountstown Highway (State Road 20) and in the immediate area of the three lakes, mostly to the north.

3.5.3.3 Soils

The most prevalent soil group in the Bradford Chain of Lakes drainage basin by far is Group A (65 percent) (**Figure 3-49)**. Group A soils are considered to have a high rate of infiltration. The remainder of the basin is mostly small clusters of Group A/D and B/D soils, which are generally adjacent to stream segments, waterbodies, or other low lying areas and are considered to have good infiltration potential, but due to elevated water table conditions, will act more similarly to soils with low infiltration potential.

3.5.3.4 Septic Systems

An estimated 1,400 septic tank units are within the boundaries of the Bradford Chain of Lakes drainage basin, based on the FDOH septic tank layer (**Figure 3-50**). The septic tanks are located in clusters around the basin. A large cluster is located around and immediately to the east of Lake Bradford. Another cluster is located within a neighborhood off Jackson Bluff Road just west of Cascade Lake. The remaining clusters are located within neighborhoods off Blountstown Highway (State Road 20) on the northern border of the basin.

Effluent from septic tanks that are in good condition should be comparable to secondarily treated wastewater effluent from sewage treatment plants. However, septic systems can be a source of pollutants, pathogens, and nutrients and are identified by FDEP as a potential source of bacteria and nutrients to waterbodies in its assessment processes.

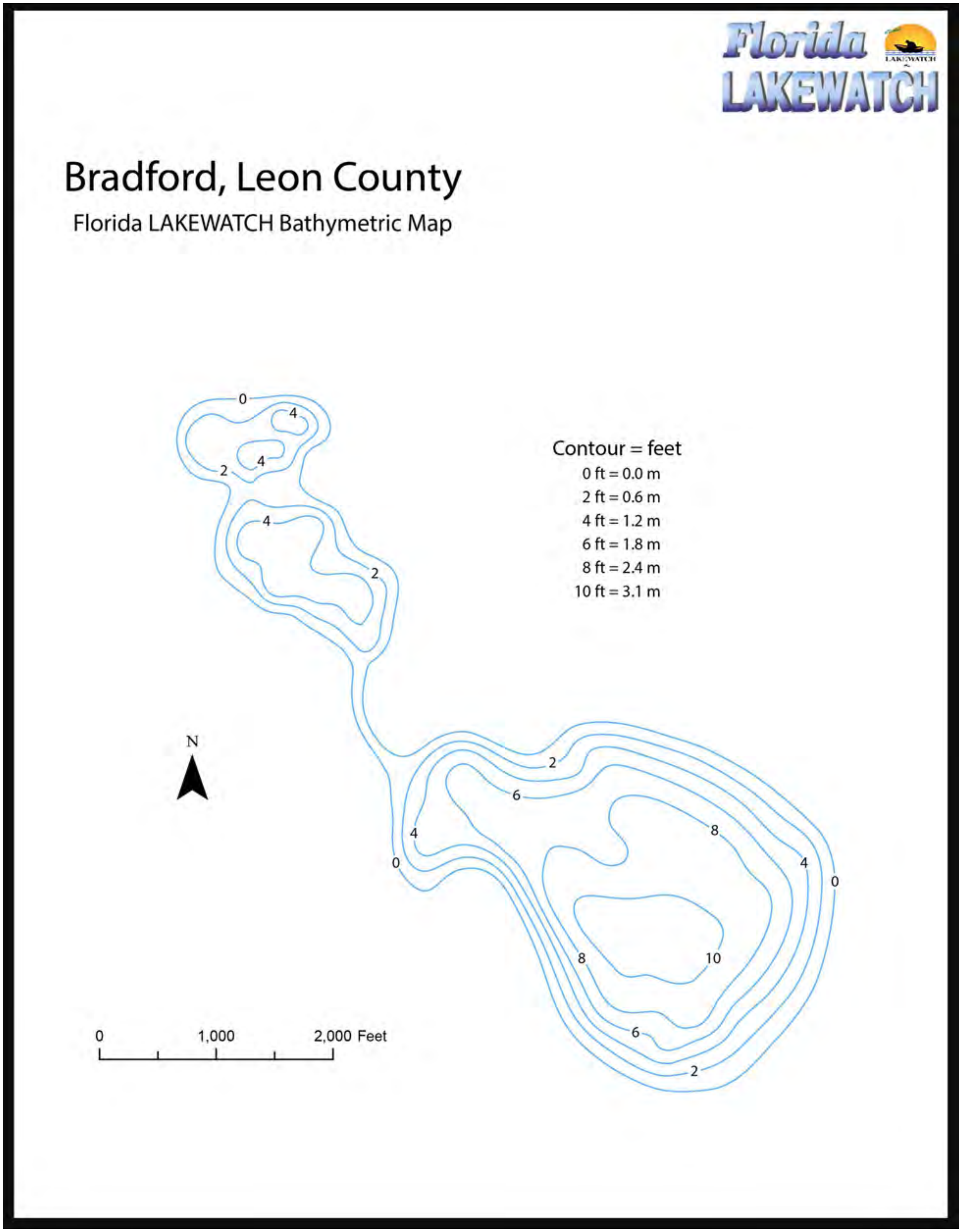
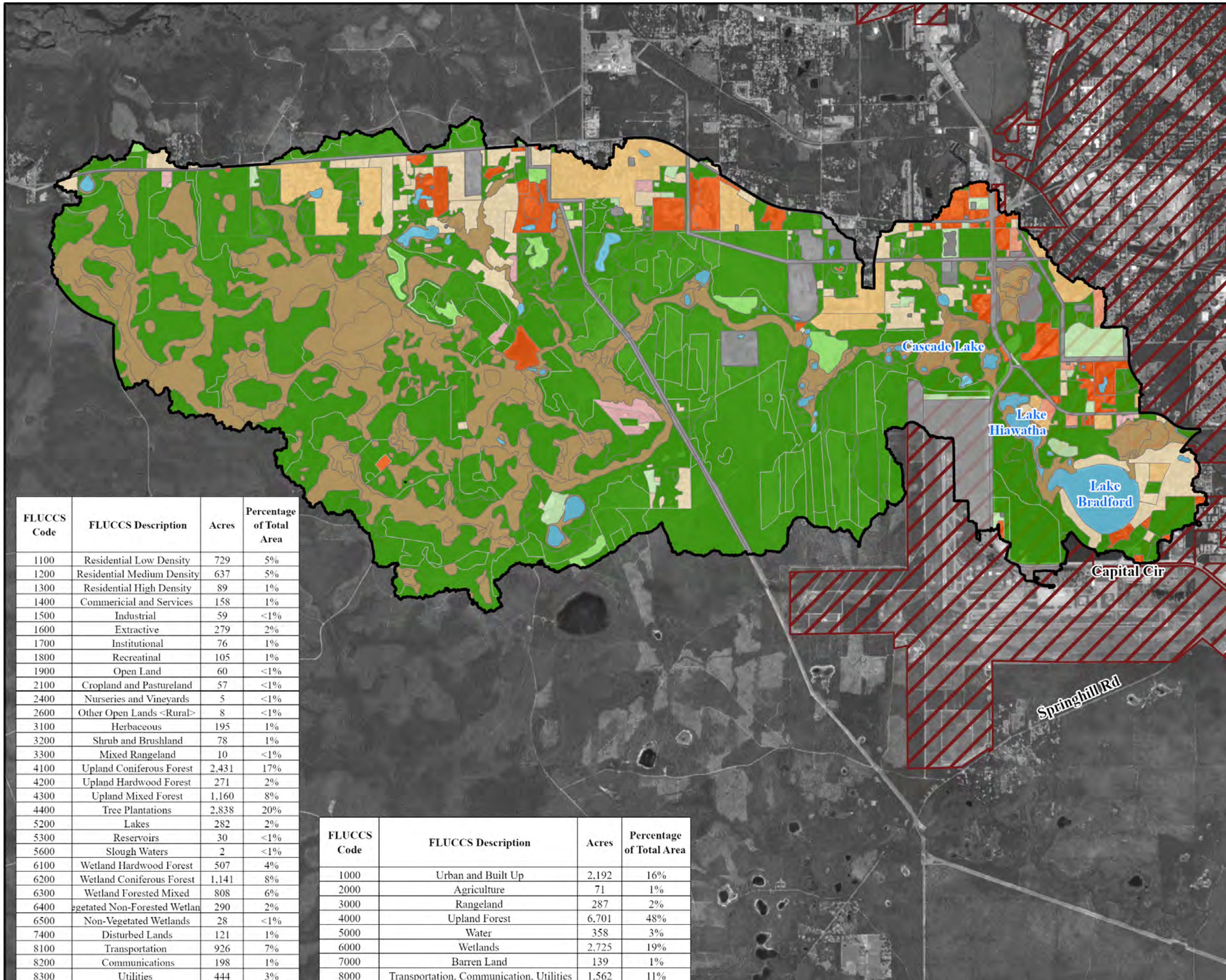


Figure 3-47: Bathymetry in Lake Bradford and Lake Hiawatha



FLUCCS Code	FLUCCS Description	Acres	Percentage of Total Area
1100	Residential Low Density	729	5%
1200	Residential Medium Density	637	5%
1300	Residential High Density	89	1%
1400	Commericial and Services	158	1%
1500	Industrial	59	<1%
1600	Extractive	279	2%
1700	Institutional	76	1%
1800	Recreatinal	105	1%
1900	Open Land	60	<1%
2100	Cropland and Pastureland	57	<1%
2400	Nurseries and Vineyards	5	<1%
2600	Other Open Lands <Rural>	8	<1%
3100	Herbaceous	195	1%
3200	Shrub and Brushland	78	1%
3300	Mixed Rangeland	10	<1%
4100	Upland Coniferous Forest	2,431	17%
4200	Upland Hardwood Forest	271	2%
4300	Upland Mixed Forest	1,160	8%
4400	Tree Plantations	2,838	20%
5200	Lakes	282	2%
5300	Reservoirs	30	<1%
5600	Slough Waters	2	<1%
6100	Wetland Hardwood Forest	507	4%
6200	Wetland Coniferous Forest	1,141	8%
6300	Wetland Forested Mixed	808	6%
6400	egetated Non-Forested Wetlan	290	2%
6500	Non-Vegetated Wetlands	28	<1%
7400	Disturbed Lands	121	1%
8100	Transportation	926	7%
8200	Communications	198	1%
8300	Utilities	444	3%

FLUCCS Code	FLUCCS Description	Acres	Percentage of Total Area
1000	Urban and Built Up	2,192	16%
2000	Agriculture	71	1%
3000	Rangeland	287	2%
4000	Upland Forest	6,701	48%
5000	Water	358	3%
6000	Wetlands	2,725	19%
7000	Barren Land	139	1%
8000	Transportation, Communication, Utilities	1,562	11%

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Sources:
Waterbodies: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
Land Use: NWFWMD, 2019
City Limits: COT, 2022

Figure 3-48:
Bradford Chain of Lakes Drainage Basin Land Use Map

Tallahassee Master Plan - Surface Water (TMaPS)

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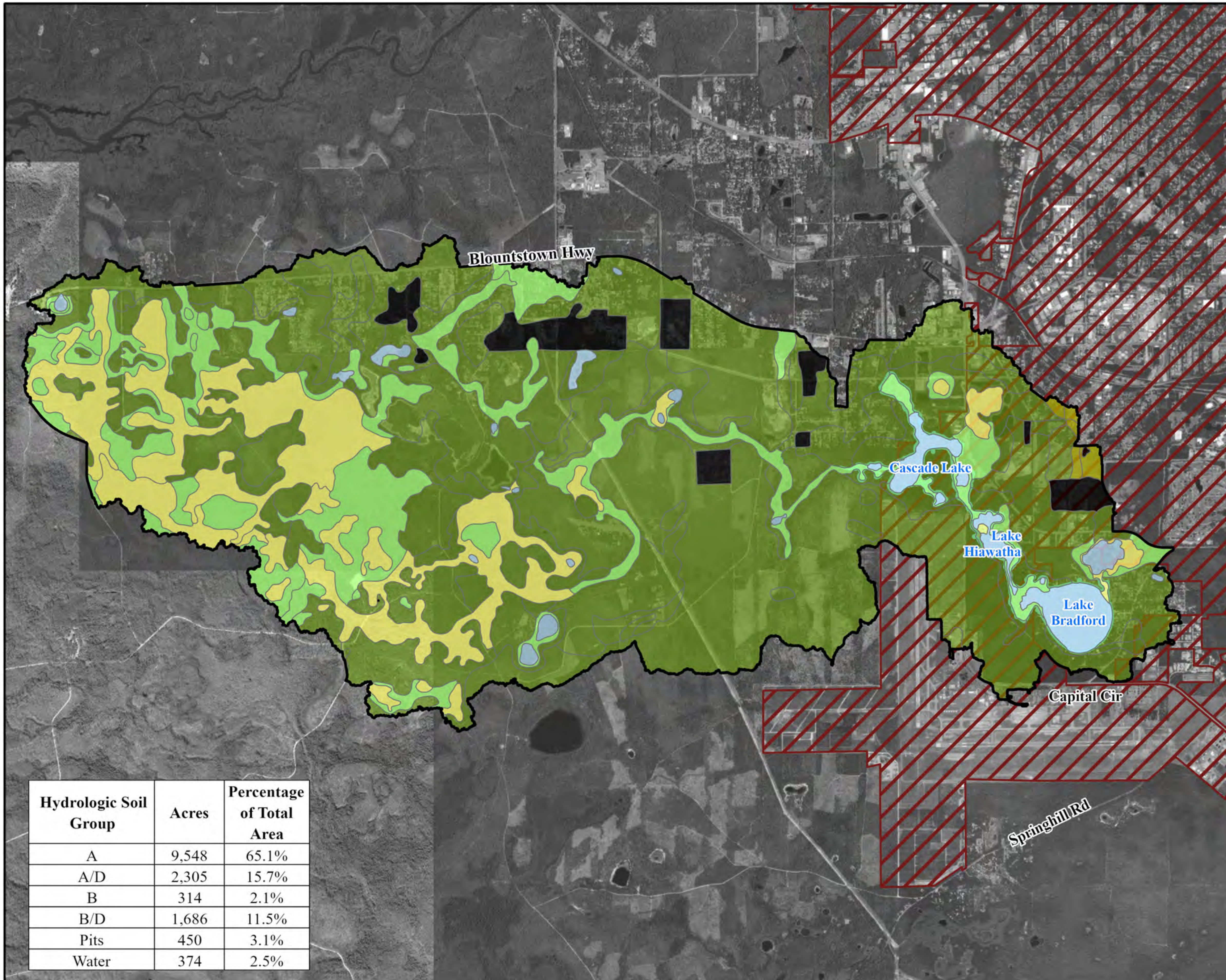

Hydrologic Soil Group	Acres	Percentage of Total Area
A	9,548	65.1%
A/D	2,305	15.7%
B	314	2.1%
B/D	1,686	11.5%
Pits	450	3.1%
Water	374	2.5%

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Bradford Chain of Lakes Drainage Basin
Tallahassee Corporate Limits
Hydrologic Soil Group
A
A/D
B
B/D
Pits
Water

Sources:
Waterbodies: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
Soils: NRCS, 2020
City Limits, 2022

Figure 3-49:
Bradford Chain of Lakes Drainage Basin Soils Map

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

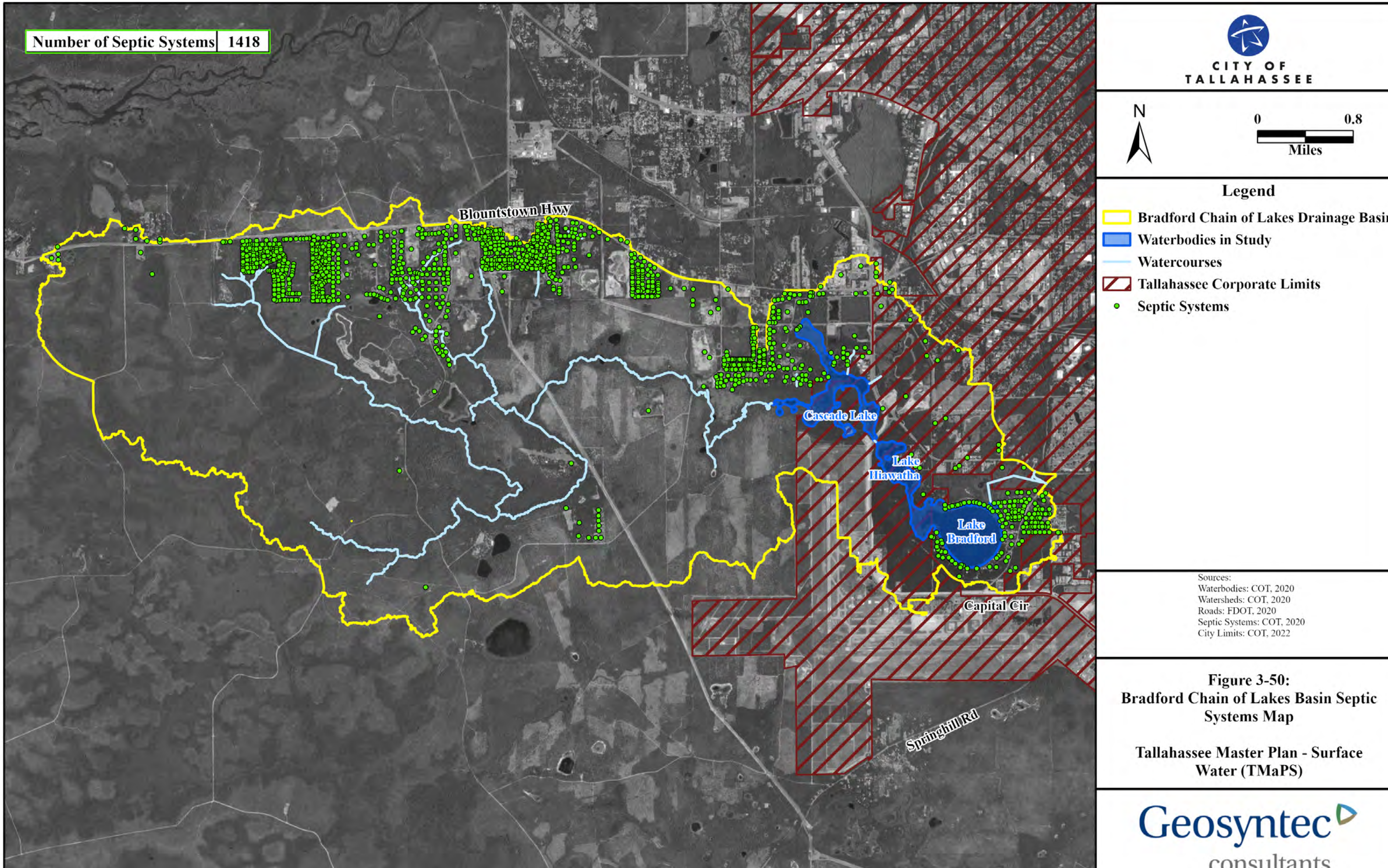

Figure 3-50: Bradford Chain of Lakes Basin Septic Systems Map

Tallahassee Master Plan - Surface Water (TMaPS)

3.5.3.5 Hydrologic Data

Exhibit 3-6 presented the locations of hydrologic data stations within the Lake Munson basin. As the map shows, there is a water level station located on Lake Bradford (Station 012082). Data from this station was obtained from 2015 to 2021. **Figure 3-51** presents a plot of the measured water levels relative to NAVD88 for the period of the available data. For the period of available data, Lake Bradford fluctuates between just below 27.0 ft-NAVD88 up to around 34.0 ft, a range of around 7 ft. The low period shown in 2020 corresponds to the period of the photo from 2020 (**Photo 3-36**) when Cascade Lake exhibited dry conditions.

A flow measurement station is located upstream of Cascade Lake where Bradford Brook crosses Aenon Church Road (**Exhibit 3-6**). These data reflect the flow out of the Apalachicola National Forest. **Figure 3-52** presents a plot of the daily average flows from 1988 through 2020. In comparison to flows from Munson Slough and the West Ditch, these flows show a much less flashy extended baseflow driven signal, which represents more natural conditions. Peak flows are as high as 400 cfs, with typical peaks ranging between 100 and 200 cfs, and are of the same order of magnitude as stations in other more urbanized areas with significantly smaller drainage areas (**Section 3.4.3.6** and **Section 3.6.3.5**).

3.5.3.6 Surface Water Quality Data

The IWR datasets for Lake Bradford (WBID 878A), Lake Hiawatha (WBID 878C), and Cascade Lake (WBID 878D) span from the 1960s for Lake Bradford and the 1980s for the other lakes to the present. Data were provided by local and state agencies (City, Leon County, FDEP, USGS, NWFWMD, and Florida LAKEWATCH) as well as private sector firms (McGlynn Lab).

Figure 3-53 presents the locations of in-lake water quality monitoring stations for the Bradford Chain of Lakes (yellow) along with stations that provide water quality data within Bradford Brook and waterbodies upstream of the lakes that flow into Cascade Lake (red – see inset on **Figure 3-53**). A table is provided in **Figure 3-53** that shows the station ID, station name, period of record, sample count, data source, and if the station represents in-lake or inflowing tributary data. Based on the number of stations and the length of the station IDs, station IDs were not included on the figure, rather each of the stations is given a number and the numbers correspond to stations in the table.

Figure 3-53 shows that water quality monitoring stations have been spread throughout the three lakes for the period of record, including stations upstream of the chain of lakes in Bradford Brook and upstream waterbodies. Relative to more recent data (after 2010), there were eight stations within Lake Bradford, two within Lake Hiawatha, three within Cascade Lake and one station upstream in Silver Lake, a body of water in the Apalachicola National Forest.

Some initial plots of the available data in the lakes are provided in this section. This includes plots of the raw data and AGMs. As nutrients are the primary constituent of interest relative to water quality conditions in the Bradford Chain of Lakes, plots are provided for the key parameters related to potential nutrient impairment. These include TN, TP, Chl-a, and TSI. Additionally, based on interest relative to septic systems and other sources, FIB, specifically *E. coli*, are included. Additional data plots and analyses are provided as part of the qualitative assessment of sources in **Section 3.5.4**.

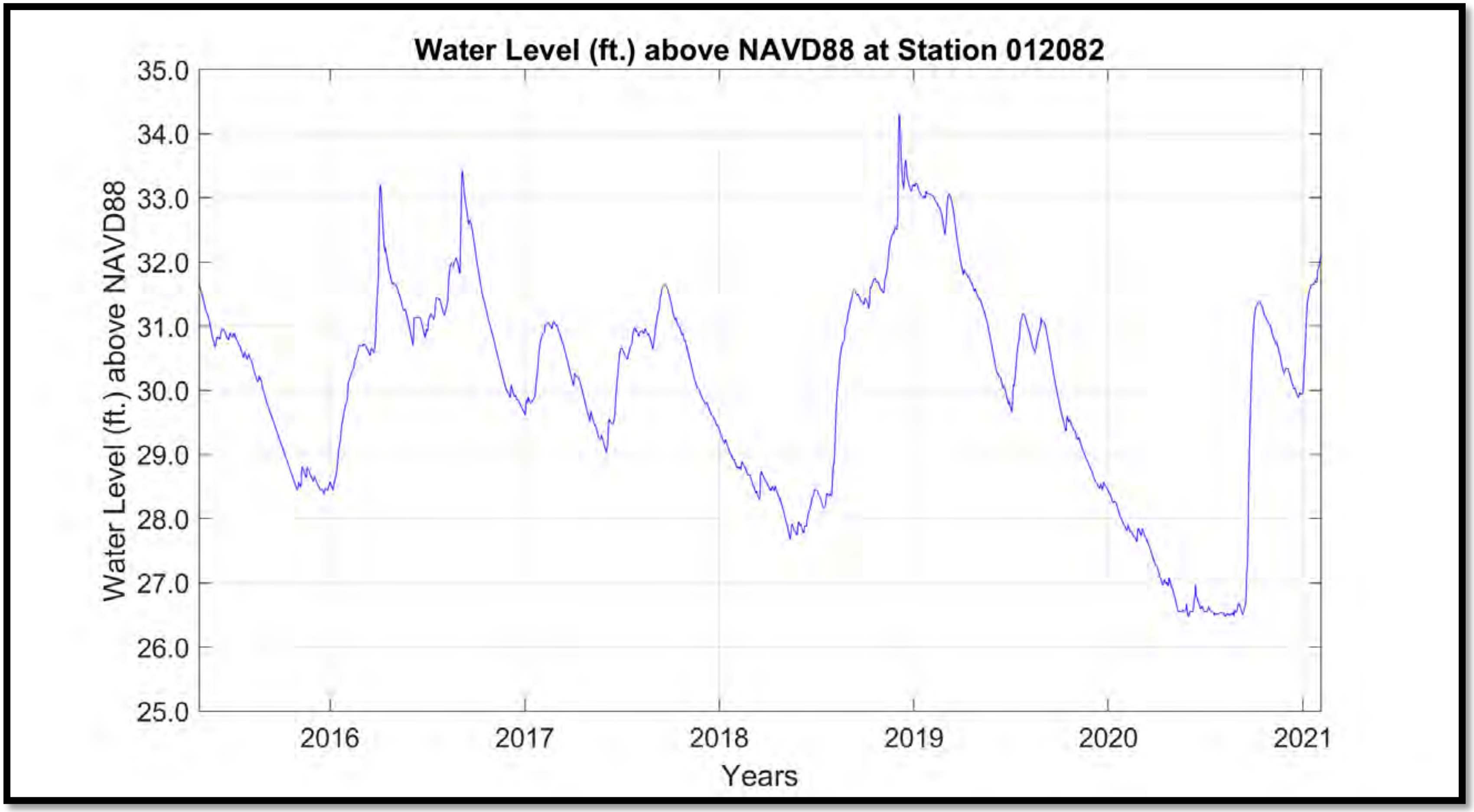

Figure 3-51: Daily Average Water Levels in Lake Bradford (Station 012082) (2015 to 2021)

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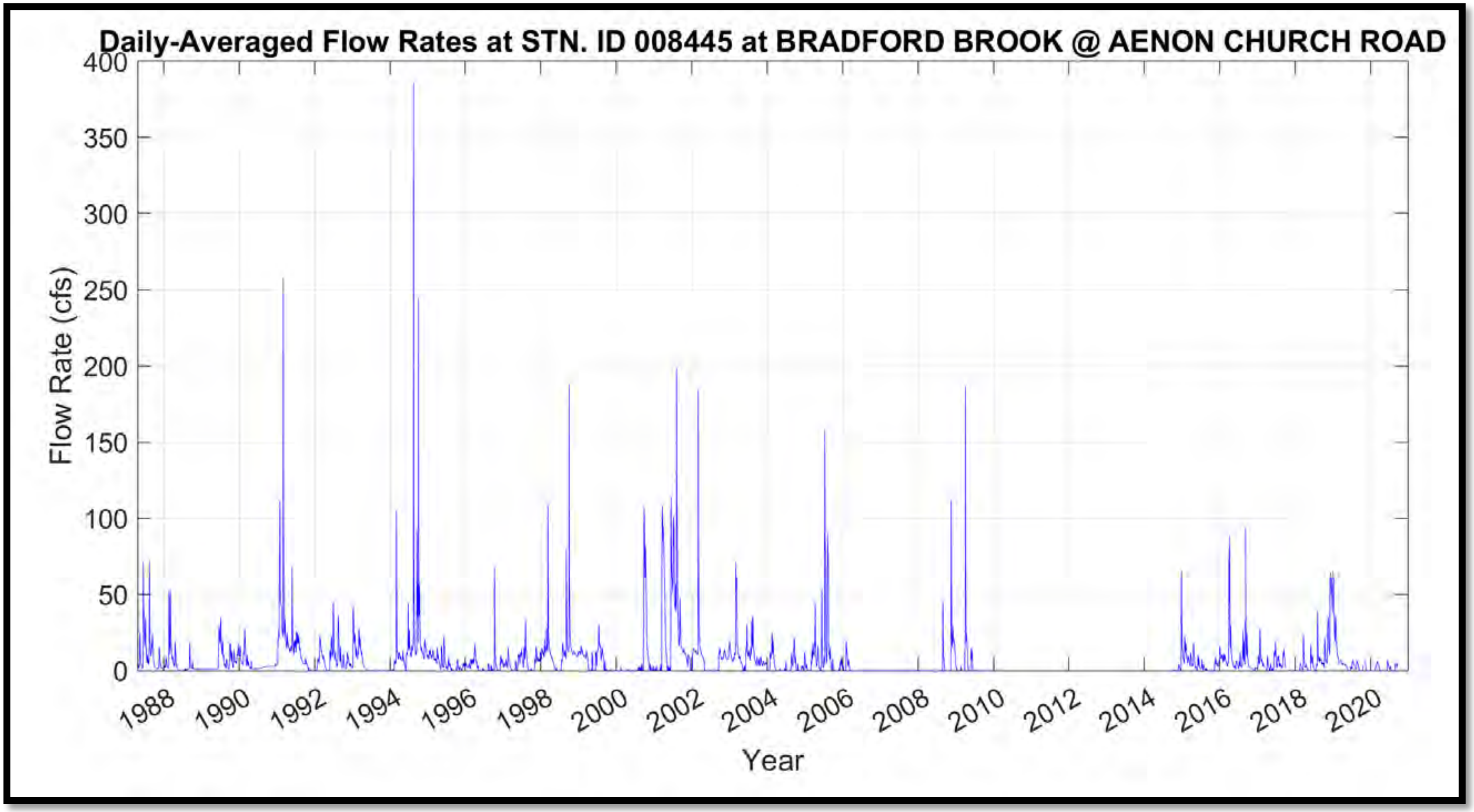
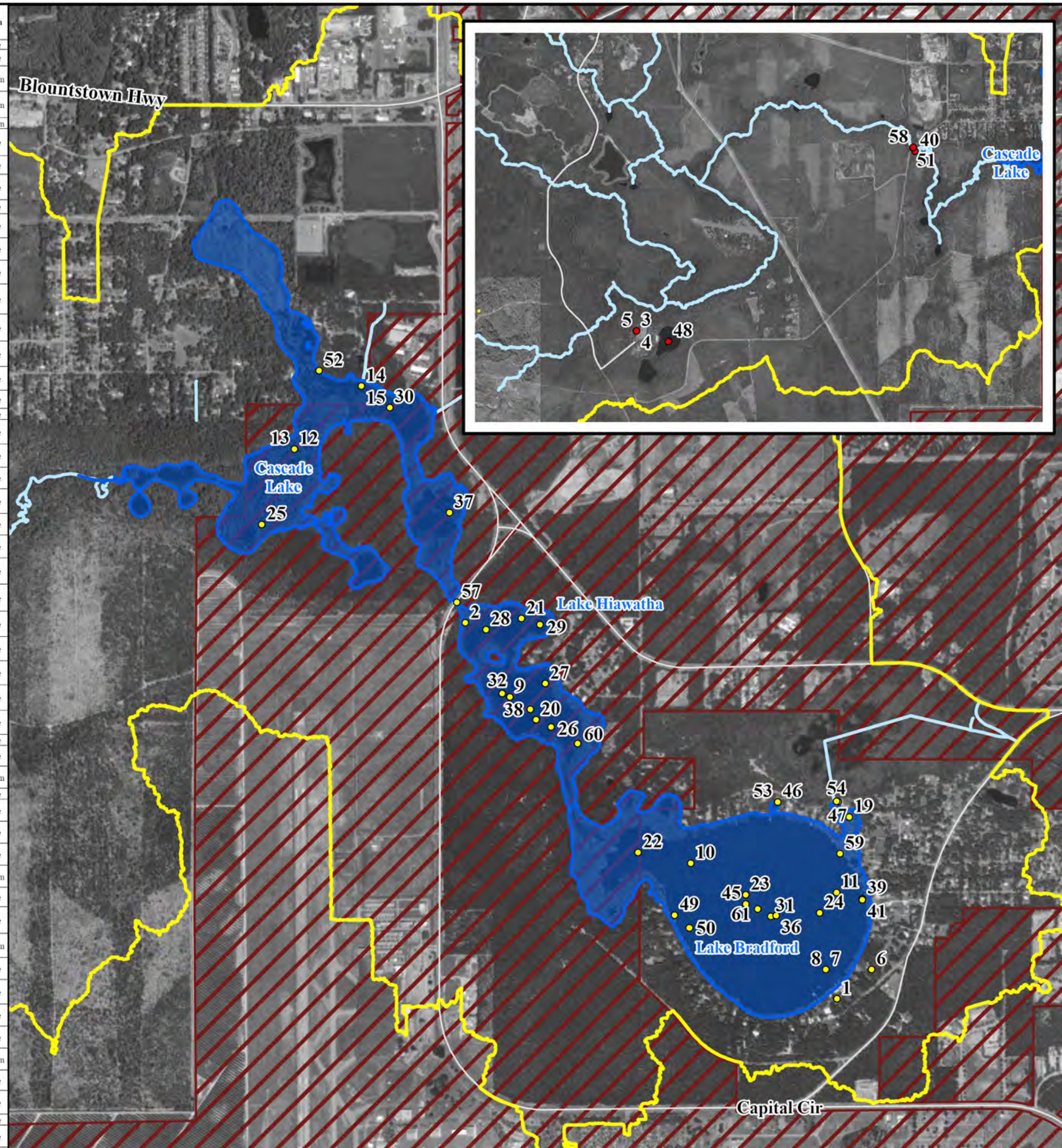


Figure 3-52: Daily Average Flow on Bradford Brook at Aenon Church Road (Station 008445) (1988 to 2020)

Number	Station ID	Station Name	Start of Record	End of Record	Position
1	1118ATL8050660	LAKE BRADFORD	1988	1989	In Lake
2	1118ATL8050661	LAKE HIAWATHA	1988	1989	In Lake
3	1118ATL8050619	SILVER LAKE, WAKULLA DISTRICT	1983	1989	Upstream
4	1118ATL8050620	AREA SWIMMING BEACH	1979	1997	Upstream
5	1118ATL8050621	AREA SWIMMING BEACH	1979	1997	Upstream
6	112WRD 02327010	LAKE BRADFORD NR TALLAHASSEE, FLA.	1966	1971	In Lake
7	112WRD 302410084201201	LKB-2	1994	1994	In Lake
8	112WRD 302410084201202	LKB-1	1994	1994	In Lake
9	12ELS1 3B3-002	LAKE HIAWATHA	1984	1984	In Lake
10	21FLCOT BRADFORD NORTH	BRADFORD NORTH	2007	2022	In Lake
11	21FLCOT BRADFORD SOUTH	BRADFORD SOUTH	2007	2022	In Lake
12	21FLCOT CASCADE AT BRAD	CASCADE AT BRADFORD BROOK	2008	2016	In Lake
13	21FLCOT CASCADE AT BRADFORD BROOK	CASCADE AT BRADFORD BROOK	2017	2022	In Lake
14	21FLCOT CASCADE AT CULV	CASCADE AT CULVERT	2008	2016	In Lake
15	21FLCOT CASCADE AT CULVERT	CASCADE AT CULVERT	2017	2022	In Lake
19	21FLCOT GRASSY LAKE	GRASSY LAKE	2008	2013	In Lake
20	21FLCOT HIAWATHA	HIAWATHA	2008	2022	In Lake
21	21FLGW 22120	NW1-LL-2040 LAKE HIAWATHA	2004	2004	In Lake
22	21FLKWATLEO-BRADFORD-1	LEO-BRADFORD-1	1988	2020	In Lake
23	21FLKWATLEO-BRADFORD-2	LEO-BRADFORD-2	1988	2020	In Lake
24	21FLKWATLEO-BRADFORD-3	LEO-BRADFORD-3	1988	2020	In Lake
25	21FLKWATLEO-CASCADE-2	LEO-CASCADE-2	1988	1990	In Lake
26	21FLKWATLEO-HIAWATHA-1	LEO-HIAWATHA-1	1988	2009	In Lake
27	21FLKWATLEO-HIAWATHA-2	LEO-HIAWATHA-2	1988	2009	In Lake
28	21FLKWATLEO-MINNIEHAH-1	LEO-MINNIEHAH-1	1988	2009	In Lake
29	21FLKWATLEO-MINNIEHAH-2	LEO-MINNIEHAH-2	1989	2009	In Lake
30	21FLLEONLCCA3042484355	Cascade Lake	2008	2021	In Lake
31	21FLLEONLCLB3040584339	Lake Bradford	2006	2021	In Lake
32	21FLLEONLCLH3041384350	Lake Hiawatha	2006	2021	In Lake
36	21FLMCGLB0B	Lake Bradford, Center of Lake	2001	2006	In Lake
37	21FLMCGLB0C	Lake Cascade, Center of Lake	2002	2006	In Lake
38	21FLMCGLB0H	Lake Hiawatha, Center of Lake	2002	2006	In Lake
39	21FLNWFD302420084200601	Lake Bradford	1992	1992	In Lake
40	21FLNWFD302520084223901	AENON CHURCH ROAD	1987	1987	Upstream
41	21FLNWFDS268	Lake Bradford	1992	1992	In Lake
45	21FLPNS 302419478420239	Lake Bradford (Center of Lake)	2006	2007	In Lake
46	21FLPNS 302433008420190	Lake Bradford at FSU Reservation dock	2006	2006	In Lake
47	21FLPNS 302433108420100	Bradford Brook at Lakeview Dr outlet from Lake Bradfor	2006	2007	In Lake
48	21FLTLHRG1TLHR0095	M of Silver Lake	2014	2014	Upstream
49	21FLTLHRHAB_1009200005	Lake Bradford	2020	2020	In Lake
50	21FLTLHRTLHRHAB0008	Lake Bradford	2021	2021	In Lake
51	21FLWQA 302521208422398	Bradford Brook at Aenon Church Rd	2006	2006	Upstream
52	21FLWQA 302530408421292	Cascade Late at Geanie Drive and Nora Drive	2006	2006	In Lake
53	21FLWQA 302433008420190	Lake Bradford at FSU Reservation dock	2002	2002	In Lake
54	21FLWQA 302433108420100	Bradford Brook at Lakeview Dr outlet from Lake Bradford	2002	2005	In Lake
57	21FLWQA 302459608421082	Bradford Brook at Capital Circle SW	2002	2002	In Lake
58	21FLWQA 302503008422251	Bradford Brook at Aenon Church Rd	2002	2006	Upstream
59	21FLWQSPLEO126UL	Lake Bradford south side of lake (WBID 878A)	2005	2006	In Lake
60	21FLWQSPLEO128UL	Lake Hiawatha middle of lake (WBID 878C)	2005	2006	In Lake
61	21FLWQSP22030003	Lake Bradford	2007	2008	In Lake
60	Lake Hiawatha middle of lake (WBID 878C)	2005	2005	2006	In Lake
61	Lake Bradford	2007	2007	2008	In Lake



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Legend

- Bradford Chain of Lakes Drainage Basin
- Waterbodies in Study
- Watercourses
- Tallahassee Corporate Limits

Water Quality Stations

- Upstream of Lake
- In-Lake

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
City Limits: COT, 2020
WQ Stations: FDEP, 2022

Figure 3-53:
Bradford Chain of Lakes Water Quality Station Location Map

Tallahassee Master Plan - Surface Water (TMaPS)

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Plots of the measured TN, TP, and Chl-a data from 2010 to 2020 are presented for Lake Bradford, Lake Hiawatha, and Cascade Lake. For Lake Bradford (**Figure 3-54** through **Figure 3-56**), TN shows a slight downward trend, while TP and Chl-a concentrations appear consistent over the 10-year period. For Lake Hiawatha (**Figure 3-57** through **Figure 3-59**), all three parameters appear consistent over the 10-year period with a slight downward trend seen for TN. Finally, Cascade Lake (**Figure 3-60** through **Figure 3-62**) data show consistent TP and Chl-a data through the 10-year period, with a somewhat more noticeable downward trend in TN. For all three of the lakes, the concentrations of all three parameters are low, indicating relatively pristine water quality. Review of historical nutrient and Chl-a data within the lakes indicates that conditions have not significantly changed from historical measurements. Lake Hiawatha and Cascade Lake have missing data in 2011, 2012 and portions of 2020 due to low water conditions not allowing sample collection.

Under FDEP's NNC, the Bradford Chain of Lakes are all defined as high color waterbodies. Based on this designation, the AGM threshold for Chl-a is 20 μg/L. For TN and TP, a range of concentrations are allowable, based on maintaining Chl-a levels in the lake below 20 μg/L. For TN, the range is 1.27 mg/L to 2.23 mg/L. For TP, the range is 0.05 mg/L to 0.16 mg/L. For *E. coli*, the criteria are monthly geometric means below 126 colonies per 100 mL of water and less than 10 percent of samples above 410 colonies per 100 mL of water in any 30-day period.

TN, TP, and Chl-a AGMs are plotted for each of the lakes as these define the status relative to nutrient impairments. Where sufficient data are available to assess the AGMs, the levels are provided from 2010 through 2020. For Chl-a, only data with corrected Chl-a are provided. The Chl-a threshold and the minimum and maximum thresholds for TN and TP relative to the NNC are provided on each of the graphs as pink dashed lines. Plots of calculated TSI values in the lake are also provided. While TSI is no longer utilized for the determination of impairment, it does serve as an indicator of lake health. Based on TSI definitions, levels below 60 are deemed good condition, levels between 60 and 70 indicate fair condition, while levels above 70 indicate poor condition. Finally, *E. coli* data for each of the lakes, for the available period of record, are presented against the 410 colonies per 100 mL threshold.

Examination of the TN plots (**Figure 3-63**, **Figure 3-66**, and **Figure 3-69**) shows that between 2010 and 2020, the TN AGMs for the three lakes were all below the minimum threshold and generally in the same range. TP AGM levels (**Figure 3-64**, **Figure 3-67**, and **Figure 3-70**) for the three lakes were all below the minimum threshold, with Lake Hiawatha and Cascade Lake levels well below the minimum and Lake Bradford slightly higher. **Figure 3-65**, **Figure 3-68**, and **Figure 3-71** present the Chl-a AGMs from 2010 through 2020. As with the other nutrient parameters (TN, TP), the Chl-a AGMs for the three lakes were all well below the 20 μg/L threshold, with Lake Hiawatha and Cascade Lake showing very low levels and Lake Bradford somewhat higher.

Examination of the TSI plots (**Figure 3-72**, **Figure 3-73**, and **Figure 3-74**) shows that the levels are nearly all in the good range for Cascade Lake and Lake Hiawatha, with only a few of the samples for Lake Bradford in the fair range and none in the poor range. These results further support the findings from the Chl-a measurements that the lakes are not presently exhibiting nutrient enrichment. Lake Bradford switches between phosphorus limitation and nutrient balance while Lake Hiawatha and Cascade Lake are more phosphorus limitation dominant.

