CHAPTER 8: EXISTING NATURAL SYSTEMS CONDITIONS

8.1 Overview

The Brooker Creek watershed area encompasses 14,272 acres in Hillsborough County. The watershed contains plant communities, both terrestrial and aquatic, that provide a variety of important environmental functions, including habitat for listed species and other wildlife, stability for stream banks and lake shores, improvement of water and air quality, and moderation of water and air temperatures. However, plant communities have undergone several periods of significant alteration since the 1830's as land use in the watershed changed from original conditions to agriculture to the current suburban/urban uses. Land use shifts have left the watershed with substantially less acreage in native plant communities, impaired water quality in streams, degradation of all plant communities by non-native invasive plants, and highly disturbed stream banks and lake shores. Most populations of native wildlife have been reduced and/or eliminated.

One of the objectives of this watershed management plan is to identify opportunities to restore and protect natural systems in the Brooker Creek watershed which are important in preventing excessive runoff volumes and pollutant loads, restoring and/or maintaining terrestrial and aquatic biodiversity, protecting stream channel stability, and reducing stream bank erosion. The first step toward this goal is to describe the historical and existing natural systems in the Brooker Creek watershed and to identify specific key factors that prove useful in assessing watershed ecosystem quality. The evaluation of the key factors is done by means of a prioritization matrix which ranks the subwatersheds with respect to environmental quality. A discussion of the overall trends in environmental quality is provided early in the chapter, followed by more discussion of the significant issues for habitats and wildlife within the Brooker Creek watershed.

8.2 Data Sources/Literature Review

Several reports were reviewed for this report, and a list appears in the Bibliography in Section 8.9. Further, Geographic Information System (GIS) databases were utilized from the following organizations:

- Florida Department of Environmental Protection (FDEP)
- Florida Department of Transportation (FDOT)
- Florida Fish and Wildlife Conservation Commission (FFWCC)
- Hillsborough County Stream Waterwatch Program
- Florida Natural Areas Inventory (FNAI)
- Hillsborough County Environmental Protection Commission (EPC)

- Hillsborough County Environmental Lands Acquisition and Protection Program (ELAPP)
- Hillsborough County Planning Commission
- Hillsborough River Greenways Task Force (HRGTF)
- Southwest Florida Water Management District (SWFWMD)
- Natural Resources Conservation Service (NRCS)
- U.S. Fish and Wildlife Service (USFWS)
- University of Florida, Geoplan Center, Florida Geographic Data Library (FGDL)
- University of Florida Lakewatch Program
- University of South Florida, Florida Center for Community Development and Design

8.3 Overall Trends and Summary

There are numerous ecological factors and relationships that define the condition of a natural system, and therefore the “level of service” that can be provided by that system. To evaluate and score the watershed, a series of parameters were considered which represented important ecological functions, extent of human development/impacts, and the presence/absence of important wildlife species. The data that were used to develop quantitative parameter scores were processed and generated from a library of information and staff experience, in addition to existing GIS data provided by the SWFWMD and Hillsborough County. Most of these data are presented in subsequent subsections of this chapter. The parameters used in this are described as follows:

- historical and existing land use – expressed as a percent, this factor describes the change in land uses in the watershed area over the period from the 1950 to 2004;
- loss of natural lands
  - habitat fragmentation – describes the impact to the watershed area of the splitting up and isolation of wildlife habitat;
  - riparian buffers – describes the losses of forested systems in stream floodplains and their significance to ecosystem quality in the watershed area;
- hydrologic alterations – describes the impact to environmental quality and function resulting from physical alterations to streams and lakes such as channelization, diversion, filling, and encroachment;
- exotic flora and fauna – describes the impact to native plant and animals in the watershed area of the invasion and establishment of exotic species;
- strategic habitat conservation areas – describes the identification by FFWCC of areas that are particularly important to preserve in terms of wildlife conservation; and
- land held in public ownership – describes the land acreage currently acquired by public resource conservation agencies that provides important natural environmental functions in the watershed area.

Using the data described in the following sections of this chapter, a natural systems evaluation matrix was developed to provide a comparative tool for measuring the quality and quantity of existing natural habitats within the watershed. This tool can be used to evaluate the overall condition of the watershed so that future efforts to protect or restore natural systems can be prioritized and implemented effectively either as stand-alone projects or in conjunction with flood and/or water quality improvement activities. An overall score was calculated based on the sum of scores for each habitat parameter (Table 8-1). Using a scoring technique similar to the water quality level of service evaluation, the overall natural system evaluation matrix score was based on the ratio of the total watershed score divided by the maximum possible score. The watershed was then given a grade based on the following ratios: *1.0 to 0.8 = A, 0.79 to 0.6 = B, 0.59 to 0.4 = C, 0.39 to 0.20 = D, <0.2 = F*.

Based on the criteria described above, the score assigned to the watershed was a "C." This watershed contains a relatively large amount of contiguous natural habitat and intact riparian buffer and has a large proportion of land area under public ownership. No watersheds in the Northwest Hillsborough County area scored an "A" or a "B," indicating the overall degraded nature of natural systems in the region.

Table 8-1 Natural Systems Evaluation Matrix - Brooker Creek Watershed

HABITAT PARAMETER	SCORE
Habitat fragmentation	0
Riparian buffer rating	2
Natural habitat remaining	2
Strategic Habitat Conservation Areas	1
Public ownership for conservation/restoration purposes	2
Overall score	C

The status of the natural systems in the Brooker Creek watershed as a whole is described in this report section. Detailed descriptions of the conditions and an assessment of the natural systems are included in the following sections.

8.4 Historical and Existing Habitats

This section discusses, in broad terms, the historical (pre-1900) natural systems conditions in general terms based on information derived from the General Land Office Survey Notes. This description is presented as background for detailed discussion of the land use patterns and natural systems areal coverages existing in the 1950's and currently (2004). Information on the 1950's and 2004 land uses were obtained from SWFWMD. The following tables have collapsed the Level III Florida Land Use Cover and Forms Classification System (FLUCFCS) (2004) land use codes to Level I to enhance comparisons among the pre-1900, 1950's, and 2004 time periods. The figures illustrating land uses retain the Level III coding. The narratives following the tables provide details of the Level III land use cover types included in the Level I listings in the tables.

Historical (pre-1900) land uses and cover types – Prior to the permanent settlement of Hillsborough County in the first half of the 19th century, approximately 60% of the land in the Brooker Creek watershed was occupied by soils that supported two land cover types: pine flatwoods (FLUCFCS 411) and longleaf pine-xeric oak (FLUCFCS 412). Xeric oak (FLUCFCS 421) composed approximately 10% of the land cover types. The remainder of the land in the watershed was occupied by temperate hardwoods (FLUCFCS 425), cypress swamps (FLUCFCS 621), wetland coniferous forests (FLUCFCS 620), lakes (FLUCFCS 520), and cypress-pine-cabbage palm (FLUCFCS 624). The swamps bordering Brooker Creek and the 38 lakes in the watershed were significant contiguous wetlands in the watershed. By 1910, Hillsborough was the most populous county in the state, and considerable development of roads and railroads had occurred. By 1916, in the Brooker Creek watershed, the current main roadways (Gunn Highway, Boy Scout Road, Keystone Road, Lutz Lake Fern Road) were hard surface facilities; at least four churches and one cemetery existed; several homes had been constructed; and one railroad (Tampa and Gulf Coast) traversed the watershed with two lines. Agriculture had become established on the uplands lands located near lakes and streams, with citrus occupying the highest elevations and crops and pasture occupying the lands at lower elevations. By 1950, agriculture accounted for 31% of the lands in the watershed, while uplands were reduced to 33% of the watershed. By 2004, the percent coverage of the watershed by uplands was further reduced to 10.3%.

Land uses and cover types from the 1950's - Table 8-2 provides a list and the acreages of land uses and cover types existing in 1950; each land use is compared to the total watershed area. Figure 8-1 illustrates the 1950 land uses and cover types in the Brooker Creek watershed.

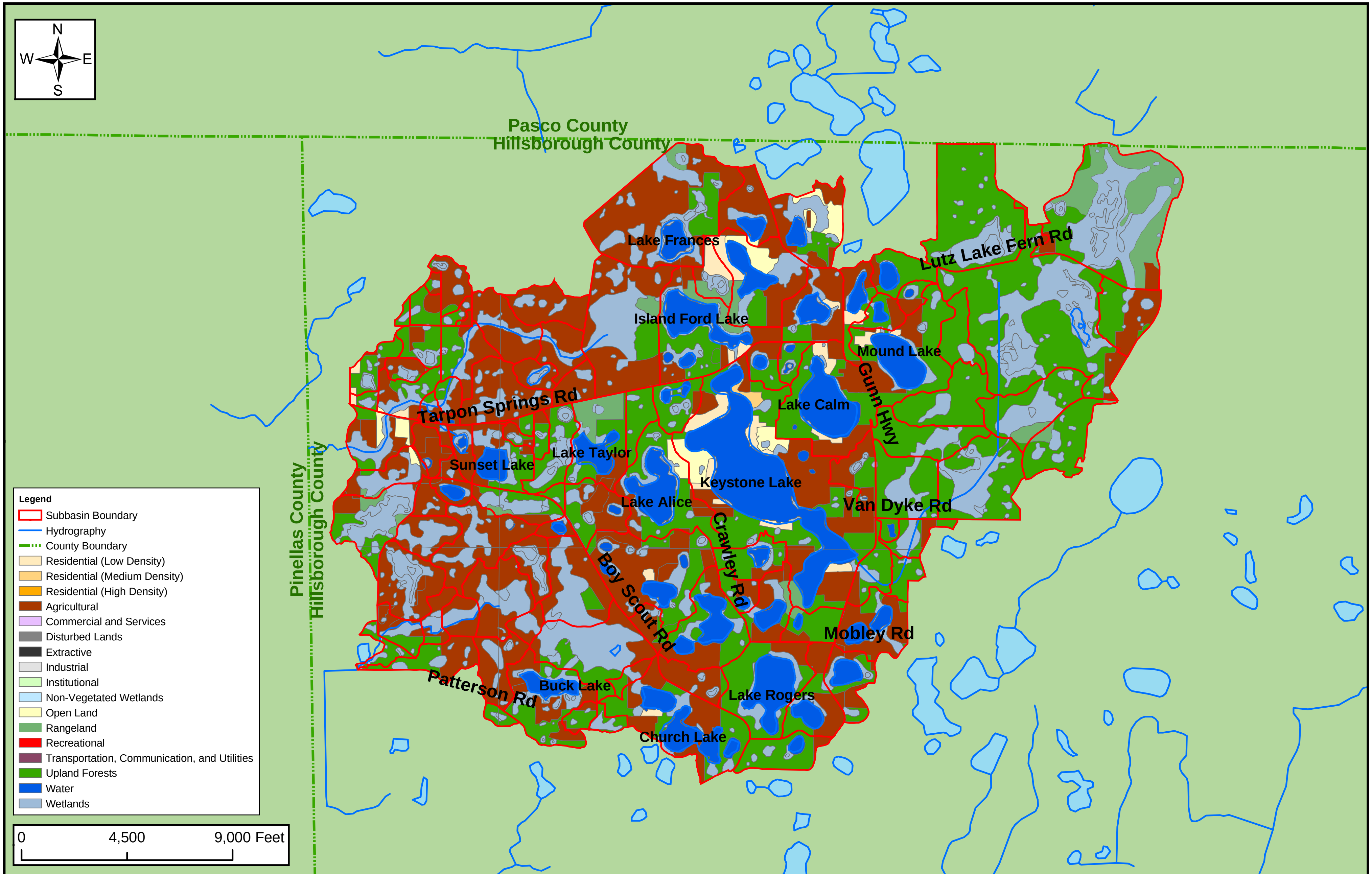
Table 8-2 Land Use in the Brooker Creek Watershed, 1950

Land Use	Total Area (acres)	% of Watershed
Uplands	4,709	33
Herbaceous wetlands	414	3
Forested wetlands	2,801	20
Agriculture	4,486	31
Lakes and Reservoirs	1,584	11
Low/Medium Density Residential	225	2
Commercial, Utilities, Transportation, Institutional	0	0
Total	14,219	100%

2004 land uses and cover types - Table 8-3 provides a list and the acreages of land uses and cover types existing in 2004; each land use is compared to the total watershed area. Figure 8-2 illustrates the 2004 land uses and cover types in the Brooker Creek watershed.

Table 8-3 Land Use in the Brooker Creek Watershed, 2004

Land Use	Total Area (acres)	% of Watershed
Uplands	1,471	10.3
Wetlands	2,916	20
Agricultural	3,851	27
Water	1,784	13
Open Land / Recreational	418	2.9
Low/Medium Density Residential	3,645	26
High Density Residential	18	0.13
Commercial, Utilities, Transportation, Institutional	166	1.16
Total	14,270	100%



Historical Land Use in the Brooker Creek Watershed (1950)

Figure 8-1

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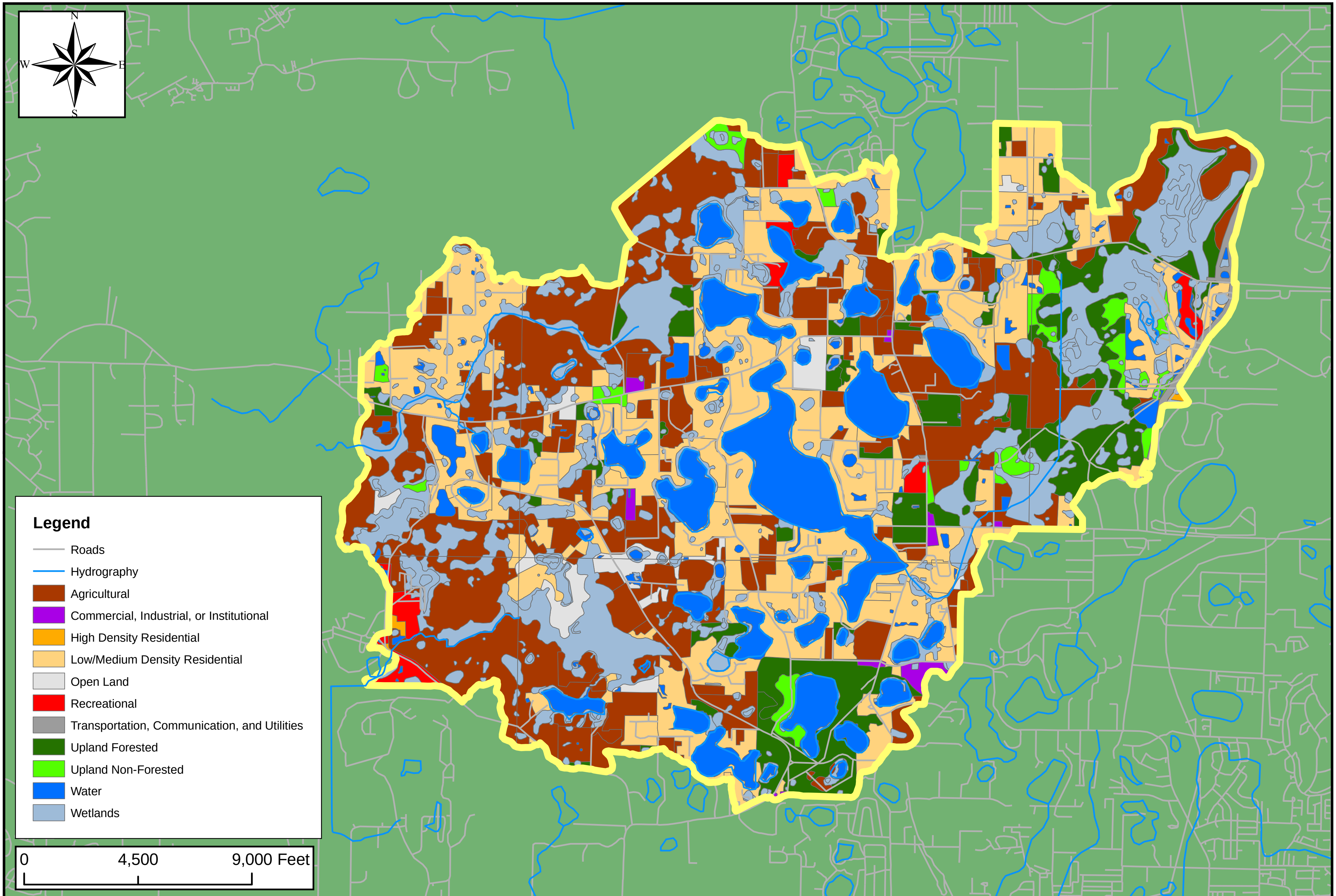


Land Use in the Brooker Creek Watershed (2004)

Figure 8-2

8.4.1 Upland Natural Systems

The following upland habitat descriptions are based on the information contained in Harper (1921), Carlisle et al. (1978), University of South Florida (1993), Florida Department of Transportation's FLUCFCS (1999), and the Soil Surveys of Hillsborough County from 1916, 1958, and 1989. In the plant community descriptions below, only the species that are most characteristic of the plant community in the Brooker Creek watershed are mentioned as being present; however, the natural plant communities that still remain in the watershed are highly diverse and contain many more species than are mentioned in this report. For ease of reading, only common names of plants are used in the report narrative, but Section 8.10 provides a list of all scientific names of plants and animals included in the report.

Pine flatwoods (411)

The most common upland plant community in the state and in the Brooker Creek watershed, pine flatwoods are associated with Myakka fine sands. The primary canopy species common to pine flatwoods is slash pine with some longleaf pine, while the shrubby understory is dominated by saw palmetto with some gallberry, staggerbush, blueberry, and tarflower. Herbaceous ground cover is sparse and includes wiregrass, several species of bluestem, and goldenrod. This community occurs on flat, moderately to poorly drained terrain composed of acid sands overlying an organic/clayey hardpan. Even on better drained terrain, flatwoods can experience periods of inundation when rainfall amounts are in the normal to above normal range. On less well drained terrain, a wet phase of pine flatwoods occurs in which obligate to facultative-wet plant species can be found in flatwoods regularly. These species include trees: sweetbay, gordonia, red maple; shrubs: wax myrtle, gallberry, fetterbush; and herbs: spikerush, redroot, bog buttons, pink sundews, and yellow-eyed grass. Pine flatwoods is a fire-maintained community that will transition to a hardwood-dominated community with very dense canopy dominated by live oak, laurel oak, and pignut hickory if fire is excluded (see photo). In the Brooker Creek watershed, pine flatwoods have been used for pasture, row crops, and (with drainage) some citrus. More recently, some residential and commercial development has replaced agriculture, and the percent of the watershed occupied by pine flatwoods decreased from 29.5% in 1950 to 1.6% in 2004.

Longleaf pine-xeric oak (412)

The longleaf pine - xeric oak plant community, also known as sandhill, is associated with Zolfo fine sands in the Brooker Creek watershed. Natural canopy vegetation is dominated by longleaf pine, and characteristically has a mid-canopy of bluejack oak, turkey oak, sand live oak. The understory contains a medium to low density shrub community consisting of shiny blueberry, Darrow's blueberry, gopher apple, Adam's needle, and beautyberry. Herbs compose the ground cover and include: wiregrass, sky-blue lupine, drumheads, Carolina elephant's foot, dwarf pawpaw, and eastern milk pea. This community also is a fire-maintained community that will transition to a hardwood-dominated community with few to no pines and a very dense canopy dominated by sand live oak, turkey oak, bluejack oak if fire is excluded. This plant community occupied a large percentage of the watershed in the pre-development period, but was largely replaced by citrus by 1950. Currently (2004), this community occupies 1.3% of the watershed.

Upland coniferous forest (410)

Upland coniferous forest is a general category defined by FLUCFCS as any natural upland forest having a 66% canopy closure of coniferous species. In the Brooker Creek watershed, this community currently (2004) occupies 0.83%, and it is a particularly dense pine flatwoods that could not be differentiated on the satellite imagery used for land use mapping purposes. It was not an identified community in 1950.

Upland hardwood forest (420)

Upland hardwood forest is a general category defined by FLUCFCS as natural upland forest having 66% crown canopy dominated by hardwood tree species. This community currently (2004) occupies 0.07% in the watershed, and it was not an identified community on the 1950 mapping.

Hardwood conifer mixed forest (434)

In a hardwood-conifer mixed forest, neither upland conifers nor hardwoods attain more than 66% dominance in the canopy. By definition, these areas typically occur on well-drained but non-droughty soils and are often the result of fire suppression in pine flatwoods. Mixed forests are often successional to upland hardwood forests. This community has the same species as the longleaf pine-xeric community (FLUCFCS 412) except that neither the pines nor the oaks dominate. The percent coverage of this community increased from 0.7% to 3.7% between 1950 and 2004 probably as a result of natural successional activity.

Shrub and brushland (320)

Shrub and brushland occurs on the same soils as pine flatwoods and longleaf pine-xeric oak communities. However, it is dominated by herbs and shrubs; few to no trees are present. Typical species include saw palmetto, gallberry, wax myrtle, species of bluestem, other woody scrub plant species, and various short herbs and grasses. It often develops following the clearing of pines for timber or on long-fallow cropland. This community occupied 3.1% of the watershed in 1950 and 1.6% by 2004. The decrease in areal cover of this community is likely related to the conversion of these lands to residential or commercial uses.

Mixed rangeland (330)
Mixed rangeland is defined by FLUCFCS as rangeland where there is more than 33% mixture of grassland and shrub-brushland range species. This community occupied 0.1% of the watershed in both 1950 and 2004.

8.4.2 Wetland/Aquatic Natural Systems

The following wetland habitat descriptions are based on the information contained in Carlisle et al. (1978), University of South Florida (1993), Florida Department of Transportation's FLUCFCS (2004), and the Soil Surveys of Hillsborough County from 1916, 1958, and 1989. For information on lakes, the SWFWMD's Directory of Lakes (SWFWMD, 2005) was consulted; for lakes and Brooker Creek, this report also consulted the USF Hillsborough Watershed Atlas (http://www.hillsborough.wateratlas.usf.edu). In the plant community descriptions below, only the species that are most characteristic of the plant community in the Brooker Creek watershed are mentioned as being present; however, the natural plant communities that still remain in the watershed are highly diverse and contain many more species than are mentioned in this report. For ease of reading, only common names of plants are used in the report narrative, but Section 8.10 provides a list of all scientific names of plants and animals included in the report.

Cypress swamp (621)
Cypress swamp is the most common wetland community in the watershed. Formerly (1950) occupying 9.4% of the land in the Brooker Creek watershed, the cypress swamp community currently (2004) covers 7.6% of the watershed. It is associated with depressional Basinger, Holopaw, and Samsula soils that are located on the margins of most of the 38 lakes in the watershed. These natural systems are typically large basins characterized by peat substrates, seasonal to year-round inundation, still water, and occasional fire. The typical vegetation canopy species is pond cypress which is associated with swamp black gum, southern red maple, laurel oak, and dahoon holly. The understory is shrubby and is composed of fetterbush, Virginia willow, and buttonbush. The herbaceous understory includes a variety of ferns (royal fern, cinnamon fern, netted chain fern, Virginia chain fern, and toothed mid-sorus fern) associated with alligator flag, water hoarhound, false nettle. Endangered and threatened species such as butterfly orchid, Spanish moss, and ball moss occur occasionally in cypress swamps.

Bay Swamp (611)
Formerly (1950) occupying 2.4% of the land in the Brooker Creek watershed, the bay swamp community currently (2004) covers 2.0% of the watershed. Canopy trees include lobllolly bay, sweetbay, swamp bay, slash pine, and loblolly pine. Understory vegetation is typically dense and composed of gallberry, fetterbush, wax myrtle, and titi.

Stream and Lake swamp (615)

Formerly (1950) occupying 5.4% of the land in the Brooker Creek watershed, the stream and lake swamp community currently (2004) covers 5.9% of the watershed. The community is also referred to as bottomland hardwood forests and is associated with the stream channel of Brooker Creek. Canopy tree species include red maple, water oak, sweetgum, swamp black gum, pond cypress, and some tall Carolina willows. The subcanopy and understory in this community are typically of open aspect except in forests where the hydroperiod (depth and duration of inundation) has been reduced, which has allowed a tangle of shrub species to become established on the forest floor and close the understory. In such cases, shrubs such as fetterbush and buttonbush make the forest virtually impenetrable.

Wetland coniferous forest (620)

In the Brooker Creek watershed, the wetland coniferous forest is a wetland forest dominated by pond cypress but which has other coniferous species (slash pine, bald cypress, red cedar) as common associates. Not reported as a dominant community in the late 19th and early 20th centuries, the wetland coniferous forest formerly (1950) covered 0.9% of the land in the Brooker Creek watershed, and currently (2004), it covers 0.7% of the watershed.

Wetland Forested Mixed (630)

Wetland forested mixed is a wetland forest where neither hardwoods nor conifers achieve a 66% dominance of the crown canopy composition. Formerly (1950) occupying 1.5% of the land in the Brooker Creek watershed, this community currently (2004) covers 0.9% of the watershed. Species common to this community are those described for the Stream and Lake Swamp community (FLUCFCS 615).

Freshwater marsh (641)

Formerly (1950) occupying 2.2% of the land in the Brooker Creek watershed, this community remains essentially unchanged, as currently (2004) it covers 2.1% of the watershed. This habitat is typically characterized by large basins with peat substrates, seasonal to year-round inundation, and infrequent fire. Freshwater marshes usually occur as open expanses of grasses, sedges, rushes, and other herbaceous species in soils that are usually saturated or covered with surface water for two or more months during the year (Brown et al., 1990). Freshwater marsh is highly diverse and marshes may differ significantly from one another even though located in geographic proximity. In the Brooker Creek watershed, typical species include sawgrass, cattail, arrowhead, maidencane, buttonbush, cordgrass, soft rush, and fire flag. The species composition of freshwater marsh habitat often occurs in zones and is dependent upon soil type, hydroperiod, water depth, and successional stage (Wolfe and Drew, 1990).

Wet prairies (643)
Formerly (1950) occupying 3.6% of the land in the Brooker Creek watershed, the wet prairie community currently (2004) covers 0.8% of the watershed. Wet prairies are usually open, mixed grass-sedge associations, which occur in areas of periodic flooding and are distinguished from marshes as having shorter herbaceous species and longer, drier hydroperiods (Wolfe and Drew, 1990). Like freshwater marshes, wet prairies support a diversity of species, and each system may be different from a neighboring system. Important species in the Brooker Creek watershed wet prairie systems include spike rushes, beak rushes, St. John's wort, yellow-eyed grass, whitetop sedge, pink sundew, early whitetop fleabane, and meadow beauty.

Emergent aquatic vegetation (644)
The areal coverage of emergent aquatic vegetation in the Brooker Creek watershed remained essentially unchanged at 0.1% over the period 1950 – 2004. Typically, this habitat is associated with the deepwater portions of freshwater marshes and includes species such as water lettuce, spatterdock, water hyacinth, duckweed, and water lilies.

Streams and waterways (510)
While Brooker Creek is the dominant linear waterway in the watershed, it is not identified in either the 1950 or the 2004 land use mapping due to its channel and flow characteristics. The channel is narrow except where it flows through Lakes Keystone and Island Ford, and flow is intermittent. Discharge rates and water elevations are controlled by two water control structures and several culverts as the creek flows from its head near Jiretz Road to Pinellas County, a distance of 6 miles. From the Hillsborough-Pinellas County line, the creek continues to flow westerly into Pinellas County to its ultimate outfall in Lake Tarpon.

The plant community supported on the creek banks is included under the Stream and Lake Swamp Community description (FLUCFCS 615). However, the creek itself should be recognized for its habitat and habitat support functions. Although flow is not continuous along the entire creek channel all year, the creek does support plant species valuable for water quality and wildlife food and habitat purposes; species include bladderworts, duckweed, water spangles, white water lily, and parrot's feather.

Lakes (520)/Reservoirs (530)

Lakes are defined by FLUCFCS as inland water bodies excluding reservoirs. In the Brooker Creek watershed, lakes are water bodies ranging in surface area from less than 10 acres to greater than 400 acres. The larger lakes in the watershed are: Keystone (417 ac), Calm (127 ac), Island Ford (96 ac), and Crescent (46 ac). Lakes Keystone and Island Ford represent the channel of Brooker Creek for approximately 40% of the creek's length in Hillsborough County, and flows are controlled by structures on the lakes' outfalls. These water features are permanently inundated, although water elevations rise and fall as a result of rainfall and control structure operations. Most lakes have undergone some degree of development on bordering lands; however, some cypress swamp and wetland coniferous forests remain on lake margins. The lakes also support in-lake plant communities that are extraordinarily valuable in terms of fish production and water quality functions. Plant communities include emergent aquatic species along the shallow lake margins and rooted submerged aquatic species in the deeper zones of the lakes. The areal coverage of lake in the watershed has not changed between 1960 and 2004, and remains at approximately 11%.

Reservoirs are artificial impoundments of water. Not recognized in the land use mapping of 1950, this community type occupies (2004) 1.6% of the watershed. These water features have been constructed in association with residential development in the watershed and generally are managed to provide aesthetic or stormwater management functions.

8.4.3 Urban Altered Land Use

The following land use descriptions are based on the 2004 land use map of the Brooker Creek watershed, the corresponding descriptions in FLUCFCS, and staff knowledge of the area.

Tree plantation (440)

This land use category, not present in the 1950 land use mapping, occupies 1% of the watershed in 2004. It represents small, mostly overgrown southern yellow pine plantings.

Residential [(Low (110), Medium (120), and High (130)] Density

Residential land uses occupied less than 1% in 1918 and less than 2% of the watershed in 1950. By 2004, they accounted for 26% of the watershed, reflecting much more rapid growth in the last half of the 20th century. In 2004, 18.2% is in low density uses (< 2 units/acre), while 7.3% is occupied by medium density uses (2-5 units/acre). Less than 1% of the residential uses is in high density use (>5 units/acre). The majority of the residential development has occurred on lake shorelines and at major crossroads where native upland habitat has been replaced by dwelling units.

Commercial and Services (140)

Commercial areas and services is a land use that is predominantly associated with the distribution of products and services. This category is composed of a large number of individual types of commercial land uses, which often occur in complex combinations. This category often includes a main building and the integral areas that support the main structure. In the Brooker Creek watershed, this category was absent in 1950 mapping but occupies 0.2% of the watershed currently (2004). Due to its extremely small areal coverage in the watershed, this land use is not broken down further; land uses present in the watershed that fall into the Commercial areas and Services category include: service stations and convenience stores, small restaurants, and cemeteries.

Institutional (170)

In the Brooker Creek watershed, Institutional land uses include schools, churches, and small office facilities. At least four churches and a school were present in the early 1900's, but the category was absent from the 1950 land use mapping. Currently (2004), this category occupies 0.2% of the watershed.

Recreational (180)

Recreational land uses were absent in the1950 land use mapping but were reported as occupying 0.7% of the watershed in 2004 which represent area parks, community recreational facilities, and historic sites.

Open Land (190)

Open Land includes undeveloped land within urban areas and inactive land with street patterns but without structures. Open land normally does not have any structures or any indication of intended use. Urban inactive land is often in a transitional state and will eventually be developed into one of the typical urban land uses. Occupying 1.2% of the watershed in 1950, open land increased in areal coverage slightly to 1.7%.

Cropland and Pastureland (210)
Formerly occupying 21% of the watershed, this land use category decreased to 14.6% of the watershed in 2004. Included here are chiefly pastures with some vegetable and small fruit crops.

Tree Crops (220)
In the Brooker Creek watershed, this category includes citrus groves which are located adjacent to or very near lakes in the area. The areal coverage of this land use category was at about 10% of the watershed in 1950, and decreased to 6.2% in 2004.

Nurseries and Vineyards (240)
This category, composed of nurseries and one vineyard, was absent in the 1950 land use mapping but now occupies 1% of the watershed.

Specialty Farms (250)
Specialty farms currently occupy 1.1% of the watershed and include dog kennels and horse farms.

Other Open Lands (260)
Other open lands are agricultural land with a use that cannot be determined from available imagery. It occupies 3.4% of the watershed and represents lands that are resting between crops.

Disturbed Land (740)
Disturbed lands are areas that have been changed primarily due to human activities other than mining and include rural lands in transition to residential land uses, and temporary spoil sites. The category is not included on the 2004 land use mapping.

Transportation (810)
In the Brooker Creek watershed, this category includes: roads and highways, railroads lines. It was not present on the 1950 land use mapping, but in 2004, now represents 0.6% of the watershed.

Communications (820)
In the Brooker Creek watershed, this category includes microwave towers. The category is not included on the 2004 land use mapping.

Utilities (830)
In the Brooker Creek watershed, this category includes water, production, treatment, and transmission facilities. It is not included on either the 1950 land use mapping, but currently (2004) occupies 0.01% of the watershed.

8.4.4 Natural Systems Trends

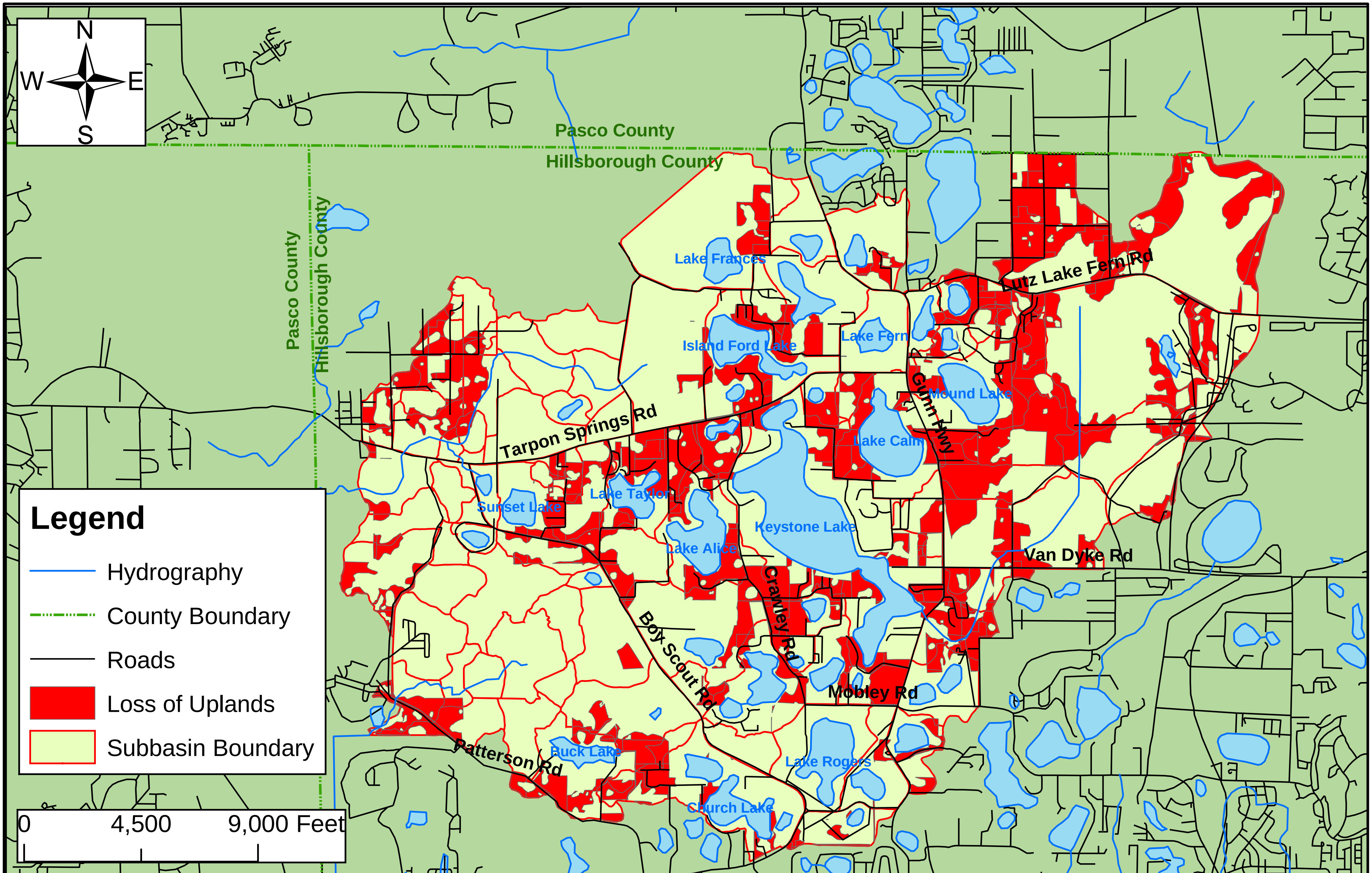
This section identifies the historical and remaining upland, wetland, and aquatic natural systems in the Brooker Creek watershed and summarizes the relative loss of natural habitat between 1950 and 2004 land cover. Existing land use classifications other than natural systems, such as reservoirs and developed and altered lands, were not included in the habitat loss analysis. Historical and existing land use types were consolidated into general habitats of uplands and wetlands for the purpose of estimating percent habitat loss. An analysis of "type for type" habitat loss is not possible due to differences in the classification of vegetation communities, as well as inaccuracies inherent in the historical land use data. Table 8-4 demonstrates the historical and existing upland and wetland acreage, the relative habitat loss of each, based on the total available area of the natural systems.

Historical and Existing Land Cover Changes

The areal coverage of uplands in the Brooker Creek watershed in 1950 is estimated at 4,763 acres, and existing uplands are estimated at 1,471 acres. The difference between these periods represents a 70% net loss as native upland communities were converted to agricultural and urban land uses and supporting infrastructure. The most attractive areas for citrus production were lands occupied by the longleaf pine-xeric oak community, while pine flatwoods were the primary upland community displaced for pasture cultivation and cattle production. Residential development and transportation facilities also are preferentially located on lands supporting these two plant communities. Remaining upland communities have been degraded by adjacent agricultural and urban land uses and/or by encroachment within a remnant community.

The areal coverage of historical wetlands was estimated at 4,797 acres, and the coverage by wetlands today is approximately 2,916 acres. Wetlands have been degraded by physical disturbances associated with agricultural practices, the construction of transportation facilities, and residential development. Wetlands located within citrus groves generally have been rim-ditched to enhance drainage for rows of trees adjacent to the wetland. In the case of wetlands located in pastures, pasture grass is planted and cattle graze up to and through the wetland itself. Consequently, wetlands have no protective buffer zones; they are invaded by pasture grass species and other non-wetland plants; and they are the receiving waters for stormwater and irrigation runoff containing pesticides and fertilizers.

See Figures 8-3 and 8-4 for loss of uplands and wetlands.



