Evaluation of Nutrient Sources and Potential Nutrient Reduction Projects for Santa Fe Lake

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DB Environmental

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Executive Summary

Despite the designation as an Outstanding Florida Water, degradation of water quality within Santa Fe Lake has been observed in recent years. To assist Alachua County with addressing this issue, the location and magnitude of nutrient inputs to the lake were determined by DB Environmental scientists, using a combination of field reconnaissance, modeling and calculations using the results of recent hydrologic modeling efforts (ECT 2021a, 2021b), digital elevation models and land use maps. This analysis was essential to identifying stormwater input locations along the Alachua County portion of the lake (Task 1) and the drainage basins that contribute to these stormwater outfalls (Task 2). Included are some nutrient reduction strategies to address those sources and protect the lake from further degradation.

Since 1985, water quality in the Santa Fe Lake system has been declining. Increased nutrient levels (total phosphorus (TP) and total nitrogen (TN)) coincided with poorer water clarity (measured as Secchi depth) which was likely from increased algae concentrations and/or color in the lake water, both reducing light penetration into the water column. Chlorophyll *a* concentrations have increased, suggesting that phytoplankton growth has been triggered by the increase in nutrients. In general, temporal water quality patterns in the Santa Fe Lake system have been dominated by the effects of natural perturbations including record droughts (1998-2002), high rainfall (2002 and 2003), several tropical cyclones (2004) and wildfires in Santa Fe Swamp (2007) which transported significant loads of nutrients and increased TN and TP concentrations in the Sata Fe Lake system. Despite these natural events, anthropogenic impacts from land use changes in the watershed cannot be dismissed.

Our evaluation of land use changes between the 1970s and 2019 determined that urban development increased throughout the watershed. In the Little Santa Fe watershed urban development increased by 327 acres (248% increase) during this period. The Santa Fe Lake drainage basin saw a large conversion of upland forest, agricultural and barren lands to urban development (398 acres, 52% increase) and transportation (71 acres). The Santa Fe Swamp drainage basin experienced the largest conversion of upland forest, and agricultural lands to urban development and transportation, which together increased by 645 acres, more than a 290% increase. Across all drainage basins, the acreage of lands used for urban development increased by 1,437 acres between the 1970s and 2019, while agricultural land uses decreased by 1,065 acres.

The increase in developed land and the remaining agricultural lands are certainly present-day sources of nutrients to the lake. Our evaluation of nutrient loading based on land use and rainfall runoff estimates suggests that the P load to all three major basins (Little Santa Fe Lake, Santa Fe Lake and Santa Fe Swamp) is primarily (65-71%) from urban development and/or agriculture. On the other hand, natural sources, such as wetlands and flatwoods make up 50-54% of the N load to the lakes and 84% of the N load to the Santa Fe Swamp. The N load from urban sources is greater than the load from agriculture in both lake watersheds. Identifying the location and magnitude of runoff from the developed areas was the next step in addressing controllable nutrient loads to the lake and is the main focus of this report.

There are 8 different developed areas identified within the Alachua County portion of Santa Fe Lake system that discharge stormwater into a lake or littoral wetlands of the lakes (Table 1). Generally, these are subdivisions and roadways that drain through a network of roadside ditches and culverts which ultimately discharge into the lake. A total of 37 stormwater drainage basins have been delineated and an estimate of nutrient loads was determined for some of them (Table 1). The Alachua County Stormwater Manual has adopted the event mean concentrations (EMC) used in the "BMP Trains" model to determine the pre- and post-development runoff, nutrient loads and reductions based on BMP selections. The "Nutrient Loading by Land Use" calculations estimated annual nutrient loads based on the annual runoff volume and land use from the MFL modeling and EMC were used calculate annual loads from some of these watersheds.

Residential and developed land uses are the primary source of controllable nutrients in several of these areas including the Trout Street Boat Ramp, Lake Bonnet Estates area, NE 221st St and NE 69th Ave, Earleton, FL and the Santa Fe Pass area (Figure 1). Together these nutrients sources contribute approximately 697 lbs of TN and 80 lbs of TP per year. To prioritize these drainage basins, additional analysis and modeling of nutrient runoff and the effectiveness of BMP options in each of the 37 drainage basins, as well as site specific design constraints, needs to be completed in the next phase of this project.

There are opportunities to implement BMPs in the rights-of-way of County-maintained roads in these drainage basins to reduce runoff and nutrient loads to the lake. These include using curb cuts in front of the inlets with vegetated roadside swales to infiltrate most rainfall events. Other options include removing curbs, inlets and collector pipes and replacing them with vegetated roadside swales. Increasing the size and infiltration capacity of existing ditches and installing ditch blocks.

Additional work is needed to determine if the 5 existing stormwater basins identified in the Santa Fe Lake watersheds are being maintained and if there are opportunities to improve the nutrient reduction capacity by adding permanent pools and/or Biosorption Activated Media. Additional treatment options exist if land adjacent to the flow path are available for constructing stormwater ponds, treatment wetlands, infiltration basins and other stormwater BMPs. Most of the waterfront residential lots on the lake discharge runoff from roofs, driveways, and lawns directly to the lake, all of which are controllable sources of nutrients to the lake. The County could use social marketing or other methods to educate property owners about nutrient reduction strategies they can implement, such as eliminating fertilizer use, septic tank upgrades and reducing runoff with rain gardens and other BMPs. Even though all these nutrient loads are relatively small in comparison to the total loads to the lake, **these are controllable nutrient sources from residential and developed areas, and County-maintained roads which deserve further investigations to determine if nutrient reduction projects are feasible and prioritize those that are.**

Table 1. Summary of stormwater nutrient inputs to Santa Fe Lake from Alachua County.

Stormwater Areas	Primary Nutrient Sources	Drainage Area (acres)	Estimated Loads (lbs/year)		Method	Recommendations
			TN	TP		
Trout Street Boat Ramp	Residential	19	105	17	BMP Trains	Vegetated swales
SR 26 and NE 221st St	Agricultural	127	728	132	BMP Trains	Tailwater pond
SR 26 and NE 221st St	Agricultural	102	362	71	EMC Runoff	
Earleton, FL	Residential	31	95	15	BMP Trains	Pond, vegetated swales
Lake Bonnet Estates	Residential	62	218	19	EMC Runoff	Upgrade Ponds
NE 69th Ave	Residential	81	148	18	EMC Runoff	BMP Trains model
NE County Road 1469	Agricultural	43	To be determined			BMP Trains model
Santa Fe Pass Subdivisions	Residential	134	131	11	EMC Runoff	BMP Trains model
NE 132nd Avenue	Agricultural	51	To be determined			BMP Trains model

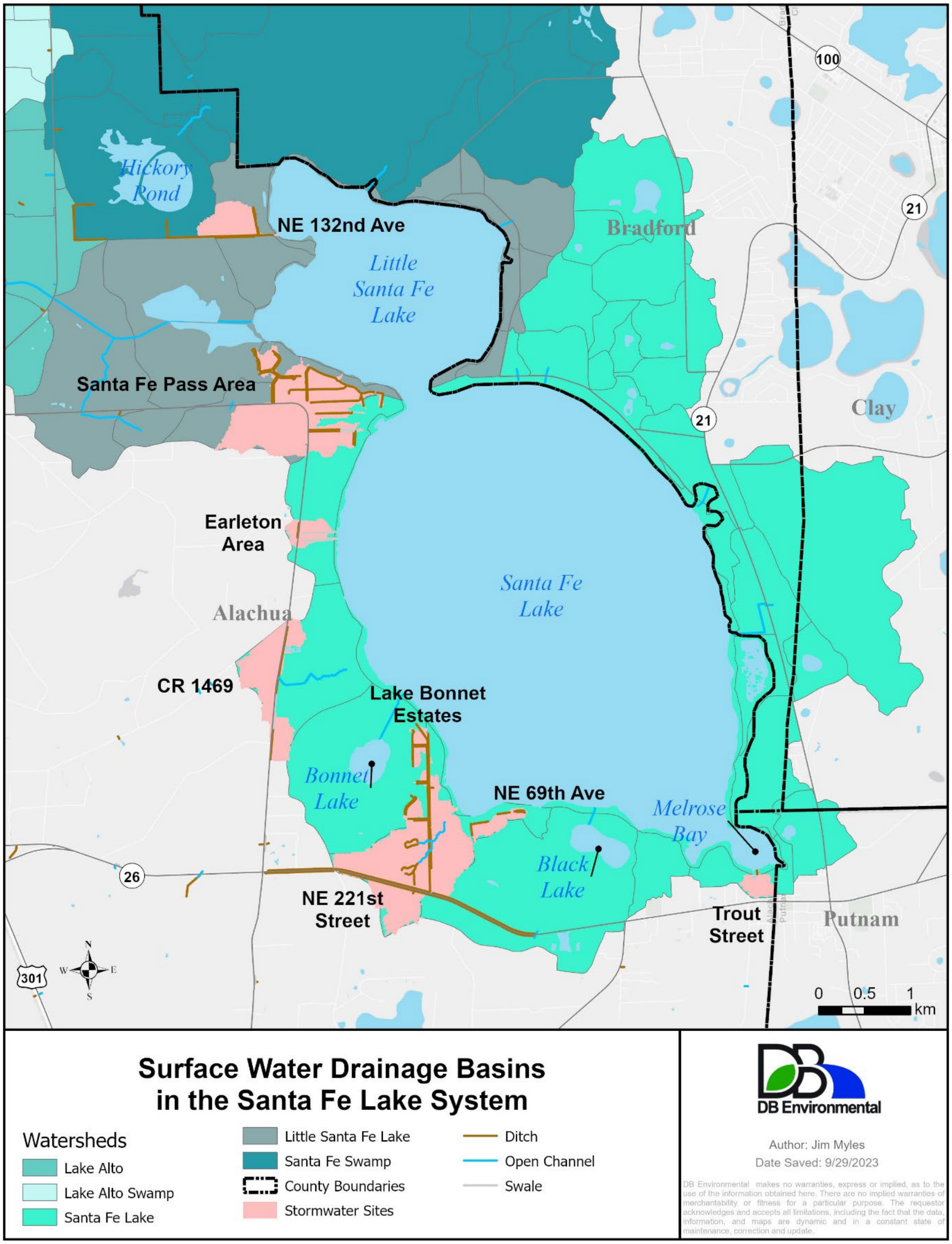

Figure 1. Stormwater inputs to Santa Fe Lake identified in Alachua County, FL.

Introduction and Background on Watershed Nutrient Sources

Historical Water Quality

Historical water quality data for the Santa Fe Lake system is available from monitoring agencies such as USGS and FDEP as far back as the 1950s, though monitoring was sparse prior to 1985 when LAKEWATCH began intensive monthly monitoring. The infrequent sampling and higher detection limits for P analysis limit the utility of the earlier data. Average values and precise temporal trends differ somewhat among datasets and data handling approaches of different agencies. In general, however, the available data indicates that within the intensively monitored interval since 1985, water quality in the Santa Fe Lake system is declining. Increased nutrient levels (TP and TN) coincide with poorer water clarity (measured as Secchi depth) which could be from increased algae concentrations and/or color in the lake water, both reducing light penetration into the water column. Increased chlorophyll *a* concentrations have been observed, supporting the notion that greater phytoplankton growth has been triggered by the observed increase in nutrient availability. As management options are considered, several random, non-anthropogenic events are also likely factors that have exerted both short-term and long-term influence on water chemistry in the lake system, often producing cumulative effects.

In general, temporal water quality patterns in the Santa Fe Lake system have been dominated by the effects of natural perturbations. Following a prolonged drought (1998-2002), high rainfall in 2002 and 2003, and several tropical cyclones in 2004 transported significant loads of colored water including organic nitrogen from the swamps and watershed to the lake, increasing TN concentrations by 50% between 2003 and 2005. TN concentrations remained elevated after the Dairy Road Fire in 2007 and remained high through 2010. Since 2010, the TN concentrations have been steadily decreasing. Similarly, annual average TP concentrations significantly increased following the high rainfall in 2002 and 2003, and tropical cyclones in 2004. Following the Dairy Road Fire and subsequent rainfall in 2007 the TP concentrations increased by 50% in 2008. Since 2008, the TP concentrations have been decreasing but have not returned to historic levels.

Some anthropogenic impacts in the lake drainage area, such as residential land development and the number of on-site sewage treatment and disposal systems (OSTDS) or septic systems, have increased during the period of record, but the effect on lake water quality is difficult to define. One investigation concluded “An impact of land-use changes on water quality at [Santa Fe Lake

System] cannot be totally dismissed, but the circumstantial evidence leads to the need to consider that forces other than cultural eutrophication may be exerting a greater impact on water quality at [Santa Fe Lake System]" (Canfield et al. 2016).

Land Use Changes in the Watershed

Changes in land use in the Santa Fe Lake watershed may be responsible for some fraction of the recent increases in lake water nutrients and chlorophyll *a* which decreased water clarity (Secchi depth). Residential development has increased during the last half of the twentieth century and into the current century, but the timing and extent of this development is not well documented due to incomplete records and differences in methodology used to define land use. However, recently published data of current land use and land cover allowed us to calculate changes since the 1970's.

A quantitative examination of land use change in the Santa Fe Lake watershed was made using geospatial datasets of land use and land cover types in the watershed from the 1970's (Price et al. 2005) and 2019 (FDEP 2022). Land use categories in these datasets were defined by the classification system of Anderson 1976. Level I Land Use and Land Cover types in the watershed are illustrated by Figure 2. Acreage belonging to each land use category and the associated percent change between 1970 and 2019 were extrapolated from the dataset for each major watershed and presented in Table 2. The interpretation of land use from imagery collected in 2019 was at a much higher resolution than was done in the 1970s and as a result some categories such as Rangeland and Transportation were not accounted for in the earlier data. The increased detail of the 2019 dataset also accounts for the apparent increase in acreage of wetlands which were often classified as upland forests in the 1970s dataset, due to their small spatial extent. This was especially the case in the Santa Fe Swamp and Santa Fe Lake watersheds (Table 2).

In the Little Santa Fe Lake drainage basin, the largest change observed was the conversion of agricultural land to urban development and upland forests. Overall urban development increased by 327 acres which was a 248% increase between the 1970s and 2019 (Table 2). The Santa Fe Lake drainage basin saw a large conversion of upland forest, agricultural and barren lands to urban development (398 acres) and transportation (71 acres) (Table 2). The Santa Fe Swamp drainage basin experienced the largest conversion of upland forest, and agricultural lands to urban development and transportation, which together increased by 645 acres (Table 2.). Across all drainage basins, the acreage of lands used for urban development increased by 1,437 acres between the 1970s and 2019, while agricultural land uses decreased by 1,065 acres (Table 2).

Table 2. Land use changes in the Santa Fe Lake watershed between the 1970s and 2019 summarized by the Level 1 land use categories.

Watershed	Land Use	1970s (acres)	2019 (acres)	Change (acres)	Percent Change
Little Santa Fe Lake	Urban	132	459	327	248%
	Agriculture	900	299	-601	-67%
	Rangeland		45		
	Upland Forest	775	896	121	16%
	Water	1070	1145	75	7%
	Wetlands	415	420	5	1%
	Barren Land		26		
	Transportation		2		
Santa Fe Lake	Urban	769	1167	398	52%
	Agriculture	885	681	-205	-23%
	Rangeland		74		
	Upland Forest	2759	1994	-766	-28%
	Water	4055	4173	118	3%
	Wetlands	890	1289	399	45%
	Barren Land	157	65	-92	-59%
	Transportation		71		
Santa Fe Swamp	Urban	145	565	420	290%
	Agriculture	1720	1461	-259	-15%
	Rangeland		790		
	Upland Forest	8780	6498	-2283	-26%
	Water	144	131	-14	-9%
	Wetlands	6748	7881	1132	17%
	Barren Land	56	42	-15	-25%
	Transportation		225		

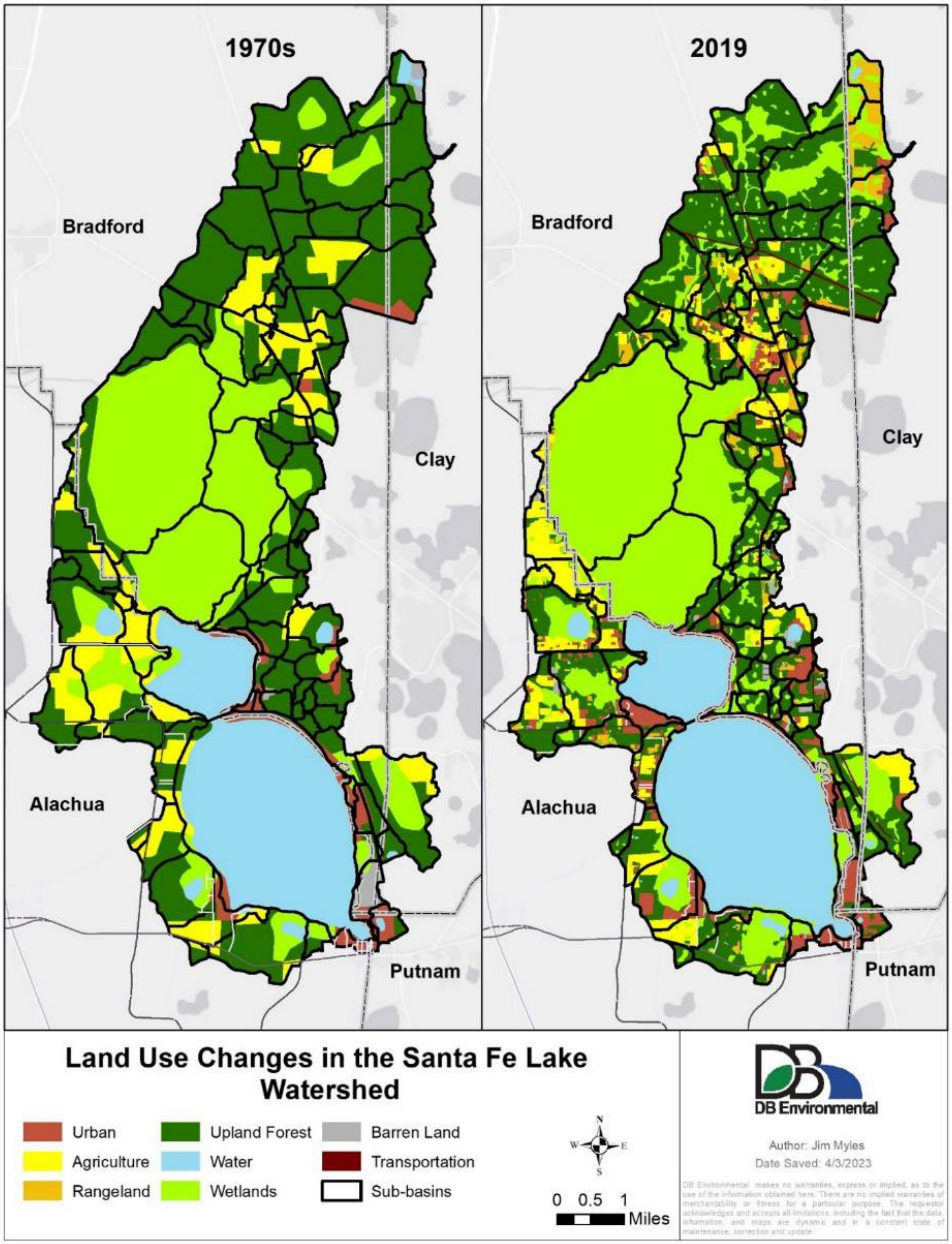

Figure 2. Land use and land cover changes in the Santa Fe Lake watershed between the 1970s and 2019.

Nutrient Loading by Land Use

Understanding the variety of and relative acreage occupied by the different land use types within the greater Santa Fe Lake drainage basin allows us to better estimate which regions of the watershed may be contributing elevated amounts of nitrogen and phosphorous to the lake. To gauge nutrient loading, Level II Land Use types from the Florida Land Use, Cover, and Forms Classification System (FDOT 1999) from the 2019 dataset were matched to a category of land use or land cover types which have an event mean concentration (EMC) for Total Nitrogen (TN) and Total Phosphorous (TP) designated in the Alachua County Stormwater Manual (Alachua County 2018) (Figure 3) (Appendix A). Following land use categorization and calculation of acreage by land use type within each sub-basin of Santa Fe Lake watershed, an approximation of potential TN and TP loading was determined using the acreage and EMC along with an estimate of annual rainfall runoff from the SWMM model output (ECT 2021a). The total runoff, reported in inches, for each sub-basin over the 10-year modeling period (2006-2016) was provided in the appendix of the Lake Alto and Santa Fe Lake Water Budget Modeling Technical Report (ECT 2021a). The total annual runoff for each basin was proportioned based on acreage of the land use type in each sub-basin. This simplified estimate of annual runoff does not account for the variation in runoff of the different land use types which are affected by the soil types and percent impervious area. The determination of runoff volumes based on specific land use, soil type and percent impervious area for the entire watershed was beyond the scope of work for this project. This estimate of runoff from each land use category along with the associated EMC was used to calculate the load of TN and TP from each land use category in each sub-basin. Equation 4.6.2. from the Alachua County Stormwater Manual (Alachua County 2018) was used to calculate the annual loads of TN and TP.

Annual Mass Loading (lb/year) = Annual Runoff Volume (ac-ft/year) * 43,560 ft^2/ac * 7.48 gal/ft^3 x 3.785 liter/gal * EMC (mg/L) * 1 lb/453,592 mg

Figure 4 demonstrates the relative nutrient contribution of each land use category in the Little Santa Fe Lake, Santa Fe Lake and Santa Fe Swamp watersheds. In the Little Santa Fe Lake watershed the total estimated annual load of TN is 3,684 lbs/yr and TP is 285 lbs/yr. Urban and developed areas are the largest controllable source of nutrient loads, comprising up to 30% of TN (1,123 lbs TN/yr) and 38% of TP (108 lbs TP/yr), with agricultural lands (14% or 529 lbs TN/yr and 27% or 78 lbs TP/yr) following close behind. Natural sources including upland forest and wetlands represent 54% TN load (1,996 lbs/yr) and 34% of the TP load (98 lbs/yr).

In the Santa Fe Lake drainage basin, the total estimated annual load of TN is 14,359 lbs/yr and TP is 1,261 lbs/yr. Of the controllable sources of nutrients, agriculture is the largest contributor to TP (41% or 517 lbs/yr) and the fourth largest contributor to TN (19% 2,686 lbs/yr) while urban and developed areas could contribute as much as 28% of the TN (4,019 lbs/yr) and 30% of the TP loads (373 lbs/yr). Natural sources including upland forests and wetlands contribute as much as 50% of the TN and 27% of the TP load. (Figure 4)

The Santa Fe Swamp drainage basin occupies the largest area at 17,590 acres, and has the greatest nutrient loads at 45,490 lbs of TN and 2,364 lbs of TP each year. Natural sources like upland forest and wetlands, account for most of the nutrient load, including 87% of the TN (39,762 lbs TN/yr) and 57% of the TP (1,349 lbs TP/yr) annually. Agricultural sources contribute 11% of TN and 27% of TP while urban development accounts for 38% of the TP load and only a fraction of the TN load (2%) (Figure 4).

To visualize these potential nutrient loads in relation to each sub-basin, the percentage of TN and TP loads were plotted by basin and sub-basin in Figure 5. The three sub-basins with the highest loads in the Santa Fe Swamp drainage basin contained the Santa Fe Swamp Conservation Area and when combined accounted for 59% of the total basin TN and 32% of the basin total TP (Figure 5). While all three sub-basins owe over 90% of their TN load to natural sources, the southern and northwestern sub-basins owe 50% and 49% of their TP load to agricultural runoff, respectively.

Of the two highest loading sub-basins in the Little Santa Fe Lake drainage basin, one contains Little Santa Fe Lake and portions of the shoreline which accounts for 26% of the total basin TN load (957 lbs TN/yr) and 21% of the total basin TP load (59 lbs TP/yr). This load is primarily from direct runoff from the shoreline parcels into the lake. The other sub-basin is the Santa Fe Lake Alto Canal and accounts for 28% of the total basin TN load (1,034 lbs TN/yr) and 26% of the total basin TP load (73 lbs TP/yr). This sub-basin derives its high nutrient load from naturally occurring flatwoods, and upland pines, while the Little Santa Fe Lake sub-basin owes 59% of its TN load and 91% and of its TP load to developed residential sources (Figure 5).