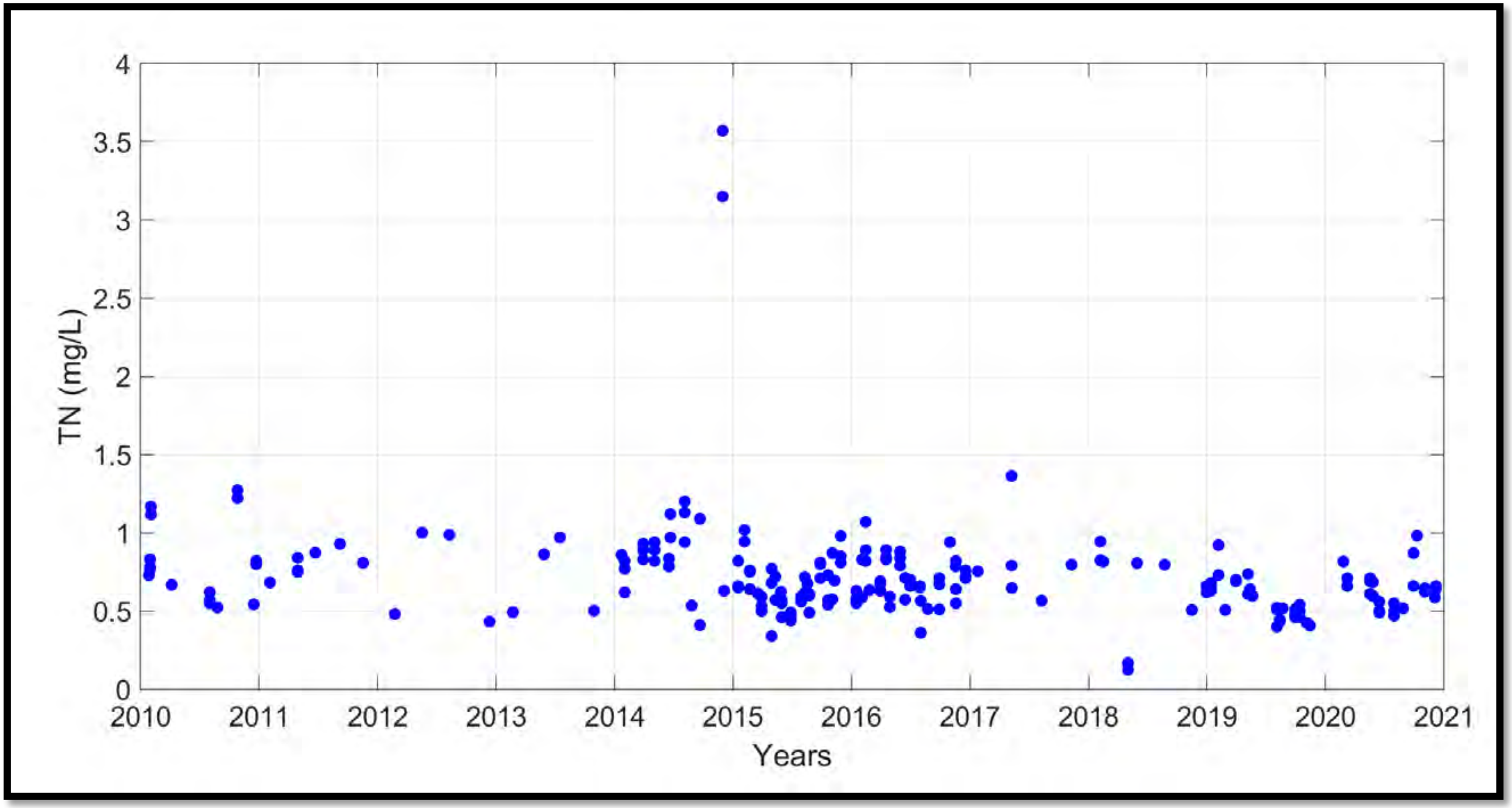

Figure 3-54: Plot of Measured TN in Lake Bradford

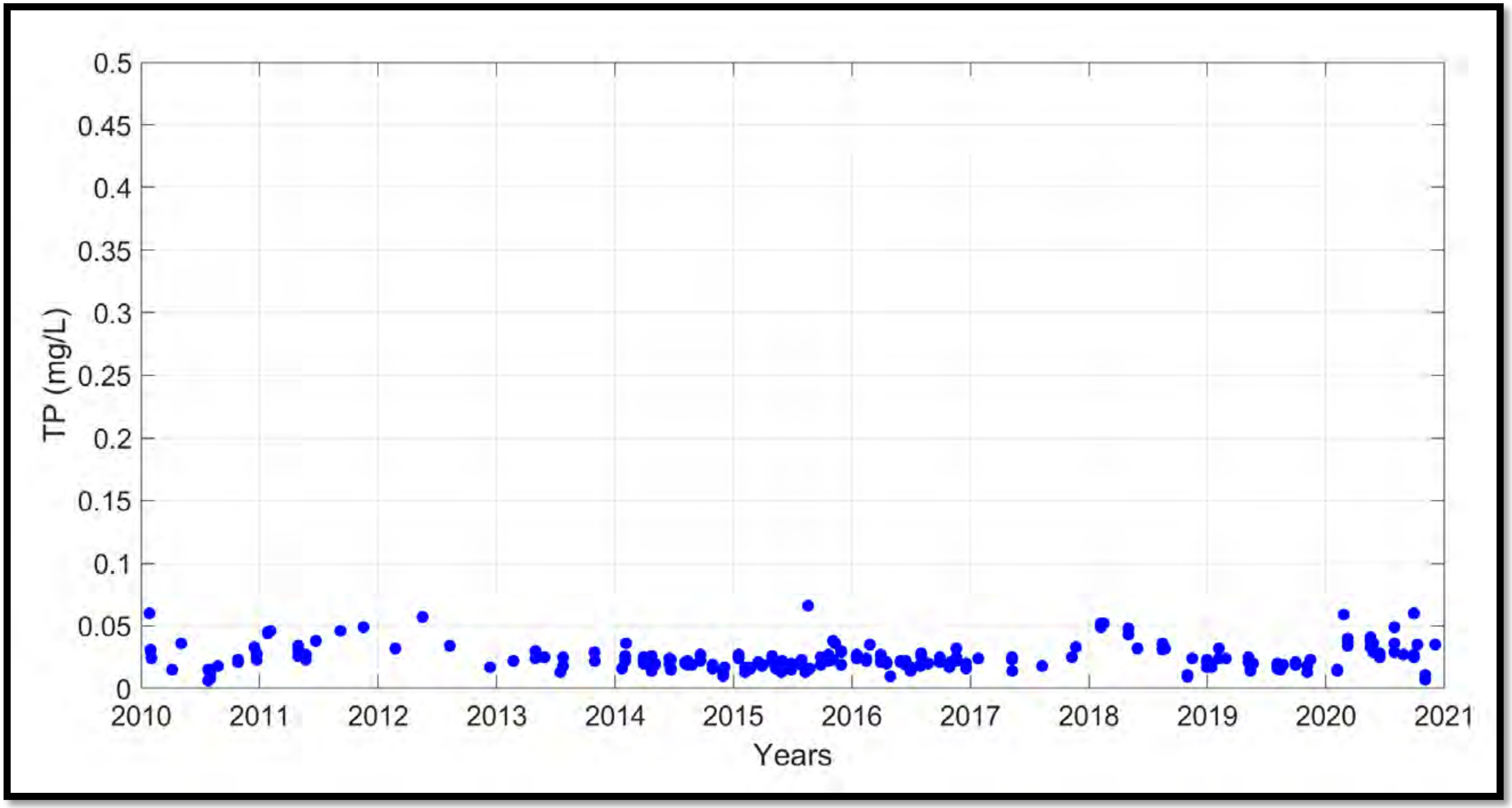

Figure 3-55: Plot of Measured TP in Lake Bradford

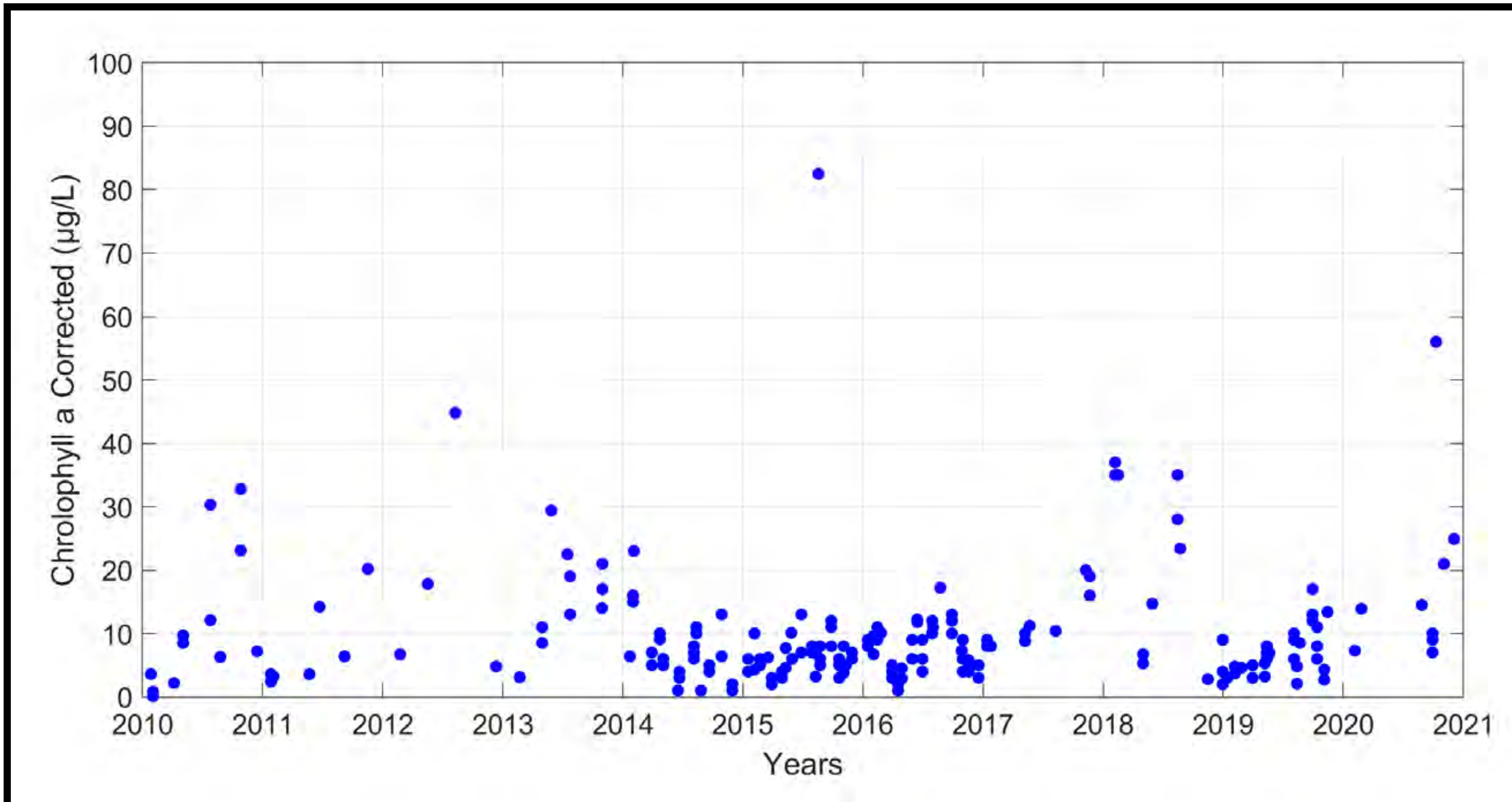

Figure 3-56: Plot of Measured Chl-a in Lake Bradford

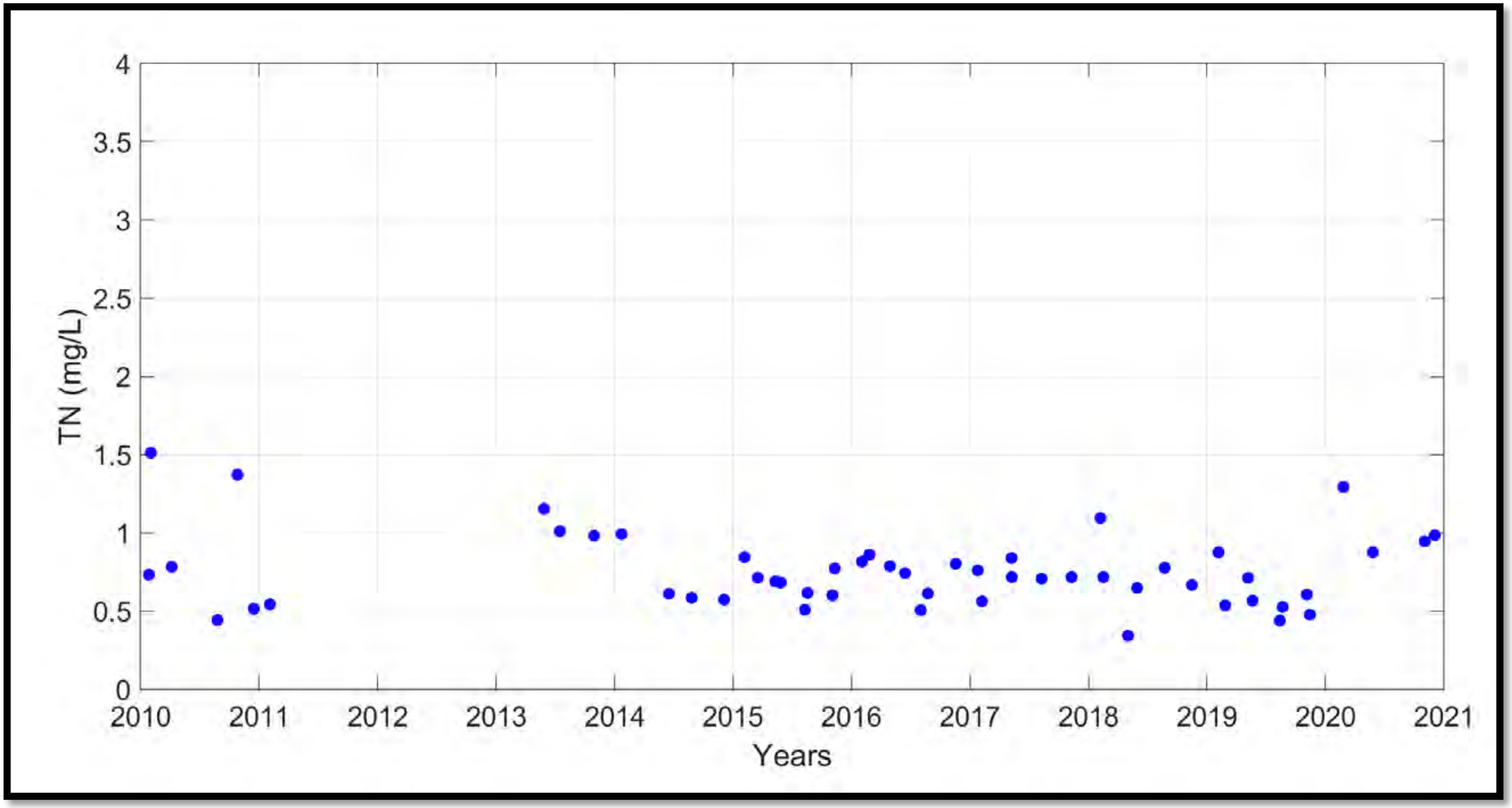

Figure 3-57: Plot of Measured TN in Lake Hiawatha

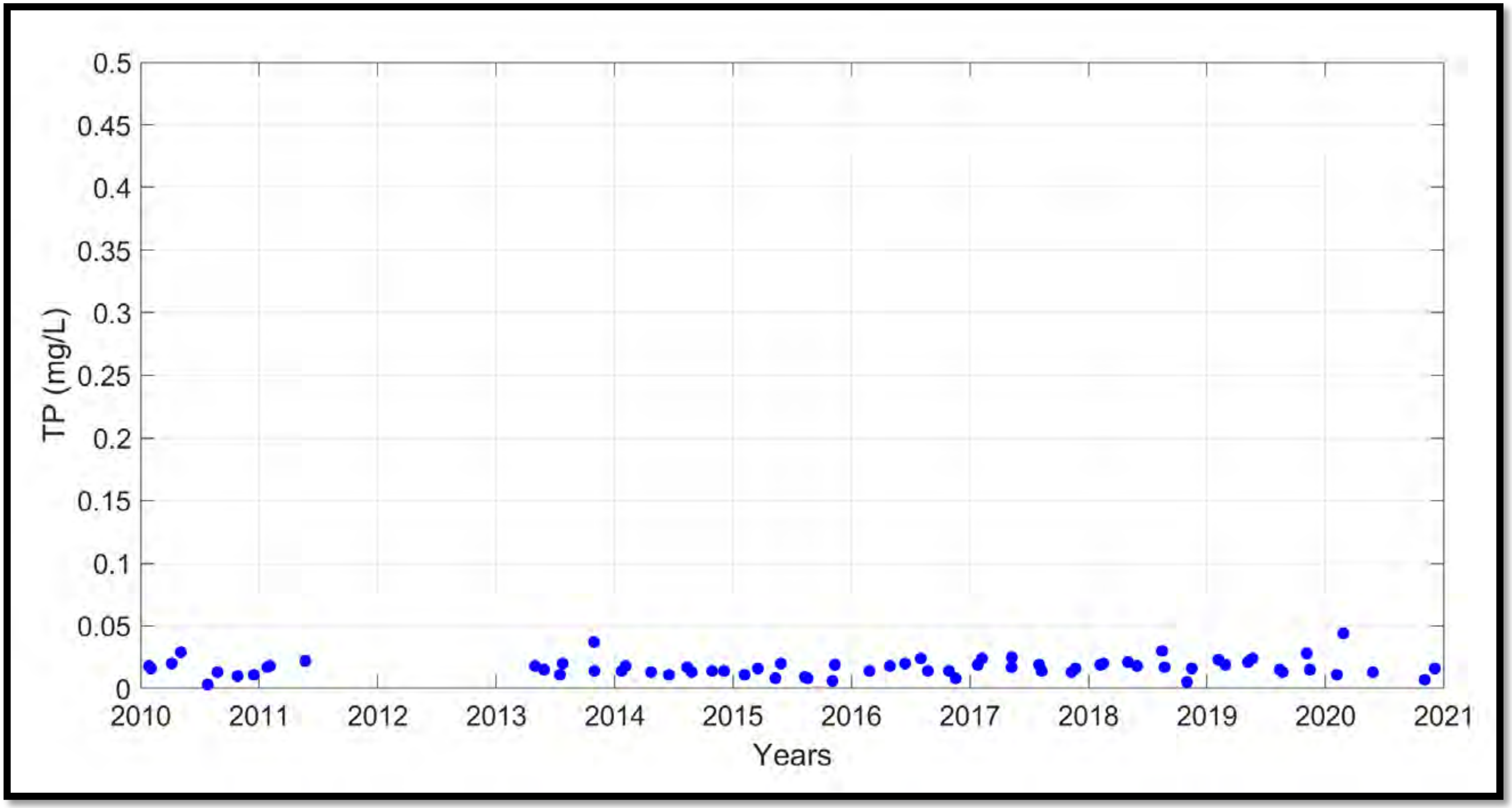

Figure 3-58: Plot of Measured TP in Lake Hiawatha

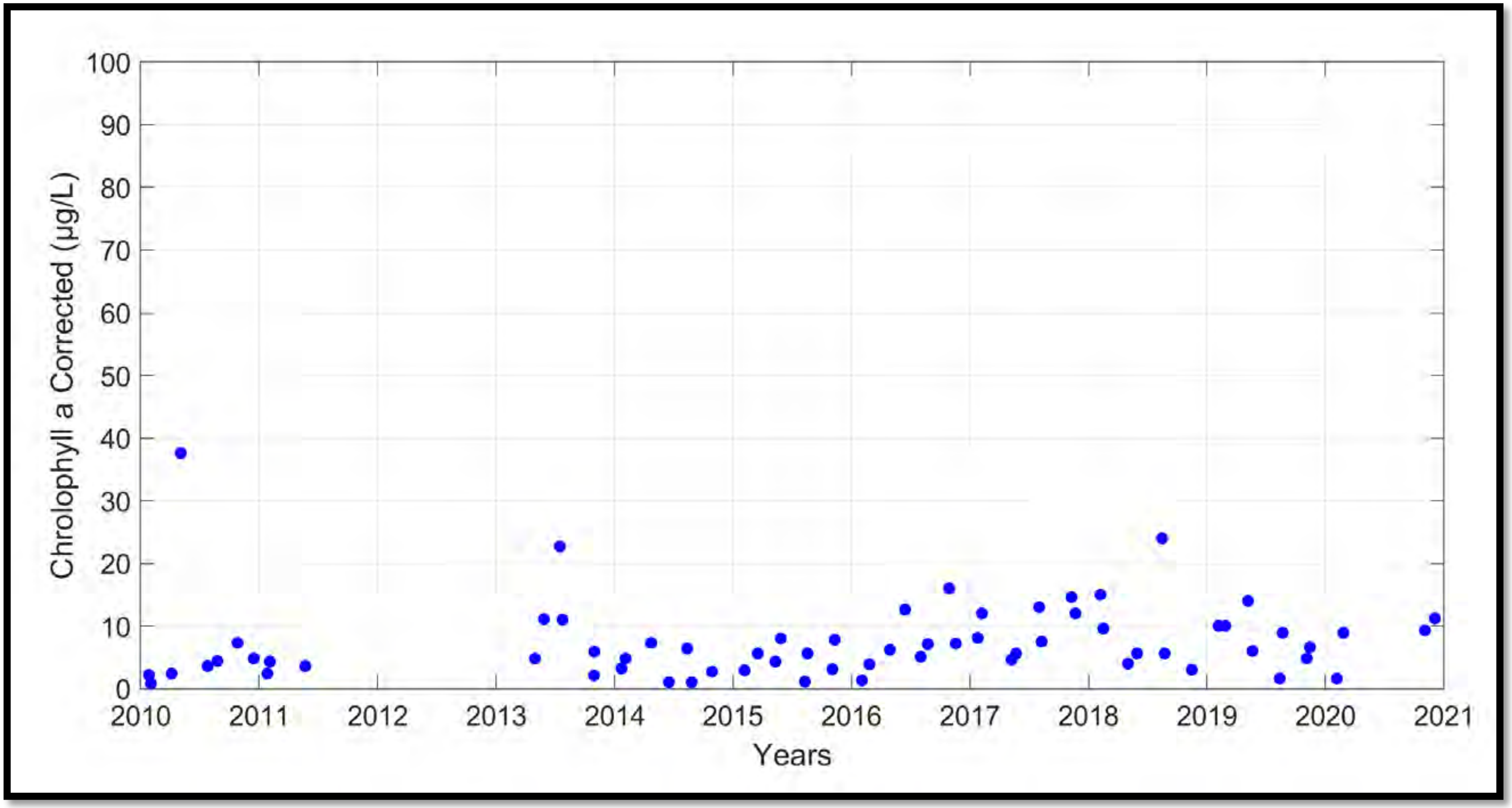

Figure 3-59: Plot of Measured Chl-a in Lake Hiawatha

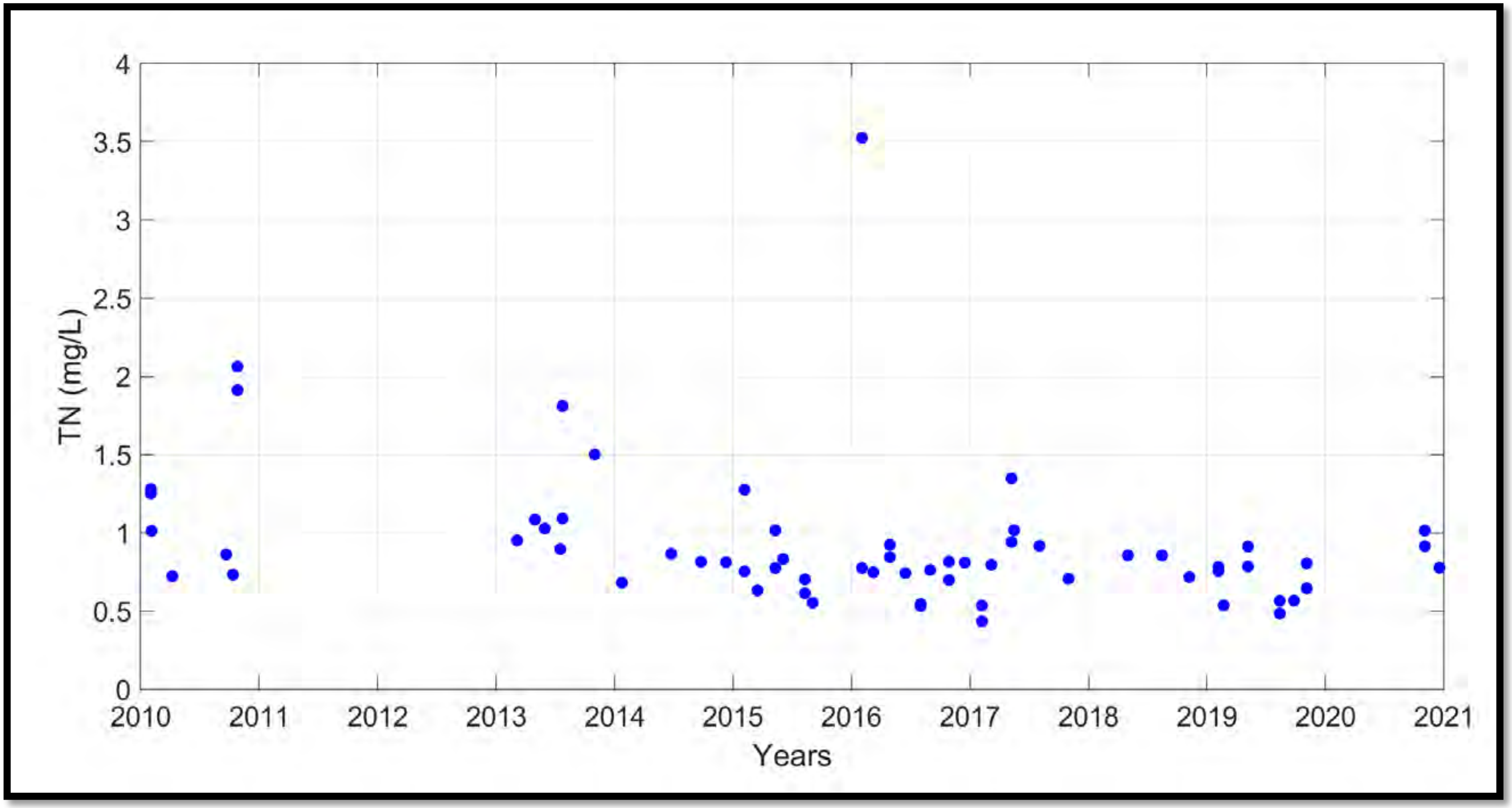

Figure 3-60: Plot of Measured TN in Cascade Lake

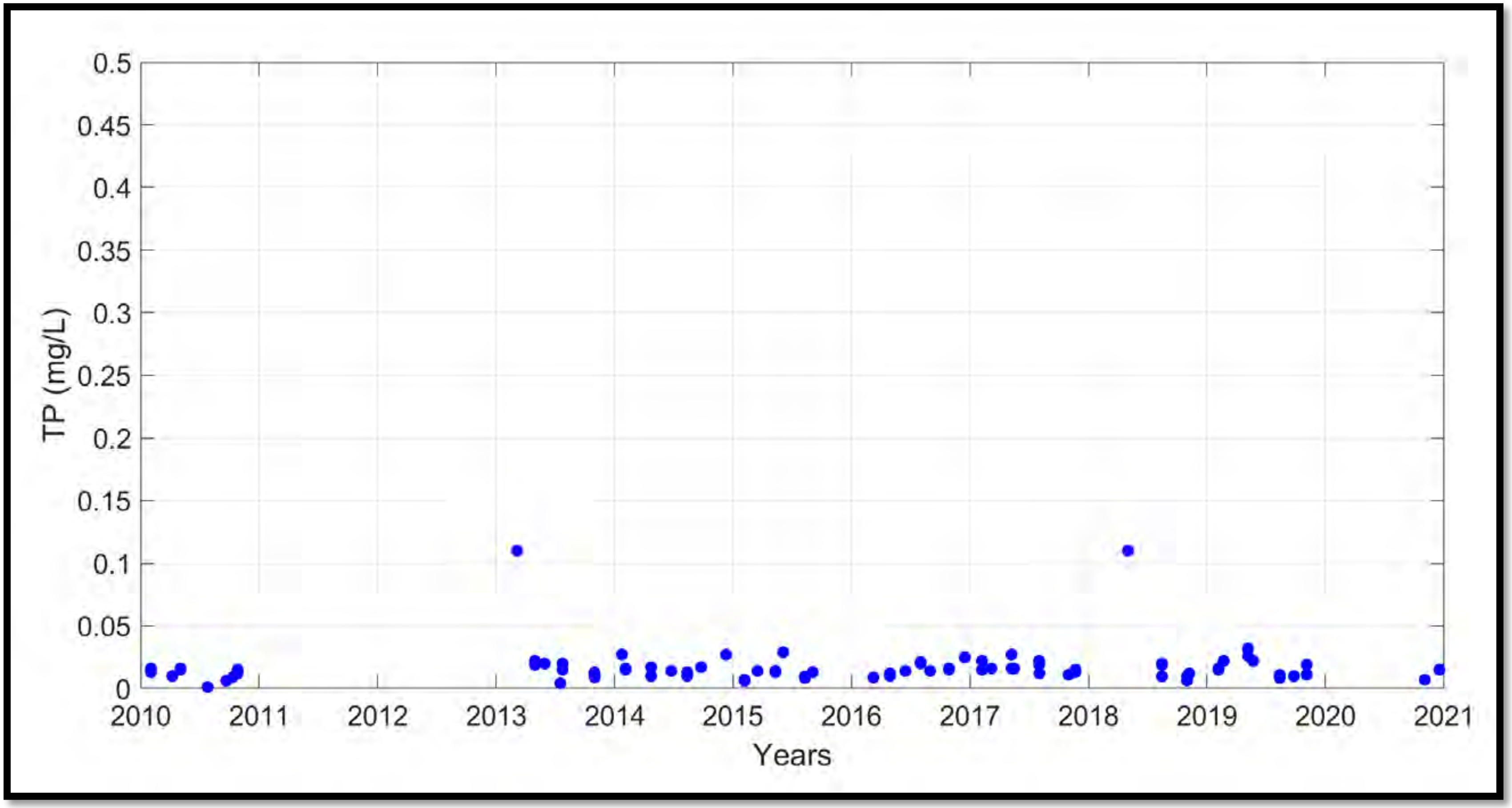

Figure 3-61: Plot of Measured TP in Cascade Lake

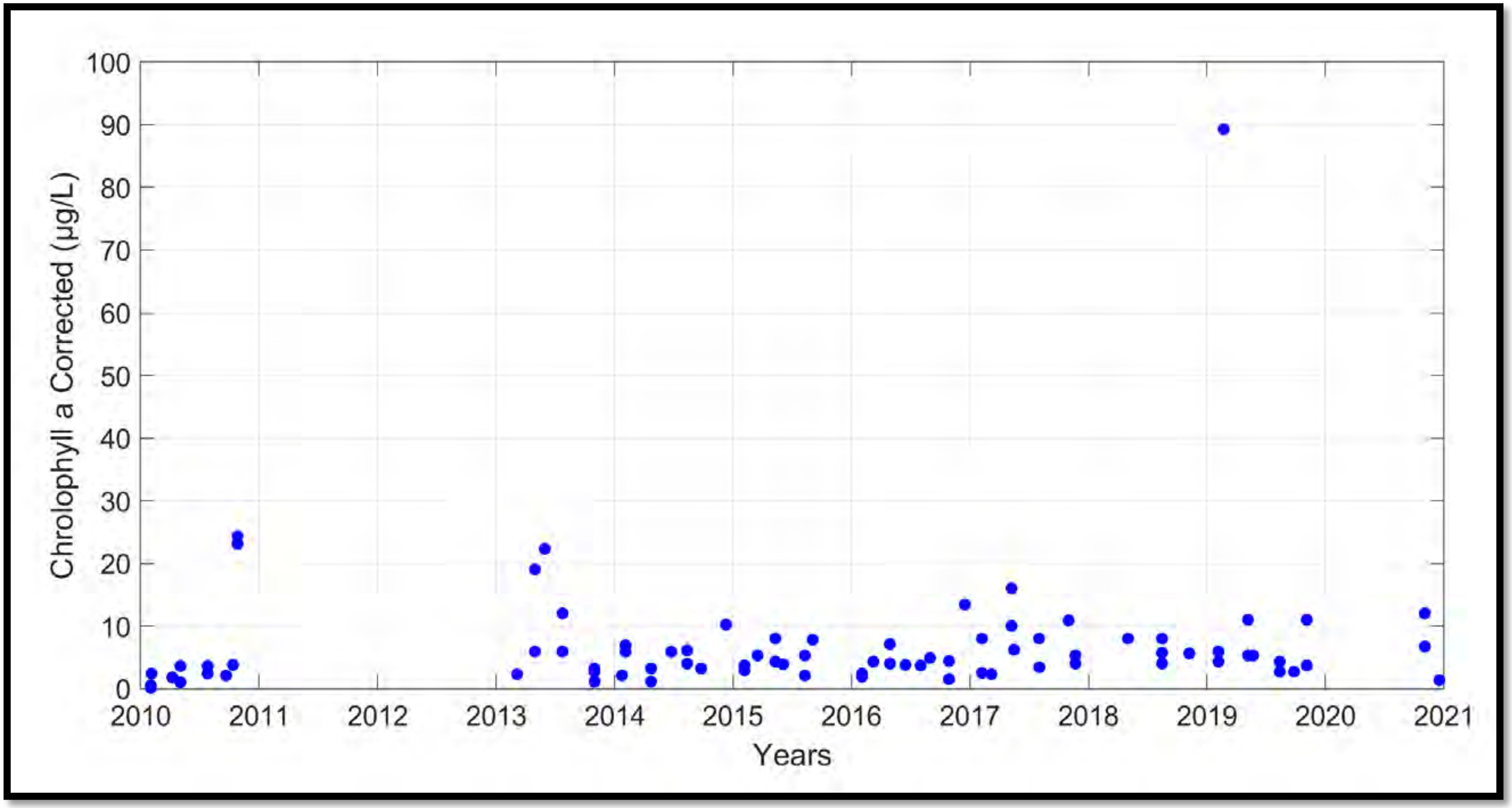

Figure 3-62: Plot of Measured Chl-a in Cascade Lake

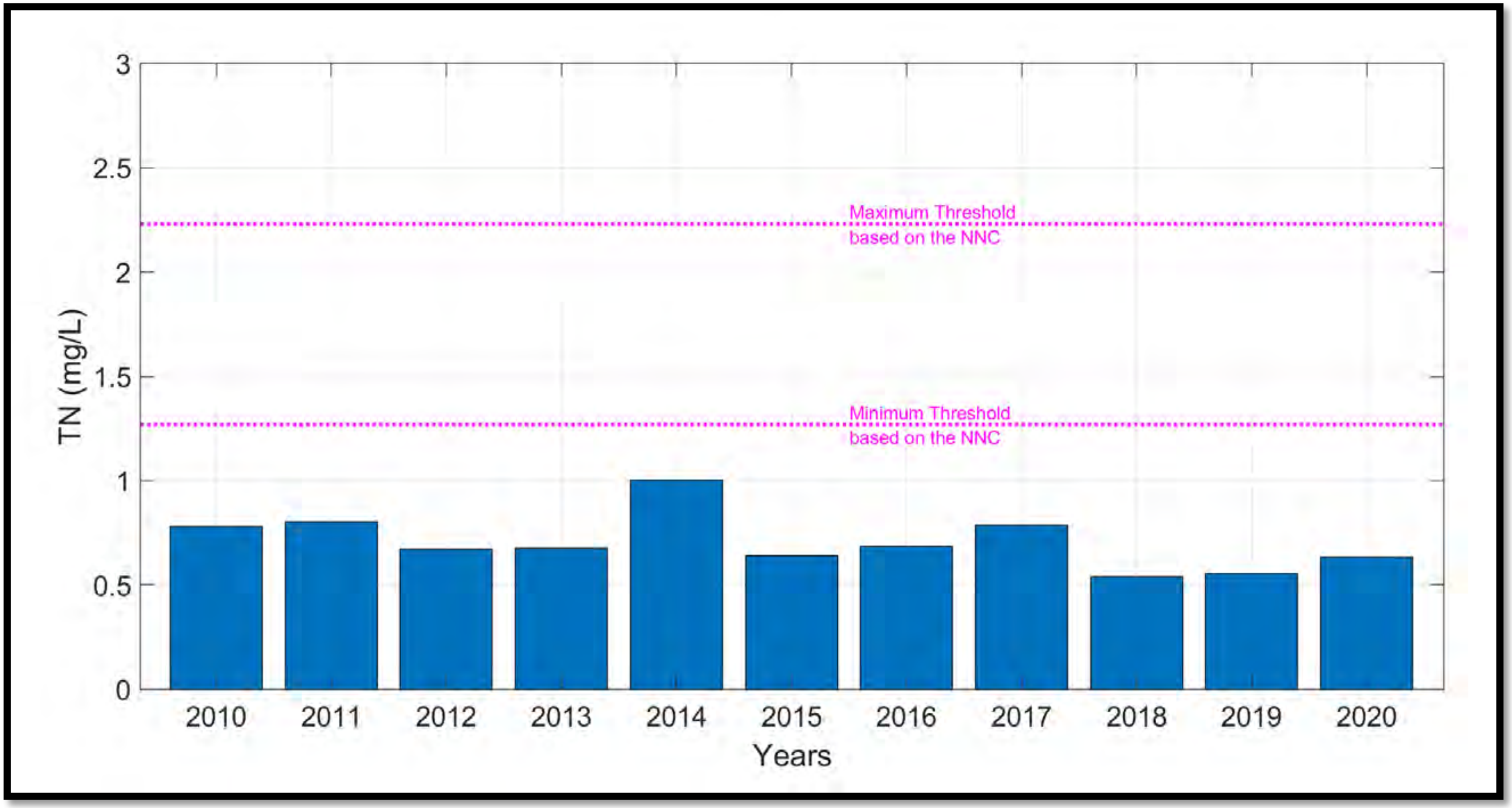

Figure 3-63: Plot of Annual Geometric Means for TN with NNC Criteria for Lake Bradford

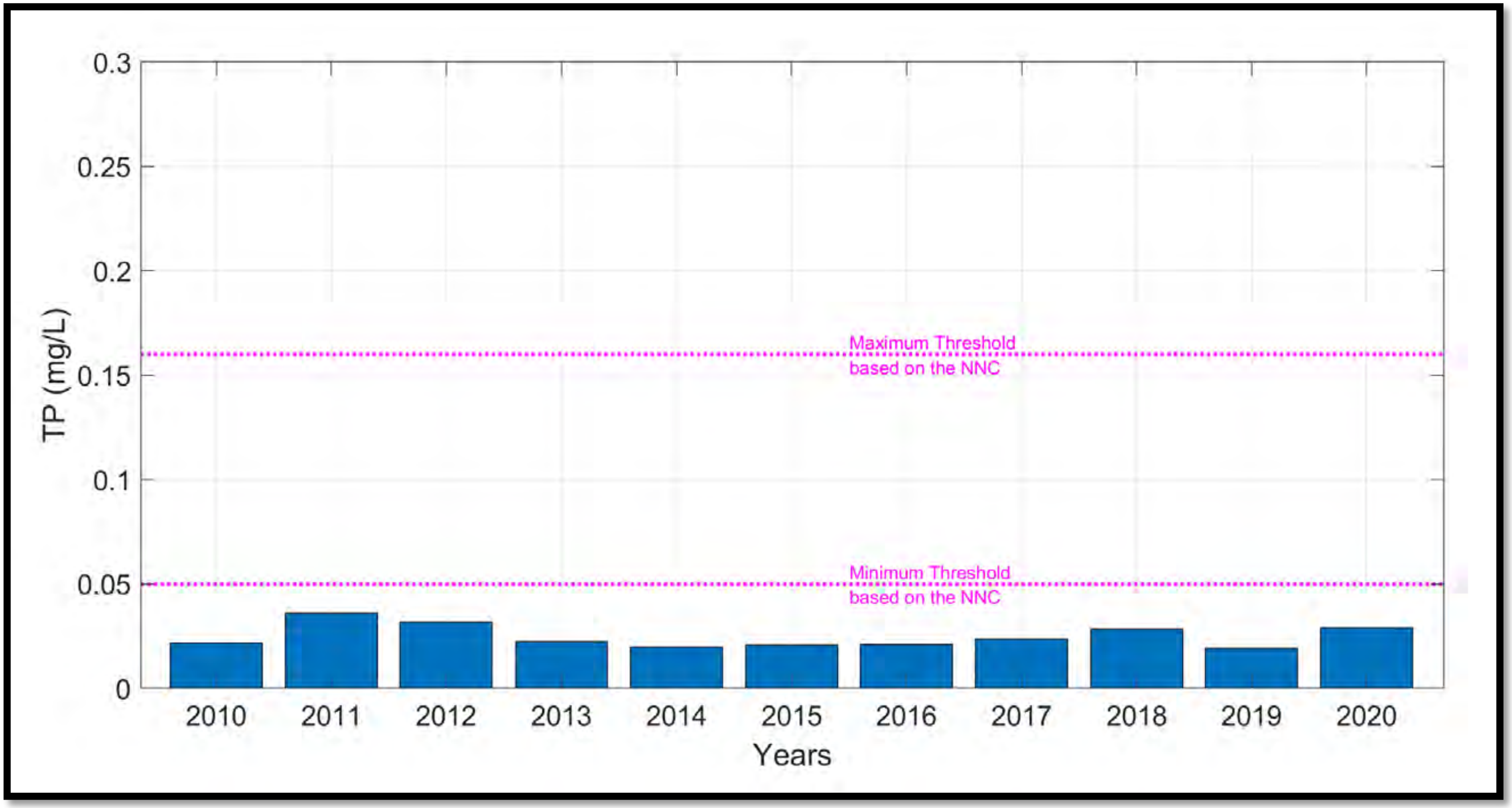

Figure 3-64: Plot of Annual Geometric Means for TP with NNC Criteria for Lake Bradford

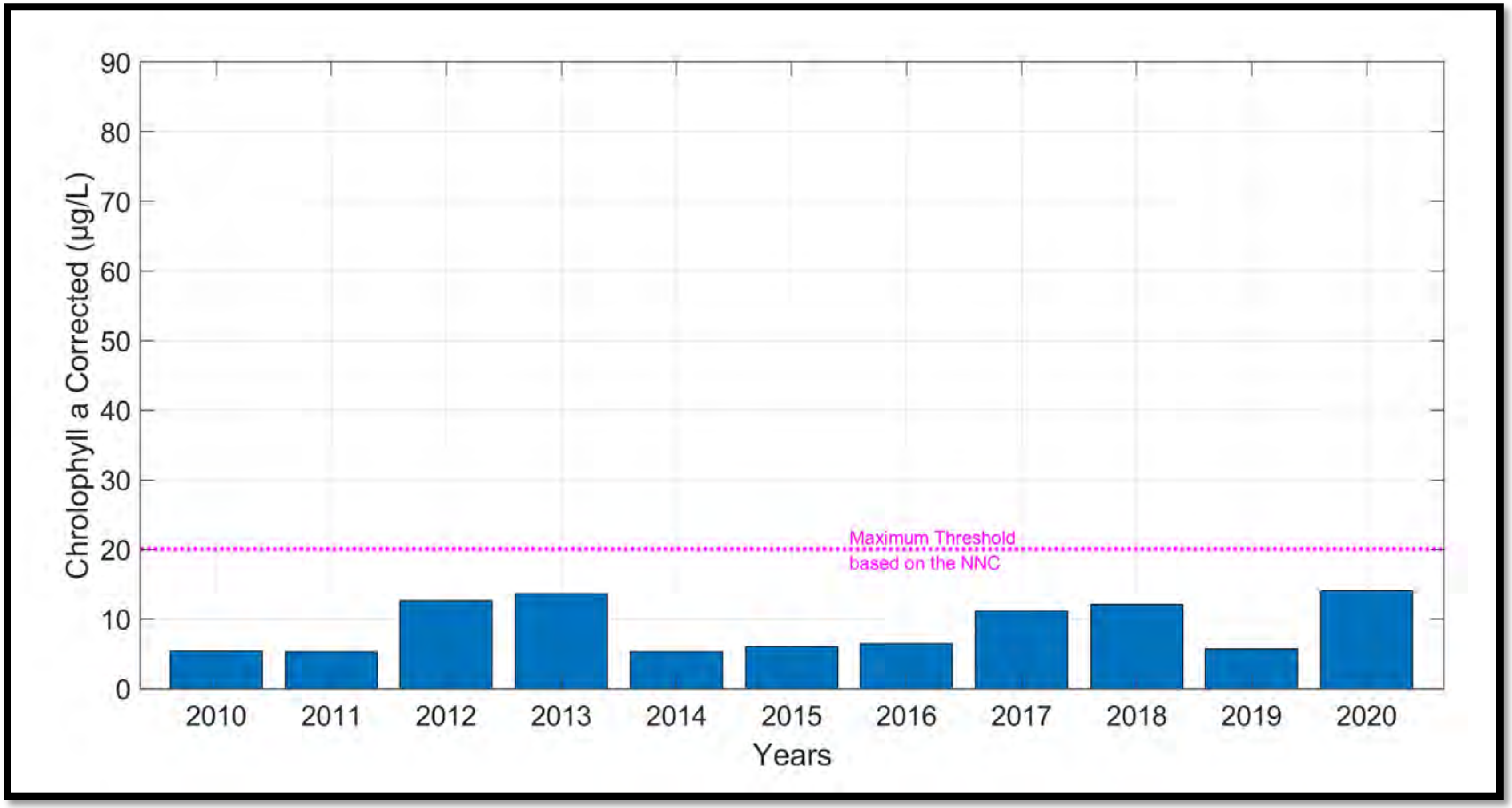

Figure 3-65: Plot of Annual Geometric Means for Chl-a with NNC Criteria for Lake Bradford

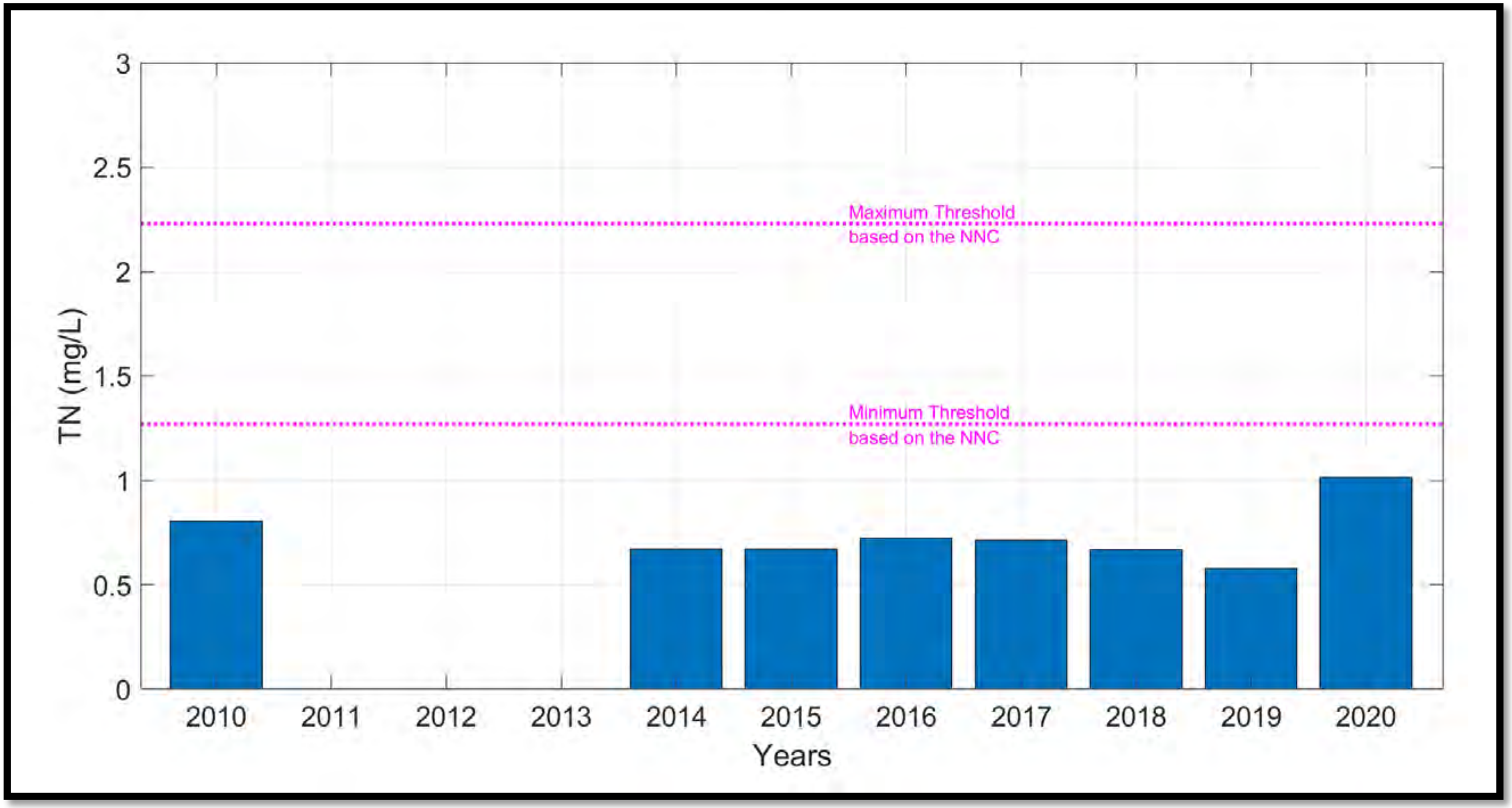

Figure 3-66: Plot of Annual Geometric Means for TN with NNC Criteria for Lake Hiawatha

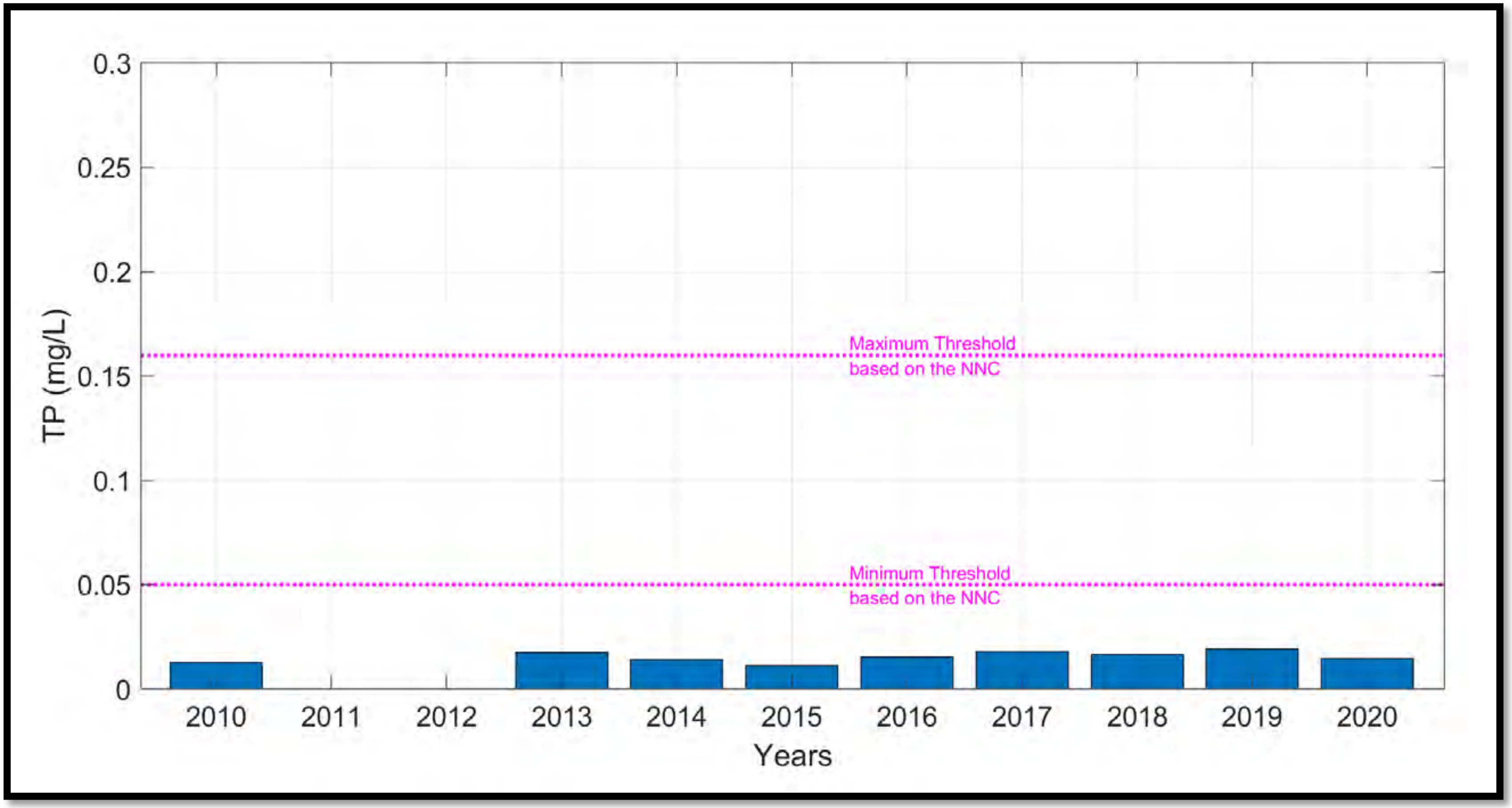

Figure 3-67: Plot of Annual Geometric Means for TP with NNC Criteria for Lake Hiawatha

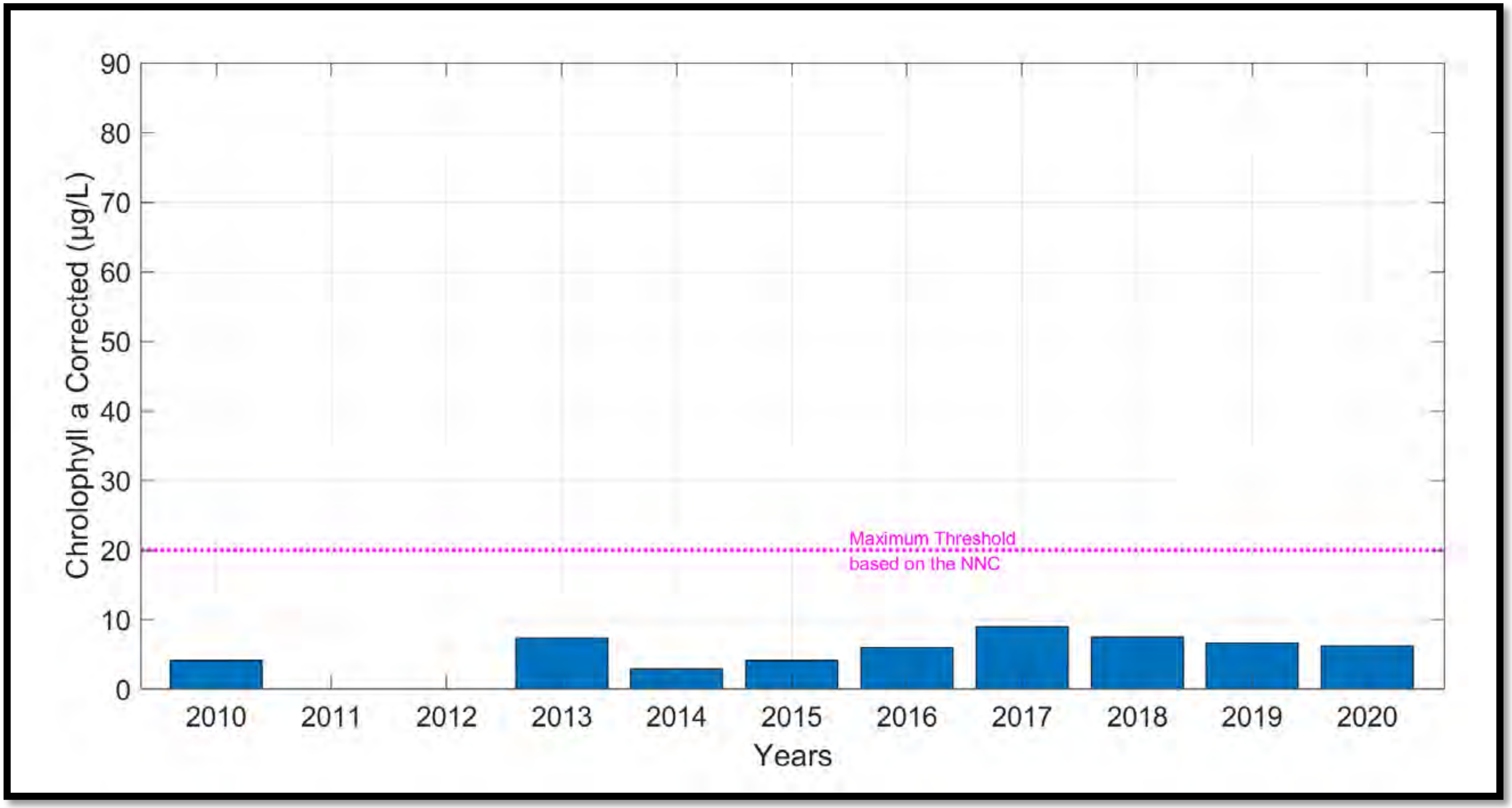

Figure 3-68: Plot of Annual Geometric Means for Chl-a with NNC Criteria for Lake Hiawatha

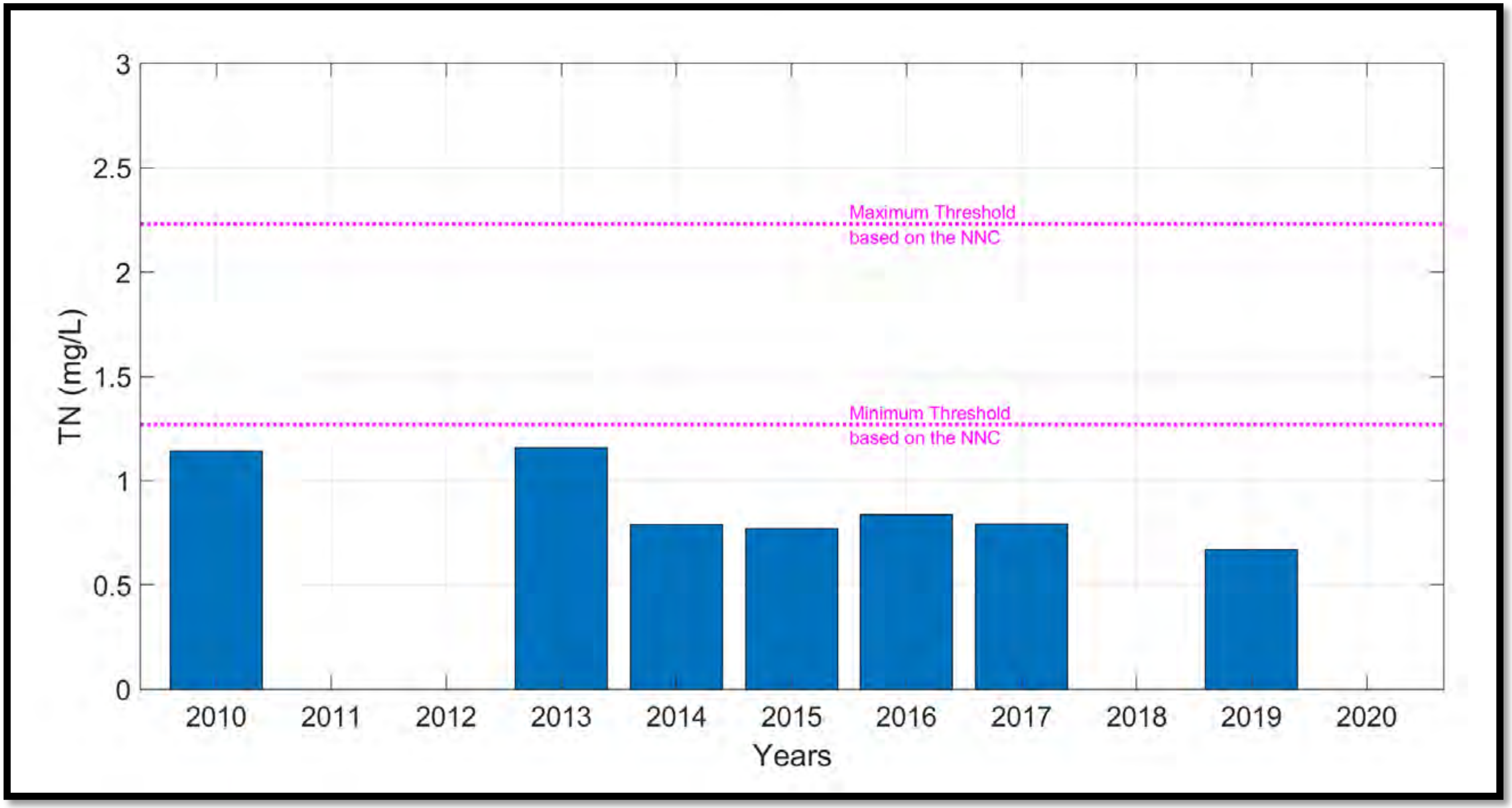

Figure 3-69: Plot of Annual Geometric Means for TN with NNC Criteria for Cascade Lake