Loss of Uplands in the Brooker Creek Watershed

Figure 8-3

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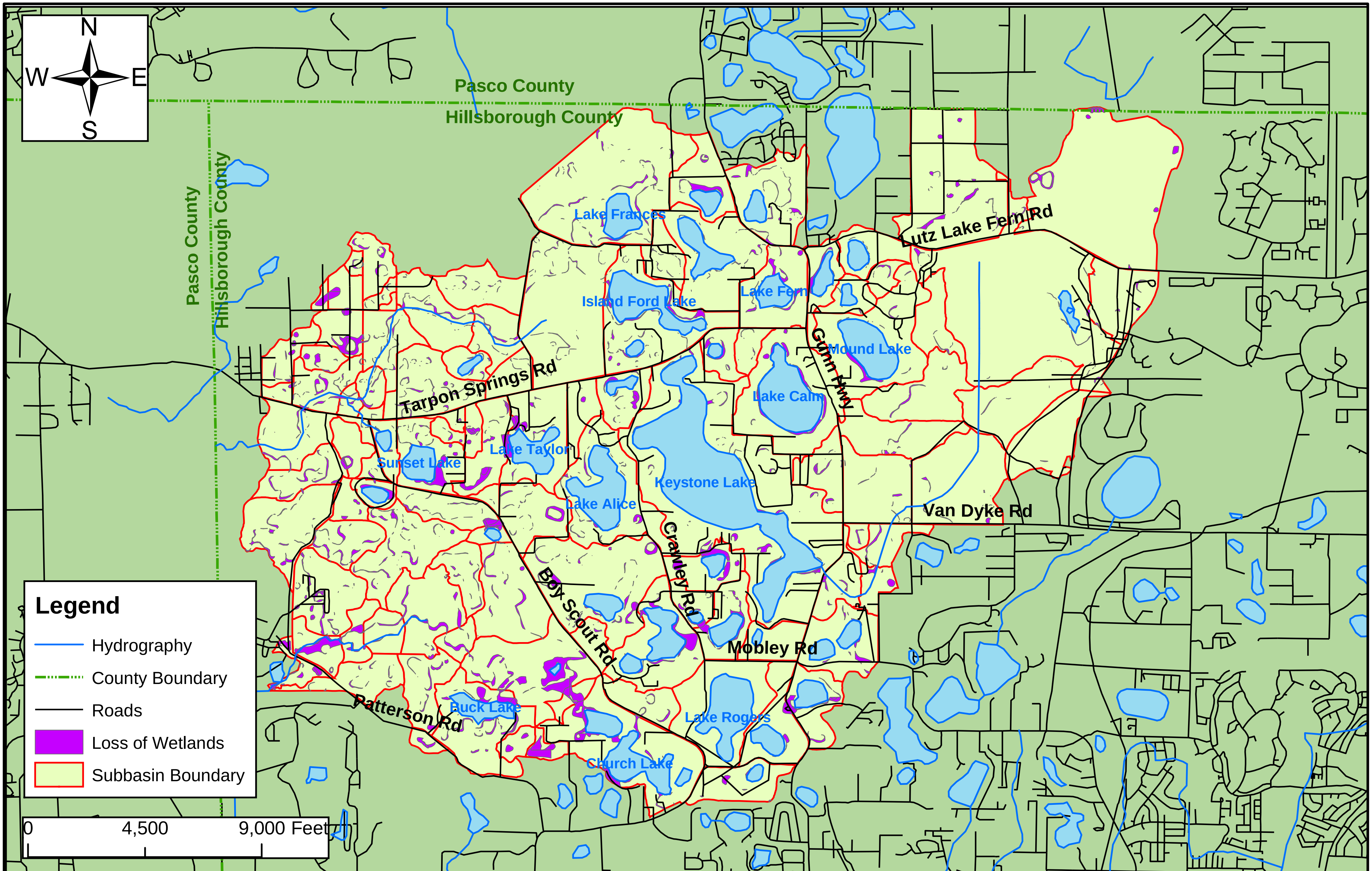

Loss of Wetlands in the Brooker Creek Watershed

Figure 8-4

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Table 8-4 Change of Uplands and Wetlands in the Brooker Creek Watershed

	Acres in 1950	Acres in 2004	Acre Reduction	% Reduction
Uplands	4,763	1,471	3,292	69.12%
Wetlands	4,797	2,916	1,881	39.21%

8.4.5 Prioritization of Restorable Habitat Types

Uplands
Based on the ecological value and rarity within the watershed currently, pine flatwoods, longleaf pine-xeric oak, and upland coniferous forest were identified as priority habitats for restoration.

Wetlands
Based on ecological value, stream and lake swamp associated with the channel of Brooker Creek was identified as a priority habitat for restoration.

8.5 Natural Systems Issues and Areas of Concern

8.5.1 Habitat Loss, Degradation, and Fragmentation

As described above, the Brooker Creek watershed was once composed of a wide variety of upland and wetland habitats. Within the last century, many large tracts have been converted from natural land features to agricultural uses, predominantly in the northern and easternmost portions of the watershed. Based on 2004 SWFWMD land use data, approximately 57% of the watershed has been altered by human activities with approximately 27% of the watershed impacted by agricultural activities and approximately 26% developed for urban, suburban, commercial, industrial, and mining uses. Lands in a near-natural condition (uplands and wetlands) comprise an estimated 43% of the watershed, although most native habitats are disturbed and degraded to some degree by agricultural practices, urban development, or water production activities in the watershed.

Despite these alterations and impacts to natural systems, some large tracts containing freshwater wetlands, hardwood swamp, and forested uplands remain undeveloped in the watershed. Protection is provided by means of regulatory programs of SWFWMD and EPC and by the acquisition of 1,526 acres (11% of the watershed) critical to preservation and restoration.

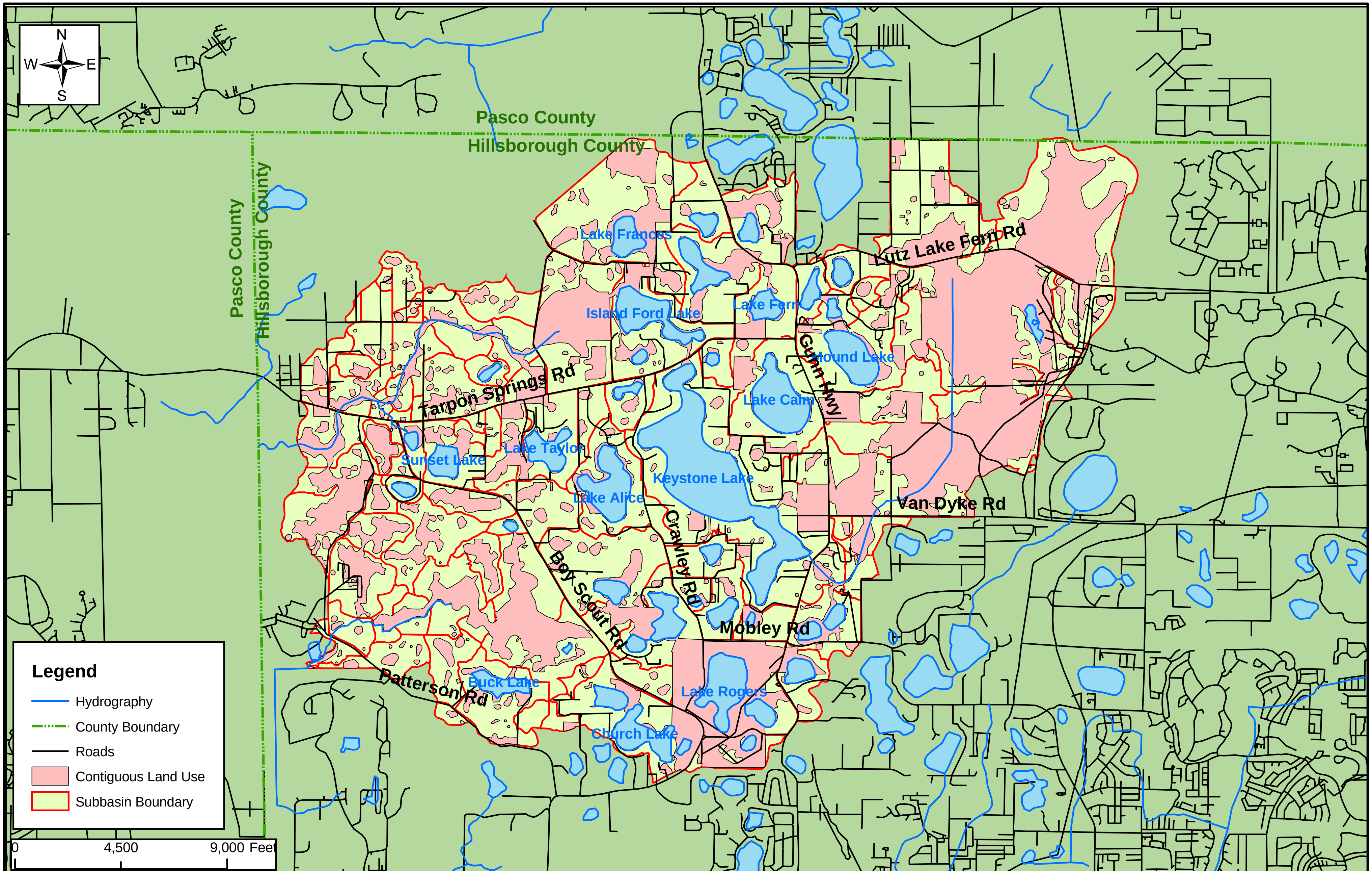
Habitat Fragmentation

Habitat fragmentation is defined as the break-up of a continuous landscape containing large patches into smaller, numerous, less connected patches. To measure habitat fragmentation within the watershed, ArcView was used to join contiguous natural habitat polygons from SWFWMD's 2004 land use layer. The polygons with FLUCFCS code of 3000, 4000, 5000, 6000, and 7000 (natural systems designations) were dissolved to form contiguous polygons throughout each watershed. The areas of these contiguous polygons were then calculated and compared to the overall area of a given watershed. If one or more contiguous polygons represented a significant proportion of a watershed (i.e., greater than 75%), the watershed was categorized as having relatively little fragmentation. Alternately, if a watershed was comprised of several small contiguous natural systems polygons and few large contiguous polygons, then the area was categorized as being highly fragmented. Large numbers of small polygons represent a high level of fragmentation, while small numbers of large polygons represent a low level of fragmentation. The level of fragmentation was evaluated for each region and watershed (Figure 8-5).

The watershed has a total of 293 contiguous natural areas, none of which represent more than 25% of the watershed. Therefore, the degree of habitat fragmentation in the watershed can be described as high and a score of 0 assigned (Table 8-5).

Table 8-5 Distribution of Contiguous Natural Systems Polygons within the Brooker Creek Watershed

	Contiguous Natural Polygons			
Score = 0	<25 %	=>25% but <50%	=>50% but <75%	=>75%
Degree of fragmentation	High	Moderate	Low	Very Low
Number of polygons	293	0	0	0



Extent of Contiguous Land Use in the Brooker Creek Watershed

Figure 8-5

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8.5.2 Wildlife Corridors

Wildlife corridors are naturally existing or restored native linear landscape features connecting two or more larger tracts of habitat functioning as a dispersal route for native flora and fauna, and for the occurrence of the natural ecological processes such as fire (Harris, 1991). With the continuing need for land development to support an increasing human population, wildlife habitats are cleared and destroyed to meet human needs. In the Brooker Creek watershed where urbanization, agriculture, and deforestation have fragmented natural habitats, it has been necessary to establish natural pathways for movement and migration for wildlife to prevent inbreeding or overexploitation of prey. The Hillsborough County Comprehensive Plan defines wildlife corridors as “contiguous stands of Significant Wildlife Habitat which facilitate the natural migratory patterns, as well as other habitat requirements (e.g., breeding, feeding) of wildlife.” The need for and use of wildlife corridors became apparent as early as the 1930s (Edmisten, 1963) and corridors have been used widely ever since for the benefit of game species (McElfres, et al. 1980) as well as non-game animals (Maher, 1990).

Regulatory Component

Wildlife corridors are one of the many avenues that support the Biodiversity Treaty proposed by the United Nations and signed by President Clinton, but not ratified by the United States Congress. In 1992, the United Nations published the Global Diversity Assessment for the purpose of implementing the Global Biodiversity Treaty and Agenda 21. Section 10.4.2.1.2 of the Global Biodiversity Assessment sets forth the criteria for protected areas stating that, “Representative areas of all major ecosystems in a region need be reserved, blocks should be as large as possible, buffer zones should be established around core areas, and corridors should connect these areas.” These core areas and buffer zones would then be connected by wildlife corridors, in accordance with the Wildlands Project. The goal is to allow animals to travel from one core habitat to another through wildlife corridors without anthropogenic obstruction or interference. The remaining areas will be utilized for human habitats conforming to the principles of sustainable development as supported by Executive Order 94-54 that created the Governor’s Commission for a Sustainable Florida and Section 163.3244 F.S. (Sustainable Community Demonstration Project). Establishment of wildlife corridors is consistent with the Hillsborough Comprehensive Plan (CARE Policy 14.2) and the Hillsborough County Land Development Code.

Wildlife Corridors in the Brooker Creek Watershed

As discussed in the previous section, significant habitat fragmentation has occurred throughout the watershed. The protection of wildlife corridors and major routes between two or more core and/or remnant areas of wildlife habitat is critical for the long-term survival of a wide range of plant and animal species. Public lands in the watershed provide habitat and wildlife corridor opportunity between the Lake Dan, Brooker Creek Corridor, and the Brooker Creek Buffer Preserve parcels. The identification and protection of remaining wildlife corridors is essential to restoring natural areas in this watershed. The Brooker Creek watershed has areas of development where wildlife corridors and greenways have been identified through the Hillsborough Comprehensive Plan, Land Development Code, and Hillsborough Greenways Task Force as supported by the Hillsborough

County Natural Resources Regulation. Approximately 43% (6,171 acres) of the watershed remains undeveloped, although undeveloped uplands and wetlands have been disturbed and encroached upon, diminishing their ecological value. Environmentally sensitive areas within this remaining area are identified in greater detail in Section 8.5.5.

Conservation Development

Conservation development is a concept proposed for urban watersheds that focuses on residential development designs that utilize conservation strategies such as inter-connected networks of permanent open space. The method allows residential developments that maximize open space conservation without reducing overall building density. The same method could be applied to commercial and industrial developments. This approach will allow new development to utilize space clustering land uses for human utilization, passive recreational use, and wildlife habitat conservation. The Conservation Development concept is consistent with Hillsborough County Natural Resources Regulation, serving as an avenue to identify areas that may serve as wildlife corridors and/or areas that should be protected and preserved as core habitats or environmentally sensitive lands.

Basically, development with wildlife preservation considered within the overall site plan will allow for innovative and creative land use and design for new urban communities. Additionally, the FWC is committed to working with land use planners, developers, and homeowners to assist them with development designs that offer homes for both humans and wildlife. Clustering, designing corridor trails away from critical wildlife areas, and designing wildlife crossings all contribute to increased wildlife habitat. Throughout Florida, several innovative and creative wildlife crossings have been constructed. For example, the FDOT has constructed numerous underpasses for black bears, Pinellas County has constructed fish bridges allowing fish migration through weirs, and the City of Clearwater has constructed a wildlife bridge across a fast flowing channel, allowing small mammals to cross.

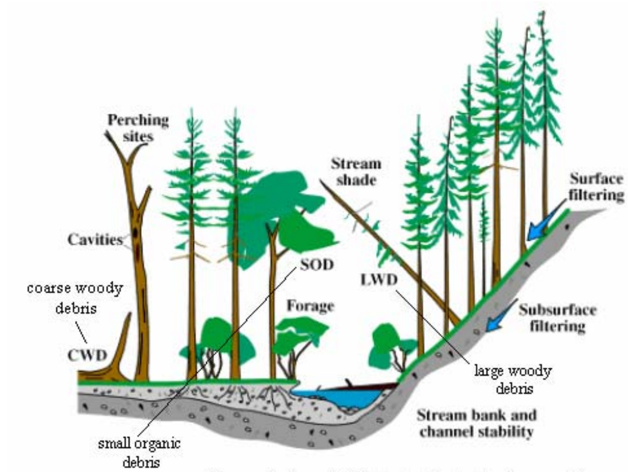
Criteria for significant wildlife habitat minimum widths and sizes are contained in Appendix B of the Hillsborough County Natural Resources Regulation. Existing studies have established a definitive link between habitat area size and species diversity (Miller and Schaeffer, 1998). The Hillsborough County Natural Resources Regulation sets a 75-acre minimum based on wildlife research review that concluded that species diversity rapidly declines below 60 acres, while another study determined 50 to 74 acres as the optimum minimum habitat. Although wildlife corridors do not have to follow these criteria for size and width, reserving 75 acres or more of significant wildlife habitat should be taken into consideration as core habitat or as the basis for a wildlife corridor.

Although wildlife corridors can help conserve habitat dependent species affected by encroaching urbanization, it is important to consider that the total amount of available habitat is the critical factor and that no amount of corridors connecting isolated habitat areas will replace extensive loss of habitat. Wildlife corridors allow for the linkage and preservation of isolated wildlife habitats in the competition for space with humans.

8.5.3 Identification of Existing Riparian Buffer Areas

Measures of ecosystem health can play an important role in the linkage between land use practices, ecological integrity, and water quality. The loss of natural riparian vegetation due to agriculture and development impair the functional role of riparian buffers, strongly influencing the diversity and productivity of both the aquatic and terrestrial biota, and the physical stability of the streambank and channel. A critical component of the riverine ecosystem, riparian buffers function ecologically to:

- regulate sediment storage and transport, stream flow characteristics;
- maintain bank and channel stability by provision of solid root mass and ground cover, regulate stream temperature;
- regulate instream biological production by determining the inputs of small organic debris (SOD);
- buffer streams from fine sediments;
- provide wildlife habitat features, including coarse woody debris (CWD), large woody debris (LWD), and nest and perch sites; and
- provide summer and winter forage for terrestrial fauna.



Source: Province of BC Watershed Restoration Program; BC Ministry of Environment, Lands and Parks

Factors such as the width of riparian (streamside vegetation) zones and the abundance and diversity of plant and macroinvertebrate communities can serve as biological indicators of environmental stress and water quality. Table 8-6 summarizes a rating system that was used in this plan to evaluate existing environmental conditions within the Brooker Creek watershed. This rating scheme was used to assess the existing riparian habitats within the Brooker Creek watershed. Unfortunately, detailed macroinvertebrate or water quality data were not available for the watershed, and the analyses were restricted to the vegetation component of this rating system (riparian buffer widths and percent of riparian buffer as developed land use).

A number of agencies throughout the U.S. have developed stream buffer protection ordinances (Baltimore County, Rhode Island Coastal Resources Management Council, City of Napa – California, Portland Metro). More detailed buffer zone analyses have been performed in Florida, specifically in the Wekiva River basin and the east central Florida region (Brown et al., 1987; Brown and Schaefer, 1990). The purpose of the Florida studies were to develop methodologies for determining buffer zone widths for regionally significant wetland systems that could then be used for the purposes of establishing minimum criteria for future land use planning. The buffer zone widths developed by Brown et al. (1987) are similar to those used in this riparian buffer rating system described above with minimum buffer widths ranging from 24m to 98m (Table 8-7).

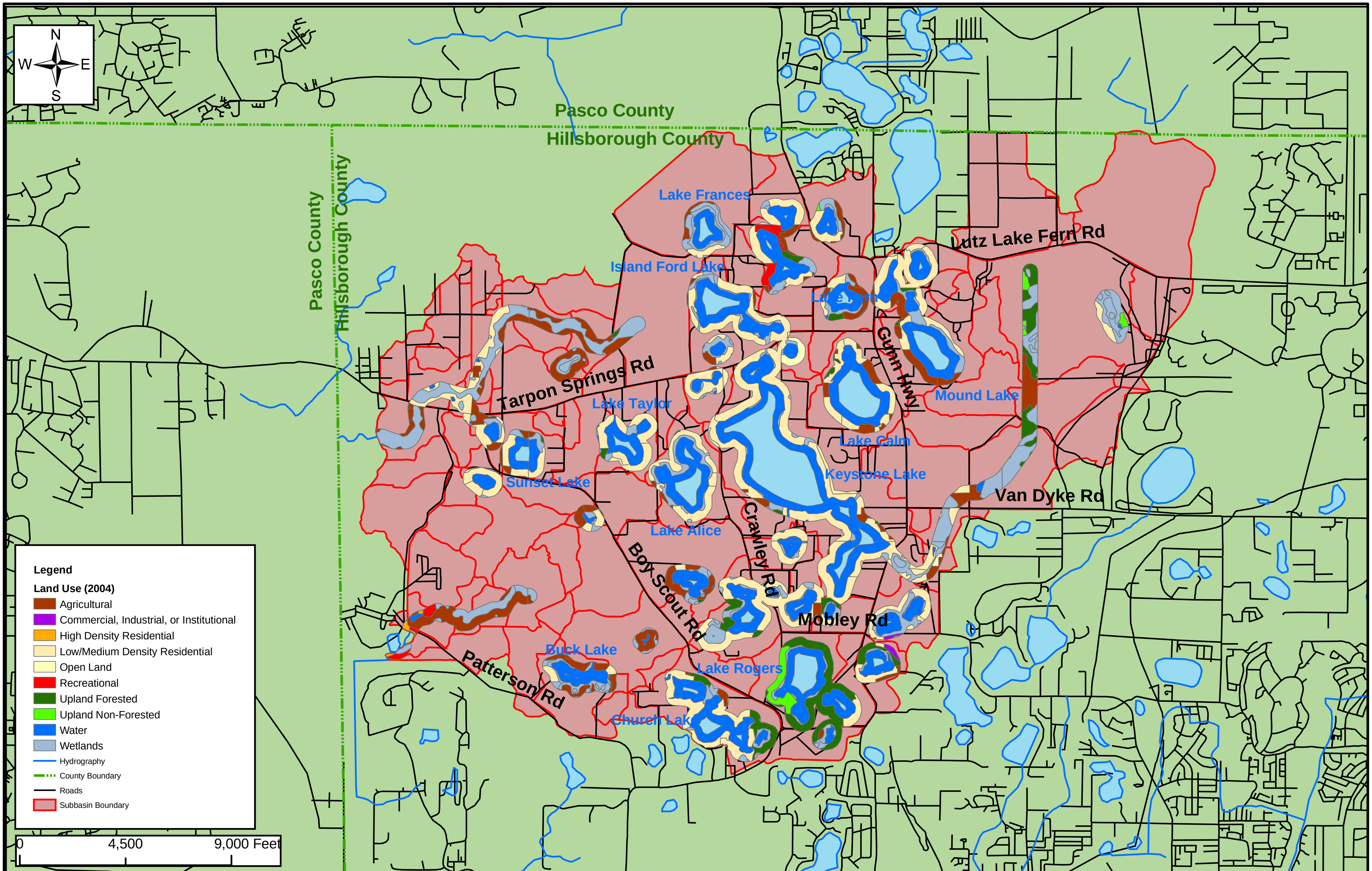
Table 8-6 Rating of Stream Water Quality and Health based on existing vegetation and development activities within a watershed
(modified from Office of the Commissioner for the Environment, Victoria, Australia, 1988)

Rating	Vegetation
Excellent	Streamside vegetation intact for minimum 100m width from the bank, with continuous cover essentially unmodified and with few exotic plants. Watershed vegetation substantially uncleared. Less than 10% of watershed developed.
Good	Existing streamside vegetation communities intact, with cover essentially unmodified for, at a minimum, 30m width for over 80% of each stream segment. Infrequent exotics. Largely undisturbed by roadways. Limited permanent clearing of watershed vegetation.
Fair	Existing streamside vegetation communities predominantly intact and exotics infrequent. Riparian zone intact for 30m width, at minimum, for over 60% of watershed.
Poor	Existing streamside vegetation largely fragmented and exotics frequent. Riparian zone of 30m width intact for less than 60% of watershed, and frequently disturbed by roadways/development. Watershed largely cleared of native vegetation.
Degraded	Little remnant streamside vegetation. Surviving patches fragmented. Exotics frequent. Riparian zone of 30m width intact for less then 25% of watershed, and frequently disturbed by roadways & development. Watershed substantially cleared of native vegetation.

Table 8-7 Recommended Buffer Widths (in meters) for protection of water quality and quantity and wetland-dependent wildlife habitat (from Brown and Schaefer, 1987)

	Protect Water Quantity *Minimize Groundwater Drawdown*		Protect Water Quality *Control Sedimentation*		Protect Wildlife Habitat	
Landscape Association (Habitat Type)	Min.	Max.	Min.	Max.	Min.	Max.
Flatwoods/isolated wetlands	30	168	23	114	98	168
Flatwoods/flowing-water wetlands	30	168	23	114	98	168
Flatwoods/hammocks/hardwood swamps	15	76	23	114	N/A	168
Sandhills/wetlands	6	76	23	114	98	223
Flatwoods/salt marshes	30	168	23	114	98	N/A
Coastal hammocks/salt marshes	30	168	23	114	98	N/A
AVERAGE	***24***	***137***	***23***	***114***	***98***	***182***

To calculate riparian zone widths and percentages of riparian zones that have been converted to development in the Brooker Creek watershed area, the ArcView buffer extension was used. First, 30m and 100m buffer zones were created around the stream network coverage that was created during the hydrologic analysis. From this coverage, the 2004 land use data were clipped for each of the buffer zones and evaluated to determine percent of natural land cover within each clipped area to develop a rating score (Figures 8-6 to 8-7). These scores were then converted to numerical values and used in the natural systems evaluation matrix.



Land Use Within 100m Buffer in the Brooker Creek Watershed

Figure 8-6

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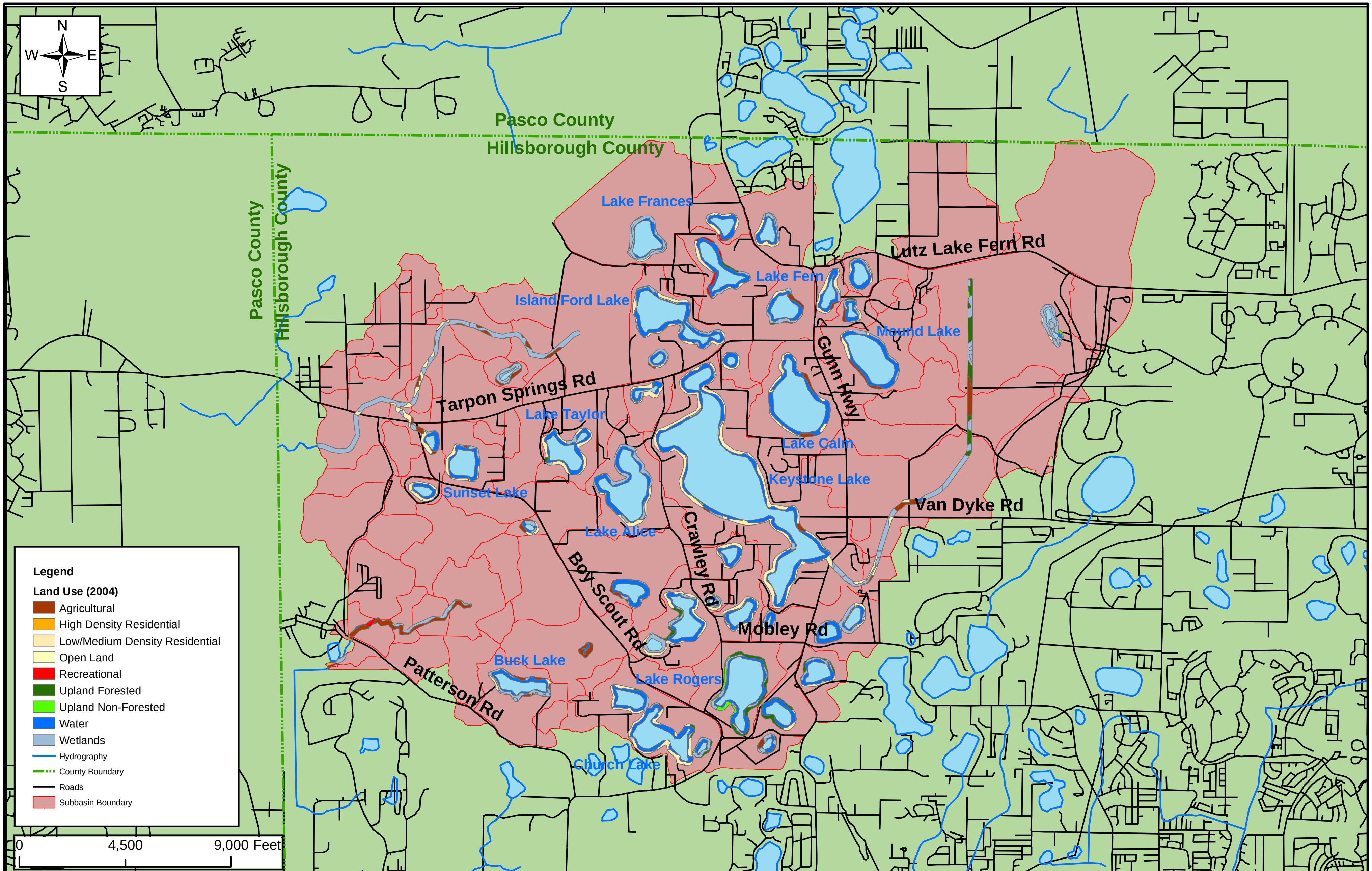

Land Use within 30m Riparian Buffer in the Brooker Creek Watershed

Figure 8-7

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Within the 100 m buffer encompassing 3,601 acres, 42% (1,542 acres) of the land has been developed for agricultural, commercial, or residential purposes, leaving 58% of the buffer area in native habitats. Within the 30 m buffer (1,145 acres), 30% of the land has been developed for agricultural, commercial, or residential purposes, leaving 70% of the buffer area in native habitats. It should be noted that much of the remaining native habitats have undergone disturbance and encroachment, reducing their ecological value. Based on the riparian zone analyses, rating scores were developed for the Brooker Creek watershed (Table 8-8). The score for the watershed was "fair."

Table 8-8 Riparian Buffer Measures within the Brooker Creek Watershed

		Excellent	Good	Fair	Poor	Degraded
Score	Vegetation Intact within 100m buffer?	<10% watershed developed	30m buffer intact for >80% of stream	30m buffer intact for >60% of stream	30m buffer intact for <60% of stream	30m buffer intact for <25% of stream
Fair (2)	no	no		70%		

8.5.4 Biological Indicators of Ecosystem Health

The ability to evaluate the "health" of an ecosystem can be extremely complex due to the variability of chemical, physical, and meteorological processes that occur over time and space and also the diversity of habitat types that may be present within a watershed. One ongoing program is currently evaluating measures of ecosystem health--FDEP's Biological Reconnaissance (BioRecon) program.

The FDEP's bioassessment program involves field sampling of aquatic biological communities to characterize community structure (i.e. diversity, pollution tolerance). The BioRecon program includes measurements of water quality indicators such as dissolved oxygen, evaluating habitat conditions, and determining the health of aquatic insect communities.

Many common insects spend their juvenile life within aquatic systems including dragonflies, mayflies, beetles, black flies, and mosquitoes. These organisms show the effects of physical habitat alterations, point and nonpoint source contaminants, and cumulative pollutants over their life cycle. To determine if a community has been negatively impacted by human activities, data are compared to reference communities (believed to be natural or relatively unimpacted by humans).

The BioRecon program has not collected macroinvertebrate data in the Brooker Creek watershed. The BioRecon procedure is a screening tool that evaluates three metrics including: the total number of macroinvertebrate taxa; number of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) or EPT; and a Florida Index which represents taxa intolerant of stream perturbations. The sampling methodology involves three sweeps of a dip net for a given stream sampling location and the identification of all organisms within the net. Scores for three categories are tabulated based on this data and if two of three exceed threshold values the stream is rated as “healthy,” if less than two meet the thresholds then the stream is rated as “suspected impaired” or “impaired. While useful for the Hillsborough River Watershed Plan, the BioRecon data can give not assessment of watershed health in Brooker Creek watershed due to an absence of information.

Data from 1973 are available from SWFWMD which supported a benthic macroinvertebrate study of selected lakes in the Brooker Creek watershed in support of its review of the proposed NRCS (formerly SCS) Brooker Creek Watershed Project (Cowell, 1973).

8.5.5 Strategic Habitat Conservation Areas

In 1994, the FWC published *Closing the Gaps in Florida’s Wildlife Habitat Conservation System*, which identifies habitats that must be conserved and managed to ensure the survival of key components of Florida’s biological diversity. The primary objectives of the report are:

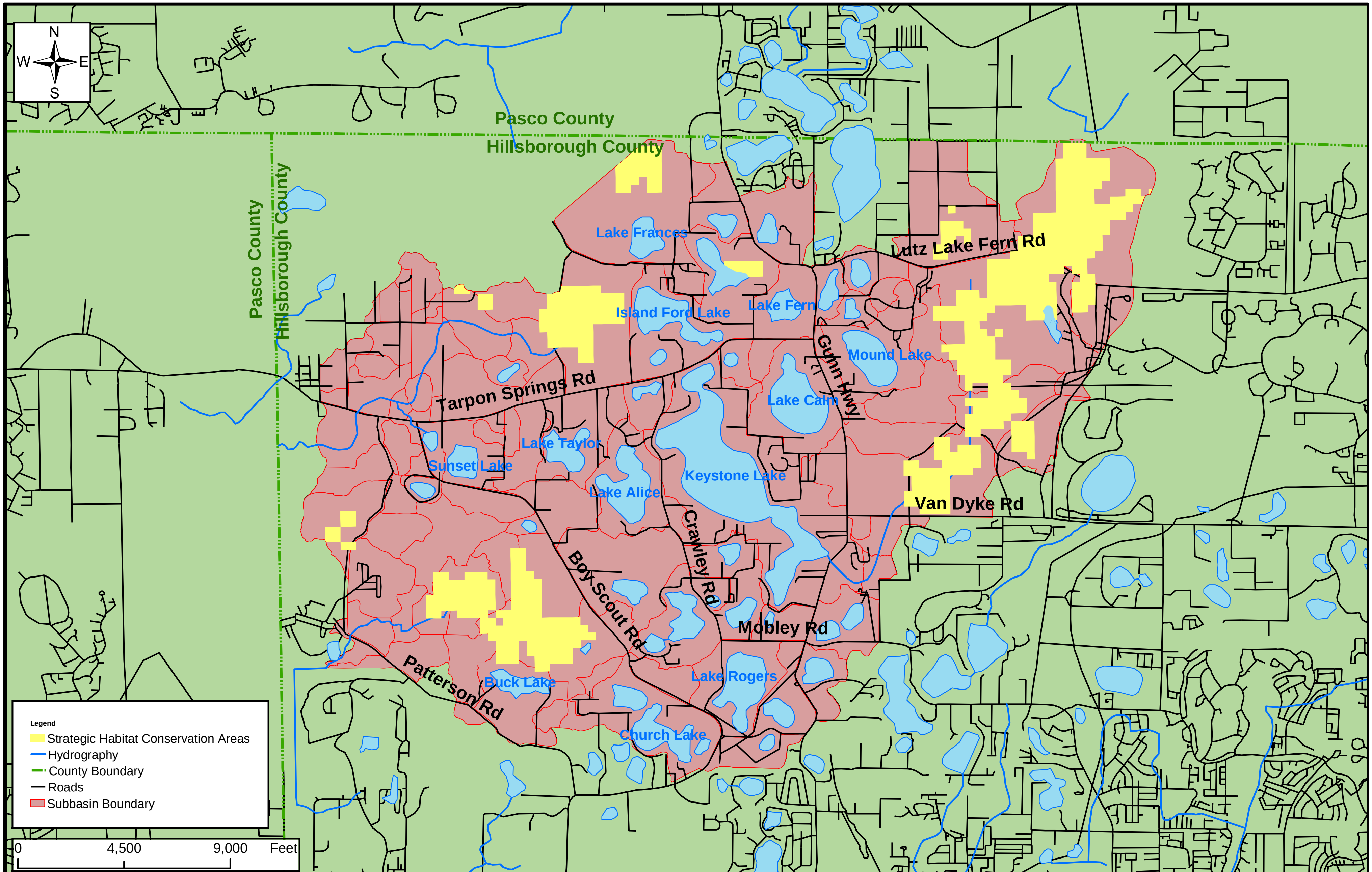
1. to identify habitat areas that are essential to the survival of rare and declining species not adequately protected by the current system of conservation areas;
2. to identify areas that are important to several globally endangered species of plants, animals, and plant communities; and
3. to identify regional areas of high biological diversity to assist in local land use planning.

The FWC utilized land cover and vegetation data, public land boundaries, and documented occurrences of species and communities to identify Strategic Habitat Conservation Areas (SHCA). Hillsborough County was identified as containing SHCA critical to the wood stork, white ibis, great egret, little blue heron, short-tailed hawk, and Florida sandhill crane.

As previously discussed, the protection and preservation of the remaining natural areas of the watershed are important components of this watershed management plan. These natural lands are critical to the maintenance of local and regional wildlife and the protection of water resources. Approximately 43% (6,171 acres) of the watershed remains undeveloped.

Strategic Conservation Habitat Areas within the Brooker Creek Watershed

The FWC SHCA GIS data was utilized to estimate the size of these areas within the Brooker Creek watershed (Figure 8-8). These areas were determined from vector data converted from the original raster data, which is contained within pixels. Therefore, these estimates are based on square polygons and not a delineated ecological boundary. A total of approximately 12% (1,628 acres) of the watershed was identified as SHCA for wading birds. These species include wood storks, great egret, white ibis, snowy egret, and little blue heron, all of which have been observed in the area.



Strategic Habitat Conservation Areas

Figure 8-8

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8.5.6 Hydrologic Alterations

Hydrologic alterations can be defined as any action that would change or affect the water cycle. The Brooker Creek watershed and its diverse array of natural systems are affected by hydrological alterations that would upset the watershed's delicate ecological balance.

Development for the purposes of residential, commercial, industrial, institutional, recreational, extractive, and agricultural land use has increased impervious surface area and/or resulted in the channelization and rerouting of surface water flows which has adversely affected the watershed's hydrological cycle. Development of groundwater supplies in the watershed has affected lake elevations and in-lake wildlife habitat. These hydrological alterations can have results such as:

1. accelerated successional changes of natural systems in both upland and wetland systems;
2. changes in the sizes of faunal populations (some species are favored and increase in numbers, while others are stressed and decline in numbers and/or viability);
3. reduced biodiversity; and
4. changes in water quality.

Natural plant communities, particularly uplands, have been replaced by agricultural, commercial, or residential development, leaving parcels of smaller size and ecological value. While wetlands have remained virtually unchanged in areal coverage, the habitat quality of existing systems can be presumed to be less than original conditions due to several factors, including: invasive species recruitment, excessive disturbance of wetland margins, elimination of protective upland buffers; trash disposal; rim ditching; and reduced hydroperiod. The elimination and disturbance of natural habitats has resulted in a decline in the number of wild animal species (lowered biodiversity) present in the watershed.

Channel Alterations

With the growing need for space for human use, natural channels in the watershed have been dredged, straightened, and/or filled to serve as water conveyances for stormwater, resulting in loss or reduction in ecological value. Channelization has also resulted in degraded water quality in streams allowing exotic species like water hyacinth to compete with native species. Increased stormwater runoff and removal of bank vegetation in these ditch systems have resulted in sedimentation and eutrophication, altering the aquatic species that utilize the system. Non-native and/or nuisance aquatic species more tolerant of anoxic or poor water quality conditions dominate these waterways which decreases biological diversity. In the Brooker Creek watershed, most alterations have occurred in the upper reaches of the watershed.

Channelization of the creek itself has occurred at several segments along the channel including: the crossings of Lutz Lake Fern Road, Van Dyke Road, Gunn Highway, and Tarpon Springs Road; the railroad grade east of Gunn Highway; and at the outfalls of Lakes Keystone and Island Ford. Channel diversions were constructed between Lutz Lake Fern Road and Van Dyke Road at some time between 1916 and 1938, providing an alternate waterway to the east of the natural channel.

Water Supply Impacts

Components of two water production facilities are located in the Brooker Creek watershed: Eldridge-Wilde Wellfield and some wells of the Cosme-Odessa Wellfield. The resultant decrease in groundwater levels would adversely impact natural systems in the watershed resulting in:

1. decreased water levels of lakes and ponds
2. dewatering of wetlands that depend on these water systems for water supply
3. loss/reduction of wetland plants and aquatic fauna.