In the Santa Fe Lake watershed, the bulk of the nutrient load is shared among four sub-basins, three of which are in Alachua County: The Bonnet Lake sub-basin, the Black Lake sub-basin, and the Santa Fe Lake sub-basin (Figure 5). The Santa Fe Lake sub-basin, which includes most of the lake's shoreline, accounts for 21% of the total basin TN load (3,086 lbs TN/yr) and 15% of the total basin TP load (188 lbs TP/yr), with up to 63% of its TN load and 90% of the TP load coming from developed areas. The Black Lake sub-basin accounts for 13% of the total basin TN (1,820 lbs TN/yr) and 10% of the total basin TP (122 lbs TP/yr) of which 84% of that TN load and 68% of the TP load is coming from natural sources such as mesic to wet flatwoods and ruderal upland pines. The Bonnet Lake sub-basin accounts for 12% of the total basin TN (1,768 lbs TP/yr) and 15% of the total basin TP (184 lbs TP/yr), with an estimated 44% of its TN load and 69% of its TP load coming from pasture, rangeland and row crops. An additional 12% of the TN load and 10% of the TP load is from low-density residential areas.

In examining nutrient load potentials from the greater Santa Fe Lake drainage basin, several sub-basins within Alachua County were identified as the largest contributors to the total TN and TP load within the basin. The sub-basins containing Little Santa Fe Lake and Santa Fe Lake owe their large nutrient loads to developed areas, primarily residential runoff. The Santa Fe Swamp Conservation Area and Bonnet Lake sub-basins owe their high nutrient loads to runoff from agricultural and natural areas.

In addition to the stormwater runoff, these developed parcels are serviced by OSTDS. The number of septic systems in the Santa Fe Lake watershed was estimated using the statewide inventory effort by the Florida Department of Health (FDOH) (Ursin 2016). There are approximately 1,538 septic tanks in the Santa Fe Lake watershed, with an estimated 760 septic systems located within a 200-meter buffer of the lake and associated canals (DBE 2021). There are approximately 237 developed parcels along the 9.3-mile shoreline in Alachua County that are either waterfront or on a canal. Bradford County encompasses most of the eastern shoreline with 7.6 miles and approximately 337 developed parcels with OSTDS on the lake or a canal. Putnam County has a small area along Melrose Bay, with 0.7 miles of shoreline and 19 developed lots.

OSTDS are a common and widespread source of nutrients to shallow groundwater, and to receiving water bodies interacting with that groundwater. Recent estimates calculated nutrient loads to the lake from groundwater beneath the drain fields of approximately 10,915 lbs N/year and 633 lbs P/year from OSTDS within 200 m of the Santa Fe Lake system (DBE 2021). Alachua County is currently offering 50% rebates to Alachua County property owners that upgrade traditional systems to Enhanced Nitrogen Reducing (ENR) systems. However, septic systems within Alachua County represents less than 50 % of the total number of systems within 200 m of the lake shore (DBE 2021). The other OSTDS are outside the jurisdiction of Alachua County, as are the stormwater discharges from those neighboring counties. Therefore, the objective of this study is to identify stormwater input locations along the Alachua County portion of the lake (Task 1) and the drainage basins that contribute to these stormwater outfalls (Task 2).

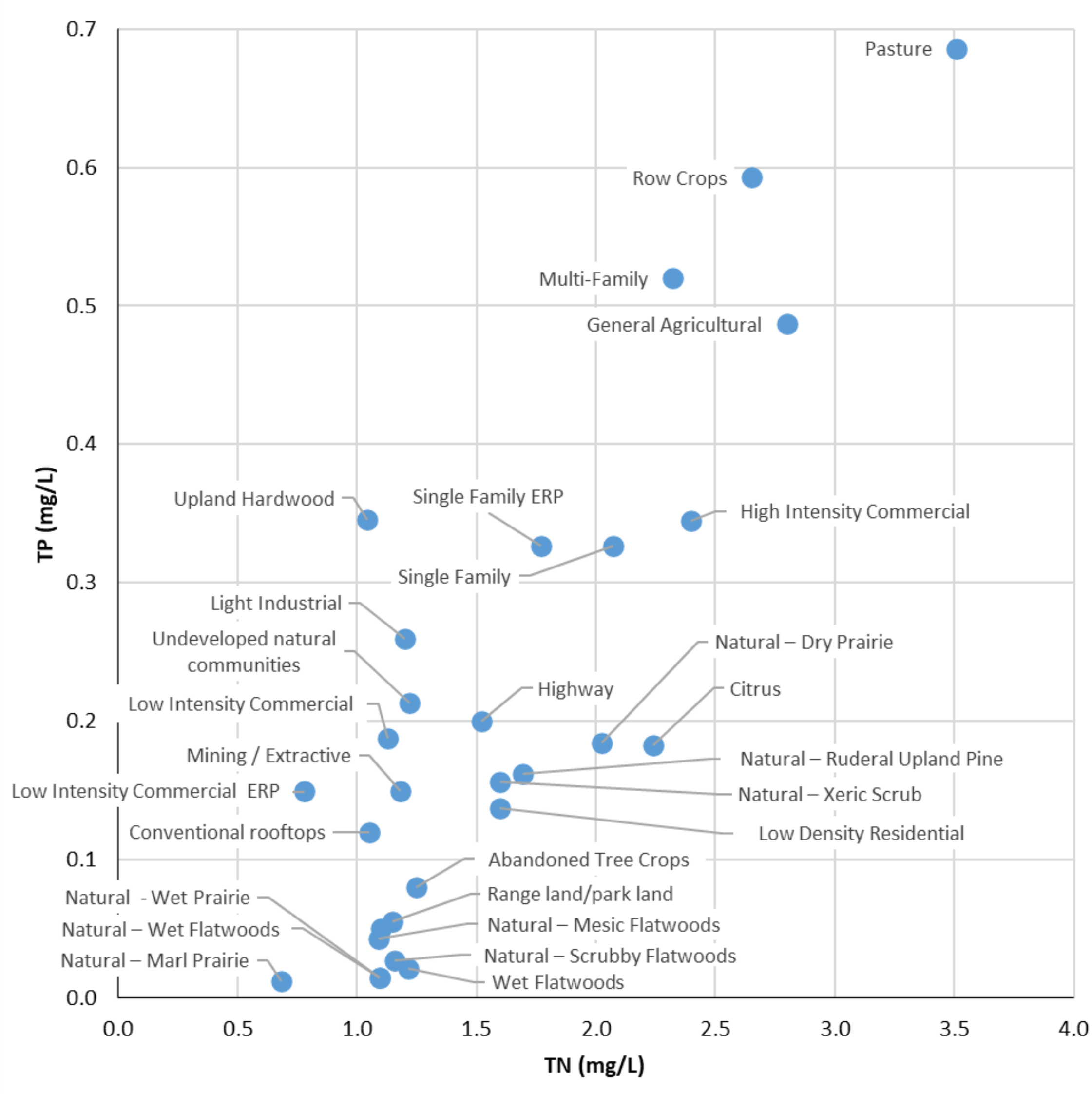

Figure 3. Event mean concentrations of TN and TP for various land use and land cover types.

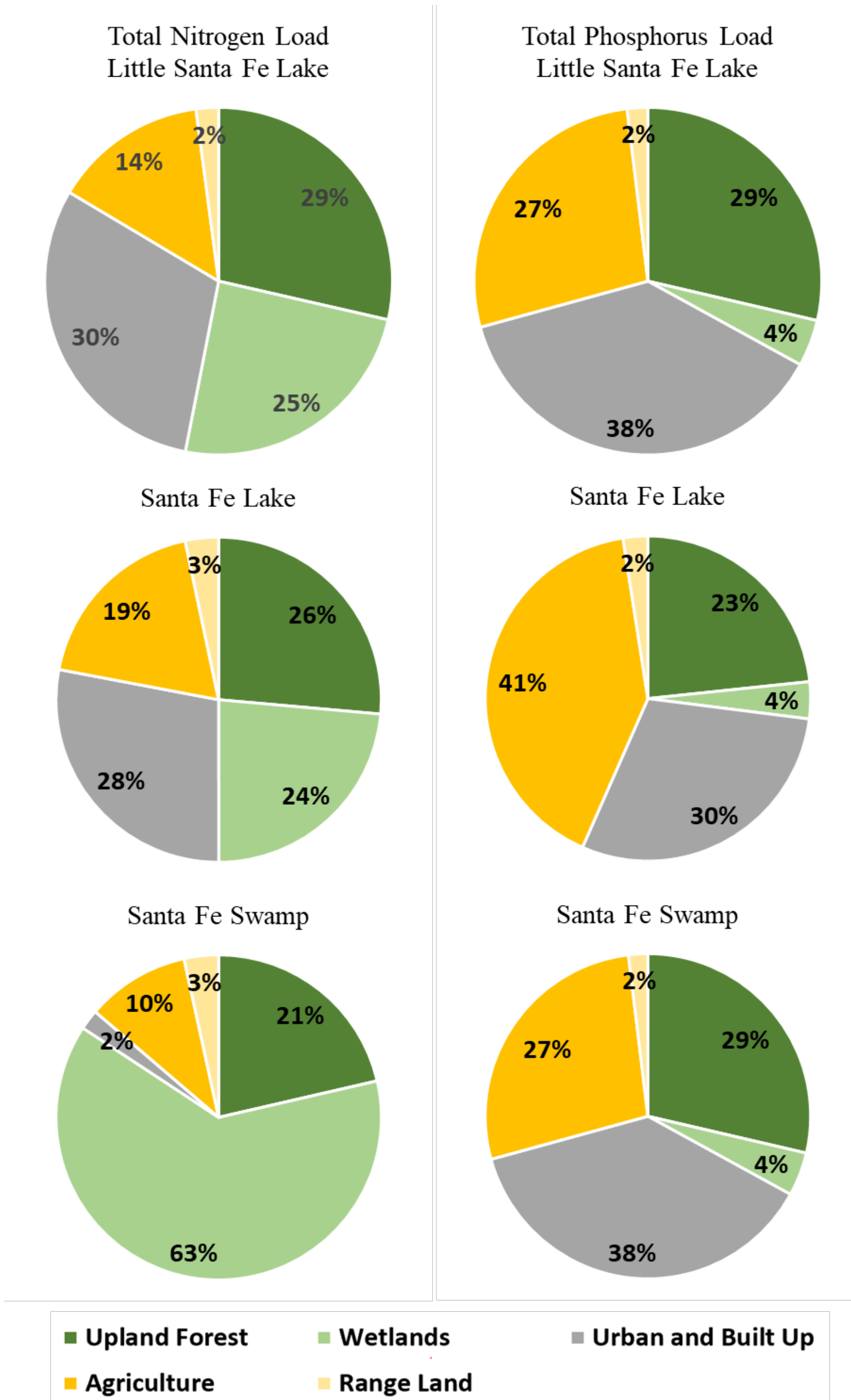

Figure 4. Percent nutrient contribution by land use category for Little Santa Fe Lake, Santa Fe Lake and Santa Fe Swamp.

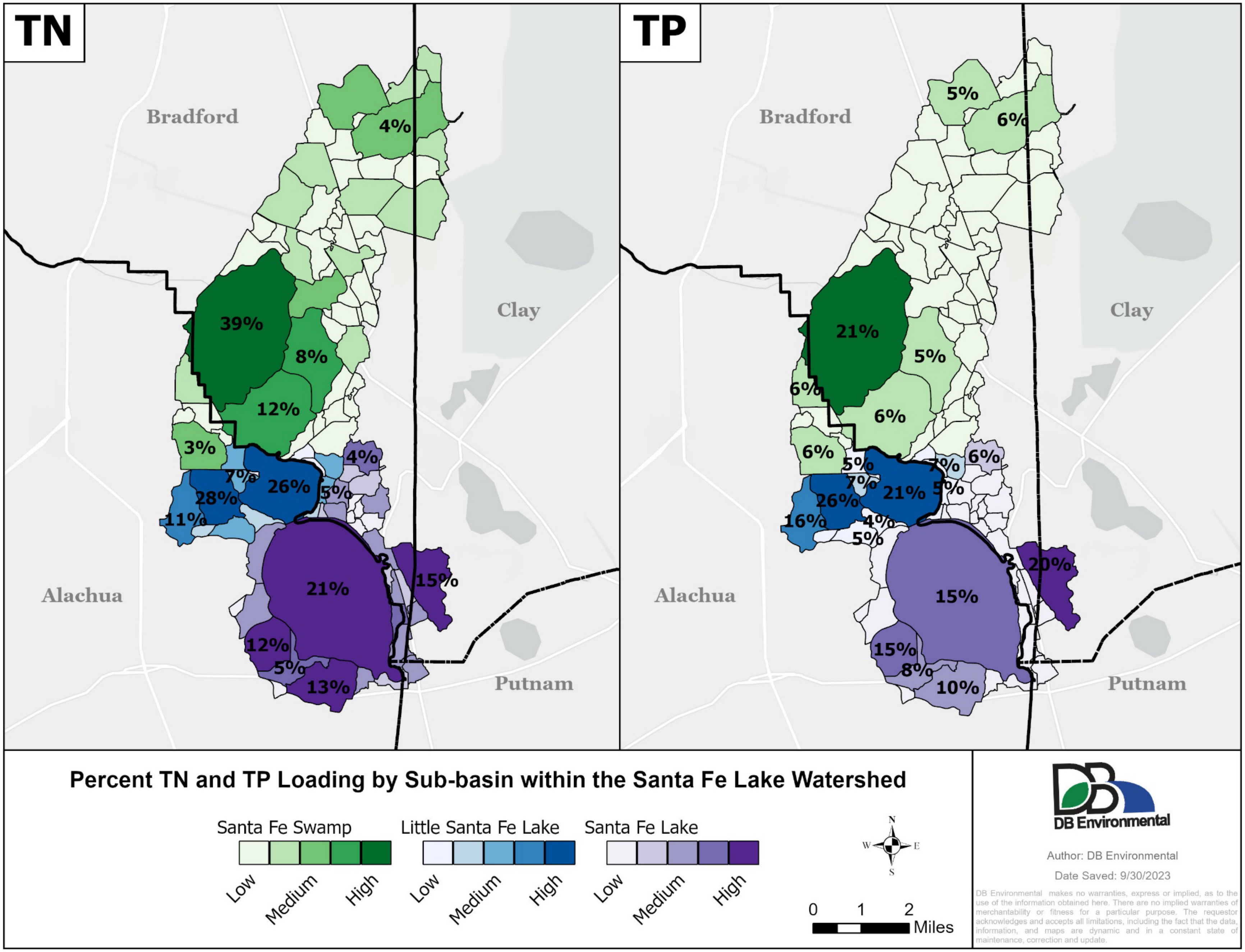

Figure 5. Percent TN and TP Loading by Sub-basin within the Santa Fe Lake Watershed.

Specific Stormwater Discharges to the Lake

Rainfall within the watershed is the primary source of water to Santa Fe Lake and with the runoff comes nutrients and other pollutants from the surrounding landscapes. The lake receives direct stormwater runoff from surrounding parcels and communities. At least one example exists of high TN and TP concentrations in stormwater runoff from agricultural lands and road runoff. However, the quality and quantity of stormwater runoff from parcels around the lake was generally not well documented and is highly variable among contributing drainages depending on land use and cover.

Most of these point inputs had not been inventoried prior to this investigation which identified numerous stormwater inputs within Alachua County and provides opportunities to reduce nutrient loading from that runoff to Santa Fe Lake through stormwater management and treatment. These stormwater inputs were identified using a combination of field investigations, modeling and assessment of recent geospatial datasets including stormwater infrastructure, DEMs and land use layers.

Identification, Delineation and Sampling of Stormwater Inputs to Santa Fe Lake

The initial step for Task 1 was acquiring and consolidating multiple geospatial datasets representing stormwater infrastructure and drainage features. The Alachua County Public Works (ACPW) department maintains a geodatabase of stormwater infrastructure in the unincorporated portion of the County, while the City of Gainesville (COG) maintains a stormwater geodatabase of the greater Gainesville area. DBE assembled both stormwater geodatabases into one using the new database schema adopted by the COG. A copy of the compiled geodatabase was provided to ACEPD and ACPW. This database was updated with stormwater infrastructure identified during this investigation. A recently updated (2020) geodatabase of stormwater infrastructure maintained by FL Department of Transportation (FDOT) was acquired and some features within the Santa Fe Lake watershed were added to the County's stormwater geodatabase. **It is recommended that all the FDOT data be appended to the County's stormwater geodatabase.**

Evaluation of Hydrologic Connections

Some drainage structures and hydrologic connections between the sub-basins were surveyed (ECT 2021a) during the development of the MFL (ECT 2021b) for the lake. These data were obtained from SRWMD and incorporated into the County's stormwater geodatabase. The invert elevations of these hydrologic connections were then compared to the historical stage data from Little Santa Fe and Santa Fe Lakes to determine the frequency at which the surrounding waterbodies are connected to the lakes. A record of historic water levels for Santa Fe Lake was compiled from four different USGS datasets (02320601 - Santa Fe Lake near Earleton, 02320611 - Little Santa Fe Lake, 02320610 Little Santa Fe Lake near Waldo, FLA, and 02320600 Santa Fe Lake near Keystone Heights, FLA) by converting all elevation data from NGVD29 to NAVD88 and averaging any differing values between datasets for the same dates (Figure 6). The correction factor to convert from NGVD29 to NAVD88 in this part of Florida is -0.85 ft. This compiled water level dataset was then plotted against the following invert elevations taken from ECT 2021a, below which the associated sub-basins are hydrologically cut off from the Santa Fe Lake system: Bonnet Lake (136.1 ft), Black Lake (134.8 ft), and Lake Alto's Upper (135.5 ft) and Lower (132.6 ft) (Figure 6). According to our analysis, the Bonnet Lake and Black Lake sub-basins are nearly always connected hydrologically to Santa Fe Lake except during times of extreme drought. The Lake Alto sub-basin is always connected to Little Santa Fe Lake by the Lower Canal cross section, however the upper section of the canal is also disconnected under extreme drought conditions (Figure 6).

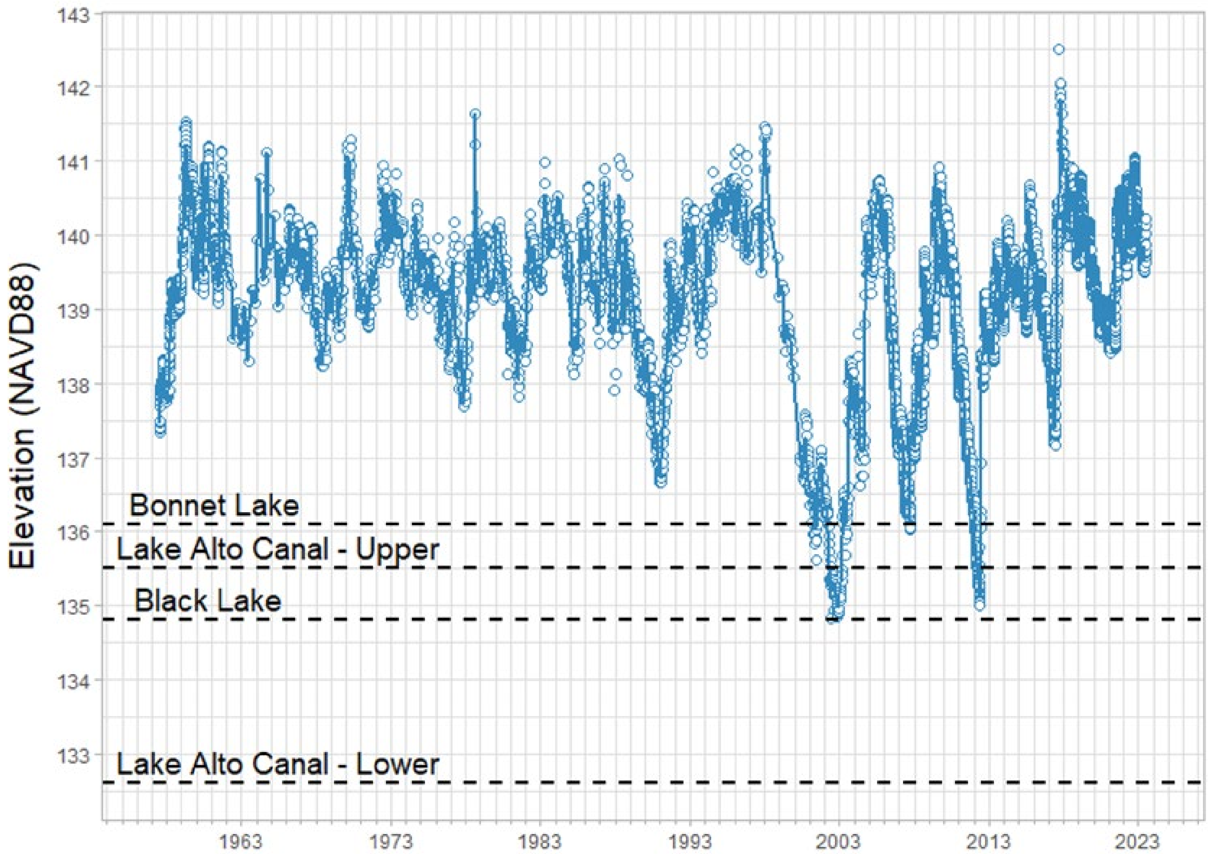

Figure 6. Hydrograph showing historical records of water levels in Santa Fe Lake. Dashed lines represent the invert elevation for each of the associated sub-basins connected to Santa Fe Lake.

Shoreline Reconnaissance to Identify Stormwater Outfalls

Task 1a focused on identifying stormwater discharges to the Alachua County portion of the lake. Key activities included performing a reconnaissance of the shoreline and canals to locate any discharge points, investigating the contributing area of each outfall, and documenting the location and description of the associated stormwater infrastructure. This information was used to update the Alachua County stormwater geodatabase and conduct additional modeling of stormwater drainage features.

A reconnaissance of the shoreline from the Alachua County portion of Melrose Bay, west along the southern shore and then north to Little Santa Fe Lake and the Santa Fe Swamp was performed. This shoreline reconnaissance identified a previously undocumented direct stormwater discharge into the lake, from an outfall near the Bristol Harbor condominiums in Earleton, FL. Subsequent field surveys and modeling of the DEM identified the contributing area of the stormwater discharge from NE 101st Avenue. Additional field investigations of developed areas surrounding the lake identified several additional areas with multiple stormwater inputs, including the Santa Fe Pass area, Wallace Groves and Bonnet Lake Estates subdivision as well as other developed areas (Figure 1) which are discussed in the following sections of this report.

Delineation of Stormwater Basins in the Santa Fe Lake Watershed

The purpose of Task 2 was to delineate the surface water drainage basin of the stormwater discharges identified in this investigation and described in this report. The surface water drainage features were modeled using available LiDAR-derived DEM and the location of culverts and swales identified during our field investigations. The high-resolution DEM obtained from SRWMD for the Santa Fe Lake watershed has a 2.5-foot by 2.5-foot cell size which allows for modelling detailed flow paths across the land surface (Dewberry 2017). This newly identified stormwater infrastructure, including culverts and open channels were added to the stormwater geodatabase. The DEM was then modified to account for the flow of water through those culverts under road crossings.

When modeling runoff from the original DEM, each elevated roadway acts as barrier to flow and does not accurately represent the flow of water through culverts. To modify the DEM, separate Stream and Roads layers were created to account for the intersection of all drainage features and road crossings where a culvert was identified. This included driveways and other access roads that have culverts to allow vehicle travel over a roadside swales and ditches. At every culvert, a stream and road crossing was created. In addition, the location of previously digitized streams was modified based on the location of stormwater infrastructure and the DEM. This vector data was then used to burn the streams into the DEM at each location a culvert crosses under a roadway (Soille et al. 2003; Lindsay 2016). This process lowers the elevation of the coincident pixels in the DEM, to allow the model to accurately simulate flow across the roadway at these culvert crossings. The resulting DEM was then filled to remove pits or depressions within the DEM. A point near Santa Fe Lake was selected as the outfall or pour point for the initial watershed delineations and flow path modeling. If necessary, sub-basins were then modeled for individual culverts or inlets. The drainage basin delineations and flow paths are presented in the following sections of this report.