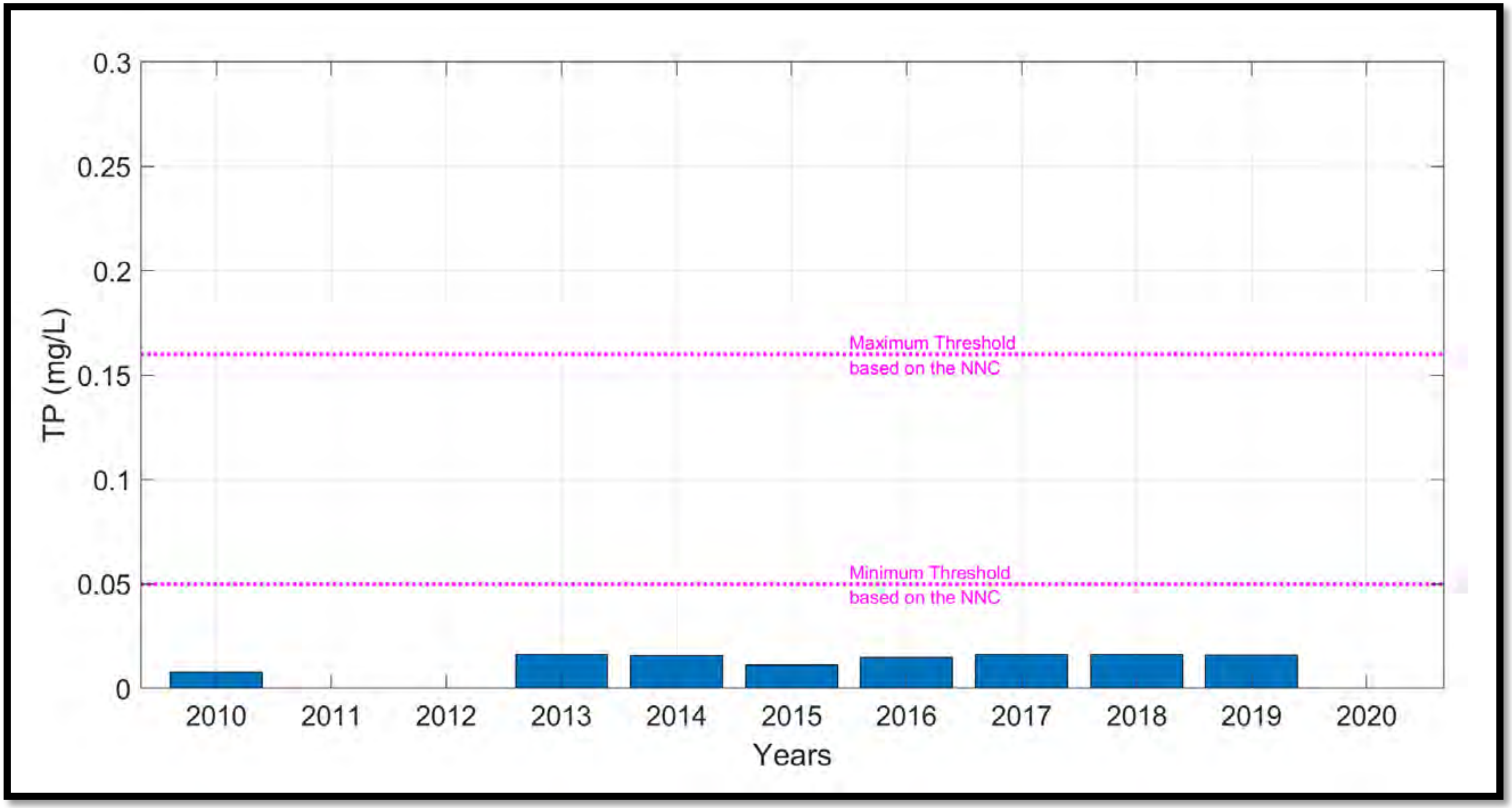

Figure 3-70: Plot of Annual Geometric Means for TP with NNC Criteria for Cascade Lake

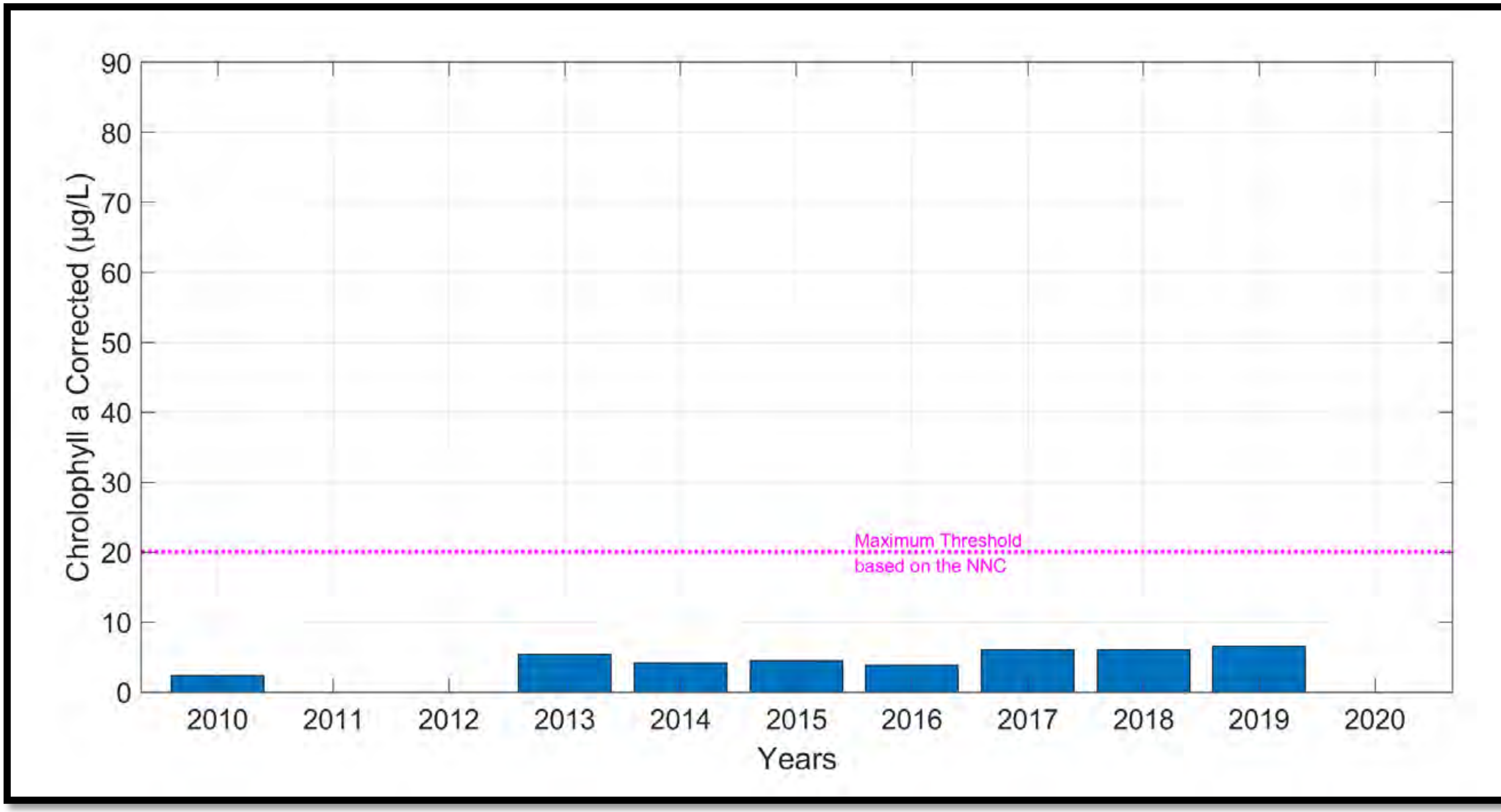

Figure 3-71: Plot of Annual Geometric Means for Chl-a with NNC Criteria for Cascade Lake

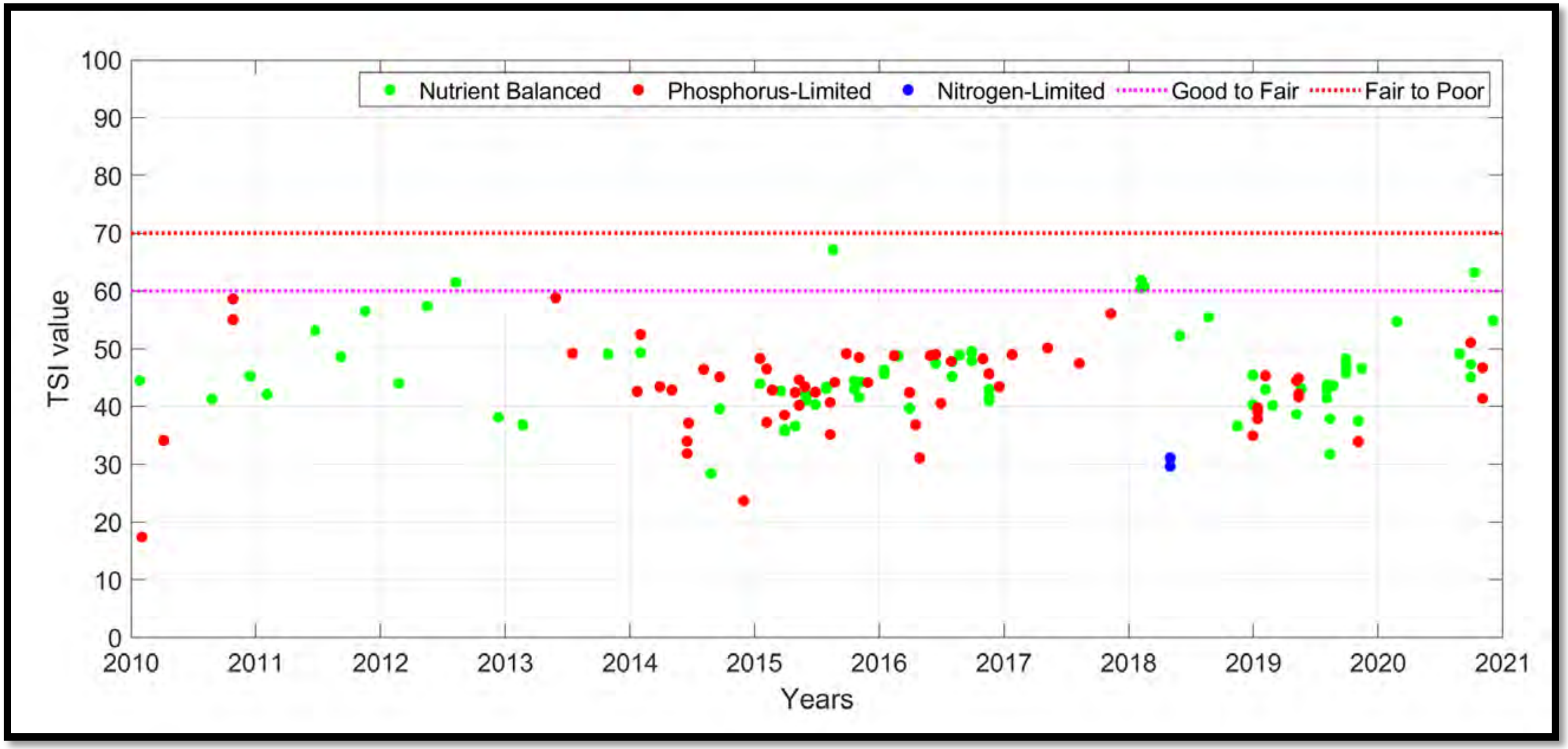

Figure 3-72: Trophic State Index for Lake Bradford

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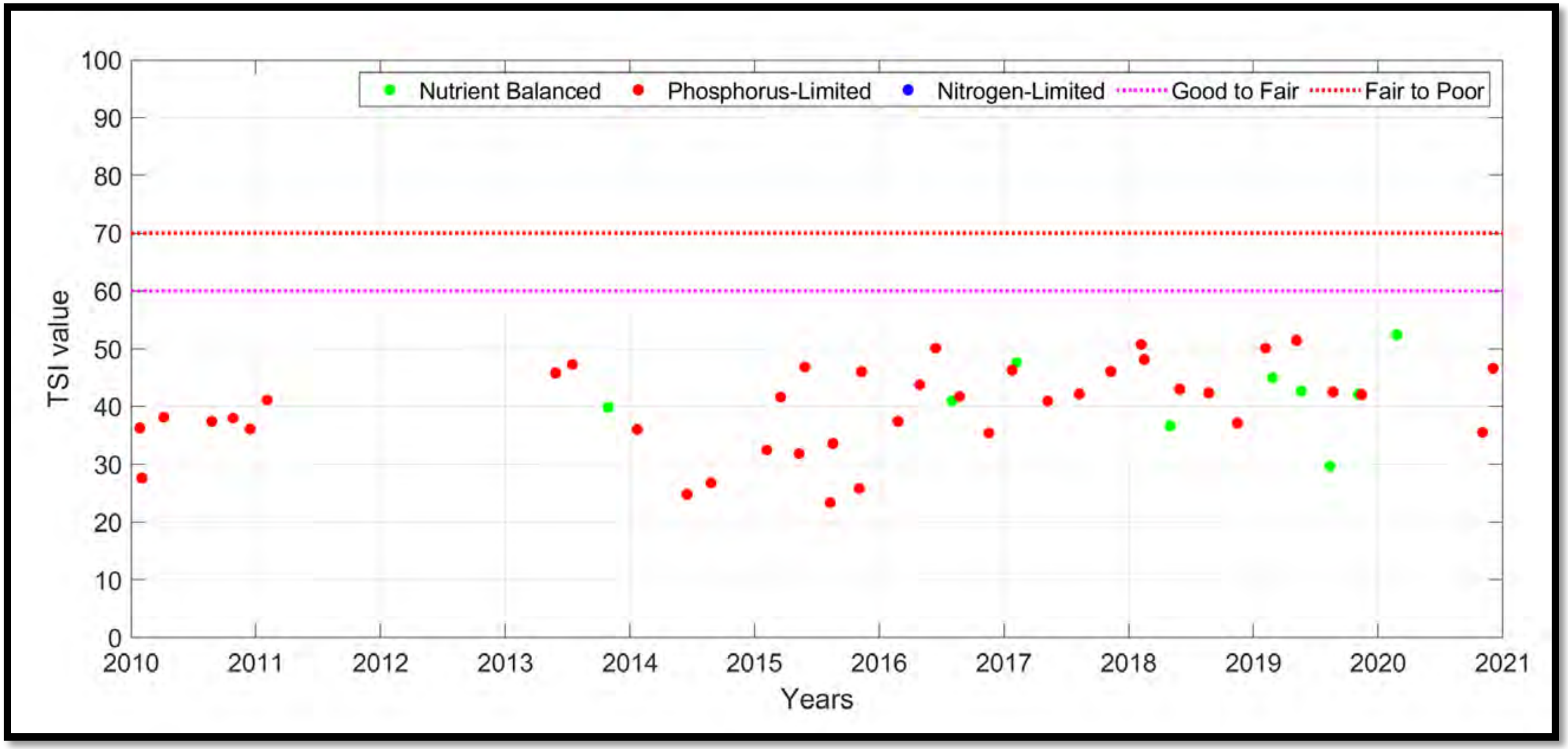

Figure 3-73: Trophic State Index for Lake Hiawatha

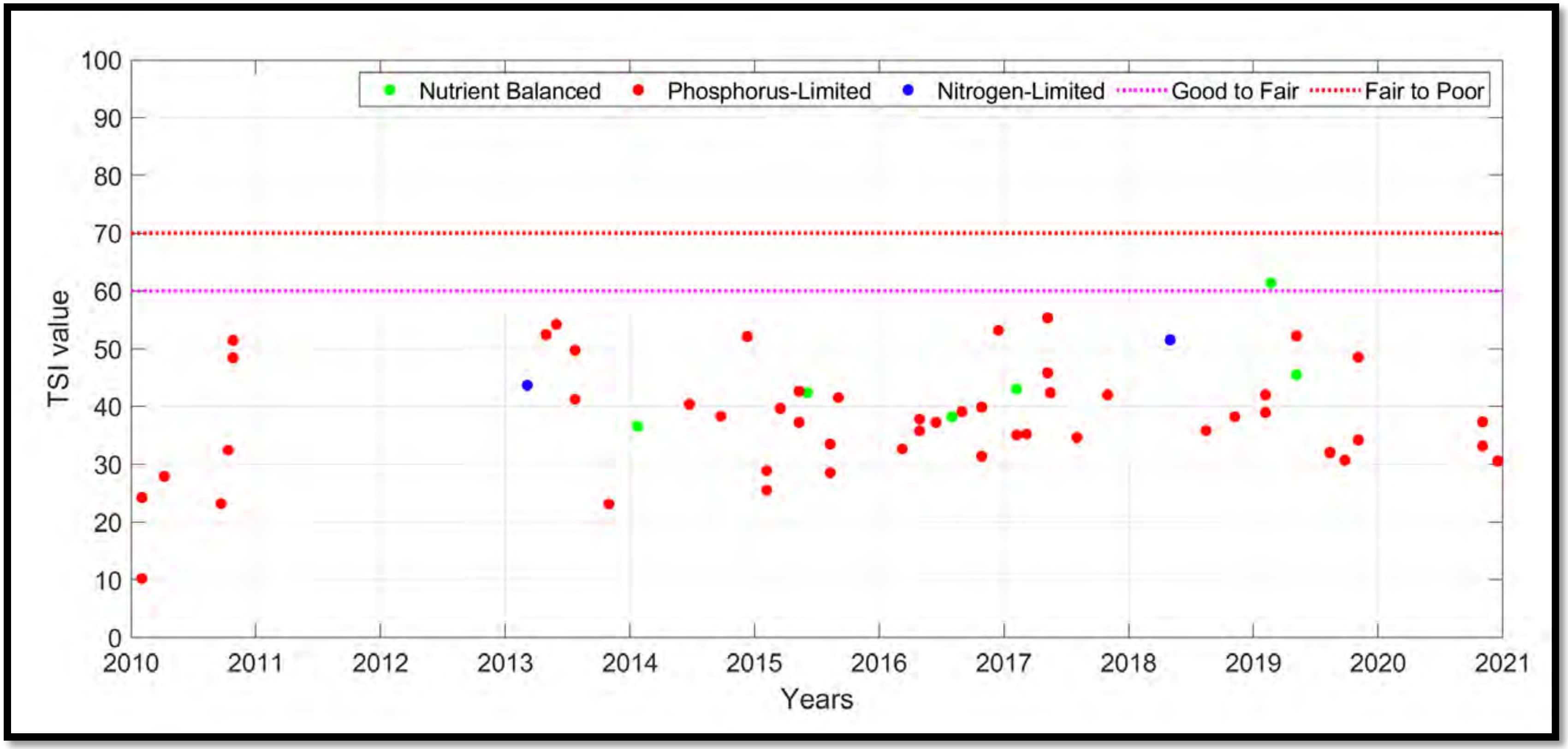

Figure 3-74: Trophic State Index for Cascade Lake

Figure 3-75, **Figure 3-76**, and **Figure 3-77** present a plot of measured *E. coli* levels in the lakes from 2014 through 2020. The concentrations in Lake Hiawatha and Cascade Lake are all very low, with most at or below detection limits and well below the 410 MPN/100 mL threshold. The concentrations in Lake Bradford are also low, with a few higher values recorded in 2020 and one above the 410 MPN/100 mL threshold.

3.5.3.7 Groundwater Data

Figure 3-23 presented the surficial aquifer groundwater sampling wells within the Lake Munson basin boundaries. Station AAD5312 is located within the Lake Bradford Estates neighborhood downstream of Lake Bradford. Data for this station is only available from 2000. Station AAA0291 is located within the Silver Lake Recreation Area within the Apalachicola National Forest. Data for this station is available from 1993 to 1999.

3.5.3.8 Biological Data

Table 3-14 through **Table 3-16** present LVI data collected by Leon County and FDEP on the three lakes. Lake Bradford data range from 53 up to 75, reflecting conditions between healthy and exceptional. Lake Hiawatha and Cascade Lake data range from 79 up to 95, reflecting exceptional conditions for all sampling events.

3.5.3.9 Stormwater Treatment Facilities

In assessing potential sources of pollutants to the Bradford Chain of Lakes, and ultimately for targeting loads and reductions, it is important to identify treatment facilities adjacent to and along tributaries flowing into the three lakes. **Figure 3-78** presents a map showing the locations of stormwater treatment facilities throughout the Bradford Chain of Lakes subbasin. These are maintained by Leon County, the City, FDOT, and private neighborhoods. The bulk of the facilities are located in and around Capital Circle SW where it passes just north of Cascade Lake and Lake Hiawatha. Five private stormwater ponds are located in neighborhoods south of Blountstown Highway (State Road 20).

3.5.3.10 Atmospheric Deposition Data

Figure 3-24 presented the location of the nearest atmospheric deposition station to the Bradford Chain of Lakes, the Quincy, FL station. This is the same station utilized in the Lake Munson calculations.

3.5.3.11 Data Summary

For the purposes of the qualitative analysis of sources of pollutants to the Bradford Chain of Lakes (**Section 3.5.4**), the available data are reasonable. There are sufficient active surface water quality stations within the lakes to support the qualitative assessment. The water quality conditions in the lakes limit the need for additional data. Based on the relatively pristine water quality, it is assumed anthropogenic loads are minimal. The following outlines some limitations in the available data. Specific recommendations on additional data collection efforts are provided in **Section 3.8**.

- The water quality data along Bradford Creek immediately upstream of Cascade Lake is old and limited (prior to 2006).

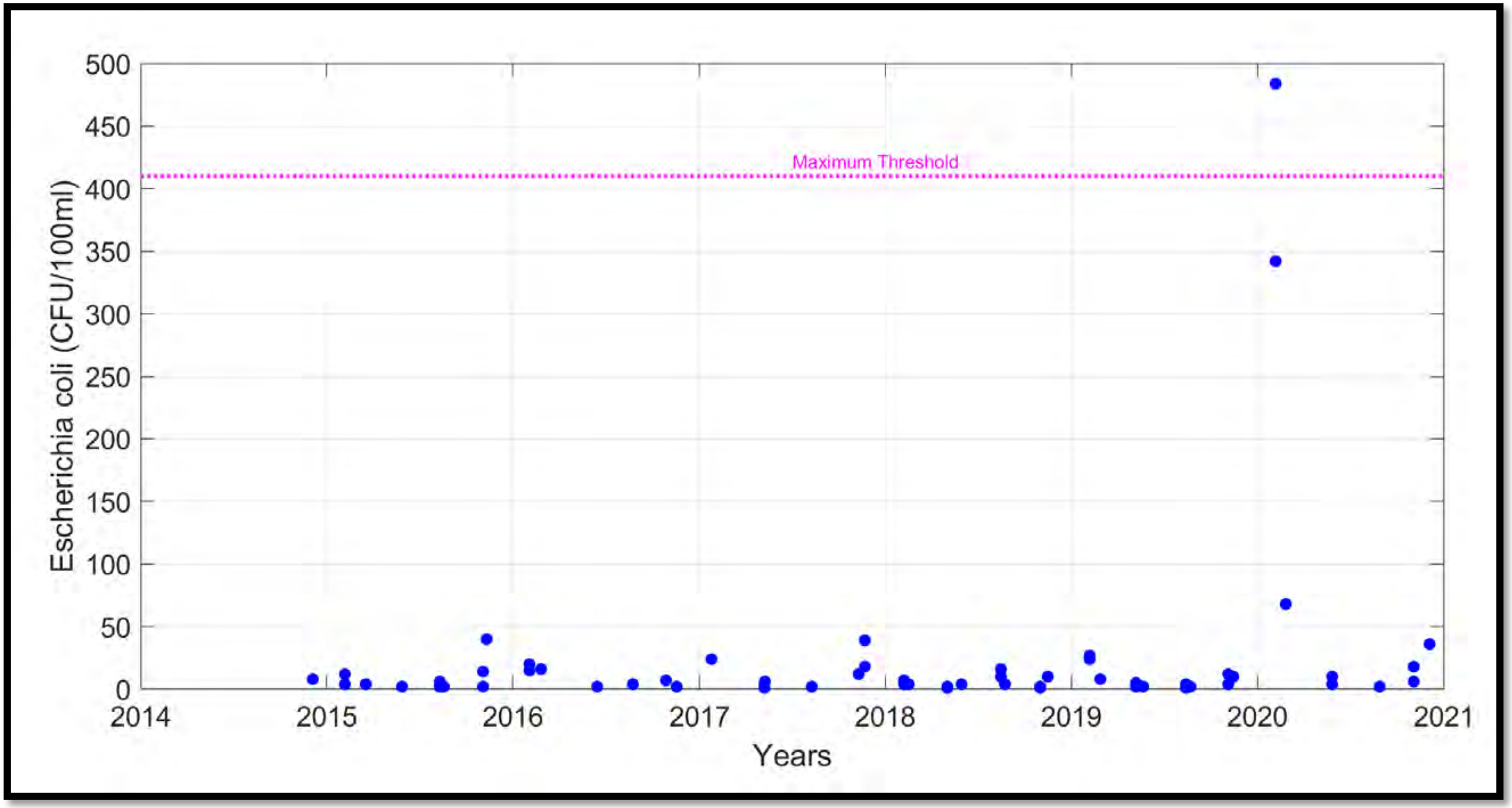

Figure 3-75: Plot of *E. coli* for Lake Bradford

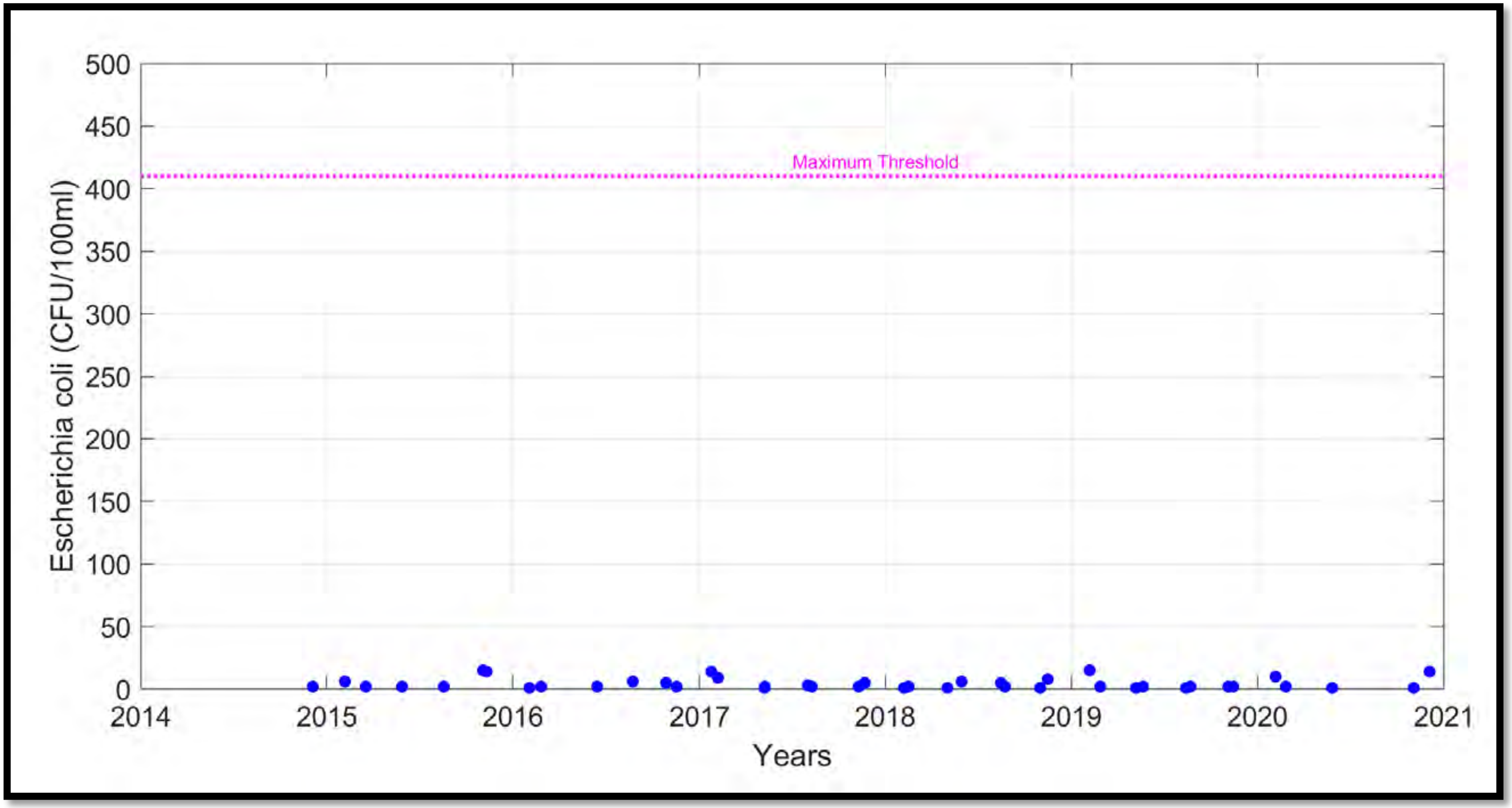

Figure 3-76: Plot of *E. coli* for Lake Hiawatha

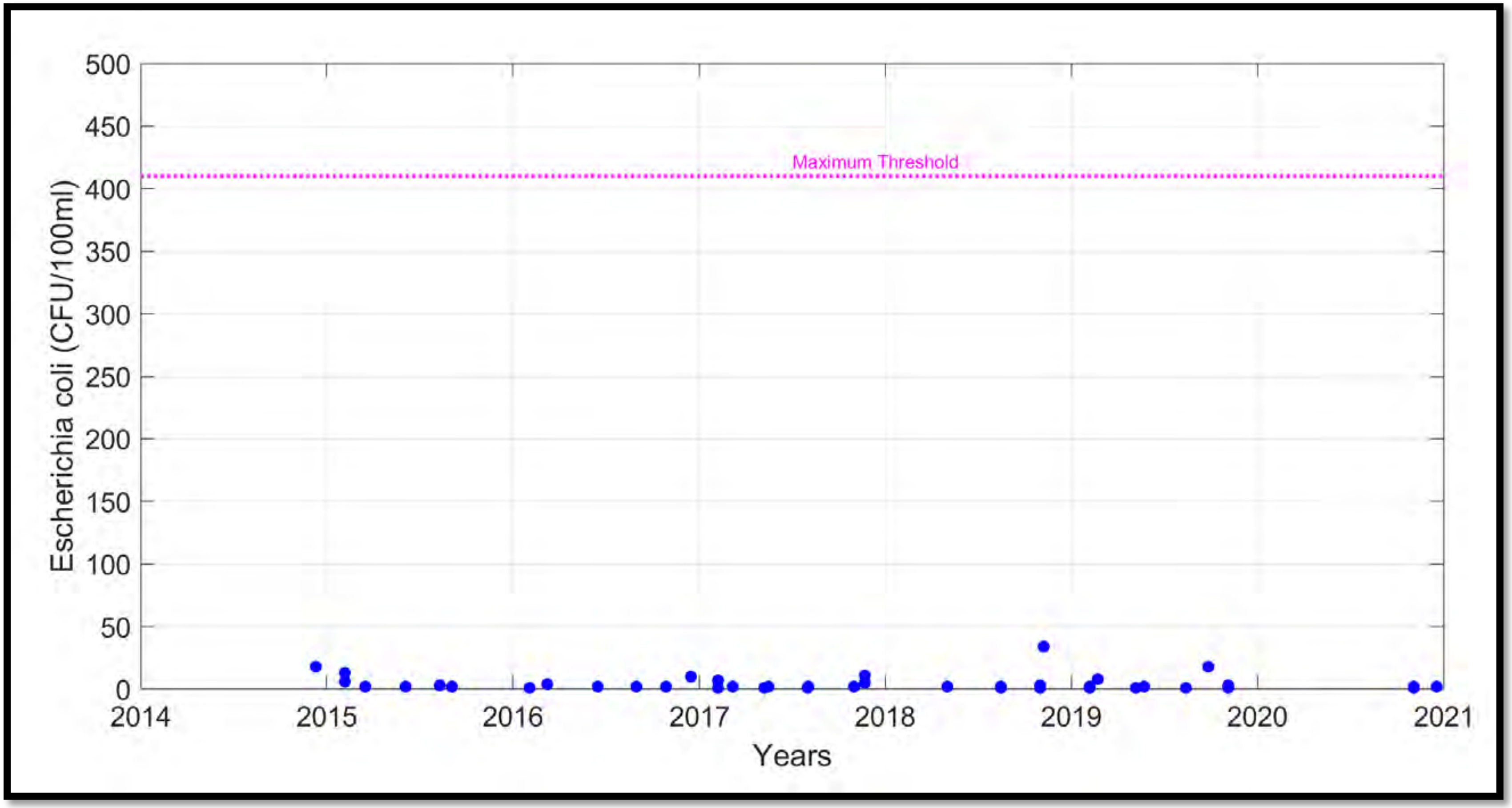

Figure 3-77: Plot of *E. coli* for Cascade Lake

Table 3-14: Summary of LVI Data for Lake Bradford

Date	Station ID	LVI	Aquatic Life Use Category
6/23/2010	21FLCOT COTLVI001	53	Healthy
8/25/2010	21FLLEONLEONLVI001	76	Exceptional
8/9/2013	21FLLEONLEONLVI001	60	Healthy
10/15/2013	21FLCOT COTLVI001	75	Exceptional
8/26/2014	21FLLEONLEONLVI001	68	Exceptional
8/19/2015	21FLLEONLEONLVI001	65	Exceptional
9/23/2015	21FLCOT COTLVI001	60	Healthy
8/24/2016	21FLLEONLEONLVI001	56	Healthy
7/26/2018	21FLLEONLEONLVI001	64	Exceptional
7/24/2019	21FLLEONLEONLVI001	72	Exceptional

Table 3-15: Summary of LVI Data for Lake Hiawatha

Date	Station ID	LVI	Aquatic Life Use Category
6/23/2010	21FLCOT COTLVI003	93	Exceptional
8/25/2010	21FLLEONLEONLVI005	79	Exceptional
8/9/2013	21FLLEONLEONLVI005	86	Exceptional
8/26/2014	21FLLEONLEONLVI005	95	Exceptional
8/18/2015	21FLLEONLEONLVI005	92	Exceptional
9/23/2015	21FLCOT COTLVI003	82	Exceptional
8/24/2016	21FLLEONLEONLVI005	80	Exceptional
7/26/2018	21FLLEONLEONLVI005	88	Exceptional
7/24/2019	21FLLEONLEONLVI005	84	Exceptional

Table 3-16: Summary of LVI Data for Cascade Lake

Date	Station ID	LVI	Aquatic Life Use Category
7/8/2010	21FLCOT COTLVI009	80	Exceptional
9/29/2010	21FLLEONLEONLVI003	79	Exceptional
8/23/2013	21FLLEONLEONLVI003	89	Exceptional
9/9/2014	21FLLEONLEONLVI003	90	Exceptional
9/14/2015	21FLLEONLEONLVI003	89	Exceptional
10/17/2016	21FLLEONLEONLVI003	90	Exceptional
7/27/2018	21FLLEONLEONLVI003	86	Exceptional
7/22/2019	21FLLEONLEONLVI003	79	Exceptional

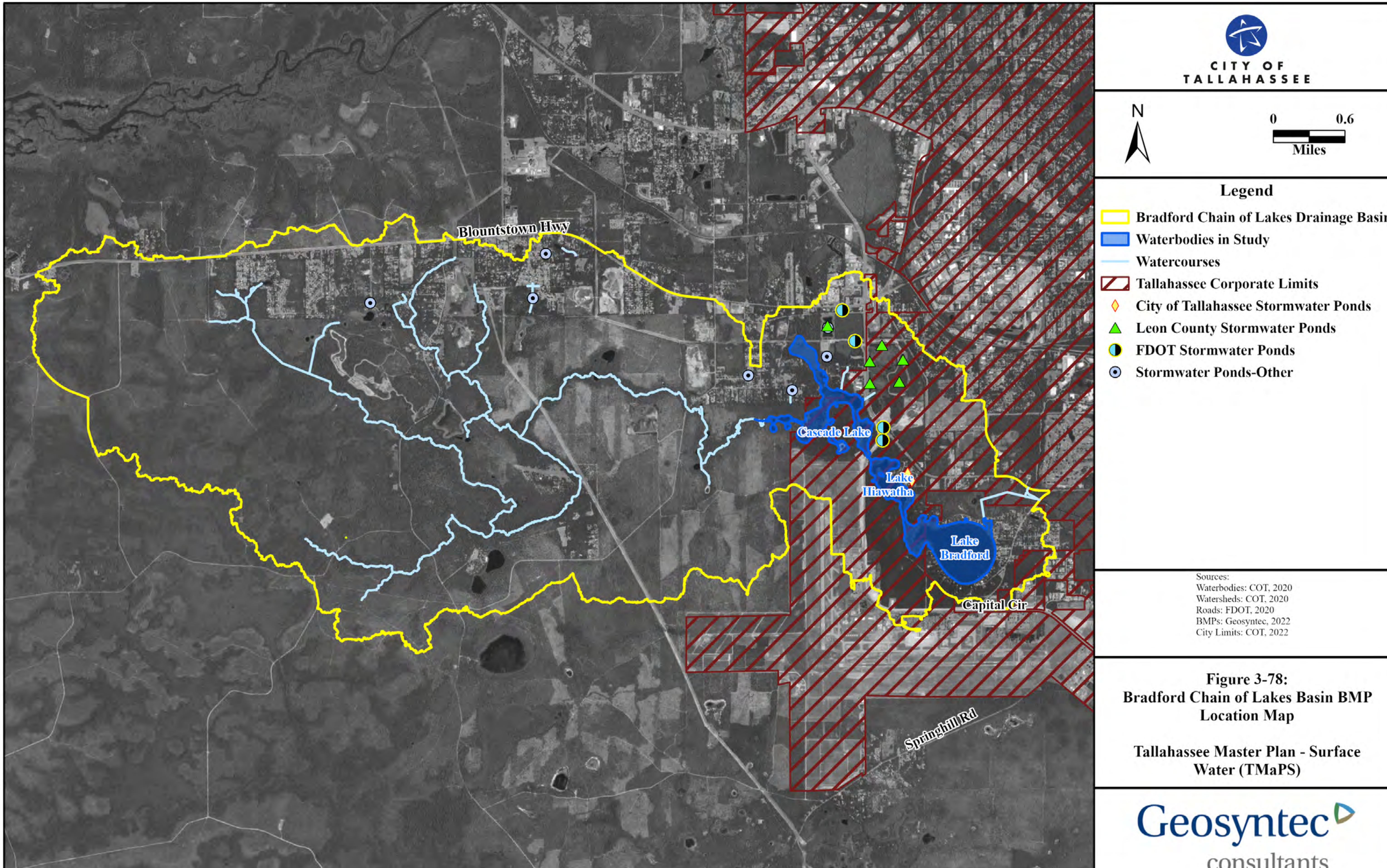

Figure 3-78: Bradford Chain of Lakes Basin BMP Location Map

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- There are limited data to evaluate the potential for seepage of pollutants to the lakes from the surficial aquifer, i.e., surficial groundwater sampling stations, around the lakes with recent data.

3.5.4 Qualitative Assessment of Sources

As outlined in **Section 3.4.4** for Lake Munson, prior to performing loading calculations and other analyses to quantify existing pollutant sources to the Bradford Chain of Lakes, it is important to analyze available data and summarize findings from historical studies to support identification of likely sources and quantification of the magnitude of impact.

For the Bradford Chain of Lakes, the sources to be evaluated include the following:

- Stormwater runoff
- Septic systems
- Internal recycling and seepage
- Wastewater
- Atmospheric deposition
- Interconnected flows

An overview of analyses and findings for each source listed above is provided in the following sections. Prior to the discussions of each of the potential sources, an in-lake analysis is provided to build on the information presented in **Section 3.5.3**. Following the discussions for each source type, a summary of findings for the qualitative assessment is provided.

3.5.4.1 In-Lake Water Quality

Following the methodology utilized for Lake Munson in **Section 3.4.4.1**, analyses were conducted on the available in-lake data for the three lakes from 2010 to 2020. This provides an evaluation of the baseline water quality conditions as well as the spatial variation through the system of lakes. The parameters analyzed for Bradford Chain of Lakes include color, alkalinity, TP, TN, Chl-a, TSI, and *E. coli*.

As was done for Lake Munson (**Section 3.4.4.1**), stations were clustered where they represent conditions within a specific area and all stations with data after 2010 were assigned to a specific cluster. The clustered data from 2010 to 2020 were analyzed to provide the average of the annual geomeans or the 90^{th} percentile, depending upon the parameter. The results are presented on a map, with colors representing the results. The levels associated with the colors are reflective of water quality thresholds as outlined in 62-302 Florida Administrative Code (F.A.C.) and are discussed and presented in **Section 3.4.4.1**. The Bradford Chain of Lakes analyses use the same ranges as the Lake Munson analyses.

Figure 3-79 presents the data clustering used for the analyses and associated stations. For the Bradford Chain of Lakes, data since 2010 were available at multiple locations throughout the chain. Within Lake Bradford, there were three clusters, at the outfall of the lake prior to flowing into Grassy Lake (BE), in the center of the lake (BC), and in the northwestern lobe of the lake

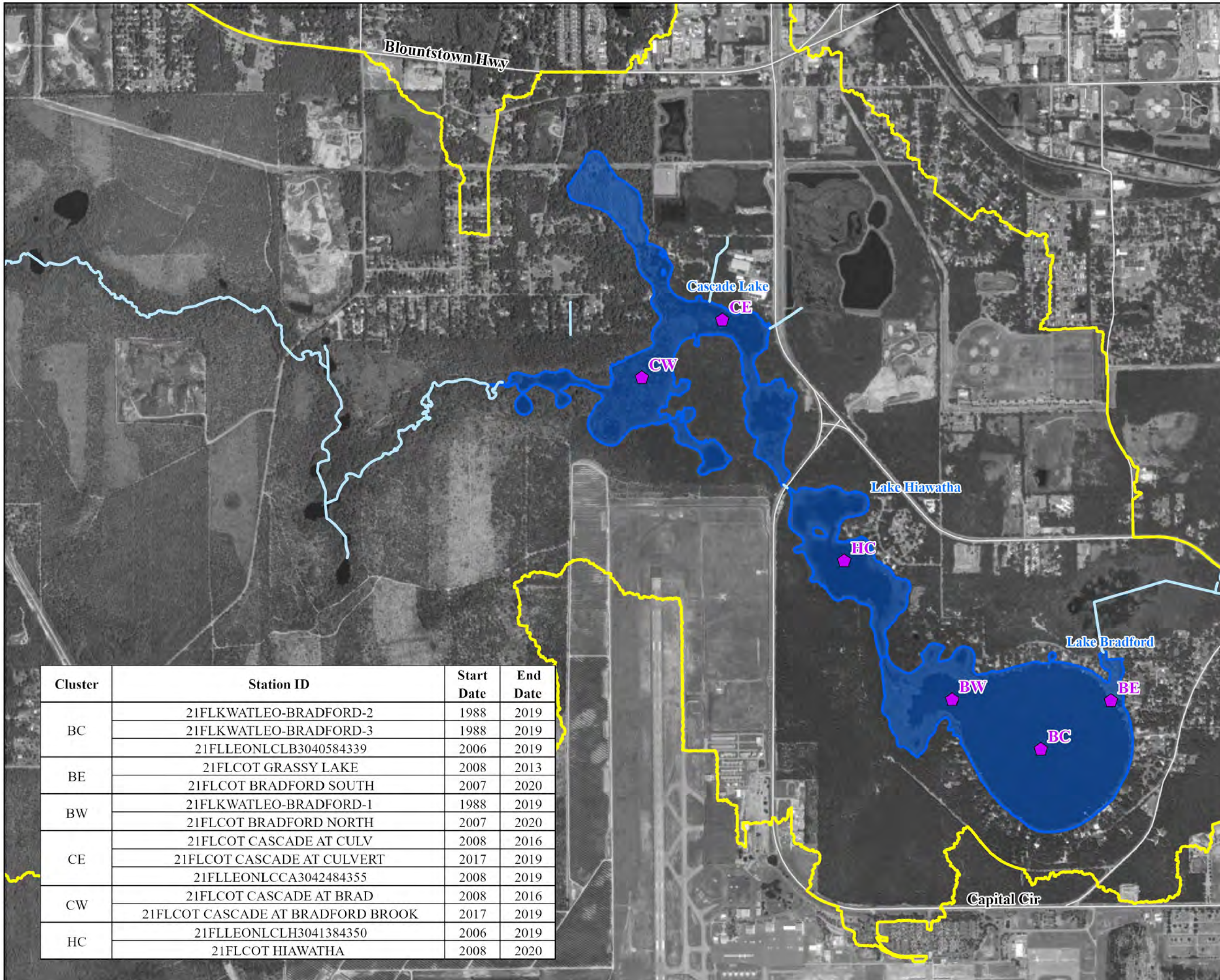
(BW). Within Lake Hiawatha, there is a single cluster (HC) in the center of the lake. Finally, within Cascade Lake, there are two clusters, one at the center of the lake (CE) and the other on the upstream end near where Bradford Brook flows in (CW). These stations, viewed together, present the spatial variation as water passes through the chain. While **Figure 3-53** did show historical water quality stations within Bradford Brook immediately upstream of Cascade Lake, the only data since 2000 was one sample collected in 2006. Based on this, no cluster analysis was performed at this location.

Figure 3-80 presents the color. For color, the scales were set such that values of 40 PCU and below were blue, with the remaining segments from green to red divided into 40 PCU segments. This is due to the high color found within the Bradford Chain and allows visualization of the color changes moving through the system. Moving from Cascade Lake down to Lake Bradford, color averages show a distinct drop from values above 160 PCU in Cascade Lake, steadily down to between 80 PCU and 120 PCU in Lake Bradford (CW=260 PCU, CE=219 PCU, HC=153 PCU, BW=119 PCU, BC=116 PCU, BE=119 PCU). The drop in color likely reflects the dilution of high color inflow from Bradford Brook with more localized, less tannic, runoff.

Figure 3-81 presents the alkalinity. The scales were set such that values above 20 mg/L were red, based on the NNC cutoff for low alkalinity lakes, with the remaining colors (orange down to blue) , in 5 mg/L segments down to 0 mg/L. Moving from Cascade Lake down to Lake Bradford, alkalinity levels are very low, with all values (other than the center station in Lake Bradford) below 5 mg/L (CW=1.6 mg/L, CE=3.0 mg/L, HC=2.8 mg/L, BW=2.4 mg/L, BC=5.0 mg/L, BE=2.4 mg/L). These values reflect the acidic nature of the lakes.

Figure 3-82 and **Figure 3-83** present the TN and TP. The ranges were set the same way as described for Lake Munson, with blue lower than the minimum NNC threshold and red higher than the maximum. The TN plot shows all station averages at below the minimum 1.27 mg/L threshold (CW=1.07 mg/L, CE=0.80 mg/L, HC=0.67 mg/L, BW=0.71 mg/L, BC=0.61 mg/L, BE=0.76 mg/L). The data do show higher TN averages in Cascade Lake. The TP map shows all station averages below the minimum 0.05 mg/L threshold (CW=0.013 mg/L, CE=0.015 mg/L, HC=0.016 mg/L, BW=0.023 mg/L, BC=0.025 mg/L, BE=0.024 mg/L). The data show increasing averages moving through the system.

Figure 3-84 and **Figure 3-85** present maps of the Chl-a and TSI. The ranges were set the same way as described for Lake Munson, with red representing Chl-a values above the 20 µg/L NNC threshold and the TSI transition from good to fair. The Chl-a map shows all station averages below 10 µg/L (CW=4.4 µg/L, CE=5.1 µg/L, HC=5.3 µg/L, BW=8.2 µg/L, BC=8.0 µg/L, BE=9.2 µg/L). While all stations are well below the threshold, there is an increase in the averages moving through the system. The TSI map shows all station averages below the 60 threshold between good to fair, with all stations below 45 (CW=27.8, CE=20.6, HC=37.6, BW=40.8, BC=43.1, BE=32.4). The data show a similar trend with TSI that was seen for Chl-a and TP.