Water Control Structures

Two facilities, one each on the outfalls of Lake Keystone and Lake Island Ford, allow a degree of control on streamflow and lake levels. They are operated in accordance with Guidance Levels developed by the Southwest Florida Water Management District.

8.5.7 Wildlife

The information for this section was developed from previous surveys conducted by Hillsborough County and ELAPP staff, the Brooker Creek Preserve Management Plan by the University of South Florida (1993), FFWCC (1992) WFNAI Species Occurrence records, and staff experience in the area. A list of species that were observed or which may potentially occur in the watershed is located at the end of this chapter. This list is by no means indicative of all the species present within the watershed. However, it represents an approximation of all potentially occurring species. Review of compiled fauna indicates that 25 species of fish, 22 species of amphibians, 52 species of reptiles, 159 species of birds, and 41 species of mammals potentially utilize the watershed.

8.5.8 Protected Species

Many native fauna and flora are protected from activities that harm or interfere with them or their habitat by federal, state, and local regulations. Fauna and flora are federally protected by the USFWS under Title 50 Code of Federal Regulations (CFR) 17 and 23. Federally protected species are categorized as threatened or endangered. State protection of fauna is administered by the FWC under F.A.C., Rules 39-27.003, 39-27.004, and 39-27.005. The Florida Department of Agriculture and Consumer Services administers F.A.C., Chapter 5B-40. State protected floral species are categorized as commercially exploited, threatened, or endangered. Management strategies are still needed to be developed to protect these species, including coordination efforts with Florida Natural Areas Inventory (FNAI), FWC, and USFWS. Hillsborough County EPC indirectly protects these species by protecting wetland habitats essential to the survival of these species. In addition, the County's upland habitat ordinance provides protection of essential habitats.

The presence of wildlife or plant species is often considered indicative of the quality of natural systems. Many animal species, both protected and unprotected, have been observed in the Brooker Creek watershed in recent years. A literature search was conducted to determine the floral and faunal composition of the watershed. This search included the review of recent surveys conducted within the watershed by Hillsborough County and ELAPP staff, standard Florida literature references such as the *Rare and Endangered Biota of Florida*, the *Florida Atlas of Breeding Sites for Herons and their Allies*, the FNAI, the FFWCC, and the USFWS. Protected species that have been observed and/or may utilize the watershed are listed in Table 8-9. The table also includes information on their preferred habitat. A species is noted as occurring within the watershed if evidence of their presence was observed through animal tracks, scat, burrows, nests, dens, scratchings, vocalizations, or animal sightings by county or state staff. Nineteen protected species potentially occur in the Brooker Creek watershed.

Fish
No protected fish species are expected to utilize habitats in the Brooker Creek watershed.

Reptiles and Amphibians
Protected reptiles and amphibians that may occur in the Brooker Creek watershed are the American alligator, eastern indigo snake, gopher tortoise, short-tailed snake, and gopher frog. Of these, the American alligator, eastern indigo snake, and gopher frog have been documented as occurring in the watershed (Table 8-9).

The **American alligator** is a resident of river swamps, lakes, marshes, bayous, and other bodies of water and is prevalent within the watershed. The required habitat of the short-tailed snake is longleaf pine-turkey oak associations and adjacent upland hammocks or sand pine scrub.
The Florida gopher frog (Rana capito) prefers a xeric upland habitat, but are often found in commensal association with the gopher tortoise (Gopherus polyphemus). Florida gopher frogs breed in habitats that are seasonally flooded, grassy ponds, and cypress heads that lack fish populations.

The **gopher tortoise** prefers dry well-drained soils. Many xeric habitats may be used including sand pine scrub, live oak, or turkey oak communities. The gopher tortoise excavates a long burrow and occupies it semi-permanently.

The **eastern indigo snake** is restricted to the southeastern United States and inhabits a wide variety of habitats from mangrove swamps to xeric pinelands and scrub. It often lives in association with the gopher tortoise where the tortoise burrows provide shelter from desiccating heat and cold winter temperatures. During warmer months, the indigo snake ranges widely, utilizing a territory of 125-250 acres. Wetland edges are preferred foraging areas, where eastern indigo snakes feed on small birds, mammals, fish, and frogs.

Avifauna

The following nesting and feeding habitat requirements are from Rodgers et al. (1996). Protected wading birds that may occur in the watershed include little blue heron, snowy egret, tricolored heron, wood stork, and white ibis. Most of these species require relatively shallow water habitats for foraging, although the white ibis is known to forage in pastures and lawns. Many of these species nest in marine habitats, but freshwater habitats including cypress, wetland hardwoods, or shrub swamps are also important nesting areas. Wood storks more specifically feed in shallow marshes and wet prairies. Degradation of both nesting and foraging habitats has contributed to population declines in these species.

Other protected wetland dependent avian species that may occur in the watershed are the Florida sandhill crane and limpkin. The two most important habitat requirements for sandhill cranes are shallow pickerelweed/maidencane freshwater marshes and adjacent open, low herbaceous uplands. The apple snail, which may be found in lakes, marshes, broad swales, and impoundments is the most important feeding habitat requirement of limpkins. They are known to nest among tall grasses such as bulrush, between the knees of cypress, in vine-covered shrubs, or in the tops of cabbage palms or cypress trees.

Protected birds of prey that may occur in the watershed include the bald eagle, southeastern American kestrel, and osprey. The bald eagle is found in a variety of habitats, but prefers high water-to-land edge ratios where prey is concentrated. The southeastern American kestrel is a secondary cavity-nester, nesting in cavities formed by woodpeckers in long-leaf pine, sand pines, turkey oaks, or live oaks, and requiring open fields for foraging. Ospreys require open, relatively clear water to locate and capture fish. Their nesting habitats are the tops of large living or dead trees including cypress, pine, and swamp hardwoods.

The **Florida burrowing owl** is a small long-legged owl that prefers sandy ground with little vegetative growth. Habitats such as open, well-drained prairies, sandhills, and farmland are optimal areas for the Florida burrowing owl to nest. This species excavates an entrance mound of waste soil, a twisting tunnel, and an enlarged nest chamber at the end of the tunnel. Although this species historically occurred within the watershed, it has not been observed during recent surveys.

Mammals

Listed species of mammals that may occur in the watershed are Sherman's fox squirrel and the Florida mouse, both of which are documented as occurring in the watershed. Both the Florida mouse and Sherman's fox squirrel typically inhabits areas of fire-maintained longleaf pine-turkey oak sandhills, and flatwoods (Humphrey, 1992). The fox squirrel was identified by Cox et al. (1994) as an indicator of remaining natural communities including sandhill, mixed pine-hardwood, dry prairie, and open pine flatwoods.

Table 8-9 Protected Animal Species that potentially occur in the Brooker Creek Watershed

Species Common Name	FFWCC	USFWS	Observed
AMPHIBIANS			
Gopher frog	SSC	-	0
REPTILES			
American alligator	SSC	T(S/A)	x
Eastern indigo snake	T	T	x
Gopher tortoise	SSC	-	x
Florida pine snake	SSC	-	x
Short-tailed snake	T	-	x
BIRDS			
Roseate spoonbill	SSC	-	0
Florida scrub jay	T	T	0
Limpkin	SSC	-	0
Little blue heron	SSC	-	x
Snowy egret	SSC	-	x
Tri-colored heron	SSC	-	x
White ibis	SSC	-	x
Peregrine falcon	E	E	0
Southeastern American kestrel	T	-	x
Sandhill crane	T	-	x
Southern bald eagle	T	T	x
Wood stork	E	E	X
Florida burrowing owl	SSC	-	0
MAMMALS			
Florida mouse	SSC	-	x
Sherman's fox squirrel	SSC	-	x

FFWCC – Florida Wildlife Conservation Commission USFWS – United States Fish and Wildlife Service
E = Endangered T= Threatened SSC = Species of Special Concern C = Commercially Exploited
T(S/A) = Threatened due to similarity of appearance

Flora

Over 500 species of plants have been documented as occurring in the Brooker Creek watershed. The watershed's habitat, geographical location, and climate suggest that 83 species that are listed as endangered, threatened, or commercially exploited by the US Department of Agriculture potentially occur there. Of the 83 species, 20 have been verified as occurring in the watershed (Table 8-10). Both uplands and wetlands support protected species, but with the elimination of much of the native upland habitat, many of the protected species that may still be present in the watershed are species that prefer wetland habitats, for example orchids and ferns.

Table 8-10 Protected Plant Species documented in the Brooker Creek Watershed

Floral Species scientific name	Common name	FDA listing
Calopogon barbatus	Bearded grasspink	Threatened
Encyclia tampensis	Butterfly orchid	Threatened
Habenaria floribunda	Orchid	Threatened
Ilex ambigua	Carolina holly	Threatened
Ilex cassine	dahoon	Commercially exploited
Lilium catesbaei	Catesby's lily	Threatened
Osmunda cinnamomea	Cinnamon fern	Commercially exploited
Osmunda regalis	Royal fern	Commercially exploited
Phlebodium aureum	Golden polypody	Threatened
Pinguicula lutea	Yellow butterwort	Threatened
Pinguicula pumila	Small butterwort	Threatened
Pteris vittata	Chinese ladder brake	Threatened
Selaginella apoda	Meadow spikemoss	Threatened
Spiranthes praecox	Greenvein ladies' tresses	Threatened
Spiranthes vernalis	Spring ladies' tresses	Threatened
Thelypteris kunthii	Southern shield fern	Threatened
Thelypteris palustris	Marsh fern	Threatened
Tillandsia fasciculata	Cardinal airplant	Commercially exploited
Tillandsia simulata	Southern needleleaf	Threatened
Tillandsia utriculata	Giant airplant	Commercially exploited

8.5.9 Exotic Species

Florida is particularly prone to biological invasions due to the widespread disturbance of native habitats as well as its semi-tropical climate, great expanse of waterways, and "island-like habitat" (bounded on three sides by water and the fourth by frost). This section discusses exotic plants and animals that have been observed or have the potential of invading the Brooker Creek watershed.

8.5.9.1 Exotic Plants

An exotic plant is a non-indigenous species, or one introduced to this state either purposefully or accidentally. A naturalized exotic is a non-native plant that has reproduced on its own either sexually or asexually.

Approximately 1.7 million acres of Florida's remaining natural areas have been invaded by exotic plant species. These exotic plant invasions degrade and diminish Florida's natural areas. Invasive, non-indigenous plants are non-native plants that have invaded Florida's forests and wetlands. They replace native plant species and often form exotic monocultures. In many cases, these stands of exotic plants are not useful to the state's wildlife, which have evolved to depend on native plants for food and shelter. Native animals are rarely able to adapt to new exotic plants. Animals that depend on native plants will move away or even become extinct if exotic plants replace too many of our native plants. Some of the effects of invasive plant species include:

- decrease in biological diversity of native ecosystems
- poisoning of some wildlife and livestock species
- reduction of aquatic habitat for native fish and wildlife species, including Listed species
- decrease in the ecological value of important habitats for native fish and wildlife
- clogging of lakes and waterways and other wetlands, impeding wildlife movements

Exotic Plant Species Control Programs

The FDEP’s Bureau of Invasive Plant Management is the lead agency in Florida responsible for coordinating and funding two statewide programs to control invasive aquatic and upland plants on public conservation lands and waterways. Florida’s aquatic plant management program, established in the early 1900s, is one of the oldest invasive species removal programs. With the addition of the Upland Invasive Plant Management Program under Florida Statute 369.252, the state addresses the need for a statewide coordinated approach to the upland exotic and invasive plant problem. Additionally, Hillsborough County’s Land Development Code requires the removal of exotic species for newly developed areas. The Exotic Pest Plant Council (EPPC) has played a major role in identifying exotic species that pose a threat to natural flora. The EPPC was established in 1984 for the purpose of focusing attention on:

1. impacts to biodiversity from exotic pest plants;
2. impacts of exotic plants to the integrity of native plant community composition and function;
3. habitat loss due to exotic plant infestations;
4. impacts of exotic plants to endangered species primarily due to habitat loss and alteration

(e.g., Cape Sable Seaside Sparrow);
5. the need to prevent habitat loss and alteration by comprehensive management for exotic plants;
6. the socioeconomic impacts of exotic pest plants (e.g., increased wildfire intensity and frequency in *Melaleuca*);
7. changes in the seriousness of exotic pest plants by determining which are the worst problems; and
8. informing and educating resource managers about which species deserve to be monitored, and helping managers set priorities for management.

The Council's Florida chapter, the Florida Exotic Pest Plant Council (FEPPC), compiles a list of Florida's most invasive exotic plant species every few years, grouping them according to degree of invasiveness. The most recent compilation can be found at the end of this chapter. The FEPPC has also developed a database map for the Noxious and Exotic Weed Task Team of Category I species throughout the state. A review of this database resulted in the list of species occurring within the watershed. This list is based on the definitions of invasive exotic species made by the EPPC Committee:

- Category I are exotic pest plants that invade and disrupt Florida's native plant communities;
- Category II are exotic pest plants that have the potential to invade and disrupt native plant communities as indicated by (1) aggressive weediness; (2) a tendency to disrupt natural successional processes; (3) a similar geographic origin and ecology as Category I species; (4) a tendency to form large vegetative colonies; and/or (5) sporadic, but persistent, occurrence in natural communities;
- (N) indicates a species listed as noxious on the United States Department of Agriculture and the Florida Department of Agriculture and Consumer Services lists; and
- (P) indicates a species listed as prohibited by the Florida Department of Environmental Protection under Rule 62C-52, F.A.C.

Exotic Plants in the Brooker Creek Watershed

The Brooker Creek watershed has been susceptible to exotic species invasion as a result of the physical disruption of habitats for development purposes, agricultural and industrial operations, and the escape of exotic species from residential landscapes. Information contained in several reports (see Bibliography) and on site visual inspection of the watershed revealed the presence of a total of 18 exotic species in the watershed including: air potato, alligator weed, Australian pine, Brazilian pepper, castor bean, chinaberry tree, Chinese tallow tree, cogon grass, earpod tree, hydrilla, latex plant, lead tree, paper mulberry, parrot's feather, punk tree, skunk vine, water hyacinth, and wild taro. Below is a brief description of the exotic species observed within the Brooker Creek watershed. The vegetative descriptions are from the University of Florida's Northeast Region Data Center. The photographs are reprinted from the University of Florida, Institute of Food and Agricultural Sciences Aquatic, Center for Aquatic and Invasive Plants, online Aquatic, Wetland and Invasive Plant Information Retrieval System (APIRS).

Alligator Weed

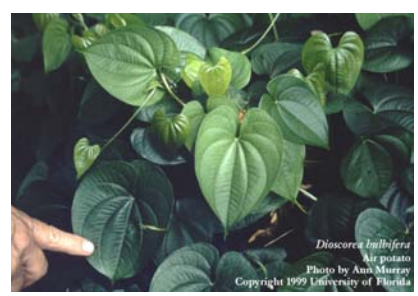
Alligator weed is an immersed plant that is usually found in water, but can grow in a variety of habitats, including dry land. It may form sprawling mats over the water or along shorelines. Alligator weed stems are long, branched, and hollow. Leaves are opposite, simple, elliptic, and have smooth margins. Flowers grow on stalks and are whitish and papery, and bloom during the warm months.

Australian pine

Several species of Australian pine were introduced into Florida prior to 1920 (Morton, 1980). The three species of Australian pine in Florida are Casuarina equisetifolia, C. glauca, and C. cunninghamiana. Hybridization of these species is extensive and complicates identification (Schardt and Schmitz, 1990). The tree is an emersed hardwood, native to Australia and Malaysia, and occurs along rocky coasts, dunes, sand bars, and islands.

The Australian pine was primarily planted to form windbreaks along coastal areas. The trees can reach 35-m heights and grow at a rate of 1.0 to 1.5 m a year. In southern and central Florida, Australian pines typically produce dense stands and form thick carpets of needles on the ground prohibiting the growth of native vegetation. In dune communities, Australian pine's dense shade and leaf-litter retard the growth of native coastal vegetation (Schardt and Schmitz, 1990). Dense monospecific stands of Australian pine crowd out native vegetation in coastal areas and affect habitat for several listed and non-listed species.

Air potato



It is believed that air potato was introduced to Florida as an ornamental and food plant around 1905. It was already recognized as a pest plant throughout the state by the 1970s. It is a non-native, invasive vine covered with large handsome leaves. It can quickly grow 60-70 feet in length, which is long enough to overtop (and shade-out) tall trees. A member of the yam family (Dioscoreaceae), air potato produces large numbers of aerial tubers, (potato-like growths attached to the stems) that grow into new plants.

Water hyacinth

The water hyacinth is a floating plant that grows in all types of freshwaters. It has inflated petioles and forms large floating mats that can completely cover lakes, ponds, and streams. It is a prolific tropical weed now naturalized in waterways throughout the state and the frost-free coastal areas of the Southeast (Bell and Taylor, 1982). Water hyacinths vary in size from a few inches to over three feet tall. It has showy lavender flowers. The leaves are rounded and leathery, attached to a spongy and sometimes inflated stalk. The plant has dark feathery roots.

Cogon Grass

Cogon grass is a non-native grass with extensive rhizomes, spreading stems from 3-10 feet. It is one of the most aggressive weeds of dry lands in Florida, but can occur in areas that become briefly flooded. It can cover large areas. Native to the warmer regions of the Old World, it was brought to the U.S. as experimental forage. It has spread, partially through its use as a packing material. It is commonly seen along roadsides, ditches, swales, and abandoned land. Difficult to eradicate due to its hardy rhizomes, the plant quickly out competes most native grasses.

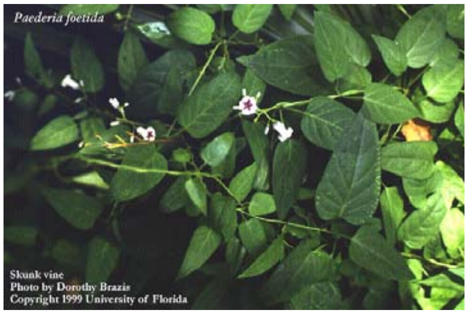
Punk Trees (Melaleuca)

Melaleuca trees, also known as punk trees or paperbark tea trees, are native to Australia, New Guinea, and New Caledonia. Melaleuca is characterized in Florida by a rapid growth rate, efficient

reproduction, and the ability to invade a wide variety of habitats (Meskimen, 1962). This exotic tree grows along roadsides, on ditchbanks, in mesic prairies, in sawgrass marshes, and on lake shorelines. Once established, trees form dense stands that are nearly impenetrable (Center and Dray, 1986). More than 4,000 trees per hectare are not uncommon in melaleuca forests. Melaleuca is a pest, especially in the Everglades and surrounding areas, where the trees grow into immense forests virtually eliminating all other vegetation. Although small mammals seem to use these forests, species diversity in wet prairie-marsh ecosystems with dense monocultures of melaleuca decreases by 60-80% (Austin, 1978; Woodall, 1978; Mazzotti et al., 1981). Schortemeyer et al. (1981) reported that only 10% of the bird species in melaleuca stands actually fed there and only 1.5% of their activity involves nesting in these trees. Melaleuca can replace native pond cypress. Punk trees are particularly prevalent along Tarpon Springs Road and Gunn Highway.

Chinaberry Tree

Chinaberry is a naturalized, fast-growing tree in the southeastern U.S. It is invading the forests, fence lines, and disturbed areas of Florida and elsewhere, including Hawaii. Belonging to the mahogany family of plants, chinaberry is native to Asia. Striking and colorful, chinaberry was widely introduced as an ornamental shade tree because of its large compound leaves, distinctive clusters of lilac-colored flowers, and round yellow fruits. Chinaberry seeds are spread by fruit-eating birds. Chinaberry outgrows, shades-out, and displaces native vegetation. The bark, leaves, and seeds are poisonous to farm and domestic animals. Chinaberry is a landscape element on residential properties in the watershed.

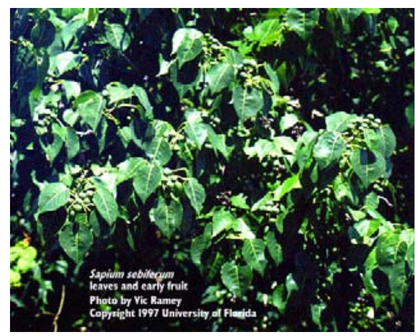


Skunk Vine

Skunk vine, a woody vine from Asia, actually does smell more-or-less skunk-like. The aggressive, competitive plant may grow high into the trees in a variety of habitats, from mesic hammocks to xeric sand hill communities. It appears to prefer sunny floodplains and bottomlands, and can even grow under water. Reportedly introduced in 1897 as a "potential fiber crop", skunk vine now occurs throughout the southeastern U.S. Herbarium records indicate that skunk vine grows in at least 17 counties of central and north central Florida. Its stems root freely. This species is prevalent on the edges of the Stream and Lake Swamp habitat.

Chinese Tallow

Like melaleuca, the Chinese tallow is a tree that grows and spreads rapidly, is difficult to kill, and tends to take over large areas by out-competing native plants. Chinese tallow is spreading rampantly in large natural areas, including Paynes Prairie State Preserve near Gainesville, state-owned protected lands along the St. Johns River. It is a landscape element on residential property and has escaped into all but the xeric plant communities.



Brazilian Pepper

Brazilian pepper is one of the most aggressive of the invasive non-indigenous plants in Florida. It is invading aquatic and terrestrial habitats, greatly reducing the quality of native biotic communities in the state. Brazilian pepper is from South America, and was probably introduced as an ornamental in the mid 1800s. Since it is not cold hardy, the tree occurs mostly in southern Florida. Brazilian pepper is indigenous to the coast of tropical Brazil, Paraguay, and Argentina (Ewel, 1986). It was present in Florida in the early 1840's (Barkley, 1944) and was re-introduced into Florida in 1898 (Morton, 1978). This plant was once sold as a landscape ornamental because it produced dense masses of scarlet berries. The species is established in the watershed in the Stream and Lake Swamp habitat.

Wild taro

The wild taro is an emergent plant, imported from the Pacific Islands. It occurs in and out of water. The leaves can grow to two feet long and are medium to large in size, arrowhead-shaped with heart-shaped bases. They are dark, velvety green, and water repellant. Wild taro leaves are peltate: the leaf stem attaches more-or-less to the middle of the underside

of the leaf. Leaf stems grow to four feet tall. Flowers occur in small fingerlike spikes.

Of the other documented exotic plant species not described above, the most common is **castor bean**.

This species is an escapee from landscapes in which it was a favored element in the past. Highly invasive, it now can be seen in disturbed areas such as ditches and roadsides.

The earpod tree, latex plant, lead tree, and paper mulberry are also escapees from landscapes. Not purposely planted around homes and buildings today, these species are represented by a sufficient number of individuals to provide an adequate seed source for further invasion of upland native habitats, particularly disturbed sites. Plants of these species are commonly seen along roadsides, particularly Gunn Highway, Van Dyke Road, and Lutz-Lake Fern Road.

Hydrilla and parrot's feather, both of which are submerged aquatic plants that are rooted in the bottom substrate, escaped from the aquarium trade and are well established in ponds and some lakes in the watershed. Hydrilla is particularly invasive and has been a serious problem in some of the larger lakes in the watershed in the past. Control measures include chemical treatment and the introduction of the Chinese grass carp, a plant-eating fish species.

8.5.9.2 Exotic Fauna

An exotic animal is a non-indigenous species introduced to an area either purposefully or accidentally. Exotic, non-indigenous, invasive species compete with native species for space, food, and ecological niche. Activities to prevent and control invasive animal species that severely impact the lands and waters of the United States have become a priority for watershed management. The term invasive species is defined by the Presidential Executive Order 13112. Known as "exotic-invasive" or "alien-invasive" species, these invasive plants and animals cause vast ecological and economic damage, and sometimes, human health impacts in areas that they infest. These species have gained a foothold on public and private lands throughout the nation and in other parts of the world, and range across almost every ecosystem of the country including those found within the Brooker Creek watershed. Common methods of introduction include release of pets, escape from pet dealers, or intentional introduction for pest control.

USGS, FDEP, UF-IFAS, and Hillsborough County information on non-indigenous species were reviewed to compile a list of exotic species that have been observed or reported in the watershed. Some of the exotic and nuisance animals found in Hillsborough County include: Nine-banded armadillo, Cuban tree frog, Greenhouse frog, and Brown anole. These four species arrived in Florida by natural migration (nine-banded armadillo) and by accidental introduction (Cuban tree frog, Greenhouse frog, and Brown anole). Armadillos disturbed soils in all habitats, particularly Stream and Lake Swamp, Cypress, and other wetlands during the dry season. The Cuban treefrog is a voracious predator and will attack and devour anything smaller than itself, including native frogs, fish, and invertebrates. The greenhouse frog may be replacing native frogs, particularly in south Florida, while the brown anole competes to some degree with the native Carolina anole (chameleon).

8.6 Conservation and Preservation Programs

Conservation and preservation programs are critical instruments in the protection of natural communities. These programs promote and protect biological diversity which are supported by international treaties, federal regulations, state legislation, local comprehensive management plans, and local ordinances which are discussed in detail in Section 8.7.

Local governments in Florida may use two instruments of preservation: conservation easement as supported by 704 F.S. and 193 F.S. and land acquisition. These Florida Statutes support the following methods of preservation:

- full fee acquisition;
- less than fee acquisition;
- 193 F.S. easement;
- transfer of development rights; and
- purchase of development rights.

8.6.1 Land Acquisition Conservation and Preservation Programs

There are several land acquisition conservation and preservation programs in Florida available to local governments that have jurisdiction over the Brooker Creek watershed. These programs are briefly described in the following sections.

Conservation and Recreation Lands Program
The Conservation and Recreational Lands (CARL) program was established in 1979 by the Florida Legislature which expanded the 1972 Environmentally Endangered Lands Program to include resource conservation measures for other types of lands. It is one of Florida's environmental land acquisition programs for the protection and conservation of unique natural areas, endangered species, unusual geologic features, wetlands, and significant archaeological and historical areas. Mineral-extraction severance taxes and documentary stamp fees funded the CARL program until the recent creation of the Preservation 2000 (P2000) program. The CARL program receives approximately $105 million annually from the sale of bonds. Future funding from the sale of bonds is dependent on legislative action, but the Florida Forever program is scheduled to continue until 2010.

The Land Acquisition and Restoration Council (ARC) was established by Section 259.035 (1) F.S., and selects and ranks projects on the CARL acquisition list each year. Nine members of ARC represent the following state agencies: Department of Community Affairs, DEP, Division of Forestry of the Department of Agriculture and Consumer Affairs, FWC, Division of Historical Resources of the Department of State, and four appointees of the Governor with backgrounds from scientific disciplines related to land, water, or environmental science.

The FDEP Bureau of Land Acquisition reviews all CARL and P2000 acquisitions and handles land exchanges, negotiates, and acquires lands for the department and other state agencies. Lands acquired under the CARL program are maintained as parks, recreation areas, wildlife management areas, wilderness areas, forests, and greenways.

Save Our Rivers Program

The Save Our Rivers (SOR) program is an environmental land acquisition program financed by the Water Management Lands Trust, which is administered statewide by FDEP and locally implemented by the SWFWMD since 1981. Beginning in 2001, funds for this program were used for the management and restoration of acquired conservation lands and other projects and activities under the Surface Water Improvement and Management (SWIM) Program of the SWFWMD.

Preservation 2000

Preservation 2000 is a ten-year, $3 billion land acquisition program that was approved by the Florida Legislature in 1990. P2000 has supplemented most of Florida's existing land acquisition programs by forging partnerships with both public and private agencies. These agencies include the Nature Conservancy and local governments. In 1999, the P2000 Program was replaced by the Florida Forever Act.

Florida Forever Program

Established in 1999 by the Florida Legislature, the Florida Forever Program is the principal land acquisition program for Florida. It provides for up to $3 billion statewide over a 10-year period to protect and improve environmental lands, water resources, and urban green space. The allocation to SWFWMD equates to approximately 25% of total funds expected to be provided under the program. To date, SWFWMD has acquired 1,038 acres in fee for the Brooker Creek Headwaters project; an additional 636 acres are proposed for acquisition.

Hillsborough County Environmental Lands Acquisition and Protection Program

The HCELAPP was established by Hillsborough County in 1987 for the purpose of acquiring, preserving, and protecting endangered and environmentally sensitive lands, beaches, parks, and recreational lands. Although resource protection is the primary purpose of acquiring sensitive lands in the county, public use that is compatible with the preservation and protection of such lands has been allowed on select parcels. The program is administered through the county's Parks and Recreation Department and is overseen by an advisory committee composed of both local citizens and public agency staff.

Parcels deemed environmentally sensitive are evaluated and ranked on a site-by-site basis through an annual nomination process. HCELAPP's land acquisition efforts for acquiring environmentally sensitive lands are often in cooperation with FDEP's CARL Program, SWFWMD, the Florida Forever Program, and The Nature Conservancy.

Nature Conservancy

The Nature Conservancy (TNC) is a non-profit international organization whose goals are to conserve biological diversity through habitat conservation. TNC works with the Natural Heritage Inventory scientists and other researchers to set conservation priorities and acquire lands for conservation management.

TNC utilizes acquisition, land exchanges, conservation easements, retained life estates, and other arrangements to work with property owners to protect natural habitats. They also provide landowners with technical assistance on identifying and managing natural resources including rare species and unusual natural communities.

Trust for Public Lands

The Trust for Public Land (TPL) is a national non-profit land conservation organization that was created to protect land for public use and enjoyment. The principal goal of TPL is to acquire lands suitable for open space and parks, and convey them to public agencies for ownership and management. TPL also provides training and technical assistance to private landowners, local land trusts, and government agencies to enhance their land conservation goals.

Wetland Reserve Program

The Wetland Reserve Program (WRP) is administered through the USDA Natural Resources Conservation Service (NRCS). The WRP is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The NRCS provides technical and financial support for conservation easements and wetland restoration in an effort to achieve the greatest wetland functions and values, along with optimum wildlife habitat.

8.6.2 Public Lands in the Brooker Creek Watershed

A review of existing public lands within the watershed was conducted utilizing GIS metadata for conservation lands in Florida compiled by the Florida Greenways Planning Team, Department of Landscape Architecture of the University of Florida based on:

- SWFWMD GIS acquired and proposed land data
- CARL, Conservation Lands 2004, and FNAI Managed areas GIS data (FGDL)
- Hillsborough County ELAPP GIS data
- Atlas of Outstanding Florida Waters

Hillsborough County Parks information provided by the Hillsborough Planning Commission was also reviewed and utilized for this report. An analysis of the GIS data layers was performed to approximate proposed and acquired land area. Almost 1,800 acres have been acquired for conservation purposes (Table 8-11). Figure 8-9 shows the 2004 conservation areas identified by SWFWMD.

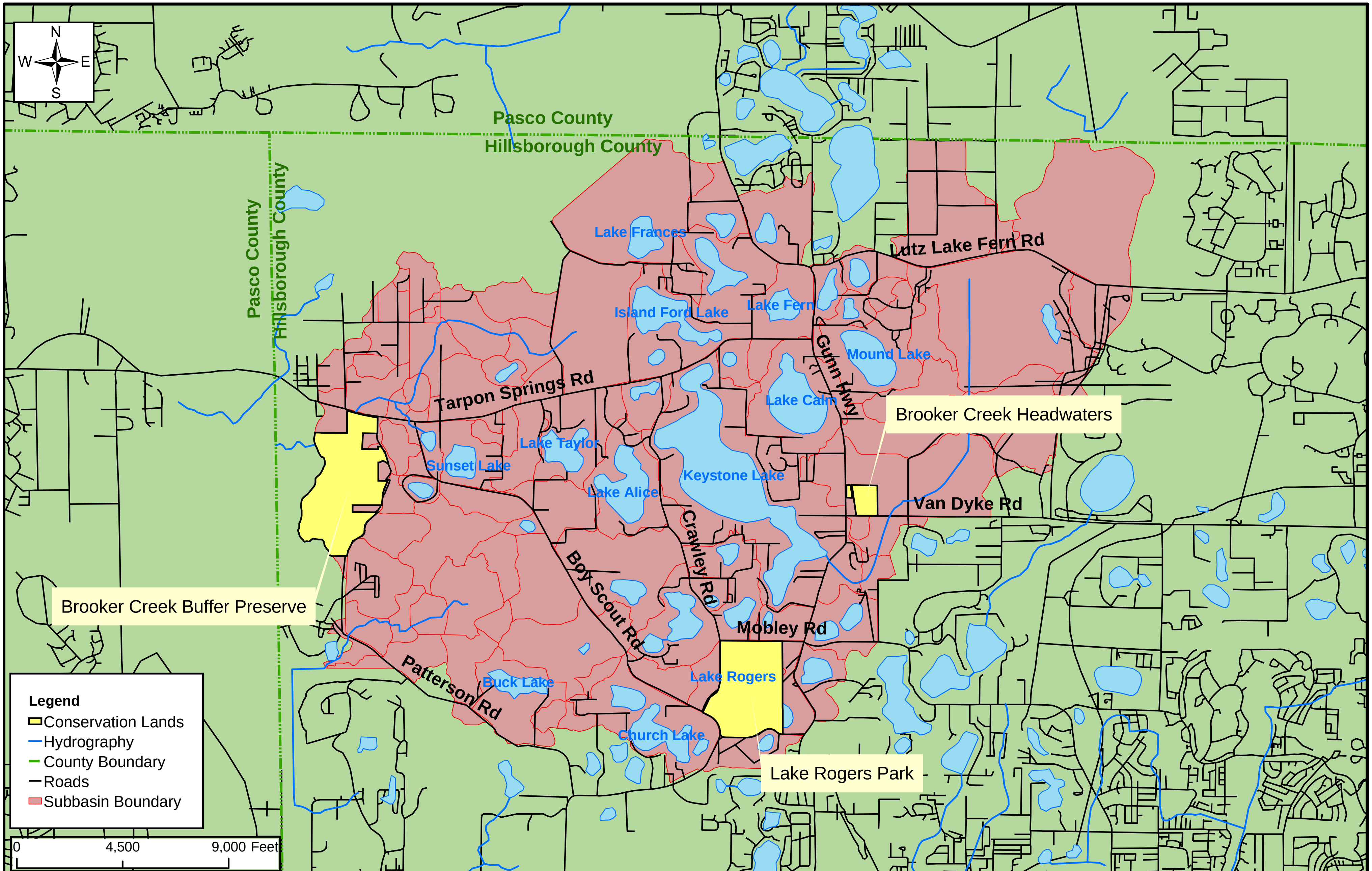
Table 8-11 Acreages of Lands for Conservation Purposes within the Brooker Creek Watershed

Parcel Name	Acres
Brooker Creek Headwaters	1,111
Brooker Creek Preserve	415
Lake Rogers Park	259
Total	1,795

8.6.3 Greenways and Trails

Subsection 260.012(1) (2) F.S. (The Florida Greenways and Trails Act) defines “greenways” as linear open space established along either a natural corridor such as a riverfront, stream valley, or ridgeline, or over land along a railroad right-of-way converted to recreational use, a canal, a scenic road or other route; any natural or landscaped course for pedestrian of bicycle passage; an open space connector linking parks, nature reserves, cultural features, or historic sites with each other and populated areas; or a local strip or linear park designated as parkway or greenbelt. The same statute defines “trails” as a linear corridor and any adjacent support parcel on land or water providing public access for recreation or authorized alternative modes of transportation.

Greenways can be hard surfaced pathways that permit different recreational uses such as walking, jogging, skating, and biking, or they can be natural corridors with a simple path along a stream or riverbank. Many greenways connect destination points such as parks, libraries, schools, and shopping areas. A utility or drainage ROW, or an abandoned railroad corridor can be converted to a pedestrian bike or walkway. Conservation areas protecting a community’s natural resources such as rivers, streams, wetlands, wildlife, and floodways are often included in greenways. Greenways benefit the community in many ways by providing opportunities for recreation and alternative transportation, improving environmental protection, providing places for environmental education, and stimulating economic development.



Conservation Lands in the Brooker Creek Watershed

Figure 8-9

AYRES ASSOCIATES

The Hillsborough County's Greenway System plans to develop two facilities: the NW Regional Connector Trail east of Gunn Highway to connect to the Upper Tampa Bay Trail, and bike trails along Tarpon Springs Road, Boy Scout Road, and Race Track Road.

Funding sources for the development of greenways and trails are available from:

1) **Recreational Trails Program** - The Recreational Trails Program (RCT) is a federally competitive grant program that provides, renovates, or maintains recreational trails. The Intermodal Surface Transportation Efficiency Act ISTEA) of 1991 included the National Recreational Trails Fund Act (NRTFA) and established the National Recreational Trails Funding Program (NRTFP). The National Highway System Designation Act (NHS Act) of 1995 amended and revived the NRTFA. The Transportation Equity Act for the 21st Century (TEA-21) amended the previous legislation and provided six years of funding. In Florida, the RCT is administered by the FDEP in coordination with the U.S. Department of Transportation, Federal Highway Administration.

2) **Florida Recreation Development and Assistance Program** - The Florida Recreation and Development Assistance Program is a competitive program that provides grants for acquisition and development of land for public outdoor recreation use.

3) **FDOT Transportation Enhancement Program** - The Florida Department of Transportation (FDOT) Transportation Enhancement Program provides funds for transportation-related activities designed to strengthen the cultural, aesthetic, and environmental aspects of Florida's intermodal transportation system. The program provides for implementation of a variety of projects including bike and pedestrian facilities. Projects are selected by local metropolitan planning organizations and the FDOT district offices.

4) **Florida Scenic Highways Program** - The Florida Scenic Highways Program is administered by the FDOT. This program works with local governments to identify and protect scenic roadways throughout the state. Designated corridors, including associated greenway and trail projects, may be eligible for increased funding opportunities.

8.6.4 Natural Systems Restoration

The Brooker Creek watershed reflects a variety of land uses that have resulted in the both the conversion of natural lands to urban, suburban, commercial, and agricultural development and the degradation of remaining native habitats. Increased future land development will continue to produce adverse impacts to natural systems. Consequences of development have included: reduction in biological diversity, overall habitat quality, abundance, and distribution, as well as habitat fragmentation, species isolation, impairment of water quality, and loss of wildlife corridors.

In order to alleviate the negative impacts of development, it is necessary to protect and restore natural systems within the watershed through land acquisition, conservation methods, public environmental education, exotic plant species removal, and replacement of native habitats where they have been eliminated and/or degraded. High quality natural areas are a priority to both the human population and animal populations within the watershed, and the implementation of a meaningful restoration/protection plan will produce substantial ecological and aesthetic benefits.

Restoration - There are several candidate areas for restoration. Chief among these areas are the locations at which roadways cross Brooker Creek: Lutz Lake Fern Road, Van Dyke Road, Gunn Highway, Tarpon Springs Road (2 crossings). At all of these crossings, the Creek has been subject to factors that have degraded stream habitat, discouraged wildlife establishment, allowed the invasion of exotic plant species, resulted in trash accumulation in the channel, and negatively affected water quality. Priority restoration measures at these areas include:

1) Diversion and treatment of untreated stormwater runoff,
2) Exotic species removal.
3) Reshaping channel banks to eliminate erosion and undercutting,
4) Trash removal, and
5) Re-establishing desirable native plant species consistent with the original habitat and compatible with the needs of each transportation facility.