Identified Stormwater Infrastructure and Sampled Stormwater Inputs

Multiple stormwater inputs draining several areas into Santa Fe Lake have been identified within Alachua County under Task 1b. At these locations the upstream stormwater infrastructure was geolocated and added to the stormwater geodatabase (Figure 1). Initially, stormwater runoff from agricultural land currently used for sod production near the intersection of SR 26 and NE 221st Street was sampled on several occasions following rainfall events. However, multiple attempts to sample the outfalls from Trout Street and those in Earleton, FL found that they were not flowing shortly after the rainfall. These three stormwater outfalls are shallow, concrete-lined swales (Figure 7) that only flow during and immediately after storm events. The short period of flow in these stormwater systems hindered the collection of grab samples and the channel configuration prevented installing first flush samplers. Other options to estimate nutrient loads were discussed, including installing autosamplers, a temporary weir or utilizing a model. Because of the following requirements it was determined that collecting data to define site-specific nutrient runoff concentrations was not cost effective.

Any stormwater improvements in these drainage areas will require Environment Resource Permitting which requires the determination of pre- and post-development nutrient loads. The Alachua County Stormwater Manual has adopted the event mean concentrations (EMC) used in the "BMP Trains" model (Wanielista et al. 2021) to determine the pre- and post-development runoff, nutrient loads and reductions based on BMP selections. The State of Florida through FDEP is proposing a statewide stormwater water rule with similar EMCs. In the rule, FDEP does allow an applicant to propose alternate event mean concentrations (EMC) of TN and TP which are determined in regional or local studies, such as this one.

These studies must be submitted with the permit application and follow quality assurance protocols outlined in chapter 62-160, F.A.C. These include data collected at a representative variety of rainfall depths; a minimum of 10 rainfall events; minimum of one year of data with seasonal variation; use of autosamplers to allow for runoff to be sampled for the duration of the rainfall event; collection of volume or time weighted composite samples; sampling occurring at point of discharge upstream of all on-site stormwater treatment; minimum of three or more sites with the same land use category; sample locations must be representative of site conditions; and data must be collected for all land use EMCs for the region. In addition, the contributing area should represent a single land use type, and the results should be reasonably consistent with other similar studies.

Due to these requirements, it was not feasible to determine site-specific EMCs for the previously mentioned stormwater drainage basins. After discussions with ACEPD, the “BMP Trains” model (Wanielista et al. 2021) was selected to estimate runoff and annual loading from the Trout Street Boat Ramp drainage basin, the agricultural basin near SR 26 and NE 221st Street and residential area in Earleton, Fl. The results of investigations into these and five other area identified during this study (Figure 1) are discussed in the following sections of this report.

Trout Street Boat Ramp

The neighborhood surrounding Trout Street located on Melrose Bay contributes untreated stormwater runoff to the lake through a stormwater collection system that discharges at the boat ramp. The stormwater infrastructure was surveyed and added to the Alachua County stormwater geodatabase (Figure 8). This collection system drains several blocks of residential properties between SR 26 and the boat ramp. Curb inlets and drop inlets discharge into a concrete-lined channel that leads directly into Melrose Bay. The drop inlets that drain SR 26 discharge stormwater south of the highway and into the Etonia Creek watershed which is in the SJRWMD.

The contributing area for the collection system (Figure 8) was determined by modeling runoff based on the modified DEM, using the same methodology presented in the previous section of this report (Delineation of Stormwater Basins in the Santa Fe Lake Watershed). Runoff is primarily from directly connected impervious surfaces resulting in flashy runoff during storm events. Multiple trips to this location following rain events found no flow in the stormwater collection system. The stormwater outfall is a shallow, concrete-lined swale going directly into the lake (Figure 7). Other options to estimate loads include deploying autosamplers, installing temporary weirs or using models such as BMP Trains were considered. After discussions with ACEPD, the BMP Trains model was selected to estimate annual nutrient loads from this drainage area.

Modeled Nutrient Loads

The BMP Trains model was used to estimate runoff and annual loading from the Trout Street drainage area. The 19.4-acre drainage basin is primarily low-density residential land use (14.9 acres) with limited commercial parcels along SR 26 (1 acre) and a 3.5-acre institutional (church) parcel which has a small dry detention basin (Figure 8). The soil consists of the Millhopper and

Tavares Sands which are in hydrologic soil group A (HSG) (USDA NRCS classification). Group A soils have low runoff potential when thoroughly wet since water is freely transmitted through the primarily sandy soil. The runoff curve number was determined following guidelines in Urban Hydrology for Small Watersheds and is based on the cover type, hydrologic condition and hydrologic soil group (HSG) (USDA NRCS 1986). The area of these three land cover types in HSG A (Residential ½ acres lots CN=54 and commercial CN=89) were used to calculate a weighted composite runoff curve number for the pervious areas within this drainage basin (72.41) (Table 3).

To determine the amount of impervious area, a combination of existing data and manual interpretation was used. The property appraiser's office supplied a building footprint layer (Figure 8) which was compared to the total square feet of the structure reported in Parcel attributes. The building footprint accounted for more impervious area and was used for this model. The areal extent of the roadways was digitized from the manual interpretation of recent aerial imagery and the DEM (Figure 8). The total impervious area is estimated to be 4.25 acres, which is approximately 22% of the drainage area (Figure 8).

Several assumptions were made for this initial estimate, including that the entire basin is considered Single Family Residential for determination of the event mean concentrations and all impervious areas, including roofs, are considered directly connected. These assumptions would tend to skew the loading estimate toward the higher end and may overestimate the nutrient loading. For this and all other model runs, the average annual rainfall for Santa Fe Lake was determined to be 50 inches based on the Annual Rainfall Isopleths in Alachua County (Alachua County 2018). This model run resulted in an estimated annual runoff of 18.6 acre-feet of water transporting approximately 105 pounds of nitrogen and 17 pounds of phosphorus per year (Table 3).

The larger sub-basin in which this stormwater outfall and drainage area (19.4 acres) lies, is approximately 87 acres of primarily residential areas and 5 acres of commercial land uses. This sub-basin includes most of Melrose Bay including areas in Putnam County, FL. The SWMM model used in determination of the MFL, estimated runoff from this larger sub-basin to be 39 ac-ft/yr. This runoff volume and the EMC of the different land use types was used to calculate the nutrient load from this sub-basin which is approximately 169 lbs of TN and 15 lbs of TP per year. On a per-acre basis this estimate is less than the estimate determined by the BMP Trains model.

The SWMM model estimated this sub-basin to have 15% impervious areas, which is less than that determined for the stormwater drainage basin (22%) and may explain the lower runoff volume and nutrient load estimates. Stormwater loads from the Trout Street residential/commercial drainage represent a sizeable fraction of the estimated loads from the larger sub-basin. This implies that these anthropogenic loads are a reasonable target within this sub-basin.

The BMP Trains model can also be used to determine the potential load reduction from implementing BMPs in this drainage area but was outside the scope of work for this phase of the project. The evaluation of these modeled loads and the potential nutrient reductions from BMP implementation should be the next steps toward prioritizing external nutrient loads to Santa Fe Lake and developing nutrient reduction strategies. **Some BMPs to consider in this basin include using curb cuts in front of the inlets with vegetated roadside swales to infiltrate most rainfall events. Other options include removing the curbs, inlets and collector pipes and replacing them with vegetated swales.** The County could also educate homeowners in the aera about stormwater runoff from their properties and BMPs they can implement, such as rain gardens, rain barrels and fertilizer management. Even though these nutrient loads are relatively small in comparison to the total loads to the lake, they are controllable nutrient sources which deserve further investigations to determine if nutrient reduction projects are feasible.

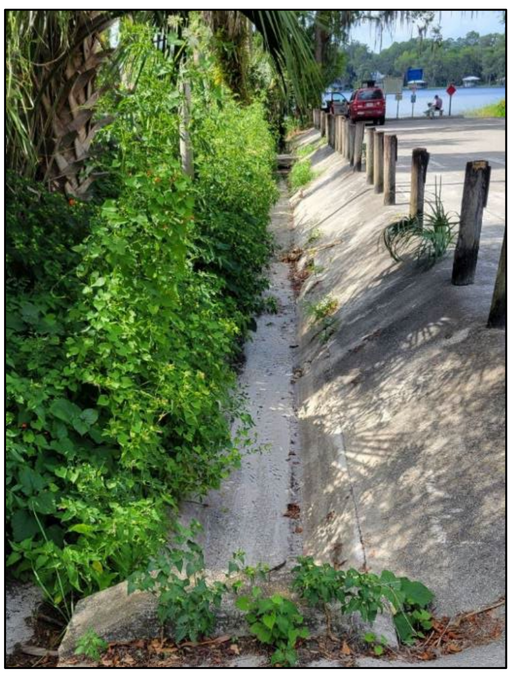

Figure 7. The concrete channel discharging stormwater into Melrose Bay.

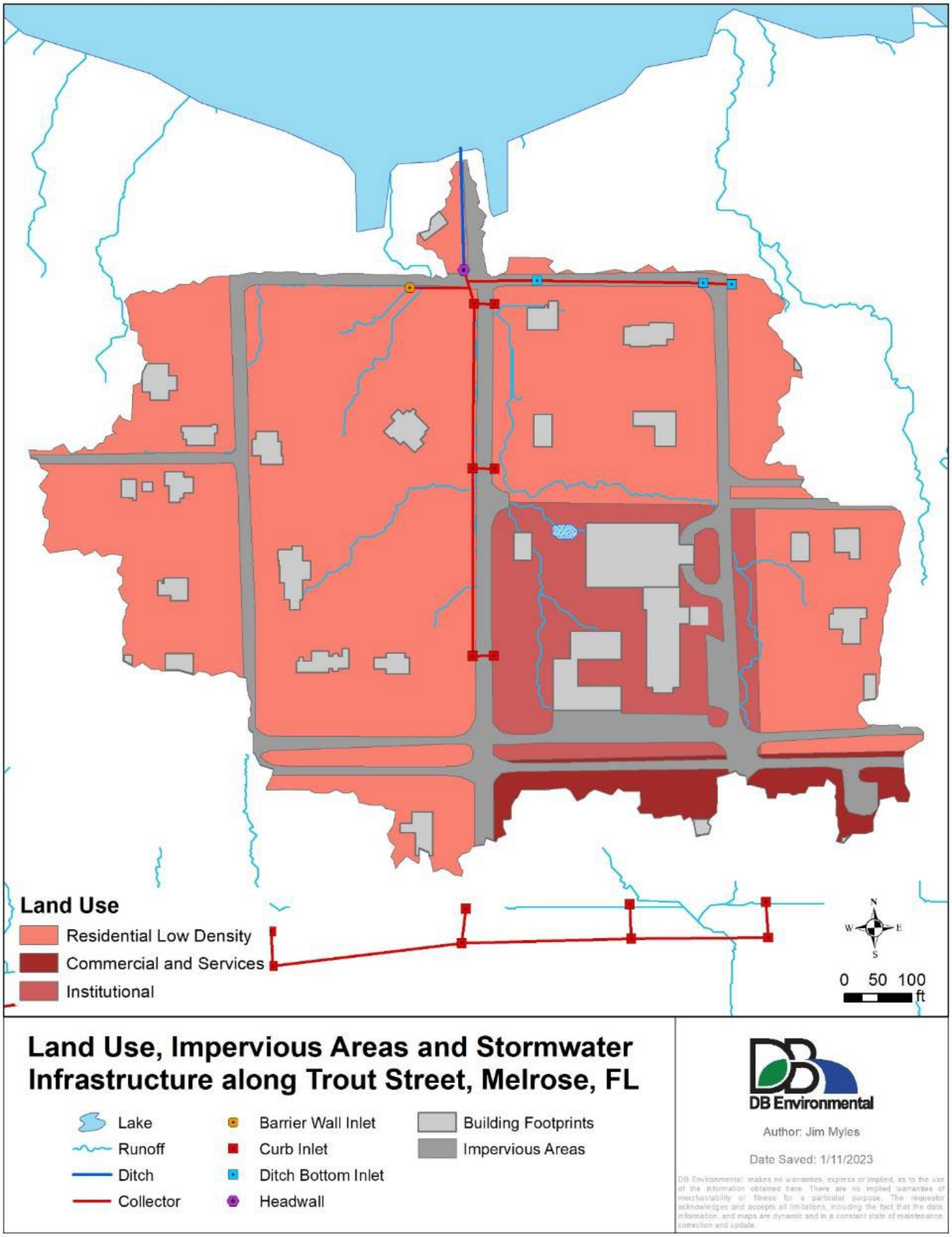

Figure 8. Land use and impervious areas contributing to the stormwater collection system discharging into Melrose Bay at Trout Street, Melrose, FL.

Table 3. Estimated annual runoff and nutrient loading from the Trout Street drainage basin calculated with the BMP Trains model.

Model Parameters/Assumptions	
Catchment Name:	Trout Street
Rainfall Zone:	Florida Zone 2
Annual Mean Rainfall (in):	50
Land Use	Single-Family
Event Mean Concentration (mg/L)	TN=2.07, TP=0.327
Condition Area (acres)	19.42
Rational Coefficient (0-1)	0.23
Non DCIA Curve Number	72.41
DCIA Percent (%)	21.9
Model Results	
Runoff Volume (ac-ft/yr)	18.63
Nitrogen Loading (lbs/yr)	105
Phosphorus Loading (lbs/yr)	17

SR 26 and NE 221st Street

Stormwater runoff from the agricultural parcels (18794-000-000) at the northwest corner of SR 26 and NE 221st Street has been a known issue since at least 2007. This drainage feature also receives runoff from SR 26 and NE 221st Street which flows east through two culverts under NE 221st Street (Figure 9). These channels then flow through a parcel acquired by the Alachua County Forever program (18796-002-000), prior to discharging into a canal on the southwest shore of Santa Fe Lake (Figure 9).

In January 2007, the agricultural parcel (18794-000-000) was converted from pasture and hay production into turf grass production. Complaints of stormwater runoff from bare soil on the farm, which flowed into a canal on Santa Fe Lake at NE 69th Lane (Figure 9), were received by ACEPD. Water samples collected by ACEPD between 2007 and 2013 significantly exceeded the Numeric Nutrient Criteria (NNC) threshold for TP (0.3 mg/L) and occasionally exceeded the TN threshold (1.87 mg/L) (DBE 2021). The P was primarily in the soluble form (soluble reactive phosphorus or SRP) which is readily available to algae and one of the least costly forms of P to remove. Sometime after 2013 the property was again managed for hay production and pasture.

In October of 2021, the property was acquired by Grovin Farms, LLC and in early 2022, sod harvesting resumed. By mid-summer the entire property had been harvested of sod, while shrubs and trees were cleared and burned, and the area tilled (Figure 10). To address this stormwater runoff, both the quantity and quality of the water entering Santa Fe Lake from this drainage area needs to be determined. Several key pieces of information are required to estimate these loads, including the contributing areas, surface water flow paths, discharges, and water quality. To gather the necessary information, the stormwater infrastructure was located and then the flow path and drainage area was modeled. To estimate nutrient loading, a stream gauging station was installed, and water quality monitoring was initiated.

Determining the Drainage Basin and Flow Path

To determine the extent of the drainage basin, the stormwater infrastructure was first located, and then the flow path of surface water runoff was determined through modeling of the DEM. The culverts under NE 221st Street were inspected and captured in the stormwater geodatabase (Figure 9). From the initial observations of excessive erosion and downcutting of the stream channels going through the Alachua County Forever parcel, it was evident that there are high stormwater flows through these culverts. Based on the size and depth of the southern channel, it appeared to receive more flow than the one located further north on NE 221st Street. Broken concrete rubble was observed below the undermined outfall structure of the southern culvert and western stream bank to mitigate the excessive erosion. Considerable trash and debris was also observed in this highly incised channel (Figure 11) that has been down cut approximately 8 feet below the adjacent land surface and several feet into a dense layer of clay (Figure 12). A soil sample was collected from the exposed clay comprising the stream bed and sent to the laboratory for analyses to determine P content and leachability. The total P content of the clay was 43 mg/kg, which is relatively low and there was no detection of water extractable P (WEP) from the laboratory analysis.

Additional culverts and open channels were identified throughout the drainage basin and once the stormwater infrastructure was mapped, the DEM was modified to account for the flow of water through culverts and under road crossings. Using the same methodology presented in the previous section of this report, the flow path and drainage areas were delineated.

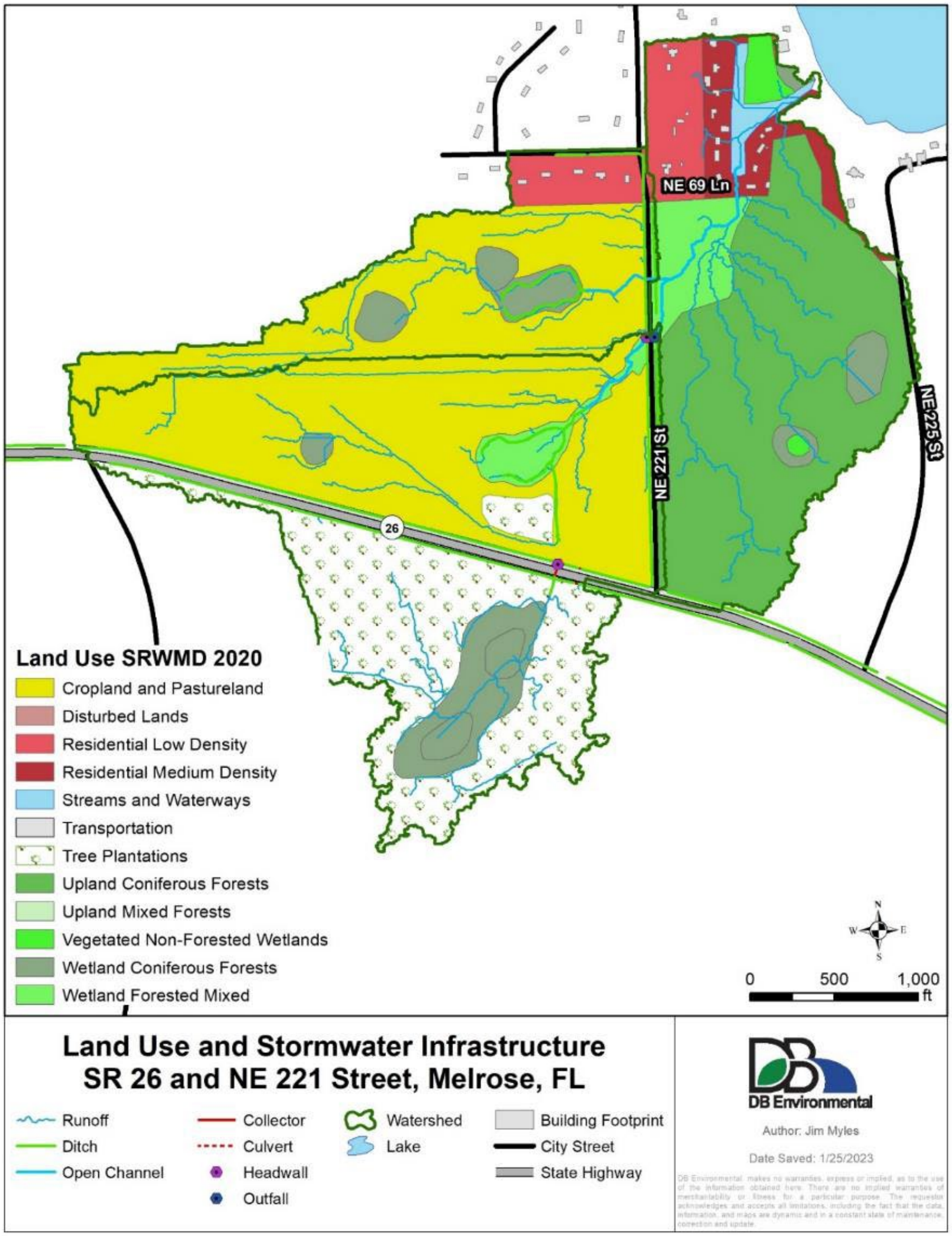

Figure 9. Stormwater collection system and contributing areas along SR 26, NE 221st Street and the surrounding area that discharge into Santa Fe Lake near Melrose, FL.

Figure 10. Grovin Farms after the sod was cut and the land was tilled.

Figure 11. Garbage and turbidity barrier in channel east of NE 221st Street.

Figure 12. Incised channel near the staff gauge downstream of the southern culvert on NE 221st Street.

Hydrologic and Water Quality Monitoring

To determine the hydroperiod of this ephemeral stream, a staff gauge and water level recorder were installed in the southern channel on May 27, 2022 (Figure 12). The early part of summer 2022 was relatively dry and several trips to sample water quality in these culverts after rain events found the streams dry or disconnected. The pressure transducer data was downloaded regularly, and the mean daily stage of the stream was calculated (Figure 13). The mean daily stream stage does not accurately represent how flashy the flow is within these stream channels and how high the peak flows can be (Figure 13). The data collected by the pressure transducers on a 10-minute interval shows stage increases of up to 3 feet in less than an hour which quickly subsides within hours of the peak rainfall (Figure 14 through Figure 18). This has made it difficult to collect samples and flow measurements during the peak stormwater flows.

Water quality samples were collected on August 22, August 30, September 8, September 9, November 10, 2022, and March 13, 2023, following storm events (Figure 14 through Figure 18). Discharge measurements along with corresponding staff gauge readings were collected during 3 sampling events (Figure 15 and Figure 16). These measurements were made after the peak flows with discharge measurements between 0.15 and 1.8 cubic feet per second (cfs). Without discharge measurements at peak stages, a useful stage-to-discharge relationship for this gauge could not be constructed. **It is recommended that additional efforts be made to measure flow during a large storm event to acquire the necessary data.**

The nutrients measured in the runoff from these open channels were very high with average concentrations of TP at 519 µg/L, and TN at 2.15 mg/L. These are extremely high compared to the mean concentrations within Santa Fe Lake (TP 18 µg/L, TN 0.6 mg/L), especially the soluble P in the northern tributary (Figure 21). Although these channels do not meet the State's definition of a "Stream" (FDEP 2016a), the nutrients exceed the NNC for streams in the North Central Florida Nutrient Watershed Region (TP 300 µg/L, and TN 1.87 mg/L) (FDEP 2016b) (Figure 21 and Figure 22). These concentrations are similar to the event mean concentrations (EMC) of runoff from general agriculture (2.8 mg TN/L and 487 µg TP/L)(Alachua County 2018; Wanielista et al. 2021). P concentrations in the northern tributary were higher than expected (mean of 860 µg TP/L) even for pasture which has the highest EMC of any land use at 686 µg TP/L (Alachua County 2018; Wanielista et al. 2021). Samples collected from this tributary by ACEPD in 2007 and 2013 had even higher P concentration (mean of 2,411 µg TP/L). Possible sources of elevated P in this runoff include fertilizer, animal waste and high-P soils exposed to erosion.

Most of these grab samples were collected after the storm and peak flows (Figure 14 through Figure 18). Typically, nutrients increase in concentration during the first flush and the initial stages of increasing stream discharge and generally decrease as the storm event continues (McDiffett et al. 1989). Given that these samples were collected after the first flush and the increasing limb of the stream hydrograph when concentrations were likely higher, these samples may underestimate the actual EMC and nutrient load from this runoff. Based on these concentrations this stormwater input could be an important nutrient source to the lake. However, to determine the magnitude of the load, additional streamflow and water quality data need to be collected during the initial runoff and at peak discharges. For comparison to the other stormwater discharges, runoff and nutrient loads from this drainage basin was also modeled using the BMP Trains tool. This additional analysis was deemed valuable and was completed even though it was outside the scope of work.