Cluster	Station ID	Start Date	End Date
BC	21FLKWATLEO-BRADFORD-2	1988	2019
	21FLKWATLEO-BRADFORD-3	1988	2019
	21FLLEONLCLB3040584339	2006	2019
BE	21FLCOT GRASSY LAKE	2008	2013
	21FLCOT BRADFORD SOUTH	2007	2020
BW	21FLKWATLEO-BRADFORD-1	1988	2019
	21FLCOT BRADFORD NORTH	2007	2020
CE	21FLCOT CASCADE AT CULV	2008	2016
	21FLCOT CASCADE AT CULVERT	2017	2019
	21FLLEONLCCA3042484355	2008	2019
CW	21FLCOT CASCADE AT BRAD	2008	2016
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019
HC	21FLLEONLCLH3041384350	2006	2019
	21FLCOT HIAWATHA	2008	2020

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Miles

Legend

- Bradford Chain of Lakes Drainage Basin
- Waterbodies in Study
- Watercourses
- In-Lake Station Clusters

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023

Figure 3-79:
Station Clustering for Spatial Analyses of Bradford Chain of Lakes

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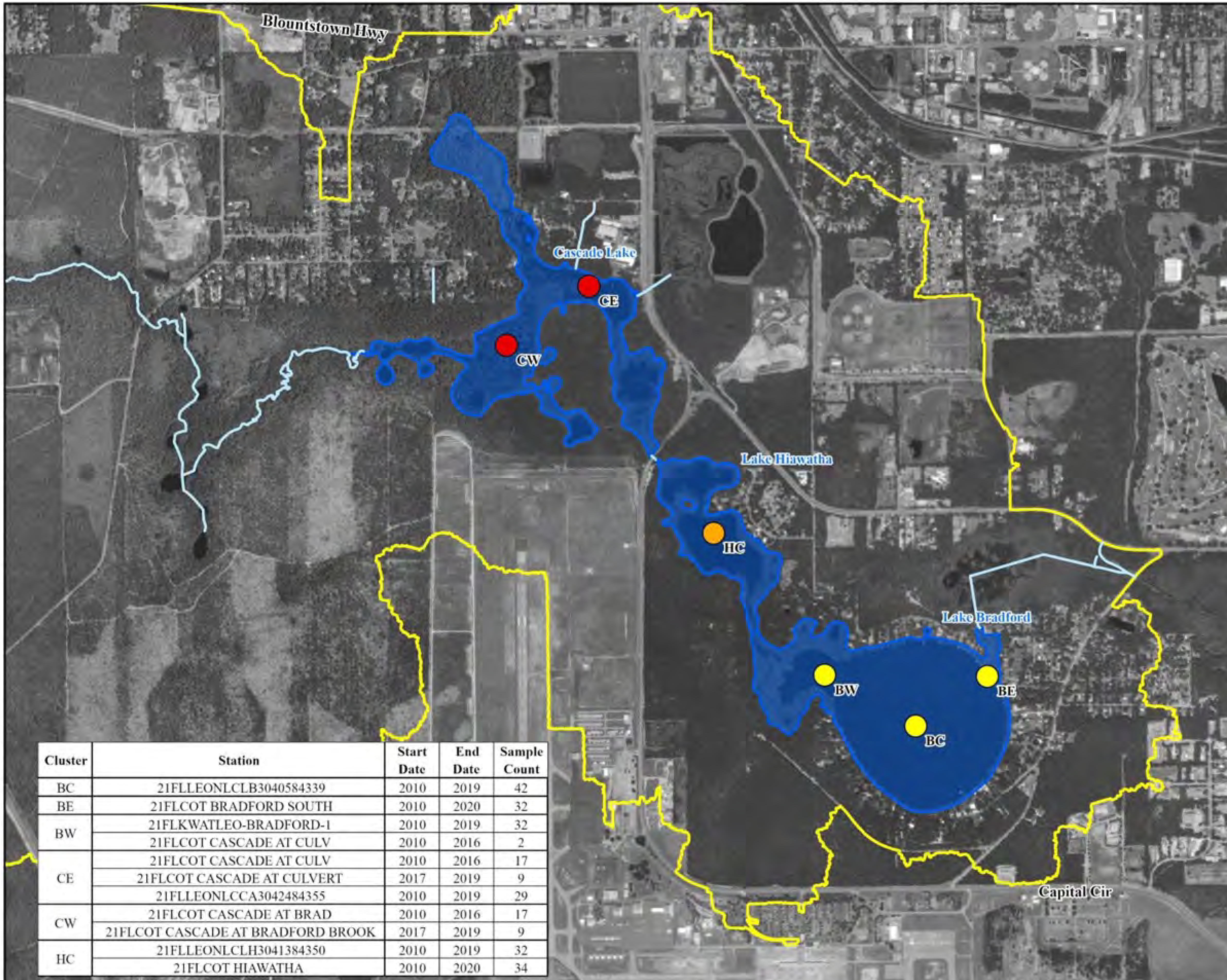

Cluster	Station	Start Date	End Date	Sample Count
BC	21FLLEONLCLB3040584339	2010	2019	42
BE	21FLCOT BRADFORD SOUTH	2010	2020	32
BW	21FLKWATLEO-BRADFORD-1	2010	2019	32
	21FLCOT CASCADE AT CULV	2010	2016	2
CE	21FLCOT CASCADE AT CULV	2010	2016	17
	21FLCOT CASCADE AT CULVERT	2017	2019	9
	21FLLEONLCCA3042484355	2010	2019	29
CW	21FLCOT CASCADE AT BRAD	2010	2016	17
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	9
HC	21FLLEONLCLH3041384350	2010	2019	32
	21FLCOT HIAWATHA	2010	2020	34

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Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-80: Spatial Assessment of Color in Bradford Chain of Lakes

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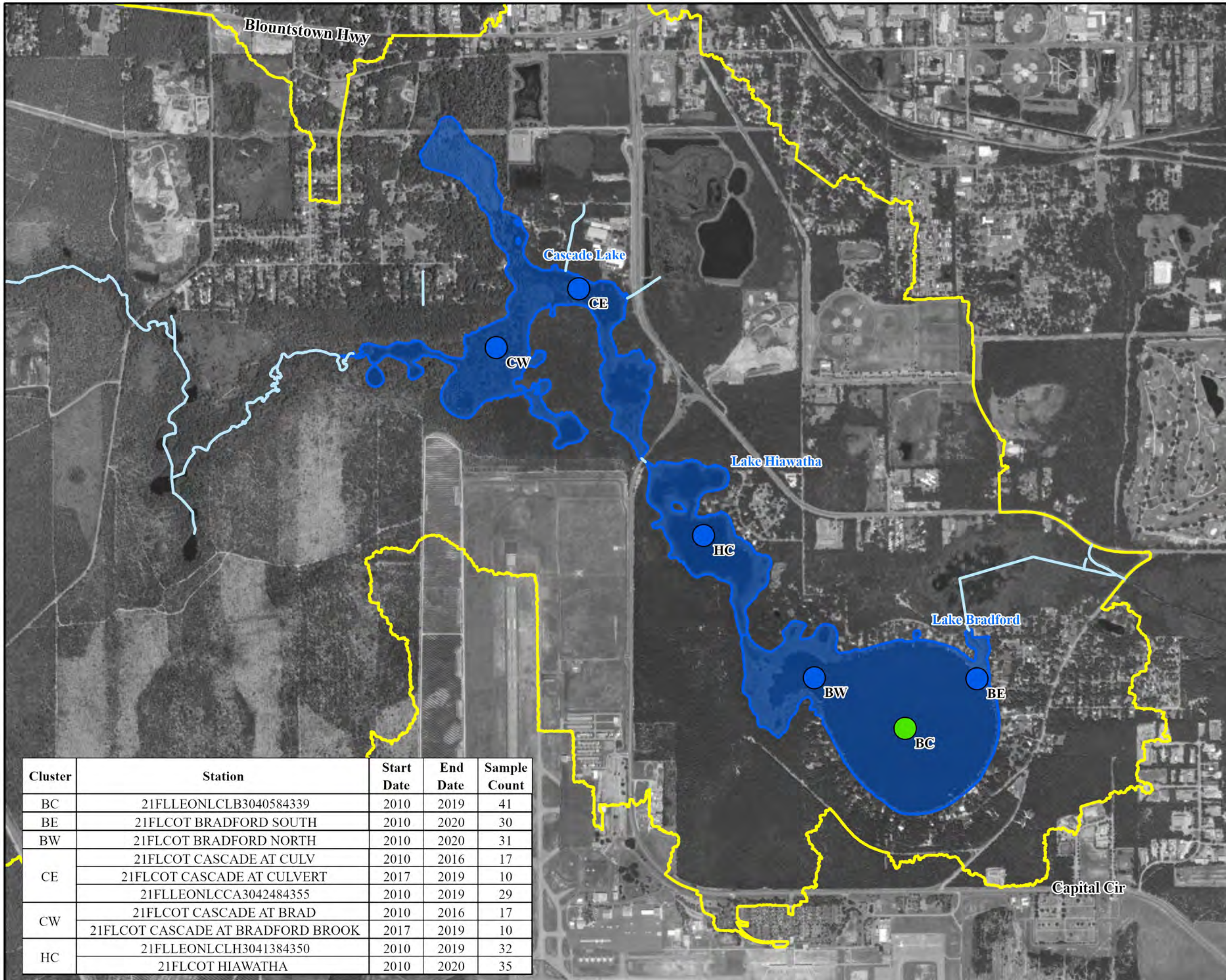

Cluster	Station	Start Date	End Date	Sample Count
BC	21FLLEONLCLB3040584339	2010	2019	41
BE	21FLCOT BRADFORD SOUTH	2010	2020	30
BW	21FLCOT BRADFORD NORTH	2010	2020	31
CE	21FLCOT CASCADE AT CULV	2010	2016	17
	21FLCOT CASCADE AT CULVERT	2017	2019	10
	21FLLEONLCCA3042484355	2010	2019	29
CW	21FLCOT CASCADE AT BRAD	2010	2016	17
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	10
HC	21FLLEONLCLH3041384350	2010	2019	32
	21FLCOT HIAWATHA	2010	2020	35

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Figure 3-81: Spatial Assessment of Alkalinity in Bradford Chain of Lakes

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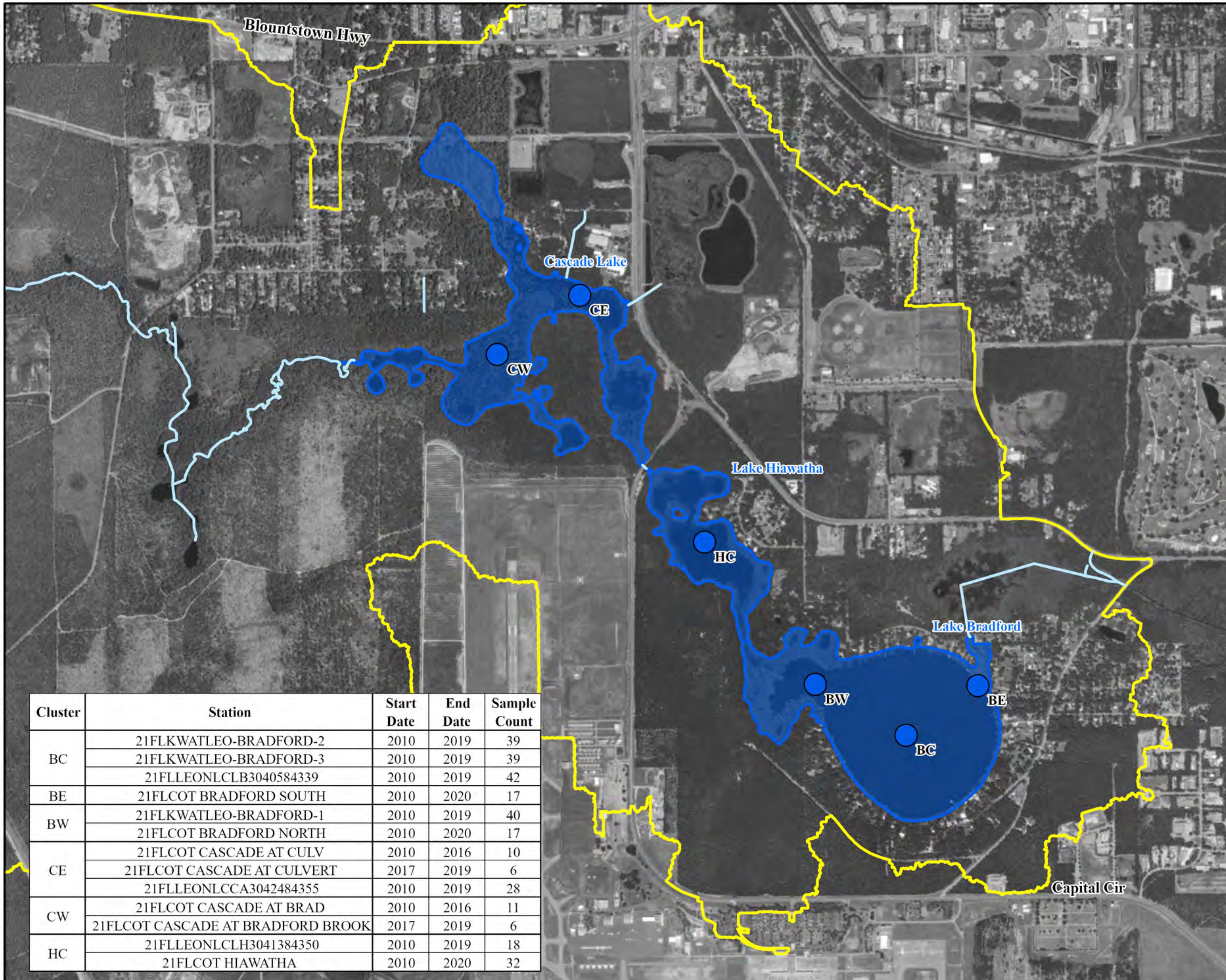


Cluster	Station	Start Date	End Date	Sample Count
BC	21FLKWATLEO-BRADFORD-2	2010	2019	39
	21FLKWATLEO-BRADFORD-3	2010	2019	39
	21FLLEONLCLB3040584339	2010	2019	42
BE	21FLCOT BRADFORD SOUTH	2010	2020	17
BW	21FLKWATLEO-BRADFORD-1	2010	2019	40
	21FLCOT BRADFORD NORTH	2010	2020	17
CE	21FLCOT CASCADE AT CULV	2010	2016	10
	21FLCOT CASCADE AT CULVERT	2017	2019	6
	21FLLEONLCCA3042484355	2010	2019	28
CW	21FLCOT CASCADE AT BRAD	2010	2016	11
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	6
HC	21FLLEONLCLH3041384350	2010	2019	18
	21FLCOT HIAWATHA	2010	2020	32

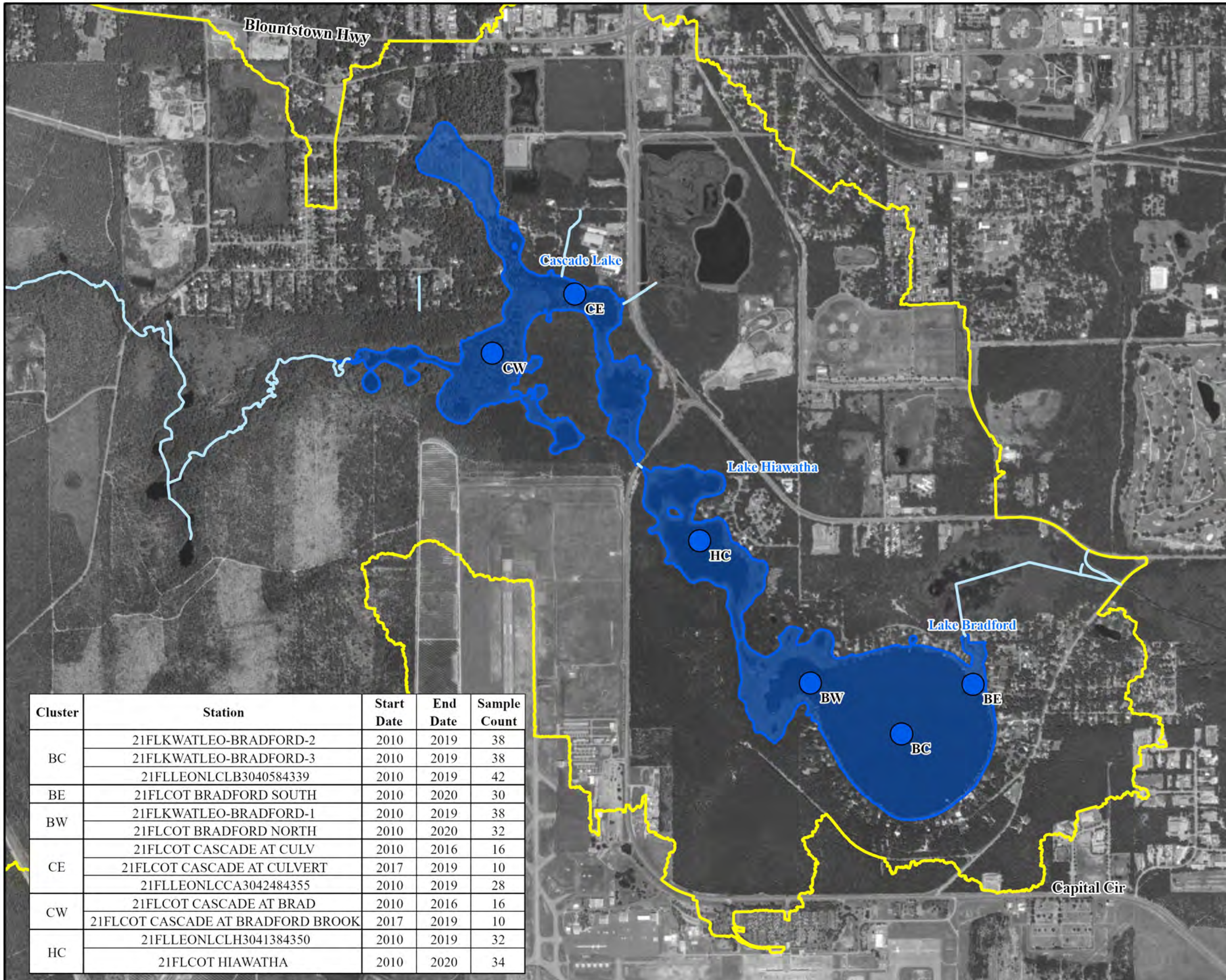
CITY OF TALLAHASSEE

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-82:
Spatial Assessment of TN in Bradford Chain of Lakes

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Cluster	Station	Start Date	End Date	Sample Count
BC	21FLKWATLEO-BRADFORD-2	2010	2019	38
	21FLKWATLEO-BRADFORD-3	2010	2019	38
	21FLLEONLCLB3040584339	2010	2019	42
BE	21FLCOT BRADFORD SOUTH	2010	2020	30
BW	21FLKWATLEO-BRADFORD-1	2010	2019	38
	21FLCOT BRADFORD NORTH	2010	2020	32
CE	21FLCOT CASCADE AT CULV	2010	2016	16
	21FLCOT CASCADE AT CULVERT	2017	2019	10
	21FLLEONLCCA3042484355	2010	2019	28
CW	21FLCOT CASCADE AT BRAD	2010	2016	16
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	10
HC	21FLLEONLCLH3041384350	2010	2019	32
	21FLCOT HIAWATHA	2010	2020	34

CITY OF TALLAHASSEE

N

0 0.2

Miles

Legend

Bradford Chain of Lakes Drainage Basin

Waterbodies in Study

Watercourses

In-Lake TP Average 2010-2020

mg/L

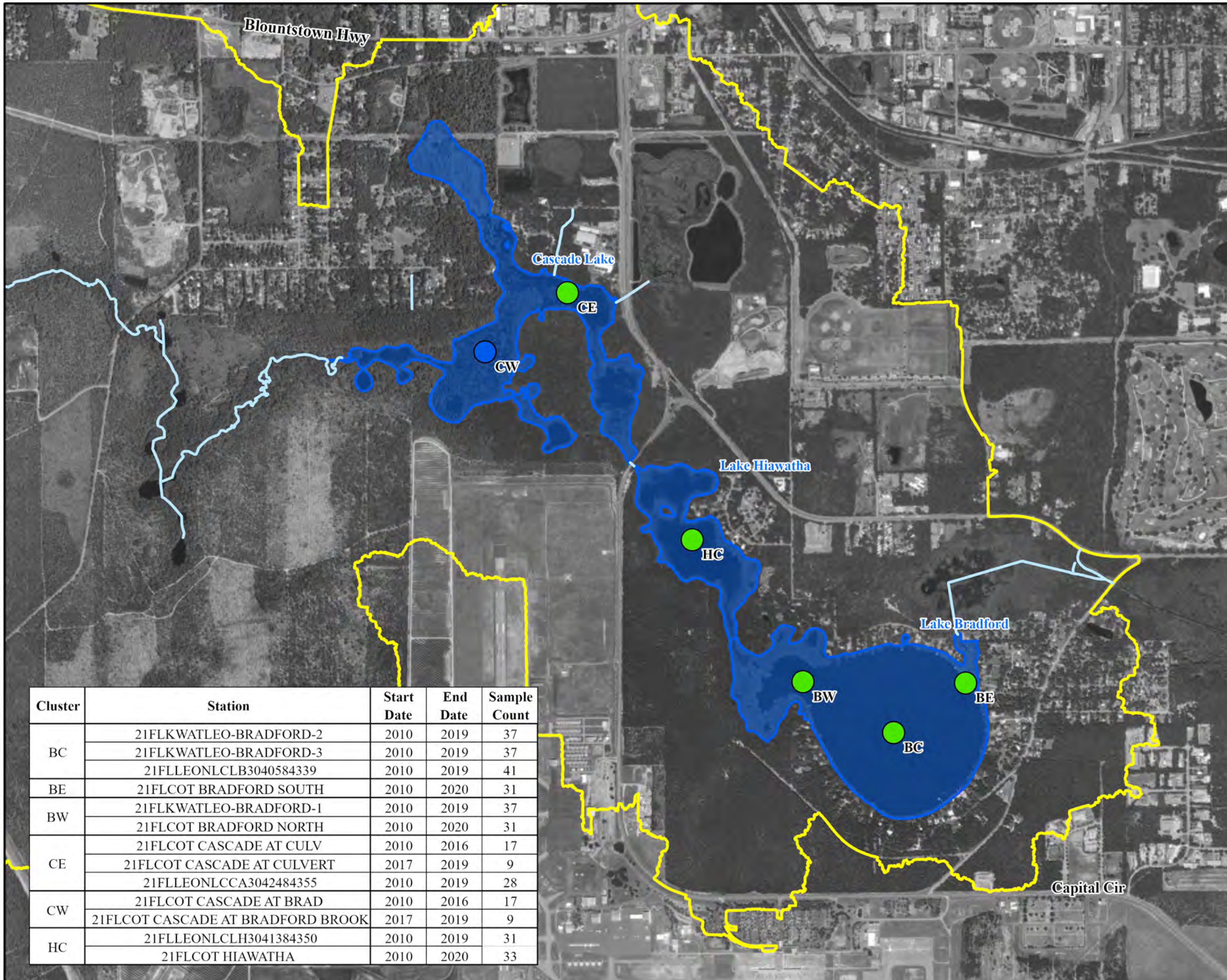
- 0-0.05
- 0.05-0.09
- 0.09-0.13
- 0.13-0.16
- >0.16

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-83:
Spatial Assessment of TP in Bradford Chain of Lakes

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Cluster	Station	Start Date	End Date	Sample Count
BC	21FLKWATLEO-BRADFORD-2	2010	2019	37
	21FLKWATLEO-BRADFORD-3	2010	2019	37
	21FLLEONLCLB3040584339	2010	2019	41
BE	21FLCOT BRADFORD SOUTH	2010	2020	31
BW	21FLKWATLEO-BRADFORD-1	2010	2019	37
	21FLCOT BRADFORD NORTH	2010	2020	31
CE	21FLCOT CASCADE AT CULV	2010	2016	17
	21FLCOT CASCADE AT CULVERT	2017	2019	9
	21FLLEONLCCA3042484355	2010	2019	28
CW	21FLCOT CASCADE AT BRAD	2010	2016	17
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	9
HC	21FLLEONLCLH3041384350	2010	2019	31
	21FLCOT HIAWATHA	2010	2020	33

CITY OF TALLAHASSEE

N

0 0.2
Miles

Legend

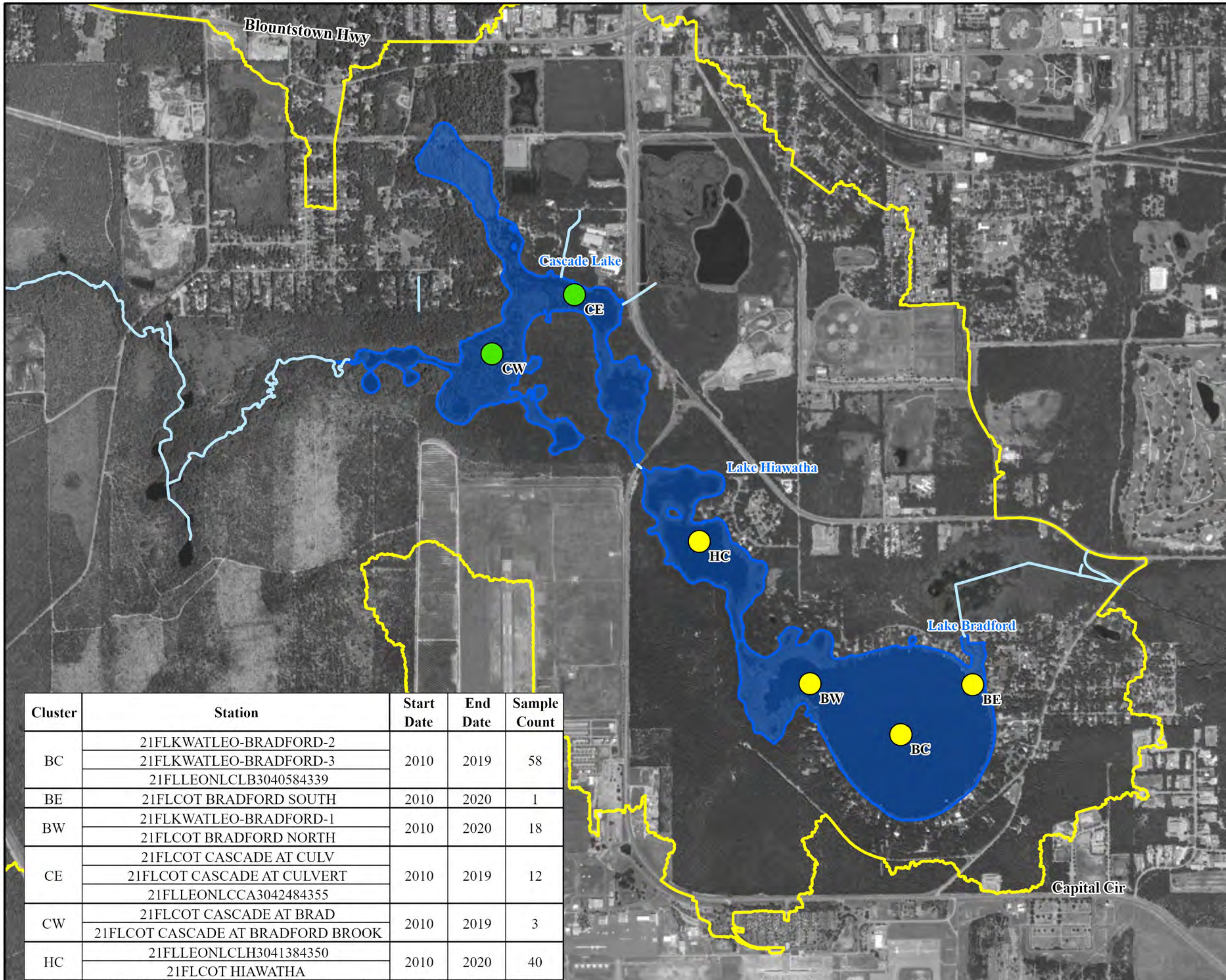
Bradford Chain of Lakes Drainage Basin
Waterbodies in Study
Watercourses
Chl a Average 2010-2020
µg/L
0-5
5-10
10-15
15-20
>20

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-84:
Spatial Assessment of Chl a in Bradford Chain of Lakes

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Cluster	Station	Start Date	End Date	Sample Count
BC	21FLKWATLEO-BRADFORD-2 21FLKWATLEO-BRADFORD-3 21FLLEONLCLB3040584339	2010	2019	58
BE	21FLCOT BRADFORD SOUTH	2010	2020	1
BW	21FLKWATLEO-BRADFORD-1 21FLCOT BRADFORD NORTH	2010	2020	18
CE	21FLCOT CASCADE AT CULV 21FLCOT CASCADE AT CULVERT 21FLLEONLCCA3042484355	2010	2019	12
CW	21FLCOT CASCADE AT BRAD 21FLCOT CASCADE AT BRADFORD BROOK	2010	2019	3
HC	21FLLEONLCLH3041384350 21FLCOT HIAWATHA	2010	2020	40

CITY OF TALLAHASSEE

N

0 0.2
Miles

Legend

Bradford Chain of Lakes Drainage Basin
Waterbodies in Study
Watercourses
TSI Average 2010-2020
TSI Score
0-15
15-30
30-45
45-60
>60

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-85: Spatial Assessment of TSI in Bradford Chain of Lakes

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

Figure 3-86 presents a map of the *E. coli* levels. The data analyzed are from 2014 through 2020 and were analyzed to provide the 90th percentile to compare against the 410 MPN/100 mL criteria per the FDEP approach in the IWR analyses. The map shows that all stations have 90th percentile values well below the 410 MPN/100 mL threshold, with all stations below 100 MPN/100 mL (CW=2.2 MPN/100 mL, CE=5.2 MPN/100 mL, HC=2.9 MPN/100 mL, BW=15.9 MPN/100 mL, BC=5.6 MPN/100 mL, BE=12.3 MPN/100 mL). The data show stations closer to the shoreline within Lake Bradford have higher averages. This may be reflective of seepage from septic systems along the shoreline of the lake.

3.5.4.2 Stormwater Runoff

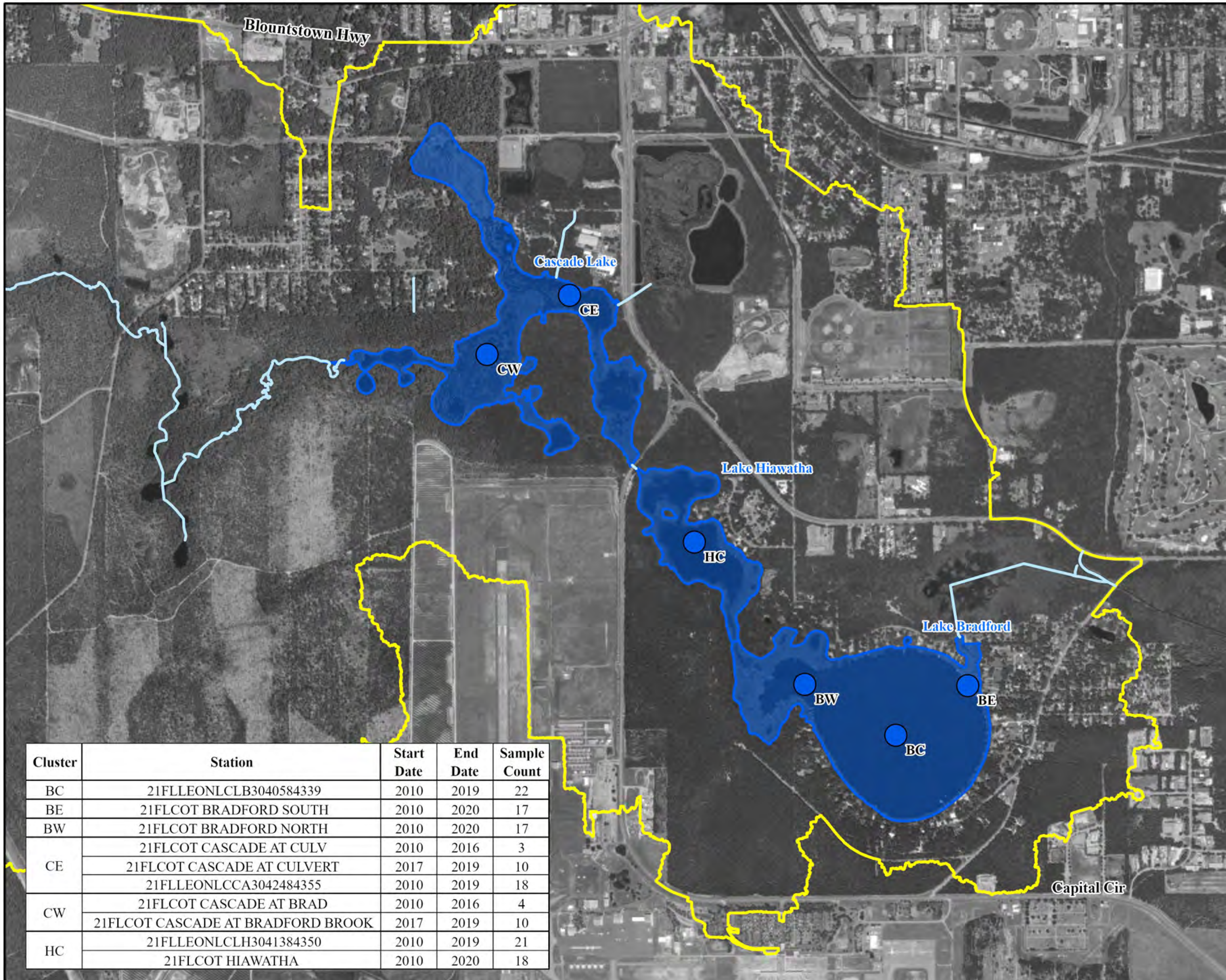
To assess stormwater runoff as a potential source of pollutant loads to the Bradford Chain of Lakes, LDI levels within the subbasins draining to the lake were assessed. In **Section 3.4.4.2**, LDI values were presented by subbasin in **Figure 3-34** for all of the Lake Munson basin. The basins draining directly to the lakes and the northern watershed draining to Bradford Brook were identified as good. The remainder of the watersheds draining to Bradford Brook were identified as excellent. These classifications indicate limited potential for anthropogenic stormwater loads to the lakes. This aspect, along with the relatively pristine nature of the water quality in the lakes relative to nutrient enrichment and bacteria, supports the determination that stormwater loads are not a significant source of anthropogenic load to the lakes.

While specific identification of potential sources of metal loads is not within the scope of this assessment, past studies indicate that potential sources of lead exist within the contributing basin. The identified sources are best mitigated by source removal versus construction of stormwater treatment facilities.

3.5.4.3 Septic Systems

Figure 3-50 presented the locations of septic systems within the Bradford Chain of Lakes basin. **Figure 3-35** presented a map showing the septic tank densities by subbasin for the full Lake Munson basin. Two of the watersheds draining to Bradford Brook show somewhat higher septic densities. These contain septic systems located within neighborhoods along Blountstown Highway (State Road 20) and just to the west of Cascade Lake. Based on the watershed area, septic densities are not high for the Lake Bradford watershed, but there are a significant number of septic systems immediately adjacent to the lake. The clusters in this area, and their proximity to the lake, can be seen in **Figure 3-50**.

Based on the bacteria data, it does not appear that septics are a significant source of bacteria load to Cascade Lake. By comparison, while bacteria levels within Lake Bradford were generally low, the analyses in **Section 3.5.4.1** indicated more elevated levels at clusters nearer to the shoreline versus the cluster in the lake center and suggest septics may be a potential source of bacteria load to Lake Bradford.



CITY OF TALLAHASSEE

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-86:
Spatial Assessment of E. coli in Bradford Chain of Lakes

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

Cluster	Station	Start Date	End Date	Sample Count
BC	21FLLEONLCLB3040584339	2010	2019	22
BE	21FLCOT BRADFORD SOUTH	2010	2020	17
BW	21FLCOT BRADFORD NORTH	2010	2020	17
CE	21FLCOT CASCADE AT CULV	2010	2016	3
	21FLCOT CASCADE AT CULVERT	2017	2019	10
	21FLLEONLCCA3042484355	2010	2019	18
CW	21FLCOT CASCADE AT BRAD	2010	2016	4
	21FLCOT CASCADE AT BRADFORD BROOK	2017	2019	10
HC	21FLLEONLCLH3041384350	2010	2019	21
	21FLCOT HIAWATHA	2010	2020	18

3.5.4.4 Internal Recycling and Seepage

Internal Recycling

To date, no studies or data collection efforts have been undertaken to assess the potential for nutrient loading/recycling from sediments in the Bradford Chain of Lakes. Given the good water quality, healthy biological conditions, and the nature of the direct drainage areas to the lakes, internal loading is not identified as having a high potential as an anthropogenic source to any of the lakes. And since data to support calculation of the loads are not available for any of the lakes, loads are not quantified in **Section 3.5.5**.

Seepage

As outlined in **Section 3.5.3.7**, and presented in **Figure 3-23**, there was a surficial aquifer sampling site to the east of Lake Bradford. Station AAD5312 was located within the Lake Bradford Estates neighborhood. The only sample collected at this site was in June 2000 and did not show high levels of TN or TP. However, the data are insufficient to determine if seepage is a potential significant source to the lakes or to support calculation of potential seepage load from nearby groundwater. Septic systems were identified as a source to calculate (**Section 3.5.4.3**) and likely represent the primary potential source of seepage loads to the Chain of Lakes.

3.5.4.5 Wastewater

No direct wastewater discharges are currently within the Bradford Chain of Lakes basin. Additionally, no areas in the Bradford Chain of Lakes basin have reuse discharges. **Figure 3-39** presented a map of the Lake Munson basin boundaries in relation to sewer service areas. There is no sewer infrastructure in the watersheds draining to Bradford Brook. The wastewater service area is within the watersheds draining directly to Cascade Lake and Lake Hiawatha along the eastern side. Additionally, the wastewater service area is located within some portions of the watershed draining directly to Lake Bradford. The immediate area around Lake Bradford is not within the service area, hence the high density of septic systems discussed in **Section 3.5.3.4**. Based on the limited sewer service area, along with the existing water quality, wastewater infrastructure is not identified as a potential significant source of pollutant load to the Bradford Chain of Lakes.

3.5.4.6 Atmospheric Deposition

For the overall surface area (combined three lakes) of the Bradford Chain of Lakes, the ratio of the watershed area to lake area is around 35:1. With this ratio, and the potential attenuation of rainfall runoff, direct atmospheric deposition to the lakes may play a minor role in overall loading to the lakes. Atmospheric deposition will be quantified in **Section 3.5.5** for comparison to other loads. **Section 3.5.3.10** identified the nearest atmospheric deposition station as the Quincy station (FL14). The data from this station will be utilized to calculate the atmospheric deposition to the Bradford Chain of Lakes.

3.5.4.7 Interconnected Flows

Within the Bradford Chain of Lakes, Cascade Lake is the most upstream waterbody and discharges directly into Lake Hiawatha. Lake Hiawatha then flows into Lake Bradford. The upstream lakes have the potential to contribute to nutrient loading and be a source to consider for the downstream lakes.

Cascade Lake has a surface area of about 109 acres and is located within an area that predominantly drains portions of the Apalachicola National Forest through Bradford Brook. Areas of low-density and medium-density residential drain to the lake from the north but these areas are small in relation to the overall basin. Water quality within the lake (**Section 3.5.3.6** and **Section 3.5.4.1**) was identified as pristine and was shown to be the best in the chain. As such, the flow from Cascade Lake to Lake Hiawatha is not a likely significant source of anthropogenic load.

Lake Hiawatha has a surface area of about 40 acres and is located downstream of Cascade Lake. As with Cascade Lake, areas of low-density and medium-density residential drain to Lake Hiawatha from the north, but these areas are small in relation to the overall basin. Water quality within the lake (**Section 3.5.3.6** and **Section 3.5.4.1**) is also identified as pristine and was shown to be of higher quality than conditions in Lake Bradford. As such, the flow from Lake Hiawatha to Lake Bradford is not a likely significant source of anthropogenic load.

3.5.4.8 Summary of Findings for Qualitative Assessment of Sources

At present, water quality and biological conditions in the Bradford Chain of Lakes are relatively pristine and are not exhibiting declining trends. The overall drainage basin to the lakes is mostly undeveloped and, therefore, stormwater runoff is not expected to be a significant source of pollutant loads. The only potentially significant source identified within the previous sections was septic loads to Lake Bradford, based on somewhat elevated bacteria levels nearshore in relation to the other lakes and the center station within Lake Bradford.

Though the sources do not appear significant, stormwater runoff, septic, interconnected flows (between lakes), and atmospheric deposition are quantified for comparative purposes as part of this study based on available data. Internal recycling, seepage, and wastewater do not appear to be significant sources and were not quantified as part of this study based on limited data.

3.5.5 Calculation of Potential Nutrient Loads

This section presents calculations of potential nutrient (TN and TP) loads to the Bradford Chain of Lakes for the sources identified for calculation in **Section 3.5.4.8**. These include stormwater runoff, septic systems, interconnected flow (between lakes), and atmospheric deposition. Where loads were not calculated, the following sections provide brief discussions. The load calculations are for the purpose of comparing the potential magnitudes of each source relative to one another.

3.5.5.1 Stormwater Pollutant Load

To calculate the stormwater TN and TP loads to the Bradford Chain of Lakes, average annual pollutant load modeling was performed. The goal was to identify outfalls that are contributing higher TN and TP loads relative to one another and to quantify the total TN and TP loads to the Bradford Chain of Lakes. TN and TP loads were calculated using the SIMPLE-Seasonal model. The model methodology was described in detail in **Section 3.4.5.1** for the stormwater loads to Lake Munson. The loads coming into the Bradford Chain of Lakes represent inflow from the

Apalachicola National Forest, with limited contribution from neighborhoods located along Highway 20 and neighborhoods immediately adjacent to the lakes. As such, anthropogenic sources are expected to be limited.

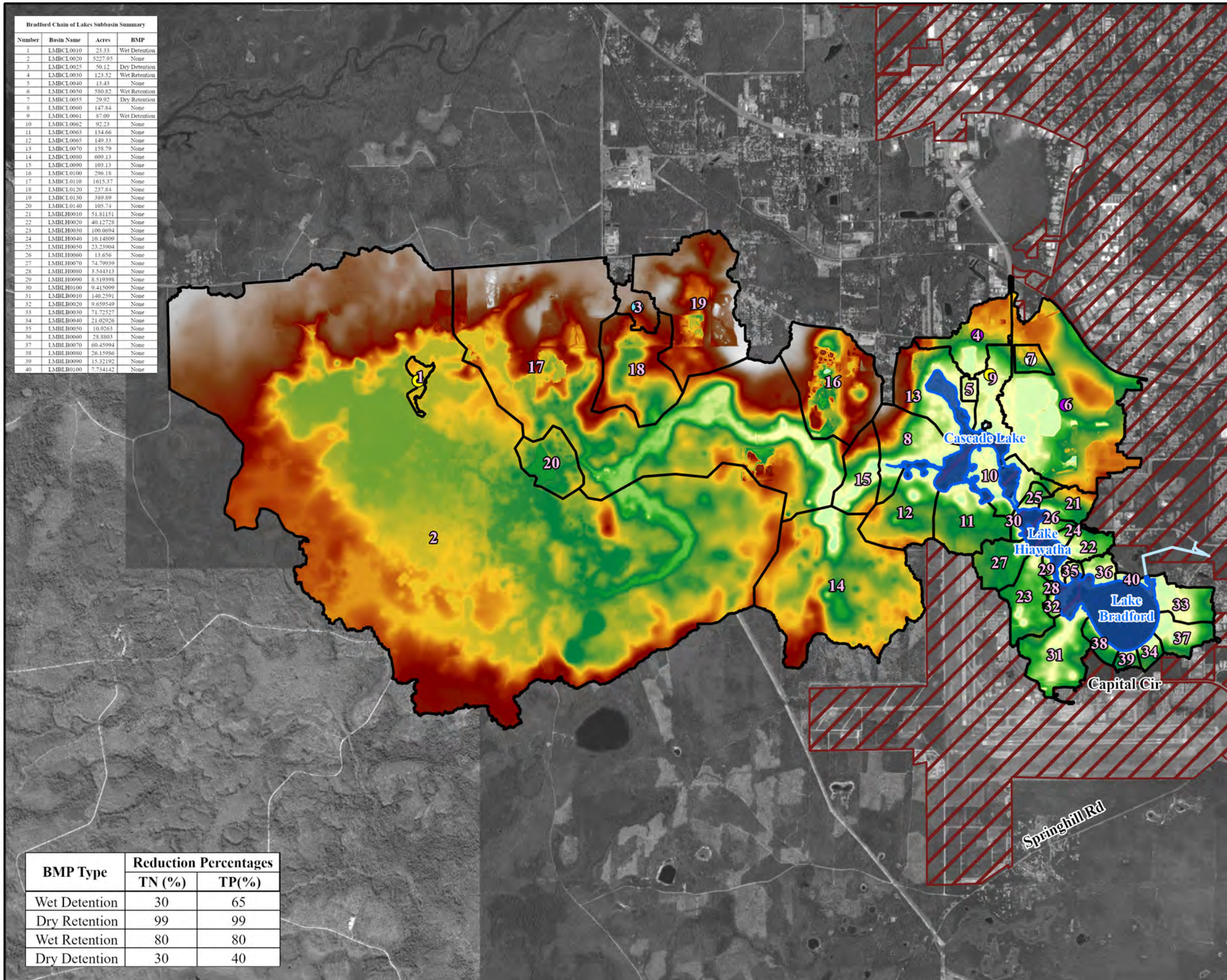
Figure 3-87 presents the subbasins and the DEM utilized in the SIMPLE model calculations for the Bradford Chain of Lakes. **Figure 3-88** presents the aggregated land use. The extent of the natural areas of the Apalachicola National Forest can be seen in the land use distribution, with over 70 percent of the land use being natural. Finally, **Figure 3-89** presents the CDAs for the Bradford Chain of Lakes stormwater loading to define total and per acre TN and TP loads, as well as the ranking of CDAs around the lakes.

As a check on the modeled annual volumes from the SIMPLE model, the data from the flow station presented in **Section 3.5.3.5** were used to calculate measured annual volumes for years with sufficient data. The calculated annual volumes using the flow data ranged from around 3,400 acre-ft up to around 6,000 acre-ft. The annual volumes calculated at the station from the SIMPLE model were around 3,700 acre-ft. As such, the modeled annual volumes are reasonable.

<u>Stormwater Nutrient Loads to the Bradford Chain of Lakes</u>

Figure 3-90 presents the distribution of the ranking of the CDAs for TN along with the total load and per acre loads (see the table on **Figure 3-90**). The rankings are color coded, with the highest ranked CDAs in green moving down to the lowest ranked in pale yellow. The CDAs are color coded and ranked based on the individual waterbodies. The calculated total stormwater TN loads from the CDAs ranged from as low as 1.2 lb/yr up to 10,249 lb/yr. The per acre loads ranged from 0.1 lb/acre/yr up to 6.0 lb/acre/yr. The highest ranked CDAs for the TN loading are generally found south of the lakes associated with portions of the airport and higher density residential areas to the east of Lake Hiawatha. Other than some of the loads coming off the areas around the airport, the per acre loads are not high and generally reflect predominantly natural conditions. The calculated total TN loads to the lakes from stormwater runoff are 12,006 lb, 617 lb, and 340 lb for Cascade Lake, Lake Hiawatha, and Lake Bradford, respectively. The higher stormwater load to Cascade Lake is based on it receiving the runoff from the watershed to the west, along with local drainage. The Lake Bradford and Lake Hiawatha stormwater loads only reflect the local drainage. The additional load to Lake Bradford and Lake Hiawatha will be reflected in the interconnected loads in **Section 3.5.5.4**.

Figure 3-91 presents the distribution of the ranking of the CDAs for TP along with the total load and per acre loads (see the table on **Figure 3-91**). The calculated total stormwater TP loads from the CDAs ranged from as low as 0.2 lb/yr up to 2,428 lb/yr. The per acre loads ranged from less than 0.1 lb/acre/yr up to 0.9 lb/acre/yr. Similar to what was seen for TN, while the ranking would point to the CDA on the southeast side, overall, the low per acre loads would not indicate any as targets for load reduction. The calculated total TP loads to the lakes from stormwater runoff are 2,751 lb, 106 lb, and 74 lb for Cascade Lake, Lake Hiawatha, and Lake Bradford, respectively. As identified for the stormwater TN loads, the stormwater TP loads to Cascade Lake are based on the drainage from the full watershed, while the loads to Lake Hiawatha and Lake Bradford reflect local drainage. The loads to those lakes from the larger watershed will be reflected in the interconnected loads in **Section 3.5.5.4**.



Bradford Chain of Lakes Subbasin Summary			
Number	Basin Name	Acres	BMP
1	LMBCL0010	23.33	Wet Detention
2	LMBCL0020	5227.95	None
3	LMBCL0025	50.12	Dry Detention
4	LMBCL0030	123.52	Wet Retention
5	LMBCL0040	13.43	None
6	LMBCL0050	580.82	Wet Retention
7	LMBCL0055	29.92	Dry Retention
8	LMBCL0060	147.84	None
9	LMBCL0061	87.09	Wet Detention
10	LMBCL0062	92.23	None
11	LMBCL0063	134.66	None
12	LMBCL0065	149.33	None
13	LMBCL0070	158.79	None
14	LMBCL0080	609.13	None
15	LMBCL0090	103.13	None
16	LMBCL0100	296.18	None
17	LMBCL0110	1615.37	None
18	LMBCL0120	237.84	None
19	LMBCL0130	389.89	None
20	LMBCL0140	105.74	None
21	LMBLH0010	51.81151	None
22	LMBLH0020	40.12728	None
23	LMBLH0030	100.0694	None
24	LMBLH0040	10.14809	None
25	LMBLH0050	23.23904	None
26	LMBLH0060	13.656	None
27	LMBLH0070	74.79939	None
28	LMBLH0080	3.544313	None
29	LMBLH0090	8.519398	None
30	LMBLH0100	9.415099	None
31	LMBLB0010	140.2591	None
32	LMBLB0020	9.659549	None
33	LMBLB0030	71.72527	None
34	LMBLB0040	21.02926	None
35	LMBLB0050	10.9263	None
36	LMBLB0060	28.8803	None
37	LMBLB0070	60.45994	None
38	LMBLB0080	26.15986	None
39	LMBLB0090	15.32192	None
40	LMBLB0100	7.734142	None

BMP Type	Reduction Percentages	
	TN (%)	TP(%)
Wet Detention	30	65
Dry Retention	99	99
Wet Retention	80	80
Dry Detention	30	40

CITY OF TALLAHASSEE

N

0 0.8
Miles

Legend

- Waterbodies in Study
- Tallahassee Corporate Limits
- Subbasins
- Watercourses

BMP Type
- Dry Detention
- Dry Retention
- Wet Detention
- Wet Retention

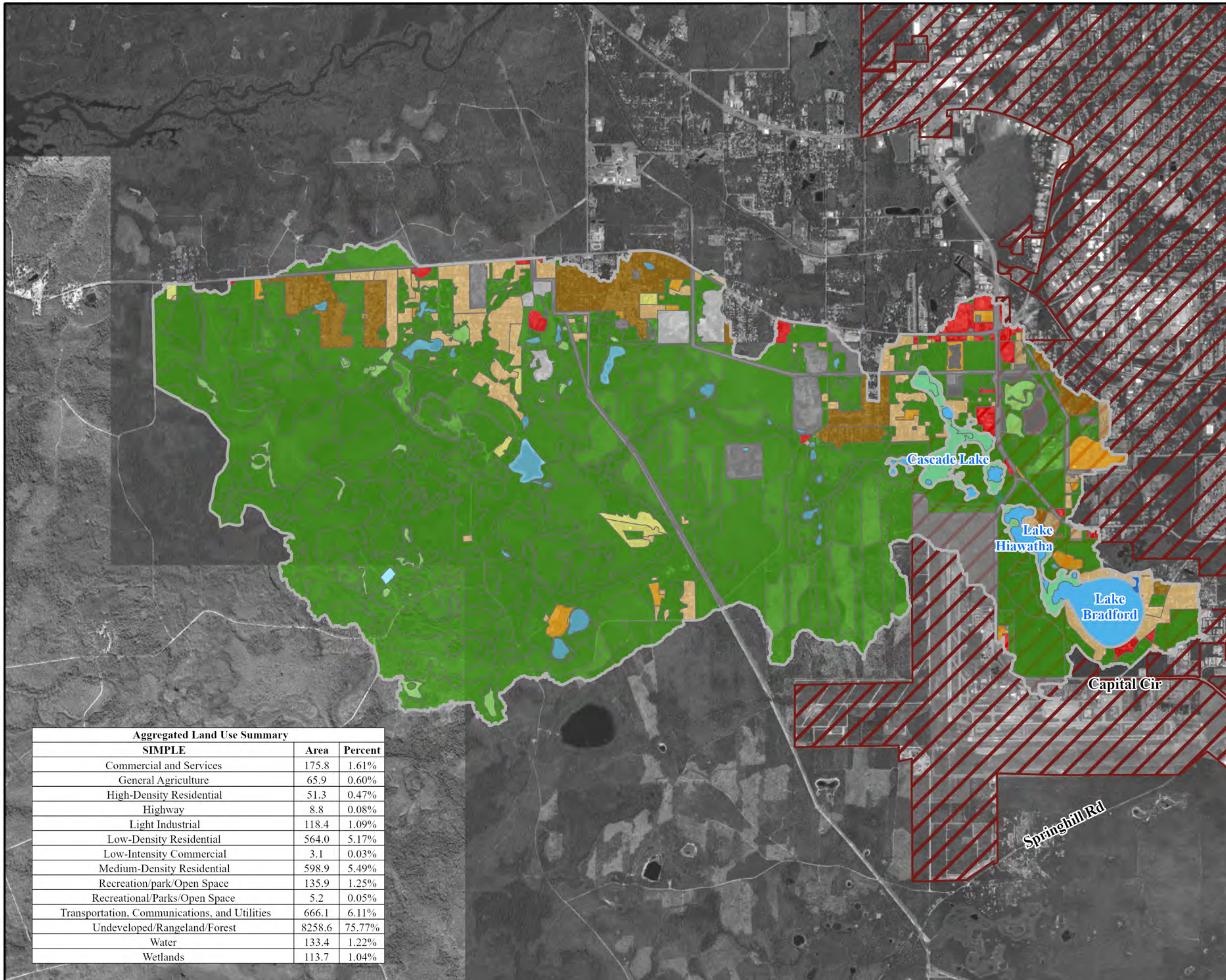
Topographic Elevation
Ft. NAVD88
191
19

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Subbasins: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
BMPs: Geosyntec, 2023
Elevation: COT-Leon County, 2018

Figure 3-87:
Bradford Chain of Lakes Subbasin Delineation and BMPs

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Aggregated Land Use Summary		
SIMPLE	Area	Percent
Commercial and Services	175.8	1.61%
General Agriculture	65.9	0.60%
High-Density Residential	51.3	0.47%
Highway	8.8	0.08%
Light Industrial	118.4	1.09%
Low-Density Residential	564.0	5.17%
Low-Intensity Commercial	3.1	0.03%
Medium-Density Residential	598.9	5.49%
Recreation/park/Open Space	135.9	1.25%
Recreational/Parks/Open Space	5.2	0.05%
Transportation, Communications, and Utilities	666.1	6.11%
Undeveloped/Rangeland/Forest	8258.6	75.77%
Water	133.4	1.22%
Wetlands	113.7	1.04%

CITY OF TALLAHASSEE

N

0 0.8
Miles

Legend

- Waterbodies in Study
- Watercourses
- Tallahassee Corporate Limits

Aggregated Land Use

Land Use Type

- Commercial and Services
- General Agriculture
- High-Density Residential
- Light Industrial
- Low-Density Residential
- Medium-Density Residential
- Recreation/park/Open Space
- Transportation, Communications, and Utilities
- Undeveloped/Rangeland/Forest
- Water
- Wetlands

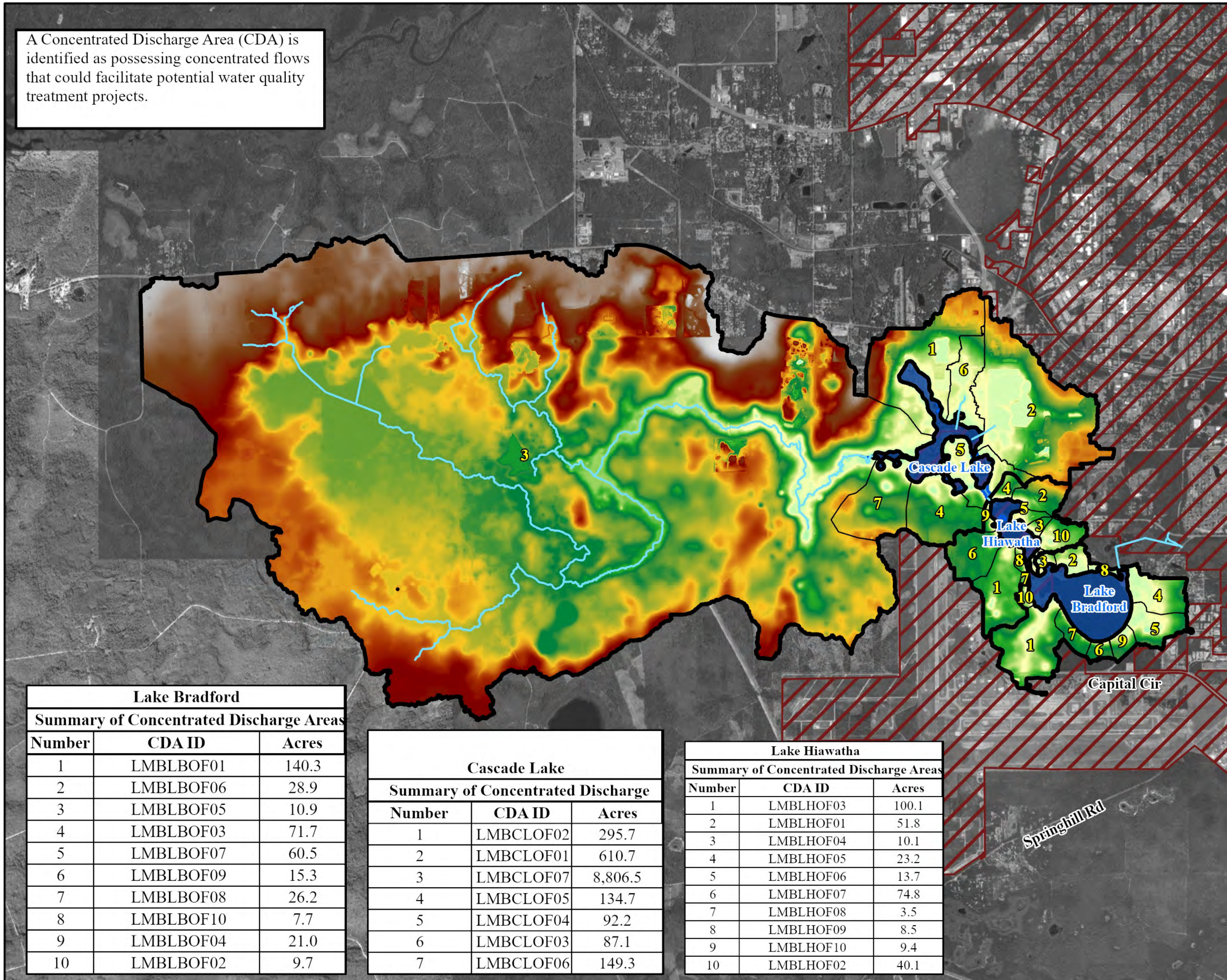
Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Land Use: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-88:
Bradford Chain of Lakes Aggregated Land Use

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

A Concentrated Discharge Area (CDA) is identified as possessing concentrated flows that could facilitate potential water quality treatment projects.