Other candidate areas for restoration include:

1) Lake shores where shoreline vegetation has been completely cleared – Assistance should be provided to willing lakefront property owners to re-establish desirable emergent aquatic plants to promote lake fisheries, reduce erosion potential, and protect lake water quality from fertilizers and pesticides.
2) Roadway rights-of-way where exotic species have become established – Following the removal of exotic species, desirable native species should be planted, and a maintenance program should be implemented to ensure restoration success. Appropriate signage at each restoration site should be erected for public education purposes.
3) Restoration of hydrology and ecology, where feasible, on the diversion canal built between 1916 and 1938 between Lutz-Lake Fern Road and Van Dyke Road (see Section 8.5.6) – This area should be assessed to determine the actual potential of restoring flow to the natural waterway and re-establishing native habitats (pine flatwoods).
4) Restoration of native habitats on public lands within the watershed – A detailed assessment of public lands should be performed in which specific areas needing restoration should be identified. Areas should be prioritized according to expected benefits to water resources in the watershed, and projects should be undertaken that improve and protect water quality.

8.7 Regulations Protecting Natural Systems

As part of the development of the Brooker Creek watershed management plan, existing regulatory mechanisms that protect natural communities within the watershed and throughout the County were researched and reviewed. Regulations are an important component in the protection, maintenance, preservation, and conservation of natural lands.

HCEPC Wetland Rule

The Hillsborough County Environmental Protection Commission's (HCEPC) Chapter 1-11 (Wetlands) Rule provides standards for the identification, protection, maintenance, and utilization of wetlands in Hillsborough County.

Hillsborough County

Wetlands, uplands, and environmentally sensitive areas are protected by the County Land Development Code (Ordinance No. 00-21, PART 4.01.00) requirements including set backs, buffer zones, and other mechanisms. The Natural Resources regulations protect habitats that are scarce within the county and supports the Endangered Species Act, enforcing protection of listed species and their habitats.

Environmental Resource Permit

The Environmental Resource Permit (ERP) process is administered by the SWFMWD and The FDEP under Part IV of Chapter 373, Florida Statutes (F.S.) and Chapters 40D-4, 40, 45, and 400, Florida Administrative Code (F.A.C.). This permit provides protection for surface water bodies, wetland ecosystems, partially through coordination with the Florida Fish and Wildlife Conservation Commission, NMFS, USFWS, and the USACOE.

Federal Regulation

Federal protection for wetlands is provided under the Section 404 Dredge and Fill Permit administered by the USACOE and the National Pollutant Discharge Elimination System Permit (NPDES) administered by the EPA.

Tampa Bay Comprehensive Conservation Management Plan

The Tampa Bay Estuary Program has developed a Comprehensive Conservation Management Plan that promotes improved land and water management throughout the Tampa Bay watershed, including the protection and restoration of declining natural communities that serve as indicators of the health of Tampa Bay.

Hillsborough County Comprehensive Plan

County comprehensive plans are mandated by Chapter 163 F.S., as amended by the Local Government Comprehensive Planning and Land Development Regulation Act. This act requires the development of a comprehensive plan by each local government within Florida. Chapter 163

F.S. is further defined by Rule 9J-5, F.A.C., which establishes minimum criteria for each element of the comprehensive plan. The Hillsborough Comprehensive Plan has the following elements:

1) coastal management;
2) conservation and aquifer recharge;
3) future land use;
4) transportation;
5) housing;
6) recreation and open space;
7) economically disadvantaged groups;
8) potable water;
9) sanitary sewage;
10) storm water;
11) solid waste; and
12) capital improvement projects.

Elements that directly affect natural communities within the Brooker Creek watershed are coastal management, recreation and open space, potable water, conservation and aquifer recharge, and capital improvement projects.

8.8 Public Education

Public education is one of the most important components of a watershed management plan. Public outreach programs and projects can promote the participation and involvement of local residents, which contributes to the acceptance, approval, and successful implementation of this watershed management plan. The following is a summary of current public education and outreach programs throughout the state that apply to the concerns and goals of the Brooker Creek watershed. More specific information pertaining to these programs can be found by contacting the responsible agency by phone or through their web site.

Hillsborough County implements several programs applicable county-wide, including the Brooker Creek watershed:

1) **Officer Snook Program** - The Officer Snook Program teaches children about water pollution and its effect on our rivers, ponds, lakes, and streams. Officer Snook provides a fun and educational coloring book for each student, as well as curriculum guides and activity books for teachers who want to continue pollution prevention education in their classrooms.

2) **Stormwater Ecologist** – This program is designed to give students and teachers the power to make responsible decisions about stormwater pollution prevention and to demonstrate how our actions all play a role in the health of the world around us. Stormwater Ecologist not only talks about making a difference, we'll actually help you make one with our hands-on and community

projects. This program incorporates aspects of science, politics, and economics, making it appropriate for a wide range of classes.

3) **Hillsborough County's Adopt-A-Pond** - The Adopt-A-Pond program is a public-private partnership helping neighborhoods improve their water quality, wildlife habitat value, and aesthetic value of stormwater ponds. The program is dedicated to improve pond environments. The program offers free education on stormwater runoff, storm drain marking kits, free native wetland plants, technical advice on pond management, and the opportunity to participate in a network of other members of the program. In the watershed, one pond is included in the Program, Bethania's Pond (#03-13) in Section 14, Township 27, and Range 17.

4) **Hillsborough County Stream Waterwatch** - The Stream Waterwatch program is a cooperative effort between Hillsborough County, Hillsborough County Community College, FWC, and the SWFWMD. The goal of this program is to ensure clean and healthy streams. Volunteers are trained to collect water quality samples, to take field measurements of physical parameters, and to collect, sort, and identify macroinvertebrates. Volunteers collect monthly stream samples and measurements. They also participate in stream clean-ups, restoration projects, and related activities.

5) **Hillsborough County Lake Management Program** - The Lake Management Program (LaMP) is a cooperative program involving Hillsborough County, University of Florida LAKEWATCH, and the University of Florida. Volunteers take monthly samples and learn about aquatic plants, water quality, and the wildlife that utilize their lakes. Citizens learn what they can do in their households and yards to improve the health of their lakes. Collected data is entered in a web-based database maintained by the University of South Florida at http://www.hillsborough.wateratlas.usf.edu/.

6) **Nature's Classroom at the Wilderness Park** - The Nature's Classroom is located within the Wilderness Park, an award winning outdoor educational facility for sixth graders in Hillsborough County. Nearly 10,000 students and faculty have experienced the Hillsborough River first hand by viewing animals and plants in their natural habitats. The SWFWMD's Hillsborough River Basin Board for flood control and water quality protection originally purchased the Wilderness Park.

University of Florida/Hillsborough County Cooperative Extension Service

The Cooperative Extension Service (CES) is an educational service of the University of Florida and Hillsborough County that provides research-based information to the public through workshops, publications, and mass media. The CES offers assistance on creating and maintaining a Florida yard, composting, creating wildlife habitat, xeriscaping, water conservation with micro-irrigation, butterfly gardening, and landscaping for beginners.

Several programs are implemented in Hillsborough County:

1) **Master Gardener Program** - The CES offers the Master Gardener Program that provides gardeners with training and the opportunity to improve their horticultural knowledge and skills. Through organized volunteer activities, gardeners then share their experience with the public. Master gardeners help to educate the community by helping gardeners solve their plant problems, promoting environmental responsibility through water conservation and pest control, beautifying Hillsborough County by teaching about appropriate plants for its climate, and working with school and community gardens.

2) **Backyard Wildlife Habitat Program** - The CES offers the Backyard Wildlife Habitat Program, which promotes the use of native plants. The program teaches that the right selection of native plants can provide a natural food source year-round that many native plants are attracted to. When used correctly the plants will require less water, fertilizer, and pesticides.

3) **Florida Yards and Neighborhoods Program** - The CES offers the Florida Yards and Neighborhoods Program (FYNP). The FYNP is a partnership of concerned citizens, members of the landscape industry, the University of Florida's Cooperative Extension Service, the National Estuary Program, Florida Sea Grant College Program, and numerous environmental agencies. The program was developed to address serious problems of pollution and disappearing habitats by enlisting homeowners to help save our waterways. The program provides special education and outreach activities in the community by assisting residents to reduce pollution and enhance their environment by improving home and landscape management.

SWFWMD Environmental Education Programs

SWFWMD implements several programs throughout it 16-county service area that includes Hillsborough County:

1) Xeriscape - The xeriscape program promotes water conservation through creative landscaping. Landscapes that conserve water will save the homeowner money on water, energy, and maintenance bills, and will help preserve valuable fresh water resources and provide wildlife habitat. The program guides homeowners through a seven-step process including 1) design, 2) plant selection, 3) improving the soil, 4) wise utilization of turf, 5) efficient irrigation, 6) using mulch, and 7) maintenance.

2) SWFWMD In-School Education Programs - The In-School Education Program helps achieve the SWFWMD's goal of preserving and protecting water resources and related ecosystems through educational materials for teachers and students from Kindergarten through grade 12.

3) SWFWMD Mini-grants is a program that offers teachers funding to do classroom projects on water quality, water supply, water conservation, or watersheds. Applications are available through the SWFWMD at http://www.swfwmd.state.fl.us/infoed/educators/minigrants/hillsboroughmg.pdf.

4) SWFWMD Teacher workshops provide teachers information on water resources in the Brooker Creek watershed, as well as hands-on activities and strategies for the best instructional methods on water issues.

5) Project WET is an inter-disciplinary water education program for teachers and other educators working with young people in Kindergarten through grade 12. The program can be integrated into existing curricula of a school, museum, or community organization. The goal of the project is to facilitate and promote appreciation, awareness, knowledge, and stewardship of water resources though the development of classroom-ready teaching aids and the through the establishment of internationally and state-sponsored Project WET programs. The Project WET Curriculum and Activity Guide is a collection of over 90 innovative, interdisciplinary activities that are hands-on, easy to use, and fun. Designed with a commitment to state, provincial, and national education standards, Project WET activities cover diverse topics and disciplines. The Project WET Curriculum and Activity Guide activities promote critical thinking and problem-solving skills. These activities help provide young people with the knowledge and experience they will need to make informed decisions regarding water resource management.

6) The Envirothon is a problem-solving, natural resource education program for high school students. Student team to solve problems and conduct hands-on investigations about forestry, soils, aquatics, wildlife, and current environmental issues. SWFWMD sponsors an annual Envirothon in Hillsborough County inviting local high schools to compete against each other in solving problems in various disciplines.

7) Florida Waters Project Teacher's Guides is a set of activities and background information designed to encourage students to investigate and explore the water systems in their communities, to learn more about water issues and land resources in their communities, and to take an active role in the protection and preservation of our precious water resources.

8) SWFWMD Water Matters is a set of multi-disciplinary activities and background information designed to help students learn about the process of water management and how they can be involved with the process. Water Matters is available to the public.

9) My Water Activity Book is full of fun activities to help students from kindergarten through 2^{nd} grade learn about water resources by coloring and completing mazes, word games, dot-to-dot, and puzzles. This book is available to teachers and students.

10) SWFWMD Splash! Water Education Packet is a colorful, multidisciplinary middle school packet

containing fact and activity sheets on wetlands, the hydrologic cycle, desalination, water use, water conservation, community planning, and water management. The packet is free to educators.

11) Water Drops Newsletter is a water resource newsletter available to teachers from grades 3 through 5. Newsletter issues come with a teacher's guide on water conservation, water cycle, and a visit to a nature park. The newsletter was designed to assist teachers discuss water related issues with their students.

12) The Watershed Education Resources Box is a collection of puppets, poetry, fiction, and non-fiction available to teachers to help students understand watersheds and the importance of watersheds.

13) The Watershed Excursion Tabloid includes information about watersheds found throughout the SWFWMD, explains to students why watersheds are important to Florida's ecosystems, and how we can all work to keep our watersheds clean and healthy.

14) The Water Education Week Publications were created and distributed in conjunction with the Newspaper In-Education Program. This 16-page newspaper tabloid with teacher's guide focuses on a particular water topic each year. Materials are designed for grades 4 to 7. The booklets on water quality, habitats, water management and use, technology, and sustainability are available as class sets and are free to educators.

15) The Water From the Ground Up is a full curriculum available to teachers that includes text, a teacher's guide, an activity book, and basic District hydrologic information for students in grades 3 to 5. The curriculum includes topics on surface water and groundwater sources in west central Florida, water quality, water use, floods, droughts, and water conservation.

16) The Water Watchers is a video and teacher's guide available to kindergarten through grade 3 teachers that includes classic children's songs with water resource lyrics. It also features simple experiments to illustrate such concepts as the hydrologic cycle, water pollution, saltwater intrusion, etc.

17) Who Gets the Water? is an interdisciplinary curriculum available to middle school teachers that provides a basic understanding of the environmental and economic concepts necessary to make good decisions in the face of limited resources.

Florida Department of Education, Office of Environmental Education, Environmental Program

The Florida Department of Education has divided Florida into several Environmental Education Regional Service Areas. The Brooker Creek watershed is within Regional Service IV that covers Charlotte, De Soto, Glades, Hardee, Hendry, Hernando, Highlands, Hillsborough, Lee, Manatee, Pasco, Pinellas, Polk, and Sarasota counties. Each regional service area has several environmental projects, including the promotion of “Teaching Naturally.” This is an interdisciplinary guide using activities to make education real for students by using the environment as an integral concept across subject areas for all grade levels. The mission of Regional Service Projects (RSP) is to assist their region's pre-K through 12 schools, colleges, and universities in improving teaching and learning through environmental education. The RSP IV functions include:

- Conducting assessments of educational needs of teachers and students that environmental education can meet.
- Soliciting and brokering resources to match the needs of teachers, preservice educators, and students that environmental education can meet.
- Publishing and distributing Regional Resource Guides that cover a broad spectrum of regional, state, and national resources for educator use.
- Developing and supporting a cadre of skilled facilitators, most of whom are classroom teachers, to deliver workshops.
- Developing materials and workshops that link environmental education with Sunshine State Standards.
- Collaborating with Area Centers for Educational Enhancement to improve teaching and enhance student performance.
- Assisting post-secondary educators in integrating environmental education concepts and methods in their teaching.

Materials developed by the program of the Office of Environmental Education are distributed at no cost to the public.

Florida Fish and Wildlife Conservation Commission implements several programs state-side, including Hillsborough County and the Brooker Creek watershed:

1) **Project WILD** is a supplementary, interdisciplinary instructional program for teachers of kindergarten through high school age students. It is a way for teachers to incorporate concepts related to people, wildlife, and a healthy environment into major school subjects and skill areas. WILD activities are organized around a conceptual framework that addresses awareness and appreciation of wildlife, human values and wildlife, wildlife and ecological systems, wildlife conservation, cultural and social interaction with wildlife, wildlife issues and trends, and responsible human actions. Project WILD is one of the most widely used conservation and environmental education programs among educators. It is based on the premise that young people and educators have a vital interest in learning about our natural world. The program emphasizes on wildlife because of its intrinsic and ecological values, as well as its importance as a basis for teaching how ecosystems function. Project WILD addresses the need for human beings to develop as responsible citizens of our planet.

2) **FWC Schoolyard Wildlife Project** is an environmental education program that teaches teachers, parents, and students how to turn school grounds into an effective outdoors classroom. The Schoolyard Wildlife Project’s resources help incorporate Florida’s natural

history into school curricula to teach environmental awareness, problem-solving, basic biology, and ecological principles. Two types of hands-on, interactive, one-day workshops are offered: Schoolyard Activities & Ecology and Schoolyard Ecosystems. A combination weekend workshop is offered twice a year. The Schoolyard Activities & Ecology workshop provides teachers with high quality, Florida-specific natural history and ecology lessons, and natural science explorations. This four- to six-hour workshop targets educators in grades K-6. The Schoolyard Ecosystems workshop teaches educators about local ecosystems and how to involve their students in the creation, restoration, or enhancement of native wildlife habitats on school grounds. This six-hour workshop targets educators in grades K-12. The Schoolyard Wildlife Activity Guide and Schoolyard Ecosystems book can be received only by attending the workshop.

Florida Wildlife Federation Backyard Wildlife Habitat Program - The Florida Wildlife Federation, together with the National Wildlife Federation, offers all Florida residents an opportunity to take part in the Backyard Wildlife Habitat Program. The program's goal is to promote and expand gardening for wildlife in Florida. This program promotes the use of native plants, wildlife habitat creation, water conservation, and the use of fewer fertilizers and pesticides to result in less water pollution. As a result, the homeowner trades time-consuming lawn care for hours spent watching birds, butterflies, and small mammals.

Tampa Audubon Society Audubon Resource Center

The Tampa Audubon Society is a non-profit organization dedicated to preserving Florida's resources and unique habitats. It is one of 45 chapters in Florida that assist members and other community leaders in taking on the challenges of local environmental conservation, education, and advocacy. The Tampa Audubon Society offers conservation education and outreach programs to students, providing solid, science-based curricula and site-based programs in subjects as far reaching as aquifer function and wetland conservation. Outdoor and experience-based conservation education is the heart of Audubon's work in Tampa. By giving children, families, and adults the opportunity to experience Florida's natural resources and identify wildlife and habitat types, the Audubon helps to create and nurture a culture of conservation.

Within the Tampa Bay area, factors such as the elimination of wetlands development, decreased water quality, and an increase in population make it essential for residents to understand the Tampa Bay ecosystem so that growth and development can proceed in harmony with nature. Being intimately involved with these issues, the Audubon Society has developed a unique partnership with the Hillsborough County Parks and Recreation Department. Through this partnership, an Audubon Resource Center (ARC) was established in April 1998 at Lettuce Lake Park. The purpose of the ARC is to help foster a "culture of conservation" and an environmental ethic in the Tampa Bay region that will encourage community involvement as part of the Audubon mission. The Hillsborough River borders the 240-acre urban park and visited by 650,000 people each year, including school classes, clubs, inner-city youth, minorities, and families.

The ARC at the Lettuce Lake Park is designed to enhance Audubon's education and community involvement goals and helps citizens develop an appreciation, awareness, and understanding of the natural world and the interplay of forces that affect living things. The ARC is a multi-faceted hub for conservation and utilizes guided tours, educational brochures and materials, and hands-on activities like nest box building and habitat enhancement to reach its goals. The Center includes a natural history exhibit, nature store, and resource center full of books and informational materials. The exhibit shows wildlife of Tampa Bay and the Hillsborough River in their natural setting, giving students, young and old, a close look at the interrelationship of the ecosystem.

8.9 Bibliography

The attached bibliography includes a list of references used for this study and additional references that could be cited by readers.

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8.10 List of Common and Scientific Names for Plants and Animals Mentioned in Report

Trees

Australian pine, Casuarina equisetifolia
Bald cypress, Taxodium distichum
Bluejack oak, Quercus incana
black gum, Nyssa sylvatica var sylvatica
Brazilian pepper, Schinus terebinthifolius
Carolina holly, Ilex ambigua
Carolina willow, Salix caroliniana
castor bean, Ricinus communis
chinaberry tree (Melia azedarach),
Chinese tallow tree (Sapium sebiferum)
dahoon, Ilex cassine
laurel oak, Quercus laurifolia
lobllolly bay, Gordonia lasianthus
loblolly pine, Pinus taeda
longleaf pine, Pinus palustris
Pond cypress, Taxodium ascendens

punk tree (Melaleuca quinquenervia)
red maple, Acer rubrum
sand live oak, Quercus geminata
slash pine, Pinus elliottii
southern red maple, Acer rubrum
swamp bay, Persea palustris
sweetbay, Magnolia virginiana
Turkey oak, Quercus laevis

Shrubs
Beautyberry, Callicarpa Americana
Buttonbush, Cephalanthus occidentalis
Darrow's blueberry, Vaccinium darrowii
Fetterbush, Lyonia lucida
Gallberry, Ilex glabra
Gopher apple, Licania michauxii
saw palmetto, Serenoa repens
shiny blueberry, Vaccinium myrsinites
staggerbush, Lyonia ferruginea
tarflower, Bejaria racemosa
titi, Cyrilla racemosa
Virginia willow, Itea virginiana
Wax myrtle (southern bayberry), Myrica cerifera

Herbs
Adam's needle, Yucca filamentosa
air potato, Dioscorea bulbifera
alligator flag (fire flag), Thalia geniculata
Alligator weed, Alternanthera philoxeroides
Arrowhead, Sagittaria lancifolia
ball moss, Tillandsia recurvata
Beak rush, Rhyncospora sp.
Bearded grasspink, Calopogon barbatus
bladderwort, Utricularia purpurea
bladderwort, Utricularia inflata
bog buttons, Lachnocaulon anceps
bushy bluestem, Andropogon glomeratus
Butterfly orchid, Encyclia tampensis
Cardinal airplant, Tillandsia fasciculata
Carolina elephant's foot, Elephantous carolinianus
Catesby's lily, Lillium catesbaei
Cattail, Typha, latifolia
Cattail, Typha domingensis

Chinese laddere brake, Pteris vittata
Cinnamon fern, Osmunda cinnamomea
cogon grass, Imperata cylindrical/I. brasiliensis
drumheads, Polygala cruciata
duckweed, Spirodela punctata
dwarf pawpaw, pygmaea
eastern milk pea, Glactia regularis
false nettle, Boehmeria cylindrica
fire flag (alligator flag), Thalia geniculata
giant airplant, Tillandsia utriculata
golden polypody, Phlebodium aureum
goldenrod, Solidago fistulosa.
greenvein ladies' tresses, Spiranthes praecox
maidencane, Panicum hemitomon
marsh fern, Thelypteris palustris
early whitetop fleabane, Erigeron vernus
meadow beauty, Rhexia sp.
meadow spikemoss, Selaginalla apoda
netted chain fern, Woodwardia areolata
parrot's feather, Myriophyllum heterophyllum
Pink pink sundew, Drosera capillaris
redroot, Lachnanthes caroliana.
royal fern, Osmunda regalis
sand cordgrass, Spartina bakeri
sawgrass, Cladium jamaicensis
skunk vine, Paederia foetida
sky-blue lupine, Lupinus diffusus
southern needleleaf, Tillandsia simulate
Southern shield fern, Thelypteris kunthii
Small butterwort, Pinguicula pumila
Soft rush, Juncus effuses
Spanish moss, Tillandsia usneoides
Spatterdock, Nuphar luteum
spike rush, Eleocharis sp.
Spring ladies' tresses, Spiranthes vernalis
St John's wort, Hypericum fasciculatum
toothed mid-sorus fern
tropical soda apple, Solanum viarum
Virginia chain fern, Woodwardia virginica
Water hoarhound, Lycopus rubellus
water hyacinth, Eichhornia crassipes
Water lettuce, Pistia stratoides
water spangles, Salvinia minima

whitetop sedge, Rhynchospora colorata
white water lily, Nyphaea odorata
wild taro, Colocasia esculenta
wiregrass, Aristida beyrichiana
yellow butterwort, Pinguicula lutea
yellow-eyed grass, Xyris sp.

ANIMAL SPECIES

Amphibians
gopher frog, Rana capito

Reptiles
American alligator, Alligator mississippiensis
eastern indigo snake, Drymarchon corais couperi
Florida pine snake, Pituophis melanoleucus mugitus
gopher tortoise, Gopherus polyphemus
short-tailed snake, Stilosoma extenuatum

Birds
Florida burrowing owl, Athene cunicularia
Florida scrub jay, Aphelocoma coerulescens
Little blue heron, Egretta caerulea
Limpkin, Aramus guarauna
Peregrine falcon, Falco peregrinus
Roseate spoonbill, Ajaia ajaja
Sandhill crane, Grus canadensis
Southeastern American kestrel,
Snowy egret, Egretta thula
Tricolored heron, Egretta tricolor
White ibis, Eudocimus albus
Wood stork, Mycteria americana

Mammals
Florida mouse, Podomys floridanus
Sherman's fox squirrel, Sciurus niger shermani

CHAPTER 9: WATER SUPPLY

9.1 Overview

The combination of increased water demand with the highly karstic nature of the watershed's geology has resulted in the development of a number of critical issues relating to water supply in the Brooker Creek watershed, including:

- lowered average water levels and increased fluctuations in lakes and wetlands
- declines in average elevations of the potentiometric surface and the water table
- increased annual fluctuations in the elevations of the potentiometric surface and the water table
- reduced streamflows in Brooker Creek
- saltwater contamination of coastal groundwater sources due to saline intrusion and upconing in coastal areas
- reduced reliability of private water supply wells
- increased sinkhole occurrence
- contamination of groundwater resources by agricultural practices, septic tanks, and stormwater runoff

As a result of these issues, increased emphasis has been placed on the development of alternative water supply sources, reuse, off-line reservoirs, surface water withdrawals, aquifer storage and recovery, and water conservation programs in the region. In 2002, an estimated 36% of Hillsborough County's water demand was supplied by surface waters, a figure that is 3% higher than in 1993. This entire amount was derived from the Hillsborough River Reservoir system which provides the majority of the City of Tampa's water supply. The reservoir system includes the Hillsborough River, Sulphur Springs, and the Tampa Bypass Canal. Groundwater resources occur throughout the county and are used extensively; however, higher quality groundwater is typically found with increasing distances from the coast.

Sinkhole formation occurs throughout the county with most occurrences reported in northern and western Hillsborough County. Northwest Hillsborough county area is considered to be an area of "very numerous" sinkhole formation, particularly the cover – collapse category of sinkholes that occur abruptly. The Florida Department of Environmental Protection (FDEP) Sinkhole Database (2006) lists a total of 84 sinkholes that have been reported in the Northwest Hillsborough area, many of which are located in the vicinity of the Cosme, Section 21, and Eldridge-Wilde Wellfields. For example, within 1 month of increasing the pumping rate at Section 21 wellfield, 64 new sinkholes formed within a 1-mile radius of the well field. Most of the sinkholes were formed in the vicinity of well 21-10, which was pumping at nearly twice the rate of the other wells.

Neighboring areas also noticed dramatic declines in lake levels and dewatering of wetland areas. At this point it is recognized that sinkholes can occur as a result of natural geologic phenomena and by the influence of human activities including groundwater pumping, well construction, building construction, etc.

The entire Northwest Hillsborough watershed area lies within the Northern Tampa Bay Water Use Caution Area (NTBWUCA), an area that includes Pinellas County, western and central Hillsborough County, and western and southern Pasco County. This designation was created in 1989 by the Southwest Florida Water Management District (SWFWMD) in response to the impacts observed in connection with groundwater withdrawals and the anticipated future increases in water demand in the area. Through this designation, the District developed a resource assessment and recovery strategy that is implemented through a combination of regulatory measures, conservation and supply projects, and voluntary compliance. The components of the assessment and recovery strategy are enunciated in *Rule 40D-8, Florida Administrative Code (F.A.C).* and include:

- “All water use permittees within the Area are addressed by this Rule 40D-80.073, F.A.C. However, Tampa Bay Water…facilities account for the majority of water withdrawals within the Area. For this reason, these facilities are the primary focus of the portion of the recovery strategy encompassed by this Rule 40D-80.073, F.A.C. Other users…are addressed in 40D-80.073(5), F.A.C.”

- “Recovery to Wetland and Lake Minimum Levels for wetlands and lakes described in and established in 40D-8 …. is the objective of this Rule 40D-80.073, F.A.C.”

- “…the Floridan Aquifer Recovery Management Levels set forth in Table 80-1 below shall be used as long-term guidelines for allocating withdrawals within the Operations Plan, submitted to the District by TBW pursuant to the Agreement, and shall be reevaluated in 2010.”

- Based on that analysis and evaluation, on or before December 31, 2010, the District will initiate rulemaking to revise the MFLs…as necessary; adopt rules to implement the existing or the New MFLs…; and incorporate a second phase to this Recovery Strategy.

The Interim Recovery monitoring effort focuses on addressing other (non-Tampa Bay Water) water use, supplemental hydration of lakes and wetlands, and new applications for water use. The portion of the District's recovery strategy embodied within this Rule is the first regulatory phase of a long-term approach toward eventual attainment of the Minimum Flows and Levels Program goals.

All users, including public water supply utilities, are required to incorporate conservation measures as a means of reversing detrimental environmental trends such as lake level declines and adverse wetland impacts. A number of planning efforts have been developed to protect and enhance water supplies in the Northwest Hillsborough area watersheds. These include:

Hillsborough County Comprehensive Plan (Conservation and Aquifer Recharge Element) – The purpose of the Conservation and Aquifer Recharge Element of the County's Comprehensive Plan is to provide a plan and policy direction for the preservation, conservation, and management of the natural resources of Hillsborough County. The plan provides guidelines for future governmental programs and decisions related to the protection and enhancement of the County's natural environment, as well as the public health, safety and welfare. The objective of the Conservation and Aquifer Recharge Element is to ensure that the air, land, water and living resources of Hillsborough County remain an asset, rather than become a liability, to the quality of life of all existing and future inhabitants.

Hillsborough County Water Resources Team Goals – The mission of the Hillsborough County Water Resource Team is to address water supply and natural resource protection issues, as they relate to projects proposed or operated in Hillsborough County by Tampa Bay Water. Specifically, the Water Resource Team is to:

- Pro-actively coordinate with Tampa Bay Water to develop new and innovative water supply projects that are sensitive to the protection of natural resources
- Protect the County's environmental resources from adverse impacts that may result from water supply development projects undertaken by Tampa Bay Water
- Evaluate the water supply projects proposed by Tampa Bay Water for public health, ecological sustainability and cost effectiveness, in order to influence Tampa Bay Water to improve the projects in those areas where deficiencies exist
- Evaluate the operation of Tampa Bay Water's existing water supply projects and recommend actions to protect the County's environmental resources from adverse impacts
- Evaluate related proposed plans, rules and other initiatives undertaken by the Southwest Florida Water Management District and the Florida Department of Environmental Protection with the aim of protecting the County's environmental resources and safeguarding the quality of life for citizens of Hillsborough County
- Recommend action to the Board of County Commissioners and the Hillsborough County Environmental Protection Commission that will safeguard the rights of the County, its citizenry and the Environmental Protection Commission

Southwest Florida Water Management District Water Management Plan (DWMP) - The 2005 District Water Management Plan (Plan) was accepted by the Governing Board in July 2005 and represented the second five-year update of the District's "comprehensive plan." The Plan serves as a guide to the District in carrying out all its water resource management responsibilities, including those for Water Supply, Flood Protection, Water Quality and Natural Systems, and also reflects the District's Management Services support activities. It plays a significant role in ensuring coordination and consistency of District planning and management, as well as helping to link the District's activities with the planning and management activities of local governments and other agencies.

Southwest Florida Water Management District Northern Tampa Bay Water Resources Assessment Project (NTBWRAP) and Northern Tampa Bay Phase II Program (NTB II) - The Northern Tampa Bay Water Use Caution Area was designated in 1989, and it precipitated the expansion and development of projects to collect data and assess water resource conditions. In 1996, the District published the final report of a multi-year study which assessed the regional water resources of the Northern Tampa Bay area. This study, known as the Northern Tampa Bay Water Resources Assessment Project, was an effort to better understand the current state of the water resources of the area, as well as to provide the foundation for future, more detailed, hydrogeologic and biologic studies.

Since that time, the District has entered into a Partnership Agreement with Tampa Bay Water and its member governments to reduce groundwater withdrawals in the area from 158 mgd to 90 mgd by 2007. Additionally, the District has established a Minimum Flows and Levels Rule (40D-8), which includes minimum levels for cypress wetlands, lakes, and aquifers.

As a follow-up to previous hydrologic and biologic analyses performed in the Northern Tampa Bay area, the Southwest Florida Water Management District has launched a new program known as the Northern Tampa Bay Phase II program (NTB II). NTB II consists of a series of technical projects in Northern Tampa Bay to support the ongoing development of minimum flows and levels, water resources recovery, water use permitting, and environmental resource permitting.

Southwest Florida Water Management District's Northwest Hillsborough Basin Board – The basin board has approved a total of $6,831,519 for water supply-related projects for FY2006, many of which directly affect the region of northwest Hillsborough covered in this report.

Tampa Bay Water's Master Water Plan - Originally approved in 1995 and revised several times since then, this plan is currently aimed at providing a total capacity of 111 million gallons per day (mgd) of water supply by 2008 and reducing demand through conservation. The Master Water Plan is the blueprint to meet long-term drinking water needs for the people of the Tampa Bay region. This strategic plan studies, analyzes and compares water supply options. The options proven to be technically feasible, environmentally sound and economical are selected and implemented by Tampa Bay Water's Board of Directors Figure (9-1A and 9-1B).

The first configuration of the Master Water Plan project is nearing completion, with many of the projects having been implemented in the 2002 – 2005 timeframe. This group of water supply projects will meet regional water demands through 2012. Currently, Tampa Bay Water is working on a second configuration of projects to meet future demand in 2012 and beyond.

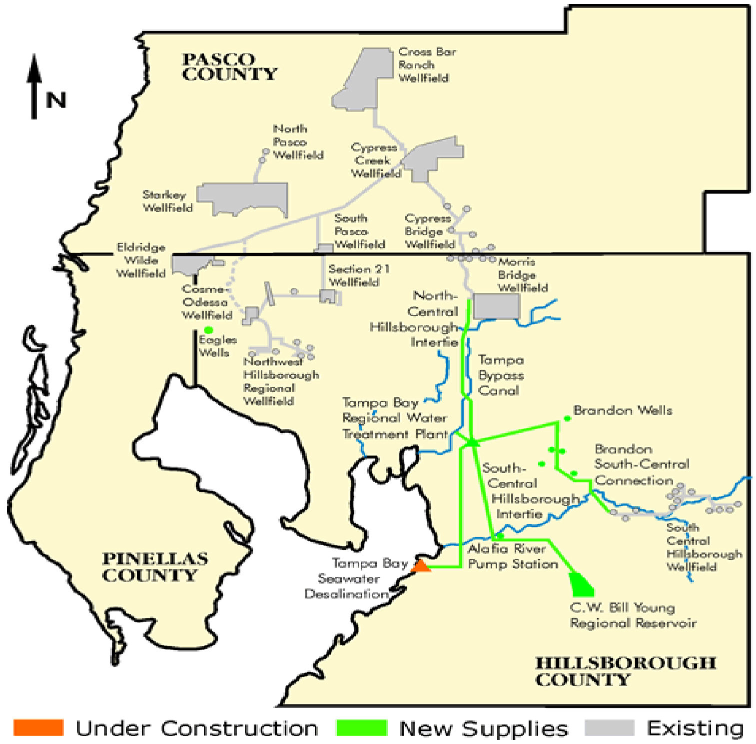


Figure 9-1A Tampa Bay Water Existing Facilities
(Source: Tampa Bay Water, 2006)

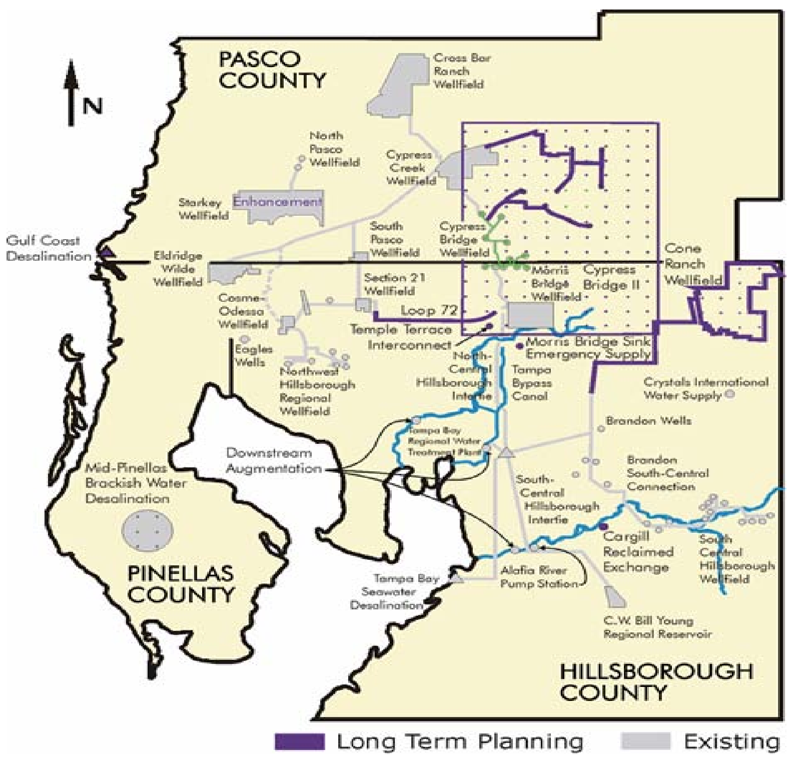


Figure 9-1B Tampa Bay Water Future Infrastructure
(Source: Tampa Bay Water, 2006)

In the Master Plan, one new project, involving the two Eagles Wells, is located in the Northwest Hillsborough area (Figure 9-1C). Some of the components are in the Brooker Creek watershed. Together, the two supply wells in the Eagles development could cost-effectively provide the currently permitted quantity of 198,000 gallons per day of drinking water in an environmentally sound manner. This capacity could be increased to 490,000 gallons per day of drinking water with no significant environmental impacts. The Eagles Wells Enhancement project includes the re-development of Well 2, the replacement of Well 1, and the installation of well houses for both wells.

The water will be transported through a new pipeline to the wholesale water supply system near the Cosme Water Treatment Plant. Tampa Bay Water will submit an application to modify the existing Water Use Permit by letter to replace Well 1 and adjust the individual well quantities for rotational purposes.