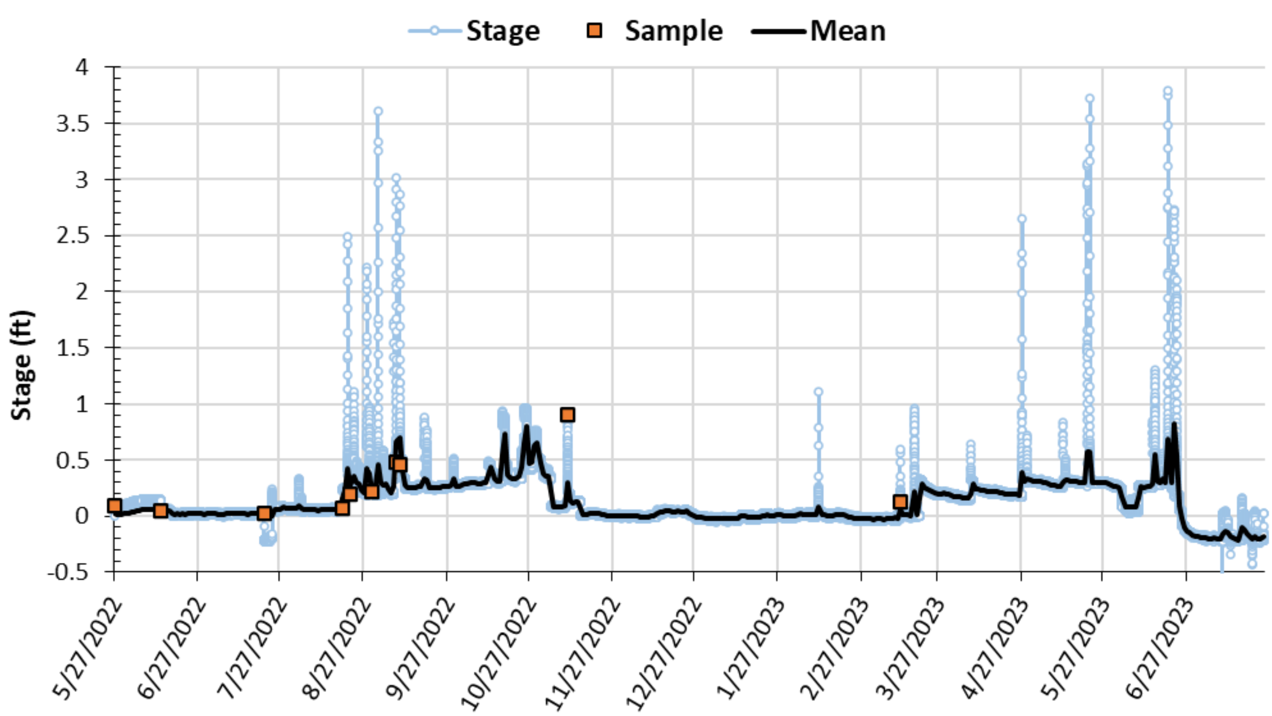

Figure 13. Stage and mean daily stage in the open channel draining NE 221st Street, near Melrose, FL, from May 2022 to July 2023.

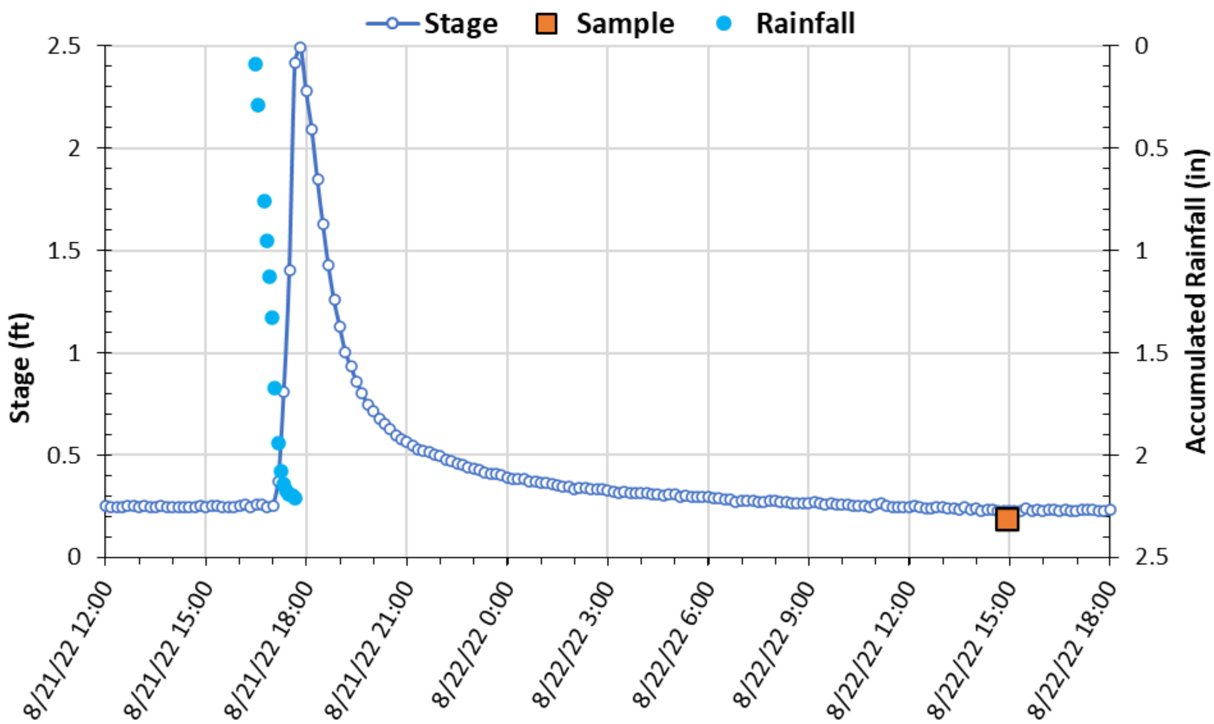

Figure 14. Stormwater hydrograph of the southern tributary showing the stage when water quality samples were collected on August 22, 2022.

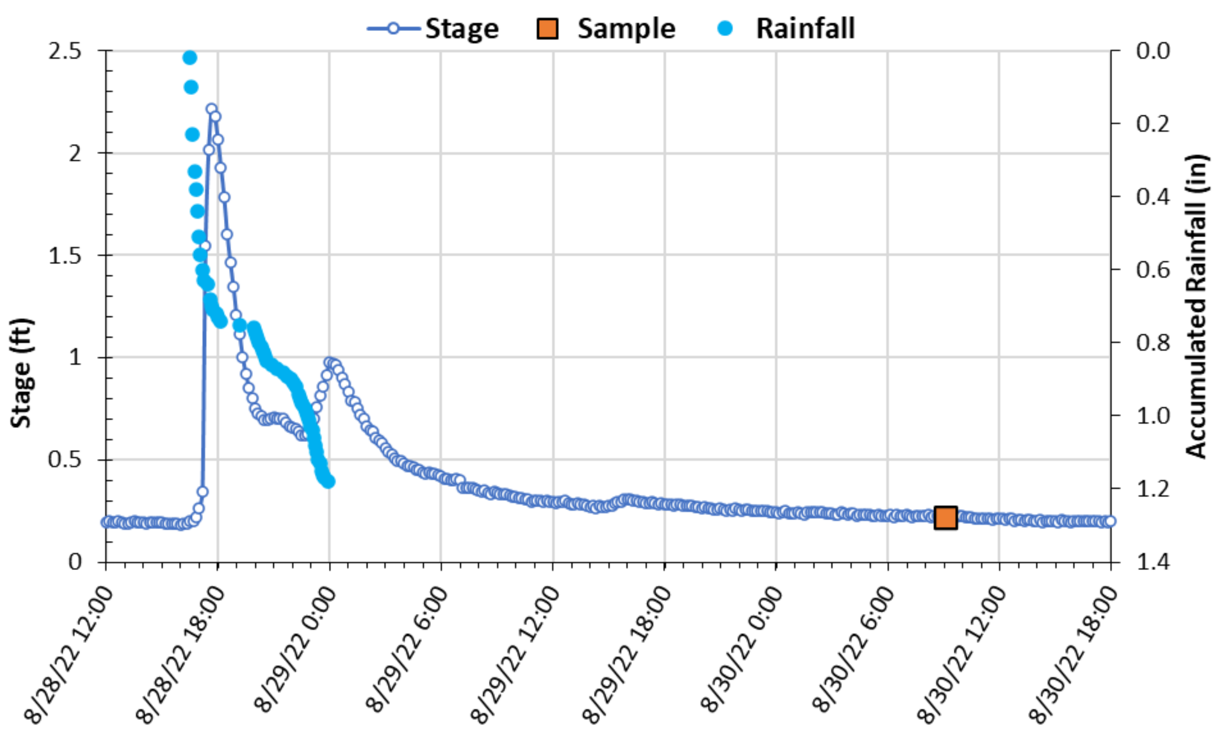

Figure 15. Stormwater hydrograph of the southern tributary showing the stage when water quality samples were collected and discharge was measured on August 30, 2022.

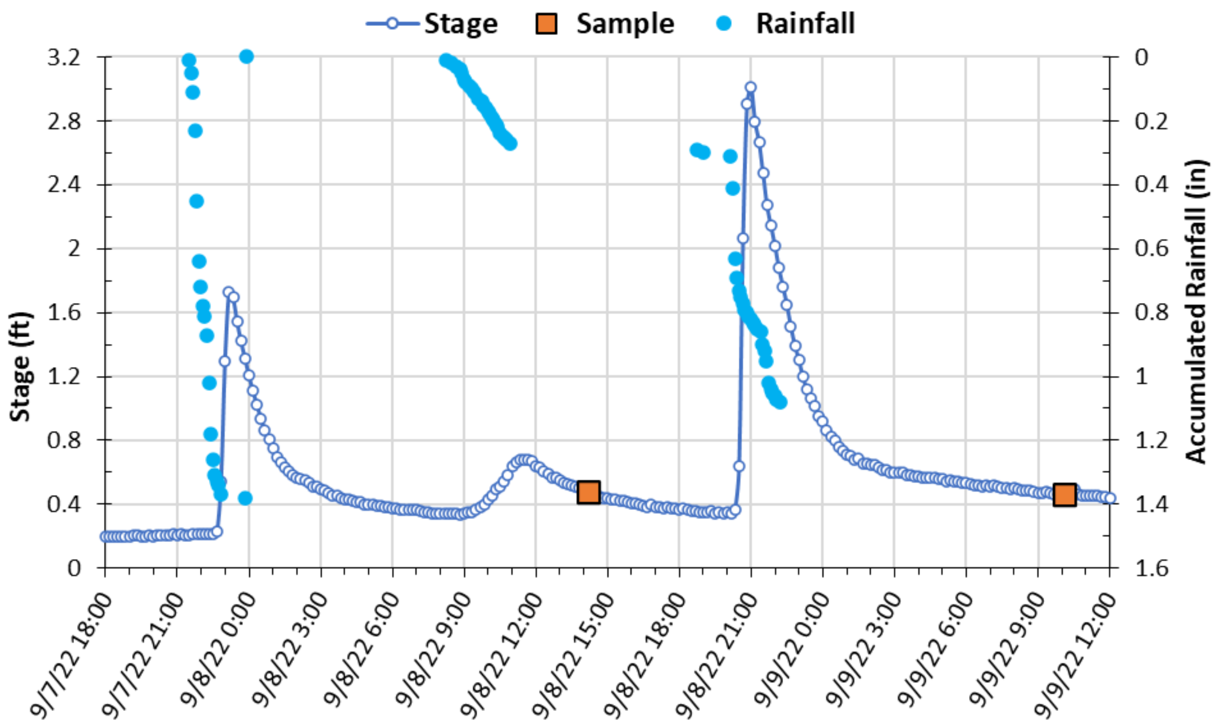

Figure 16. Stormwater hydrograph of the southern tributary showing the stage when water quality samples were collected and discharge was measured on September 8 and 9, 2022.

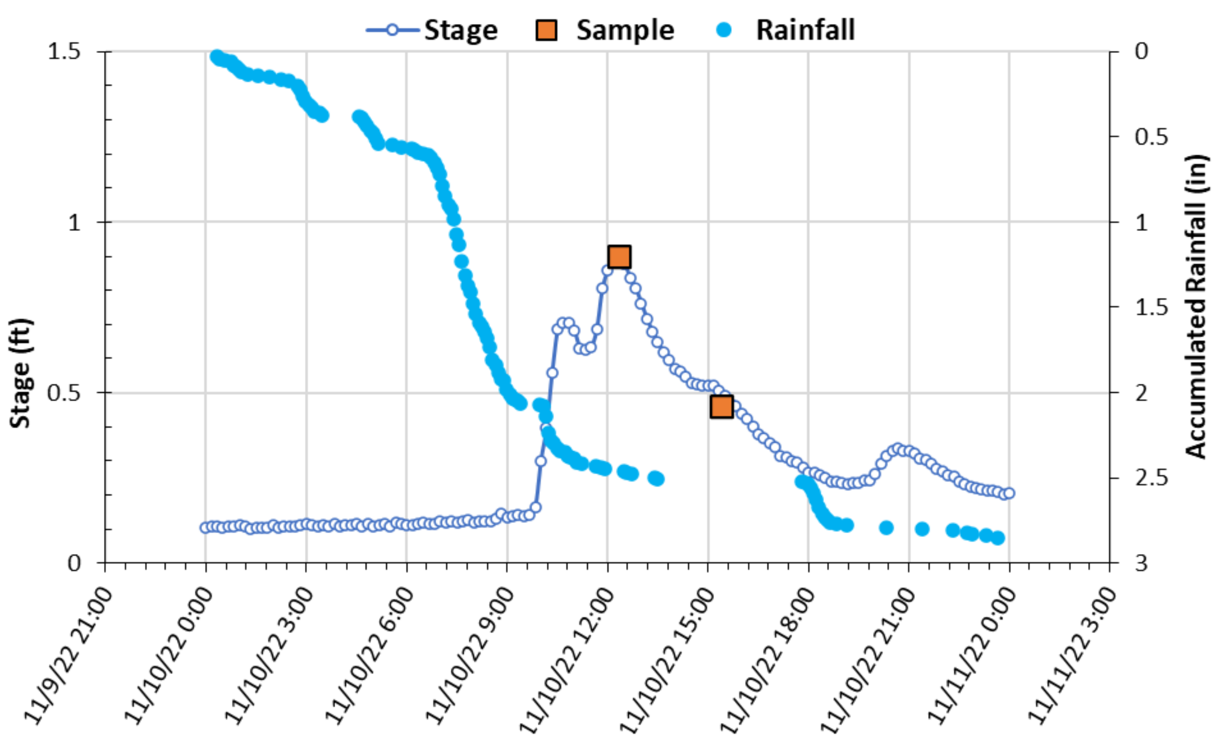

Figure 17. Stormwater hydrograph of the southern tributary showing the estimated stage when the first flush sampler was filled on November 10, 2022.

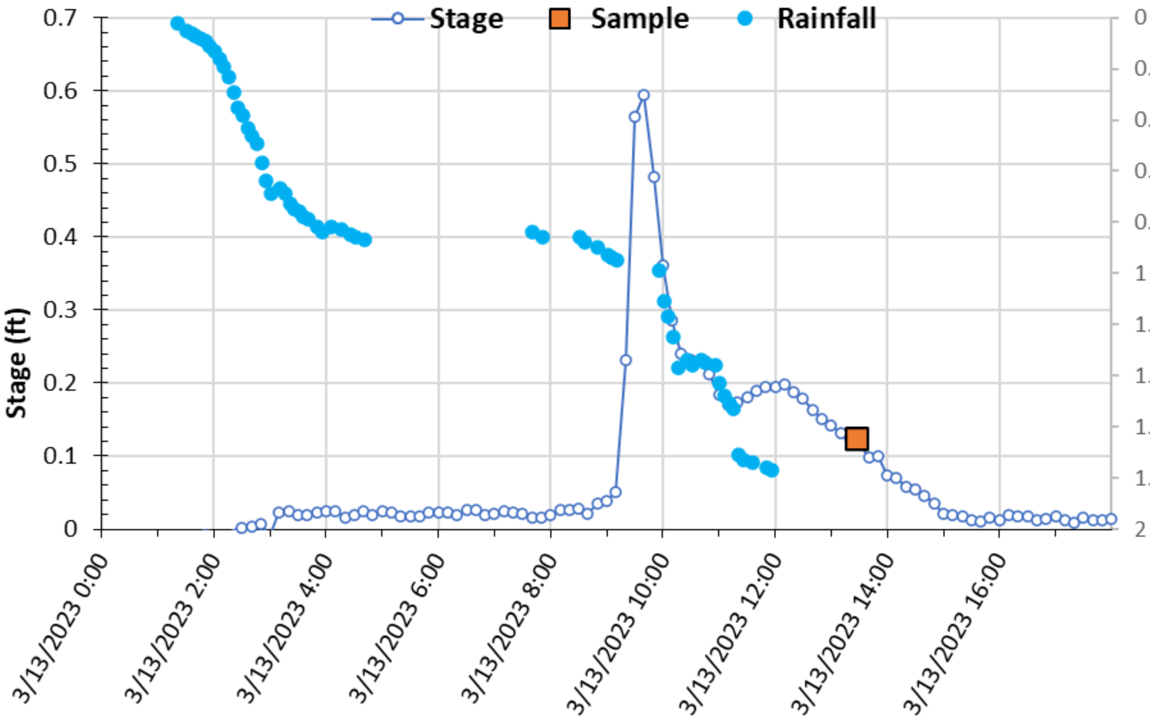

Figure 18. Stormwater hydrograph of the southern tributary showing the estimated stage when the water sample was collected on March 13, 2023.

Figure 19. Flow in the southern culvert at NE 221st Street.

Figure 20. First flush sampler installed at the staff gauge in the southern culvert at NE 221st Street.

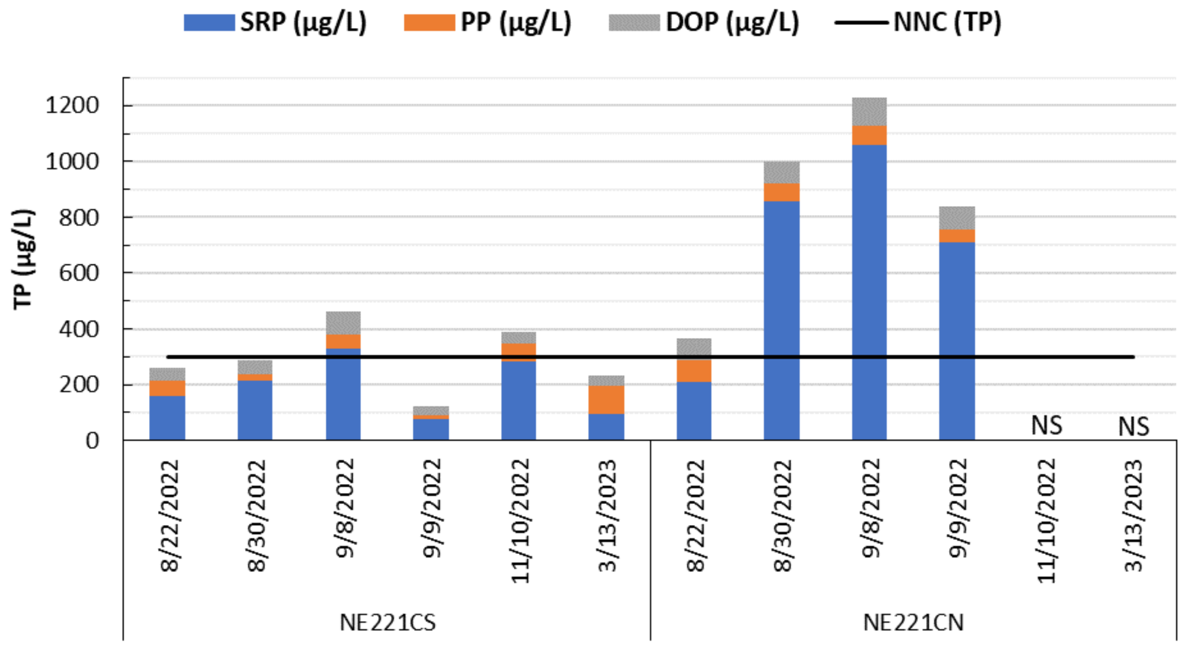

Figure 21. Total phosphorus concentration of runoff sampled downstream of the culverts beneath NE 221st Street, near Melrose, FL.

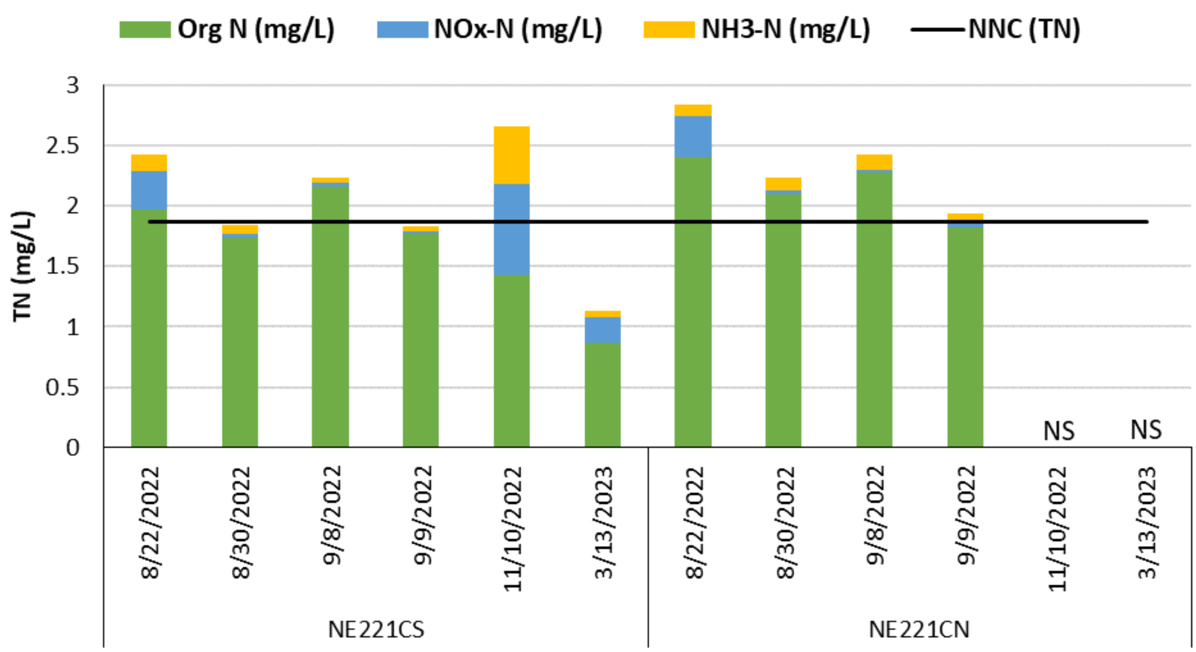

Figure 22. Total nitrogen concentration of runoff sampled downstream of the culverts beneath NE 221st Street, near Melrose, FL.

Modeled Nutrient Loads

The first step in modeling the runoff and nutrient load is to determine the contributing area or drainage basin. The initial drainage basin delineation of 269 acres was based on an outlet location near the canal mouth on Santa Fe Lake. Two sub-watersheds were then modeled upstream of each culvert crossing under NE 221st Street which were also the water quality sampling locations previously discussed (Figure 9). Upstream of these two culverts the combined drainage area is 181 acres.

The northern culvert drains approximately 49 acres, of which 36.5 acres is classified as cropland and pastureland, 6.25 acres is low-density residential, and 6 acres is forested wetlands (Figure 9). The soil beneath the agricultural land consists of Wauchula sand which is classified in the HSG C/D and Pomona sand which is in the group A/D (USDA NRCS classification). Wet soils with a high-water table (<24") are assigned to Group D even if the hydraulic conductivity is high enough to be classified in Groups A, B or C. The first letter of these dual hydrologic soil groups applies to the drained condition and the second to the undrained condition. Group C soils have moderately high runoff potential when thoroughly wet and water transmission through the soil is somewhat restricted. Group D soils have high runoff potential when thoroughly wet and water movement through the soil is restricted. For determining the runoff curve number (USDA NRCS 1986), these soils were considered in hydrologic soils group D, which results in a higher curve number (78) producing more runoff.