CITY OF TALLAHASSEE

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-89:
Bradford Chain of Lakes Concentrated Discharge Areas

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

Lake Bradford
Summary of Concentrated Discharge Areas

Number	CDA ID	Acres
1	LMBLBOF01	140.3
2	LMBLBOF06	28.9
3	LMBLBOF05	10.9
4	LMBLBOF03	71.7
5	LMBLBOF07	60.5
6	LMBLBOF09	15.3
7	LMBLBOF08	26.2
8	LMBLBOF10	7.7
9	LMBLBOF04	21.0
10	LMBLBOF02	9.7

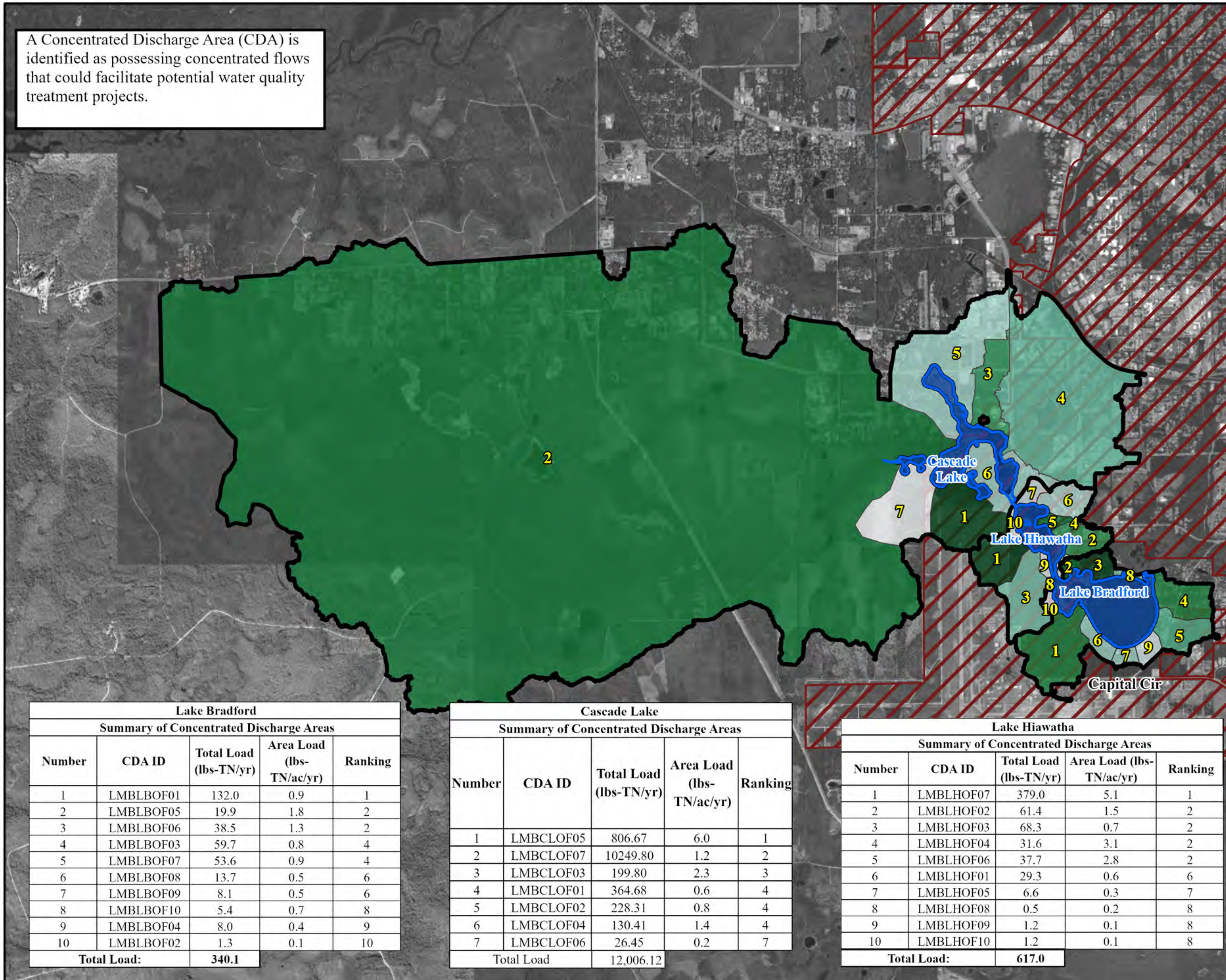
Cascade Lake
Summary of Concentrated Discharge

Number	CDA ID	Acres
1	LMBCLOF02	295.7
2	LMBCLOF01	610.7
3	LMBCLOF07	8,806.5
4	LMBCLOF05	134.7
5	LMBCLOF04	92.2
6	LMBCLOF03	87.1
7	LMBCLOF06	149.3

Lake Hiawatha
Summary of Concentrated Discharge Areas

Number	CDA ID	Acres
1	LMBLHOF03	100.1
2	LMBLHOF01	51.8
3	LMBLHOF04	10.1
4	LMBLHOF05	23.2
5	LMBLHOF06	13.7
6	LMBLHOF07	74.8
7	LMBLHOF08	3.5
8	LMBLHOF09	8.5
9	LMBLHOF10	9.4
10	LMBLHOF02	40.1

A Concentrated Discharge Area (CDA) is identified as possessing concentrated flows that could facilitate potential water quality treatment projects.



Lake Bradford				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TN/yr)	Area Load (lbs-TN/ac/yr)	Ranking
1	LMBLBOF01	132.0	0.9	1
2	LMBLBOF05	19.9	1.8	2
3	LMBLBOF06	38.5	1.3	2
4	LMBLBOF03	59.7	0.8	4
5	LMBLBOF07	53.6	0.9	4
6	LMBLBOF08	13.7	0.5	6
7	LMBLBOF09	8.1	0.5	6
8	LMBLBOF10	5.4	0.7	8
9	LMBLBOF04	8.0	0.4	9
10	LMBLBOF02	1.3	0.1	10
Total Load:		340.1		

Cascade Lake				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TN/yr)	Area Load (lbs-TN/ac/yr)	Ranking
1	LMBCLOF05	806.67	6.0	1
2	LMBCLOF07	10249.80	1.2	2
3	LMBCLOF03	199.80	2.3	3
4	LMBCLOF01	364.68	0.6	4
5	LMBCLOF02	228.31	0.8	4
6	LMBCLOF04	130.41	1.4	4
7	LMBCLOF06	26.45	0.2	7
Total Load		12,006.12		

Lake Hiawatha				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TN/yr)	Area Load (lbs-TN/ac/yr)	Ranking
1	LMBLHOF07	379.0	5.1	1
2	LMBLHOF02	61.4	1.5	2
3	LMBLHOF03	68.3	0.7	2
4	LMBLHOF04	31.6	3.1	2
5	LMBLHOF06	37.7	2.8	2
6	LMBLHOF01	29.3	0.6	6
7	LMBLHOF05	6.6	0.3	7
8	LMBLHOF08	0.5	0.2	8
9	LMBLHOF09	1.2	0.1	8
10	LMBLHOF10	1.2	0.1	8
Total Load:		617.0		

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-90: Bradford Chain of Lakes Concentrated Discharge Areas-Total Nitrogen

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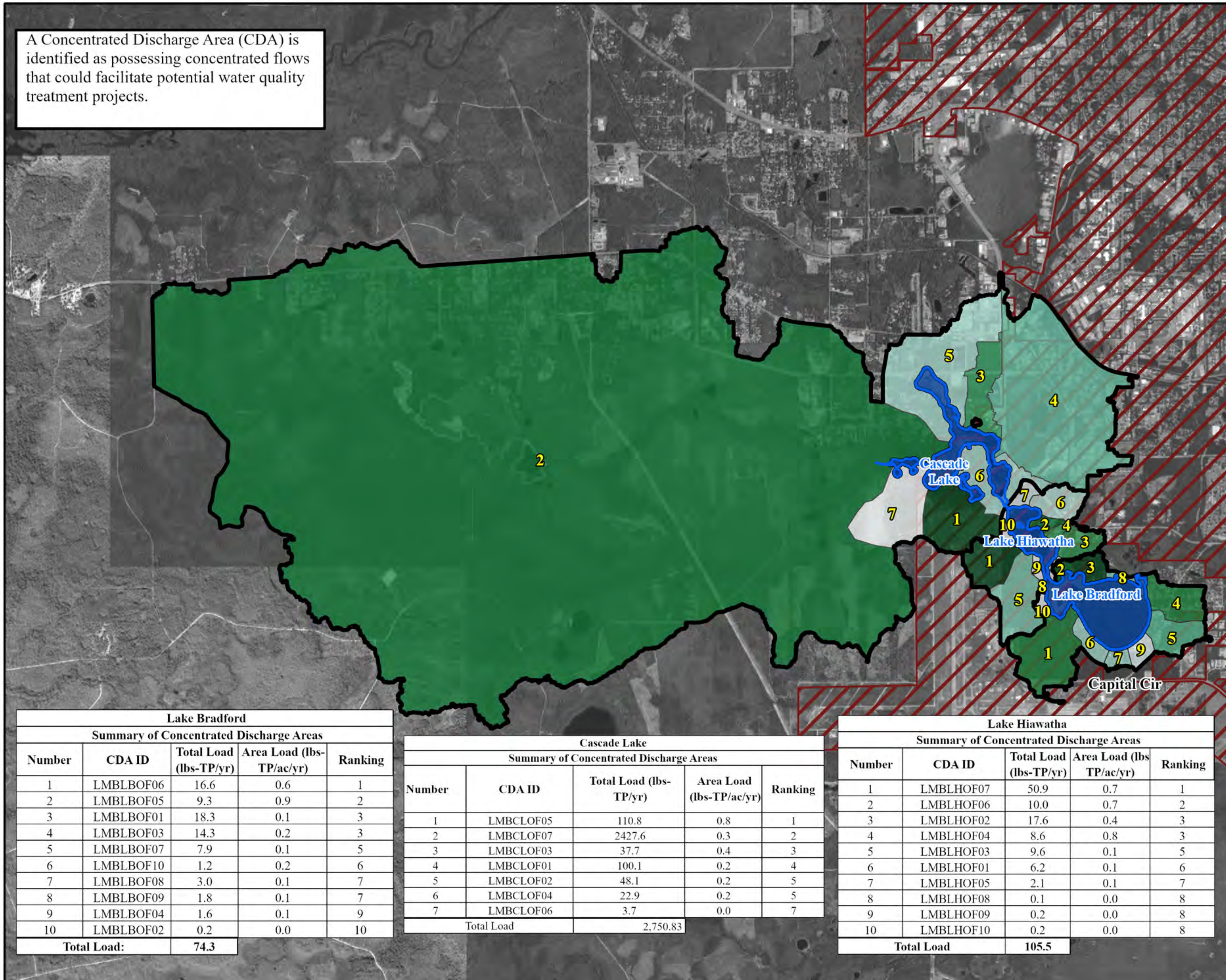
A Concentrated Discharge Area (CDA) is identified as possessing concentrated flows that could facilitate potential water quality treatment projects.



Lake Bradford				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TP/yr)	Area Load (lbs-TP/ac/yr)	Ranking
1	LMBLBOF06	16.6	0.6	1
2	LMBLBOF05	9.3	0.9	2
3	LMBLBOF01	18.3	0.1	3
4	LMBLBOF03	14.3	0.2	3
5	LMBLBOF07	7.9	0.1	5
6	LMBLBOF10	1.2	0.2	6
7	LMBLBOF08	3.0	0.1	7
8	LMBLBOF09	1.8	0.1	7
9	LMBLBOF04	1.6	0.1	9
10	LMBLBOF02	0.2	0.0	10
Total Load:		74.3		

Cascade Lake				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TP/yr)	Area Load (lbs-TP/ac/yr)	Ranking
1	LMBCLOF05	110.8	0.8	1
2	LMBCLOF07	2427.6	0.3	2
3	LMBCLOF03	37.7	0.4	3
4	LMBCLOF01	100.1	0.2	4
5	LMBCLOF02	48.1	0.2	5
6	LMBCLOF04	22.9	0.2	5
7	LMBCLOF06	3.7	0.0	7
Total Load		2,750.83		

Lake Hiawatha				
Summary of Concentrated Discharge Areas				
Number	CDA ID	Total Load (lbs-TP/yr)	Area Load (lbs TP/ac/yr)	Ranking
1	LMBLHOF07	50.9	0.7	1
2	LMBLHOF06	10.0	0.7	2
3	LMBLHOF02	17.6	0.4	3
4	LMBLHOF04	8.6	0.8	3
5	LMBLHOF03	9.6	0.1	5
6	LMBLHOF01	6.2	0.1	6
7	LMBLHOF05	2.1	0.1	7
8	LMBLHOF08	0.1	0.0	8
9	LMBLHOF09	0.2	0.0	8
10	LMBLHOF10	0.2	0.0	8
Total Load		105.5		

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Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-91: Bradford Chain of Lakes Concentrated Discharge Areas-Total Phosphorus

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3.5.5.2 Septic Load

To analyze the potential impacts from septic tank units to the Bradford Chain of Lakes, the SPIL method adopted by FDEP was utilized to quantify the potential septic load. The approach and calculations were described in **Section 3.4.5.2**, which presented the septic loading to Lake Munson. As outlined earlier, the calculations were only done for nitrogen (TN), and based on literature on transport and assimilation, may represent a conservative potential load.

An estimated 100 septic tank units were identified within 200 meters of the three lakes within the chain and associated upstream tributaries, with the majority (67) around Lake Bradford. **Figure 3-92** shows the septic systems utilized in this analysis, with green representing those associated with direct loading to the waterbody and pink representing those associated with loading to tributaries. A table provided on the figure summarizes the calculated TN load from septic units to each of the lakes.

For Cascade Lake, there were a number of systems upstream along Bradford Brook and its tributaries. This accounted for a potential load of 411 lb/yr. The potential load from systems within 200 meters of Cascade Lake was 281 lb/yr. Based on the soil characteristics (highly drained) within the watershed upstream of Cascade Lake and the travel distance for the largest cluster along the tributary, the potential load from the septics along the tributaries is likely overestimated. For Lake Hiawatha, there were only seven systems within 200 meters of the lake, and no systems along tributaries that drain directly to Lake Hiawatha. The potential load was then calculated at 76 lb/yr. Lake Bradford had a significant number of septic systems in the immediate vicinity of the lake shoreline. The calculated potential load from the systems was 725 lb/yr.

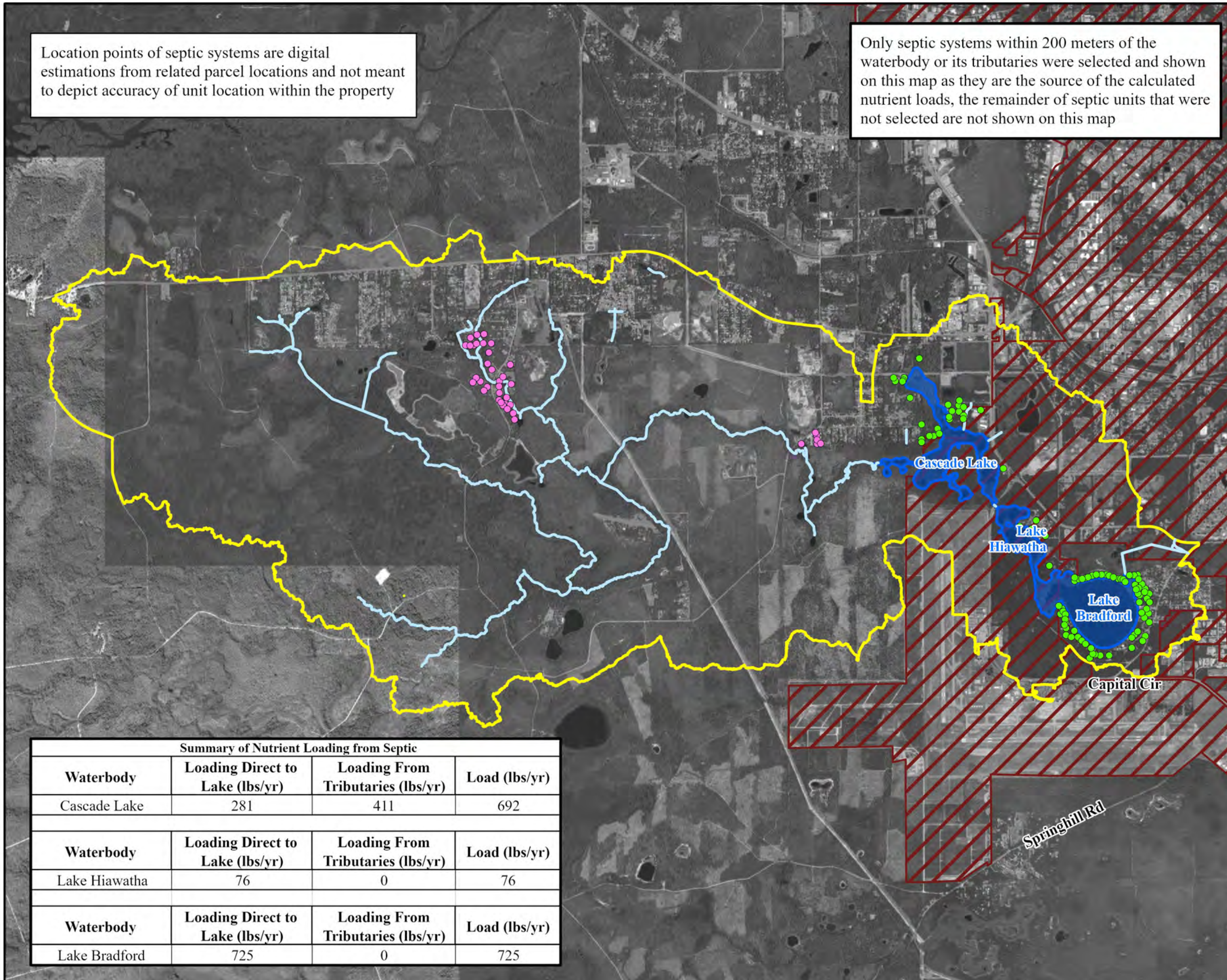
3.5.5.3 Point Source Load

No active point sources were identified within the Bradford Chain of Lakes upstream of Lake Bradford. Therefore, the point source loads for TN and TP are set to 0 lb/yr for the Bradford Chain of Lakes.

3.5.5.4 Lake Inflow Load

As discussed in **Section 3.5.4.7** each of the upstream lakes (Cascade Lake and Lake Hiawatha) flow to downstream receiving lakes (Lake Hiawatha and Lake Bradford) and represents load to the downstream lake. **Figure 3-93** presents the upstream and downstream connections. The determination was made in the qualitative assessment that, based on the good water quality in each of the upstream lakes, these would not represent significant sources of anthropogenic load to the downstream lakes.

Calculations of the load are provided herein based on the availability of modeled flows and in-lake concentrations. The approach utilized in the calculation of the inter-lake loading was described in **Section 3.4.5.4** for Lake Munson. The lakes and connections are shown in **Figure 3-93**, along with a table summarizing available water quality data, flow, load calculations and impairment status. These loads represent the surface runoff and baseflow load to the lower lakes, accounting for the changes in in-lake concentrations as the water passes through.



Summary of Nutrient Loading from Septic

Waterbody	Loading Direct to Lake (lbs/yr)	Loading From Tributaries (lbs/yr)	Load (lbs/yr)
Cascade Lake	281	411	692

Waterbody	Loading Direct to Lake (lbs/yr)	Loading From Tributaries (lbs/yr)	Load (lbs/yr)
Lake Hiawatha	76	0	76

Waterbody	Loading Direct to Lake (lbs/yr)	Loading From Tributaries (lbs/yr)	Load (lbs/yr)
Lake Bradford	725	0	725

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Septic Systems: COT, 2020
Watershed: COT, 2020
Roads: COT-Leon County, 2023

Figure 3-92:
Septic Loading to Bradford Chain of Lakes

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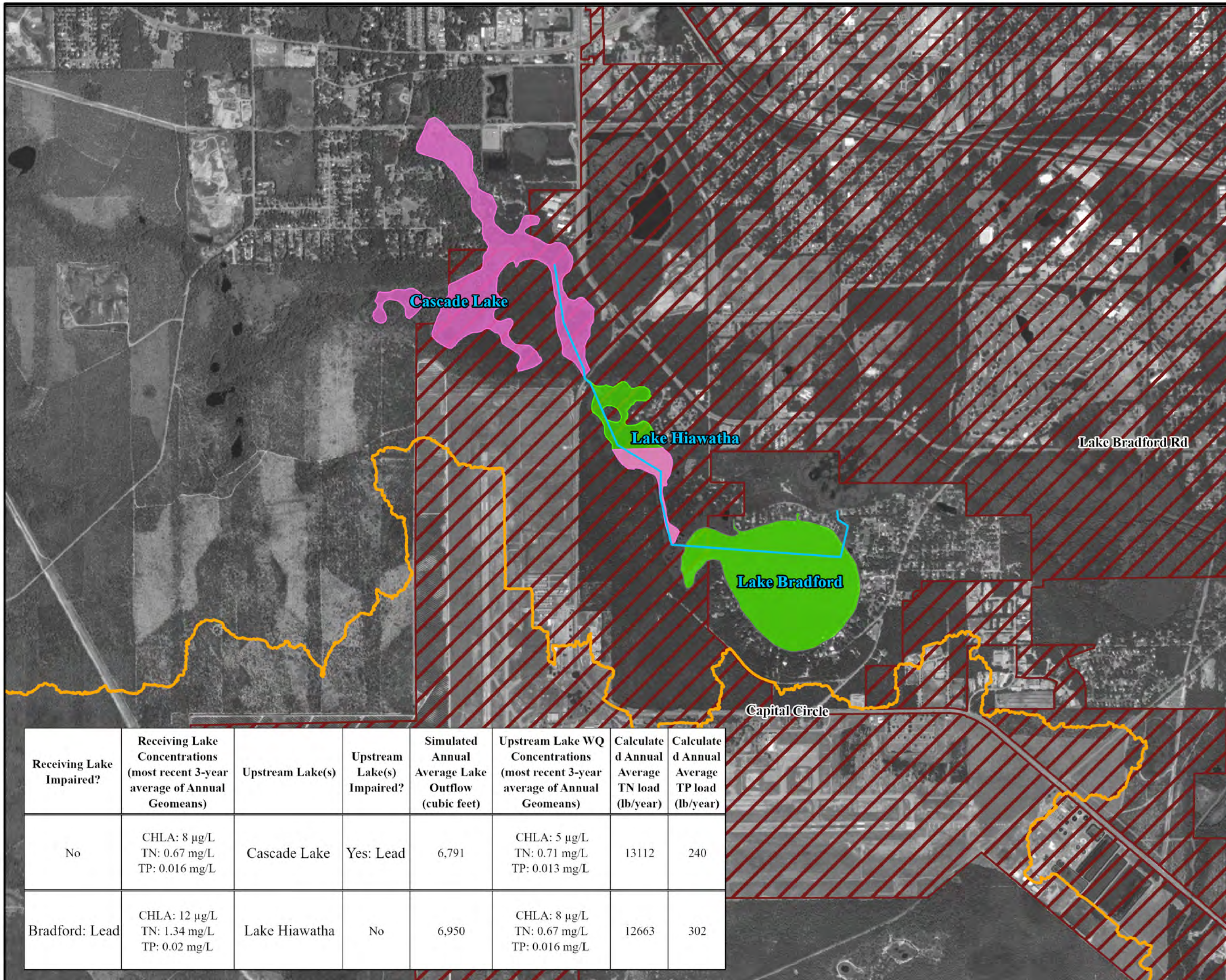

Receiving Lake Impaired?	Receiving Lake Concentrations (most recent 3-year average of Annual Geomeans)	Upstream Lake(s)	Upstream Lake(s) Impaired?	Simulated Annual Average Lake Outflow (cubic feet)	Upstream Lake WQ Concentrations (most recent 3-year average of Annual Geomeans)	Calculated Annual Average TN load (lb/year)	Calculated Annual Average TP load (lb/year)
No	CHLA: 8 µg/L TN: 0.67 mg/L TP: 0.016 mg/L	Cascade Lake	Yes: Lead	6,791	CHLA: 5 µg/L TN: 0.71 mg/L TP: 0.013 mg/L	13112	240
Bradford: Lead	CHLA: 12 µg/L TN: 1.34 mg/L TP: 0.02 mg/L	Lake Hiawatha	No	6,950	CHLA: 8 µg/L TN: 0.67 mg/L TP: 0.016 mg/L	12663	302

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Sources:
Waterbodies: COT, 2020
Flowlines: USGS, 2020
Watershed: COT, 2020
Roads: COT-Leon County, 2023
City Limits: COT, 2020

Figure 3-93:
Inflow Loading to Bradford Chain of Lakes

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The calculated TN and TP loads from Cascade Lake to Lake Hiawatha were 13,112 lb/year and 240 lb/year, respectively. The calculated TN and TP loads from Lake Hiawatha to Lake Bradford were 12,663 lb/year and 302 lb/year, respectively.

3.5.5.5 Internal Lake Load

In the qualitative assessment of potential pollutant loads to the Bradford Chain of Lakes (see **Section 3.5.4.4**), an assessment was made relative to the potential for anthropogenically driven internal loading to play a significant role in the nutrient budget. The assessment determined that, given the water quality, healthy biological conditions, and nature of the direct drainage areas to the lakes, internal loading was not likely to have a high potential for loading to the lakes.

3.5.5.6 Atmospheric Deposition

As presented and discussed in **Section 3.4.5.6** the annual average atmospheric TN load per acre was calculated from the Quincy NADP station (FL14) at 2.56 lb/acre/year. Multiplying this by the acreage for each of the lakes within the Bradford Chain gives total TN loads for each. No data are available for TP, therefore, only the nitrogen load is provided. Cascade Lake has a surface area of 109 acres and a calculated TN load of 279 lb/yr. Lake Hiawatha has a surface area of 40 acres and a calculated TN load of 102 lb/yr. Lake Bradford has a surface area of 149 acres and a calculated TN load of 381 lb/yr.

3.5.5.7 Summary of Calculated Loads

Nutrient loads to each of the lakes within the Bradford Chain were calculated for stormwater runoff, septic systems, lake inflow, and atmospheric deposition. **Table 3-17** presents the calculated total loads to the lake for TN and TP. For septic systems and atmospheric deposition, only TN loads were calculated (see **Section 3.5.5.2** and **Section 3.5.5.6**, respectively, for explanation).

Table 3-17: Summary of Calculated Loads to the Bradford Chain of Lakes

Source	Lake Bradford		Lake Hiawatha		Cascade Lake	
	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
Stormwater Runoff	340	74	617	105	12,006	2,751
Septic Systems	725	ND	76	ND	692	ND
Lake Inflow	12,646	302	13,095	240	NA	NA
Atmospheric Deposition	381	ND	102	ND	279	ND

ND – No data available to calculate, NA – Load calculation not applicable

3.6 Silver Lake/East Drainage Ditch

This section presents the results from Tasks 1 through 3 for the Silver Lake/East Drainage Ditch basin. This includes an overview and history of the lake and basin, present impairment status, an overview of available data, a qualitative assessment of potential pollutant sources, and calculation of potential pollutant loads.

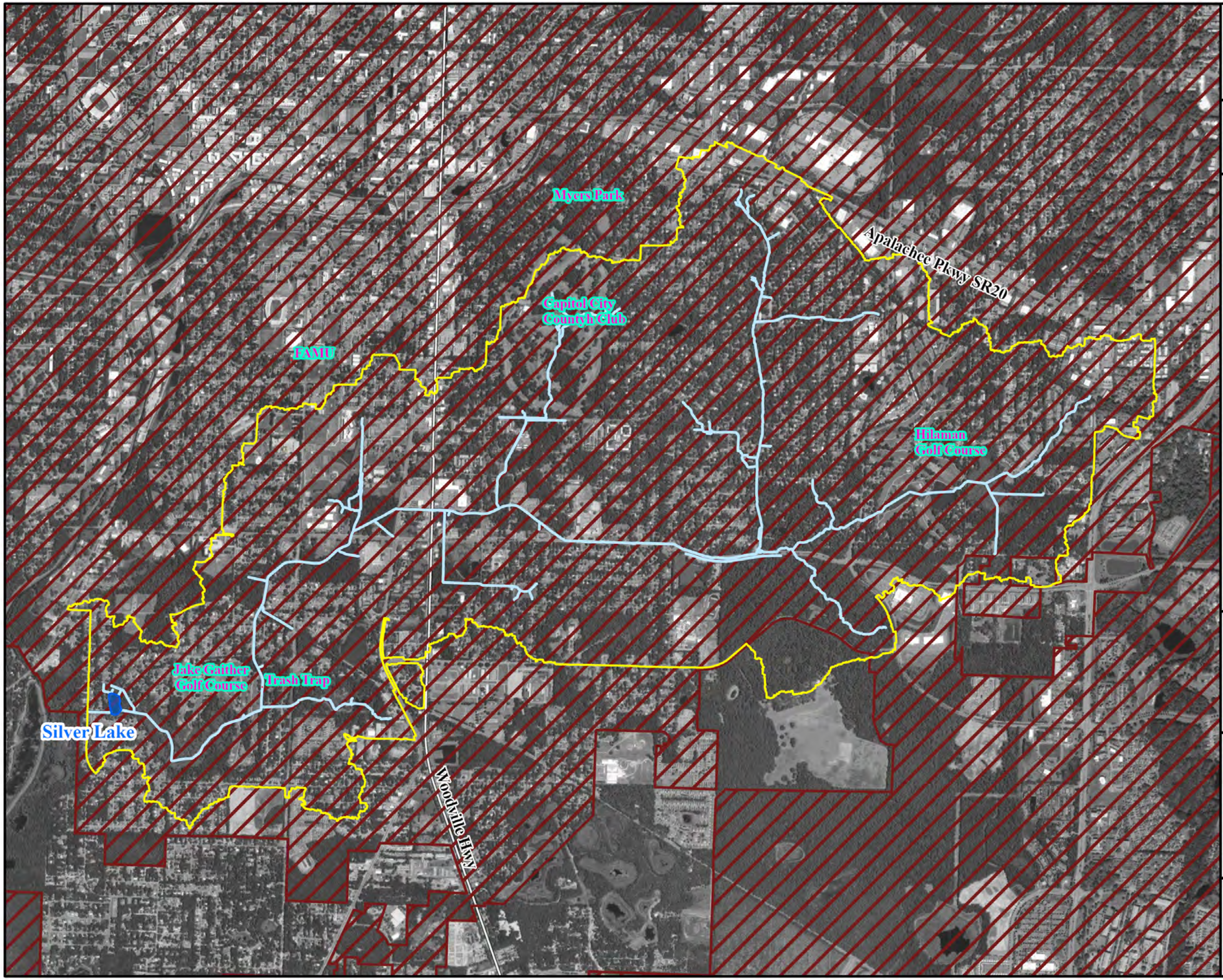
3.6.1 Overview and History

Silver Lake is a 2.1-acre open water area located at the downstream end of the East Drainage Ditch (**Figure 3-94**). The Silver Lake/East Drainage Ditch basin includes two watersheds, the Hydrangea watershed and the Indian Head watershed (**Exhibit 3-1**). The drainage basin is approximately 3,800 acres and is bordered by Apalachee Parkway along the northeast, Capital Circle SE on the east, and Paul Russell Road along portions of the southern side. Key areas that drain into the East Drainage Ditch and ultimately through Silver Lake include portions of Florida Agricultural and Mechanical (A&M) University (FAMU), highly urbanized areas along South Monroe and Orange Avenue, portions of the Myers Park neighborhood along Magnolia, and multiple other high-density and medium-density neighborhoods. There are three golf courses within the Silver Lake/East Drainage Ditch basin: the Jake Gaither Golf Course, the Capital City Country Club, and the Hilaman Golf Course. Outflows from Silver Lake flow under North Ridge Road and into the Lake Henrietta SWMF upstream of Lake Munson under baseflow conditions and for smaller storm events. Water from the basin will bypass the Lake Henrietta SWMF for larger storm events, discharging directly to Munson Slough and then Lake Munson.

Photo 3-37 through **Photo 3-44** present aerial views of Silver Lake from 1937 through 2020. The earlier aerial photos show that historically, Silver Lake consisted of two connected waterbodies (**Photo 3-37** and **Photo 3-38**), with the eastern waterbody susceptible to being at times dry and with the more permanent pool located at what is known as Silver Lake today. Ditching upstream continued through the years and altered the nature of the upstream areas.

Silver Lake sits between neighborhoods off North Ridge Road. **Photo 3-45** presents a photo of the lake taken in 2021 from the dock within Silver Lake Park, which is a City park. **Photo 3-46** shows the outflow canal from the lake that drains under North Ridge Road and into Munson Slough, also taken from the dock. **Photo 3-47** shows the discharge canal taken just upstream from the crossing of North Ridge Road. Immediately upstream of Silver Lake are wetlands through which the East Drainage Ditch flows. These wetlands are bordered to the north by the Jack Gaither Golf Course. Historical issues with trash coming down the East Drainage Ditch led to the construction of a trash trap just upstream of the adjacent wetland areas (**Figure 3-94**). **Photo 3-48** shows a picture of the trash trap taken in 2021. It is noted that at the time of this study, improvements to the trap are under design.

The East Drainage Ditch is primarily a heavily vegetated ditch with natural slopes along the reaches upstream of the crossing at South Monroe Street. **Photo 3-49** shows a portion of the ditch where it crosses Texas Street, exemplifying the typical vegetation density and side slopes. **Photo 3-50** shows a portion of the ditch just upstream of the crossing of South Monroe Street, showing bank erosion and some slope failure. In the downstream sections of the ditch, stabilization projects have been completed along portions of the ditch. **Photo 3-51** shows an area where gabion baskets and reno mattresses were installed to reduce erosion.



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Legend

- Silver Lake Drainage Basin
- Silver Lake
- Watercourses
- Major Roads
- Tallahassee Corporate Limits

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Roads: COT-Leon County, 2023
City Limits, COT, 2022

Figure 3-94:
Silver Lake/East Drainage Ditch Basin Overview Map

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Photo 3-37: Silver Lake Aerial (1937)

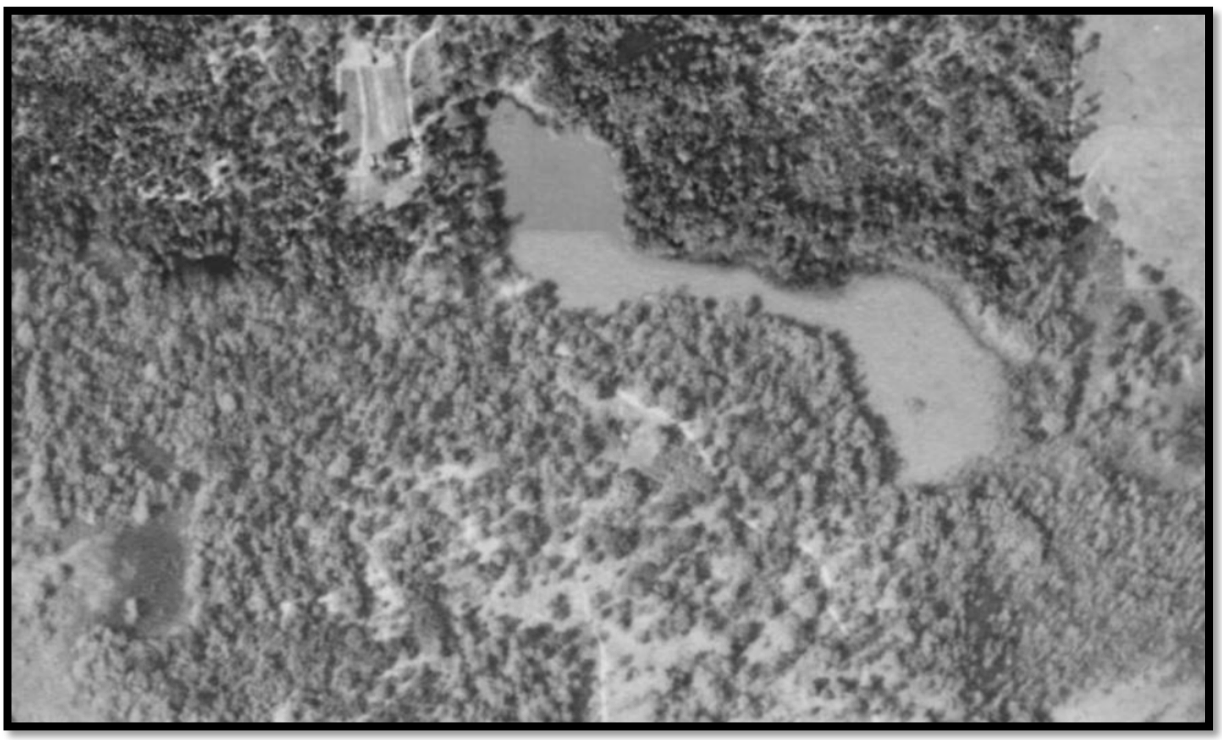


Photo 3-38: Silver Lake Aerial (1949)

Photo 3-39: Silver Lake Aerial (1954)

Photo 3-40: Silver Lake Aerial (1970)

Photo 3-41: Silver Lake Aerial (1983)

Photo 3-42: Silver Lake Aerial (1996)

Photo 3-43: Silver Lake Aerial (2007)

Photo 3-44: Silver Lake Aerial (2020)

Photo 3-45: Photo of Silver Lake from the Public Dock in Silver Lake Park (2021)

Photo 3-46: Photo of Outflow Canal on Silver Lake from the Public Dock (2021)

Photo 3-47: Photo of Silver Lake Outflow Canal Immediately Upstream of North Ridge Road (2021)

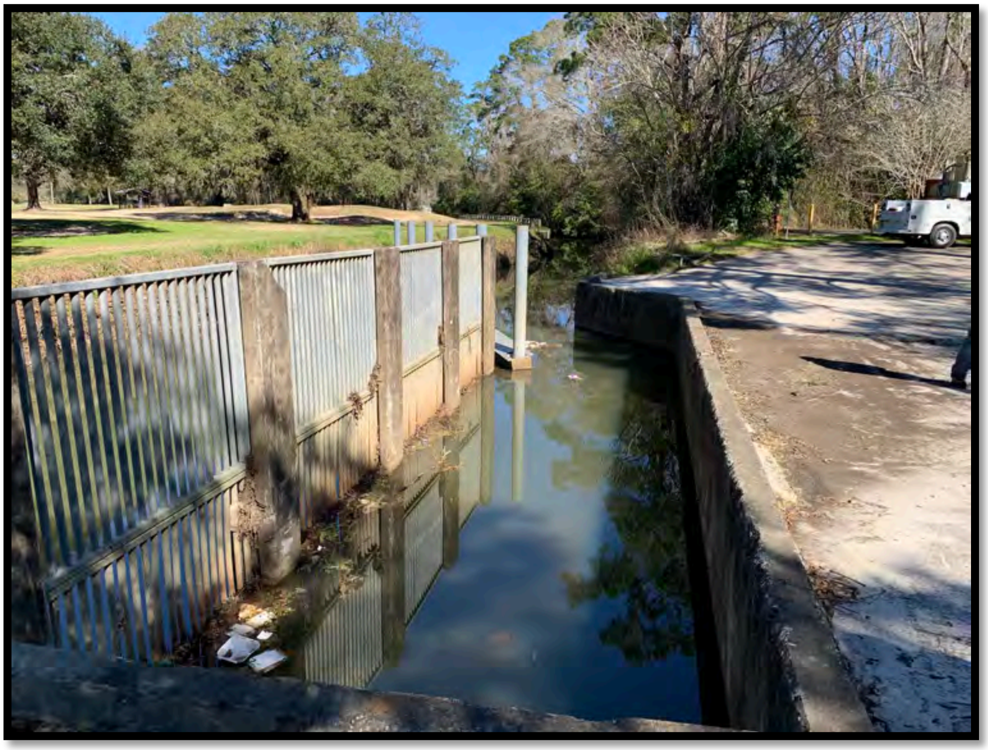


Photo 3-48: Photo of Trash Trap on East Ditch Upstream of Silver Lake (2021)

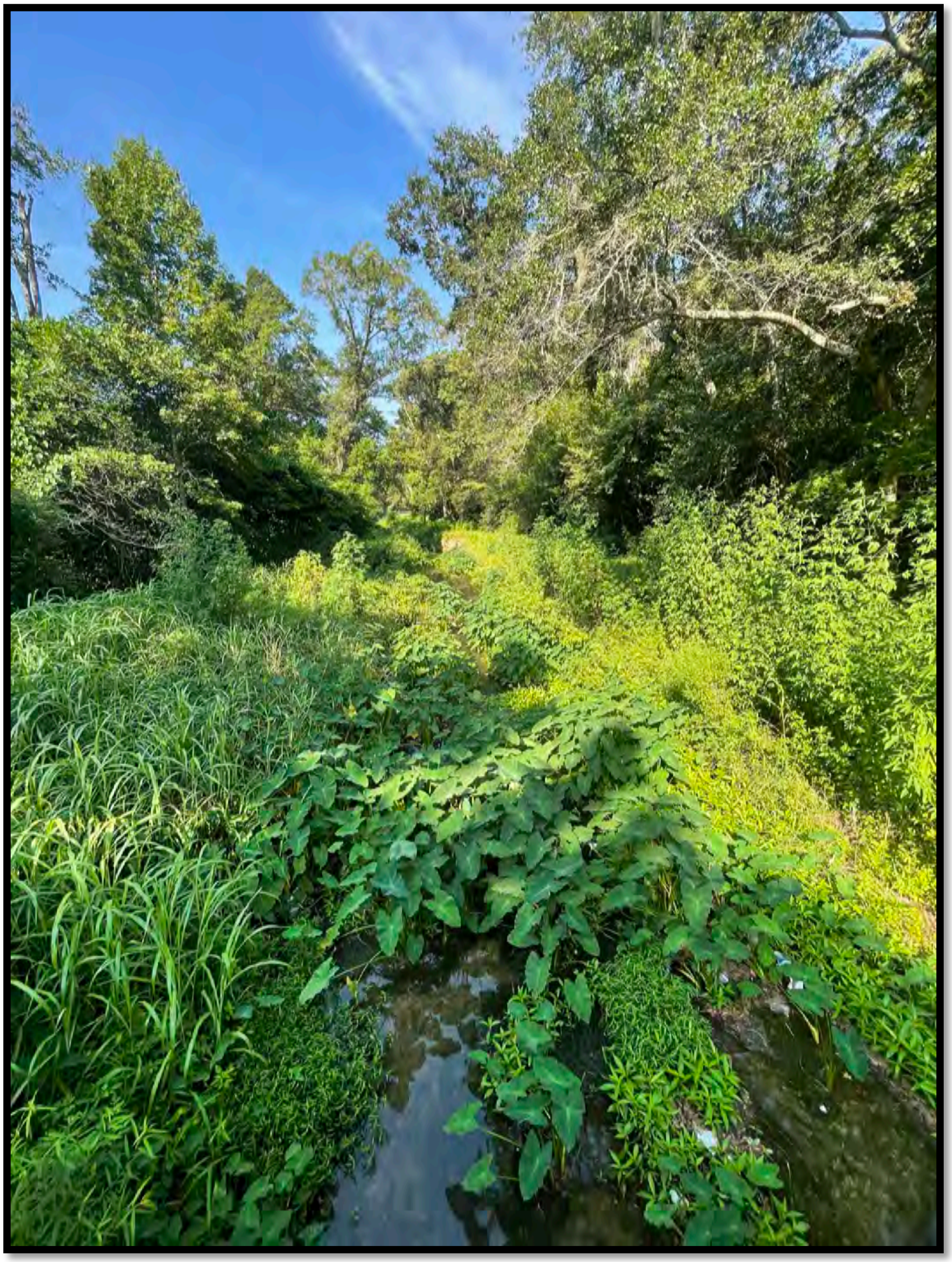


Photo 3-49: Photo of East Ditch at Texas Street Crossing (2023)

Photo 3-50: Photo of Erosion Along East Ditch Upstream of Crossing of South Monroe Street (2023)

Photo 3-51: Photo of Bank Stabilization along East Ditch West of South Adams Street (2021)

3.6.2 Regulatory Status

Exhibit 3-2 presented the verified impaired waters within the overall Lake Munson basin. The open water area of Silver Lake presently is not classified as a lake in the IWR database, but rather it is assessed as part of the East Drainage Ditch WBID (916) as a part of the stream segment. The City collects and has collected data within the open water area as well as upstream and downstream within the ditched areas. WBID 916 is classified as a stream segment by FDEP, so the applicable criteria for assessment for data collected within the WBID are the stream criteria. This includes the Panhandle East NNC thresholds and other stream criteria.

At present, WBID 916 is verified impaired for fecal coliform. However, fecal coliform is no longer the applicable bacteria parameter for its waterbody classification. *E. coli* is utilized as the assessment parameter for bacteria impairment. Presently, there is insufficient data in the IWR database to assess against *E. coli*. The fecal coliform impairment will remain on the Verified List until such time as the WBID can be assessed against *E. coli*.

Section 3.6.3.6 presents plots of the data from the WBID against the stream NNC and *E. coli* thresholds, including data from the open water areas of Silver Lake and the upstream and downstream stations. This is consistent with the present FDEP classification for the waterbodies.

3.6.3 Waterbody Data Review and Summary

This section presents an overview of available data and data sources for Silver Lake and the East Drainage Ditch basin, including bathymetry, land use, soils, septic systems, hydrologic measurements, surface water quality, groundwater quality, biological, stormwater treatment facilities, and atmospheric deposition.