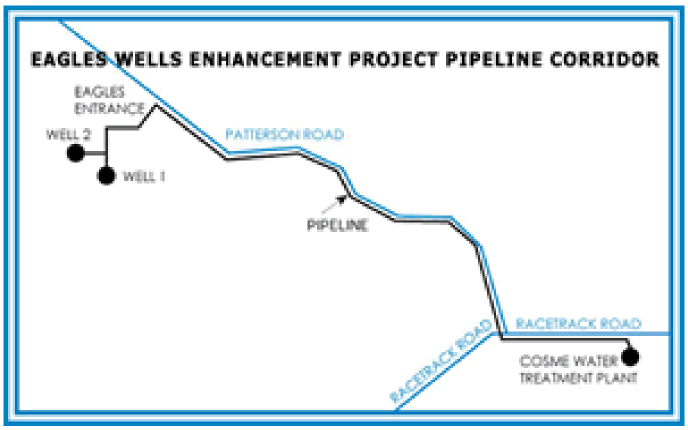


Figure 9-1C   Eagles Wells System Configuration

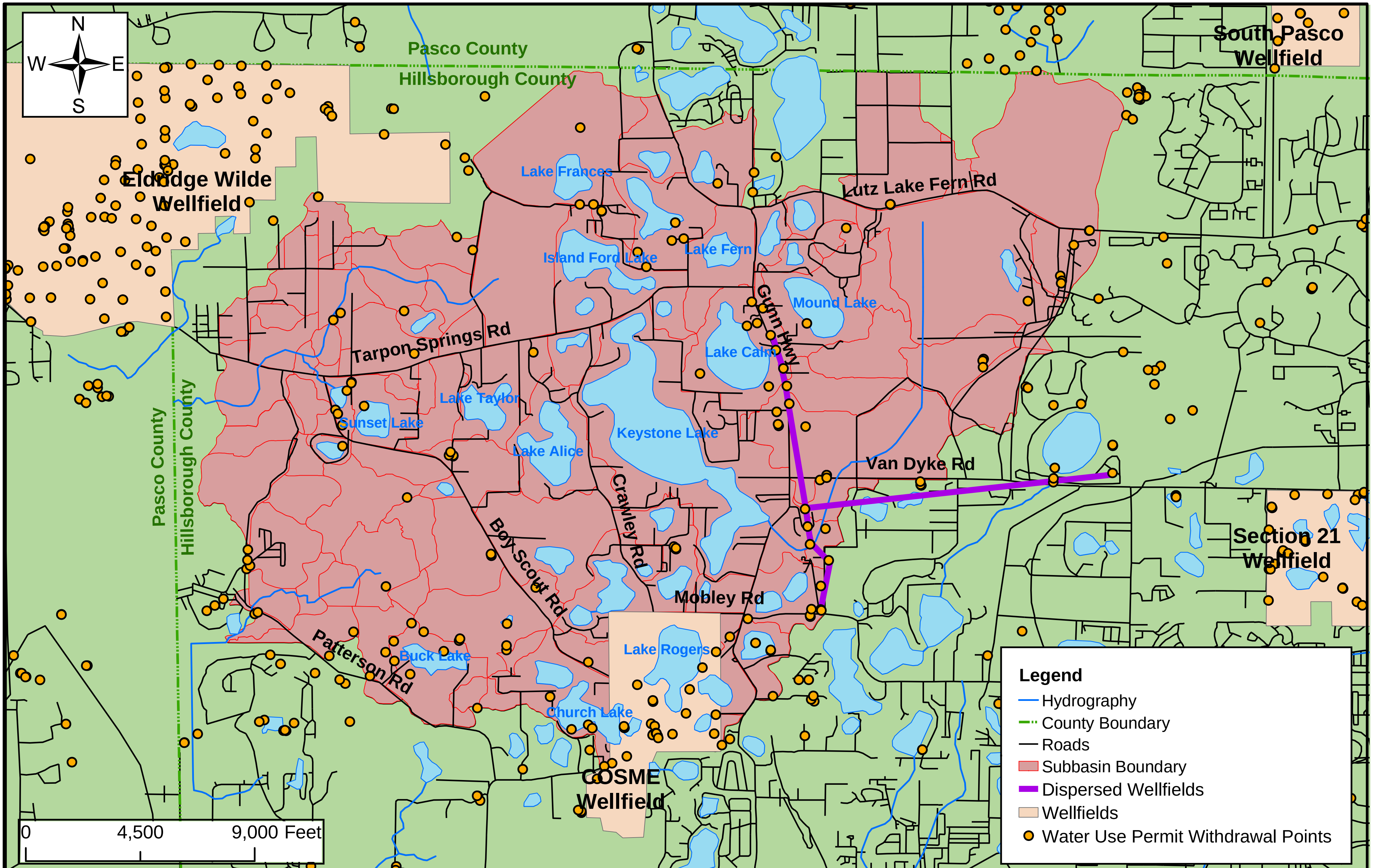
9.2 Groundwater Use

Hydrogeologic Setting - The project area constitutes a hydrogeologic transition zone between the northern and southern regions of the SWFWMD's 16-county service area. The surficial aquifer is composed of unconsolidated deposits of fine-grained sand, silt, and clayey sands having an average thickness of 30 feet. The elevation of the water table ranges from 5 feet NGVD to approximately 50 feet NGVD in the northern portion of Northwest Hillsborough County. In the Brooker Creek watershed, groundwater elevations range from 20 – 50 feet NGVD. Groundwater derived from this aquifer is used most often for lawn irrigation and livestock watering as the aquifer produces yields that typically range around 20 gallons per minute.

While of no significance for direct use for potable supply, the surficial aquifer is important in the northeastern portion of the project area as a source of recharge for the Upper Floridan Aquifer via vertical leakage across the semi-confining unit, a vertical zone composed of clays of a thickness ranging from 2.0 to 90 feet that is discontinuous across the project area. The Upper Floridan Aquifer, composed of a continuous series of carbonate units, ranges from 1000 feet to 1100 feet thick in the project area; in the Brooker Creek watershed, the thickness of the Upper Floridan is approximately 1000 feet. The Upper Floridan is very close to the land surface in some areas. In the Brooker Creek watershed, the Upper Floridan comes to within 20 feet of the land surface. Because of the Upper Floridan's close proximity to land surface in the northern portion of the Northwest Hillsborough Area and in view of the recharge potential in that area, the opportunity for contamination of the Upper Floridan is high there. In the central to southern portions of the Northwest Hillsborough area, contamination potential ranges from low to moderate.

Components of two major municipal supply facilities are located within the Brooker Creek watershed in addition to numerous domestic supply facilities (Figure 9-2).

In the Hillsborough County portion of the NTBWUCA, the estimated withdrawal of groundwater amounted to 92.6 million gallons per day (mgd) in 2002, while the permitted groundwater quantities totaled 116.2 mgd. Over the period 1993 – 2002, actual withdrawals from the four public supply facilities that are located in the Northwest Hillsborough area (Cosme-Odessa, Eldridge-Wilde, Northwest Hillsborough, and Section 21) have ranged from a low of 51.4 mgd in 1993 to a high of 59.3 mgd in 2000 (Figure 9-3). However, the groundwater withdrawal reduced after 2000 (Figure 9-3). Groundwater withdrawals over that period have shown a very slight increasing trend, although the increase is not statistically significant. For comparison, in all of Hillsborough County, a total of 174.8 mgd was utilized for potable supply (47.5%), agriculture (38.9%), industrial and commercial uses (6.3%), recreational and aesthetic uses (5.9%), and mining/dewatering (1.3%).



Wellfield and Well Locations in the Brooker Creek Watershed

Figure 9-2

AYRES ASSOCIATES

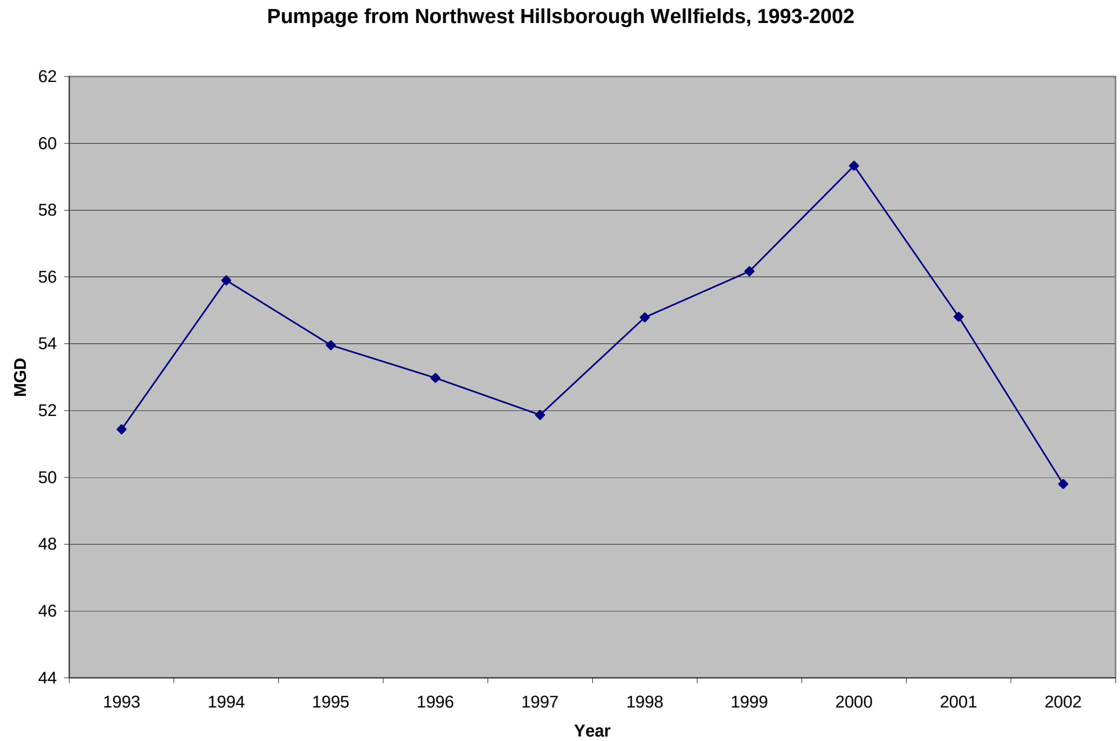


Figure 9-3 Groundwater Withdrawals-Northwest Hillsborough Public Supply Facilities *(Source: SWFWMD, Estimated Water Use, 2002)*

Currently, the average production limit for the public supply facilities in the Northwest Hillsborough area totals 57.5 mgd (Table 9-1).

Table 9-1 Average Production Limits (mgd) for the Public Supply Facilities in the Northwest Hillsborough Area

WATER SUPPLY FACILITY	AVERAGE PRODUCTION LIMIT (MGD)	DESTINATION OF WATER PUMPED
Eldridge – Wilde wellfield	26.5	SK Keller pumping station
Northwest Regional wellfield	10	Cosme treatment plant and NW Hillsborough treatment facility
Cosme-Odessa	11	Cosme treatment plant
Section 21	10	Lake Park treatment plant
TOTAL	57.5	

Total per capita water use for the period, 1993 – 2002, ranged from a low of 105 gallons per capita per day (gpcd) in 1998 to a high of 154 gpcd in 1995 for both surface and groundwater sources (Figure 9-4). Per capita water use showed a slight decreasing trend over that period, but it was not statistically significant. In 2003, Hillsborough County utilized approximately 70% of its reuse capacity. On a per capita basis, the actual rate of reuse amounted to 30.54 gpcd, while the reuse capacity equaled 43.4 gpcd.

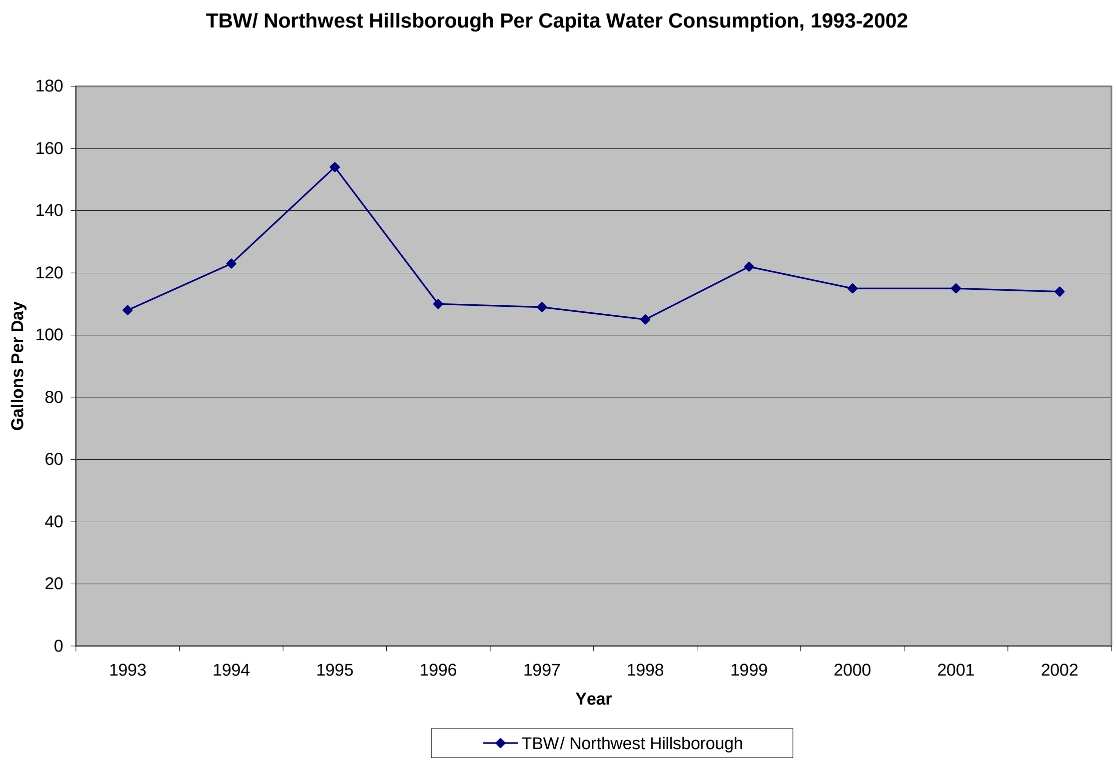


Figure 9-4 Per Capita Water Use in the NTBWUCA
(Source: SWFWMD, Estimated Water Use, 2002)

Figure 9-5 shows the cumulative rainfall (inches) and the “variance from normal” (NOAA) for the period between May 2005 through April 2006 for Tampa International Airport (TIA), while Table 9-2 lists other rainfall stations that are located within the NTBWUCA and operated by SWFWMD. The TIA station reports an above-normal rainfall condition equaling 2.7 inches at that location.

However, due to the nature of rainfall over a large geographic area, the rainfall surplus for the area as a whole as represented by the nine rainfall stations listed in Table 9-2 amounts to 0.7 inches over the April 2005 – March 2006 time period. In addition, the average rainfall amount for March 2006 in the Northwest Hillsborough area was 0.13 inches, which represents a departure from the normal March rainfall amount totaling -3.24 inches. Since January 2006, the departure from normal for the time period January – March was 1.49 inches.

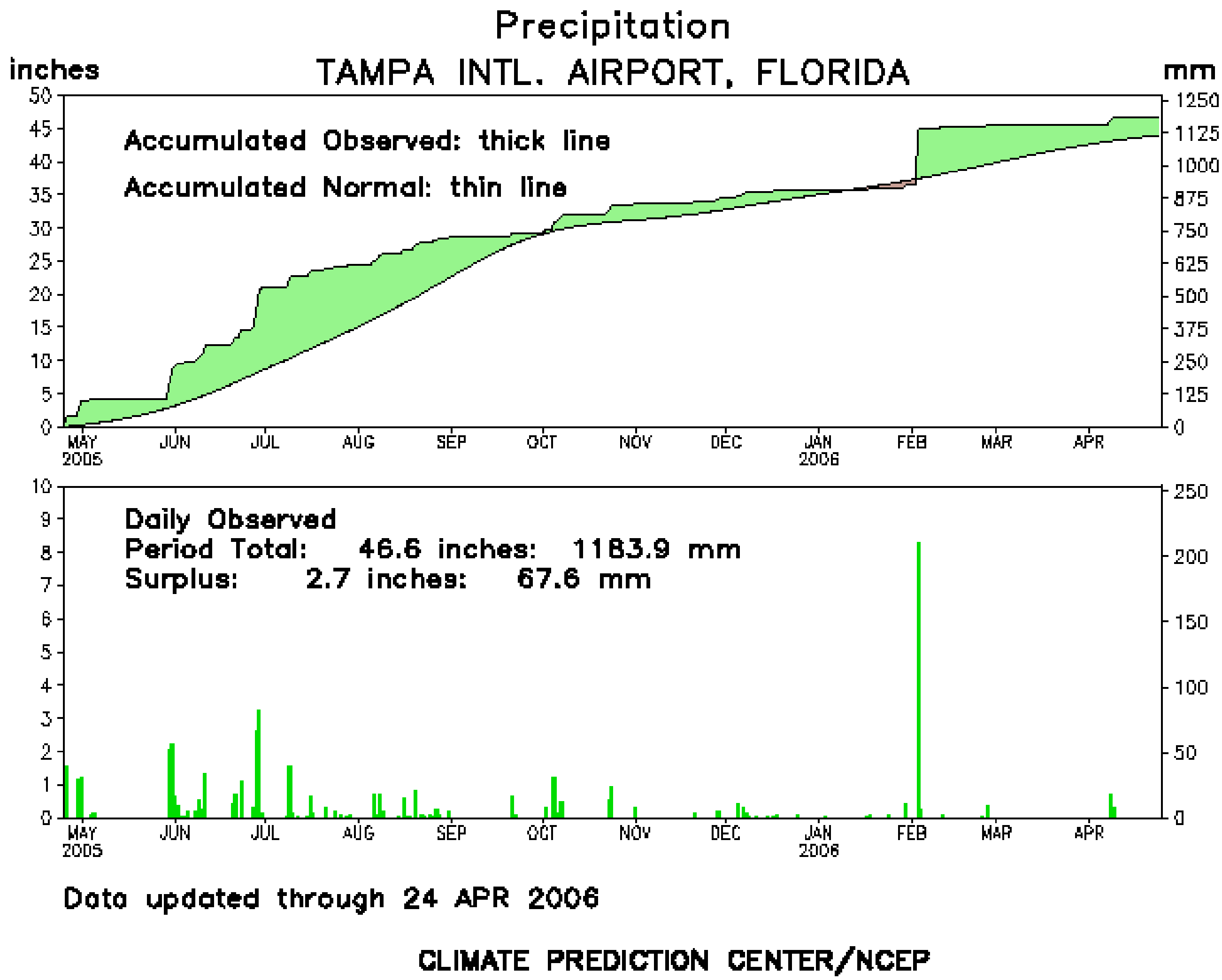


Figure 9-5 Rainfall and Departure from Normal for the Tampa International Airport (*Source: SWFWMD, Estimated Water Use, 2002)*

Table 9-2 Rainfall Stations in the Northwest Hillsborough Area *(Source: SWFWMD)*

TYPE	SITE	SITE NAME	LATITUDE	LONGITUDE
RNF	313	E-101 (ROMP TR 13-3)	280355.05	823818.34
RNF	390	CRESCENT LAKE	280918.04	823552.34
RNF	394	ISLAND FORD	280909.04	823614.34
RNF	395	BAY LAKE	280410.05	822958.33
RNF	440	LAKE COMO ET	281056.03	822811.33
RNF	503	LAKE HANNA	280830.02	822648.92
RNF	538	ELDRIDGE-WILDE 2N	281011.04	823905.34
RNF	561	ST PETE 42	281036.03	823056.33
RNF	582	ST PETE JACKSON 26 A RAIN	280733.04	823057.33

Groundwater levels in the Northwest Hillsborough area as represented by three monitoring wells, (EWWF 11 FLDN, EWWF 2S DEEP, AND COSME 3 FLDN) indicate that groundwater elevations for March 2006 are declining from those observed in April 2006, but they have not reached the historical low for March (Table 9-3).

Table 9-3 Comparison of Groundwater Elevations (NGVD) in the Northwest Hillsborough Area
(Source: SWFWMD, Hydrologic Conditions Report – March 2006)

WELL	WATER LEVEL MARCH 2006	CHANGE FROM PRIOR MONTH	MARCH HISTORICAL LOW LEVEL	LOW LEVEL FOR PERIOD OF RECORD
COSME 3 FLDN	21.47	-5.45	20.77	10.94
EWWF 11 FLDN	14.32	-2.57	7.33	0.31
EWWF 2S DEEP	16.45	-2.29	6.62	-1.16

The Northern Tampa Bay Phase II (NTB II) project was initiated by SWFWMD as an outgrowth of the 1989 declaration of the NTBWUCA and the Northern Tampa Bay Water Resource Assessment Project (WRAP) which was completed in 1996. This study will continue through 2010 and will include assessments of the biological and hydrological conditions in Northern Tampa Bay to support the development of minimum flows and levels, water resource recovery, water use permitting, and environmental resource permitting. NTB II consists of a series of technical projects in Northern Tampa Bay to support the ongoing development of minimum flows and levels, water resources recovery, water use permitting, and environmental resource permitting.

The goal of the NTB II project is to enhance the data collection effort, implement projects for the assessment of water supply needs, and to develop a water resources recovery strategy. As of 2005, 30 nested groundwater monitoring sites have been installed and 50 new wetland monitoring sites have been established, many of them in the Northwest Hillsborough area. These projects include detailed assessments of water resources and involve intensive data collection and monitoring to characterize hydrologic conditions and determine the effects of water withdrawals (SWFWMD, 2000).

9.3 Surface Water Use

The majority of the Northwest Hillsborough area relies on groundwater for its water supply, but the Sweetwater Creek and Lower Sweetwater Creek watersheds together with a portion of the Rocky/Brushy Creek watershed are within the service area of the City of Tampa for which the primary water source is Hillsborough River Reservoir. In 2002, the NTBWUCA was supplied with 54.998 mg for public supply from wellfields in the area; in that same year, a total of 85.477 mg was provided from surface water sources.

In the Brooker Creek watershed, there are 36 named lakes ranging in surface area from less than 10 acres to greater than 400 acres. The larger lakes in the watershed are: Keystone (417 ac), Calm (127 ac), Island Ford (96 ac), and Crescent (46 ac). Lakes Keystone and Island Ford represent the channel of Brooker Creek for approximately 40% of the creek's length in Hillsborough County, and flows are controlled by structures on the lakes' outfalls. Lakes in the Brooker Creek watershed are not utilized for potable supply, but they are used for irrigation of lawns and some citrus groves in the area.

While Brooker Creek is the dominant waterway in the watershed, it is not identified on the 1950 land use mapping due to its channel and flow characteristics. The channel is narrow except where it flows through Lakes Keystone and Island Ford, and flow is intermittent. Discharge rates and water elevations are controlled by two water control structures and several culverts as the creek flows from its head near Jiretz Road to Pinellas County, a distance of 6 miles. From the Hillsborough-Pinellas County line, the creek continues to flow westerly into Pinellas County to its ultimate outfall in Lake Tarpon. Brooker Creek is not used for potable supply, and its use for landscape irrigation is extremely limited due to its intermittent flow characteristics along most of its length.

9.4 Water Supply Issues / Areas of Concern

With the recent occurrence of widespread drought within the region, many concerns have been raised as to how the future water supply needs will be met.

In recent years, several projects have been proposed and initiated to meet the future water needs of the region. However, it remains to be seen whether these new projects will provide sufficient water without causing significant adverse impacts on the environment. Several studies have documented the decline in water levels of wetlands, lakes as well as groundwater (SWFWMD, 1996). The demand for water will continue to increase as population grows and both groundwater and surface water supply needs increase. Furthermore, with increasing development in the region, there will be less permeable land available for the rainfall to replenish the groundwater.

9.4.1 Aquifer Recharge

Approximately half of the Northwest Hillsborough area occupies lands where recharge to the Floridan Aquifer occurs at a rate varying from 1.0 inch to 10 inches per year. This area includes the upper reaches of the Brooker Creek watershed. The remainder of the Northwest Hillsborough area is a discharge area that discharges from the Floridan aquifer at an estimated rate of 1 to 5 inches per year (SWFWMD, 1996). Figure 9-6 presents the recharge and discharge rates in the Northwest Hillsborough area.

Protection of recharge areas in the watershed is critical to the preservation of the regional groundwater sources and meeting regional water supply demands.

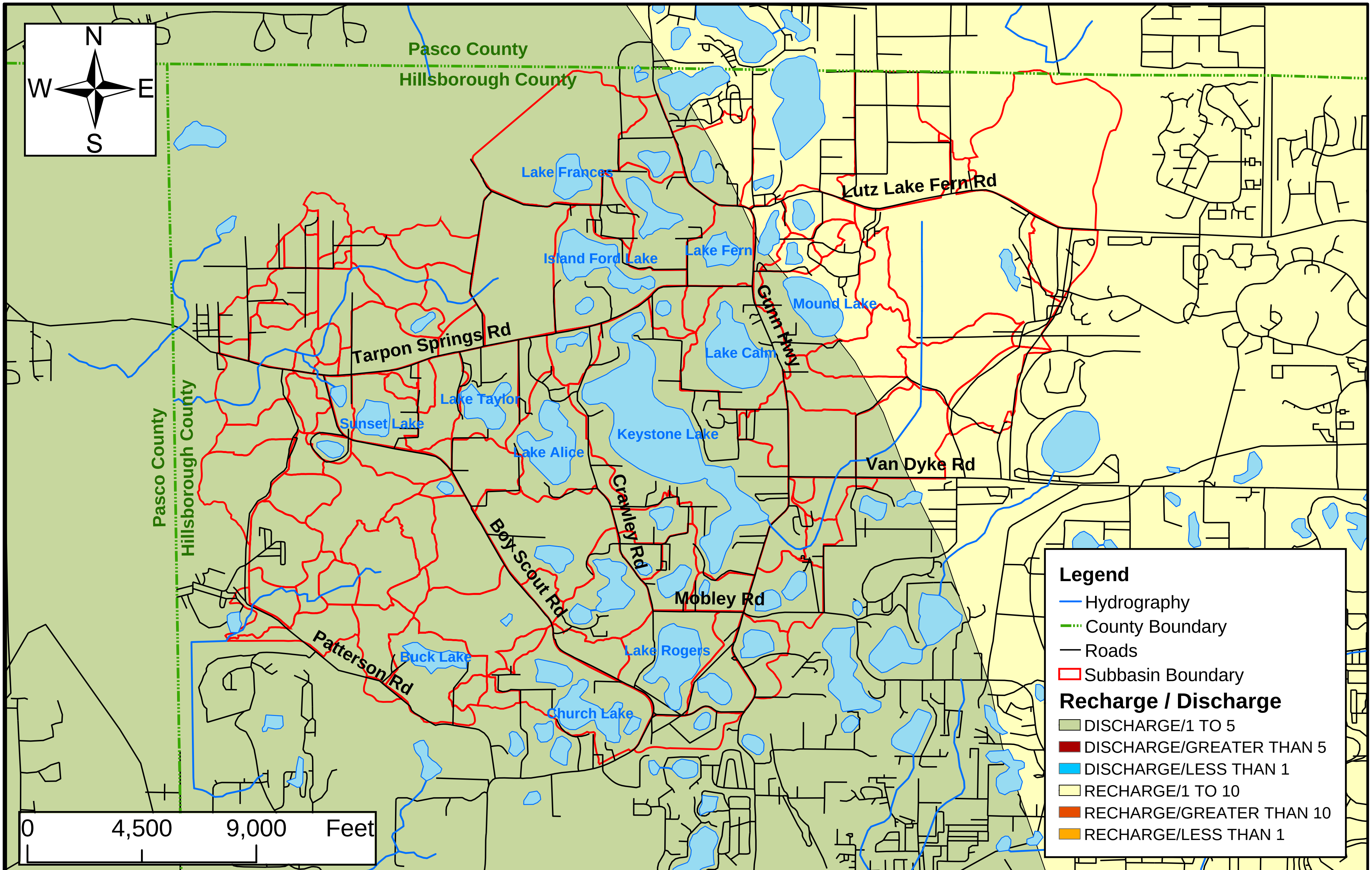
Several management and regulatory strategies have been undertaken in recent years to enhance aquifer recharge in the Northwest Hillsborough area, which include the following:

- Optimization and expansion of existing aquifer storage and recovery systems
- Delineation of recharge/discharge relationship
- Identification of sites for wetlands, lake, and aquifer rehydration
- Identification of opportunities to re-engineer stormwater management systems to enhance groundwater recharge and improve water quality in waterbodies used for drinking water
- Identification of opportunities to use reclaimed water for rehydration
- Improvement of wellhead protection ordinances to include recharge areas and landuse ordinances
- Modification of Environmental Resource Permit (ERP) regulations to enhance aquifer recharge
- Modification of local, state, and District regulations to maintain and enhance groundwater recharge

9.4.2 Impacts Due to Water Withdrawals

The literature describing the effects of groundwater withdrawal on wetland hydroperiods and lake stages dates to 1971. Since that time, the nature of the impacts to wetlands has been documented in wetlands both in and around major wellfields (Rochow, 1998).

Generally, symptoms of wetland health decline (e.g., replacement of aquatic plant species by upland species, tree-fall, soil subsidence, loss of wetland-dependent wildlife) have occurred in the vicinity of large-scale groundwater withdrawals (e.g., Section 21, Cosme, Northwest Regional, and Eldridge – Wilde Wellfields). As a Water Use Permit (WUP) condition, permit holders have been required to monitor water levels and ecological indicators of wetland viability, and annual reports have been prepared describing wetland hydrobiological conditions since the mid-1970s. The link has been made between groundwater withdrawals and reduced hydroperiod in area wetlands.



Generalized recharge or discharge rate of the Floridian Aquifer System (in/yr)

Figure 9-6

Under the NTB II project, the SWFWMD has established many more wetland monitoring sites, and recovery strategy has been developed. The recovery strategy involves:

- District and Tampa Bay Water (TBW) water level monitoring
- District and TBW biologic monitoring (WAPs)
- TBW annual assessment of wellfields (annual reports)
- District Minimum Flows and Levels (MFL) monitoring
- Environmental Monitoring Plan (EMP) referrals to the Operations Plan

During the first several years of pumpage from the three wellfields in the project area, wetlands within the wellfield's zone of influence exhibited signs of wetland health decline including the replacement of wetland vegetation with upland species. These ecological changes were attributed to sustained groundwater production as well as below normal rainfall conditions. From about 1986 to 1993, overall annual pumpage rates for the wellfield were reduced by nearly 40% compared to the original production period. Recent pumpage data from the area's three wellfields, however, indicates that the production in the wellfield has increased but not significantly.

Several management strategies have been proposed/undertaken to minimize the impacts due to water withdrawals, which include the following:

- Development of operation and management plans to minimize environmental impacts for all permitted water users
- Implementation of projects associated with the NTBWUCA
- Investigation for alternative sources of water
- Development and implementation of aggressive water conservation and water reuse programs
- Continuation of cooperative funding to encourage development of alternative water sources
- Continuation of regulatory requirements/incentives for alternative water sources

9.4.3 Minimum Flows and Levels

Chapter 373.042 (2) F.S., requires the SWFWMD to adopt minimum flows and levels on streams, lakes and aquifer water levels throughout the District. By statute the District must prioritize the adoption of minimum levels in areas of Hillsborough, Pinellas, and Pasco counties which are experiencing or are expected to experience adverse impacts because of groundwater withdrawals. In response to this charge, the District has proposed minimum levels in lakes, wetlands, and aquifers in priority areas including the Northwest Hillsborough area.

Establishment of minimum flows and levels (MFLs) constitutes defining the minimum flow regime and water levels necessary to prevent significant environmental impacts to lakes, wetlands, streams, and aquifers. The Hillsborough County Comprehensive Plan (Coastal Management Element) requires cooperation between the County and the SWFWMD to ensure that the minimum freshwater flows needed to support natural, optimal diversity and productivity in estuarine areas are scientifically determined and maintained. To date in the Northwest Hillsborough area, levels have been set by the District on 15 wetlands, seven wells, and 15 lakes. Lakes having Minimum Levels adopted by SWFWMD's Governing Board include: Alice, Calm, Church, Crescent, Echo, Garden, Horse, Jackson, Juanita, Little Moon, Mound, Rainbow, Sunset, and Taylor.

In addition, Lakes Raleigh and Rogers are scheduled for MFL development in 2006, and Brooker Creek is scheduled in the 2011 – 2018 timeframe.

The key management strategies of the MFL program include:

- Prioritization of areas where determination of minimum flows and levels are needed
- Development of scientific justification for establishing minimum flows and levels
- Development of action plan and permitting strategies to work toward achieving the minimum flows and levels where existing levels are below the minimum levels

Water supply issues are being addressed by SWFWMD, TBW, the City of Tampa, and Hillsborough County in order to balance the protection of water resources with sustainable development. New sources of potable water are being developed by Tampa Bay Water member governments, and projects implemented through these efforts will address improvements to water supplies in concert with water quality, flooding, and natural systems restoration.

9.5 Bibliography

The attached bibliography includes a list of references used for this study and additional references that could be cited by readers.

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CHAPTER 10: POLLUTANT LOADING AND REMOVAL MODEL

10.1 Overview

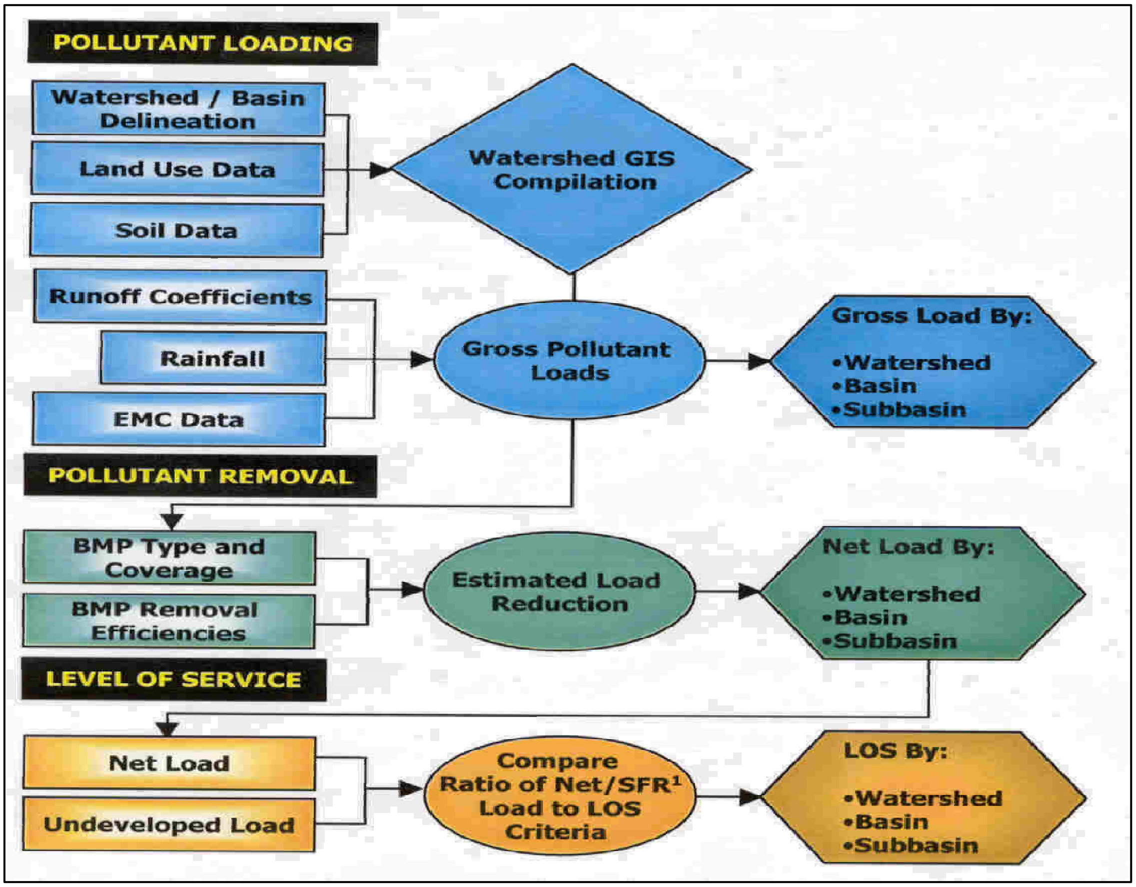
Potential water quality impacts resulting from stormwater runoff in the Brooker Creek watershed were evaluated using the Pollutant Loading and Removal Model previously developed by Parsons Engineering Science, Inc. in conjunction with the Hillsborough County Public Works/Stormwater Management Section. The model was developed to:

- estimate the potential water quality impacts resulting from the most current (2004) land use mapping and soils conditions; and
- evaluate the reduction in potential loading due to the existing best management practices (BMP) within the watershed.

This chapter discusses the process used to delineate the areas treated by existing BMPs and an estimate of their overall effectiveness in reducing pollutant loading within the watershed using the above-mentioned model. The gross pollutant loading within the watershed was estimated based on the 2004 land use and soils characteristics. Gross pollutant loading was estimated by assuming no treatment of stormwater runoff, and is indicative of the potential of various land uses to yield contaminants into the environment. From this gross loading, the reduction in loading due to the existing BMPs was subtracted to approximate the net pollutant loading within the watershed. Analyses were conducted at both watershed and subbasin levels.

10.2 Pollutant Loading and Removal Model

The Pollutant Loading and Removal Model has three main components: calculation of gross pollutant loads, estimation of net loads based on existing treatment, and evaluation of the treatment level-of-service based on individual hydrologic units (Figure 10-1). For the purposes of these analyses, the hydrologic units of interest are the subwatershed and subbasin. In the model, land use and hydrologic soil characteristics were used to determine runoff characteristics. A gross pollutant load for each subbasin was calculated as the product of the runoff volume and the stormwater event mean concentrations (EMC) for each pollutant and land use of interest. Six EMC values were measured during previous stormwater characterization studies performed by Hillsborough County, and later submitted as part of the County's National Pollutant Discharge Elimination System (NPDES) permit.



Note:
1. Ratio of net load (treated) to untreated single family residential (SFR)
2. Level of Service Criteria:
A) Net Load 20% or less of SFR
B) Net Load 20-40% of SFR
C) Net Load 40-70% of SFR
D) Net Load 70-100% of SFR
E) Net Load > 100% of SFR

Figure 10-1 Hillsborough County Pollutant Loading and Removal Model
(Source: Parsons Engineering Science, Inc.)

Net pollutant loads were estimated at the subbasin level based on the treatment provided by existing BMPs and the land use for which the BMP was implemented. The treatment level-of-service for each subbasin, described in greater detail in the following chapter, is based on comparing the net pollutant loads to a benchmark condition. This benchmark is represented by the extent of loading that would occur if the subbasins were designated as low/medium density residential land use with no stormwater treatment.

The 12 different parameters (pollutants) that are evaluated in the model are listed in Figure 10-2.

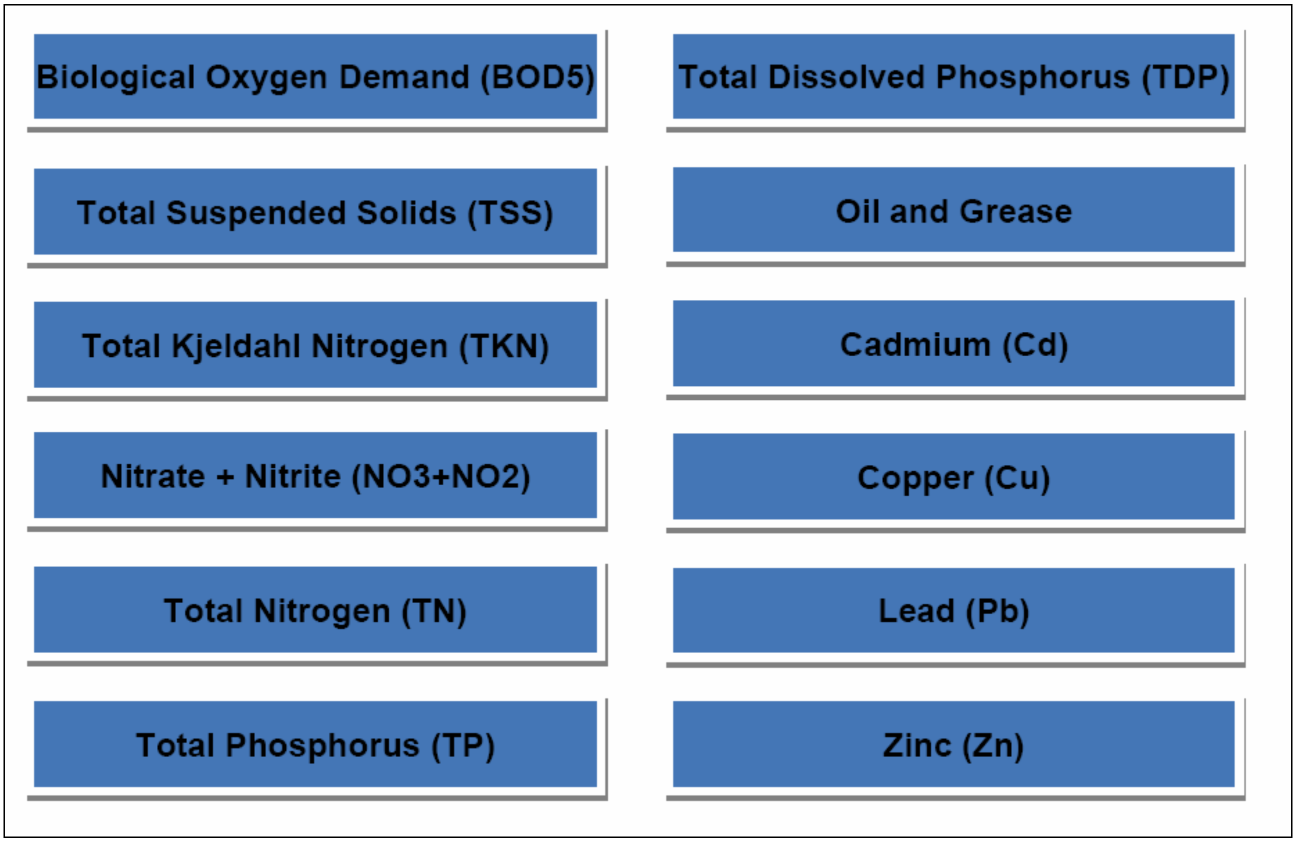


Figure 10-2 Pollutants Evaluated in the Pollutant Loading and Removal Model

10.2.1 Land Use

The percentage of impervious land surface area is typically determined by land use composition (e.g., transportation = roads = high proportion of impervious area). The degree of imperviousness can then be used to estimate the volume of runoff expected from various subbasins within a watershed. The 2004 land use coverage provided by the Southwest Florida Water Management District (SWFWMD) was used in this modeling effort to determine land use types in each subbasin.