Due to the elevated nutrient concentrations measured in the two tributaries draining this agricultural area, the higher EMC for pastures was used instead of general agriculture in the model (Table 4). The low-density residential area has 1-acre lots on Plummer fine sand which is also in HSG A/D. The hydrologic soil group D was used to select the runoff curve number of 84. The forested wetlands, which have been ditched and drained, lie on Surrency sand in HSG A/D. To determine the runoff curve number (77), this area was considered woods in good hydrologic condition. This model run resulted in an estimated annual runoff of 37.6 acre-feet of water transporting approximately 279 pounds of nitrogen and 51 pounds of phosphorus, the large majority of which is attributed to the agricultural land uses in this 49-acre drainage basin upstream of the northern culvert (Table 4).

Table 4. Estimated annual runoff and nutrient loading from the drainage basin upstream of the northern culvert crossing under NE 221st Street.

Land Use	Agricultural - Pasture	Low-Density Residential	Undeveloped - Wet Flatwoods	Totals	Total Load (lbs/yr)
Area (acres)	36.46	6.25	6.07	48.78	
Rational Coefficient (0-1)	0.16	0.34	0.14		
Non DCIA Curve Number	78	84	77		
DCIA Percent (0-100)	1.7	20	0		
Nitrogen EMC (mg/l)	3.51	1.645	1.213		
Phosphorus EMC (mg/l)	0.686	0.27	0.021		
Runoff Volume (ac-ft/yr)	23.94	8.77	3.48	36.18	
Nitrogen Loading (kg/yr)	103.6	17.8	5.2	126.6	279.0
Phosphorus Loading (kg/yr)	20.2	2.9	0.1	23.3	51.3

The drainage basin upstream of the staff gauge in the southern culvert was modeled to be approximately 132 acres of which 56 acres lies south of SR 26 and is connected through a culvert under the highway (Figure 9). The 78 acres north of SR 26 that contributes runoff to the southern culvert consists of 62 acres of cropland and pastureland, which surround several acres of ditched and drained wetlands and bordered by 6.6 acres of transportation along the southern perimeter (Figure 9). The pasture area has two soil types with differing hydrologic soil groups (Pomona sand A/D and Pelham sand B/D). The runoff curve number for a meadow cover type with HSG D is 78. The highway land use (6.6 acres) consists of the paved portion of SR 26 (2.9 acres) and the open ditches along the right of way which lie on Pomona sand in the hydrologic soil group A/D (curve number 93). The small, forested area (3.8 acres) surrounding the ditched and drained wetlands (5.5 acres) lies on Pelham sand which is in hydrologic soil group B/D. These areas were considered a wooded cover type in good hydrologic condition, with group D soils which has a curve number of 77. This model run resulted in an estimated annual runoff volume of 62 acre-feet of water transporting approximately 449 pounds of nitrogen and 81 pounds of phosphorus (Table 5).

Table 5. Estimated annual runoff and nutrient loading from the drainage basin upstream of the southern culvert crossing under NE 221st Street.

Land Use	Agricultural - Pasture	Ruderal - Upland Pine	Wet Flatwoods	Highway	Totals	Total Load (lbs/yr)
Condition Area (acres)	62.17	3.81	5.46	6.6	78.04	
Rational Coefficient (0-1)	0.15	0.14	0.14	0.6		
Non DCIA Curve Number	78	77	77	93		
DCIA Percent (0-100)	0	0	0	43.55		

Nitrogen EMC (mg/l)	3.51	1.694	1.213	1.52		
Phosphorus EMC (mg/l)	0.686	0.162	0.021	0.2		
Runoff Volume (ac-ft/yr)	37.72	2.18	3.13	16.56	59.58	
Nitrogen Loading (kg/yr)	163.2	4.6	4.7	31.0	203.5	448.6
Phosphorus Loading (kg/yr)	31.9	0.4	0.1	4.1	36.5	80.5

The area south of SR 26 appears to be a closed basin which only discharges to the channel and lake under high water conditions, which was observed on June 22, 2023 (Figure 23). The hydrologic connection is made through the culvert under SR 26, to the ditches draining the sod farm. This drainage basin has 44 acres of silviculture and 10 acres of forested wetlands (Figure 9), which have relatively low nutrient loading rates. The upland pine forest lies on Pomona sand in HSG A/D, with a cover type of Woods in good condition the runoff curve number was 77. The forested wetlands had the same soil type, cover, and runoff curve number of 77. This model run resulted in an estimated annual runoff volume of 21 acre-feet of water transporting approximately 90 pounds of nitrogen and 8 pounds of phosphorus (Table 6) which is significantly less than the agricultural basins to the north.

Table 6. Estimated annual runoff and nutrient loading from the drainage basin upstream of SR 26 as estimated with the BMP Trains model.

	Ruderal - Upland Pine	Wet Flatwoods	Totals	Total Load (lbs/yr)
Area (acres)	43.74	10.1	53.84	
Rational Coefficient (0-1)	0.09	0.09		
Non DCIA Curve Number	77	77		
DCIA Percent (0-100)	0	0		
Nitrogen EMC (mg/l)	1.694	1.213		
Phosphorus EMC (mg/l)	0.162	0.021		
Runoff Volume (ac-ft/yr)	16.73	3.86	20.59	
Nitrogen Loading (kg/yr)	34.9	5.8	40.7	89.8
Phosphorus Loading (kg/yr)	3.3	0.1	3.4	7.6

Combined, these three drainage areas upstream of NE 221st Street potentially contribute 817 lbs of N and 139 lbs of P per year and 116 ac-ft of water. Agriculture accounts for 99 acres and contributes 267 lbs on TN and 52 lbs of TN per year. For comparison, the nutrient loads were also estimated using the annual runoff volume and land use from the MFL report (ECT 2021b), along with EMC data. The sub-basin modeled in the MFL report encompasses a larger area of 306 acres which includes 102 acres of agriculture associated with the sod farm. The 102 acres of agriculture was estimated to contribute 362 lbs of TN and 71 lbs of TP per year. This is a majority of the estimated annual nutrient load for the entire 306-acre watershed (681 lbs of TN and 101 lbs of TP).

Treatment options include stormwater ponds to capture runoff from SR 26 and NE 221st Street to reduce peak runoff volumes and loads. The County should encourage FDACS to work with the producer to create tailwater ponds which will capture runoff from the fields prior to entering the ephemeral stream channel and Santa Fe Lake. Together these BMPs will reduce peak runoff and nutrient loads to the lake. These are controllable nutrient sources which deserve further investigations to determine if nutrient reduction projects are feasible.

Figure 23. Water flowing from the forested parcel south of SR 26 (top picture) onto the agricultural parcel north of the highway (bottom picture). Water was also flowing from the roadside ditches on either side of SR 26.

Earleton, FL

While reviewing the stormwater geodatabase, a collector pipe was observed near the corner of CR 1469 and NE 100th Avenue. The stormwater infrastructure downstream of this area was surveyed and appended to the Alachua County stormwater geodatabase (Figure 24). Stormwater runoff from CR 1469 and NE 100th Avenue (CR NE 28-D) and the surrounding residences flows east into Santa Fe Lake. On either side of the road there are concrete-lined swales with culverts at each residential driveway collecting and quickly transporting runoff toward the lake (Figure 25). At the end of the concrete channel there is a small parcel where the stormwater discharges into a grass swale that extends approximately 220 ft before reaching the lake (Figure 26). The parcel is maintained for private access to the lake.

During the shoreline reconnaissance an outfall was observed near the Bristol Harbor condominiums. Subsequent field visits determined that stormwater runoff from NE 101st Avenue discharges directly into the lake. A concrete lined channel on the north side of the road transports stormwater from the roadway and surrounding residential lots into the lake on the Bristol Harbor condominium property (Figure 27). The stormwater infrastructure upstream of this area has been identified and appended to the Alachua County stormwater geodatabase (Figure 24).

As with the other stormwater discharges, these drainage basins were delineated by simulating flow over a modified DEM to determine the flow paths and drainage basin boundaries. The outfalls of each stormwater collection system on Santa Fe Lake were selected as the discharge locations or pour points for the initial drainage basin delineations. The stormwater collection system along NE 101st Ave drains approximately 12.2 acres which consists of 9.9 acres of low-density residential uses and 2.3 acres of upland hardwood forest (Figure 24). The drainage basin around NE 100th Ave is approximately 17.3 acres which is primarily low-density residential (15.5 acres) with some other land uses (Figure 24).

Several field visits to collect water quality samples within the same day or day after rain events found these stormwater collection systems were no longer flowing. Since these systems primarily drain directly connected impervious surfaces the runoff is quick and does not last long after the rain has ceased. Other options included installing autosamplers with area velocity meters or a temporary weir to record flow and create a pool to allow for collecting samples were considered. In place of direct measurements of discharge and nutrients, which were determined not to be feasible or cost effective at these locations, the BMP Trains model was used to estimate loading from these drainage areas.

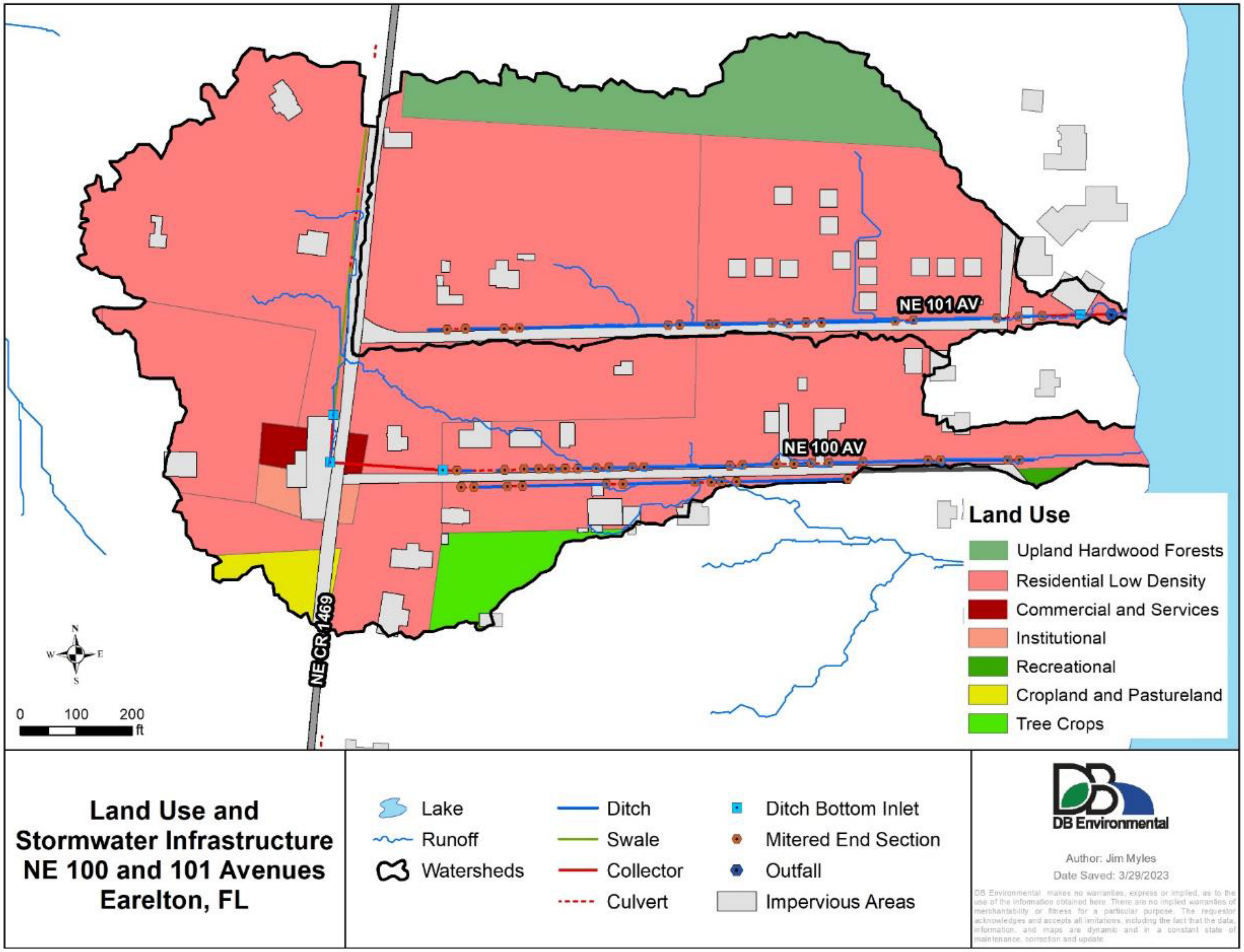

Figure 24. Land Use and stormwater infrastructure in the contributing areas along County Road 1469, NE 100th and 101st Avenues which discharge into Santa Fe Lake near Earleton, FL.

Figure 25. Stormwater collection system along NE 100th Avenue.

Figure 26. Outfall from the stormwater collection system along NE 100th Avenue that discharges into a grass swale before reaching Santa Fe Lake.

Figure 27. Outfall from the stormwater collection system along NE 101st Avenue that discharges into Santa Fe Lake.

Modeled Nutrient Loads

The BMP Trains model was used to estimate runoff and annual loading from the drainage areas draining NE 100th and NE 101st Avenues (Figure 24). The land uses within the drainage basins are primarily low-density residential with some upland woods, agriculture and commercial areas (Figure 24). The soils consist of the Lochloosa fine sand and Newnan sand soil types which are in Hydrologic Group A (USDA NRCS classification). The amount of impervious area within the basin was compiled from the building footprint layer and digitizing the areal extent of the roadways from recent imagery and DEM. The total impervious area is estimated to be 3.43 acres or 20% of the drainage area along NE 100th Avenue and 10% (1.27 acres) of the area draining NE 101st Avenue (Figure 24).

Several assumptions were made for this estimate, including that each land use was its own catchment that were routed in sequence from one to another and discharging to the lake. The curve number and percent impervious area for each land use type was determined along with the appropriate EMC (Table 7 and Table 8). This model run resulted in an estimated annual runoff of

15.7 acre-feet from NE 100th Avenue transporting approximately 75 pounds of nitrogen and 12 pounds of phosphorus (Table 7). The drainage basin for NE 101st Avenue discharges approximately 4.76 acre-feet of water carrying 20 pounds of nitrogen and 3 pounds of phosphorus per year (Table 8). The BMP Trains model can also be used to determine the potential load reduction from implementing BMPs in this drainage basin. **The evaluation of these modeled loads and the potential nutrient reductions from BMP implementation should be the next steps toward prioritizing external nutrient loads to Santa Fe Lake and developing nutrient reduction strategies. Some BMPs to consider in this basin include a stormwater pond to capture runoff from the County Road and commercial area at the top of the hill and replacing the concrete swales with vegetated swales NE 100th and 101st Avenues.** The potential reductions in nutrient loads from these drainage basins are relatively small when compared to other sources identified in this report. However, these are controllables sources from residential areas and County maintained roads.

Table 7. Estimated annual runoff and nutrient loading from the NE 100th Avenue drainage basin as estimated with the BMP Trains model.

Land Use	Low-Density Residential	Agricultural - General	Agricultural - Pasture	High-Intensity Commercial	Totals	Total Load (lbs/yr)
Area (acres)	17.3	0.69	0.39	0.73	19.11	
Rational Coefficient (0-1)	0.19	0	0.01	0.69		
Non DCIA Curve Number	61	36	49	89		
DCIA Percent (0-100)	20	0	0	80		
Nitrogen EMC (mg/l)	1.645	2.8	3.51	2.4		
Phosphorus EMC (mg/l)	0.27	0.487	0.686	0.345		
Runoff Volume (ac-ft/yr)	13.54	0.01	0.02	2.11	15.68	
Nitrogen Loading (kg/yr)	27.5	0.0	0.1	6.2	33.8	74.6
Phosphorus Loading (kg/yr)	4.5	0.0	0.0	0.9	5.4	12.0

Table 8. Estimated annual runoff and nutrient loading from the NE 101st Avenue drainage basin as estimated with the BMP Trains model.

Land Use	Low-Density Residential	Undeveloped - Upland Hardwood	Totals	Total Load (lbs/yr)
Area (acres)	9.93	2.31		
Rational Coefficient (0-1)	0.11	0		
Non DCIA Curve Number	61	29.9		
DCIA Percent (0-100)	10	0		
Nitrogen EMC (mg/l)	1.645	1.042		

Phosphorus EMC (mg/l)	0.27	0.346		
Runoff Volume (ac-ft/yr)	4.56	0.02	4.58	
Nitrogen Loading (kg/yr)	9.2	0.0	9.3	20.4
Phosphorus Loading (kg/yr)	1.5	0.0	1.5	3.4

Lake Bonnet Estates Area

The first phase of Lake Bonnet Estates was platted in 1985 and consisted of 15 parcels located on the west side of the County Road NE 221st Street (Plat Book M Page 88). The Lake Bonnet Estates Phase II subdivision (Plat Book S Page 99) was platted in 1996. The roadside ditches in this neighborhood discharge into four different stormwater retention ponds located within drainage easements (Figure 28). Based on our review of the records it is unclear whether these stormwater ponds are maintained by Alachua County, however the plat map dedicated the rights-of-way and easements to the public. The four drainage areas contributing runoff to these stormwater ponds were delineated and total 26 acres (Figure 28).

This subdivision is part of the larger Bonnet Lake sub-basin that was modeled for the MFL (Figure 29) and include rainfall runoff estimates (ECT 2021a) that we used to calculate annual nutrient loads. The average annual runoff from the 62 acres of low-density residential land use in the Bonnet Lake sub-basin (Figure 29) is 50 ac-ft which transports approximately 218 lbs of TN and 19 lbs of TP annually. The residential land use includes the Lake Bonnet Estates subdivision and a private gated community called Lake Bonnet Woods. Since the Lake Bonnet Estates subdivision already has stormwater basins **the next step is to determine if they are being maintained and if there are opportunities to improve the nutrient reduction capacity of these stormwater BMPs.**

The homes along the north and east side of this peninsula were platted in 1946 as the Santa Fe Shores subdivision (Plat Book D Page 20). There were no drainage easements recorded on the plat maps for this subdivision. There are 60 additional residential lots south of Santa Fe Shores that were not platted (Figure 28). The roadways serving these communities are private and not maintained by Alachua County (NE 222nd St, NE 223 St and NE 69th Ln) (Figure 28). Runoff from the County maintained road NE 221st Streets appears to drain through several of these private parcels before discharging into a canal on Santa Fe Lake (Figure 28). The 9-acre drainage area for this discharge to the lake was delineated (Figure 28). The Santa Fe Shores subdivision and other homes on the east of NE 221st Street (approximately 50 acres) are part of a larger sub-basin that was modeled for the MFL (ECT 2021b) and includes the area previously discussed (SR 26 and NE 221st St) as well as the residences along NE 69th Avenue which are discussed in the next section.

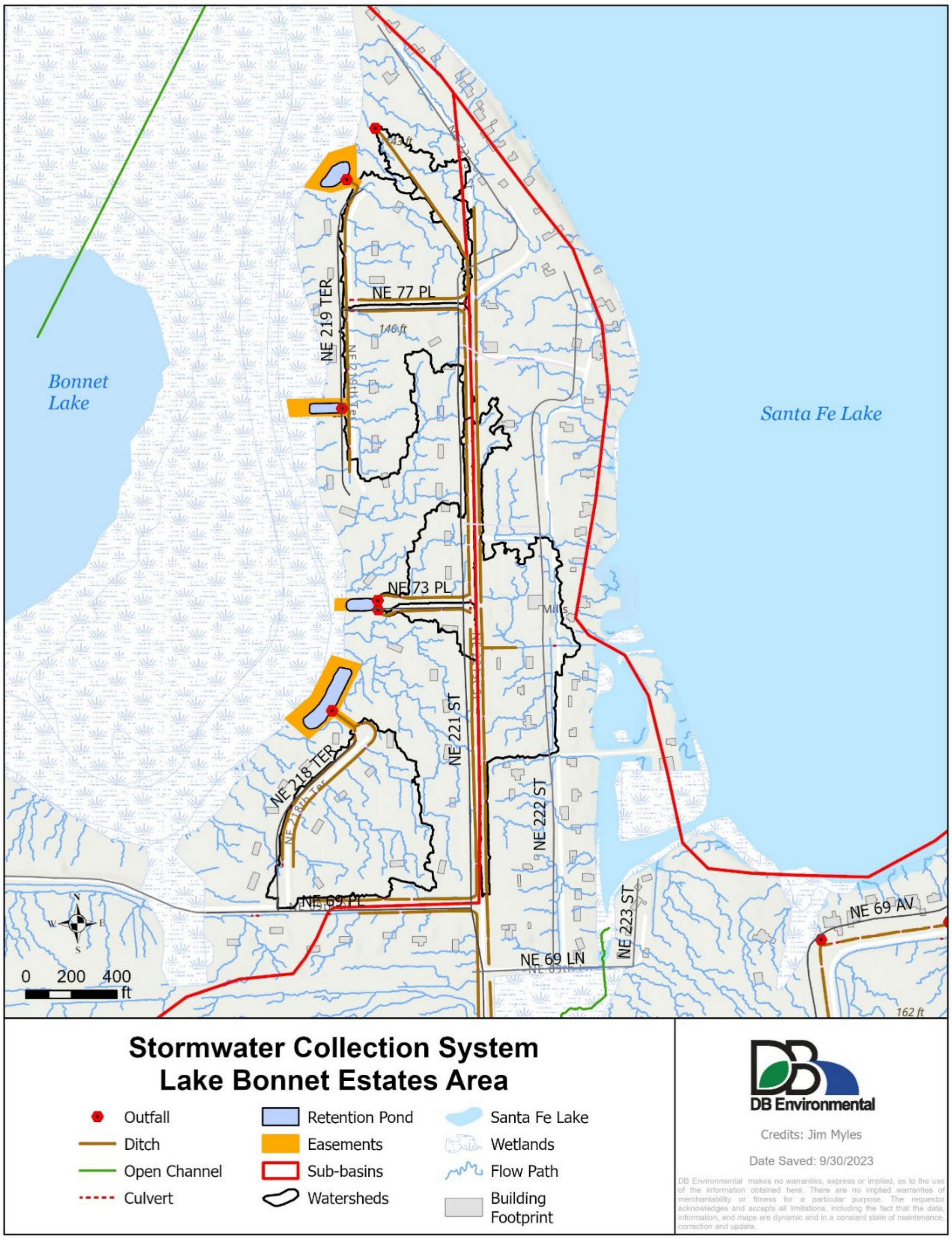

Figure 28. Stormwater collection system located near the Lake Bonnet Estates subdivision.