3.6.3.1 Bathymetry

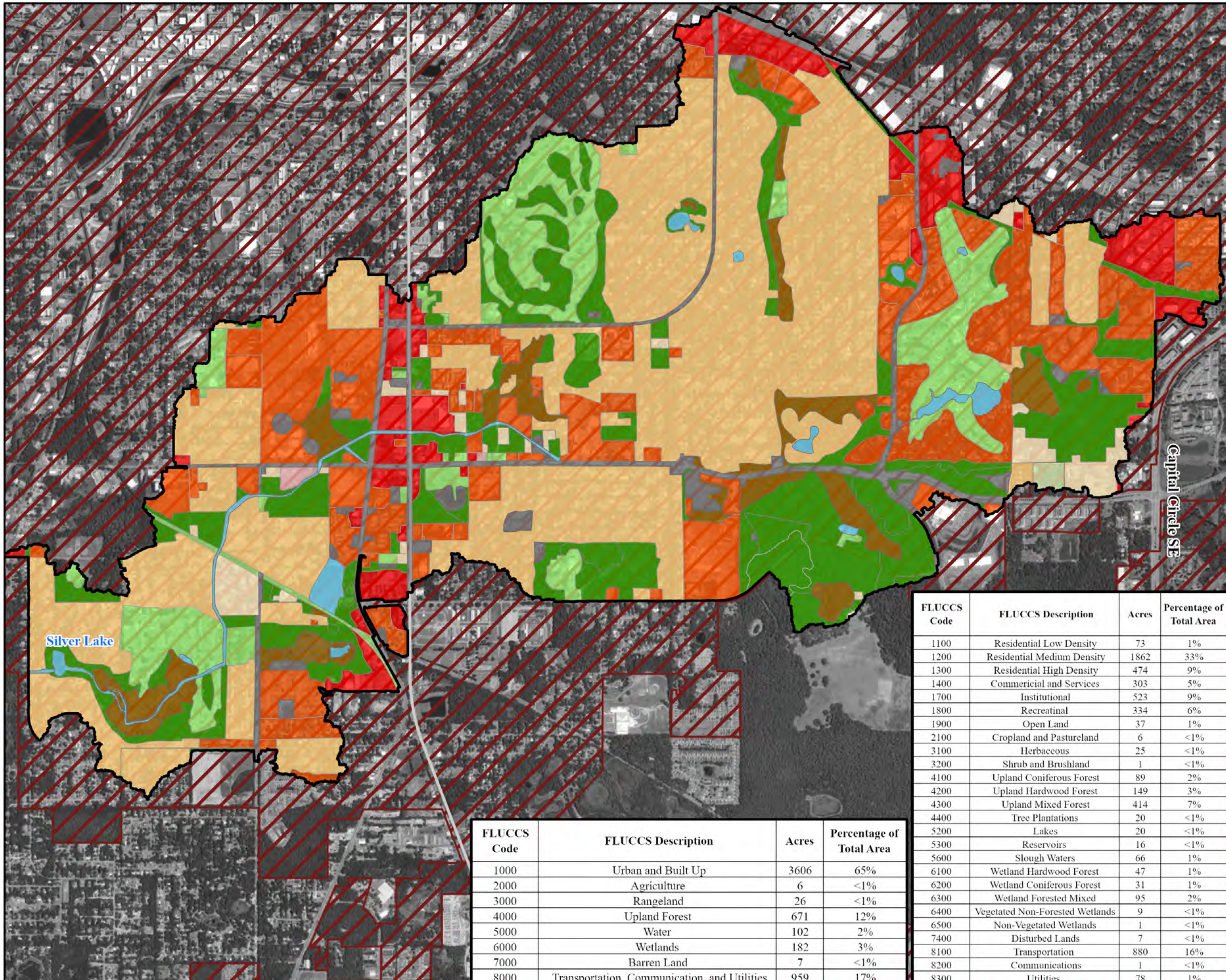
No bathymetric data were available for the open water areas of Silver Lake.

3.6.3.2 Land Use

Figure 3-95 presents a map of the Level 2 land uses within the Silver Lake/East Drainage Ditch basin. A table is provided to show the overall acreages and percent cover for the various levels. Tables are provided for both the Level 2 and grouped Level 1 land uses. The largest land use type by far within the basin per the grouped Level 1 categories is Urban and Built Up (65 percent), with the next highest being Transportation, Communications and Utilities at 17 percent. Within the Urban and Built Up Level 1, the largest use is medium-density residential at 33 percent. Within the Level 1 Transportation, Communications, and Utilities, nearly all is under Transportation.

3.6.3.3 Soils

The two most prevalent soil groups in the Silver Lake/East Drainage Ditch basin are Group C (33 percent) and Group B (31 percent) (**Figure 3-96**). Group B soils are considered to have a moderate rate of infiltration while Group C soils are considered to have a low rate of infiltration. These types of soils are located throughout the eastern portions of the basin. Soils near the wetlands just upstream of Silver Lake are predominantly Group A/D (26 percent). These are considered to have good infiltration potential, but due to elevated water table conditions, will act more similarly to soils with low infiltration potential.



FLUCCS Code	FLUCCS Description	Acres	Percentage of Total Area
1000	Urban and Built Up	3606	65%
2000	Agriculture	6	<1%
3000	Rangeland	26	<1%
4000	Upland Forest	671	12%
5000	Water	102	2%
6000	Wetlands	182	3%
7000	Barren Land	7	<1%
8000	Transportation, Communication, and Utilities	959	17%

FLUCCS Code	FLUCCS Description	Acres	Percentage of Total Area
1100	Residential Low Density	73	1%
1200	Residential Medium Density	1862	33%
1300	Residential High Density	474	9%
1400	Commericial and Services	303	5%
1700	Institutional	523	9%
1800	Recreatinal	334	6%
1900	Open Land	37	1%
2100	Cropland and Pastureland	6	<1%
3100	Herbaceous	25	<1%
3200	Shrub and Brushland	1	<1%
4100	Upland Coniferous Forest	89	2%
4200	Upland Hardwood Forest	149	3%
4300	Upland Mixed Forest	414	7%
4400	Tree Plantations	20	<1%
5200	Lakes	20	<1%
5300	Reservoirs	16	<1%
5600	Slough Waters	66	1%
6100	Wetland Hardwood Forest	47	1%
6200	Wetland Coniferous Forest	31	1%
6300	Wetland Forested Mixed	95	2%
6400	Vegetated Non-Forested Wetlands	9	<1%
6500	Non-Vegetated Wetlands	1	<1%
7400	Disturbed Lands	7	<1%
8100	Transportation	880	16%
8200	Communications	1	<1%
8300	Utilities	78	1%

Sources:
Waterbodies: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
Land Use: NWFWMD, 2019
City Limits: COT, 2022

Figure 3-95:
Silver Lake/East Drainage Ditch Basin Land Use Map

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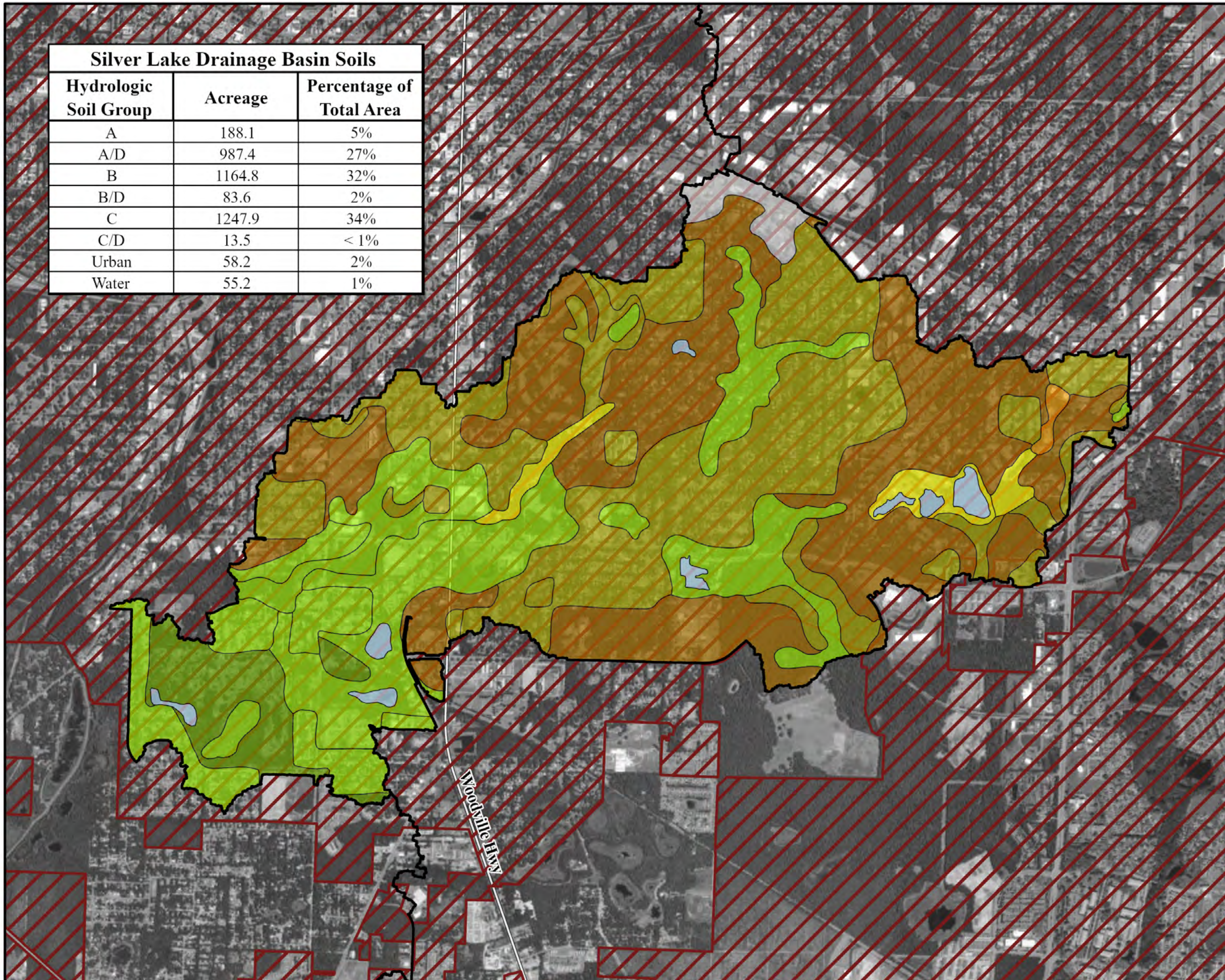
Silver Lake Drainage Basin Soils		
Hydrologic Soil Group	Acreage	Percentage of Total Area
A	188.1	5%
A/D	987.4	27%
B	1164.8	32%
B/D	83.6	2%
C	1247.9	34%
C/D	13.5	< 1%
Urban	58.2	2%
Water	55.2	1%



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Silver Lake Drainage Basin

Tallahassee Corporate Limits

Hydrologic Soil Group

- A
- A/D
- B
- B/D
- C
- C/D
- Urban land
- Water

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Roads: COT-Leon County, 2023
City Limits, COT, 2020
Soils: NRCS, 2020

Figure 3-96
Silver Lake/East Drainage Ditch Basin Soils Map

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3.6.3.4 Septic Systems

An estimated 119 septic tank units are within the boundaries of the Silver Lake/East Drainage Ditch basin, based on the FDOH septic tank layer (**Figure 3-97**). The septic tanks are located in small, sparse clusters all around the basin.

Effluent from septic tanks that are in good condition should be comparable to secondarily treated wastewater effluent from sewage treatment plants. However, septic systems can be a source of pollutants, pathogens, and nutrients and are identified by FDEP as a potential source of bacteria and nutrients to waterbodies in its assessment processes.

3.6.3.5 Hydrologic Data

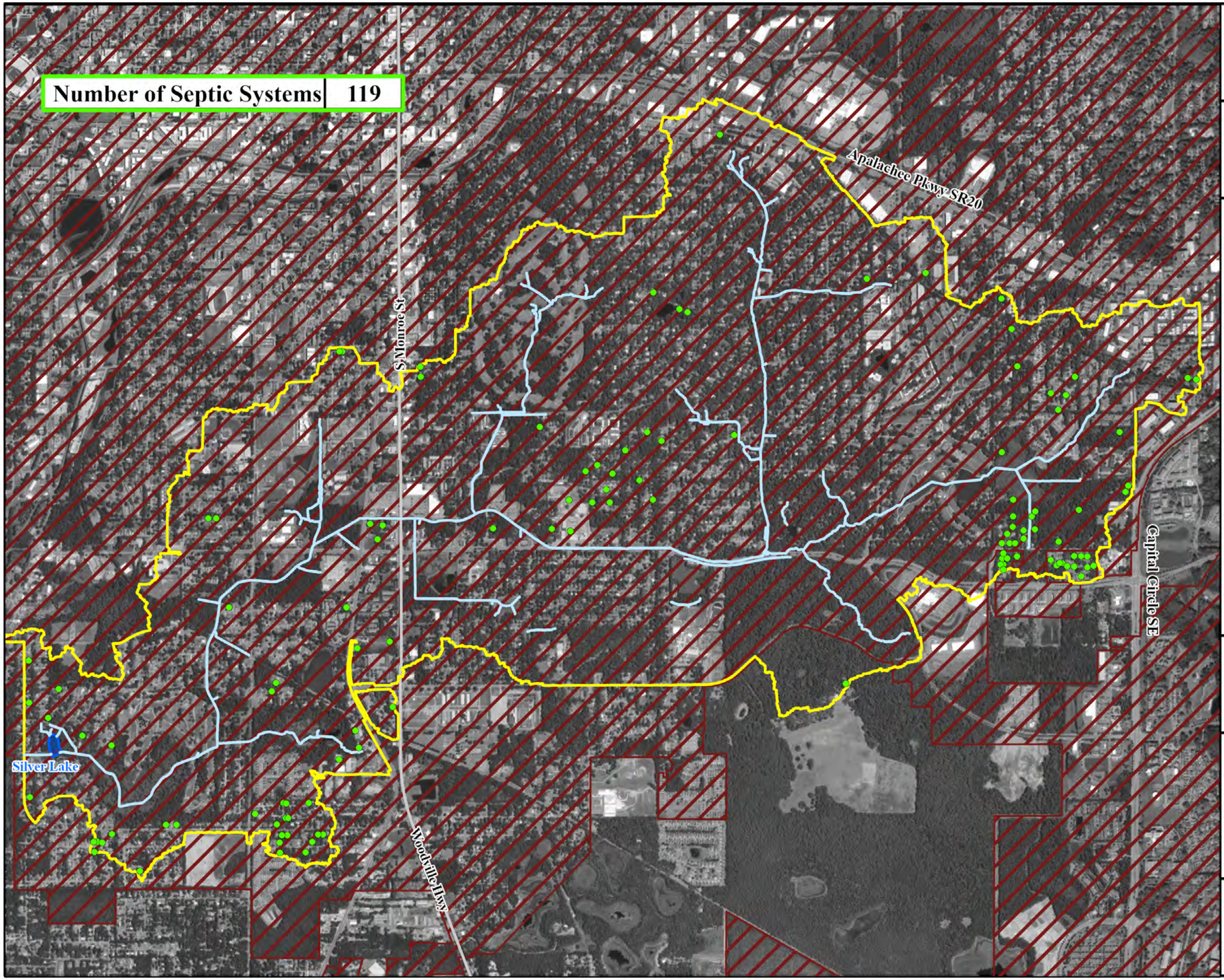
Exhibit 3-6 presented the locations of hydrologic data stations within the Lake Munson basin. There is a flow monitoring station located along the East Drainage Ditch at Adams Street (Station 008481). The flows at this station represent around two-thirds of the overall basin flow. **Figure 3-98** presents a plot of the calculated flows from 1994 through 2020. As with the calculated flows in Munson Slough and the West Ditch, the flows are highly flashy with extensive peak flows. Maximum flows over 200 cfs were calculated, with peak flows ranging between 50 and 100 cfs generally. It is noted that peak flows after 2010 were reduced in relation to peak flows in prior years. Whereas peak flows ranged between 100 and 300 cfs in the earlier years, peak flows after 2010 rarely exceeded 50 cfs. This may be reflective of additional attenuation within the watershed upstream of the flow station due to stormwater treatment pond construction and other BMPs. While the peak flows were attenuated, calculation of the annual total volumes indicated that the annual runoff volumes have not been reduced significantly.

3.6.3.6 Surface Water Quality Data

Figure 3-99 presents the location of the in-lake water quality monitoring station in Silver Lake (yellow) along with four stations that provide water quality data along the East Drainage Ditch upstream of the lake (red) and two downstream (orange). A table is provided in **Figure 3-99** that shows the station ID, station name, period of record, sample count, data source, and if the station represents in-lake or upstream/downstream data. Station IDs were not included on the figure, rather each of the stations is given a number and the numbers correspond to stations in the table.

The City collected water quality data in the lake since 2010 (Station 3 on map). Within the East Drainage Ditch upstream of Silver Lake, data were collected between 2011 and 2014 at two locations, one where the ditch flows under the St. Marks Historic Railroad Trail (Station 2 on map) and another in the ditch as it passes through the Indian Head neighborhood (Station 1 on map). Additional data, collected between 2010 and 2016 were taken at two stations where the East Drainage Ditch crosses North Ridge Road (Stations 4 and 5 on the map).

Some initial plots of the available data are provided in this section. This includes plots of the raw data and AGMs. As nutrients are the primary constituent of interest relative to water quality conditions in the basin, plots are provided for TN and TP against the NNC stream criteria. Additionally, based on interest relative to septic systems and other sources, FIB, specifically *E. coli*, are included where data are available. Additional data plots and analyses are provided as part of the qualitative assessment of sources in **Section 3.6.4.1.**



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Legend

- Silver Lake Drainage Basin
- Waterbodies in Study
- Watercourses
- Major Roads
- Tallahassee Corporate Limits
- Septic Systems

Sources:
Waterbodies: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
Septic Systems: COT, 2020
City Limits: COT, 2022

Figure 3-97:
Silver Lake/East Drainage Ditch Basin
Septic Systems Map

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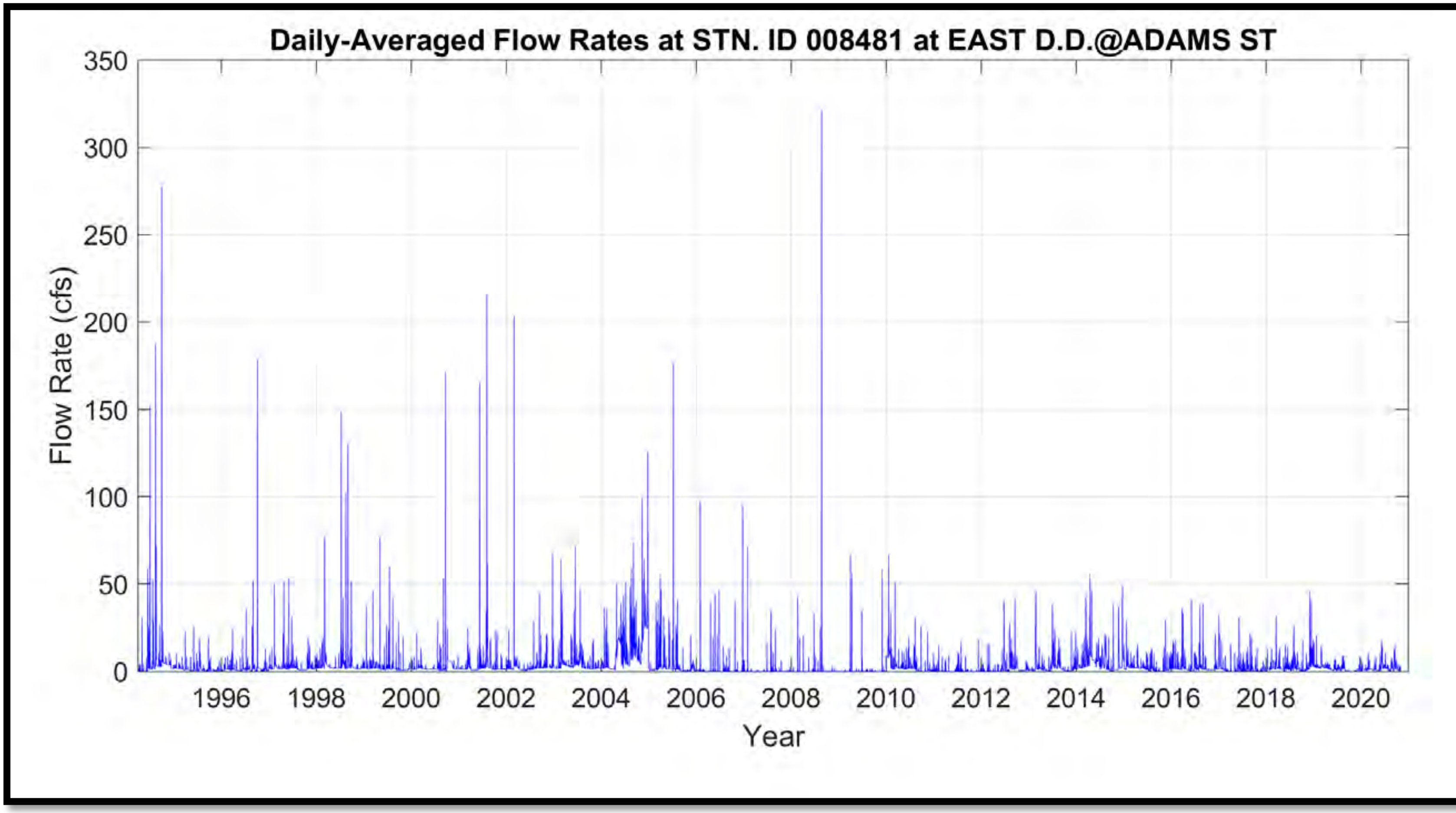
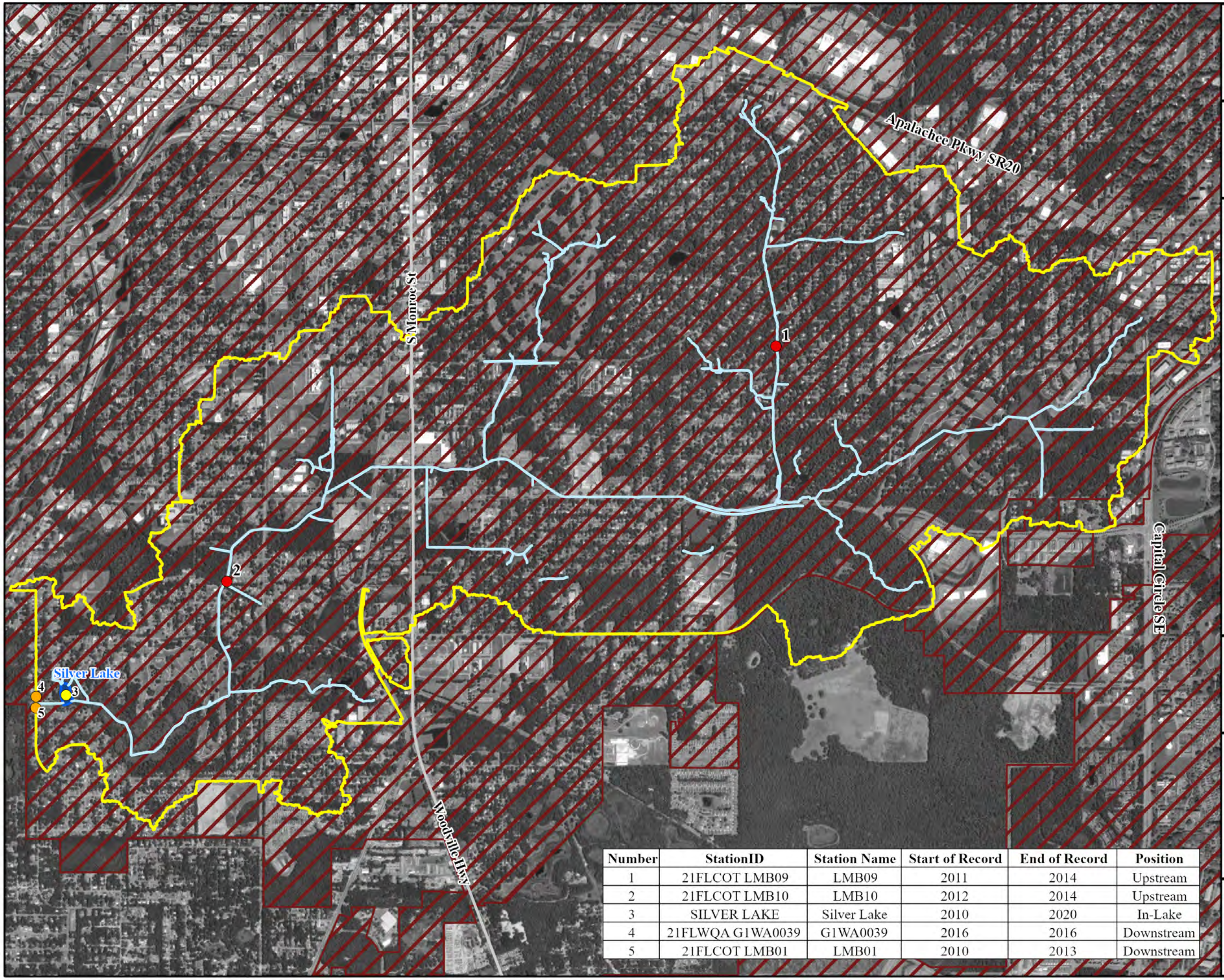


Figure 3-98: Daily Average Flow on East Drainage Ditch at Adams Street (Station 008481) (1994 to 2020)



Number	StationID	Station Name	Start of Record	End of Record	Position
1	21FLCOT LMB09	LMB09	2011	2014	Upstream
2	21FLCOT LMB10	LMB10	2012	2014	Upstream
3	SILVER LAKE	Silver Lake	2010	2020	In-Lake
4	21FLWQA G1WA0039	G1WA0039	2016	2016	Downstream
5	21FLCOT LMB01	LMB01	2010	2013	Downstream

CITY OF TALLAHASSEE

N

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Miles

Legend

- Silver Lake Drainage Basin
- Waterbodies in Study
- Watercourses
- Major Roads
- Tallahassee Corporate Limits

Water Quality Stations

Position

- In-Lake
- Upstream of Lake
- Downstream of Lake

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
City Limits: COT, 2020
WQ Stations: FDEP, 2022

Figure 3-99:
Silver Lake/East Drainage Ditch Basin Water Quality Stations Map

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

Plots of the measured TN and TP from 2010 to 2020 are presented in **Figure 3-100** and **Figure 3-101**. The higher density of samples between 2011 and 2014 reflects the inclusion of the upstream and downstream East Drainage Ditch samples (Stations 1, 2, 4, and 5) that were discontinued around 2014. Data after 2015 generally reflect data from only the open water Silver Lake portions of the ditch. TN and TP both show a general downward trend over the period of record from 2010 to 2020. This downward trend is seen in all of the data, including just the Silver Lake data.

The NNC Panhandle East stream thresholds for TN and TP are 1.03 mg/L and 0.18 mg/L. For *E. coli*, the criteria is monthly geometric means below 126 colonies per 100 mL of water and less than 10 percent of samples above 410 colonies per 100 mL of water in any 30-day period.

TN and TP AGM plots are provided for the Silver Lake/East Drainage Ditch basin as these define status relative to nutrient impairment. Where sufficient data are available to assess the AGMs, the levels are provided from 2010 through 2020. The TN and TP maximum NNC thresholds are provided on each of the graphs as pink dashed lines. *E. coli* data for the basin are presented against the 410 colonies per 100 mL threshold. *E. coli* data were available only from samples taken within the open water areas of Silver Lake after 2014.

Examination of the TN plot (**Figure 3-102**) shows that between 2010 and 2020, the TN AGMs in the basin were all below the NNC threshold (1.03 mg/L), with the bulk of the years at or below 50 percent of the threshold (0.5 mg/L). TP AGM levels (**Figure 3-103**) were all below the NNC threshold, with a significant downward trend after 2012. AGMs after 2016 were all around or below 0.1 mg/L, with the latter years showing significant drop offs.

Figure 3-104 presents a plot of measured *E. coli* levels from 2014 through 2020. All but 1 of the 23 measurements are below the 410 colonies per 100 mL threshold, with elevated measurement above 600, and 2 measurements were above 100.

3.6.3.7 Groundwater Data

Figure 3-23 presented the surficial aquifer groundwater sampling wells within the Lake Munson basin boundaries. No groundwater stations were located within the Silver Lake/East Drainage Ditch basin.

3.6.3.8 Biological Data

No biological sampling has been performed on Silver Lake. Biological sampling was conducted along the East Drainage Ditch, with data available from two sampling events in 2016. Habitat assessments of the ditch were performed where it crosses Ridge Road. The results of the assessment generally showed marginal to poor conditions based on issues of bank stability, limited riparian buffer, water velocity, and habitat smothering.

3.6.3.9 Stormwater Treatment Facilities

In assessing potential sources of pollutants to the Silver Lake, and ultimately for targeting loads and reductions, it is important to identify treatment facilities that presently exist with the basin. **Figure 3-105** presents a map showing the locations of stormwater treatment facilities throughout the Silver Lake/East Drainage Ditch basin. These are maintained by the City, FDOT, and private neighborhoods.

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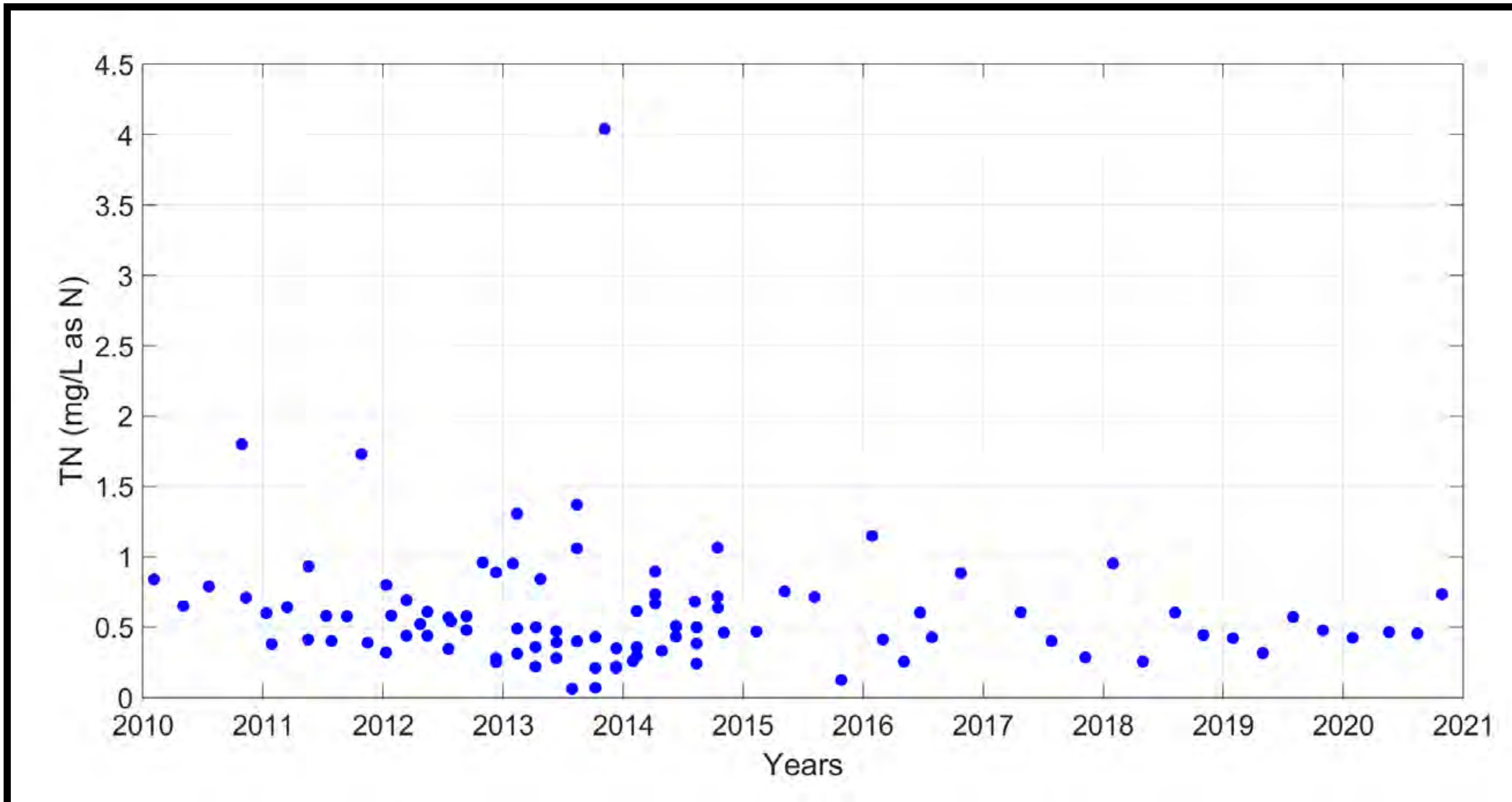


Figure 3-100: Plot of Measured TN in Silver Lake/East Drainage Ditch Basin

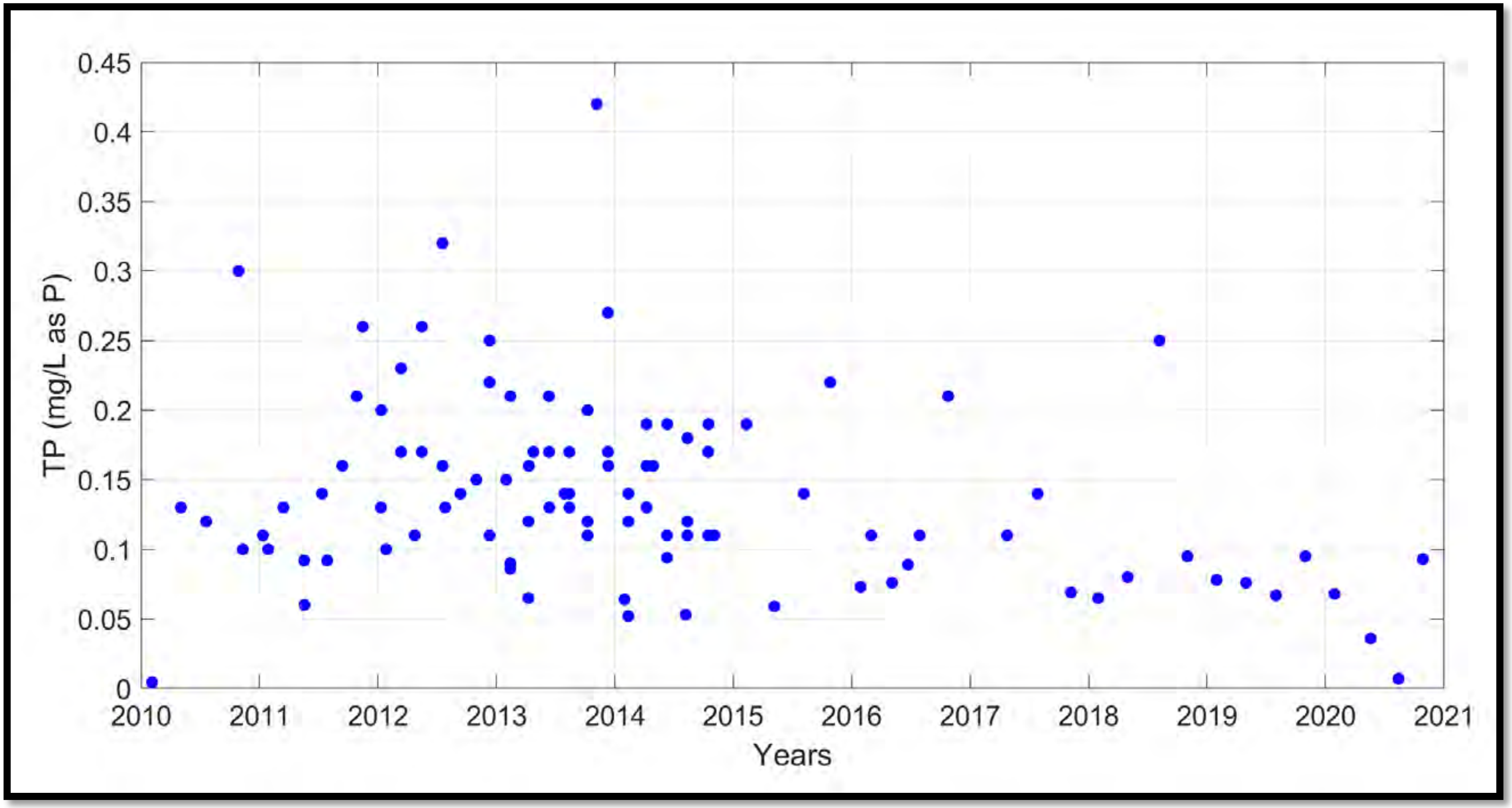


Figure 3-101: Plot of Measured TP in Silver Lake/East Drainage Ditch Basin

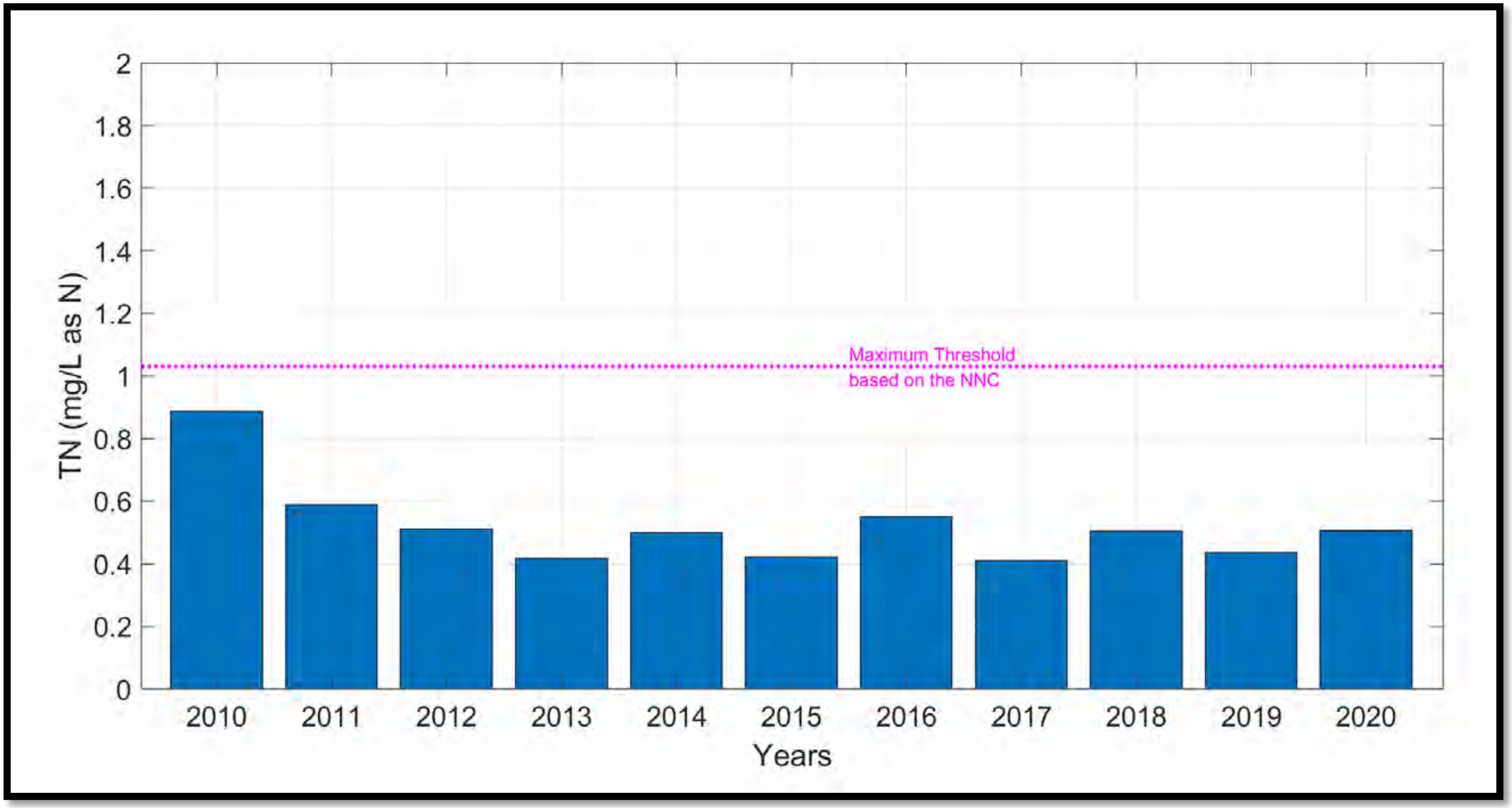


Figure 3-102 Plot of Annual Geometric Means for TN with NNC Criteria for Silver Lake/East Drainage Ditch Basin

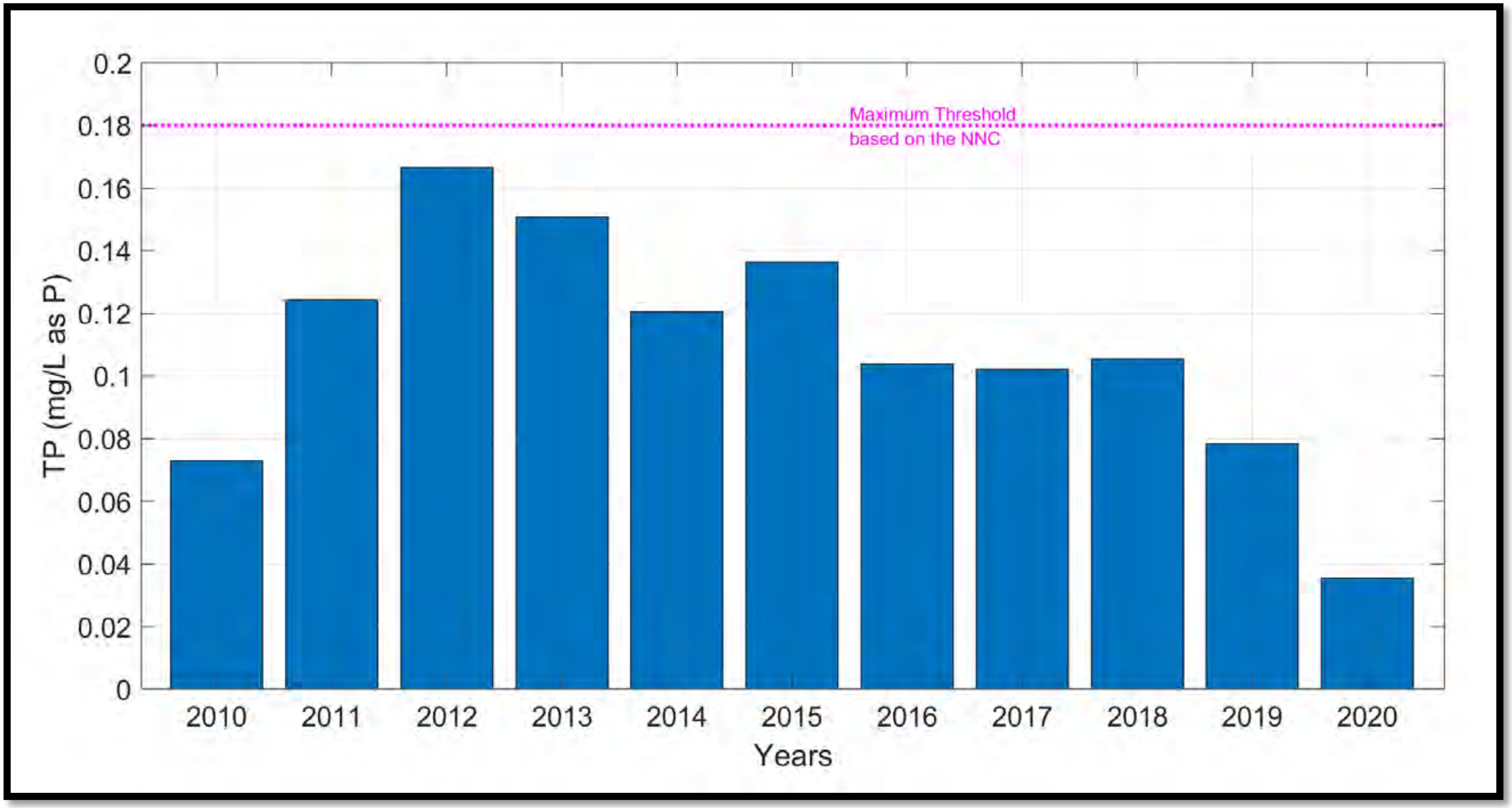


Figure 3-103: Plot of Annual Geometric Means for TP with NNC Criteria for Silver Lake/East Drainage Ditch Basin

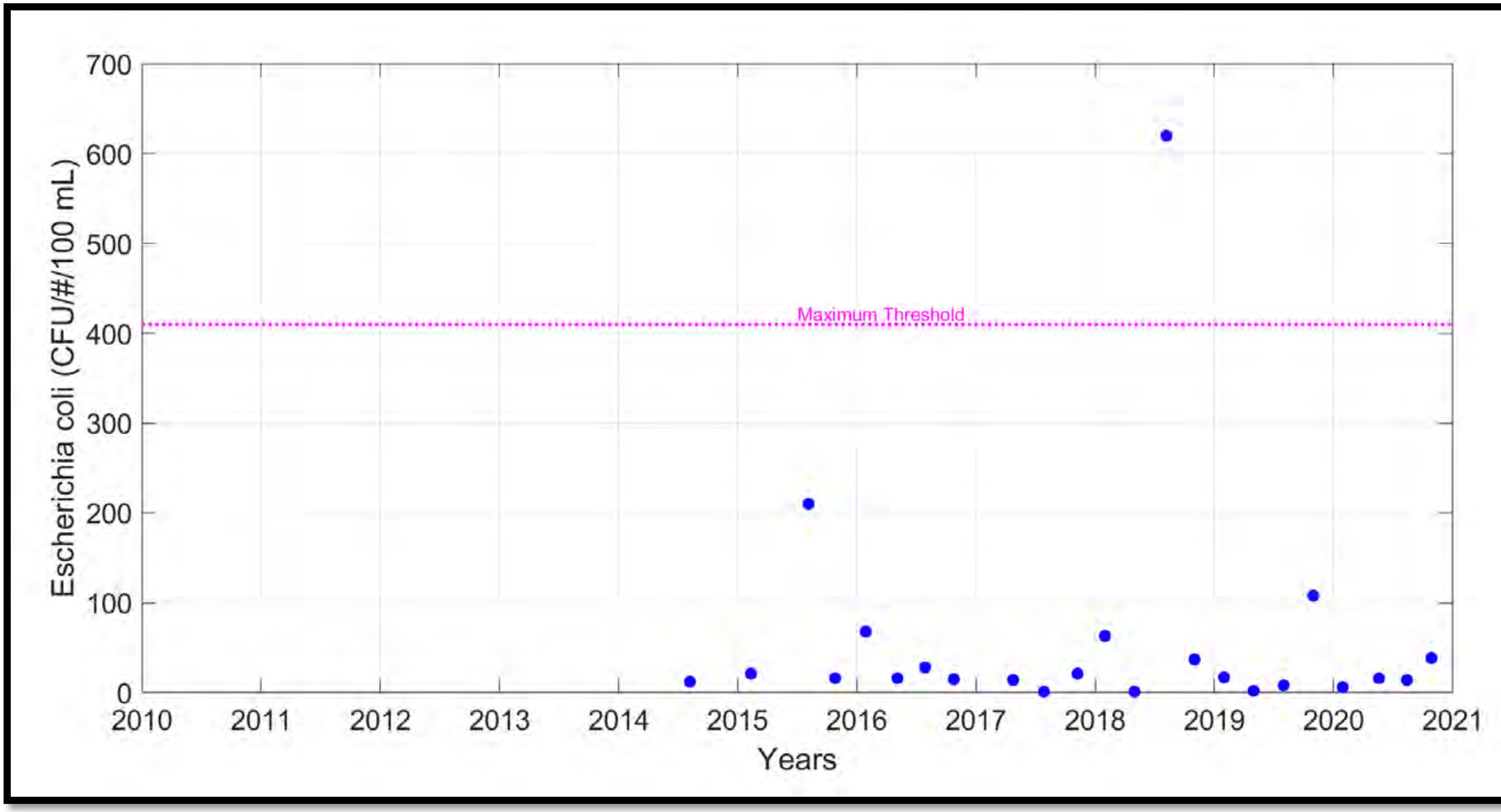
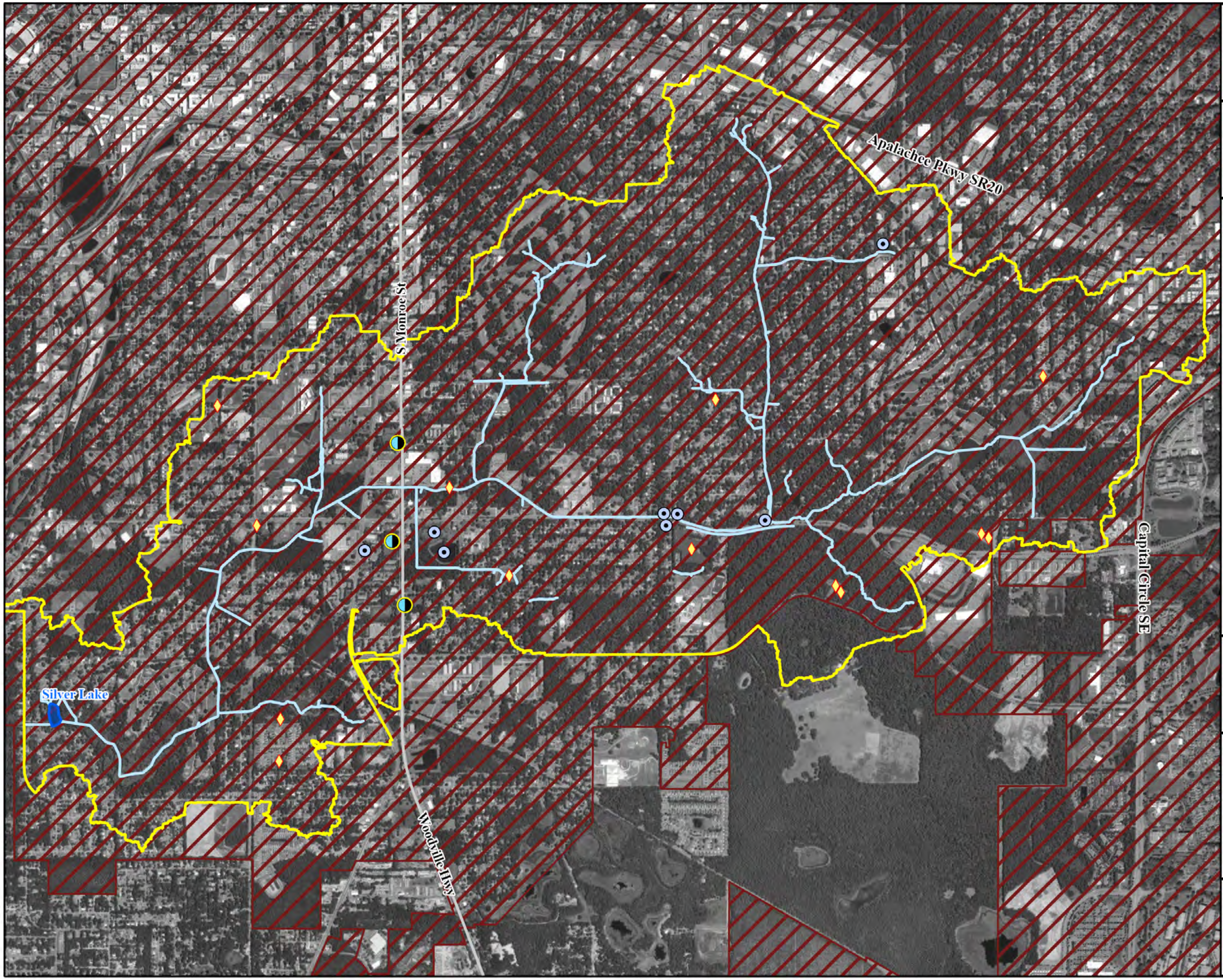


Figure 3-104: Plot of *E. coli* Measurements in Silver Lake (2014 to 2020)



CITY OF TALLAHASSEE

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Legend

- Silver Lake Drainage Basin
- Waterbodies in Study
- Watercourses
- Tallahassee Corporate Limits
- City of Tallahassee Stormwater Ponds
- FDOT Stormwater Ponds
- Stormwater Ponds-Other

Sources:
Waterbodies: COT, 2020
Watersheds: COT, 2020
Roads: FDOT, 2020
BMPs: Geosyntec, 2022
City Limits: COT, 2022

Figure 3-105:
Silver Lake/East Drainage Ditch Basin
BMP Location Map

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

3.6.3.10 Atmospheric Deposition Data

Figure 3-24 presented the location of the nearest atmospheric deposition station to the Silver Lake/East Drainage Ditch basin, the Quincy, FL station. This is the same station utilized in the Lake Munson calculations.