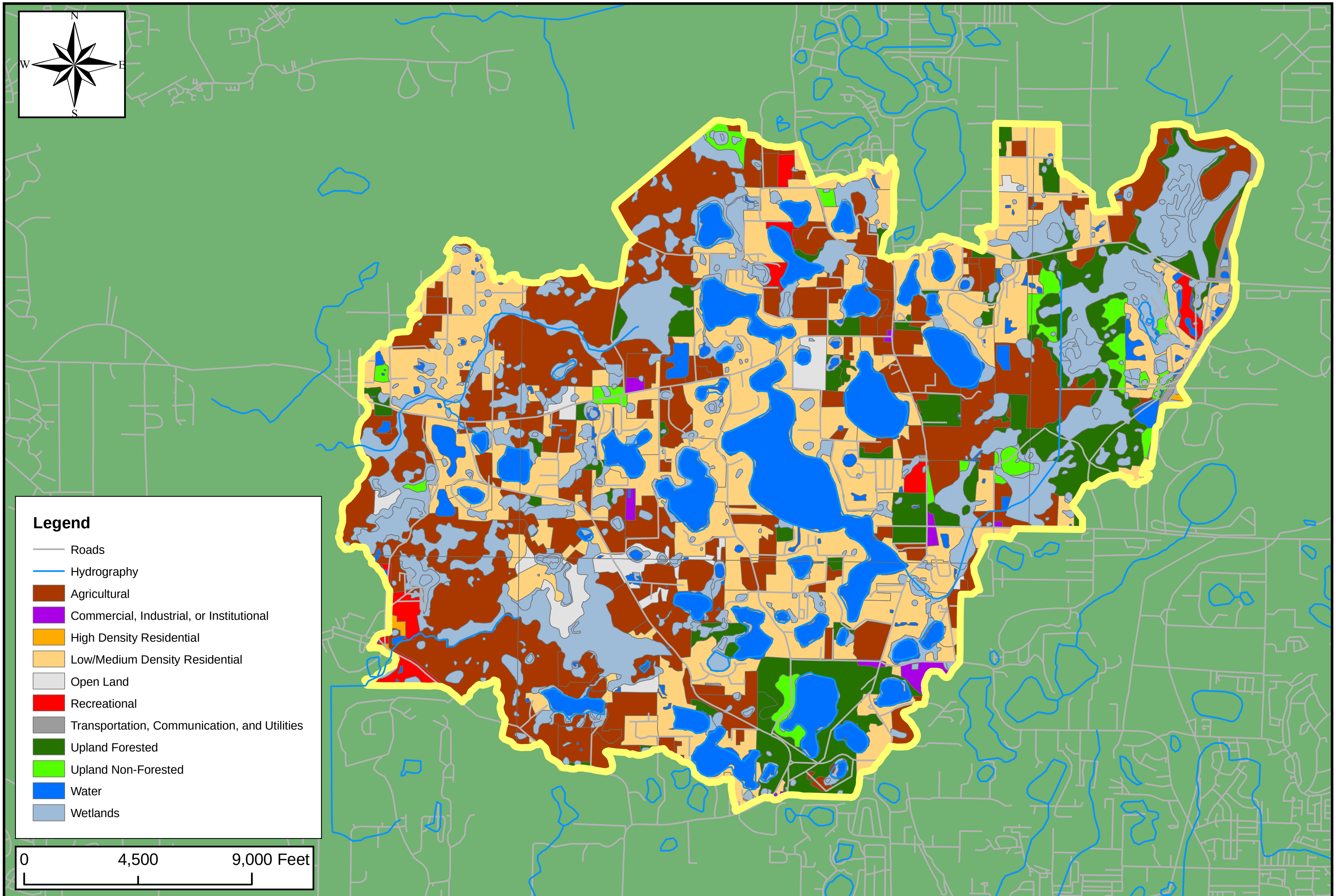
The land use categories evaluated for the pollutant loading model include:

- low/medium density residential
- high density residential
- light industrial
- agricultural
- commercial
- institutional
- highway/utility
- recreational
- open land, and
- extractive (mining)/disturbed

Figure 10-3 illustrates the distribution of the land use categories within the Brooker Creek watershed. Acreages and percentages of land uses based on these general categories for the watershed are summarized in Table 10-1.

Table 10-1 Brooker Creek Watershed 2004 Land Use Distribution

Land Use	Total Square Miles	Acreage	Percentage
Agricultural	15,585,792	3,851	27.0%
Commercial, Industrial, or Institutional	300,144	74	0.5%
High Density Residential	73,353	18	0.1%
Low/Medium Density Residential	14,752,413	3,645	25.5%
Open Land	992,857	245	1.7%
Recreational	698,249	173	1.2%
Transportation, Communication, and Utilities	372,414	92	0.6%
Upland Forested	4,962,512	1,226	8.6%
Upland Non-Forested	992,019	245	1.7%
Water	7,217,781	1,784	12.5%
Wetlands	11,800,269	2,916	20.4%
TOTAL	**57,747,807**	**14,269**	**100.0%**



Land Use Distribution in the Brooker Creek Watershed (2004)

Figure 10-3

10.2.2 Soil Characteristics

Soil type is another important component of runoff calculations since different soils have varying capacities for infiltration. Also, the distribution of soils can vary significantly throughout a watershed. Hydrologic soil groups are typically used to classify soils based on runoff potential. Soils are grouped into four hydrologic soil groups (A through D), which reflect varying levels of infiltration rates and soil moisture capacities. Descriptions of these soil groups are as follows:

- **Group A** (low runoff potential): Soils with high infiltration rates even when thoroughly wetted and which have a high rate of water transmission. The soils under this group have a typical maximum infiltration rate of 10 in/hr when dry and 0.5 in/hr when saturated.

- **Group B** (moderately low runoff potential): Soils that have moderate infiltration rates when thoroughly wetted and a moderate rate of water transmission. The soils under this group have a typical maximum infiltration rate of 8 in/hr when dry and 0.4 in/hr when saturated.

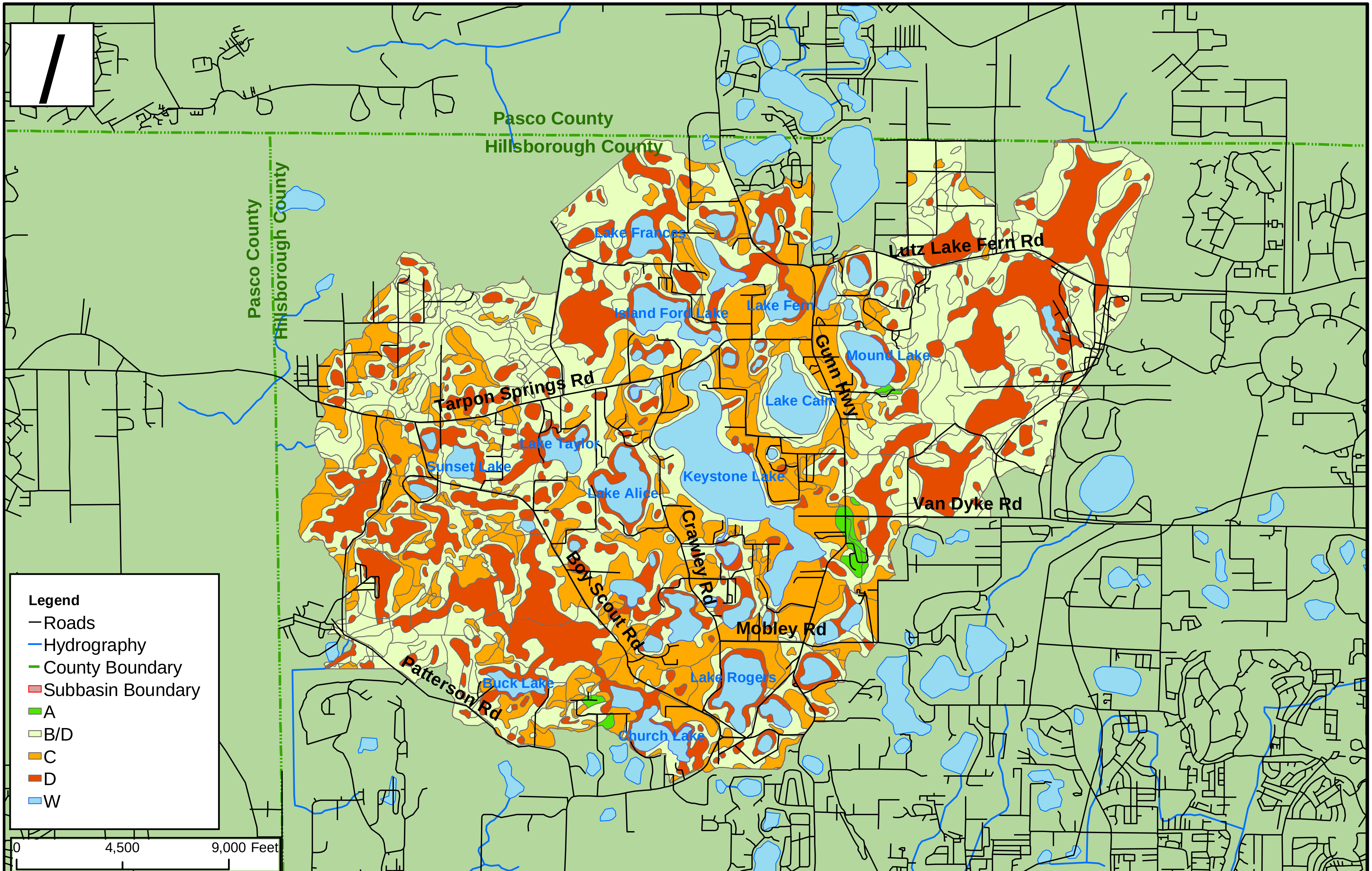
- **Group C** (moderately high runoff potential): Soils that have a slow infiltration rate when thoroughly wetted and a slow rate of water transmission. The soils under this group have a typical maximum infiltration rate of 5 in/hr when dry and 0.25 in/hr when saturated.

- **Group D** (high runoff potential): Soils having very slow infiltration rates when thoroughly wetted and a very slow rate of water transmission. The soils under this group have a typical infiltration rate of 3 in/hr when dry and 0.10 in/hr when saturated.

Some wet soils that can be adequately drained may have dual hydrologic soil group classifications (B/D). The first designation is based on the drained condition, and the second letter designation is based on the undrained or natural condition. Figure 10-4 illustrates the distribution of the soil hydrologic groups within the Brooker Creek watershed. Table 10-2 presents a summary of the percent coverages of each of the hydrologic groups in the watershed.

Table 10-2 Brooker Creek Watershed Soil Hydrologic Group Distribution

Soil Hydrologic Group	Acreage	Percentage (%)
A	70	0.50
B	0	0.00
B/D	6,477	45.39
C	3,200	22.42
D	4,524	31.70
Grand Total	**14,272**	**100**



Hydrologic Soil Groups in the Brooker Creek Watershed

Figure 10-4

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Runoff volume calculations were based on the application of runoff coefficients by soil and land use type. Most of the coefficients, listed by land use, can be found in the FDOT drainage manual. Runoff coefficients used in this analysis are summarized in Table 10-3.

Table 10-3 Runoff Coefficients by Land Use Category and Soil Type

FLUCCS Code	Land Use	Hydrologic Group			
		A	B/D	C	D
1100	Low/Medium Density Residential	0.267	0.322	0.379	0.43
1200	Low/Medium Density Residential	0.267	0.322	0.379	0.43
1300	High Density Residential	0.5	0.566	0.634	0.7
1400	Commercial	0.45	0.549	0.651	0.75
1410	Commercial	0.45	0.549	0.651	0.75
1420	Commercial	0.45	0.549	0.651	0.75
1430	Commercial	0.45	0.549	0.651	0.75
1440	Commercial	0.45	0.549	0.651	0.75
1450	Commercial	0.45	0.549	0.651	0.75
1460	Light Industrial	0.5	0.599	0.701	0.8
1500	Light Industrial	0.5	0.599	0.701	0.8
1600	Extractive (Mining)/Disturbed	0.05	0.05	0.05	0.05
1700	Institutional	0.45	0.549	0.651	0.75
1800	Recreational	0.1	0.166	0.234	0.3
1900	Open Land	0.1	0.166	0.234	0.3
2000	Agricultural	0.15	0.233	0.318	0.4
2100	Agricultural	0.15	0.233	0.318	0.4
2140	Agricultural	0.15	0.233	0.318	0.4
2200	Agricultural	0.15	0.233	0.318	0.4
2300	Agricultural	0.15	0.233	0.318	0.4
2400	Agricultural	0.15	0.233	0.318	0.4
2500	Agricultural	0.15	0.233	0.318	0.4
2550	Agricultural	0.15	0.233	0.318	0.4
2600	Agricultural	0.15	0.233	0.318	0.4
3100	Open Land	0.1	0.166	0.234	0.3
3200	Open Land	0.1	0.166	0.234	0.3
3300	Open Land	0.1	0.166	0.234	0.3
4000	Upland Forest	0.05	0.05	0.05	0.05
4100	Upland Forest	0.05	0.05	0.05	0.05
4110	Upland Forest	0.05	0.05	0.05	0.05
4120	Upland Forest	0.05	0.05	0.05	0.05
4200	Upland Forest	0.05	0.05	0.05	0.05
4340	Upland Forest	0.05	0.05	0.05	0.05
4400	Upland Forest	0.05	0.05	0.05	0.05
5000	Water	1	1	1	1
5100	Water	1	1	1	1
5200	Water	1	1	1	1
5300	Water	1	1	1	1
5400	Water	1	1	1	1
6000	Wetland Non-Forested	0.2	0.2	0.2	0.2
6100	Wetland Forest	0.1	0.1	0.1	0.1
6110	Wetland Forest	0.1	0.1	0.1	0.1
6120	Wetland Forest	0.1	0.1	0.1	0.1
6150	Wetland Forest	0.1	0.1	0.1	0.1
6200	Wetland Forest	0.1	0.1	0.1	0.1
6210	Wetland Forest	0.1	0.1	0.1	0.1
6300	Wetland Forest	0.1	0.1	0.1	0.1
6400	Wetland Non-Forested	0.1	0.1	0.1	0.1
6410	Wetland Non-Forested	0.1	0.1	0.1	0.1
6420	Wetland Non-Forested	0.1	0.1	0.1	0.1
6430	Wetland Non-Forested	0.1	0.1	0.1	0.1
6440	Wetland Non-Forested	0.1	0.1	0.1	0.1
6500	Wetland Non-Forested	0.1	0.1	0.1	0.1
6510	Wetland Non-Forested	0.1	0.1	0.1	0.1
6520	Wetland Non-Forested	0.1	0.1	0.1	0.1
6530	Wetland Non-Forested	0.1	0.1	0.1	0.1
7100	Wetland Non-Forested	0.1	0.1	0.1	0.1
7400	Extractive (Mining)/Disturbed	0.05	0.05	0.05	0.05
8000	Highway/Utility	0.5	0.599	0.701	0.8
8100	Highway/Utility	0.5	0.599	0.701	0.8
8200	Highway/Utility	0.5	0.599	0.701	0.8
8300	Highway/Utility	0.5	0.599	0.701	0.8

10.2.3 Basin Delineation

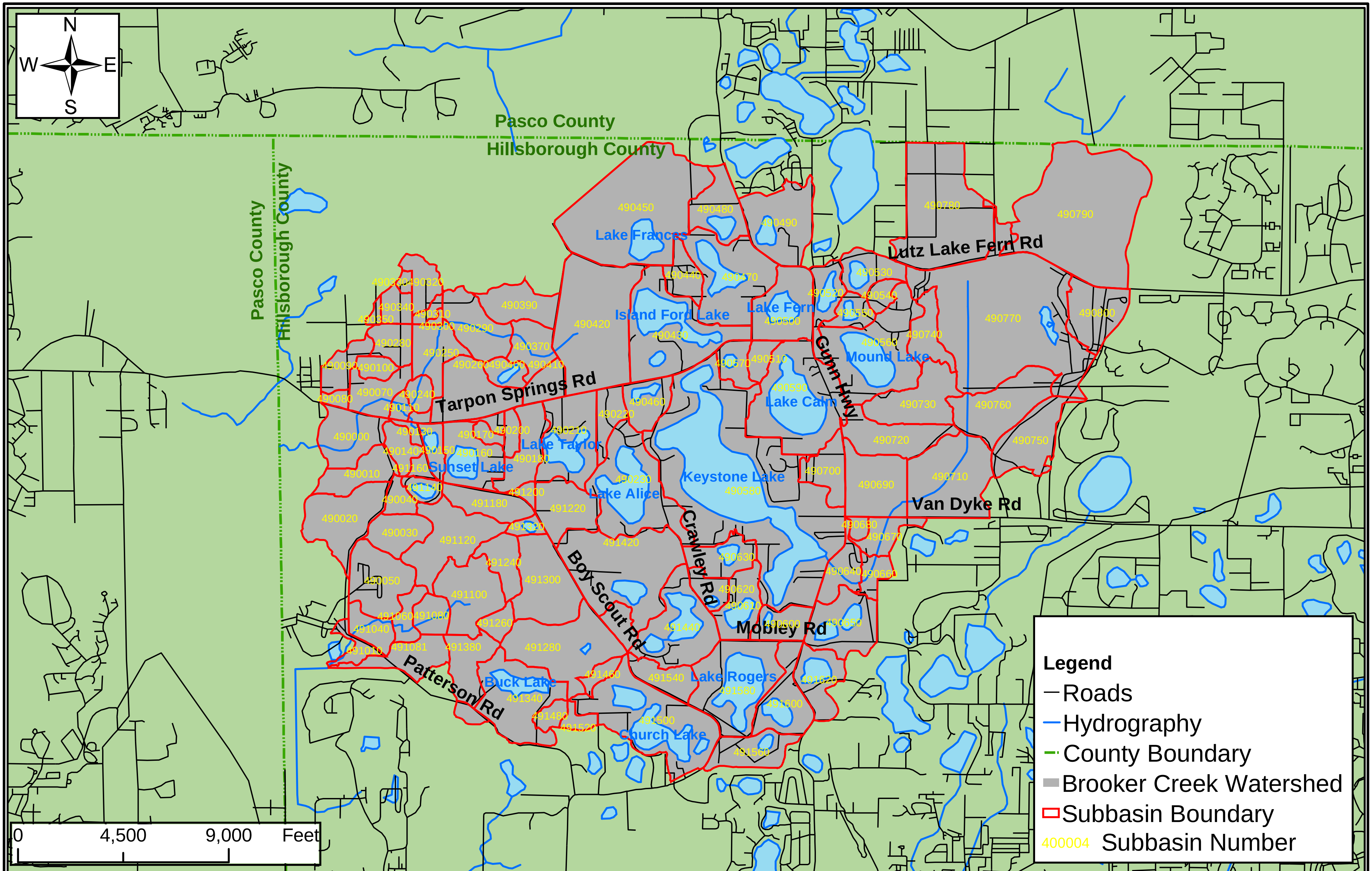
During the hydraulic analyses described earlier in Chapter 4, the Brooker Creek watershed was divided into 109 subbasins representing approximately 14,272 acres (Figure 10-5). The model described herein was run at the subbasin level (to provide a fine level of detail) by comparing hydrologic, hydraulic, and runoff water quality characteristics of the watershed. The subbasins range in size from approximately 6 acres to more than 1,000 acres with an average size of about 131 acres.

10.2.4 Event Mean Concentrations (EMC)

Pollutant loading analyses were based on the same group of parameters required for NPDES permitting of stormwater discharges for Hillsborough County, as listed in Table 10-4. The annual load of a specific constituent generated from each subbasin during cumulative annual rainfall events were calculated as the product of the annual runoff volume times the corresponding event mean concentration (EMC). The EMC is the mean concentration of a chemical parameter expected in the stormwater runoff discharged from a particular land use category during a typical (average) storm event. The calculated constituent mass represents the pollutant load.

For watershed analyses in Hillsborough County, the EMC values reported in the County's NPDES permit applications for stormwater discharges and supporting documents were used where available. For land use categories or parameters not reported by Hillsborough County, EMC data from other studies in Florida were used.

EMC values were available for many land uses for numerous pollutants including five-day biological oxygen demand (BOD5), total suspended solids (TSS), total kjeldahl nitrogen (TKN), nitrite plus nitrate (NO2+NO3), total nitrogen (TN), total and dissolved phosphorous (TP and TDP), oil and grease, cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn). Normalized EMC data (EMC values multiplied by runoff coefficients) for total nitrogen, total phosphorus, and total suspended solids are also shown graphically in Figures 10-6 through 10-8. Given land segments of equal area, the charts can be used to identify those land uses and associated soil types which contribute significant loads for these parameters. For example, highway/utilities are clearly shown to have the greatest impact on TSS loading. Likewise, agriculture and high density residential will be expected to contribute the majority of the TP loading when compared with the other land use categories with similar area and soil characteristics.



Subbasin Divisions in the Brooker Creek Watershed

Figure 10-5

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Table 10-4 Event mean concentration (EMC) values by land use in Hillsborough County

Land Use	NPDES Conventional WQ (mg/l)																NPDES Metals (mg/l)					
	BOD_5		TSS		TKN		NO_3 $+NO_2$		TN		TP		TDP		Oil and Grease		Cd		Cu		Zn	
Low/Medium Density Residential	1.0	e	19		1.082		0.281		1.363	g	0.401		0.282		1.08		0.001	e	0.013		0.022	
High Density Residential	2.6		29		1.368		0.679		2.047	g	1.337		0.552		1.073		0.001	e	0.047		0.058	
Light Industrial	2.87		18.2		2.088		0.187		2.275	g	0.332		0.187		3.663		0.001	e	0.024		0.096	
Agricultural	18.3		12.7		2.167		0.803		2.970	g	2.349		1.223		0.5	e	0.013		0.041	e	0.017	
Commercial Office	2.62		36.5		2.207		0.171		2.378	g	0.305		0.182		0.793		0.001	e	0.014	e	0.036	
Commercial Retail	2.72		9.33		1.083		0.603		1.686	g	0.253		0.132		0.5	e	0.001	e	0.021		0.015	
Commercial, combined	2.67		22.92		1.65		0.39		2.032	g	0.28		0.16		0.65		0.001		0.02		0.03	
Institutional	2.67	f	22.92	f	1.65	f	0.39	f	2.032	g	0.28	f	0.16	f	0.65	f	0.001	f	0.02	f	0.03	f
Highway/Utility	24	a	261	a	2.99	a	1.140	a	4.130	g	0.120	a	0.300	d	0.4	d	0.040	a	0.103	a	0.410	a
Recreational	3.8	b	11.1	b	2.09	b	0.508	b	2.598	g	0.050	b	0.13	c	0.9	d	0.007	b	0.041	b	0.004	b
Open Land	3.8	f	11.1	f	2.09	f	0.03	c	2.598	g	0.19	c	0.13	f	0.9	f	0.0003	c	0.001	c	0.006	
Extractive (Mining)/Disturbed	28.94	c	13.2	c	3.50	c	0.03	c	3.530	g	0.19	c	0.13	c	0.9	d	0.0003	c	0.001	c	0.006	c
Upland Forest	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h
Wetland Forest	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h
Wetland Non-Forested	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h	0	h

Note:

NPDES parameters: BOD5, COD, TSS, TDS, TKN, NO3+NO2, TP, DP, Oil and Grease; cadmium, copper, lead, zinc.

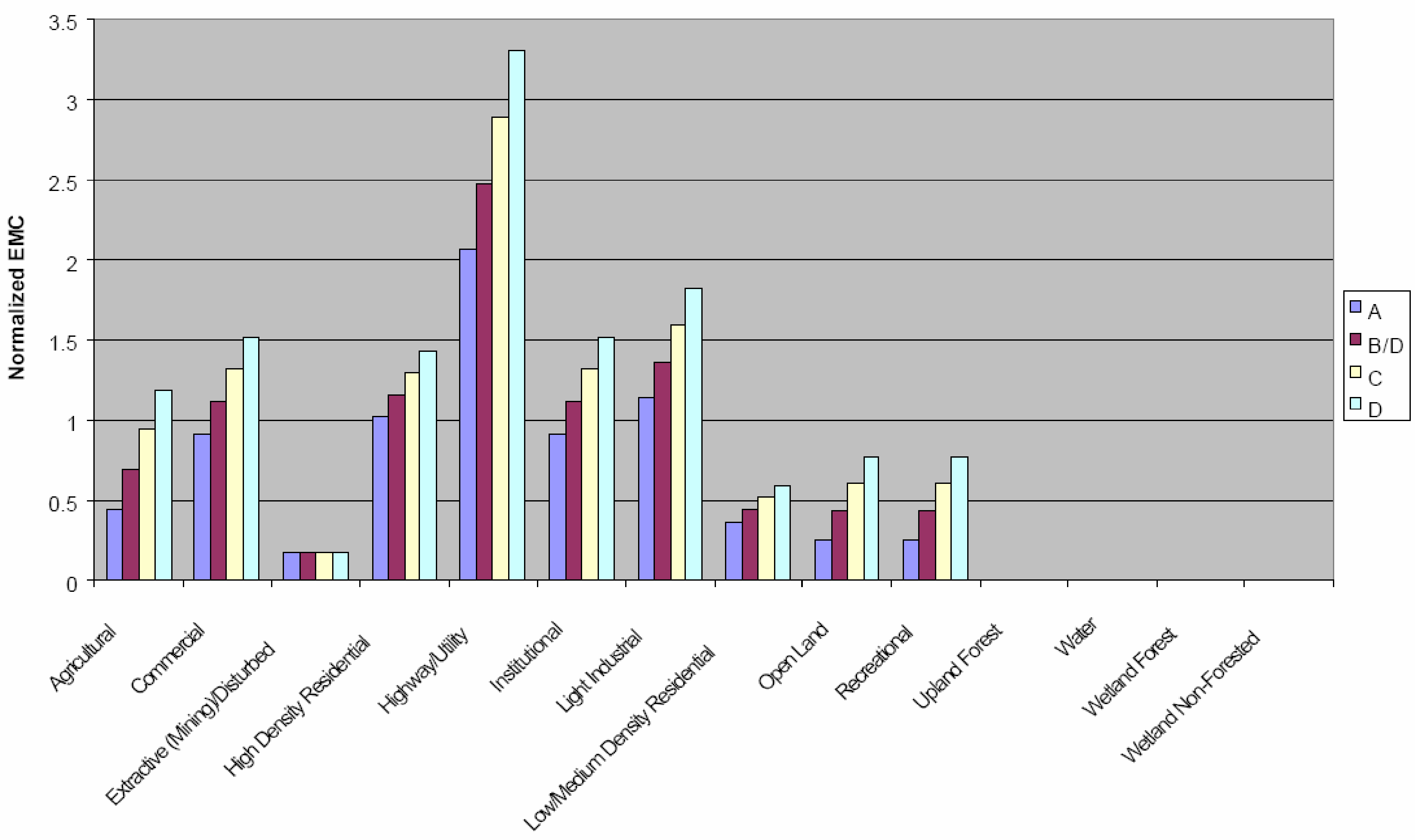
All EMC values without footnotes were obtained from samples collected for the Hills. Co. NPDES Permit Application (1993).

For parameters not detected in all samples, EMCs were calculated using half the reporting limit for nondetects.

For pollutants not reported by Hills. Co. (1993), additional sources were used as noted:

a. Average values used by Hillsborough Co. (1994) (from Smith and Lord (1990), provided in Wanielista and Yousef (1993).
b. Literature value reported as EMC in Hillsborough Co. 1994.
c. Calculated value from Sarasota County stormwater samples.
d. Orange County, 1993.
e. Surrogate based on 1/2 DL for values reported as BDL.
f. EMCs for open land use were assumed to be less than or equal EMCs for recreational land use.
g. Total nitrogen (TN) estimated as the sum of NH_3 + organic-N (TKN) and oxidized-N (NO_2+NO_3).
h. EMCs for upland forest, wetland forest, and non-forested wetland were assumed to zero for benchmark comparisons.

EMCs reported as representative of agricultural land use were used for all subcategories of agricultural land use (e.g., pastures, crops, and groves).



Total Nitrogen Loading Potential by Land Use and Hydrologic Group

Figure 10-6

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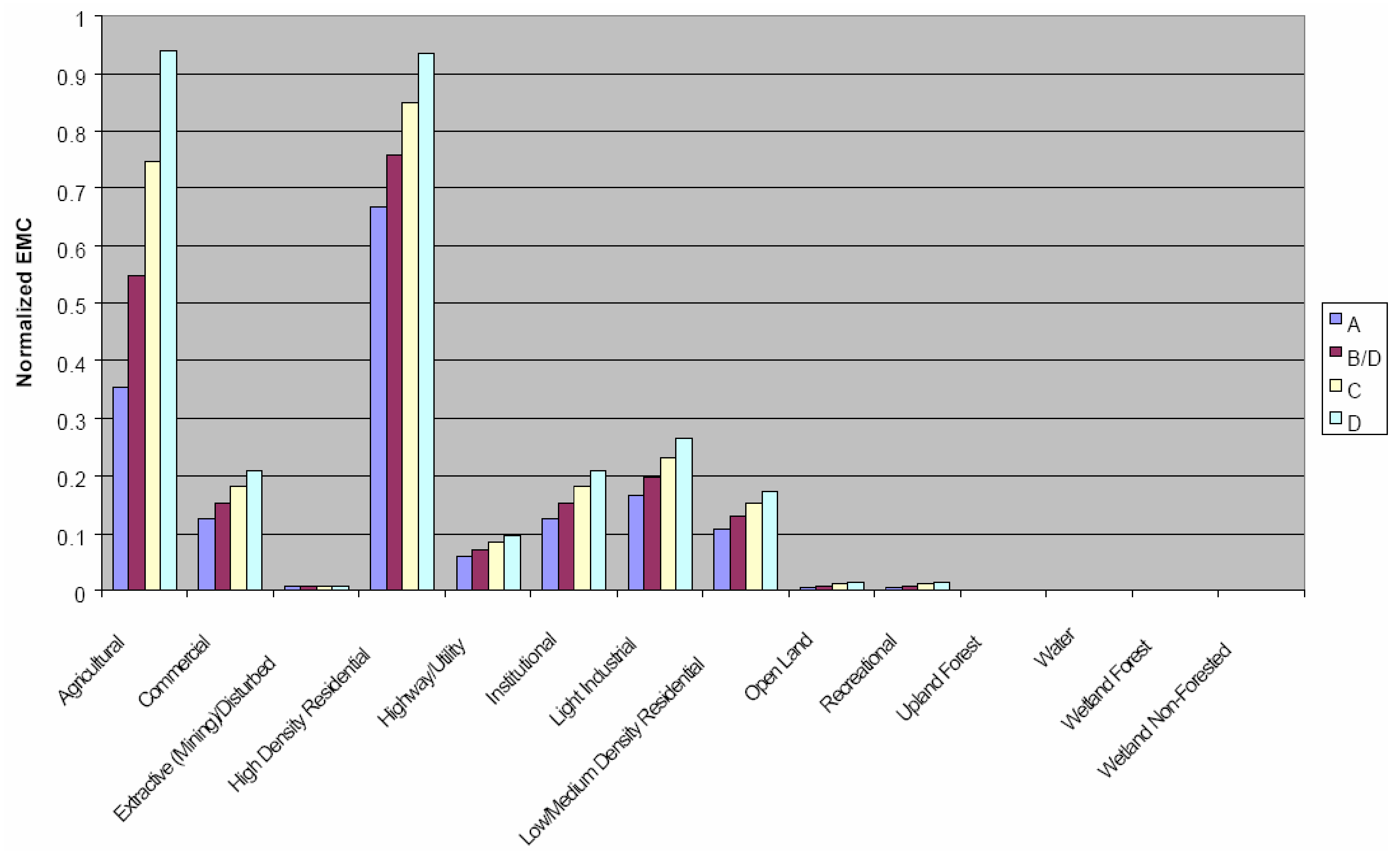
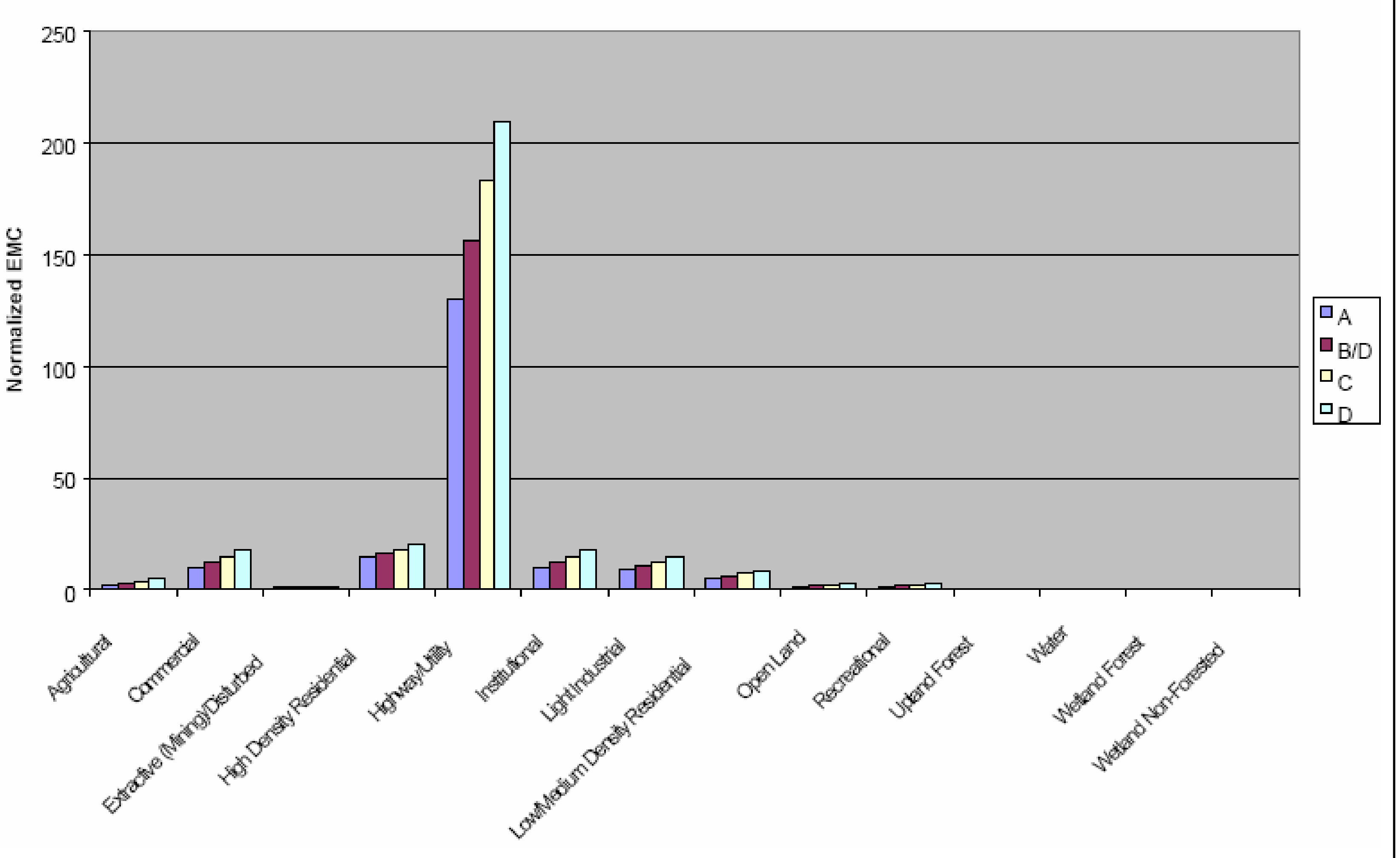


	Total Phosphorus Loading Potential by Land Use and Hydrologic Group	**Figure 10-7**	AYRES ASSOCIATES



Total Suspended Solids Loading Potential by Land Use and Hydrologic Group

Figure 10-8

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Literature reviews performed by Parsons Engineering Science, Inc. for the Northwest Hillsborough and Pemberton/Baker Creek watershed reports in 1999 included comparisons of pollutant values in Hillsborough County to other Florida and national studies. Summaries of these comparisons are provided in the following paragraphs:

- “BOD5 data found in Hillsborough County samples tend to be lower, or similar, than those found in other areas in Florida, except for agriculture. The agriculture EMC for BOD5 is approximately five times larger than other values reported in Florida. In general, Hillsborough County agricultural land use EMCs for a number of parameters, tend to be much higher than those reported elsewhere in Florida. For most parameters, these elevated EMCs increase estimated load calculations significantly where agricultural land use is found.”
- “Nitrogen from residential land uses tends to be higher in Florida and Hillsborough County than nationally due to the increased application of lawn fertilizer by homeowners and golf course managers. Slightly higher TKN and TP values for multi-family sites may reflect more intensive landscape maintenance for these land uses. Commercial land uses also have nitrogen values that are higher than national averages. This may reflect primarily atmospheric deposition, as studies in Florida have shown that commercial sites produce elevated nitrogen loads even if little green area is present. Phosphorous runoff tends to be lower in Florida than the U.S. average, although data from Hillsborough County studies differs somewhat. Phosphorous runoff from residential and commercial land uses are higher than Florida average, while runoff from industrial land uses are similar to Florida and national averages. As with nitrogen, elevated loads from multi-family land uses could reflect more intensive landscape maintenance. The Hillsborough County data indicate that total nitrogen and total phosphorus EMCs for the agricultural land use are 74 and 586 percent higher, respectively, than that for low/medium family residential uses. The total nitrogen EMC is similar to that found for other locations in Florida. However, the EMC for total phosphorus is six times as high as the average EMC found for various agricultural sites in Florida. This situation makes agriculture one of the main contributors of nutrient loadings.”
- “TSS data for Hillsborough County are comparable to other Florida locations and lower than U.S. averages. TSS results from soil erosion, with construction sites a major contributor along with agricultural practices. Additional primary sources of TSS include vehicle emissions and atmospheric deposition.”
- “Lead data for Hillsborough County are lower than other locations in Florida and across the U.S. Relatively low lead concentrations may reflect fate and transport characteristics of the particular systems sampled and/or decreased emissions due to the use of unleaded gasoline. Copper data for Hillsborough County are higher than other locations in Florida, but similar to the nationwide average. Relatively high values were observed for residential land uses. Transportation-related activities, particularly releases from brake linings, have been identified as primary sources for copper. Copper is also a common element in algaecides and fungicides, and many fertilizers contain copper. Zinc data are much lower for Hillsborough County and Florida in general than the rest of the U.S. Sources of zinc include industrial processes, transportation-related activities, atmospheric deposition and

fertilizers. Relatively low zinc concentrations may reflect fate and transport characteristics of the particular systems sampled and/or the presence of fewer industrial processing facilities in Hillsborough County than other parts of the U.S."