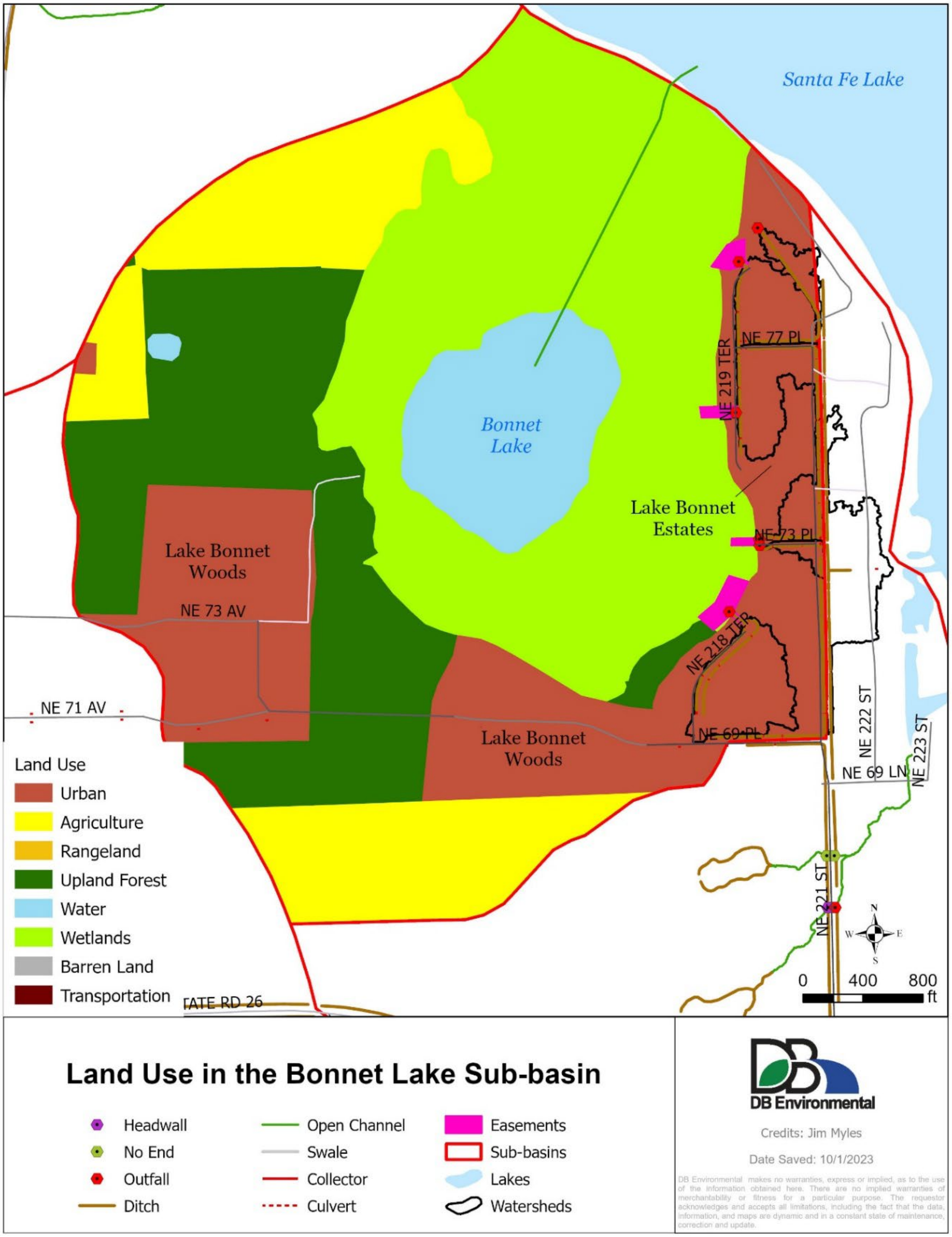

Figure 29. Land use within the Bonnet Lake Sub-basin.

NE 69th Avenue

The homes and parcels on the southern shore of Santa Fe Lake along NE 69th Avenue and NE 225th Street (Figure 30) were originally platted in 1949 as the Wallace Groves subdivision (Plat Book D, Pages 58 and 62). These plat maps did not include any drainage easements; however, a network of roadside ditches and culverts drain the area into the lake and littoral wetlands (Figure 30). The location of these culverts and ditches were verified in the field and added to the stormwater geodatabase (Figure 30). These drainage features collect runoff from the roadway and some residential lots (3.4 acres) as well as upland forests to the south of the road (16 acres) and some pasture (1.5 acres) (Figure 30). The residential lots north of NE 69th Avenue drain toward the lake (Figure 30).

This 31 acre subdivision is part of a larger sub-basin that was modeled for the MFL (ECT 2021a) and includes the areas previously discussed (SR 26 and NE 221st St) as well as the Santa Fe Shores subdivision and 60 other unplatted residential lots on the east side of NE 221st St (Figure 31). The combined residential land use in this larger sub-basin totals 81 acres (Figure 31) which produces an average annual runoff of 30 ac-ft and nutrient loads of approximately 148 lbs of TN and 18 lbs of TP per year.

Using BMP Trains to model the runoff and nutrient loads from the nine outfalls and delineated drainage areas identified in this sub-basin (Figure 31) was beyond the current scope of work. Instead, an estimate of nutrient loading by land use for the larger sub-basin was provided. **Additional modeling of the nutrient loads from all these drainage areas using the BMP Trains model and an assessment of nutrient reductions from BMP implementation should be done in the next phase of this project.**

Most of the waterfront residential lots in this area discharge runoff from roofs, driveways, and lawns directly to the lake, which are a source of controllable nutrients to the lake. **The County could use social marketing or other methods to educate property owners about nutrient reduction strategies they can implement, such as eliminating fertilizer use, septic tank maintenance and reducing runoff with rain gardens and other BMPs. The County should also investigate opportunities to reduce stormwater runoff from NE 221st Street and other County maintained roads in this area. Options include stormwater basins, swales, and ditch blocks to reduce road runoff to the lake.**

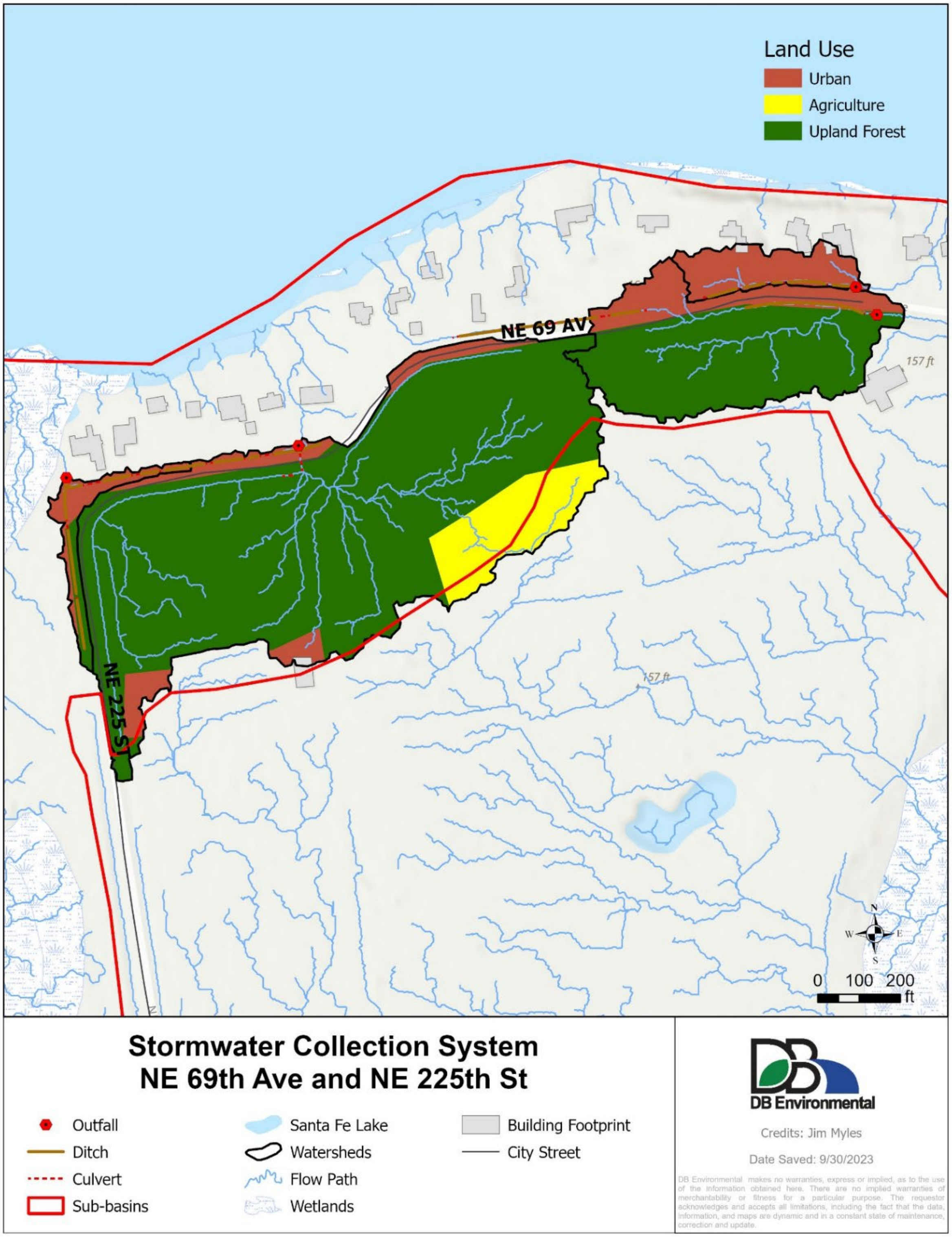

Figure 30. Stormwater collection system along NE 69th Avenue and NE 225th Street.

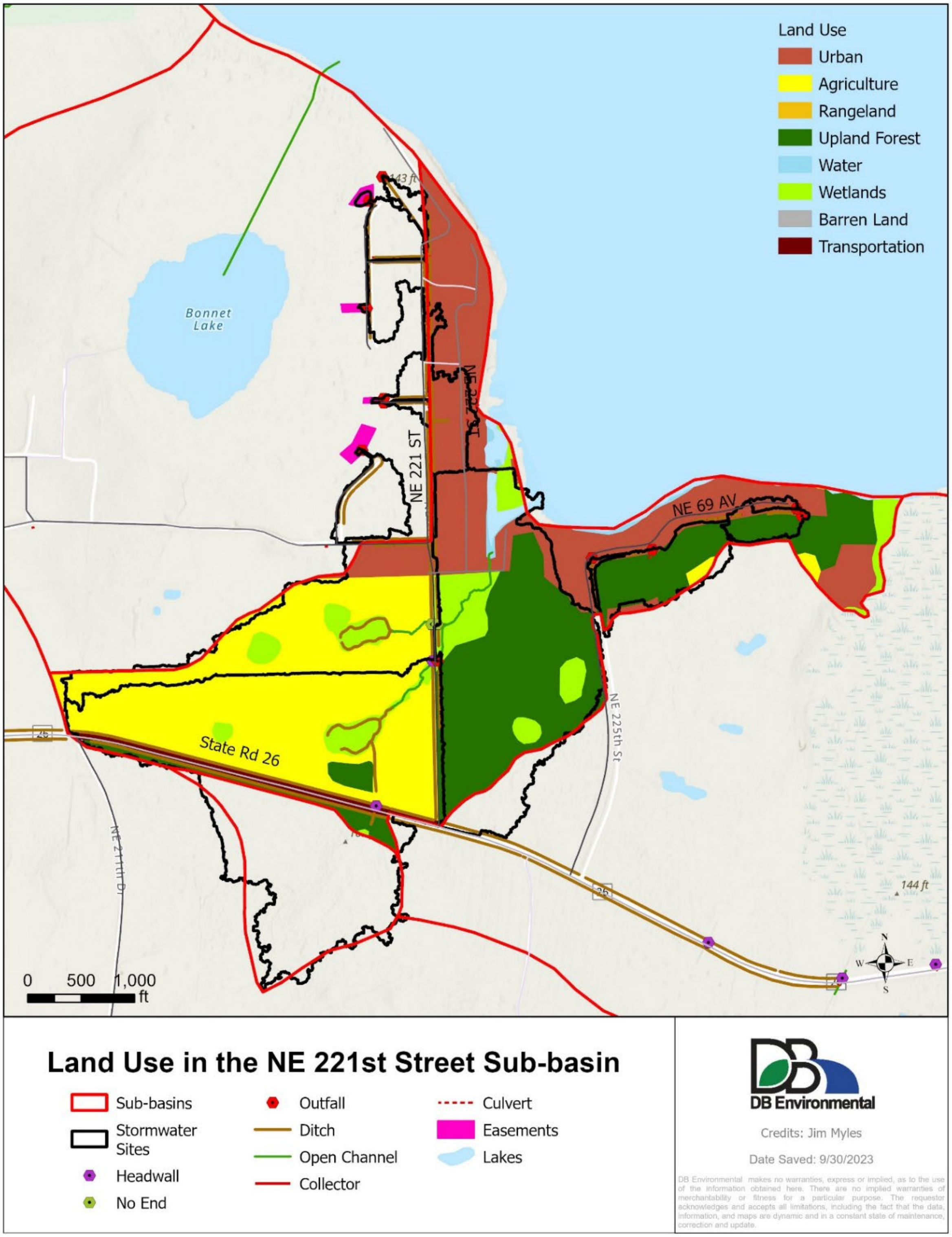

Figure 31. Land use in the sub-basin surrounding NE 221st Steet.

NE County Road 1469

Approximately 0.9 miles of NE County Road 1469 drains into a roadside ditch and concrete swales on the east side of the road (Figure 32) which discharge into an open channel on private property that ultimately flows into Santa Fe Lake (Figure 33). These roadside ditches drain approximately 30 acres of agriculture, 12.5 acres of Upland Forest, 0.8 acres of residential and 0.8 acres of water (Figure 32). Approximately 68 acres of upland forest and 3 acres of isolated wetlands are located west of NE CR 1469 which also drain through a culvert under CR 1469 and contribute to the flow in this channel (Figure 33). The entire sub-basin to the east is approximately 301 acres of which there is 112 acres of agricultural land, 16 acres of residential, 98 acres of Mesic Flatwoods, 41 acres of Wet Flatwoods and 32 acres of Upland Pine (Figure 32).

These two sub-basins were modeled as part of the MFL development and runoff estimates from the model (ECT 2021a) were used to estimate the nutrient loading from these sub-basins. The estimated annual nutrient load from these two sub-basins to Santa Fe Lake is 375 lbs TN/yr and 50 lbs TP/yr. **Estimates of flow and nutrients from just the portion flowing into the roadside ditches was beyond the scope of work for this phase of the project but recommended for the next phase.** Treatment options include stormwater retention basins on either side of the stream channel to capture and treat road runoff prior to reaching the lake. These basins should be designed with permanent pools and/or Biosorption Activated Media to enhance denitrification and binding of phosphorus transported by the stormwater. Other options include increasing the size of the roadside ditches and swales and adding ditch blocks to reduce runoff to the lake. The parcels outside of the road right-of-way in this drainage basin are privately owned. Any projects outside of the right-of-way will require the acquisition of land, a lease or easement.

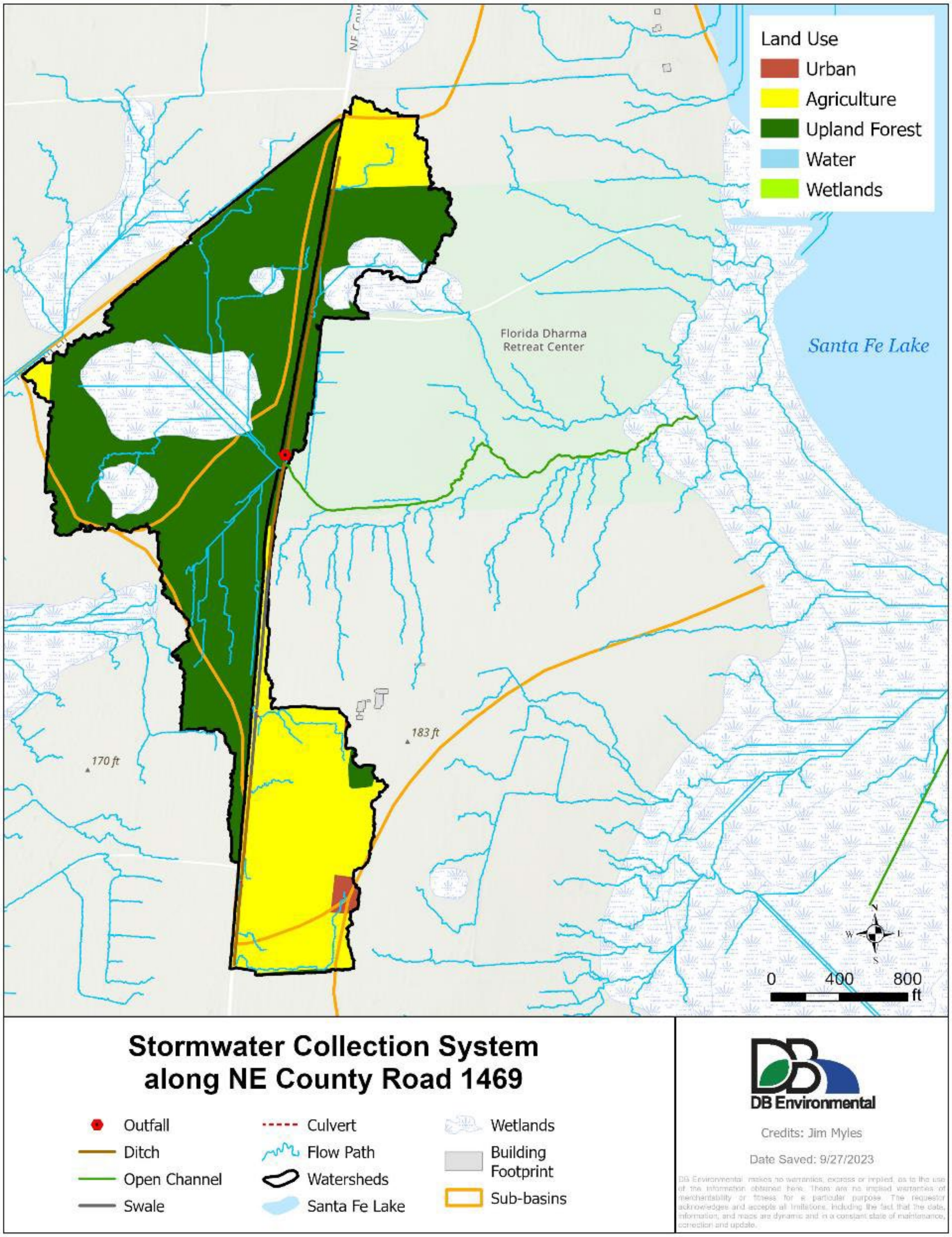

Figure 32. Stormwater collection system along NE County Road 1469.

Figure 33. Runoff in the roadside ditch along the east side of NE County Road 1469 (June 22, 2023).

Santa Fe Pass Subdivisions

The private subdivisions, now called The Cove and Bird Beach, are in Alachua County on the western peninsula forming the pass between Santa Fe Lake and Little Santa Fe Lake (Figure 35). After observing the roadside swales and culverts under each driveway during a field visit, the fate of stormwater runoff was determined through a combination of field investigations, reviewing public records and hydrologic modeling. Plat maps were downloaded from the Clerk of Courts office and georeferenced before digitizing the drainage easements which were added to the stormwater geodatabase, along with the location of roadside ditches and culverts (Figure 35). There were several plat maps that represent the original subdivisions in this area, including Santa Fe Pass (Plat Book J Page 99, Plat Book P Page 65-66), Blueberry Bay (Plat Book H Page 57, Plat Book K Page 26), Bird Beach (Unrecorded), Birds Acres (Book H Page 80), Crane Song (Book T Page 58) and Blueberry Bay Estates (Book N Page 50).

The Santa Fe Pass subdivision was re-platted in 1990 (Plat Book P Pages 65-66) and included three drainage easements to convey stormwater runoff from the roadways into the littoral wetlands of Santa Fe Lake (Figure 34). The 10-foot-wide drainage easements along all the roadways in this subdivision were not added to the stormwater geodatabase; however, the roadside ditches and culverts crossing under roads and driveways were added, along with the outfall locations (Figure 35). These outfalls represent the location where a ditch or swale discharges to an open channel, wetland, or lake.

Within this area there were 16 outfall locations identified and 13 separate drainage areas that cover a total area of 271 acres of which 128 acres is low-density residential, 113 acres of upland forest, 25 acres of rangeland and 5 acres of wetlands (Figure 36). Several of the drainage areas are almost entirely low-density residential land uses, while the largest drainage area of 113 acres consists of 24 acres of low-density residential, 66 acres of upland forest and a mix of rangeland and wetlands making up the remaining 23 acres (Figure 36). These subdivisions lie within three of the sub-basins that were modeled for the MFL (ECT 2021a) and used to estimate nutrient loading. One of these sub-basins is 134 acres and encompasses most of the peninsula, including 122 acres of low-density residential land uses (Figure 36). It was estimated that this sub-basin contributes approximately 131 lbs of TN and 11 lbs of TP to Little Santa Fe and Sante Fe Lakes annually. There are opportunities including roadside swales to capture and infiltrate stormwater from these roadways before it enters the lake, as well as in the drainage easements. **The loads from the 13 drainage areas as well as potential nutrient reduction from implementing BMPs should be complete in the next phase of this study.**

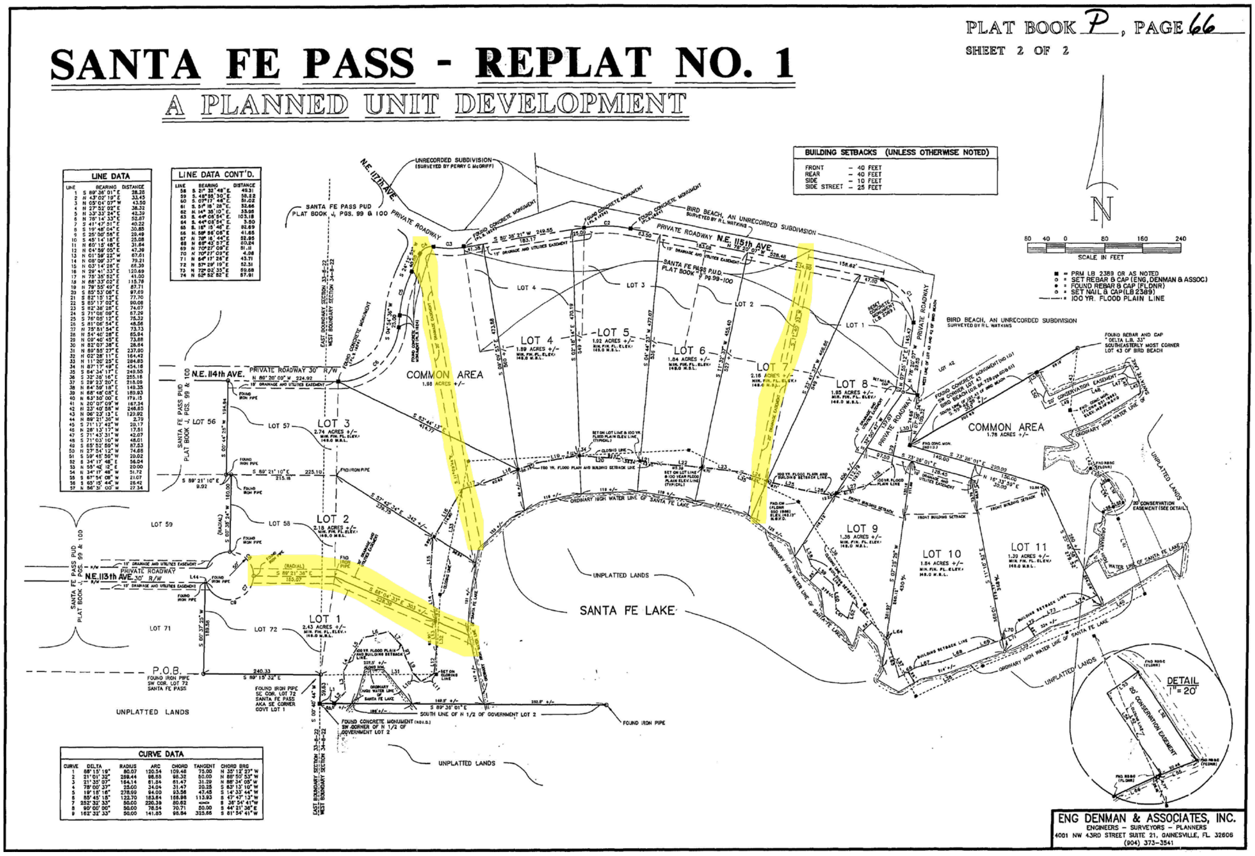

Figure 34. Santa Fe Pass Replat No 1, Plat Book P, Page 66, with the drainage easements highlighted.