3.6.3.11 Data Summary

For the purposes of the qualitative analysis of sources of pollutants to Silver Lake and the East Drainage Ditch (**Section 3.6.4),** the available data are limited. There is an active surface water quality station within the open water areas of the lake, but data in the upstream and downstream reaches of the ditch are limited. Specific recommendations on additional data collection efforts are provided in **Section 3.8**. The following outlines limitations in the available data.

- The water quality monitoring stations in the East Drainage Ditch upstream and downstream of the lake were discontinued around 2014, which limits available recent data on conditions in the ditch upstream and downstream of the lake.
- No surficial groundwater monitoring stations are located in the vicinity to determine the quality of potential seepage into the lake or ditch segments.

3.6.4 Qualitative Assessment of Sources

As outlined in **Section 3.4.4** for Lake Munson, prior to performing loading calculations and other analyses to quantify existing pollutant sources to Silver Lake and the East Drainage Ditch, it is important to analyze available data and summarize findings from historical studies to support identification of likely sources of anthropogenic load.

For Silver Lake, the sources to be evaluated include the following:

- Stormwater runoff
- Septic systems
- Internal recycling and seepage
- Wastewater
- Atmospheric deposition
- Interconnected flows

An overview of analyses and findings for each source listed above is provided in the following sections. Prior to the discussions for each potential source, additional analyses of the data within the basin are provided to build on the information presented in **Section 3.6.3**. Following the discussions for each source type, a summary of findings for the qualitative assessment is provided.

3.6.4.1 In-Stream Water Quality

Following the methodology utilized for Lake Munson in **Section 3.4.4.1**, analyses were conducted on the available data along the East Drainage Ditch and within Silver Lake from 2010 to the present. This provides an evaluation of the baseline water quality conditions and the spatial differences along the ditch (where data support a spatial assessment). The parameters analyzed include TP, TN, and TSS. *E. coli* data are only available in the lake, so no spatial analysis is provided.

As was done for Lake Munson (**Section 3.4.4.1**), stations were clustered where they represent conditions within a specific area, and all stations with data after 2010 were assigned to a specific cluster. The clustered data from 2010 to the present were analyzed to provide the average of the annual geomeans or the 90th percentile, depending upon the parameter. The results are presented on a map, with colors representing the results. The levels associated with the colors are reflective of water quality thresholds as outlined in 62-302 F.A.C. and are discussed and presented in **Section 3.4.4.1**. The Silver Lake/East Drainage Ditch basin analyses use the stream NNC thresholds for TN and TP based on the applicable Panhandle East NNC criteria.

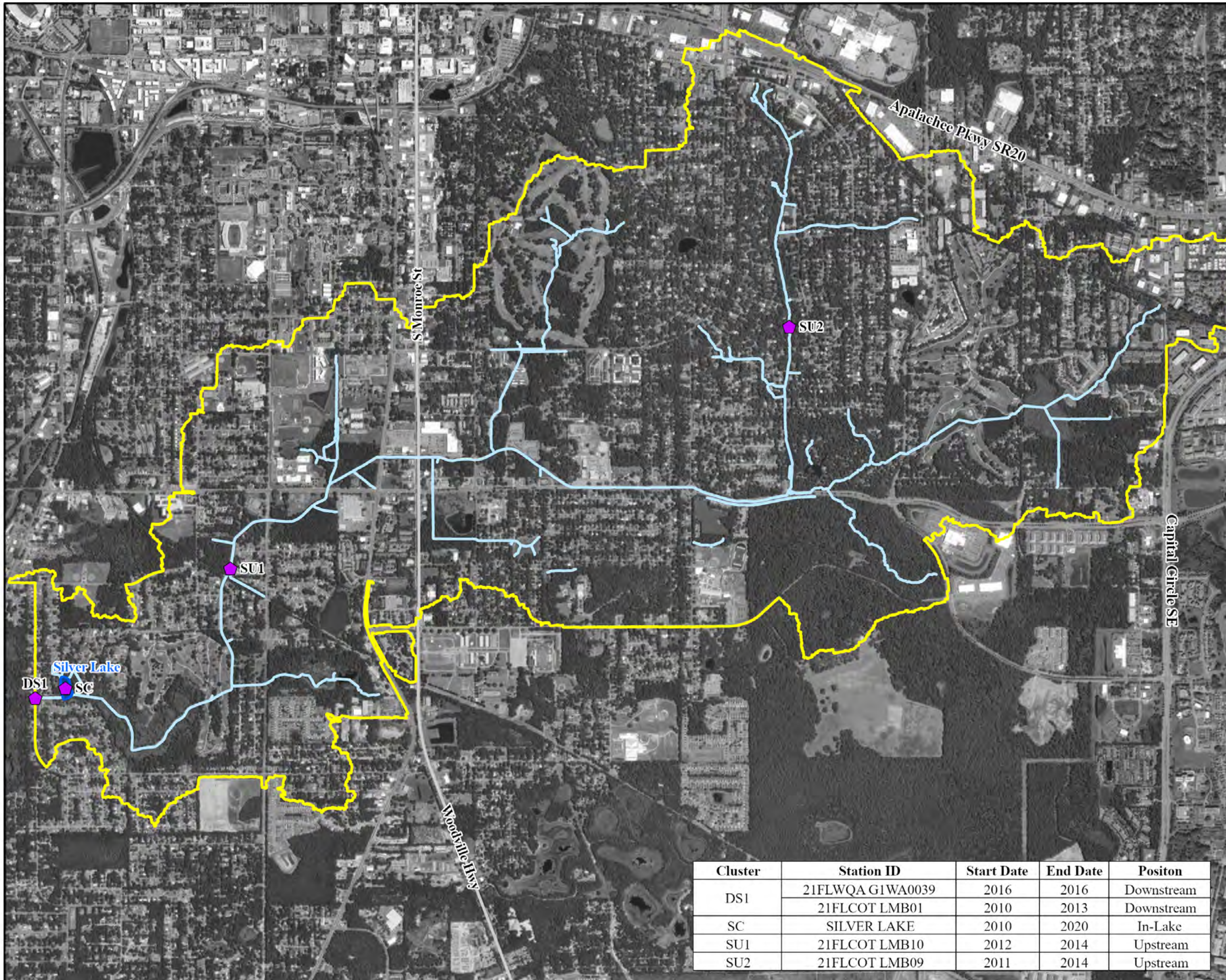
Figure 3-106 presents the data clustering used for the analyses and associated stations. Four locations were defined. Cluster SC represents the station in the lake. Cluster DS1 represents conditions immediately downstream of the lake. Clusters SU1 and SU2 represent the two locations along East Drainage Ditch where data were available. The table on **Figure 3-106** gives the period of record when data are available. Note that the stations have different periods of available data, therefore, intercomparisons discussed below should be weighed with that understanding.

Figure 3-107 and **Figure 3-108** present the TN and TP averages for each cluster. The TN averages within the East Drainage Ditch and the lake are all below the NNC stream threshold (DS1=0.55 mg/L, SC=0.58 mg/L, SU1=0.38 mg/L, SU2=0.47 mg/L). While not significantly different, the upstream TN levels appear to be somewhat lower than the downstream levels. The TP levels in the East Drainage Ditch and the lake, while below the stream condition NNC threshold, are in the higher range (DS1=0.14 mg/L, SC=0.10 mg/L, SU1=0.12 mg/L, SU2=0.17 mg/L). While the SC station shows lower values in relation to the other stations, this is mostly due to the period of record for that station having data in more recent years where the levels are lower. In general, the TP levels are relatively constant through the basin, with the most upstream station showing somewhat elevated levels.

Figure 3-109 presents the TSS levels. Generally, the stations all show low TSS levels, but as the data are collected during ambient flow conditions, they may not reflect sediment transport through the system during storm events.

3.6.4.2 Stormwater Runoff

The TN levels throughout are on average well below the stream threshold, with average levels less than one-half the threshold value for the stream criteria (**Figure 3-107**). TP levels on average are also below the stream threshold but they are closer to the threshold values (**Figure 3-108**).



Cluster	Station ID	Start Date	End Date	Positon
DS1	21FLWQA G1WA0039	2016	2016	Downstream
	21FLCOT LMB01	2010	2013	Downstream
SC	SILVER LAKE	2010	2020	In-Lake
SU1	21FLCOT LMB10	2012	2014	Upstream
SU2	21FLCOT LMB09	2011	2014	Upstream

CITY OF TALLAHASSEE

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0 0.4
Miles

Legend

- Silver Lake Drainage Basin
- Waterbodies in Study
- Watercourses
- Station Clusters

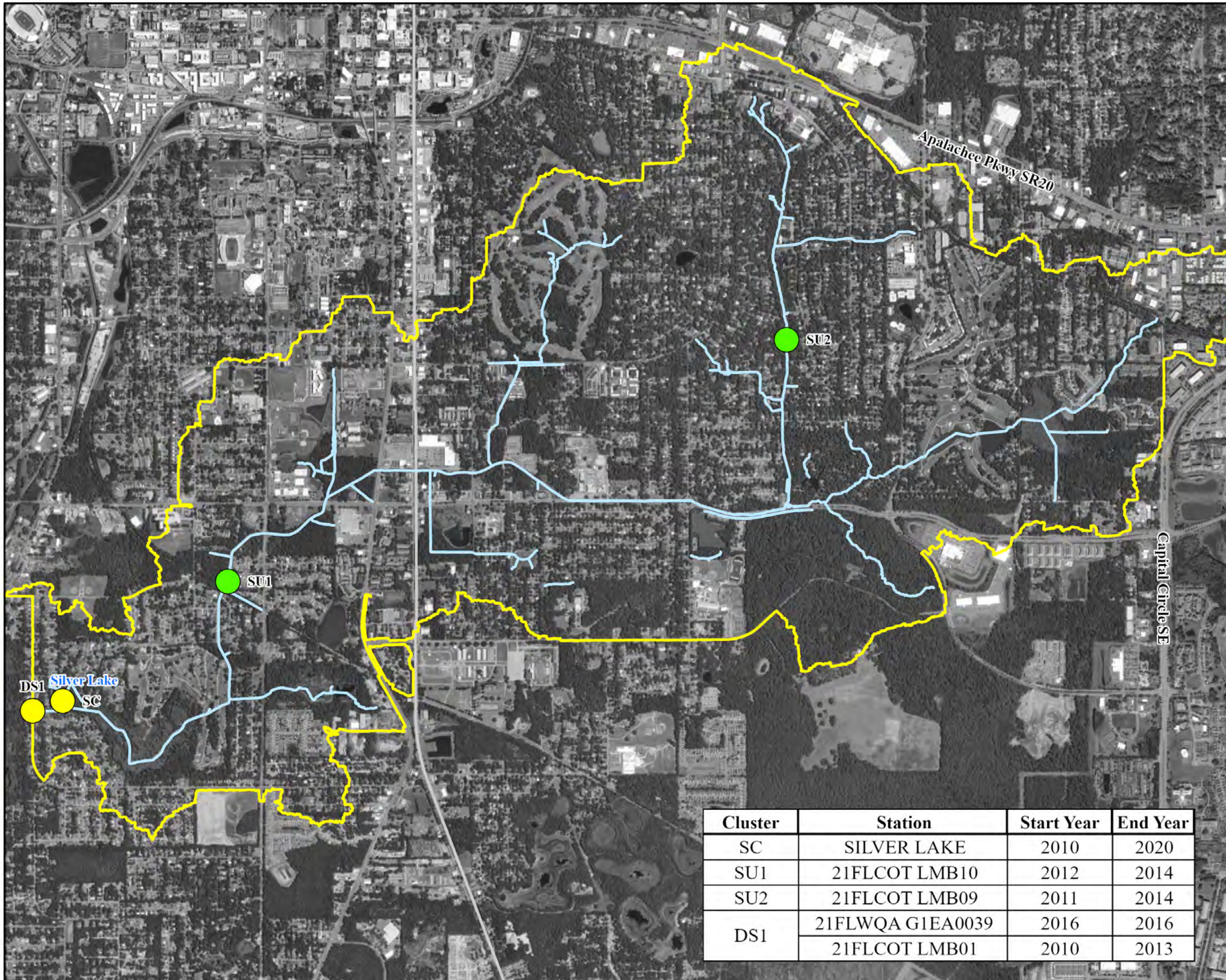
Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basin: COT, 2020
Roads: COT-Leon County, 2023

Figure 3-106:
Station Clustering for Silver Lake/East Drainage Ditch Basin

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

CITY OF TALLAHASSEE



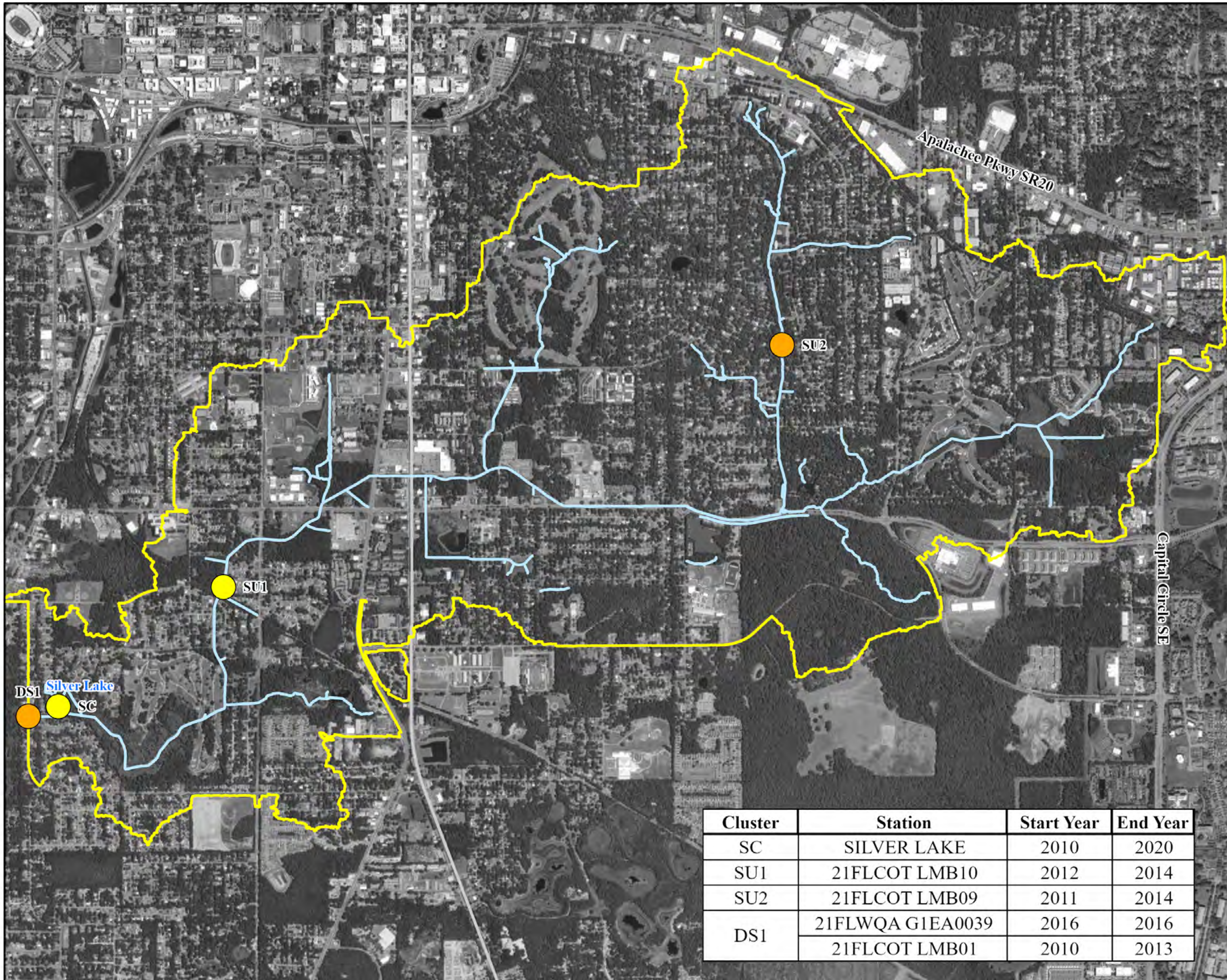
Cluster	Station	Start Year	End Year
SC	SILVER LAKE	2010	2020
SU1	21FLCOT LMB10	2012	2014
SU2	21FLCOT LMB09	2011	2014
DS1	21FLWQA G1EA0039	2016	2016
	21FLCOT LMB01	2010	2013

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-107: Spatial Assessment of TN in Silver Lake/ East Drainage Ditch Basin

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Cluster	Station	Start Year	End Year
SC	SILVER LAKE	2010	2020
SU1	21FLCOT LMB10	2012	2014
SU2	21FLCOT LMB09	2011	2014
DS1	21FLWQA G1EA0039	2016	2016
	21FLCOT LMB01	2010	2013

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0 0.4 Miles

Legend

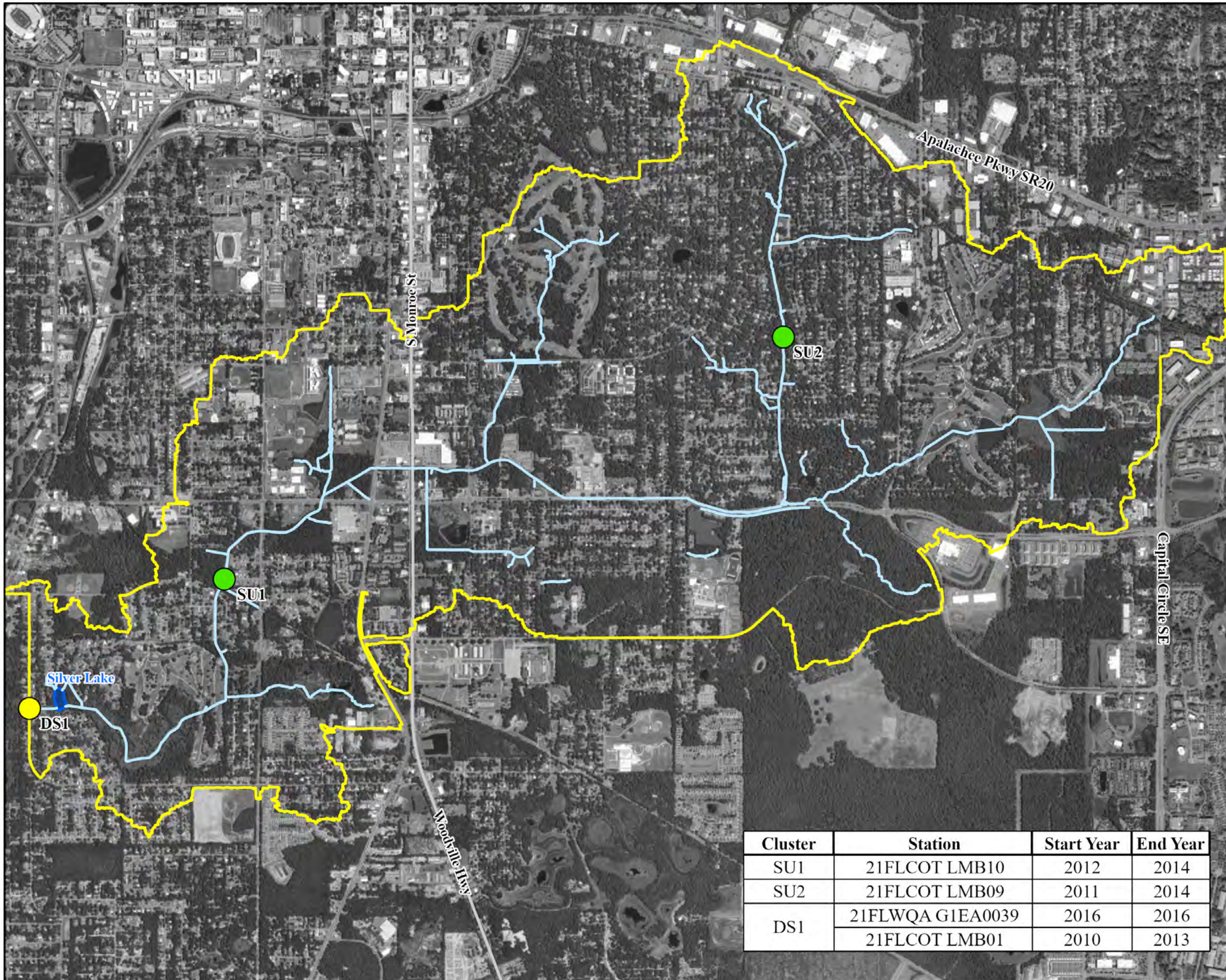
Silver Lake Drainage Basin
Waterbodies in Study
Watercourses
TP Average 2010-2020
mg/L
0 - 0.045
0.045 - 0.09
0.09 - 0.135
0.135 - 0.18
> 0.18

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-108:
Spatial Assessment of TP in Silver Lake/ East Drainage Ditch Basin

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Cluster	Station	Start Year	End Year
SU1	21FLCOT LMB10	2012	2014
SU2	21FLCOT LMB09	2011	2014
DS1	21FLWQA G1EA0039	2016	2016
	21FLCOT LMB01	2010	2013

CITY OF TALLAHASSEE

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0 0.3
Miles

Legend

- Silver Lake Drainage Basin
- Waterbodies in Study
- Watercourses

TSS Average 2010-2020
mg/L

- 0-2.5
- 2.5-5.0
- 5.0-7.5
- 7.5-10.0
- >10.0

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Drainage Basins: COT, 2020
Roads: COT-Leon County, 2023
Station Data: FDEP, 2021

Figure 3-109:
Spatial Assessment of TSS in Silver Lake/ East Drainage Ditch Basin

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants

In addition to the examination of the tributary data, to assess stormwater runoff as a potential source of pollutant loads to Silver Lake, the LDI levels within the subbasins draining to the lake were evaluated. In **Section 3.4.4.2**, LDI values were presented by subbasin in **Figure 3-34** for all of the Lake Munson basin. The figure shows that LDI levels within the Silver Lake basin are moderate. These LDI values, along with the water quality data in the East Drainage Ditch, indicate that stormwater runoff is a potential loading source to Silver Lake/East Ditch and downstream to Lake Munson.

3.6.4.3 Septic Systems

Figure 3-97 presented the locations of septic systems within the Silver Lake/East Drainage Ditch basin. **Figure 3-35** presented a map showing the septic tank densities by subbasin for the full Lake Munson basin. The septic density map shows low densities throughout the basin. As presented previously, approximately 120 septic systems are located within the Silver Lake/East Drainage Ditch basin. They are generally spread throughout the basin. Based on the limited number of septic systems, septic loads are not identified as a potential significant source. Given the readily available data, the septic load will be calculated in **Section 3.6.5** for comparison to other sources.

3.6.4.4 Internal Recycling and Seepage

Internal Recycling

To date, no studies or data collection efforts have been undertaken to assess the potential for nutrient loading/recycling from sediments in Silver Lake. Comparison of the TN and TP levels upstream, in-lake, and downstream (when samples are available during the same year) do not show significant increases moving through the lake. Additionally, given the high watershed to lake area ratio, internal loading from the lake area would not be expected to be a significant source in relation to stormwater runoff. Based on this, internal recycling from the lake is not identified as a significant load to the system. Loads are not quantified in **Section 3.5.5**.

Seepage

No studies have been performed to determine the potential for seepage as a load to Silver Lake or the East Drainage Ditch. Additionally, as outlined in **Section 3.6.3.7**, no surficial aquifer sampling stations are located in the Silver Lake/East Drainage Ditch basin to assess the quality of groundwater that may seep into the lake. Data to support calculation of the seepage load are not available, so loads are not quantified in **Section 3.5.5**.

3.6.4.5 Wastewater

No direct wastewater discharges are currently within the Silver Lake/East Drainage Ditch basin. Additionally, no areas in the Lake Munson basin presently have reuse discharges. **Figure 3-39** presented a map of the Lake Munson basin boundaries in relation to sewer service areas. Within the Silver Lake basin, the available data from the tributaries did not show elevated bacteria levels, indicating that there is not a persistent source associated with wastewater leakage in this area.

While SSOs occur from time to time, SSOs are acute events with impacts lasting for relatively short periods of time (hours to several days), depending on magnitude and environmental conditions. The mechanism for abatement would not be treatment projects but rather any needed maintenance to sewer infrastructure. The City presently tracks, reports, and addresses these issues as they arise.

3.6.4.6 Atmospheric Deposition

Section 3.6.3.10 identified the nearest atmospheric deposition station as the Quincy station (FL14). The data from this station will be utilized to calculate the atmospheric deposition to Silver Lake for TN in **Section 3.6.5** for comparison to other loads. However, given that the ratio of watershed area to lake area is around 1,800:1 and the potential attenuation of rainfall runoff, direct atmospheric deposition to the lake likely does not play a significant role in overall loading.

3.6.4.7 Interconnected Flows

There are no lakes located upstream of Silver Lake, therefore, inter-lake loading (interconnected flow) is zero.

3.6.4.8 Summary of Findings for Qualitative Assessment of Sources

Based on the discussions above, and data and information presented in **Section 3.6.3**, various sources were identified as potential loads to the Silver Lake/East Drainage Ditch basin. Load calculations are provided in **Section 3.5.5** where data are available. The following summarizes the findings for each of the potential pollutant sources.

- Stormwater Runoff – Stormwater runoff was identified as a potential source of nutrient load to the Silver Lake/East Drainage Ditch basin, and the load will be quantified in **Section 3.6.5.1**.
- Septic Systems – Based on the limited number of septic systems, septic loads were not identified as a potential significant source. Calculation of the loading is provided based on available data.
- Interconnected Flows – No lakes are located upstream of Silver Lake, therefore, interconnected flows are zero.
- Internal Recycling – Internal recycling is not identified as a significant potential load to Silver Lake and downstream and, based on lack of available data, the loads are not quantified.
- Seepage – Insufficient data is available to support calculation of direct seepage into the lake or the East Drainage Ditch.
- Wastewater – No permitted point sources are located within the Silver Lake/East Drainage Ditch basin. SSOs can contribute to loading but are short-term events that are typically addressed quickly. Based on the available data, SSOs were not identified as a potential significant source and their load is not calculated.
- Atmospheric Deposition – Based on the ratio of the direct watershed discharge to the area of the lake, atmospheric deposition is not identified as a significant load. Based on available data, the loads are calculated.

3.6.5 Calculation of Potential Nutrient Loads

This section presents calculations of potential nutrient (TN and TP) loads to Silver Lake and the East Drainage Ditch for the sources identified for calculation in **Section 3.6.4.8**. These include stormwater runoff, septic systems, and atmospheric deposition. Where loads were not calculated, the following sections provide brief discussions. The load calculations are for the purpose of comparing the potential magnitudes of each source relative to one another to support determination of sources to target for load reduction.

3.6.5.1 Stormwater Pollutant Load

To calculate the stormwater TN and TP loads to Silver Lake and the East Drainage Ditch, average annual pollutant load modeling was performed. The goal was to identify areas that are contributing higher TN and TP loads relative to one another and to quantify the total TN and TP loads from stormwater runoff to the ditch and lake. TN and TP loads were calculated using the SIMPLE-Seasonal model. The model methodology was described in detail in **Section 3.4.5.1** for the stormwater loads to Lake Munson.

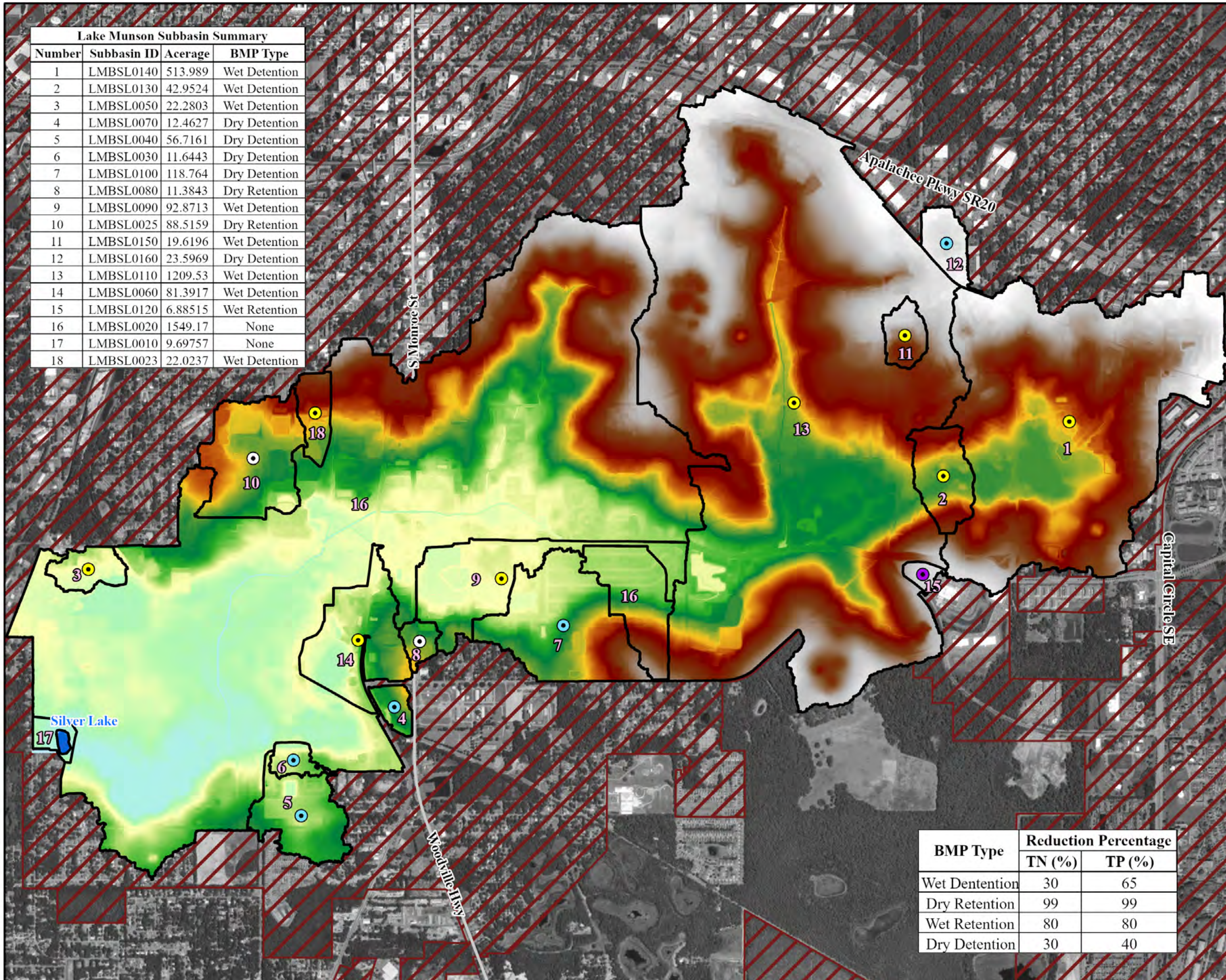
Figure 3-110 presents the subbasins and the DEM utilized in the SIMPLE model calculations for Silver Lake and the East Drainage Ditch. **Figure 3-111** presents the aggregated land use. Finally, **Figure 3-112** presents the CDAs for Silver Lake stormwater loading to define total and per acre TN and TP loads, as well as the ranking of CDAs around the Lake.

As a check on the modeled annual volumes from the SIMPLE model, the data from the flow station presented in **Section 3.6.3.5** were used to calculate measured annual volumes for years with sufficient data. The calculated annual volumes using the flow data ranged from 1,200 acre-ft up to 4,400 acre-ft. The annual volumes calculated at the station from the SIMPLE model were around 3,059 acre-ft. As such, the modeled annual volumes are reasonable, if on the high end.

<u>Stormwater Nutrient Loads to Silver Lake</u>

Figure 3-113 presents the distribution of the ranking of the CDAs for TN, along with the total load and per acre loads (see the table on **Figure 3-113**). The rankings are color coded with the highest ranked CDAs in green moving down to the lowest ranked in pale yellow. The calculated total stormwater TN loads from the CDAs ranged from as low as 22.8 lb/yr up to 13,365 lb/yr. The per acre loads ranged from 2.4 lb/acre/yr up to 3.5 lb/acre/yr. These per acre loads are high in relation to other areas within the Lake Munson basin. The total TN load is 13,554 lb.

Figure 3-114 presents the distribution of the ranking of the CDAs for TP along with the total load and per acre loads (see the table on **Figure 3-114**). The calculated total stormwater TP loads from the CDAs ranged from as low as 6.0 lb/yr up to 2,997 lb/yr. The per acre loads ranged from 0.6 lb/acre/yr up to 0.8 lb/acre/yr. These per acre TP loads are high in relation to other areas within the Lake Munson basin. The total TP load is 3,049 lb.



Lake Munson Subbasin Summary			
Number	Subbasin ID	Acerage	BMP Type
1	LMBSL0140	513.989	Wet Detention
2	LMBSL0130	42.9524	Wet Detention
3	LMBSL0050	22.2803	Wet Detention
4	LMBSL0070	12.4627	Dry Detention
5	LMBSL0040	56.7161	Dry Detention
6	LMBSL0030	11.6443	Dry Detention
7	LMBSL0100	118.764	Dry Detention
8	LMBSL0080	11.3843	Dry Retention
9	LMBSL0090	92.8713	Wet Detention
10	LMBSL0025	88.5159	Dry Retention
11	LMBSL0150	19.6196	Wet Detention
12	LMBSL0160	23.5969	Dry Detention
13	LMBSL0110	1209.53	Wet Detention
14	LMBSL0060	81.3917	Wet Detention
15	LMBSL0120	6.88515	Wet Retention
16	LMBSL0020	1549.17	None
17	LMBSL0010	9.69757	None
18	LMBSL0023	22.0237	Wet Detention

BMP Type	Reduction Percentage	
	TN (%)	TP (%)
Wet Dentention	30	65
Dry Retention	99	99
Wet Retention	80	80
Dry Detention	30	40

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Legend

- Subbasins
- Silver Lake
- Watercourses
- Tallahassee Corporate Limits

BMP Type

- Dry Detention
- Dry Retention
- Wet Detention
- Wet Retention

Topographic Elevations ft NAVD88

224

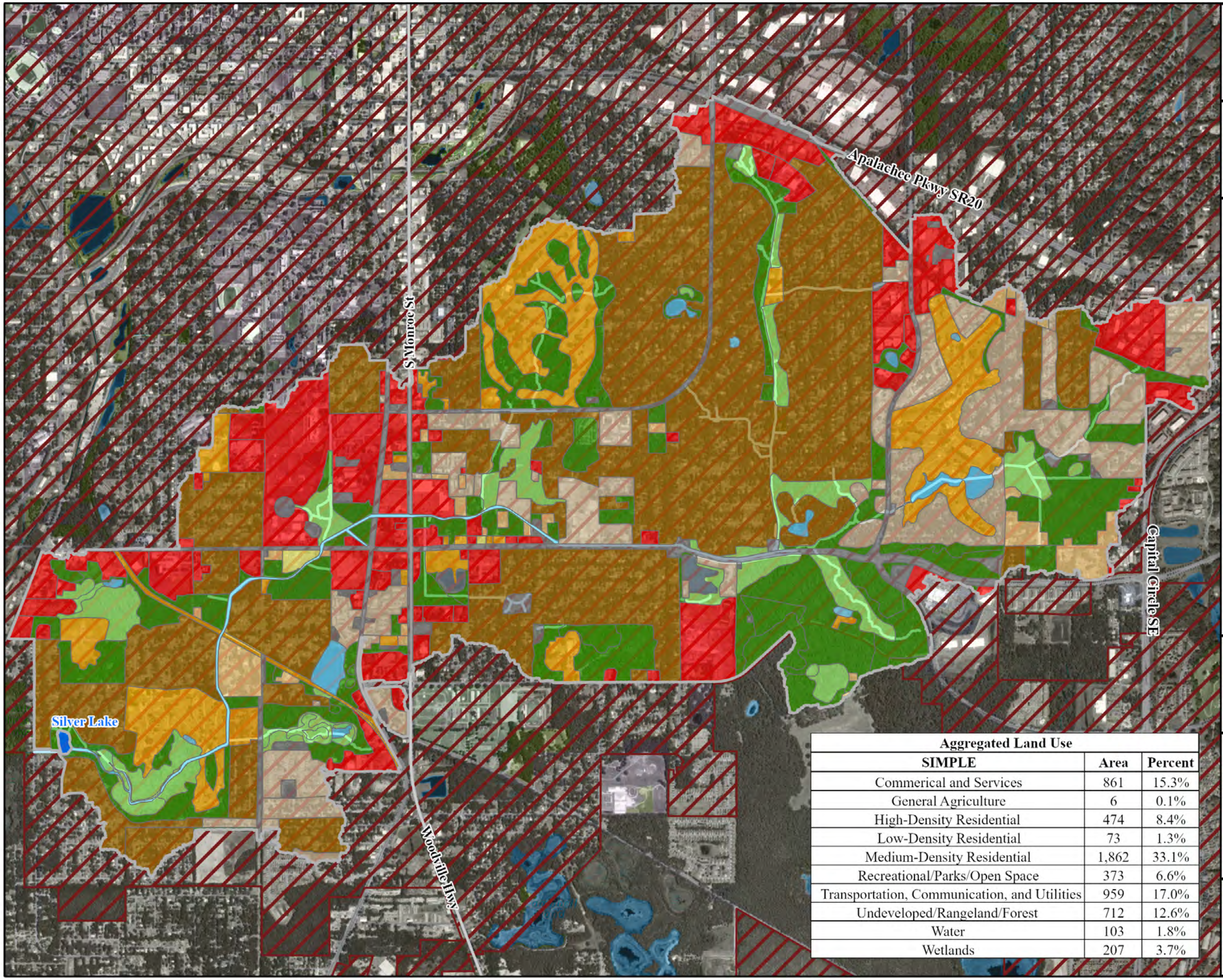
28

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Subbasins: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
BMPs: Geosyntec, 2023
Elevation: COT-Leon County, 2018

Figure 3-110: Silver Lake/East Drainage Ditch Subbasin Delineation and BMPs

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Aggregated Land Use		
SIMPLE	Area	Percent
Commerical and Services	861	15.3%
General Agriculture	6	0.1%
High-Density Residential	474	8.4%
Low-Density Residential	73	1.3%
Medium-Density Residential	1,862	33.1%
Recreational/Parks/Open Space	373	6.6%
Transportation, Communication, and Utilities	959	17.0%
Undeveloped/Rangeland/Forest	712	12.6%
Water	103	1.8%
Wetlands	207	3.7%

CITY OF TALLAHASSEE

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Miles

Legend

- Waterbodies in Study
- Watercourses
- Tallahassee Corporate Limits

Land Use Type

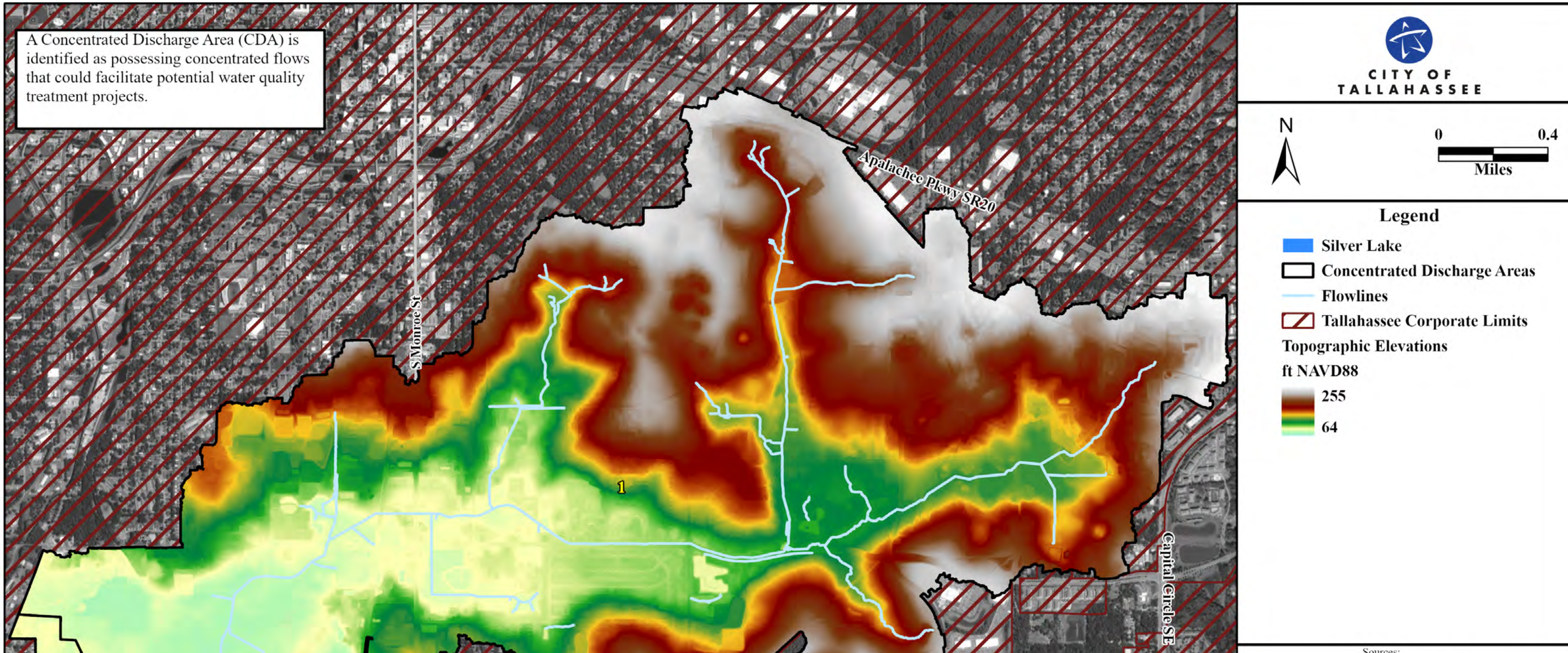
- Commerical and Services
- General Agriculture
- High-Density Residential
- Low-Density Residential
- Medium-Density Residential
- Recreational/Parks/Open Space
- Transportation, Communication, and Utilities
- Undeveloped/Rangeland/Forest
- Water
- Wetlands

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Land Use: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

**Figure 3-111:
Silver Lake/East Drainage Ditch
Aggregated Land Use**

Tallahassee Master Plan - Surface Water (TMaPS)

Geosyntec consultants



Summary of Concentrated Discharge Areas

Number	CDA ID	Acres
1	LMBSLOF02	3,830.3
2	LMBSLOF03	53.5
3	LMBSLOF01	9.7

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-112:
Silver Lake/East Drainage Ditch Concentrated Discharge Areas

Tallahassee Master Plan - Surface Water (TMaPS)

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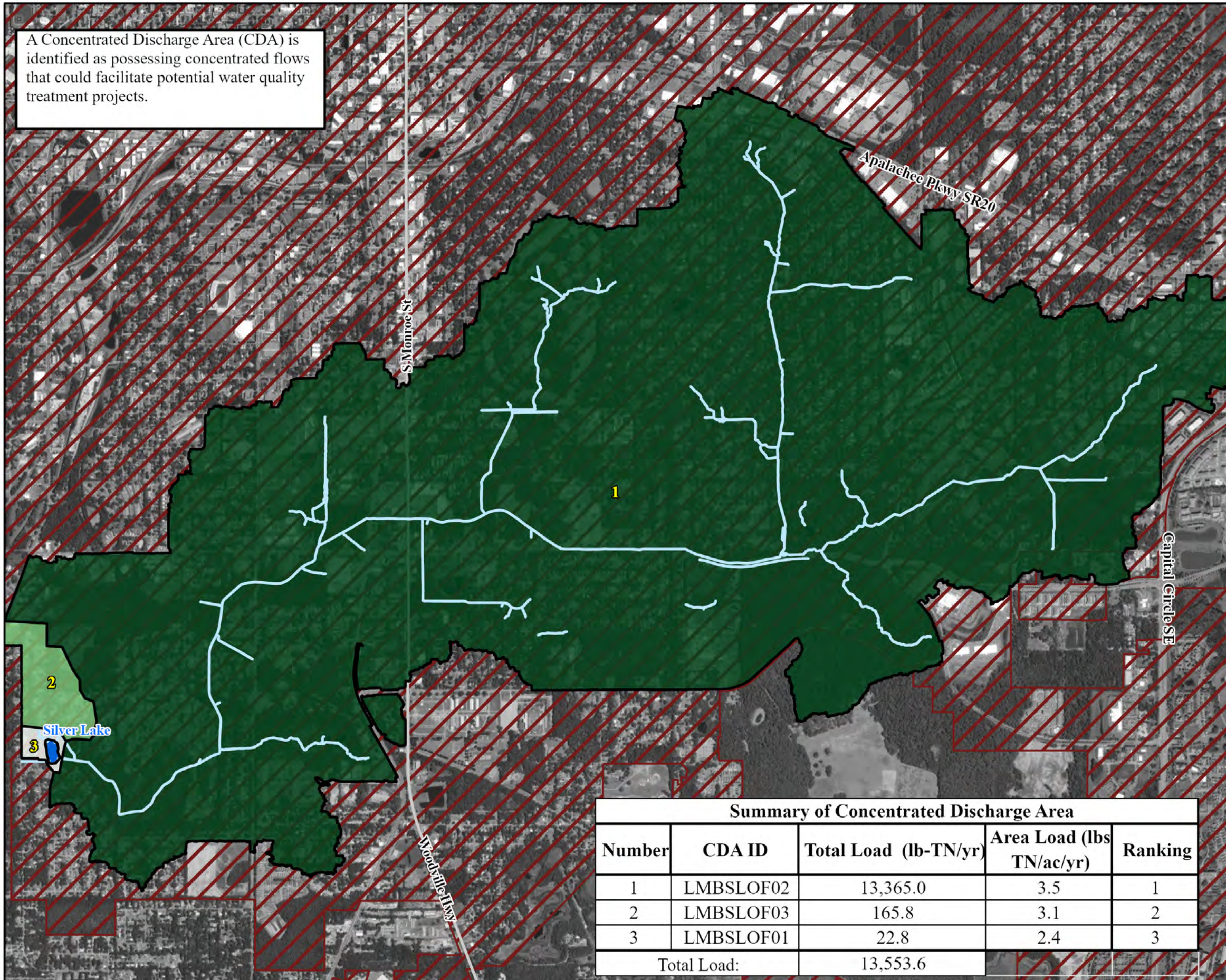

Summary of Concentrated Discharge Area

Number	CDA ID	Total Load (lb-TN/yr)	Area Load (lbs TN/ac/yr)	Ranking
1	LMBSLOF02	13,365.0	3.5	1
2	LMBSLOF03	165.8	3.1	2
3	LMBSLOF01	22.8	2.4	3
Total Load:		13,553.6		

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Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-113: Silver Lake/East Drainage Ditch Concentrated Discharge Areas - Total Nitrogen

Tallahassee Master Plan - Surface Water (TMaPS)

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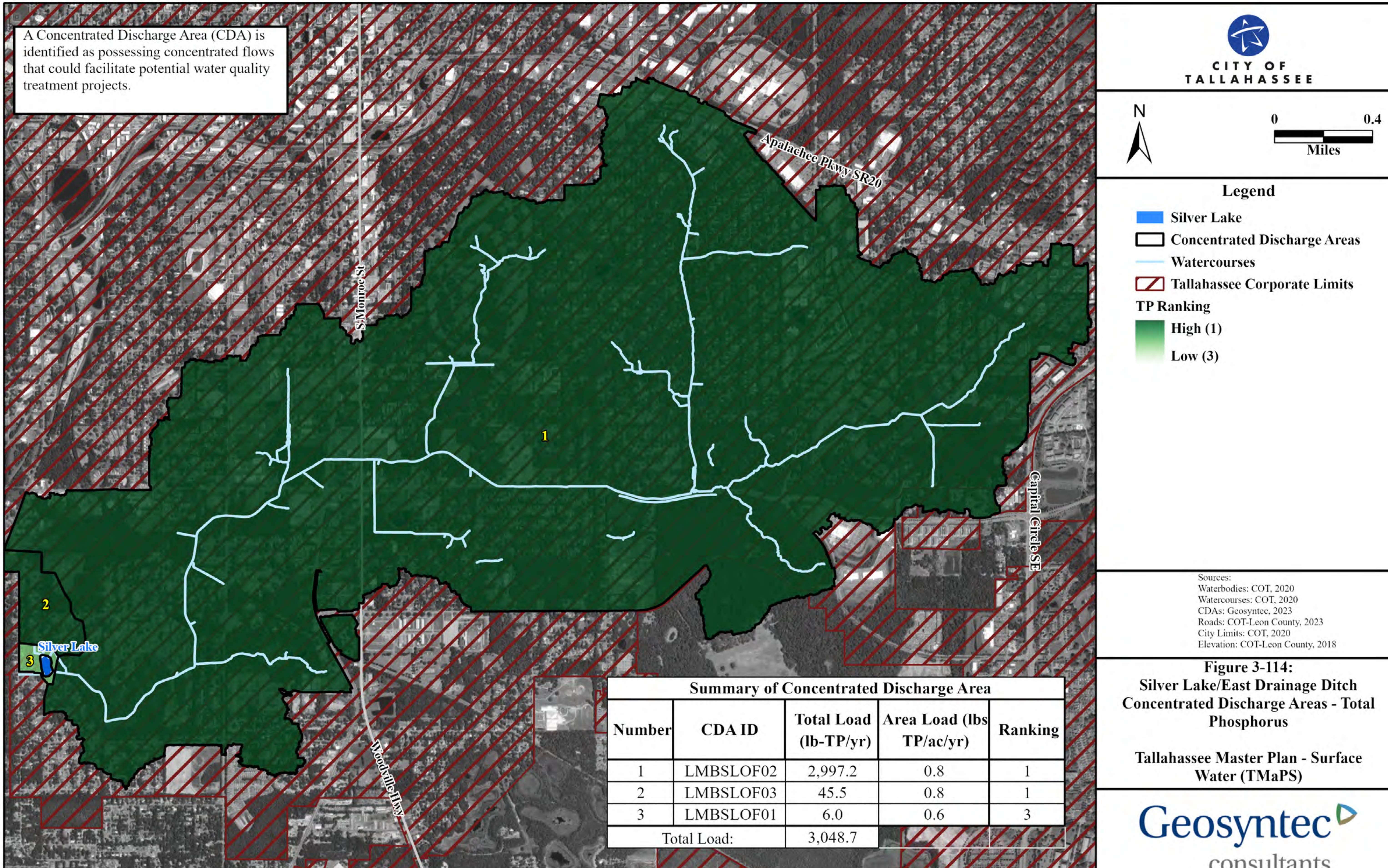
A Concentrated Discharge Area (CDA) is identified as possessing concentrated flows that could facilitate potential water quality treatment projects.



Summary of Concentrated Discharge Area				
Number	CDA ID	Total Load (lb-TP/yr)	Area Load (lbs TP/ac/yr)	Ranking
1	LMBSLOF02	2,997.2	0.8	1
2	LMBSLOF03	45.5	0.8	1
3	LMBSLOF01	6.0	0.6	3
Total Load:		3,048.7		

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
CDAs: Geosyntec, 2023
Roads: COT-Leon County, 2023
City Limits: COT, 2020
Elevation: COT-Leon County, 2018

Figure 3-114: Silver Lake/East Drainage Ditch Concentrated Discharge Areas - Total Phosphorus

Tallahassee Master Plan - Surface Water (TMaPS)

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3.6.5.2 Septic Load

To quantify the potential loads from septic tank units to Silver Lake, the SPIL method adopted by FDEP was utilized. The approach and calculations were described in **Section 3.4.5.2**, which presented the septic loading to Lake Munson. As outlined earlier, the calculations were only done for nitrogen (TN) and, based on literature on transport and assimilation, may represent a conservative potential load.

There were 2 septic tank units identified within 200 meters of Silver Lake and a total of 43 within 200 yards of the East Drainage Ditch. **Figure 3-115** shows the septic systems utilized in this analysis, with green representing systems associated with direct loading to Silver Lake and pink representing those associated with loading to the East Drainage Ditch. A table provided on the figure summarizes the calculated TN load from septic units. The loads are split between load to the East Drainage Ditch (476 lb/yr) and direct inputs to Silver Lake (22 lb/yr), for a total potential septic load of 497 lb/yr.