10.2.5 Existing Stormwater Treatment

The type and coverage of BMPs providing stormwater treatment were also determined to estimate net pollutant loads from each subbasin. BMP coverage data was developed for each aggregate land use within each subbasin based on existing Environmental Resource Permit (ERP) data (Figure 10-9) provided by the SWFWMD and photo-interpretation of digital orthophotography. BMPs used to reduce loads generated by various land uses included wet ponds, percolation ponds (dry retention basins), grassed swales, infiltration trenches, on-line retention, off-line retention/detention, wet detention with natural wetlands, and infiltration/exfiltration. Table 10-5 provides the estimated removal efficiencies of a BMP for a given pollutant.

Table 10-5 Estimated pollutant removal efficiencies for typical stormwater BMPs

BMP Type	BOD_5	TSS	TKN	NO_3+NO_2	TN	TP	TDP	Oil & Grease	Cd	Cu	Pb	Zn
Wet-detention	60% 1	85% 1	30% 1	80% 1	30% 1	65% 1	80% 3	35% 2	75% 2	65% 1	75% 1	85% 1
Percolation	80% 1	80% 1	80% 1	80% 1	80% 1	80% 1	80% 3	80% 3	80% 3	80% 1	80% 1	80% 1
Infiltration Trench		75% 4				60% 4					65% 4	65% 4
Grass Swale		60% 4	10% 4	15% 4	10% 4	20% 4					70% 4	60% 4
On-Line Retention (1)	40% 1	85% 1	15% 1	95% 1	40% 1	50% 1	10% 1			25% 1	50% 1	70% 1
Off-line Retention/Detention (Dual Ponds) (1)	80% 1	90% 1			60% 1	85% 1				65% 1	75% 1	85% 1
Wet Detention with Natural Wetlands	60% 1	80% 1	30% 1	80% 1	30% 1	65% 1	80% 1	35% 1	75% 1	65% 1	75% 1	85% 1
Infiltration/Exfiltration	90% 1	90% 1			70% 1	70% 1					70% 1	60% 1

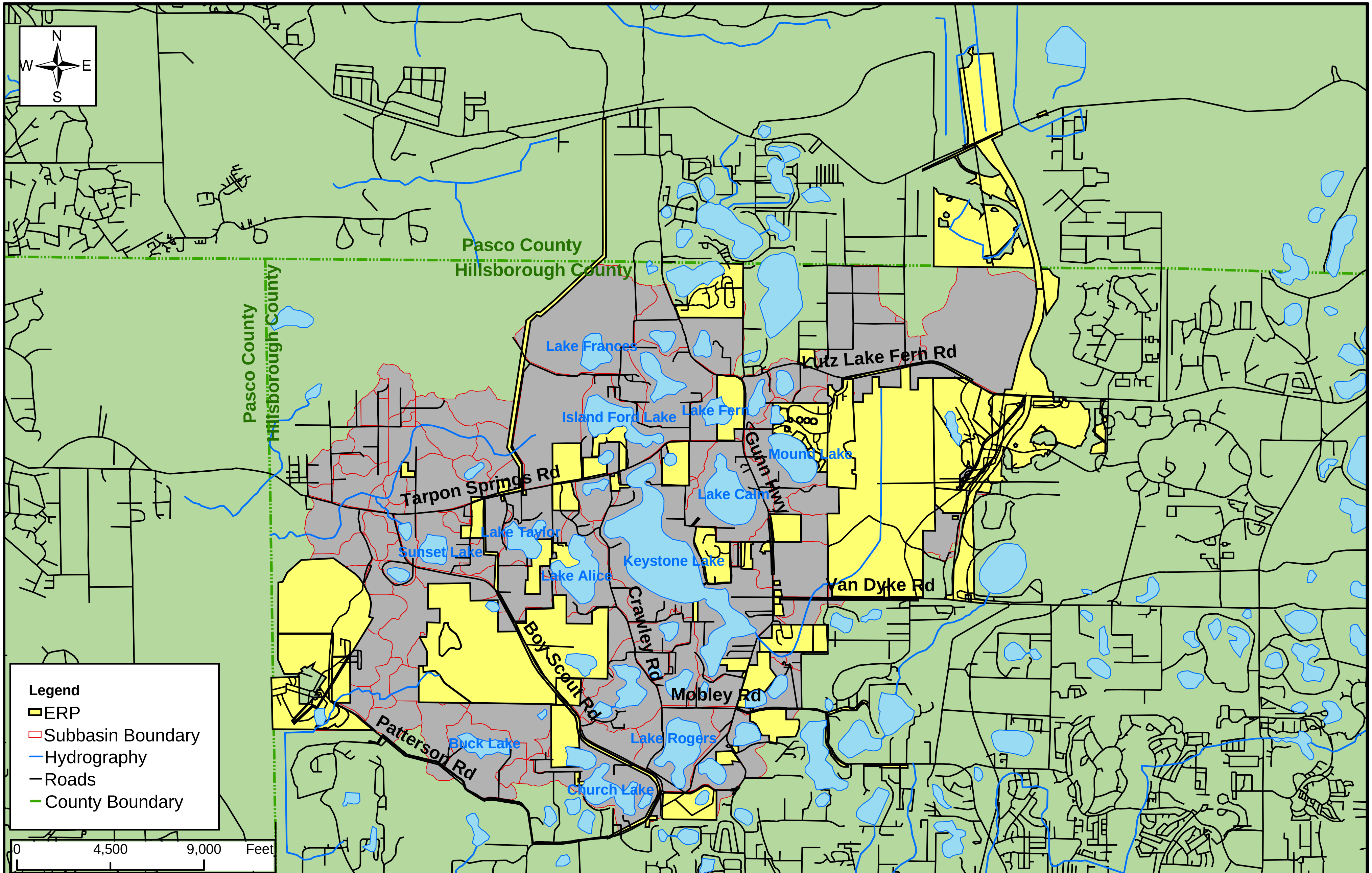
Source:

[1]Harper, H.H. 1999. Pollutant removal efficiencies for typical stormwater management systems in Florida. Florida Water Resources Journal.

[2]Kadlec, R.H. and R.L. Knight, 1996. "Treatment Wetlands." CTC Press, Inc. Boca Raton, Florida.

[3]USEPA, 1993. "Guidance specifying management measures for sources of nonpoint pollution in coastal waters." U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

[4]Parsons Engineering Science, Inc. Unpublished Data.



Location of ERPs in the Brooker Creek Watershed

Figure 10-9

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For each land use within a subbasin, a percent coverage of the area treated by a particular BMP was estimated and delineated as a polygon within a BMP coverage file created in ESRI® ArcMap™. Efforts were made to use regularly published electronic data, and to digitize the resulting treatment areas so that they could be revised as new data become available in the future. The following GIS data layers were used to create the necessary BMP input for the pollutant loading model.

1. Land use (2004) from SWFWMD
2. Soils (1990) from the United States Department of Agriculture/Natural Resource Conservation Service (formerly USDA/SCS) soil survey maps
3. Subbasin boundaries as described in Section 10.2.3
4. Digital orthophotos obtained from SWFWMD (2004)
5. ERP data from SWFWMD (2002)

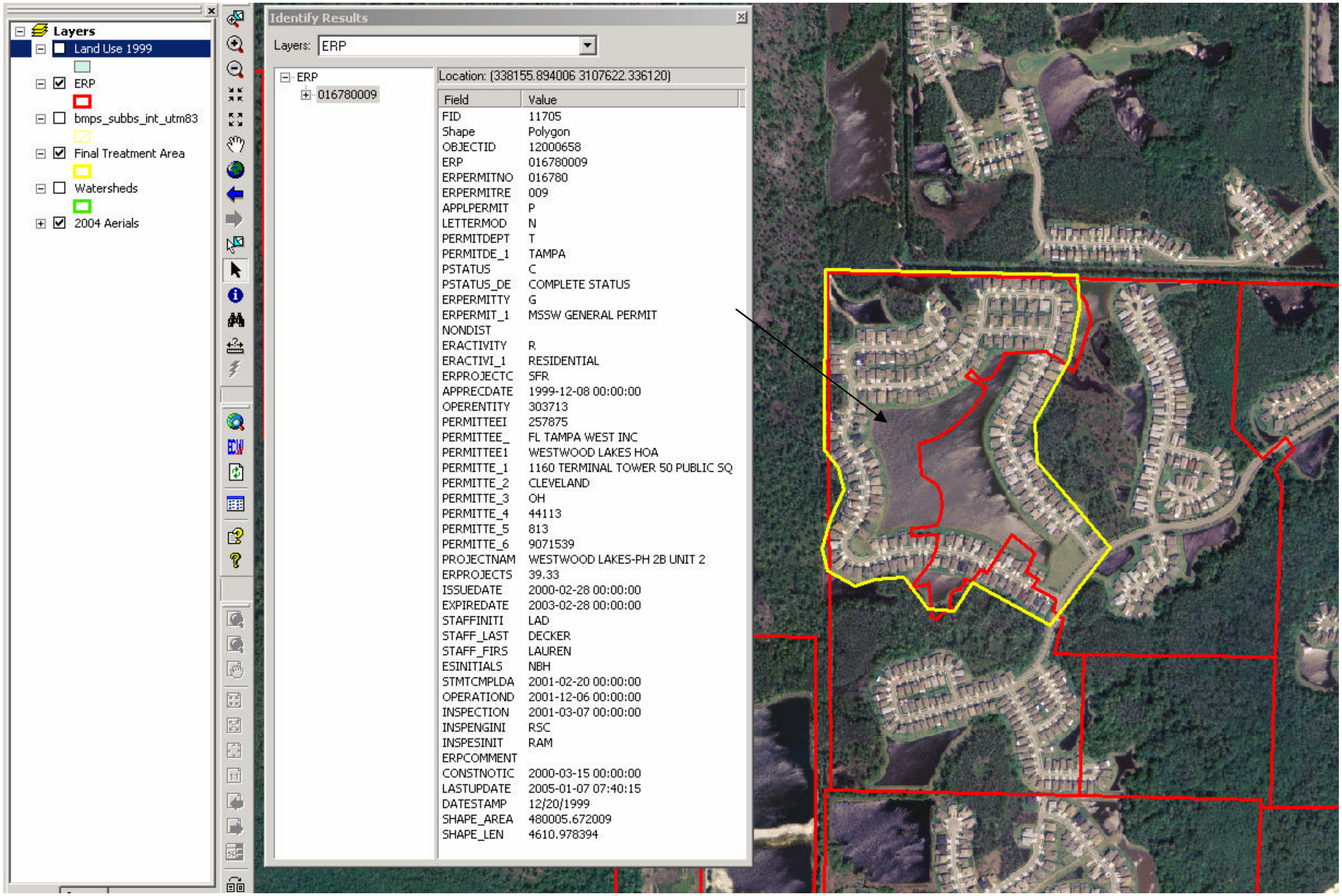
The percent of treated area within a subbasin for a particular land use was estimated by utilizing all of the available resources to pinpoint treatment ponds, treatment ditches and other recognized treatment practices. For this model, only those treatment areas that were man-made were considered. Although natural wetlands and depressions may offer some level of treatment, they were not considered. Treatment areas were first located by overlaying ERP data and 2004 orthophotography using ESRI® ArcMap™ software. Figure 10-10 illustrates a typical BMP identified using the digital orthophotographs and ERP data.

To aid in the identification of treatment areas, the orthophotos were verified against the land use coverage. Subsequently, all three data layers were viewed together (ERP, orthophotos and land use layers) to determine treatment area boundaries and confirm the type of treatment used (Figure 10-11). Once the 122 treatment areas were outlined in GIS, they were digitized in ESRI® ArcMap™ (Figure 10-12).

There are several advantages of digitizing the treatment areas, including the following:

1. Modeling results are reproducible
2. Treatment polygons may be geographically overlaid on other GIS coverages (e.g., soils, land-use, potentiometric surface, etc.)
3. Digitized information can be used in future analyses including characterizing the effects of land use changes
4. Treatment polygons can be added or deleted to reflect changes in the level of treatment. For example, when a property is developed or new regulations come into effect, the treatment characteristics of the area may significantly change.

After the treatment areas were identified, a final GIS layer was developed through a series of intersections and unions of layers containing the treatment areas, soils, land use and subbasin boundaries. As a result, each polygon in the final layer had specific soil, land use and treatment characteristics.



Identification of BMPs Using Digital Orthography and ERP Data

Figure 10-10

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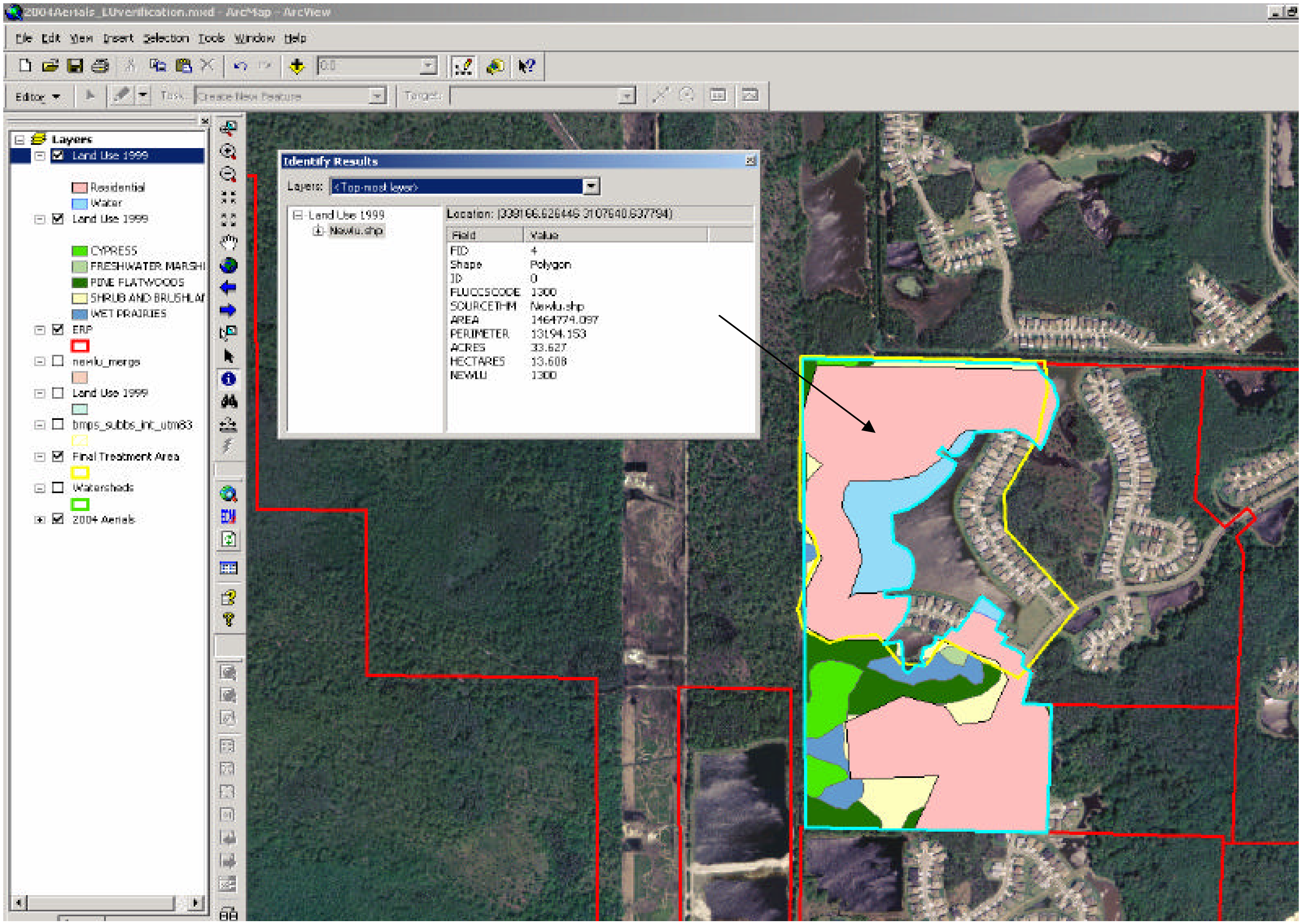
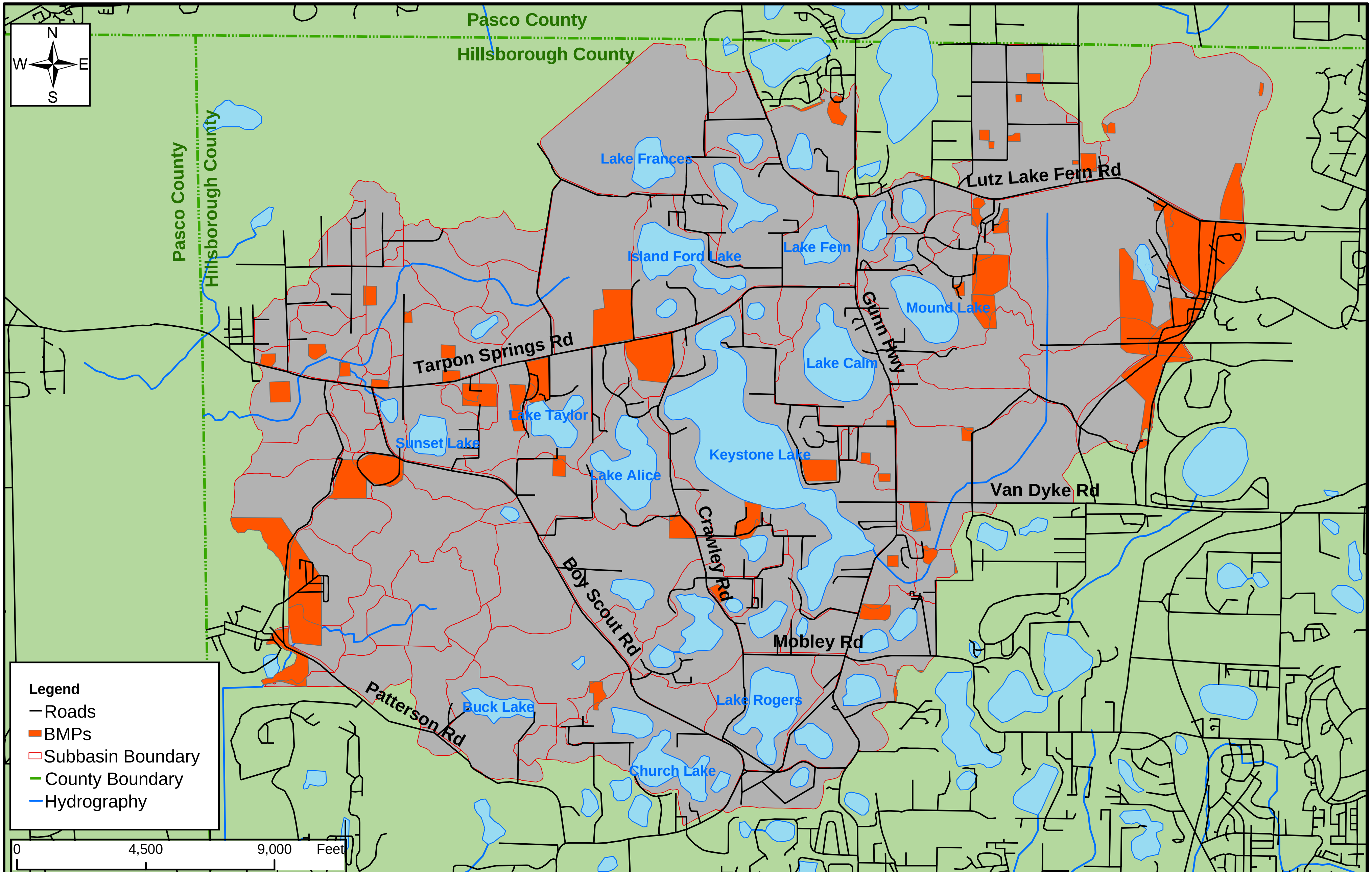


Identification of Treatment Areas

Figure 10-11



Digitized Locations of BMPs and Treatment Areas in the Brooker Creek Watershed

Figure 10-12

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In order to ascertain the percentage of coverage of each BMP for each type of land use and soil within a subbasin, the information provided by the final GIS layer was incorporated into a database. The database was then used to query for areas of unique combinations of subbasin, land use and hydrologic soil group. This database was also used to obtain information regarding the percentage of area being treated by a particular BMP for each type of land use within a subbasin. The pollutant loading model provided by the County requires that land uses be grouped in specific classifications and input data files (Excel® files) in structured formats. To accomplish this, a series of Excel® macro programs were created to aggregate land use, assign appropriate hydrologic classifications, and appropriately format the model input files. Spreadsheet calculations were also performed to verify query results, and to ensure that the land use and hydrologic classifications match those of the model and appropriate soils information.

The majority of BMPs identified in the Brooker Creek watershed were retention ponds. Distinct concentrations of ERP locations and BMPs were observed in the western and eastern portions of the watershed, primarily along Boy Scout Road and to the north of Lutz Lake Fern Road. A number of wet detention ponds were found in new residential areas that are currently under construction, including neighborhoods along Boy Scout Road, Lutz Lake Fern Road, Tarpon Springs Road, and Gunn Highway.

It is important to note that the pollutant loads generated from this modeling effort are based on the 2004 aerial photography land use information. Recently proposed and constructed developments and BMPs that are not accounted for in the 2004 land use or present on the 2004 aerial photography, were not included in this analysis. Since all of the coverages used for the model are in digital format, this information can be updated relatively easily as new land use data and aerial photography becomes available.

10.3 Pollutant Loads

The EPA Simple Method (USEPA, 1992) was used in the pollutant loading model to calculate loads. According to the Simple Method, non-point source pollutant loads are calculated using the following formula:

$$L_l = (0.227)(P)(CF)(Rv_l)(C_l)(A_l)$$

where:

- L_l = annual pollutant load per basin (lb/yr)
- P = annual average precipitation (in/yr)
- Rv_l = weighted average runoff coefficient based on impervious area
- C_l = event mean concentration of pollutant (mg/L)
- A_l = catchment area contributing to outfall (acres)
- CF = correction factor for storms that do not produce runoff (assumed CF=0.9, 10 percent of storms do not produce runoff)

The runoff characteristics discussed above were used with EMC values for specific land uses to calculate gross pollutant loads. All EMCs, runoff coefficients, and BMP efficiency values were incorporated into lookup tables provided with the model. Data generated in GIS by the union of subbasin area, hydrologic soils groups, and land use were then used to estimate average annual runoff. This runoff value was calculated as the product of the annual rainfall amount times the corresponding weighted runoff coefficient for a given subbasin. A correction factor of 0.9 was used to account for the numerous small rainfall events (possibly less than 0.1 inch) that occur throughout the year but do not result in any runoff as a result of abstraction. The contribution from each subbasin in terms of stormwater runoff volume was then calculated by multiplying the runoff coefficient times the average annual rainfall value for the Tampa Bay area (52.4 inches x correction factor or 0.9 = 47.16 inches).

10.3.1 Gross Pollutant Loads

Estimates of gross pollutant loads were calculated for each subbasin within the entire watershed using the 2004 land use and hydrologic soils information. These calculations were performed assuming no existing stormwater treatment within any of the subwatersheds throughout the project area.

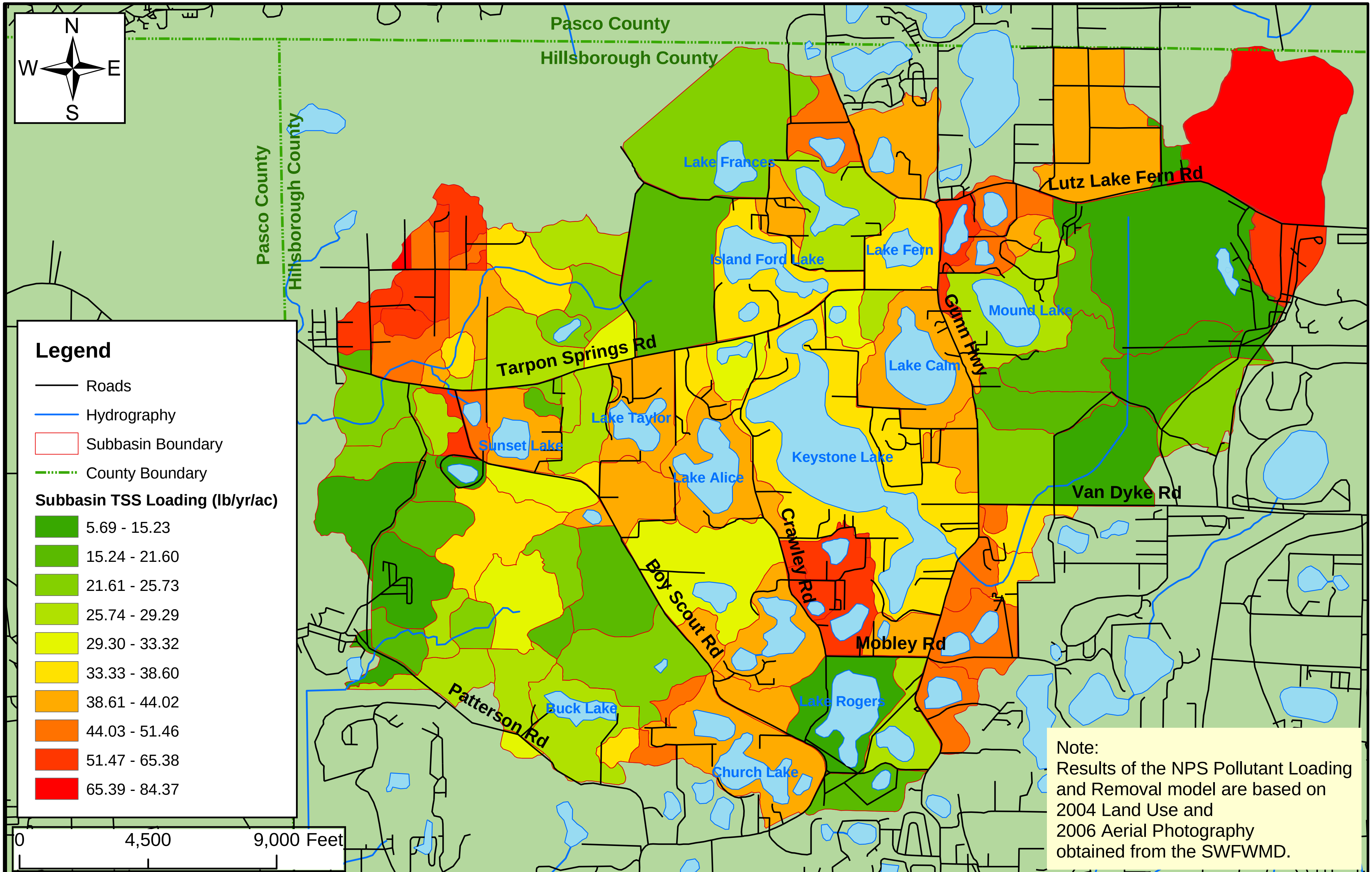
10.3.2 Annual Net Pollutant Loads

Estimates of annual net pollutant loads were subsequently calculated for each subbasin and the watershed using the 2004 land use and hydrologic soils information and the stormwater treatment BMP coverage file. These calculations typically resulted in lower pollutant loading values for those subbasins that received one or more of the eight types of stormwater treatment. Net pollutant loads are summarized for the watershed level in Table 10-6. Net pollutant loads at the subbasin level are provided in Table 10-1 in the Appendix for Chapter 10.

Table 10-6 Net Pollutant Loads for the Watershed Level for Brooker Creek Watershed (lb/yr)

BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
249,418	424,486	44,810	13,889	58,405	34,491	19,390	21,921	185	713	205	527

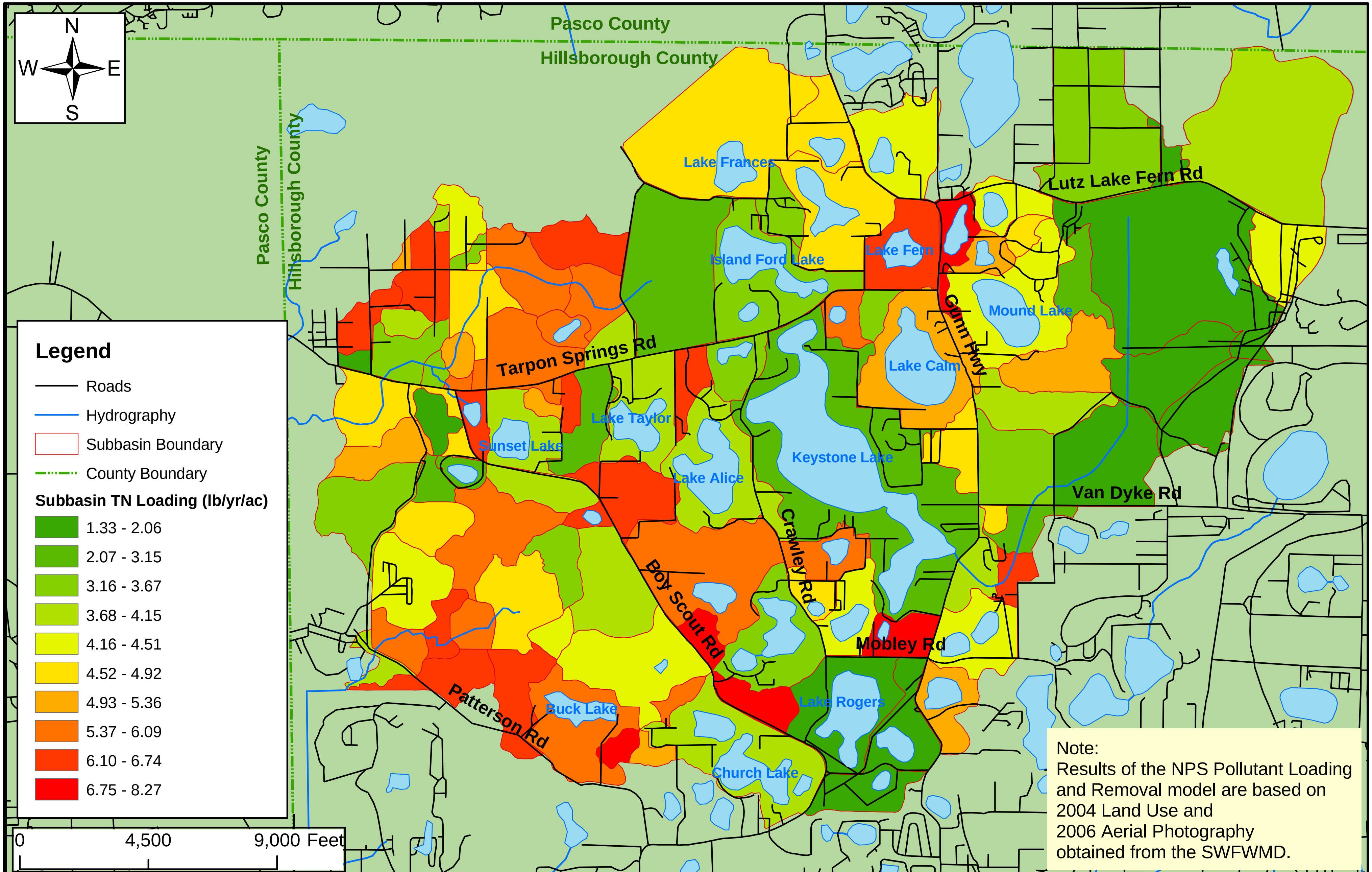
To further analyze net pollutant loading spatially, loading data was incorporated into GIS and color coded to show areas of high pollutant loading potential on an annual basis. A select number of parameters were chosen based on existing concerns within the Brooker Creek watershed. Those parameters included total suspended solids (TSS – which can limit penetration of light, causing problems for submerged aquatic vegetation), total nitrogen (TN – which can result in eutrophic conditions), and total phosphorus (TP – which can result in eutrophic conditions). Figures 10-13 through 10-15 illustrate the subbasins TSS, TN, and TP annual loading per acre.



Subbasin Loads for TSS (lb/yr/acre) in the Brooker Creek Watershed

Figure 10-13

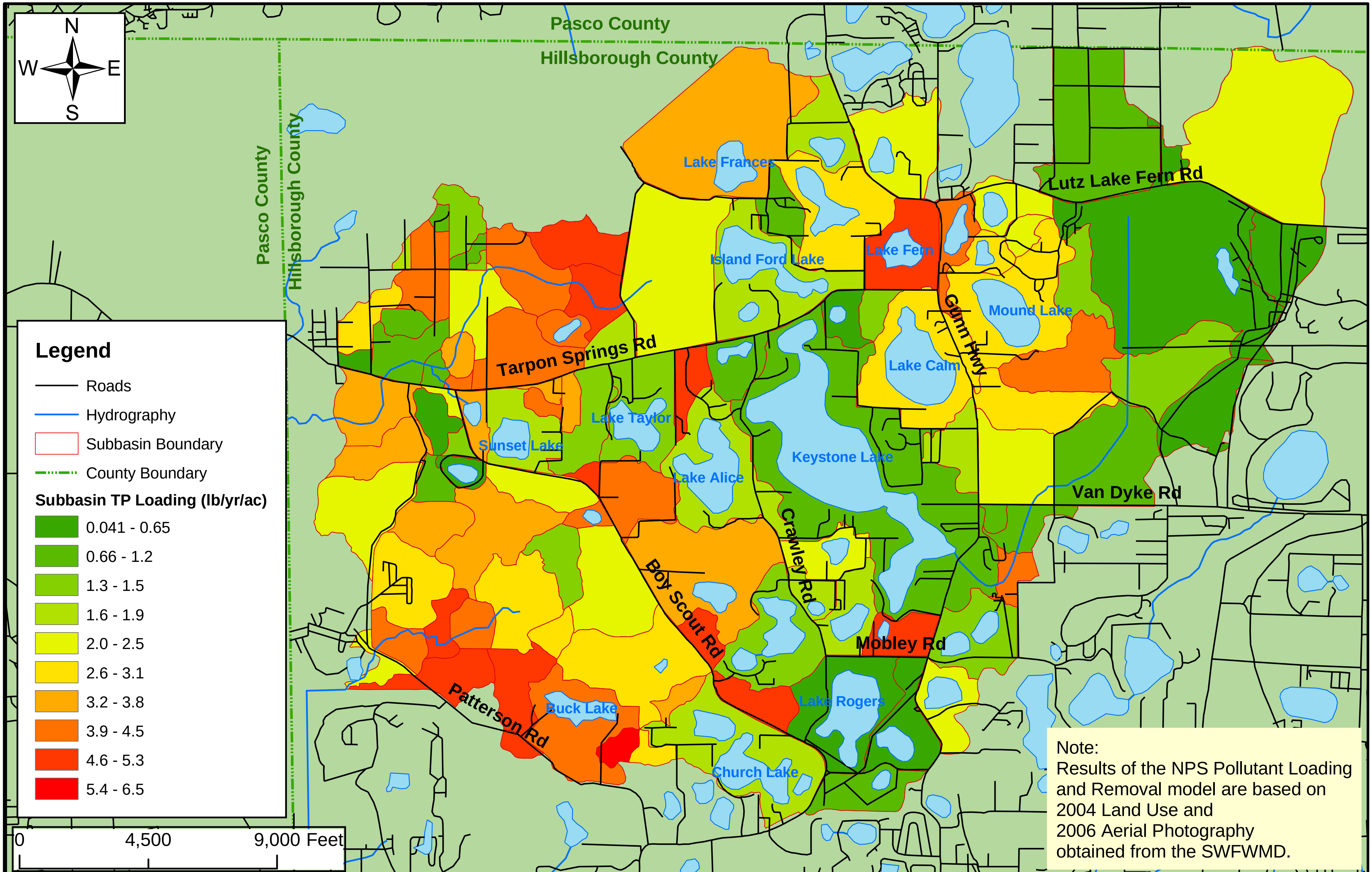
AYRES ASSOCIATES



Subbasin Loads for TN (lb/yr/acre) in the Brooker Creek Watershed

Figure 10-14

AYRES ASSOCIATES



Subbasin Loads for TP (lb/yr/acre) in the Brooker Creek Watershed

Figure 10-15

AYRES ASSOCIATES

Total Suspended Solids

Total suspended solids loading values were greatest in subbasins that contained various residential land uses (Figure 10-13). Although, Brooker Creek watershed is not characterized by highly developed areas, a high number of residential polygons exists within the watershed. Developed land uses are characterized by relatively large impervious surface area (such as roads, buildings, parking lots, etc.) which have relatively high runoff coefficients and pollutant loads. It appears that the areas exhibiting the greatest loads contain the greater density of residential land use within the watershed. For example, the subbasin incorporating Keystone Lake contains a large number of single-family homes that surround the lake. Figure 10-7 previously illustrated that the high density residential and commercial land use categories exhibit the second highest degree of loading for TSS after highway/utility land use category. Brooker Creek watershed contains only 12 acres of highway/utilities land use category, yet even those 12 acres contribute over 4 percent of the entire TSS load for the watershed.

The high percentage of coverage for residential land use within the watershed (over 50 percent for all residential land use types) and its relatively high EMC value makes it a significant contributor of TSS pollution. Table 10-7 compares the TSS loading for different types of land uses in the Brooker Creek watershed.

Table 10-7 TSS Contribution from Various Land Uses within the Brooker Creek Watershed

Land Use	Acreage	TSS Loading (lb/yr)	Percent of Land Use Cover	Percent of TSS Loading
Agricultural	4,384	156,051	30.72%	36.76%
Commercial	14	1,948	0.10%	0.46%
Extractive (Mining)/Disturbed	107	192	0.75%	0.05%
High Density Residential	5	149	0.04%	0.04%
Highway/Utility	12	17,458	0.09%	4.11%
Institutional	73	10,472	0.51%	2.47%
Low/Medium Density Residential	3,473	228,581	24.33%	53.85%
Open Land	364	7,417	2.55%	1.75%
Recreational	170	2,218	1.19%	0.52%
Upland Forest	1,153	0	8.08%	0.00%
Water	1,741	0	12.20%	0.00%
Wetland Forest	2,428	0	17.01%	0.00%
Wetland Non-Forested	348	0	2.44%	0.00%
Grand Total	14,272	424,486	100.00%	100.00%

Lowest loading values were found in subbasins having little to no development. Some subbasins to the east, west, and north of the Brooker Creek watershed primarily contain agricultural land use and wetlands. Those subbasins show the lowest TSS loads in the watershed. Plot of total TSS loads at the subbasin level (Figure 10-13) provides a more detailed spatial representation of real loading rates.

Total Nitrogen

Total nitrogen loading values were greatest in the southwestern, northwestern and northern central parts of the Brooker Creek watershed (Figure 10-14). The land uses represent a mixture of agricultural and urban land uses. As depicted in Figure 10-5, the land uses that contribute significant TN loading include highway/utility, light industrial, commercial, institutional, agricultural, and high-density residentials. Agriculture, representing about 30% of the abovementioned subbasins, contributes approximately 63% of the TN loads. Table 10-8 illustrates the percentages of land uses and the respective contribution of TN loading into the subbasins.