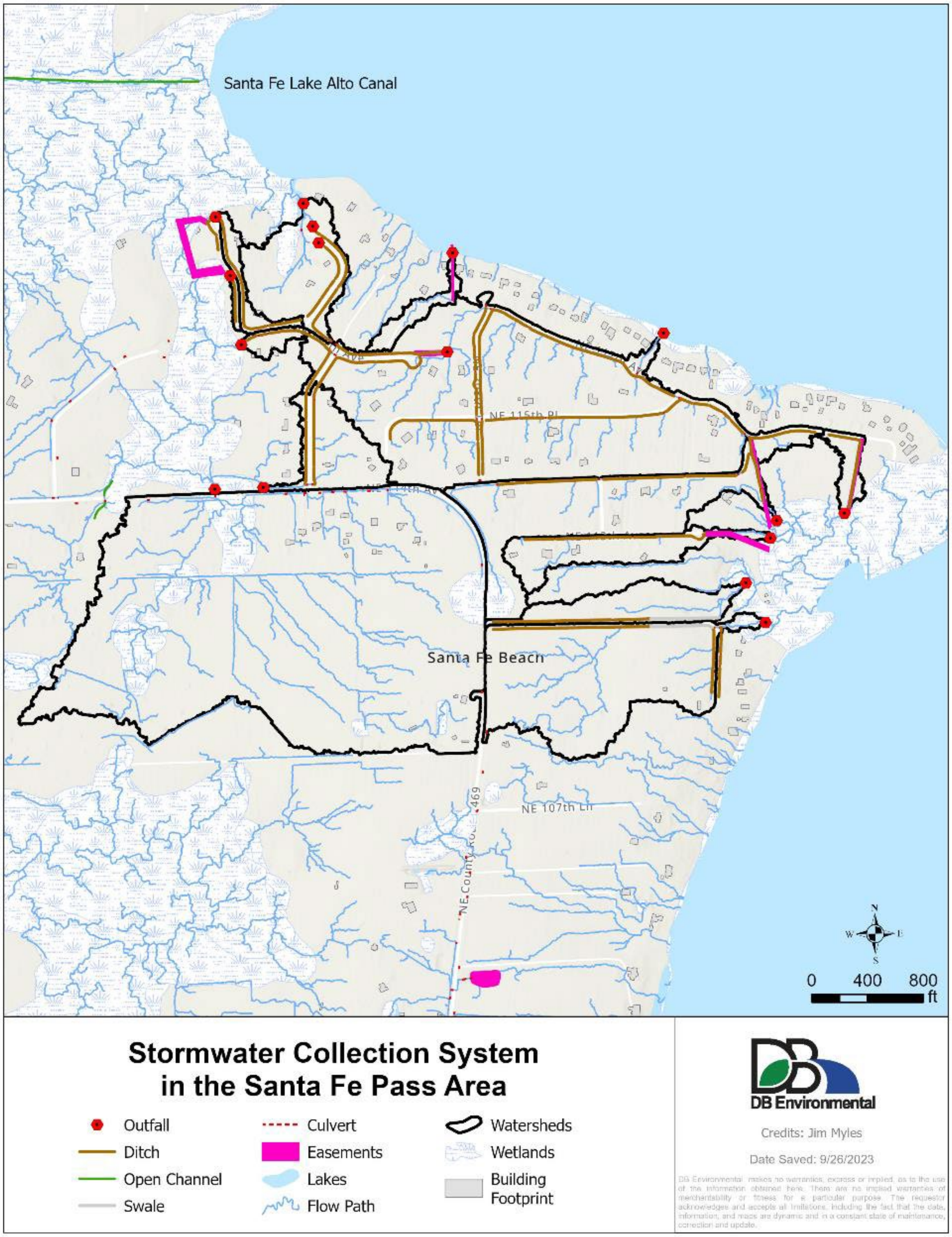

Figure 35. Stormwater collection system in the Santa Fe Pass subdivision.

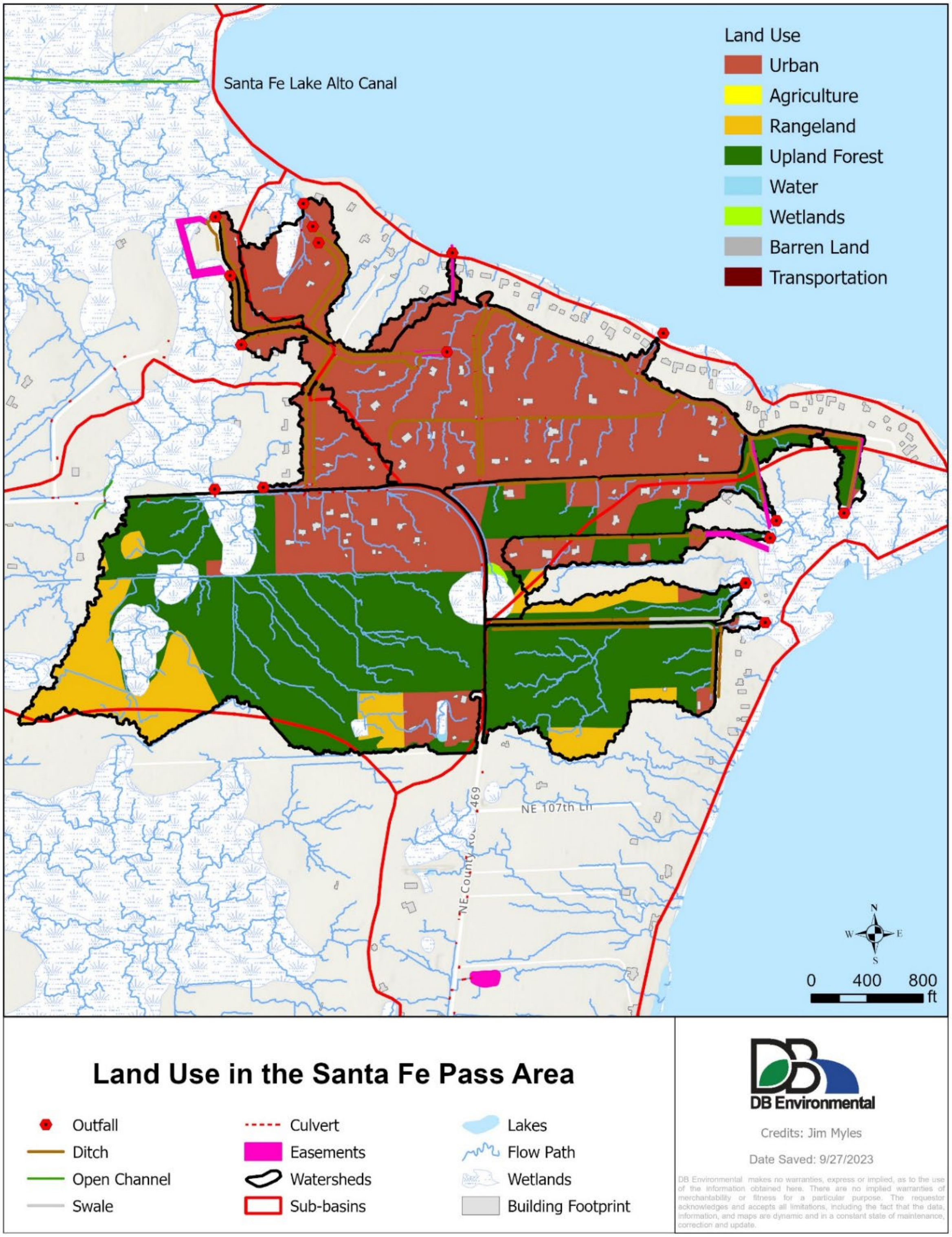

Figure 36. Land use in the Santa Fe Pass subdivisions (FDEP 2022).

NE 132nd Avenue

The eastern half mile of NE 132nd Ave drains into a ditch along the northern side of the road (Figure 37) which discharges into Santa Fe Lake through private property (Figure 38). There are also two outfalls on the south side of NE 132nd Ave that discharge into pine flatwoods that drain into the littoral wetlands of Santa Fe Lake (Figure 38). Additional outfalls were identified along NE 203rd Ter which discharges road runoff into a canal on Santa Fe Lake (Figure 38). Together these outfalls drain approximately 51 acres of which 39 acres are pecan groves, 7.5 acres are upland forest and 5 acres of low-density residential land uses (Figure 38). This 51-acre drainage basin is part of a larger (131 acres) sub-basin that was modeled for the MFL which included an estimate of annual runoff volumes. This larger sub-basin consists of 54 acres of agricultural land uses, 31 acres of urban development, 23 acres of flatwoods, 16 acres of wetlands and 5 acres of rangeland. We estimated the annual nutrient load from the larger sub-basin to be 154 lbs of TN and 14 lbs of TP.

Treatment options for stormwater consist of capturing road runoff transported by the ditches in stormwater basins or vegetated swales with ditch blocks, to infiltrate most runoff from storm events rather than discharging it to the lake.

Figure 37. Ditch along NE 132nd Avenue. Picture taken facing east toward the outfall and Little Santa Fe Lake.

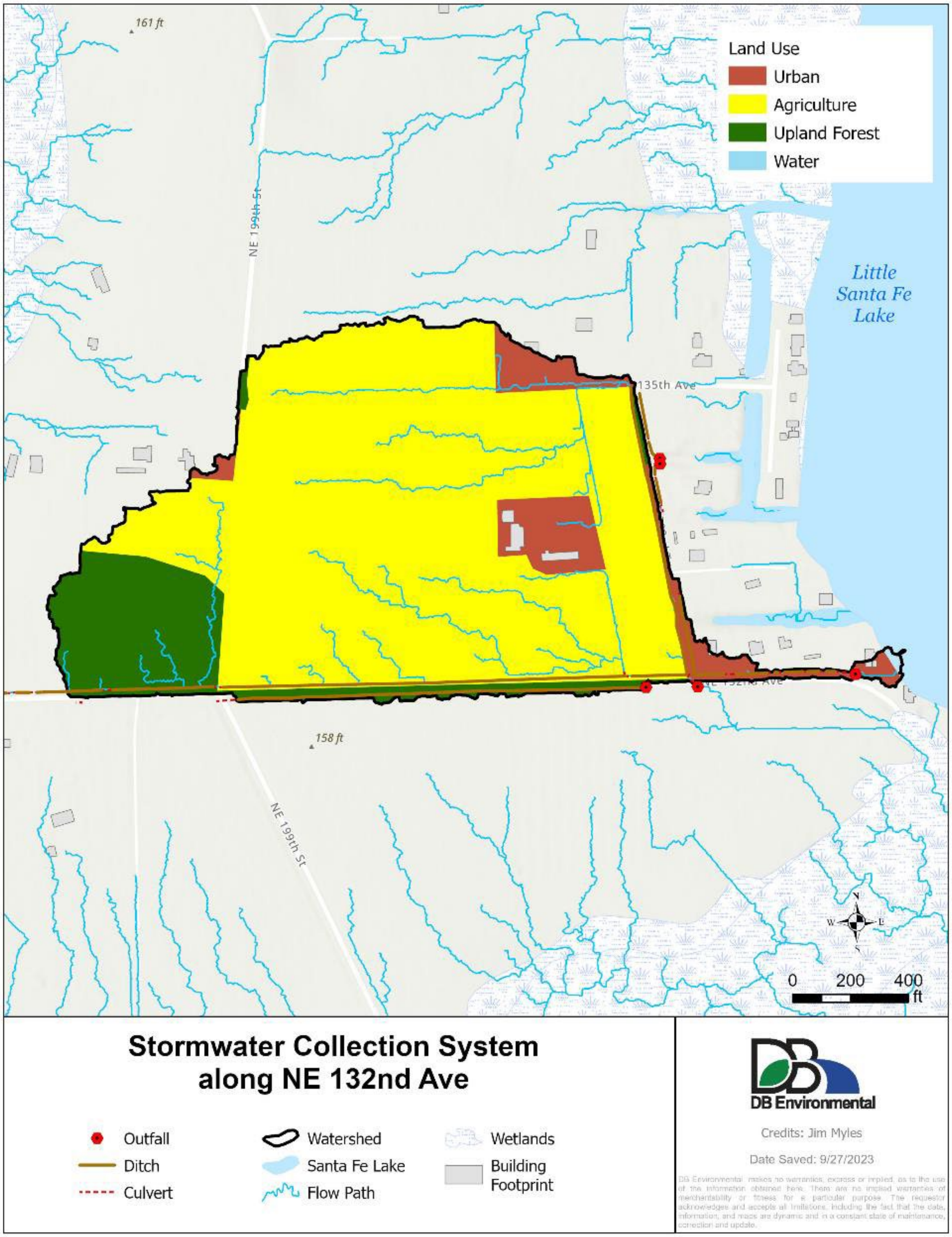

Figure 38. Ditch and culverts along NE 132nd Avenue and NE 203rd Terrace.

Summary and Recommendations

As a result of this investigation 37 stormwater drainage basins have been identified and delineated in the Alachua County portion of the Santa Fe Lake system. A combination of methods was used to estimate the nutrient loading from these stormwater discharges or from land use in the larger sub-basin. These areas and loads are summarized in Table 1. Within these 37 drainage basins, 8 areas were identified in which residential and developed land uses are the primary source of controllable nutrients. These include the Trout Street Boat Ramp, Lake Bonnet Estates, East of NE 221st St and NE 69th Ave, Earleton, FL and the Santa Fe Pass area.) (Table 1). Together these nutrients sources contribute approximately 697 lbs of TN and 80 lbs of TP per year (Table 1). To prioritize the 37 drainage basins, additional analysis and modeling of nutrient runoff and the effectiveness of BMP options in each of the 37 drainage basins as well as site specific design constraints needs to be completed in the next phase of this project.

There are opportunities to implement BMPs in the right-of-way of County maintained roads in these drainage basins to reduce runoff and nutrient loads to the lake. These include removing curbs, inlets and collector pipes and replacing them with vegetated roadside swales; increasing the size and infiltration capacity of existing ditches and installing ditch blocks; and adding curb cuts draining directly into vegetated swales all of which will infiltrate the runoff from most storm events rather than discharging it to the lake. There were only 5 existing stormwater basins identified in the Santa Fe Lake watersheds. The next step is to determine if they are being maintained and if there are opportunities to improve the nutrient reduction capacity by adding permanent pools and/or Biosorption Activated Media to enhance denitrification and binding of phosphorus transported by the stormwater. Additional treatment options exist if land adjacent to or along the flow path of the identified stormwater discharges are acquired by purchase, lease, or easement. These include building stormwater ponds, treatment wetlands, infiltration basins, filters, hydrodynamic separators, and other stormwater BMPs.

Most of the waterfront residential lots in this area discharge runoff from roofs, driveways, and lawns directly to the lake, which are all sources of controllable nutrients to the lake. **The County should use social marketing or other methods to educate property owners about nutrient reduction strategies they can implement, such as eliminating fertilizer use, septic tank upgrades and reducing runoff with rain gardens and other BMPs.** In phase 1 of this project, it was estimated that the 760 conventional septic systems contribute approximately 10,915 lbs N/year and 633 lbs P/year, from OSTDS within 200 m of Santa Fe Lake, to shallow groundwater and possibly the lake. Upgrading to nutrient reduction systems increases the treatment effectiveness by 15%, conventional systems have a 50% treatment effectiveness, and most nitrogen reduction systems have a 65% treatment effectiveness. The load reduction from upgrades would be approximately 3,275 lbs N/year.

Even though these nutrient loads are relatively small in comparison to the total loads to the lake, these are controllable nutrient sources from residential areas and County maintained roads which deserve further investigations to determine if nutrient reduction projects are feasible.

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Appendix A

Event Mean Concentration (EMC) by Land Use Category (Alachua County 2018; Wanielista et al. 2021) and the EMC from the draft Statewide Stormwater Rule (ERP)

Land Use Category	TN mg/L	TP mg/L	Source
Pasture	3.51	0.686	Alachua County/BMP Trains
Pasture ERP	3.03	0.593	ERP
General Agricultural	2.8	0.487	Alachua County/BMP Trains
Row Crops	2.65	0.593	Alachua County/BMP Trains
Row Crops ERP	2.5	0.577	ERP
High Intensity Commercial	2.4	0.345	All
Multi-Family	2.32	0.52	Alachua County/BMP Trains
General Agricultural ERP	2.29	0.381	ERP
Citrus	2.24	0.183	Alachua County/BMP Trains
Citrus ERP	2.11	0.18	ERP
Single Family	2.07	0.327	Alachua County/BMP Trains
Natural – Dry Prairie	2.025	0.184	All
Multi-Family ERP	1.84	0.52	ERP
Single Family ERP	1.77	0.327	ERP
Natural – Ruderal Upland Pine	1.694	0.162	All
Low Density Residential ERP	1.65	0.27	BMP Trains/ERP
Low Density Residential	1.6	0.137	Alachua County
Natural – Xeric Scrub	1.596	0.156	All
Highway	1.52	0.2	Alachua County/BMP Trains
Abandoned Tree Crops	1.25	0.08	BMP Trains
Highway ERP	1.25	0.173	ERP
Undeveloped natural communities	1.22	0.213	BMP Trains
Wet Flatwoods	1.213	0.021	BMP Trains/ERP
Light Industrial	1.2	0.26	All
Mining / Extractive	1.18	0.15	BMP Trains
Natural – Scrubby Flatwoods	1.155	0.027	All
Range land/park land	1.15	0.055	All
Low Intensity Commercial	1.13	0.188	Alachua County/BMP Trains
Natural - Wet Prairie	1.095	0.015	All
Natural – Wet Flatwoods	1.095	0.015	Alachua County
Natural – Mesic Flatwoods	1.09	0.043	All
Conventional rooftops	1.05	0.12	BMP Trains
Upland Hardwood	1.042	0.346	All
Low Intensity Commercial ERP	0.78	0.15	ERP
Natural – Marl Prairie	0.684	0.012	All
Natural – Upland Mixed Forest	0.606	1.166	Alachua County/ERP
Water	0	0	

Florida Land Use, Cover, and Forms Classification System matched with the Land Use categories and associated Event Mean Concentrations

FLUCCS Code	Land Use Description	EMC Land Use
1100	Residential, Low-Density-Less than two dwelling units/acre	Low Density Residential
1110	Fixed Single Family Units	Low Density Residential
1120	1120: Low Density, Mobile Home Units	Low Density Residential
1130	1130: Low Density, Mixed Units (Fixed and Mobile Home Units)	Low Density Residential
1180	Residential, Rural < or = 0.5 dwelling units/acre	Low Density Residential
1190	Low-Density Under Construction	Low Density Residential
1200	Residential, Medium-Density (Two-five dwelling units per acre)	Single Family
1210	Fixed Single Family Units	Single Family
1230	1230: Medium Density, Mixed Units (Fixed and Mobile Home Units)	Single Family
1290	Medium-Density Under Construction	Single Family
1300	Residential, High-Density	Multi-Family
1310	Fixed Single Family Units	Multi-Family
1320	Mobile Home Units	Multi-Family
1330	Residential, High-Density; Multiple Dwelling Units, Low Rise <Two stories or less>	Multi-Family
1340	Residential, High-Density; Multiple Dwelling Units, High Rise <Three stories or more>	Multi-Family
1350	Residential, High-Density; Mixed Units <Fixed and mobile Homes>	Multi-Family
1390	High-Density Under Construction	Multi-Family
1400	Commercial and Services	High Intensity Commercial
1410	Retail Sales and Services	High Intensity Commercial
1420	Wholesale Sales and Services <Excluding warehouses associated with industrial use>	Low Intensity Commercial
1430	Professional Services	Low Intensity Commercial
1440	Cultural and Entertainment	Low Intensity Commercial
1450	Tourist Services	High Intensity Commercial
1454	1454: Campgrounds	Low Intensity Commercial
1460	Oil and Gas Storage(except industrial use or manufacturing)	Light Industrial
1470	Mixed Commercial and Services	Low Intensity Commercial
1480	Cemeteries	Range land/park land
1490	Commercial and Services Under Construction	Low Intensity Commercial
1500	Industrial Under Construction	Light Industrial
1510	Food Processing	Light Industrial
1520	Timber Processing	Light Industrial
1530	Mineral Processing	Light Industrial
1540	Oil and Gas Processing	Light Industrial
1550	Other Light Industrial	Light Industrial
1560	Other Heavy Industrial	Light Industrial
1561	Ship Building and Repair	Light Industrial

FLUCCS Code	Land Use Description	EMC Land Use
1562	Pre-stressed concrete plants	Light Industrial
1590	Industrial Under Construction	Light Industrial
1600	Extractive	Mining / Extractive
1610	Strip Mines	Mining / Extractive
1611	Clays	Mining / Extractive
1620	Sand and Gravel Pits	Mining / Extractive
1632	Limerock or dolomite quarries	Mining / Extractive
1633	Phosphate quarries	Mining / Extractive
1650	Reclaimed Land	Mining / Extractive
1660	Holding Ponds	Mining / Extractive
1700	Institutional (Educational, religious, health and military facilities)	Low Intensity Commercial
1710	Educational Facilities	Low Intensity Commercial
1720	Religious	Low Intensity Commercial
1730	Military	Low Intensity Commercial
1740	Medical and Health Care	Low Intensity Commercial
1750	Governmental	Low Intensity Commercial
1770	Other Institutional	Low Intensity Commercial
1780	Commercial Child Care	Low Intensity Commercial
1790	Institutional Under Construction	Low Intensity Commercial
1800	Recreational	Range land/park land
1810	Swimming Beach	Range land/park land
1820	Golf Course	Row Crops
1830	Race Tracks(horse, dog, car, motorcycle)	High Intensity Commercial
1840	Marinas and Fish Camps	Low Intensity Commercial
1850	Parks and Zoos	Range land/park land
1860	Community Recreational Facilities	Range land/park land
1870	Stadiums (not associated with high schools, colleges, or universities)	High Intensity Commercial
1890	Other Recreational(Riding stables, go-cart tracks, skeet ranges, etc)	Range land/park land
1900	Open Land	Range land/park land
1920	Inactive Land with street patterns but without structures	Range land/park land
2100	Cropland and Pastureland	General Agricultural
2110	Improved Pasture	Pasture
2120	Unimproved Pastures	Pasture
2130	Woodland Pasture	Pasture
2140	Row Crops	Row Crops
2150	Field Crops	Row Crops
2153	2153: Hay Fields	Row Crops
2160	Mixed Crops	Row Crops
2200	Tree Crops	Citrus
2210	Citrus groves	Citrus
2220	Fruit Orchards	Citrus

FLUCCS Code	Land Use Description	EMC Land Use
2230	2230: Other Groves (Pecan, Avocado, Coconut, Mango, etc)	Citrus
2240	Abandoned tree crops	Abandoned Tree Crops
2300	Feeding Operations	General Agricultural
2310	Cattle Feeding Operations	General Agricultural
2320	Poultry feeding operations	General Agricultural
2340	Other feeding operations	General Agricultural
2400	Nurseries and Vineyards	General Agricultural
2410	Tree nurseries	General Agricultural
2420	Sod farms	General Agricultural
2430	Ornamentals	General Agricultural
2431	Shade ferns	General Agricultural
2432	Hammock ferns	General Agricultural
2450	Floriculture	General Agricultural
2500	Specialty Farms	General Agricultural
2510	Horse Farms	General Agricultural
2520	Dairies	General Agricultural
2540	Aquaculture	Light Industrial
2590	Other Specialty Farms	General Agricultural
2600	Other Open Lands - Rural	Range land/park land
2610	Fallow cropland	General Agricultural
3100	Herbaceous Dry Prairie	Natural – Dry Prairie
3200	Shrub and Brushland	Natural – Scrubby Flatwoods
3210	Palmetto Prairies	Natural – Dry Prairie
3211	Palmetto-Oak Shrubland	Natural – Dry Prairie
3212	Dry Prairie	Natural – Dry Prairie
3220	Coastal Strand	Natural – Dry Prairie
3300	Mixed Rangeland	Natural – Dry Prairie
4100	Upland Coniferous Forests	Natural – Ruderal Upland Pine
4110	Pine flatwoods	Natural – Wet Flatwoods
4111	Mesic longleaf pine flatwoods	Natural – Mesic Flatwoods
4112	Scrubby Pine flatwoods	Natural – Mesic Flatwoods
4113	Hydric pine flatwoods	Natural – Wet Flatwoods
4120	Longleaf pine - xeric oak	Natural – Upland Mixed Forest
4130	Sand pine	Natural – Xeric Scrub
4140	Upland Mixed Forest	Natural – Upland Mixed Forest
4200	Upland Hardwood Forest	Natural – Mesic Flatwoods
4210	Xeric oak	Natural – Xeric Scrub
4220	Brazilian Pepper	Natural – Ruderal Upland Pine