3.6.5.3 Wastewater Load

No active point sources were identified within the Lake Munson basin. Therefore, the point source loads for TN and TP are set to 0 lb/yr for the Silver Lake and East Drainage Ditch.

3.6.5.4 Lake Inflow Load

As discussed earlier, no lakes are located upstream of Silver Lake, therefore the lake inflow load is zero.

3.6.5.5 Internal Lake Load

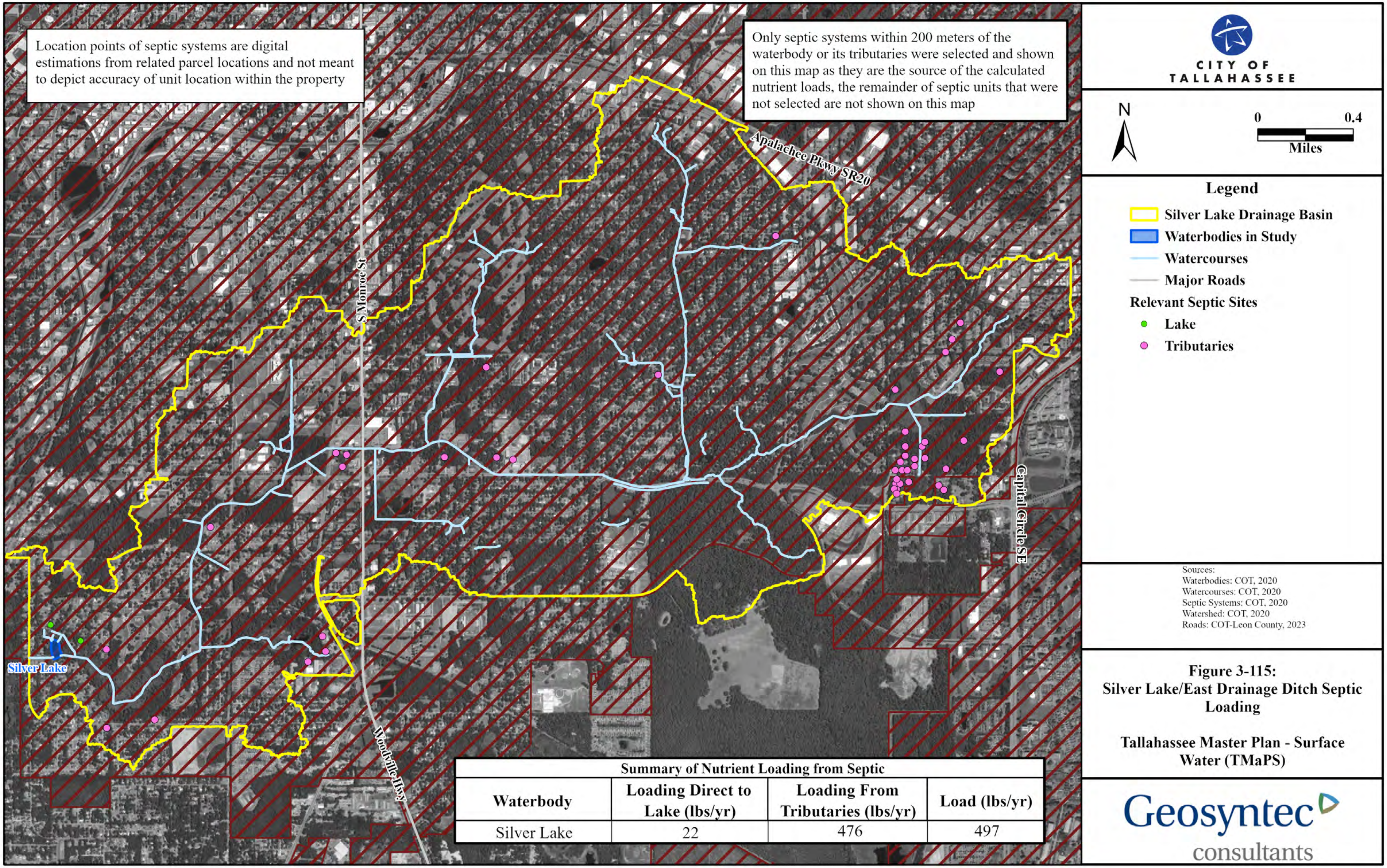
In the qualitative assessment of potential pollutant loads to Silver Lake (see **Section 3.5.4.4**), an assessment was made relative to the potential for anthropogenically driven internal loading. The assessment determined that internal recycling from the lake is not identified as a significant load to the system.

3.6.5.6 Atmospheric Deposition

As presented and discussed in **Section 3.4.5.6**, the annual average atmospheric TN load per acre was calculated from the Quincy NADP station (FL14) at 2.56 lb/acre/year. Multiplying this by the acreage of Silver Lake (2.1 acres) gives a total TN load of 5 lb/year. No data are available for TP, therefore, only the nitrogen load is provided.

3.6.5.4 Summary of Calculated Loads

Nutrient loads to Silver Lake were calculated for stormwater runoff, septic systems, and atmospheric deposition. **Table 3-18** presents the calculated total loads to the lake for TN and TP. For septic systems and atmospheric deposition, only TN loads were calculated. It is clear that for the calculated loads, stormwater runoff represents the primary source of nutrient loading to Silver Lake/East Drainage Ditch and downstream.



Summary of Nutrient Loading from Septic			
Waterbody	**Loading Direct to Lake (lbs/yr)**	**Loading From Tributaries (lbs/yr)**	**Load (lbs/yr)**
Silver Lake	22	476	497

CITY OF TALLAHASSEE

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Septic Systems: COT, 2020
Watershed: COT, 2020
Roads: COT-Leon County, 2023

Figure 3-115:
Silver Lake/East Drainage Ditch Septic Loading

Tallahassee Master Plan - Surface Water (TMaPS)

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Table 3-18: Summary of Calculated Loads to Silver Lake

Source	TN (lb/year)	TP (lb/year)
Stormwater Runoff	13,554	3,049
Septic Systems	497	NC
Atmospheric Deposition	5	NC

NC – Not calculated

3.7 Lake Munson Basin Hot Spot Analysis

Using the information presented and discussed in **Section 3.4** through **Section 3.6**, qualitative and quantitative rankings were performed to identify target areas (hot spots) within the Lake Munson basin for development of structural and non-structural projects to reduce loads and improve water quality.

The hot spot analysis was completed in three steps. The first step was to collate information presented for each of the waterbodies to support their ranking from highest to lowest based on need for water quality restoration. The second step was to utilize the load calculations presented for each of the waterbodies to rank the sources (by waterbody) from lowest to highest based on total load and other factors. The final step was to provide spatial ranking of CDAs (as defined in the TN and TP load calculations) by waterbody for use in the identification of structural and non-structural projects. The higher ranked CDAs within a highly ranked waterbody are hot spots and will be targeted for potential pollutant load reduction projects.

For the rankings, nutrients were the primary driver, with FIB data used to support some of the determinations. All rankings using actual loading data were based on nutrients. The following discusses the data utilized, the methodology, and the results of each step of the hot spot analysis, culminating in stormwater runoff and septic hot spot maps for the Lake Munson basin.

3.7.1 Waterbody Ranking

The waterbodies within the Lake Munson basin were ranked with respect to water quality or factors that could negatively affect water quality, using a qualitative approach. The ranking identified those waterbodies most in need of restoration. The waterbodies evaluated in this analysis include the following:

- Lake Munson,
- Munson Slough downstream of Lake Henrietta SWMF,
- Lake Bradford,
- Lake Hiawatha,
- Cascade Lake, and
- Silver Lake/East Drainage Ditch.

The information utilized in the development of the waterbody ranking included:

- Verified impairment status (nutrients and bacteria),
- Waterbody and tributary water quality data analyses,
- Biological data,
- Land development indices, and
- Septic densities.

Table 3-19 presents a summary of the information by waterbody for each of the categories listed above. The waterbodies were ranked for each of the four categories. Based on the summary information available, the rankings were qualitative for some categories and quantitative in others. The five rankings were then averaged. Using the average ranking, the waterbodies were ranked from highest to lowest based on need for water quality restoration.

For impairment status, the rankings were based on if the waterbodies were verified impaired for nutrients or FIB, their present status relative to TMDL development, and if the waterbody is meeting its TMDL. Waterbodies that were impaired for nutrients were given the higher ranking. Munson Slough and Lake Munson have completed nutrient TMDLs, and Munson Slough has a completed fecal coliform TMDL. As discussed in **Sections 3.4.2** and **3.4.3.7**, Munson Slough is presently meeting its nutrient TMDL and has been placed in Category 2t. Additionally, recent assessments of Munson Slough and Lake Munson relative to *E. coli* show those waterbodies as not impaired for *E. coli*. Lake Munson is presently meeting the NNC and TMDL Chl-a, and TN targets, with recent TP levels very close to the NNC and TMDL targets. As such, Lake Munson received the highest ranking relative to verified impairment, with Munson Slough just below it. The Bradford Chain of Lakes has never been and is not impaired for either nutrients or FIB and thus ranked the lowest. Silver Lake and the East Drainage Ditch have never been impaired for nutrients relative to the stream NNC but is presently impaired for fecal coliform, although recent data would indicate that once assessed against *E. coli*, the system would not be impaired for FIB. Based on this, Silver Lake and the East Drainage Ditch are ranked below Munson Slough and above the Bradford Chain of Lakes.

Analyses of water quality data presented earlier, which included evaluations of the data against the NNC and TMDL targets for the waterbodies, were utilized for the waterbody water quality ranking. The highest ranked waterbody was Lake Munson. This is based on the AGMs for TN, TP, and Chl-a exceeding the TMDL criteria for many of the years since 2010. While recent TN and Chl-a AGMs are below the threshold, TP AGMs, while near the TMDL threshold in 2020, are still above the target. Munson Slough and the Silver Lake/East Drainage Ditch data showed very similar levels of TP against the stream criteria. Munson Slough had higher TN AGMs overall, therefore, Munson Slough was identified as the second ranked waterbody and Silver Lake/East Drainage Ditch the third ranked. Finally, the Bradford Chain of Lakes all exhibit relatively pristine water quality. The rankings (Lake Bradford at fourth, Lake Hiawatha at fifth, and Cascade Lake at sixth) were determined based on which had the lower AGMs for nutrients.

For the biological assessment, the LVI waterbody rankings used the exceptional, healthy, and impaired determinations for the rankings and the numbers of each. For the waterbodies assessed as stream segments (Munson Slough below Lake Henrietta, Silver Lake/East Drainage Ditch), the evaluations were based on available HA and SCI data. Based on this assessment (outlined in **Table 3-19**), the top ranked waterbodies were Silver Lake/East Drainage Ditch and Munson Slough. These are then followed by Lake Munson, Lake Bradford, and then Lake Hiawatha and Cascade Lake (tied).

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Table 3-19: Waterbody Ranking

Waterbody	Impairment Status	Rank	Waterbody and Tributary Water Quality Analyses	Rank	Biological Data (LVI, HA or SCI)	Rank	LDI	Rank	Septic Density	Rank	Average Rank	Waterbody Rank
Lake Munson	Previously impaired for nutrients, TMDL Completed, TP levels close to the NNC and TMDL Targets.	1	AGMs for TN, TP, and Chl-a exceeded the TMDL criteria for many of the years since 2010. Recent TN and Chl-a AGMs are below the threshold, TP AGMs, while near the TMDL threshold in 2020 are still above the target.	1	LVI: 9 Healthy, 2 Exceptional	3	Mixture of Poor, Moderate, Good, and Excellent areas drain to Lake Munson.	2	Immediate areas around Lake Munson have densities between 0.16 to 0.31 units per acre.	2	1.80	**1**
Munson Slough (below Lake Henrietta)	Previously impaired for nutrients and FIB, TMDLs completed, Moved to 2t.	2	In 2010 and 2013 TN AGMs were above the NNC stream threshold. From 2010 to 2016 TN levels were below the NNC threshold but above the TMDL target. 2017 to 2020 TN AGMs below the TMDL target. From 2010 to 2020 TP AGMs were below the NNC threshold. Only 1 year (2012) had values above the TMDL target.	2	HA: Marginal to Poor, SCI: 45	1	Mixture of Poor, Moderate, Good, and Excellent areas drain to Lake Munson.	2	Immediate areas around Munson Slough have ranges from 0.12 to 0.31 units per acre but no system within 200 meters.	3	2.00	**2**
Lake Bradford	Never impaired for nutrients or bacteria.	4	TN and TP AGMs were below the NNC minimum thresholds for all years. Chl-a AGMs were below the NNC threshold for all years. Highest values for all of the three Bradford Chain of Lakes waterbodies.	4	4 Healthy, 7 Exceptional	4	Bulk of area draining to the Bradford Chain of Lakes is Excellent with some areas as Good.	3	Lake Bradford has relatively high density around the lake.	1	3.20	**4**
Lake Hiawatha	Never impaired for nutrients or bacteria.	4	TN and TP AGMs were below the NNC minimum thresholds for all years. Chl-a AGMs were below the NNC threshold for all years. AGMs were lower than Lake Bradford but higher than Cascade Lake.	5	All Exceptional	5	Bulk of area draining to the Bradford Chain of Lakes is Excellent with some areas as Good.	3	Very few systems in the immediate area of Lake Hiawatha.	4	4.20	**6**
Cascade Lake	Never impaired for nutrients or bacteria.	4	TN and TP AGMs were below the NNC minimum thresholds for all years. Chl-a AGMs were below the NNC threshold for all years. Lowest values for all of the three Bradford Chain of Lakes waterbodies.	6	All Exceptional	5	Bulk of area draining to the Bradford Chain of Lakes is Excellent with some areas as Good.	3	Some septic areas immediately north of Cascade Lake with densities between 0.16 to 0.31 units per acre.	2	4.00	**5**
Silver Lake/East Drainage Ditch	Never impaired for nutrients, impaired for fecal coliform, but likely not for *E. coli.*	3	TN AGMs well below the stream criteria from 2010 to the present. All TP AGM values below the stream criteria from 2010 to the present with some values between 2010 to 2015 near the criteria.	3	HA: Marginal to Poor	1	All of the drainage area to Silver Lake is rated as Moderate.	1	All areas draining to Silver Lake have densities between 0.03 and 0.06 units per acre.	5	2.60	**3**

Using the LDI scores presented earlier, the individual waterbodies were ranked based upon where they fell overall in the potential for anthropogenic loading based on the watershed that drains to it **(Figure 3-34).** Based on LDI, the highest ranked waterbody was Silver Lake followed by Lake Munson and Munson Slough (tied). The Bradford Chain of Lakes was the lowest ranked.

The final waterbody ranking criteria was septic density within the immediate drainage area. The top ranked waterbody was Lake Bradford, which has a significant number of septic systems immediately adjacent to the lake. Lake Munson and Cascade Lake were tied for second. Munson Slough was third. Lake Hiawatha and Silver Lake were ranked fourth and fifth, respectively.

Table 3-19 provides an average ranking for each of the waterbodies and then a final ranking based on the average ranking. The final rankings by waterbody, with respect to the need for restoration activities, are presented from most pressing (1) to least pressing (6) in the order shown below:

1. Lake Munson,
2. Munson Slough,
3. Silver Lake,
4. Lake Bradford,
5. Cascade Lake, and
6. Lake Hiawatha.

3.7.2 Pollutant Source Ranking

The pollutant source ranking utilizes load calculations presented in the **Calculation of Potential Nutrient Loads** sections for each waterbody. The specific loads quantified (where data allowed) include the following:

- Stormwater pollutant load,
- Septic load,
- Lake inflow load, and
- Atmospheric deposition.

Presently, data are not available to calculate the point source loads and the internal lake loads. The qualitative assessment of sources identified that point source loads are not significant in the basin. Silver Lake was identified as not having a significant potential for internal nutrient loads. Recent water quality data for Lake Munson indicates that internal nutrient loads have decreased but may still be a source. **Section 3.8** provides a recommendation for a study to define internal loads for Lake Munson.

Using the calculated total loads for nutrients, the load sources are ranked for each individual waterbody to support assessment of the loads to prioritize. The ranking (by waterbody) is based upon the total loads, with the highest rank (the top source to target) assigned to the largest load.

Where insufficient data are available, the load sources are not considered in the ranking. Additionally, where the loads are zero, i.e., no load, these source types are not included in the ranking. This is the case for point source loads in the Lake Munson basin as well as inter-lake loads for some of the waterbodies.

Table 3-20 presents the results of the source ranking by waterbody. As some of the load types only had TN data, TN was the main driver of the rankings. For Lake Munson, Munson Slough, and Silver Lake/East Drainage Ditch, stormwater loads are identified as the top ranked source. Based on the assessments presented earlier that evaluated concentrations in Munson Slough downstream of the Lake Henrietta SWMF, the present levels are such that while stormwater loads are the largest single load, they would likely not be targeted for reduction for Munson Slough downstream of the Lake Henrietta SWMF or Lake Munson. Those loads are highly dependent upon treatment within Lake Henrietta, so a study is recommended in **Section 3.8** to assess performance.

Due to limited data along the ditched portions upstream and downstream of Silver Lake after 2014, additional data collection is recommended in **Section 3.8** to fully quantify the loading coming from the Silver Lake/East Drainage Ditch basin and the load to Silver Lake.

Within the Bradford Chain of Lakes, stormwater loading from the Apalachicola National Forest is the primary source to Cascade Lake, but due to the flow through nature of the system, the highest loads to Lake Hiawatha and Lake Bradford are lake inflow loads from upstream lakes. Given the nature of the land uses within the Apalachicola National Forest, while these are the largest loads, they were not identified as reduction targets in the qualitative assessment (**Section 3.5.4**) due to the present water quality conditions in the system. Relative to septic loading (in relation to other loads) Lake Bradford and Cascade Lake exhibit potentially significant septic loads.

Finally, atmospheric loads were calculated to evaluate its potential relative to other sources. In general, atmospheric loads are small in relation to the stormwater loads and do not rank high for any of the waterbodies.

Based on the limited data and loading analyses that showed high per acre loads, the Silver Lake/East Drainage Ditch is a potential target for stormwater load reduction. Another target is septic loading to Lake Bradford. Other loading sources are at zero, are low compared to the stormwater or septic, are not addressable through projects (atmospheric deposition), or have insufficient data at this time (internal load to Lake Munson).

Again, however, this analysis is limited to the available data. No data is available to calculate the internal loads for any of the waterbodies. Internal loads to Lake Munson were identified as significant prior to 2016. Based on recent data, the internal loads appear to have decreased. Based on Lake Munson’s history relative to internal loads, while water quality data indicate the internal load has decreased, there is a need to quantify the present internal load to determine need for further action. A study is recommended in **Section 3.8**.

Table 3-20: Source Ranking

Waterbody	Lake Area	Stormwater Pollutant Load			Septic Load			Lake Inflow Load			Atmospheric Deposition		
		Total		Rank	Total		Rank	Total		Rank	Total		Rank
		TN (lb/yr)	TP (lb/yr)		TN (lb/yr)	TP (lb/yr)		TN (lb/yr)	TP (lb/yr)		TN (lb/yr)	TP (lb/yr)	
Lake Munson	255	60,135	5,840	1	1,049	NC	2	ND	ND		653	ND	3
Munson Slough (below Lake Henrietta)	NA	59,244	5,640	1	0	NC	NC	0	0	NC	NA	NA	NC
Lake Bradford	149	340	74	4	725	NC	2	12,646	302	1	381	ND	3
Lake Hiawatha	40	617	105	2	76	NC	4	13,095	240	1	102	ND	3
Cascade Lake	109	12,006	2,751	1	692	NC	2	0	0	NC	279	ND	3
Silver Lake/East Drainage Ditch	2.1	13,533	3,049	1	130	NC	2	0	0	NC	5	ND	3

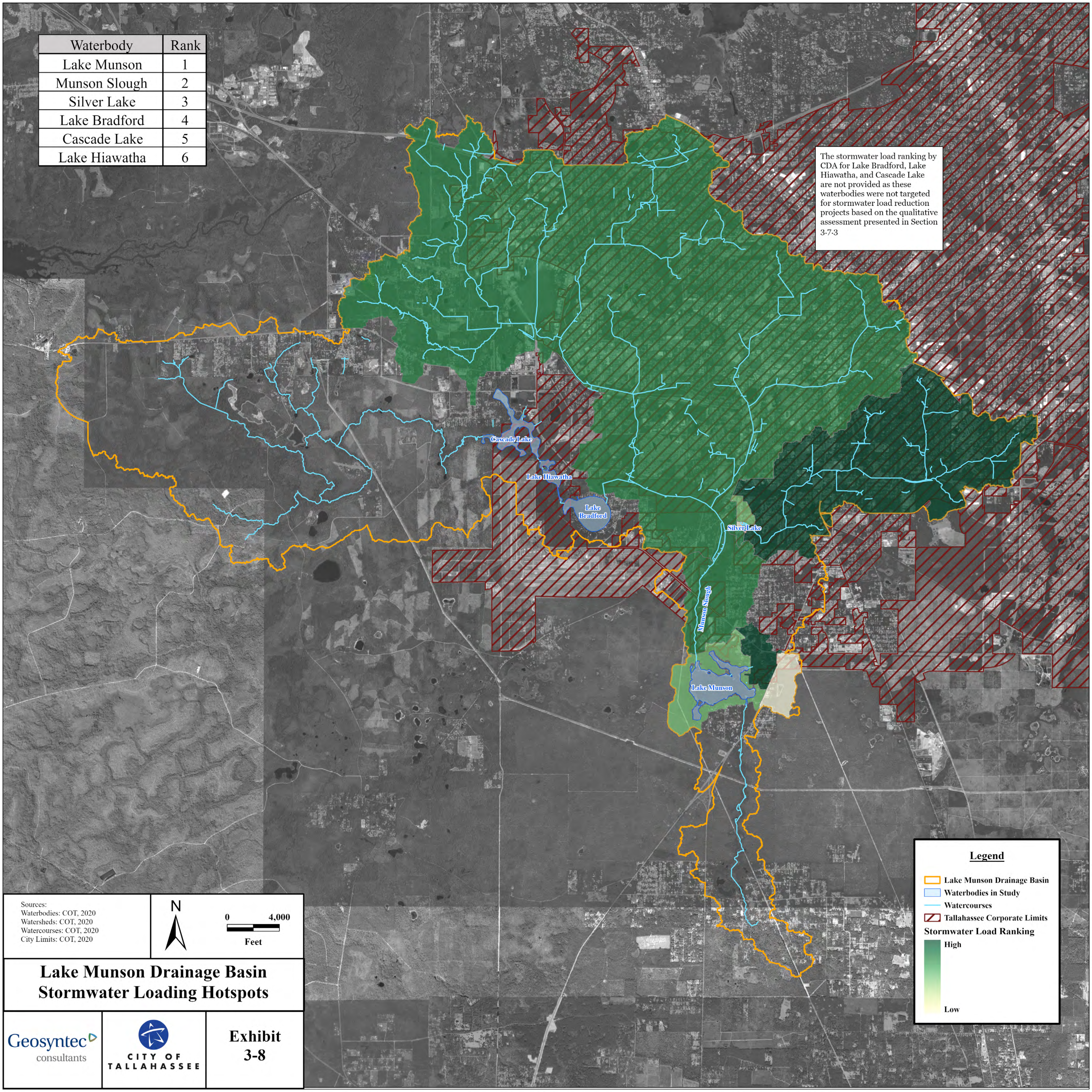
3.7.3 Identification of Hot Spot Areas

Section 3.7.1 ranked the waterbodies in the Lake Munson basin based on their relative need for water quality restoration. The next step in the evaluation of the waterbodies was to determine if each one should be considered for development of projects. This is a qualitative assessment that accounts for the present conditions and the potential for future degradation. For the Lake Munson basin, it was determined that Silver Lake and its associated drainage basin (East Drainage Ditch) should be targeted for projects relative to stormwater loads. Lake Bradford was targeted for potential projects to reduce septic loads.

The next step was to present the stormwater and septic load rankings for each of the chosen waterbodies presented on a basin-wide map. The stormwater load rankings were presented by waterbody drainage area in the **Calculation of Potential Nutrient Loads** sections. The highest to lowest ranked CDAs were highlighted from dark green to pale yellow, with the dark green representing the top ranked areas to target for load reduction activities.

For septic loads, the total loads (calculated and presented in earlier sections) were subdivided into the CDAs based upon the location of septic systems that were determined to load the waterbodies or tributaries draining to the waterbodies. The total septic load for each of the CDAs was calculated and then ranked (by waterbody drainage area) as largest to smallest based on total load, with the highest ranked having the largest total load. The septic load CDA rankings are presented separately as their loads will be different and the potential project types also different, i.e., septic-to-sewer conversions.

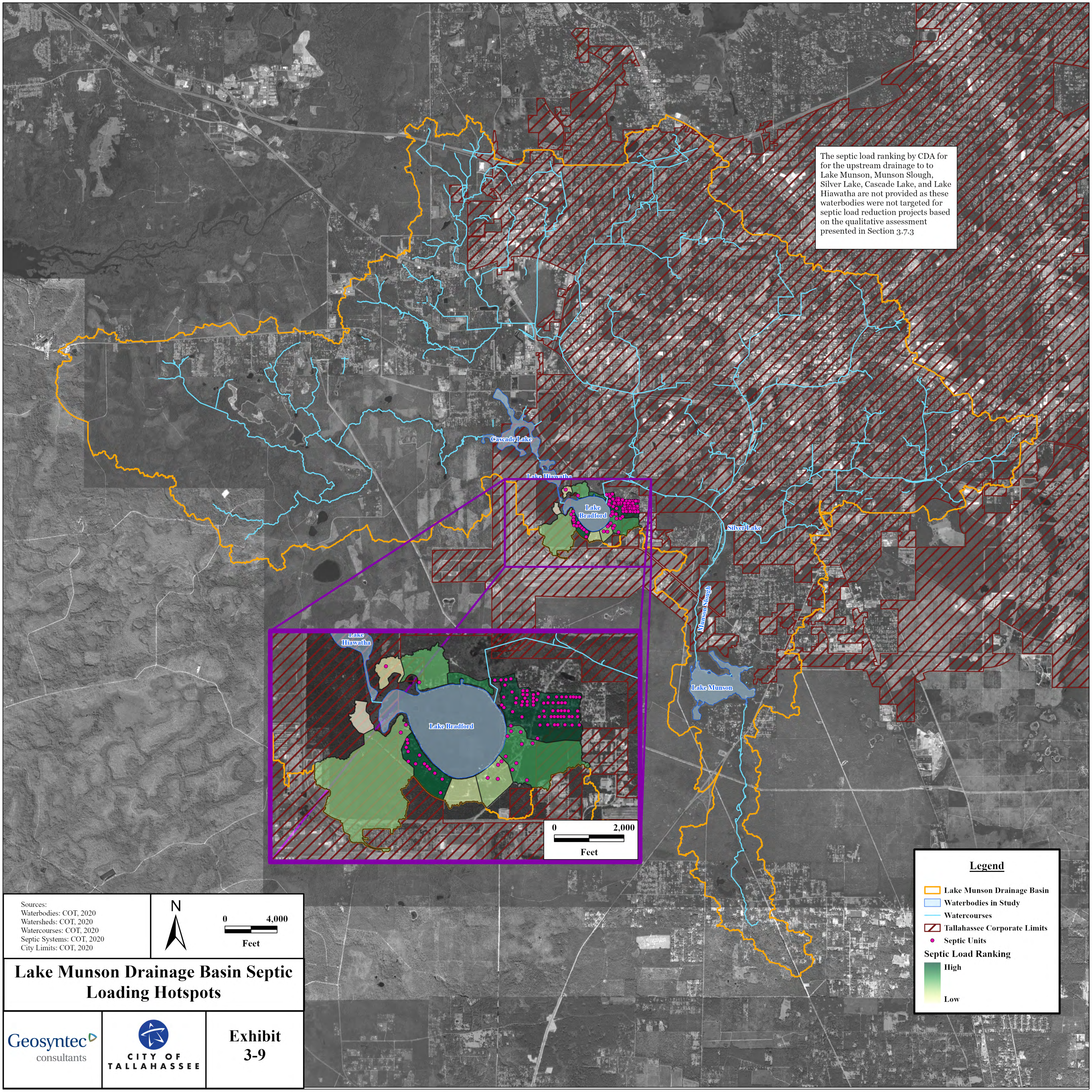
Exhibit 3-8 and **Exhibit 3-9** present the CDA rankings for the stormwater and septic loads, respectively, for each of the chosen waterbodies, with the drainage areas for the waterbodies not identified for projects (Lake Munson and Munson Slough for stormwater and septic, Cascade Lake and Lake Hiawatha for stormwater and septic, Bradford Lake for stormwater, and Silver Lake/East Drainage Ditch for septic) greyed out. The rankings are by waterbody drainage area and are shown as green for the highest ranked areas and pale yellow for the lowest ranked areas. These two maps provide the basis for project targeting for the two primary sources identified, stormwater and septic loads.



Waterbody	Rank
Lake Munson	1
Munson Slough	2
Silver Lake	3
Lake Bradford	4
Cascade Lake	5
Lake Hiawatha	6

Lake Munson Drainage Basin Stormwater Loading Hotspots

Exhibit 3-8



Lake Munson Drainage Basin Septic Loading Hotspots

Exhibit 3-9

3.8 Water Quality Study Identification and Prioritization

As part of the data review and summary provided for each of the target waterbodies (**Section 3.4** through **Section 3.7**), limitations in available hydrologic, water quality (groundwater and surface water), and benthic sediment data were identified. Additionally, as part of the qualitative assessment of sources for each waterbody, specific key stressors, i.e., significant potential sources of anthropogenic load or factors contributing to degraded water quality, were identified. Finally, **Section 3.7** presented a hot spot analysis for the Lake Munson basin that ranked the waterbodies relative to their need for restoration and identified specific waterbodies to target for restoration projects, additional data collection, or studies.

Utilizing the information outlined above, potential water quality improvement studies needed to address data gaps and quantify key stressors were proposed and ranked. The results of the previous tasks are summarized in **Section 3.8.1**, along with an overview of key stressors for the priority waterbodies (Lake Munson, Silver Lake/East Drainage Ditch and Lake Bradford). Studies are identified that fill in data gaps, support quantification of specific waterbody stressor(s) or support waterbody restoration (**Section 3.8.2**). The proposed studies include new water quality data collection, internal nutrient loading assessment, evaluation of potential septic loading, and a performance assessment for the Lake Henrietta SWMF.

3.8.1 Summary of Data Limitations, Waterbody Prioritization, and Key Stressors

Table 3-21 provides a summary of the data limitations presented at the end of the data review and summary sections for each of the waterbodies in this study (**Section 3.4** through **Section 3.6**). The data limitations identified include old water quality data, no groundwater quality data in the area of the study waterbodies to allow assessment of potential seepage, and no data to quantify internal nutrient loading.

Section 3.7.3 presented the prioritized waterbodies for restoration within the Lake Munson basin. These included Silver Lake for stormwater loads and Lake Bradford for septic loading. These waterbodies are targeted for development of projects to support water quality improvement. Identified projects are discussed in **Volume 7 – Non-Structural and Structural Project Development**.

The prioritized waterbodies are also targeted for studies to fill data gaps to further refine restoration strategies. As such, the proposed studies focus on these waterbodies.

A key task under the scope of work for the basin studies identification was to review and assess stressors for the priority waterbodies. The stressors were reviewed to confirm potential water quality impact and pathways of pollutant migration to the waterbodies. The intent is to identify where additional data collection and analysis of advanced analytic parameters might help better understand the expected load/contribution of the source. The following sections outline the key stressors identified in previous sections for the prioritized waterbodies within the Lake Munson basin (Lake Munson, Silver Lake/East Drainage Ditch and Lake Bradford).

Table 3-21: Summary of Identified Data Limitations for Waterbodies in the Lake Munson Basin

Lake Munson and Munson Slough	Silver Lake	Bradford Chain of Lakes
Limited data to evaluate the potential for seepage of pollutants to the lake from the surficial aquifer, i.e., surficial groundwater sampling stations around the lake and along the slough.	The water quality monitoring stations along the East Drainage Ditch were discontinued around 2014 which limits available recent data on the primary discharge to the lake.	The water quality data along Bradford Creek immediately upstream of Cascade Lake is old and limited (prior to 2006).
No direct measurements of internal nutrient flux within Lake Munson have been completed that reflect the internal loading conditions that exist today.	No surficial groundwater monitoring stations are located in the vicinity of the lake to determine the quality of potential seepage into the lake.	There are limited data to evaluate the potential for seepage of pollutants to the lakes from the surficial aquifer, i.e., surficial groundwater sampling stations around the lakes with recent data.
	No data are available to assess potential internal loading.	

3.8.1.1 Lake Munson Key Stressors

Water quality analyses and the qualitative assessment of sources identified internal nutrient loading as a potential key stressor to Lake Munson. The analyses of data within Munson Slough showed that stormwater inputs, while representing the largest quantified load, were at concentrations well below the stream NNC and the TMDL target for the slough and as such, stormwater loading was not identified as a key stressor. At present, no direct measurements of internal loading for the lake have been completed. Analyses of available data upstream, within, and downstream of the lake (**Section 3.4.4.4**) indicates that the internal load has decreased in more recent years and may be playing a lesser role. However, based on the lake's history relative to internal loading and the lack of data, internal loading may still be a stressor to the lake and should be quantified.

3.8.1.2 Silver Lake/East Drainage Ditch Key Stressors

Water quality analyses and the qualitative assessment of sources (**Section 3.6.3.6** and **Section 3.6.3.7**) identified stormwater loading as the key potential stressors. This was based on limited data to perform a full assessment since data collection within the East Drainage Ditch, upstream and downstream of the lake, were discontinued in 2014. Based on this, recommendations are made below on re-establishing monitoring within the East Drainage Ditch.

3.8.1.3 Lake Bradford Key Stressors

Lake Bradford is presently exhibiting relatively pristine water quality and biology. In the qualitative assessment of sources (**Section 3.5.4.8**), septic loading was identified as a potential stressor to the lake based on somewhat elevated bacteria levels nearshore in relation to the other lakes in the chain and the center station in Lake Bradford. The present density of septic systems around the lake and recommendations in the Lake Bradford Sector Plan (**Section 3.5.1**) to extend sewer to the area also indicate the need for a study of the potential impacts of septic loading on Lake Bradford.

While nutrients and FIB are the primary focus of this study, lead impairments exist in the Bradford Chain of Lakes and, therefore, a study is recommended to try to determine the potential source of the impairment.

3.8.2 Study/Data Collection Recommendations

Based on the data limitations and waterbody stressors outlined in **Section 3.8.1**, additional data collection and waterbody study recommendations were developed in conjunction with City staff. The list of recommended studies includes the following:

- East Ditch/Silver Lake – Re-establish Ambient Water Quality Monitoring,
- Lake Munson – Internal Nutrient Load Study,
- Lake Munson/Munson Slough – Lake Henrietta Treatment Facility Inflow/Outflow Study,
- Lake Bradford – Septic Study, and
- Bradford Chain of Lakes – Lead Source Assessment.

The following outlines the justification, what stressors or data limitations are being addressed, and a general description of the work to be performed, along with initial scope items for each of the data collection/studies listed previously. It is noted that some of these studies are outside of the City's incorporated areas and, therefore, the studies would need to occur under the jurisdiction of the state or county.

3.8.2.1 East Ditch: Re-Establish Ambient Water Quality Monitoring

Section 3.8.1 identified that historical ambient water quality sampling on the East Ditch was discontinued in 2014. **Figure 3-116** presents a map showing the location of the historical ambient stations. These stations were sampled from 2011 to 2014. **Section 3.8.1.2** identified nutrient loading (specifically phosphorus) to Silver Lake as one of the potential stressors. Based on this, ambient water quality monitoring of the East Ditch should be re-established with specific focus on nutrients along with *E. coli* data to support evaluation of the bacteria impairment on the ditch.

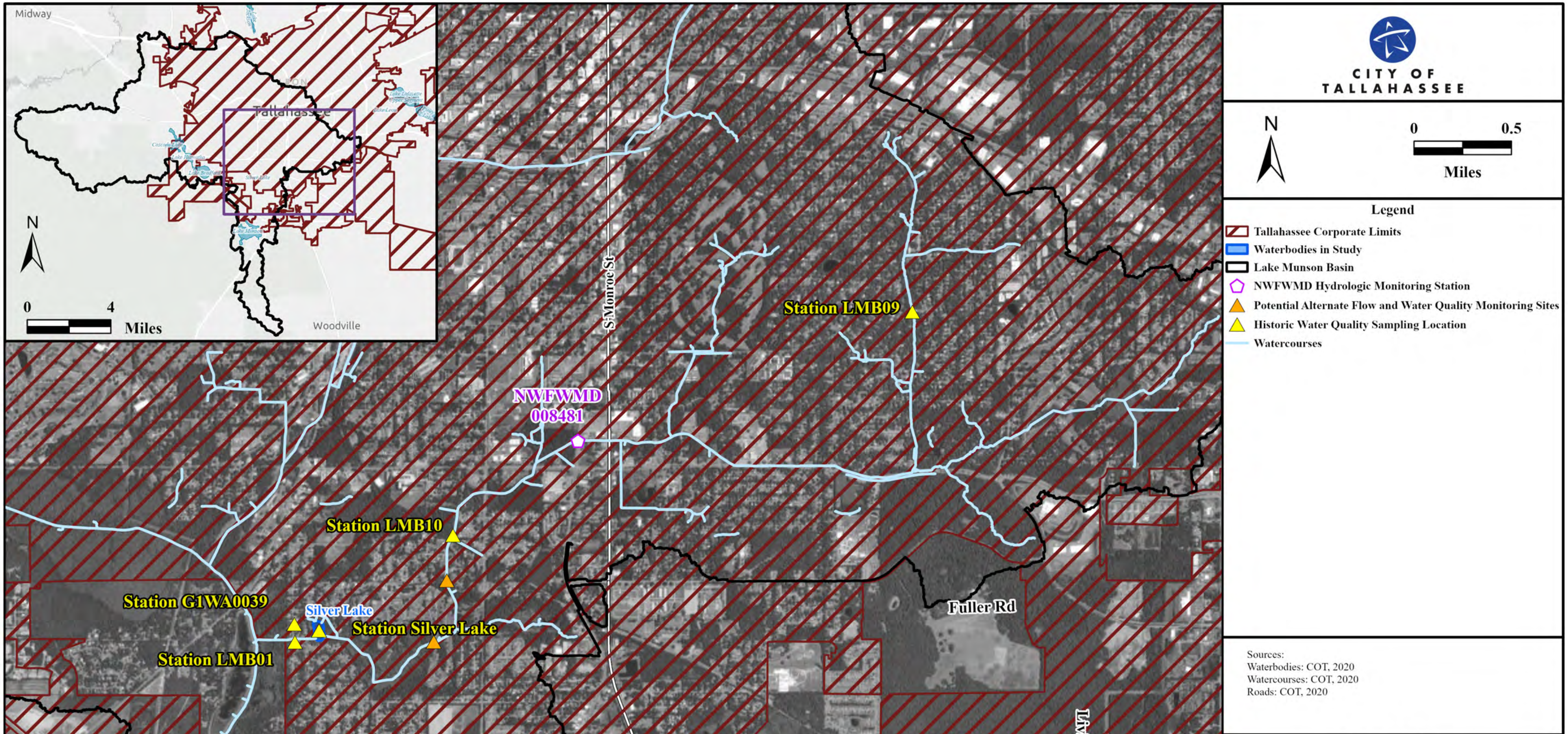


Figure 3-116:
Silver Lake/East Ditch - Reestablish Ambient Water Quality Monitoring

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Presently, NWFWMD maintains a hydrologic monitoring station (008481) along the East Ditch at the crossing with Adams Street (**Figure 3-116**). This station collects continuous water levels and calculates flow based on rating curves for the site. The ambient water quality sampling, in conjunction with the continuous flows, will allow quantification of the concentrations and loads going to Silver Lake/East Drainage Ditch and ultimately transported downstream to Lake Munson. The scope of the data collection should evaluate historical station locations versus establishment of new stations to define optimal locations, recognizing the benefit of comparison to historic data. **Figure 3-116** presents some alternative sampling locations that would quantify a larger percentage of the watershed flowing into Silver Lake than historical locations. Additionally, as the Silver Lake/East Drainage Ditch basin flows to Lake Munson, monitoring of downstream should be re-established. An additional recommendation for this study is to evaluate the accuracy of the continuous flow measurements and, if needed, make recommendations on improving the accuracy of the measurements or potentially relocating the station.

The recommended elements for the data collection effort described above are as follows.

- Site reconnaissance to understand the site logistics, including historical and potential future monitoring locations, as well as develop consensus with City staff on station locations and monitoring approach.
- Assessment of the accuracy of the continuous flow measurements at NWFWMD Station 008481 and development of recommendations for updates to the monitoring approach, including recommendations on station relocation.
- Re-establish ambient monitoring.

3.8.2.2 Lake Munson: Internal Load Measurements

In **Section 3.8.1**, an internal nutrient load study was recommended for Lake Munson based on historical conditions and lack of data to quantify present conditions. Based on this, a study is recommended to characterize the sediments in the lake and to determine if nutrient flux from those sediments is a significant load to the lake.

The recommended elements for the study outlined above are as follows.

- Site reconnaissance to understand the site logistics, lake access, and potential sites and number for sediment and core sampling.
- Development of a Quality Assurance Project Plan (QAPP) that details staff responsibilities, sampling procedure, sediment and core sampling locations, methodology, equipment, and laboratory analytical requirements for the data collection.
- Sediment sampling and collection of cores for performing nutrient flux measurements.
- Data reporting and analyses that present the raw data and any analyses outlined in the QAPP, along with an overview of the sampling methodology, issues encountered, and methods of resolution.

3.8.2.3 Lake Munson/Munson Slough: Lake Henrietta SWMF Inflow/Outflow Study

The primary stormwater treatment facility and the last point of treatment for waters draining to Lake Munson is the Lake Henrietta SWMF. This facility accepts drainage from nearly all of the Lake Munson basin. **Figure 3-117** shows the location of the Lake Henrietta SWMF, the facility components, and photos of the present conditions taken in 2021 of the northern and southern portions.

The Lake Henrietta facility resides outside the City limits and is currently operated by Leon County. However, based on identification of sedimentation and other potential issues within the system, an assessment of the present performance is warranted. Based on this, a study is proposed to do concurrent inflow and outflow monitoring during various flow conditions.

The recommended components of the monitoring outlined above are as follows.

- Site reconnaissance to understand the site logistics, including historical and potential future monitoring locations, as well as develop consensus with City staff on station locations and monitoring approach.
- Assessment of the accuracy of the continuous flow measurements at NWFWMD Station 008481 and development of recommendations for updates to the monitoring approach.
- Development of a QAPP that details staff responsibilities, sampling procedures, sampling locations, methodology, equipment, and laboratory analytical requirements for the data collection.
- Execution of the monitoring plan as outlined in the QAPP.
- Development of a final report summarizing the findings of the study.

3.8.2.4 Lake Bradford: Septic Study

In **Section 3.8.1.3**, which outlined the stressors for Lake Bradford and the qualitative assessment of sources (**Section 3.5.4.8**), the need for a quantitative analysis of the impact of septic loading to Lake Bradford was identified.

Figure 3-118 shows the distribution of septic coverage around the Bradford Chain of Lakes, showing Lake Bradford fully surrounded by lots with septic systems. Additionally, the station clusters discussed in **Section 3.5.4.8** are presented showing the nearshore clusters in the lake (BW, BE) with elevated *E. coli* averages in relation to other station clusters on the lakes.

The study approach would be to utilize targeted sampling around the lake in conjunction with advanced analytic parameters such as isotopic analysis, pharmaceuticals, and microbial source tracking. Additionally, monitoring of surficial groundwater in the immediate shoreline areas of the lake would provide information on the potential for seepage from septic systems.

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Miles

Legend

- Waterbodies in Study
- Tallahassee Corporate Limits
- Lake Munson Basin
- Lake Henrietta Treatment Facility
- Watercourses

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Roads: COT, 2020

Figure 3-117: Lake Henrietta Treatment Facility Inflow/ Outflow Study

Tallahassee Master Plan - Surface Water (TMaPS)

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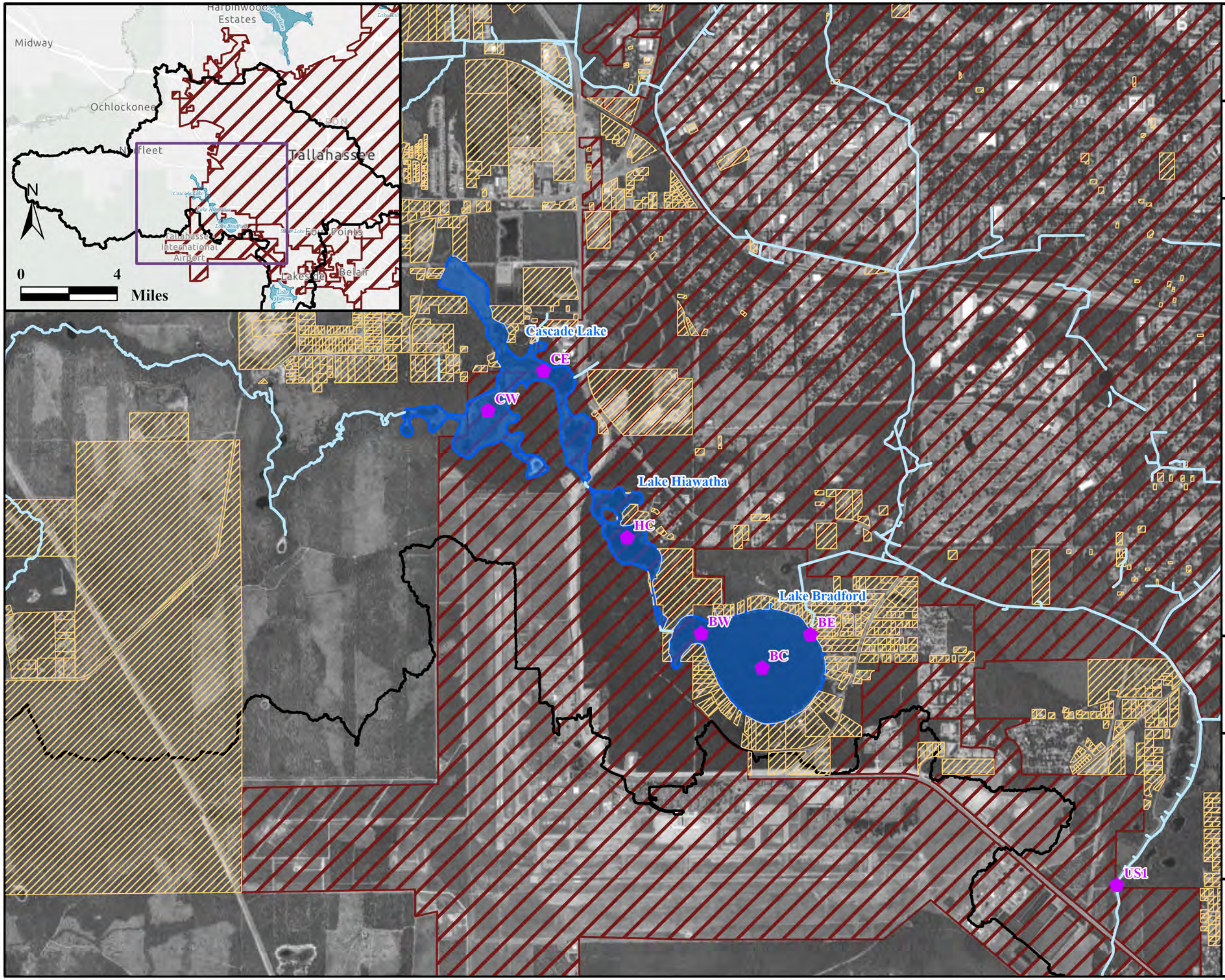

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Legend

- Waterbodies in Study
- Tallahassee Corporate Limits
- Lake Munson Basin
- Septic Coverage
- In-Lake Station Clusters
- Watercourses

Sources:
Waterbodies: COT, 2020
Watercourses: COT, 2020
Roads: COT, 2020

Figure 3-118:
Lake Bradford - Septic Study

Tallahassee Master Plan - Surface Water (TMaPS)

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The recommended elements for the study described above are as follows.

- Detailed review of historical data within Lake Bradford.
- Reconnaissance to understand the site logistics, including historical and potential future monitoring locations, as well as develop consensus with City staff on station locations, monitoring approach, and development of the QAPP.
- Development of a QAPP that details staff responsibilities, sampling procedure, methodology, equipment, and laboratory analytical requirements for this project.
- Field monitoring and sampling as outlined in the QAPP.
- Data analyses to evaluate results of the study and provide a determination on septic loading to the lake.
- Develop a final report summarizing the findings from the study.

3.8.2.5 Bradford Chain of Lakes – Lead Source Assessment

In **Section 3.5.2**, lead impairments and elevated levels were identified for the Bradford Chain of Lakes. Determination of the sources of lead is necessary to identify any potential remediation measures needed or to explain the present impairment status. A study is recommended to review the available data, perform literature review to identify potential sources or factors that presently exacerbate levels, and where appropriate, conduct additional sampling or site reconnaissance to support determination of potential sources.

The following study scope of work is proposed, with brief descriptions of the work that may be performed. A project kick-off meeting task and project management task would also be included.

- Field reconnaissance of the Bradford Chain of Lakes sub-watersheds to familiarize with conditions and potential sources as well as potential sampling locations.
- Literature review to support identification of potential sources or factors that exacerbate levels in the systems.
- Analysis of existing water quality data including data related to parameters that might exacerbate levels in the system.
- Identification of the need for additional sampling and development of a monitoring plan if sampling is needed.
- Development of a QAPP that details staff responsibilities, sampling procedure, methodology, equipment, and laboratory analytical requirements for the project.
- Execution of the monitoring plan.
- Development of a draft and final report summarizing the findings from the study.

3.8.3 Study Prioritization

To prioritize the proposed studies, a ranking table was developed that scored each of the projects in relation to the following:

- Waterbody priority ranking (**Table 3-19**),
- Source target ranking (the overall ranking of the source addressed by the study, **Table 3-20**),
- Restoration benefits (qualitative assessment of the benefits of the study),
- Extent of missing data, and
- Relative estimated cost.

Table 3-22 presents the study rankings for each of the individual metrics, the average score based on the individual rankings, and the final study ranking. The studies are divided between those that are within the City's incorporated area and those within unincorporated Leon County. These are shown on **Table 3-22**.

For the studies within the City's incorporated area, the top priority is the re-establishment of the ambient water quality monitoring on East Ditch, which is the only recommended study within the City's incorporated area.

For the studies within Leon County, the internal loading measurements in Lake Munson was identified as the top ranked study. The Lake Henrietta inflow/outflow study was second. The Lake Bradford septic study was ranked next. The lowest priority is the lead assessment study.

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Table 3-22: Proposed Study Ranking

Target Waterbody	Proposed Study	Study Location	Waterbody Priority Ranking	Source Ranking	Restoration Benefits	Extent of Missing Data	Relative Estimated Cost	Average Rank	Study Ranking
East Ditch/Silver Lake	Re-Establish Ambient Water Quality Monitoring on East Ditch	City Incorporated Area	3	1	2	3	1	2.00	**2**
Lake Munson	Internal Loading Measurements in Lake Munson	Leon County	1	1	1	1	5	1.80	**1**
Munson Slough (Below Lake Henrietta)	Lake Henrietta Treatment Facility Inflow/Outflow Study	Leon County	2	1	3	2	2	2.00	**2**
Lake Bradford	Septic Study	Leon County	4	2	1	2	4	2.60	**4**
Bradford Chain of Lakes	Lead Source Assessment	Leon County	5	4	1	2	3	3.00	**5**

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