FLUCCS Code	Land Use Description	EMC Land Use
4260	Tropical Hardwood Hammock	Natural – Wet Flatwoods
4270	Maritime Hammock	Natural – Wet Flatwoods
4271	Coastal Temperate Hammock	Natural – Wet Flatwoods
4272	Prairie Hammock	Natural – Wet Flatwoods
4275	Red Cedar- Cabbage Palm Hammock	Natural – Wet Flatwoods
4280	Cabbage palm	Natural – Wet Flatwoods
4300	Upland Hardwood Forests Continued	Upland Hardwood
4321	Xeric Oak Scrub	Natural – Xeric Scrub
4322	Xeric Hammock	Natural – Xeric Scrub
4340	Hardwood Conifer Mixed	Natural – Mesic Flatwoods
4370	Australian pine	Natural – Xeric Scrub
4400	Tree Plantations	Natural – Ruderal Upland Pine
4410	Coniferous pine	Natural – Ruderal Upland Pine
4430	Forest regeneration	Natural – Ruderal Upland Pine
5100	Streams and waterways	Water
5100	5100: Streams and Waterways	Water
5120	5120: Channelized Waterway	Water
5120	Channelized waterways, canals	Water
5200	5200: Lakes	Water
5200	Lakes	Water
5201	Pond	Water
5250	Marshy Lakes	Water
5300	5300: Reservoirs	Water
5300	Reservoirs	Water
5330	Reservoirs larger >10 <100 acres	Water
5400	Bays and estuaries	Water
5410	Embayments opening directly to the Gulf or Ocean	Water
5430	Enclosed saltwater ponds within a salt marsh	Water
5474	Spoil islands/coastal islands	Mining / Extractive
5500	Major Springs	Water
5600	Slough Waters	Water
5600	5600: Slough Waters (channels of slow moving water)	Water
5710	Atlantic Ocean	Water
6100	Wetland Hardwood Forests	Natural – Wet Flatwoods
6110	Bay swamps	Natural – Wet Flatwoods
6120	Mangrove swamp	Natural – Wet Flatwoods
6130	6130: Gum Swamps	Natural – Wet Flatwoods
6140	6140: Titi Swamps	Natural – Wet Flatwoods
6150	Lowland Harwdood Forest/Swamp	Natural – Wet Flatwoods
6151	Willow Swamp	Natural – Wet Flatwoods

FLUCCS Code	Land Use Description	EMC Land Use
6152	Red Maple Swamp	Natural – Wet Flatwoods
6153	Shrub Swamp	Natural – Wet Flatwoods
6170	Mixed wetland hardwoods	Natural – Wet Flatwoods
6172	Mixed Shrubs	Natural - Wet Prairie
6181	Cabbage palm hammock	Natural – Wet Flatwoods
6182	Cabbage palm savannah	Natural – Wet Flatwoods
6200	Wetland Coniferous Forest	Natural – Wet Flatwoods
6210	Cypress	Natural – Wet Flatwoods
6220	Pond pine	Natural – Wet Flatwoods
6250	Hydric pine flatwoods	Natural – Mesic Flatwoods
6300	Wetland Forested Mixed	Natural – Wet Flatwoods
6400	Freshwater marshes	Natural – Wet Flatwoods
6410	Freshwater marshes	Natural – Wet Flatwoods
6411	Sawgrass marsh	Natural – Wet Flatwoods
6412	Cattail marsh	Natural – Wet Flatwoods
6414	Graminoid marsh	Natural – Wet Flatwoods
6416	Flag marsh	Natural – Wet Flatwoods
6420	Saltwater marshes	Natural – Wet Flatwoods
6423	Low salt marsh	Natural – Wet Flatwoods
6424	High salt marsh	Natural – Wet Flatwoods
6430	Wet prairies	Natural - Wet Prairie
6440	Emergent aquatic vegetation	Natural – Wet Flatwoods
6460	Mixed scrub-shrub wetland	Natural – Wet Flatwoods
6500	Non-vegetated Wetland	Natural – Wet Flatwoods
6510	Tidal creek	Natural – Wet Flatwoods
6530	6530: Intermittent Ponds	Natural – Wet Flatwoods
7100	Beaches other than swimming beaches	Range land/park land
7200	Sand other than beaches	Range land/park land
7340	Exposed rocks	Range land/park land
7400	Disturbed land	Range land/park land
7410	Rural land in transition without positive indicators of intended activity	Range land/park land
7420	Borrow areas	Mining / Extractive
7430	Spoil areas	Mining / Extractive
8100	Transportation	Highway
8110	Airports	Low Intensity Commercial
8115	Grass Airports	Range land/park land
8120	Railroads	Highway
8130	Bus and truck terminals	High Intensity Commercial
8140	Roads and Highways	Highway
8150	Port facilities	High Intensity Commercial
8160	Canals and Locks	Low Intensity Commercial

FLUCCS Code	Land Use Description	EMC Land Use
8170	8170: Oil, Water or Gas Long Distance Transmission Lines	Low Intensity Commercial
8180	Auto parking facilities - when not directly related to other land uses	Low Intensity Commercial
8191	Highways	Highway
8200	Communications	Light Industrial
8220	Communication Facilities	Light Industrial
8300	Utilities	Light Industrial
8310	Electrical power facilities	Light Industrial
8320	Electrical power transmission lines	Light Industrial
8330	Water supply plants	Light Industrial
8340	Sewage Treatment	Light Industrial
8350	Solid waste disposal	Light Industrial
8360	Other treatment ponds	Light Industrial
8370	Surface Water Collection Basin	Water
8390	Utilities under construction	Light Industrial

Total runoff (inches) within each sub-basin during the SWMM modeling period of 2006-2016 for Santa Fe Lake and Lake Alto (ECT 2021a)

Sub-basin	Acres	Total Runoff (inches)	Runoff (ft/yr)	Runoff (ac-ft/yr)
A0100	319	133	1.11	352
A0110	79	72	0.60	47
A0120	57	50	0.41	24
A0200	240	117	0.97	233
A0210	96	0	0.00	0
A0220	26	0	0.00	0
A0300	178	150	1.25	222
A0310	62	24	0.20	12
A0320	126	32	0.27	34
A0330	73	0	0.00	0
A0400	582	177	1.48	860
A0405	34	116	0.97	32
A0410	66	27	0.23	15
A0412	68	32	0.27	18
A0414	44	22	0.18	8
A0420	19	23	0.19	4
A0422	20	13	0.11	2
A0430	39	28	0.24	9
A0500	308	176	1.46	451
A0505	46	48	0.40	18

Sub-basin	Acres	Total Runoff (inches)	Runoff (ft/yr)	Runoff (ac-ft/yr)
A0510	43	25	0.21	9
A0512	24	29	0.24	6
A0514	8	58	0.48	4
A0516	51	149	1.24	63
A0518	38	44	0.36	14
A0520	23	173	1.44	34
A0522	90	69	0.57	51
A0530	132	44	0.37	49
A0540	144	64	0.53	77
A0542	83	120	1.00	83
A0544	64	31	0.25	16
A0550	196	93	0.78	153
A0560	89	72	0.60	54
A0570	79	131	1.09	86
A0580	154	59	0.49	75
A0582	47	27	0.22	10
A0584	44	38	0.32	14
A0586	68	28	0.23	16
A0588	56	31	0.26	14
A0590	46	45	0.37	17
A0592	84	101	0.84	71
A0600	547	176	1.47	801
A0610	76	40	0.34	26
A0620	156	22	0.18	28
A0630	54	120	1.00	54
A0640	29	0	0.00	0
B0100	627	343	2.86	1791
B0110	121	0	0.00	0
B0112	93	0	0.00	0
B0120	216	29	0.24	52
B0130	104	47	0.39	41
B0140	14	245	2.04	29
B0150	59	0	0.00	0
B0160	82	16	0.13	11
B0200	185	93	0.78	144
B0300	119	116	0.97	115
B0400	538	120	1.00	539
B0410	26	63	0.53	14
C0100	3282	208	1.74	5700
C0110	286	48	0.40	115
C0120	305	10	0.08	25

Sub-basin	Acres	Total Runoff (inches)	Runoff (ft/yr)	Runoff (ac-ft/yr)
C0200	303	127	1.06	321
C0201	248	0	0.00	0
C0202	46	41	0.35	16
C0203	86	0	0.00	0
C0204	124	32	0.27	33
C0210	539	24	0.20	109
C0212	314	21	0.18	56
C0220	460	31	0.26	118
C0230	172	37	0.31	53
C0240	202	20	0.16	33
C0244	219	28	0.23	51
C0250	774	46	0.39	299
C0254	33	16	0.13	4
C0260	263	67	0.56	148
C0270	176	158	1.31	231
C0280	1175	53	0.44	520
C0282	243	67	0.56	136
C0300	443	155	1.29	572
C0301	46	0	0.00	0
C0303	17	34	0.29	5
C0304	144	24	0.20	29
C0306	20	47	0.39	8
C0308	88	68	0.57	50
C0310	253	43	0.36	91
C0311	96	31	0.26	25
C0314	159	27	0.23	36
C0316	112	24	0.20	23
C0320	155	0	0.00	0
C0322	116	0	0.00	0
C0330	170	27	0.23	39
C0340	484	30	0.25	120
C0342	37	73	0.61	22
C0344	49	39	0.33	16
C0350	790	26	0.21	168
C0360	224	21	0.18	40
C0370	313	17	0.14	45
C0400	970	146	1.21	1176
C0410	296	70	0.58	172
C0420	117	16	0.13	15
C0430	162	20	0.16	26
C0500	1445	148	1.23	1783

Sub-basin	Acres	Total Runoff (inches)	Runoff (ft/yr)	Runoff (ac-ft/yr)
C0505	49	0	0.00	0
C0507	121	0	0.00	0
C0508	59	48	0.40	24
C0510	118	49	0.41	48
C0520	83	61	0.51	42
C0522	70	36	0.30	21
C0530	313	24	0.20	62
C0540	196	17	0.14	28
C0550	553	91	0.76	419
C0552	75	40	0.33	25
D0040	490	19	0.16	79
D0045	63	47	0.39	25
D0050	582	57	0.47	275
D0055	207	21	0.17	36
D0100	1224	339	2.82	3457
D0110	29	138	1.15	33
D0120	73	81	0.68	49
D0130	33	29	0.25	8
D0140	64	0	0.00	0
D0150	131	30	0.25	32
D0160	10	85	0.71	7
D0170	110	61	0.51	56
D0180	134	28	0.23	31
D0200	141	28	0.23	33
E0100	4290	360	3.00	12862
E0110	193	47	0.39	75
E0120	104	158	1.32	137
E0130	42	97	0.81	34
E0140	23	163	1.36	32
E0150	280	26	0.22	60
E0160	302	22	0.19	56
E0162	48	42	0.35	17
E0170	306	45	0.38	115
E0172	48	38	0.32	15
E0180	88	104	0.86	76
E0190	87	54	0.45	39
E0200	76	109	0.91	70
E0210	100	42	0.35	35
E0220	793	67	0.56	443
E0230	87	82	0.69	59
E0300	169	70	0.58	99

Sub-basin	Acres	Total Runoff (inches)	Runoff (ft/yr)	Runoff (ac-ft/yr)
E0400	95	61	0.51	48
E0410	135	53	0.44	59
E0420	41	47	0.39	16
E0422	26	26	0.21	6
E0425	37	14	0.12	4
E0430	166	55	0.46	76
E0440	170	19	0.16	27
E0450	262	48	0.40	104
E0452	79	33	0.27	21
E0460	89	0	0.00	0
E0462	45	42	0.35	16
E0500	523	97	0.81	424
E0600	677	91	0.76	514
E0700	133	45	0.37	50

Total TN and TP load (lbs/yr) by Sub-basin for the entire Santa Fe Lake and Lake Alto watersheds.

Sub-basin	Watershed	TN Load (lbs/yr)	TP Load (lbs/yr)	Percent TN Load	Percent TP Load
A0100	Altho Swamp	1115	35	7.6%	4.4%
A0110	Altho Swamp	200	18	1.4%	2.3%
A0120	Altho Swamp	102	9	0.7%	1.2%
A0200	Altho Swamp	862	55	5.9%	6.9%
A0210	Altho Swamp	0	0	0.0%	0.0%
A0220	Altho Swamp	0	0	0.0%	0.0%
A0300	Altho Swamp	718	22	4.9%	2.8%
A0310	Altho Swamp	75	14	0.5%	1.8%
A0320	Altho Swamp	172	19	1.2%	2.5%
A0330	Altho Swamp	0	0	0.0%	0.0%
A0400	Altho Swamp	2704	73	18.5%	9.2%
A0405	Altho Swamp	154	15	1.1%	1.9%
A0410	Altho Swamp - Weldo/East of US 301 & West of RR	68	6	0.5%	0.7%
A0412	Altho Swamp - Weldo/East of US 301 & West of RR	65	3	0.4%	0.4%
A0414	Altho Swamp - Weldo/East of US 301 & West of RR	34	3	0.2%	0.4%
A0420	Altho Swamp - Weldo/East of US 301 & West of RR	23	4	0.2%	0.4%
A0422	Altho Swamp - Weldo/East of US 301 & West of RR	16	3	0.1%	0.3%
A0430	Altho Swamp - Weldo/East of US 301 & West of RR	37	3	0.3%	0.4%
A0500	Altho Swamp	1383	33	9.5%	4.1%
A0505	Altho Swamp - Weldo/East of US 301 & West of RR	72	5	0.5%	0.7%
A0510	Altho Swamp - Weldo/East of US 301 & West of RR	34	2	0.2%	0.3%

Sub-basin	Watershed	TN Load (lbs/yr)	TP Load (lbs/yr)	Percent TN Load	Percent TP Load
A0512	Altho Swamp - Weldo/East of US 301 & West of RR	24	2	0.2%	0.2%
A0514	Altho Swamp - Weldo/East of US 301 & West of RR	14	1	0.1%	0.1%
A0516	Altho Swamp - Weldo/East of US 301 & West of RR	311	34	2.1%	4.3%
A0518	Altho Swamp - Weldo/East of US 301 & West of RR	51	4	0.3%	0.5%
A0520	Altho Swamp - Weldo/East of US 301 & West of RR	155	17	1.1%	2.1%
A0522	Altho Swamp - Weldo/West of US 301	206	17	1.4%	2.1%
A0530	Altho Swamp - Weldo/East of US 301 & West of RR	185	13	1.3%	1.7%
A0540	Altho Swamp - Weldo/West of US 301	248	18	1.7%	2.3%
A0542	Altho Swamp - Weldo/West of US 301	331	31	2.3%	3.9%
A0544	Altho Swamp - Weldo/West of US 301	64	5	0.4%	0.6%
A0550	Altho Swamp - Weldo/East of US 301 & West of RR	598	46	4.1%	5.8%
A0560	Altho Swamp - Weldo/West of US 301	189	14	1.3%	1.8%
A0570	Altho Swamp - Weldo/West of US 301	350	35	2.4%	4.4%
A0580	Altho Swamp - Weldo/West of US 301	273	19	1.9%	2.5%
A0582	Altho Swamp - Weldo/West of US 301	46	5	0.3%	0.6%
A0584	Altho Swamp - Weldo/West of US 301	55	4	0.4%	0.5%
A0586	Altho Swamp - Weldo/West of US 301	64	5	0.4%	0.6%
A0588	Altho Swamp - Weldo/West of US 301	64	6	0.4%	0.7%
A0590	Altho Swamp	60	4	0.4%	0.5%
A0592	Altho Swamp - Weldo/West of US 301	291	28	2.0%	3.5%
A0600	Altho Swamp	2640	92	18.1%	11.6%
A0610	Altho Swamp	142	22	1.0%	2.8%
A0620	Altho Swamp	172	31	1.2%	4.0%
A0630	Altho Swamp	220	17	1.5%	2.1%
A0640	Altho Swamp	0	0	0.0%	0.0%
B0100	Lake Altho	515	11	12.9%	4.5%
B0110	Lake Altho	0	0	0.0%	0.0%
B0112	Lake Altho	0	0	0.0%	0.0%
B0120	Lake Altho - Santa Fe Canal	210	17	5.3%	7.0%
B0130	Lake Altho	191	15	4.8%	6.1%
B0140	Lake Altho - Waldo Canal	68	5	1.7%	2.2%
B0150	Lake Altho	0	0	0.0%	0.0%
B0160	Lake Altho	52	4	1.3%	1.7%
B0200	Lake Altho - Lake Altho Park	550	40	13.8%	16.1%
B0300	Lake Altho - North of Waldo Canal	402	21	10.1%	8.3%
B0400	Lake Altho - South of Waldo Canal	1951	131	48.9%	52.8%
B0410	Lake Altho - West of Waldo Canal	50	4	1.3%	1.5%
C0100	Santa Fe Swamp	17900	490	39%	21%
C0110	Santa Fe Swamp	785	153	2%	6%
C0120	Santa Fe Swamp	114	12	0%	0%
C0200	Santa Fe Swamp - Double Run Creek	1064	42	2%	2%

Sub-basin	Watershed	TN Load (lbs/yr)	TP Load (lbs/yr)	Percent TN Load	Percent TP Load
C0201	Santa Fe Swamp	0	0	0%	0%
C0202	Santa Fe Swamp	67	8	0%	0%
C0203	Santa Fe Swamp - Double Run Creek	0	0	0%	0%
C0204	Santa Fe Swamp - Double Run Creek	137	11	0%	0%
C0210	Santa Fe Swamp - Double Run Creek	472	43	1%	2%
C0212	Santa Fe Swamp - Double Run Creek	288	35	1%	1%
C0220	Santa Fe Swamp - Double Run Creek	514	48	1%	2%
C0230	Santa Fe Swamp - Double Run Creek	227	22	1%	1%
C0240	Santa Fe Swamp - Double Run Creek	144	13	0%	1%
C0244	Santa Fe Swamp - Double Run Creek	239	26	1%	1%
C0250	Santa Fe Swamp - Double Run Creek	1266	109	3%	5%
C0254	Santa Fe Swamp - Double Run Creek	19	2	0%	0%
C0260	Santa Fe Swamp - Double Run Creek	547	34	1%	1%
C0270	Santa Fe Swamp - Strip Mines	976	76	2%	3%
C0280	Santa Fe Swamp - Double Run Creek	1962	130	4%	6%
C0282	Santa Fe Swamp - Double Run Creek	462	34	1%	1%
C0300	Santa Fe Swamp	1903	82	4%	3%
C0301	Santa Fe Swamp	0	0	0%	0%
C0303	Santa Fe Swamp	16	1	0%	0%
C0304	Santa Fe Swamp	143	17	0%	1%
C0306	Santa Fe Swamp	39	6	0%	0%
C0308	Santa Fe Swamp	237	26	1%	1%
C0310	Santa Fe Swamp - Unnamed Creek	490	69	1%	3%
C0311	Santa Fe Swamp	157	28	0%	1%
C0314	Santa Fe Swamp	195	25	0%	1%
C0316	Santa Fe Swamp	105	10	0%	0%
C0320	Santa Fe Swamp - Unnamed Creek	0	0	0%	0%
C0322	Santa Fe Swamp - Unnamed Creek	0	0	0%	0%
C0330	Santa Fe Swamp - Unnamed Creek	195	24	0%	1%
C0340	Santa Fe Swamp - Unnamed Creek	605	74	1%	3%
C0342	Santa Fe Swamp - Unnamed Creek	110	12	0%	1%
C0344	Santa Fe Swamp - Unnamed Creek	65	5	0%	0%
C0350	Santa Fe Swamp - Unnamed Creek	709	65	2%	3%
C0360	Santa Fe Swamp - Unnamed Creek	176	16	0%	1%
C0370	Santa Fe Swamp - Unnamed Creek	197	17	0%	1%
C0400	Santa Fe Swamp	3766	113	8%	5%
C0410	Santa Fe Swamp	688	55	2%	2%
C0420	Santa Fe Swamp	72	6	0%	0%
C0430	Santa Fe Swamp	125	12	0%	1%
C0500	Santa Fe Swamp	5578	148	12%	6%
C0505	Santa Fe Swamp	0	0	0%	0%

Sub-basin	Watershed	TN Load (lbs/yr)	TP Load (lbs/yr)	Percent TN Load	Percent TP Load
C0507	Santa Fe Swamp	0	0	0%	0%
C0508	Santa Fe Swamp	98	8	0%	0%
C0510	Santa Fe Swamp	227	24	0%	1%
C0520	Santa Fe Swamp	144	11	0%	0%
C0522	Santa Fe Swamp	87	6	0%	0%
C0530	Santa Fe Swamp	258	21	1%	1%
C0540	Santa Fe Swamp	197	39	0%	2%
C0550	Santa Fe Swamp - Hickory Pond	1586	130	3%	6%
C0552	Santa Fe Swamp - To Hickory Pond	138	24	0%	1%
D0040	Lake Little Santa Fe - Santa Fe Canal	398	45	11%	16%
D0045	Lake Little Santa Fe - Santa Fe Canal	87	5	2%	2%
D0050	Lake Little Santa Fe - Santa Fe Canal	1034	73	28%	26%
D0055	Lake Little Santa Fe	157	13	4%	5%
D0100	Lake Little Santa Fe	957	59	26%	21%
D0110	Lake Little Santa Fe	114	5	3%	2%
D0120	Lake Little Santa Fe	189	14	5%	5%
D0130	Lake Little Santa Fe	35	3	1%	1%
D0140	Lake Little Santa Fe	0	0	0%	0%
D0150	Lake Little Santa Fe	154	14	4%	5%
D0160	Lake Little Santa Fe	32	4	1%	1%
D0170	Lake Little Santa Fe	241	20	7%	7%
D0180	Lake Little Santa Fe	131	11	4%	4%
D0200	Lake Little Santa Fe	154	19	4%	7%
E0100	Lake Santa Fe	3086	188	21%	15%
E0110	Lake Santa Fe	292	24	2%	2%
E0120	Lake Santa Fe	447	17	3%	1%
E0130	Lake Santa Fe	152	13	1%	1%
E0140	Lake Santa Fe	96	3	1%	0%
E0150	Lake Santa Fe	258	21	2%	2%
E0160	Lake Santa Fe	299	43	2%	3%
E0162	Lake Santa Fe	76	7	1%	1%
E0170	Lake Santa Fe	681	101	5%	8%
E0172	Lake Santa Fe	65	6	0%	0%
E0180	Lake Santa Fe	233	11	2%	1%
E0190	Lake Santa Fe - Melrose	169	15	1%	1%
E0200	Lake Santa Fe	266	22	2%	2%
E0210	Lake Santa Fe	140	11	1%	1%
E0220	Lake Santa Fe	2145	253	15%	20%
E0230	Lake Santa Fe - Unnamed Lake	203	14	1%	1%
E0300	Lake Santa Fe	347	21	2%	2%
E0400	Lake Santa Fe	200	16	1%	1%

Sub-basin	Watershed	TN Load (lbs/yr)	TP Load (lbs/yr)	Percent TN Load	Percent TP Load
E0410	Lake Santa Fe	229	18	2%	1%
E0420	Lake Santa Fe	61	4	0%	0%
E0422	Lake Santa Fe - To Sinkhole	23	2	0%	0%
E0425	Lake Santa Fe - Sinkhole	18	1	0%	0%
E0430	Lake Santa Fe - Sinkhole	281	22	2%	2%
E0440	Lake Santa Fe - Sinkhole	105	9	1%	1%
E0450	Lake Santa Fe - Indian Lake (sinkhole)	533	79	4%	6%
E0452	Lake Santa Fe - To Indian Lake (sinkhole)	93	9	1%	1%
E0460	Lake Santa Fe - To Sinkhole	0	0	0%	0%
E0462	Lake Santa Fe - To Sinkhole	57	5	0%	0%
E0500	Lake Santa Fe - Bonnet Lake	1768	184	12%	15%
E0600	Lake Santa Fe - Black Lake	1820	122	13%	10%
E0700	Lake Santa Fe - Sinkhole North of Melrose	214	21	1%	2%