Lowest loading values were found in within subbasins having little to no development including subbasins in the eastern portion of the watershed, as well as the ones to the south. Plot of total nitrogen loads at the subbasin level (Figure 10-14) provides a more detailed spatial representation of areal loading rates. Greatest loading (lb/year/acre) occurs in subbasins characterized by urban and agricultural land uses.

Table 10-8 TN Contribution from various land uses within the Brooker Creek watershed

Land Use	Acreage	TN Loading (lb/yr)	Percent of Land Use Cover	Percent of TN Loading
Agricultural	4,384	37,129	30.72%	63.57%
Commercial	14	173	0.10%	0.30%
Extractive (Mining)/Disturbed	107	131	0.75%	0.22%
High Density Residential	5	42	0.04%	0.07%
Highway/Utility	12	306	0.09%	0.52%
Institutional	73	937	0.51%	1.60%
Low/Medium Density Residential	3,473	17,165	24.33%	29.39%
Open Land	364	1,818	2.55%	3.11%
Recreational	170	704	1.19%	1.21%
Upland Forest	1,153	0	8.08%	0.00%
Water	1,741	0	12.20%	0.00%
Wetland Forest	2,428	0	17.01%	0.00%
Wetland Non-Forested	348	0	2.44%	0.00%
Grand Total	14,272	58,405	100.00%	100.00%

Total Phosphorus

Similarly to TN, for total phosphorus, greatest loading values were calculated for the southwestern, northwestern and northern central parts of the Brooker Creek watershed (Figure 10-15). Agriculture was the major contributor of total phosphorus in these subbasins, accounting for over 84% of the total loading. Table 10-9 compares the contributions of the land uses to total phosphorus loading within these subwatersheds. Lowest loading values were found in subwatersheds having little to no development including subbasins to the east and to the south of the Brooker Creek watershed. The plot of total phosphorus loads at the subbasin level (Figure 10-15) provides a more detailed spatial representation of areal loading rates. Greatest loading (lb/year/acre) occurs in subbasins characterized by residential and agricultural land uses.

Table 10-9 TP Contribution from various land uses within the Brooker Creek watershed

Land Use	Acreage	TP Loading (lb/yr)	Percent of Land Use Cover	Percent of TP Loading
Agricultural	4,384	29,254	30.72%	84.82%
Commercial	14	24	0.10%	0.07%
Extractive (Mining)/Disturbed	107	6	0.75%	0.02%
High Density Residential	5	23	0.04%	0.07%
Highway/Utility	12	9	0.09%	0.03%
Institutional	73	128	0.51%	0.37%
Low/Medium Density Residential	3,473	5,000	24.33%	14.50%
Open Land	364	35	2.55%	0.10%
Recreational	170	13	1.19%	0.04%
Upland Forest	1,153	0	8.08%	0.00%
Water	1,741	0	12.20%	0.00%
Wetland Forest	2,428	0	17.01%	0.00%
Wetland Non-Forested	348	0	2.44%	0.00%
Grand Total	14,272	34,491	100.00%	100.00%

10.4 Assessment of Pollutant Loading Model

For the purposes of this study, no statistical correlation between the existing water quality information and pollutant loading results predicted by the model was conducted. However, during other studies (Hillsborough River Watershed Management Plan, 2002) the same model was used to generate pollutant loading information which was later compared to the existing water quality conditions in the Hillsborough River watershed. In that study, it was concluded that the model appears to estimate loads within reasonable accuracy for isolated drainage areas where there are no extraneous factors that affect flow (e.g., dams, surface water withdrawals, etc.).

Pollutant loads generated by the model used in the Hillsborough River Watershed study were also compared to modeling results for the Upper Hillsborough River Diagnostic Watershed Assessment project (Limno-Tech, Inc, 1997). The methodology used to estimate areal loads in the Limno-Tech study involved the use of EPA’s Stormwater Management Model (SWMM) output to develop estimates of pollutant loads at the subbasin level for total phosphorus, total nitrogen, and total suspended solids. These values were divided by each subbasin’s area to estimate unit area load values. Due to the differences in methodology and subbasin/subwatershed delineations, only general comparisons were made between the model output of the Hillsborough River Watershed study and the Limno-Tech assessment.

Generally, the two models were in agreement in that the greatest total phosphorus and nitrogen loads occur in the developed areas near Tampa (Hillsborough River below S-155), Plant City, and western Polk County (Itchepackesassa Creek subwatershed), although the model used in the Hillsborough River Watershed study identified additional areas where elevated loads are expected to occur. Actual areal loading rates for most parameters were approximately ten times lower in the Limno-Tech study which was based on time-variable hydrodynamic calculations using actual flows for the year 1987. Changes in land use and differences in rainfall between 1987 and 1995 may partially account for the significant difference in loading values between the two studies.

During this study, the NPS modeling procedure was nearly identical to the procedure used during the Hillsborough River Watershed project, therefore, the statement about the model accuracy is assumed to remain true for this study as well.

10.5 BIBLIOGRAPHY

The attached bibliography includes a list of references used for this study and additional references that could be cited by readers.

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Net Pollutant Loads by Subbasin

Part 1 with Treatment: Existing treatment levels

Existing Cond. Part 1 (Brooker)

Subbasin ID	Basin ID	Area (acres)	Volume (acre-feet)	Runoff coefficient	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
490000	BROOKER	128.913	119.039523	0.23496432	3542.624	2869.442	459.81	152.6543	610.2414	457.5585	251.1866	132.1988	2.639928	8.389218	0.709471	3.796938
490010	BROOKER	91.221	73.8133229	0.20589575	2560.454	2026.07	341.5456	120.4725	462.0182	320.4618	169.3253	90.82311	1.784115	5.619173	0.390174	2.511738
490020	BROOKER	176.955	140.62941	0.20221845	3256.608	2289.584	467.5505	129.6699	589.48	397.6176	233.3753	131.5129	2.592837	7.848862	0.534695	2.979206
490030	BROOKER	86.318	66.5440215	0.19616211	2539.597	1760.205	300.9403	111.2633	412.1642	325.892	169.8671	69.46658	1.806131	5.692227	0.346841	2.357183
490040	BROOKER	36.977	81.011896	0.55747394	332.938	526.9142	108.4208	9.825495	111.685	43.25857	41.05734	73.99433	0.371	1.313395	0.30804	0.755827
490050	BROOKER	155.365	126.379529	0.20698124	3549.711	2287.778	545.9308	131.7919	658.2206	433.231	258.0721	176.4484	3.059937	9.805543	0.720508	3.169209
490070	BROOKER	87.14	98.2276501	0.28682939	217.1288	3967.973	239.9154	58.16668	295.9465	86.33008	62.78849	242.4557	0.224496	2.85859	1.722296	4.655274
490080	BROOKER	17.448	12.2359646	0.1784432	21.75745	376.7528	24.70071	5.45156	29.6554	8.552899	6.498131	25.34926	0.023472	0.291203	0.170631	0.450381
490090	BROOKER	62.877	93.6178112	0.37885596	1332.433	3273.843	309.843	94.40448	404.2475	192.6103	111.3457	178.853	0.940102	4.068986	1.116092	3.768832
490100	BROOKER	33.526	39.2813718	0.29813458	98.32878	1868.247	106.3917	27.63039	134.0221	39.42984	27.72872	106.1951	0.098329	1.278274	0.78663	2.163233
490110	BROOKER	20.509	24.0095372	0.29788371	49.88949	861.3543	56.71853	12.45454	67.99938	19.59978	14.92519	58.25351	0.053938	0.668302	0.391018	1.030761
490120	BROOKER	10.456	12.827351	0.31216115	342.7039	277.4298	49.46657	12.58339	61.24199	43.37044	26.87219	15.90744	0.286779	0.867833	0.081623	0.375868
490130	BROOKER	14.35	17.7806326	0.3152846	137.9503	811.6572	54.01981	15.32665	69.34646	28.36991	17.63426	44.93781	0.109324	0.72986	0.326371	0.952208
490140	BROOKER	50.664	144.914675	0.72781389	153.2534	1044.455	88.63434	22.969	111.6033	23.68083	17.32054	63.60133	0.091315	0.674077	0.368162	1.093681
490150	BROOKER	42.972	73.9983866	0.43817151	1004.041	1564.725	165.0953	55.38724	220.4751	141.5899	77.22693	77.52346	0.726306	2.755179	0.508932	1.929097
490160	BROOKER	135.552	247.048772	0.46375032	1119.613	4927.424	351.0478	102.8894	453.9372	205.5284	123.6086	269.2585	0.861017	4.947882	1.935777	5.817402
490170	BROOKER	19.576	16.5591454	0.21523922	614.0713	422.3657	78.92348	24.94944	103.0165	78.30265	43.7113	22.0597	0.463883	1.442245	0.102125	0.583529
490180	BROOKER	105.808	96.321832	0.23164007	1549.003	2195.062	265.5659	80.23918	342.3444	216.917	122.9616	133.6349	1.148939	4.338987	0.775091	2.814834
490200	BROOKER	28.644	36.4650788	0.32392983	1148.873	812.3946	162.9186	39.22871	199.0489	143.0585	90.39312	48.62062	0.980132	2.87718	0.23168	1.130383
490210	BROOKER	194.008	354.834257	0.46538604	1182.604	7140.137	540.6635	131.331	662.0446	245.9666	163.8422	465.6081	0.959538	6.708807	3.047892	8.541175
490220	BROOKER	62.999	60.1493102	0.24294303	2501.179	2107.975	315.8553	114.3721	430.2197	326.0007	171.2312	89.83482	1.779295	5.812098	0.501586	2.749686
490230	BROOKER	291.535	589.574914	0.51458337	3313.263	10060.86	802.8433	245.0759	1047.686	540.5469	313.658	538.0886	2.488635	12.0071	3.791747	12.01521
490240	BROOKER	34.308	32.9954075	0.24471779	805.1179	1259.617	132.2306	44.40691	176.6375	113.7839	62.04461	62.30116	0.58303	2.215763	0.411051	1.554661
490250	BROOKER	101.849	104.300365	0.26057726	2129.863	3890.781	390.1206	123.8601	512.2452	310.497	173.6305	210.5996	1.56204	6.296358	1.370172	4.803403
490260	BROOKER	162.14	153.372357	0.24069351	6036.593	4303.244	747.0511	258.1263	1001.701	774.4498	416.0727	193.5374	4.407454	13.87386	0.953956	5.808365
490270	BROOKER	15.703	18.9948651	0.30779463	461.5689	400.241	75.57583	17.04546	90.29392	59.89258	38.29925	33.0053	0.389148	1.256669	0.152239	0.572366
490280	BROOKER	63.846	78.5641702	0.31311097	1671.147	3341.757	315.7755	101.4091	416.6969	247.374	138.1097	175.0197	1.223927	5.055936	1.177665	4.077645
490290	BROOKER	131.155	115.140904	0.22338409	5057.496	3728.792	610.4096	224.7578	835.1675	652.4443	340.569	150.7733	3.596221	11.45969	0.784963	4.950235
490300	BROOKER	6.012	7.56667266	0.32025316	25.65658	389.0539	22.57977	5.934637	28.51441	8.82246	6.078311	22.04945	0.024099	0.275687	0.162976	0.451158
490310	BROOKER	17.954	16.8501108	0.23880807	235.6584	694.1405	55.83488	17.21352	73.0484	38.15167	21.98584	36.95041	0.175802	0.839842	0.260113	0.829658
490320	BROOKER	61.591	62.4449136	0.25798073	1681.581	2314.067	259.5039	88.64554	348.1494	232.9326	125.8637	111.9064	1.212713	4.441679	0.72245	2.882452
490330	BROOKER	12.206	13.8197507	0.28809405	35.32577	671.1896	38.22248	9.926541	48.14902	14.16563	9.961866	38.15183	0.035326	0.459235	0.282606	0.777167
490340	BROOKER	44.08	51.5395291	0.29751325	1224.027	2267.892	219.6064	72.08318	291.6895	178.2423	98.47476	115.0095	0.891968	3.576055	0.776507	2.769752
490350	BROOKER	10.737	15.3094683	0.36281447	42.01442	790.7673	45.06447	11.70882	56.77328	16.73598	11.75983	44.9439	0.041896	0.541775	0.332891	0.915677
490370	BROOKER	82.531	69.0038439	0.21274709	3123.162	2167.44	369.8302	137.0437	506.8738	400.8911	208.7228	85.33229	2.21864	6.997248	0.426661	2.901298
490390	BROOKER	105.894	90.980569	0.21861741	4202.309	2916.356	497.6176	184.3964	682.014	539.4111	280.8428	114.8172	2.985247	9.415008	0.574086	3.903784
490400	BROOKER	43.439	35.0122521	0.20509151	1493.541	1036.501	176.8581	65.53623	242.3943	191.7118	99.81421	40.80712	1.060985	3.346184	0.204036	1.387442
490410	BROOKER	55.63	44.3758544	0.2029762	1772.591	1381.169	239.1307	83.86336	322.9941	219.7362	116.2581	62.6291	1.228947	3.837678	0.250832	1.690959
490420	BROOKER	388.515	298.680138	0.19561673	6785.363	5013.34	843.0681	291.139	1120.356	842.3782	441.6049	219.2832	4.638219	14.84085	1.097227	6.605008
490430	BROOKER	312.957	638.222619	0.5189135	3356.01	10960.96	851.99	258.951	1110.844	558.9862	325.5853	588.2651	2.518624	12.58694	4.166804	13.05271
490440	BROOKER	66.019	69.4645696	0.26773297	663.1144	3009.004	225.4868	64.59456	290.0814	117.0366	71.8809	168.0026	0.556038	3.278573	1.205214	3.450454
490450	BROOKER	512.335	521.453925	0.25898187	15673.43	12165.26	2001.684	719.5385	2721.222	1994.264	1048.033	522.4925	11.08626	35.40014	2.531516	15.5513
490460	BROOKER	84.629	130.801601	0.39327949	875.9936	2319.456	283.8387	54.72515	324.1175	148.3645	101.9253	237.1265	0.720338	3.837979	1.21235	3.185379
490470	BROOKER	251.434	380.82934	0.38540189	5997.59	6808.297	891.6699	305.627	1197.297	789.3536	424.0343	326.9574	4.449579	15.96398	2.021127	8.289851

490480	BROOKER	118.015	193.182357	0.41652176	1354.972	5439.594	429.8845	124.0578	553.9422	225.5455	137.3396	304.1969	1.147457	6.431151	2.168148	6.184513
490490	BROOKER	191.601	251.210206	0.33361607	2886.604	6995.68	651.9305	193.6683	841.2771	438.4432	254.6384	405.6158	2.118006	9.44642	2.591499	8.423806
490500	BROOKER	161.22	252.751014	0.39891598	6048.738	4483.934	733.4891	269.0955	1002.585	776.9794	404.965	175.4981	4.289383	13.71159	0.896134	5.936439
490510	BROOKER	37.804	49.5633679	0.33360343	986.8856	892.0892	127.7689	45.98823	173.7572	129.7632	68.38961	38.8791	0.704344	2.33284	0.223824	1.155277
490520	BROOKER	83.032	158.066986	0.48439887	1270.473	4018.942	315.9086	96.38089	412.2895	209.2415	121.3814	214.1741	0.950326	4.689088	1.513116	4.789511
490530	BROOKER	85.019	150.726516	0.45110861	1095.367	3354.943	280.191	83.70159	363.4701	174.2433	102.2686	185.4258	0.803827	3.886754	1.244924	3.947431
490540	BROOKER	30.814	40.9336971	0.3380184	471.6533	1375.392	111.1294	34.29326	145.4226	76.09892	43.81925	73.18404	0.351466	1.671569	0.514342	1.64385
490550	BROOKER	50.574	81.6709059	0.41091076	646.9299	2112.827	174.0516	51.85201	225.9036	103.1657	60.947	115.9111	0.470754	2.32425	0.77705	2.456119
490560	BROOKER	297.169	549.783047	0.47075538	6074.754	9339.696	1059.757	325.2175	1379.375	837.8446	477.8056	500.1266	4.536743	16.72076	3.067128	11.45753
490570	BROOKER	55.941	96.1798293	0.43748304	474.2299	3357.543	215.5655	60.0368	275.6023	105.9762	67.28935	187.1055	0.384797	2.842477	1.365655	3.926403
490580	BROOKER	1080.867	2532.17815	0.59611417	12071.84	36273.64	2979.972	886.0581	3852.818	1974.956	1155.75	2039.224	9.077957	44.23718	13.95925	43.69308
490590	BROOKER	337.195	715.691188	0.54007241	9321.261	10537.7	1321.332	461.6743	1783.006	1251.299	666.6478	478.9336	6.667192	23.26204	2.938197	13.32376
490600	BROOKER	74.211	96.7988868	0.33190174	3524.271	2579.148	424.9005	156.3641	581.2645	453.4148	236.4201	102.3644	2.502599	7.972121	0.525123	3.424318
490610	BROOKER	104.32	181.103942	0.44174107	840.981	4784.155	320.6905	91.31201	412.0025	170.5091	105.5763	264.5265	0.663874	4.35307	1.919232	5.616229
490620	BROOKER	48.395	75.9523315	0.39934483	336.4303	2394.286	164.4182	42.09277	204.7666	76.67867	50.66664	147.3438	0.281233	2.128727	1.017357	2.848481
490630	BROOKER	89.739	153.881642	0.43632795	1211.679	4631.882	351.2047	101.7765	451.6657	212.9824	127.6366	261.5839	0.926805	5.022023	1.826549	5.525977
490640	BROOKER	76.328	80.2086826	0.26738987	888.3313	3260.835	255.4597	70.57716	324.4768	153.1739	94.65776	187.0767	0.710336	3.660184	1.294167	3.904325
490650	BROOKER	156.3	274.514591	0.44690365	3146.802	6570.404	663.7436	181.7688	841.5358	415.2152	241.9873	275.7988	2.326062	9.864978	1.693476	7.874899
490660	BROOKER	43.661	48.2785409	0.2813636	1428.439	1686.999	222.219	71.68772	292.2649	191.8093	105.5961	93.21066	1.031978	3.651909	0.518638	2.13562
490670	BROOKER	60.878	57.0252982	0.23834972	388.426	2173.443	154.9875	41.17178	194.747	79.27649	50.59146	131.3445	0.312572	2.07423	0.905868	2.591764
490680	BROOKER	17.324	31.600458	0.4641439	40.10677	536.1157	50.45232	7.191896	54.59508	15.01231	13.52221	54.61384	0.050609	0.572036	0.299355	0.707553
490690	BROOKER	167.436	124.563952	0.18930016	2248.265	4288.85	436.329	132.5876	567.7811	295.5479	165.9884	192.6066	1.642072	6.422645	2.52242	5.241505
490700	BROOKER	86.246	96.948215	0.28602784	2029.831	3996.975	418.9003	117.5014	533.678	244.902	145.5113	195.9582	2.007444	7.558195	6.968873	5.344145
490710	BROOKER	257.812	136.340861	0.13456445	1339.068	2561.776	287.7371	87.683	375.3437	173.0101	98.24075	134.4282	0.901766	3.526954	0.719702	2.863929
490720	BROOKER	140.022	154.942569	0.28156711	3001.808	6843.588	676.9198	196.1499	872.8618	363.2809	194.3821	223.04	1.914928	9.132121	1.215868	7.87484
490730	BROOKER	160.861	125.445431	0.19843192	5360.712	3680.277	638.582	232.1358	870.0172	686.4605	360.8275	147.8673	3.84455	12.05338	0.730588	4.944203
490740	BROOKER	80.571	69.7161996	0.22017216	1426.588	799.2141	287.7834	38.07321	312.072	149.1219	116.8764	95.67612	1.315299	3.325979	0.196513	1.026021
490750	BROOKER	148.334	129.781105	0.22262719	196.0169	843.6323	99.47033	13.5129	104.0366	18.18666	15.65426	71.17828	0.069872	0.594576	0.353973	0.964563
490760	BROOKER	187.701	105.95008	0.14362901	1843.204	1523.936	292.0992	82.58234	366.8162	234.8132	132.289	123.7049	1.303759	4.453532	0.48398	2.085224
490770	BROOKER	751.256	511.348873	0.17319558	4337.466	6345.856	1096.6	250.5962	1308.689	511.223	333.432	605.2459	2.924203	11.07219	2.238587	7.42017
490780	BROOKER	392.169	367.226742	0.23826952	2213.342	15343.28	1037.257	278.8178	1311.947	482.1176	312.5456	893.2198	1.774921	13.08482	6.275515	17.92585
490790	BROOKER	581.411	372.036209	0.16282062	10069.63	22533.33	1233.689	432.6197	1658.715	1066.486	577.2571	281.4761	8.604997	25.49818	63.66583	34.2009
490800	BROOKER	134.402	143.590041	0.27184793	421.0232	707.142	269.029	6.03083	235.6332	35.71554	47.21299	224.2291	0.512841	3.078226	0.818057	1.261801
491010	BROOKER	36.464	37.0356205	0.25844181	184.82	377.6434	128.3375	10.03883	131.9058	24.5124	22.75078	79.09569	0.363119	2.817154	0.291609	0.698027
491040	BROOKER	59.46	62.5508389	0.26767985	1592.524	1137.826	251.0373	62.89258	305.5377	200.4245	119.3117	97.63439	1.311646	4.380401	0.407635	1.609042
491060	BROOKER	46.369	41.4788903	0.22761813	1871.978	1299.132	221.6709	82.142	303.8129	240.2884	125.1054	51.14695	1.329821	4.19405	0.255735	1.738996
491080	BROOKER	53.624	44.1610209	0.20954985	1862.802	1292.764	220.5843	81.73936	302.3236	239.1105	124.4922	50.89624	1.323302	4.173491	0.254481	1.730472
491081	BROOKER	97.889	79.9855176	0.20791457	3219.031	2455.632	432.2656	149.7634	580.7034	400.2945	211.6968	113.3307	2.423225	8.165899	0.593293	2.99939
491100	BROOKER	159.508	149.176653	0.23797199	3668.405	5481.652	588.9298	198.9969	787.9266	514.6033	279.6694	269.0524	2.652418	9.944391	1.762236	6.787067
491120	BROOKER	189.758	192.117653	0.25761706	4492.492	7471.186	761.862	253.4761	1015.221	641.5851	351.5933	374.0205	3.260804	12.63097	2.48666	9.187636
491140	BROOKER	35.58	72.9590431	0.52177184	76.80986	396.668	100.0824	4.666585	93.8251	20.81871	25.66691	110.1665	0.102708	0.978495	0.415346	0.741352
491160	BROOKER	18.573	21.7681207	0.29822657	77.02304	1030.032	69.02535	17.66896	86.68878	20.43994	15.05169	60.49969	0.057199	0.658396	0.407797	1.144264
491180	BROOKER	89.918	78.4916892	0.22211837	1070.963	2959.668	243.97	75.67394	319.5661	170.5384	97.74942	157.3364	0.796219	3.706842	1.100309	3.548272
491200	BROOKER	15.748	15.2779222	0.24685751	631.6327	513.9897	78.77667	28.69572	107.4724	82.20338	43.10151	21.60757	0.449898	1.459594	0.118781	0.673832
491220	BROOKER	125.616	124.275965	0.2517385	4223.198	4140.337	576.8311	195.9512	771.153	558.3198	302.726	194.3214	3.091347	10.31737	1.133161	5.343243
491240	BROOKER	74.591	112.961012	0.38534488	307.1433	5835.723	332.3291	86.30727	418.6363	123.1645	86.61442	331.7148	0.307143	3.992863	2.457147	6.757153
491260	BROOKER	35.454	30.4549612	0.21857489	764.6542	1059.999	118.4098	40.40943	158.8192	106.0352	57.32414	51.33143	0.551572	2.024283	0.331839	1.319625
491280	BROOKER	247.96	212.880095	0.21845444	5445.434	6070.651	798.4515	274.7771	1073.067	717.9732	384.9858	289.7659	3.855638	13.21579	1.645781	7.503601
491300	BROOKER	191.561	164.288686	0.21822676	4064.984	5501.838	622.4664	213.0952	835.5615	561.7101	303.1753	265.2222	2.930106	10.683	1.706862	6.861917
491320	BROOKER	23.217	31.5054699	0.34529263	212.3361	1534.703	98.1703	27.28771	125.458	47.91791	30.49743	85.58	0.172789	1.291152	0.624944	1.794147

491340	BROOKER	226.635	321.126344	0.36054245	7828.913	6393.091	977.5905	355.9649	1333.555	1019.221	534.4938	269.1039	5.57671	18.10439	1.481856	8.377661
491360	BROOKER	19.608	18.5933723	0.24128611	819.7499	568.8974	97.07093	35.97044	133.0414	105.2236	54.78438	22.39754	0.582336	1.836598	0.111988	0.761516
491380	BROOKER	102.625	91.5388058	0.22696533	4011.799	2840.008	477.9989	176.7605	654.7593	515.7891	268.7675	112.8244	2.850796	9.021017	0.572056	3.791109
491400	BROOKER	42.961	54.9310995	0.32535041	1064.782	2444.458	215.8605	68.81411	284.6746	162.077	91.20664	127.1669	0.783385	3.38801	0.878068	2.952261
491420	BROOKER	349.476	520.478062	0.37895926	4644.194	16949.18	1301.23	369.0282	1666.84	795.446	486.536	934.2595	3.696988	18.79747	6.605853	20.16418
491440	BROOKER	215.404	358.97476	0.42405052	1259.376	7710.915	509.0086	143.8207	652.8293	263.4796	164.5262	427.5628	1.002805	6.84003	3.108861	9.039515
491460	BROOKER	26.954	46.0718734	0.43493073	577.9693	1195.109	120.1965	34.99811	153.742	85.72329	49.58235	70.95864	0.429517	1.808808	0.442935	1.472391
491480	BROOKER	29.916	30.8172994	0.262119	1516.932	1070.17	180.5457	66.7885	247.3342	194.9741	101.5824	42.44886	1.077878	3.408839	0.214721	1.429241
491500	BROOKER	341.108	568.079386	0.4237645	4350.935	10576.44	915.9339	288.6348	1204.127	671.0393	380.0694	556.3979	3.211347	14.21549	3.846687	12.7515
491520	BROOKER	25.632	28.1232254	0.27918372	468.1575	1257.306	104.5168	32.62028	137.1371	73.97978	42.24682	66.40892	0.347322	1.596912	0.464475	1.508146
491540	BROOKER	75.655	82.1110266	0.27616669	3007.52	3000.84	404.229	143.804	548.033	399.6547	211.7335	134.7119	2.150945	7.275171	0.803325	3.845528
491560	BROOKER	105.032	58.4289567	0.14155133	683.5416	1835.722	156.6487	47.57365	204.2224	101.0823	56.74081	85.30585	0.484529	2.315801	0.578686	2.179476
491580	BROOKER	261.845	412.195319	0.40055875	380.4583	1041.051	195.6206	48.02496	243.6455	8.646834	14.04714	83.49328	0.114251	0.162634	0.096154	0.580273
491600	BROOKER	133.424	173.759291	0.33137636	218.1447	3332.65	199.7241	50.69391	250.418	64.35595	44.112	170.3636	0.16938	2.333465	1.238138	3.828663
491620	BROOKER	107.045	179.746359	0.42726878	1905.559	4141.937	397.2424	118.7626	514.5547	260.4813	143.3525	175.8184	1.324583	5.938524	1.118917	4.958817

CHAPTER 11: WATER QUALITY TREATMENT LEVEL OF SERVICE

11.1 Overview

This chapter describes the results of the pollutant loading analysis performed in Chapter 10. Based on these results, a water quality treatment level of service was determined at the subbasin and watershed levels within the Brooker Creek watershed. This type of analysis will facilitate prioritization of water quality improvement alternatives (projects) for the Brooker Creek watershed.

Water quality treatment levels-of-service (LOS) criteria were used as part of this watershed study to allow comparisons of existing and proposed stormwater treatment conditions to pollutant loading goals and to help prioritize alternatives throughout the watershed.

Excess nitrogen can stimulate algal growth resulting in reduced light penetration through the water column and subsequent shading and loss of seagrasses. The nitrogen reduction goal is based on loads generated by several potential inputs including point sources, atmospheric deposition, and non-point source runoff from various land uses. The intent of this management effort is to protect water quality and, ultimately, valuable natural resources in the Brooker Creek watershed. Other factors that affect light availability in the bay are also of concern, including excess total suspended solids (TSS) loads.

11.2 Water Quality Treatment Level of Service

The identification of problem areas and pollutant load reduction goals is an important step in protecting the river, reservoir, lakes, and groundwater within the watershed, as well as the downstream estuary. For this analysis, three specific pollutants were identified and discussed in greater detail due to their importance in local water (quality) management programs. These parameters include total suspended solids (TSS), total phosphorus, and total nitrogen. In addition, based on specific concerns, some subbasins required assessment of other parameters, including heavy metals and bacteria. The results of this modeling effort and the implementation of alternatives proposed in later chapters of this report will be an important step in restoring and protecting the surface water within the Brooker Creek watershed.

The modeling effort in this plan focuses on land use and soil conditions as a basis for evaluating sources of pollutant loads and does not include any routing of pollutants. For comparison purposes, pollutant loads based on stormwater runoff from single family (low to medium density) residential land use were selected as the standard (benchmark) for comparison. In this manner, the calculation of pollutant loads is consistent with the concept of standard residential unit (SRU) sometimes used for stormwater utility assessments.

The procedure to identify a treatment level-of-service designation for each subbasin consisted of the following steps:

1) Net pollutant loads were calculated for each pollutant of interest based on 2004 land uses, soils, and existing stormwater treatment best management practices (BMPs) (completed in Chapter 10);

2) Benchmark pollutant loads were calculated for each pollutant based on the assumption that 100% of the watershed area was developed for low/medium residential land uses and there is no existing stormwater treatment;

3) Ratios of net load/gross load were calculated;

4) Criteria described below were applied to each subbasin for each pollutant to determine the LOS for the subbasin.

Based on the following ranges, water quality LOS criteria were defined as a score from A through F:

- **LOS A**, net load equivalent to 20% or less of untreated single family residential. A LOS equal to A for a subbasin would indicate the presence of a high percentage of undisturbed natural systems, or high percentages of developed areas treated with BMPs capable of removing pollution levels to those representing natural systems. Areas where typical land uses (residential) exhibit stormwater treatment levels above the minimum required per 62-40.432(5) F.A.C. (Water Policy) would also receive LOS A.

- **LOS B**, net load equivalent to between 20 and 40% of untreated single family residential areas. A LOS equal to B would indicate the presence of BMPs with removal efficiencies consistent with those representing adequately designed and maintained conditions and a relatively even mix of developed and natural land uses.

- **LOS C**, net load equivalent to between 40 and 70% of untreated single family residential areas. A LOS equal to C would indicate the presence of treatment systems showing removal efficiencies consistent with those representing average to poorly maintained conditions and a greater percentage of developed versus natural land uses.

- **LOS D**, net load equivalent to between 70 and 100% of untreated single family residential areas. A LOS equal to D would indicate minimal treatment of sub-basin discharges and relatively high percentage of developed land uses.

- **LOS F**, net load equal to or greater than 100% of untreated single family residential areas. A LOS equal to F would indicate no treatment for sub-basin discharges, or the presence of extensive areas of land uses producing larger pollution loads per unit area than typical residential land uses.

11.2.1 Water Quality Level-of-Service Pollutant Load Calculations

Benchmark pollutant loads were calculated for each pollutant based on the assumption that 100% of the watershed area was developed for low/medium residential land uses and no existing stormwater treatment existed in any of the subbasins. Table 11-1 provides a summary of the benchmark loads by subbasin for Brooker Creek watershed.

11.2.2 Water Quality Level-of-Service Scores

Based on the criteria described above, the treatment level of service designation were developed for each parameter for each subbasin, which are summarized in Table 11-2.

As mentioned earlier, the three most important parameters of concern in this watershed are total suspended solids, total nitrogen and total phosphorus. The observations on these three parameters are discussed in detail in the following section.

Total Suspended Solids

Total suspended solids (TSS) LOS values were highest in areas dominated by existing natural systems (wetlands and uplands) and open land (Figure 11-1). These land uses do not contribute any loads based on the model's EMC value input dataset. On an areal basis, subbasins to the east and the west of the Brooker Creek watershed had the greatest coverage of A scores. These areas are comprised of mainly wetlands, and agricultural land uses. Other areas dominated by A or B scores included subbasins to the north and south of the watershed that incorporate such water bodies as Lake Frances, Lake Rogers, and Church Lake.

The remaining subwatersheds were dominated by the scores of either C or D and were primarily characterized by agricultural or residential land uses. Developed land uses are characterized by relatively large impervious surface area (such as roads, buildings, parking lots, etc.), which have relatively high runoff coefficients and TSS loads.

Total Nitrogen

Total nitrogen LOS values were also highest in areas dominated by existing natural systems (wetlands and uplands) and open land (Figure 11-2). These land uses do not contribute any loads based on the model's EMC value input dataset, and are concentrated within the eastern portion of the watershed. Unlike the distribution of TSS scores, fewer A scores occurred throughout the watershed for TN. This is mainly due to greater contributions of total nitrogen from agricultural and residential land uses than TSS. The remaining areas surrounding the Brooker Creek watershed had predominantly C or D scores. Lower scores in the central subbasins were primarily due to extensive residential land uses surrounding Keystone Lake.

Table 11-1 Pollutant Loads (lbs/year) by Subbasin based on Benchmark Conditions
(entire watershed comprised of single family untreated land use)

Subbasin ID	Basin ID	Area (acres)	Volume (acre-feet)	Runoff coefficient	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
490000	BROOKER	128.913	174.7535847	0.344934654	475.1585968	9028.013339	514.1216017	133.5195657	647.6411674	190.5385973	133.9947243	513.1712845	0.475158597	6.177061758	3.801268774	10.45348913
490010	BROOKER	91.221	133.9555984	0.373657316	364.2280316	6920.3326	394.0947302	102.3480769	496.4428071	146.0554407	102.7123049	393.3662741	0.364228032	4.734964411	2.913824253	8.013016695
490020	BROOKER	176.955	267.6195948	0.384824328	727.6631911	13825.60063	787.3315728	204.4733567	991.8049295	291.7929396	205.2010199	785.8762464	0.727663191	9.459621485	5.821305529	16.00859021
490030	BROOKER	86.318	129.5145962	0.381790218	352.1528552	6690.904248	381.0293893	98.9549523	479.9843416	141.2132949	99.30710516	380.3250836	0.352152855	4.577987117	2.817222841	7.747362814
490040	BROOKER	36.977	53.49145008	0.368095194	145.4443547	2763.442739	157.3707918	40.86986367	198.2406554	58.32318623	41.01530802	157.0799031	0.145444355	1.890776611	1.163554838	3.199775803
490050	BROOKER	155.365	229.2200285	0.375410852	623.2539795	11841.82561	674.3608058	175.1343682	849.495174	249.9248458	175.7576222	673.1142978	0.623253979	8.102301733	4.986031836	13.71158755
490070	BROOKER	87.14	117.1197339	0.341995169	318.4509691	6050.568412	344.5639485	89.48472231	434.0486708	127.6988386	89.80317327	343.9270466	0.318450969	4.139862598	2.547607752	7.005921319
490080	BROOKER	17.448	25.35736608	0.369799175	68.94720073	1309.996814	74.60087119	19.37416341	93.9750346	27.64782749	19.44311061	74.46297679	0.068947201	0.89631361	0.551577606	1.516838416
490090	BROOKER	62.877	90.94400424	0.368035498	247.278621	4698.293799	267.5554679	69.48529249	337.0407604	99.15872701	69.73257111	267.0609107	0.247278621	3.214622073	1.978228968	5.440129661
490100	BROOKER	33.526	48.86895264	0.370901629	132.8756889	2524.63809	143.7714954	37.33806859	181.109564	53.28315126	37.47094428	143.505744	0.132875689	1.727383956	1.063005511	2.923265156
490110	BROOKER	20.509	26.58614739	0.329851431	72.28828243	1373.477366	78.21592159	20.31300736	98.52892895	28.98760125	20.38529564	78.07134502	0.072288282	0.939747672	0.578306259	1.590342213
490120	BROOKER	10.456	13.48679715	0.328209162	36.67087928	696.7467063	39.67789138	10.30451708	49.98240846	14.70502259	10.34118796	39.60454962	0.036670879	0.476721431	0.293367034	0.806759344
490130	BROOKER	14.35	19.75568163	0.350305993	53.71610532	1020.606001	58.12082596	15.09422559	73.21505155	21.54015823	15.1479417	58.01339374	0.053716105	0.698309369	0.429728843	1.181754317
490140	BROOKER	50.664	75.05982063	0.376977558	204.0891985	3877.694772	220.8245128	57.34906479	278.1735776	81.83976861	57.55315398	220.4163344	0.204089199	2.653159581	1.632713588	4.489962368
490150	BROOKER	42.972	64.61867916	0.382630829	175.6995198	3338.290876	190.1068804	49.37156506	239.4784455	70.45550743	49.54726458	189.7554814	0.17569952	2.284093757	1.405596158	3.865389435
490160	BROOKER	135.552	201.3258867	0.3779211	547.4092333	10400.77543	592.2967905	153.8219946	746.118785	219.5111026	154.3694038	591.201972	0.547409233	7.116320033	4.379273867	12.04300313
490170	BROOKER	19.576	27.10528467	0.352320137	73.69982739	1400.29672	79.74321323	20.7096515	100.4528647	29.55363078	20.78335132	79.59581358	0.073699827	0.958097756	0.589598619	1.621396203
490180	BROOKER	105.808	156.6372633	0.376689948	425.8999456	8092.098967	460.8237412	119.6778847	580.5016259	170.7858782	120.1037847	459.9719413	0.425899946	5.536699293	3.407199565	9.369798804
490200	BROOKER	28.644	40.11579333	0.35636018	109.0756684	2072.437701	118.0198733	30.65026283	148.6701361	43.73934305	30.7593385	117.8017219	0.109075668	1.41798369	0.872605348	2.399664706
490210	BROOKER	194.008	279.4901362	0.366567786	759.9394378	14438.84932	822.2544717	213.542982	1035.797454	304.7357146	214.3029215	820.7345928	0.759939438	9.879212691	6.079515502	16.71866763
490220	BROOKER	62.999	85.49110173	0.345298513	232.4520667	4416.589268	251.5131362	65.31903075	316.8321669	93.21327875	65.55148282	251.0482321	0.232452067	3.021876867	1.859616534	5.113954468
490230	BROOKER	291.535	444.6174217	0.388063883	1208.923929	22969.55465	1308.055691	339.707624	1647.763315	484.7784954	340.9165479	1305.637843	1.208923929	15.71601107	9.67139143	26.59632643
490240	BROOKER	34.308	45.30223791	0.335994141	123.1777181	2340.376644	133.278291	34.61293879	167.8912298	49.39426496	34.73611651	133.0319356	0.123177718	1.601310335	0.985421745	2.709909798
490250	BROOKER	101.849	135.1538476	0.337659594	367.4860957	6982.235818	397.6199555	103.2635929	500.8835484	147.3619244	103.631079	396.8849833	0.367486096	4.777319244	2.939888765	8.084694105
490260	BROOKER	162.14	234.8979078	0.368634883	638.6922502	12135.15275	691.0650147	179.4725223	870.537537	256.1155923	180.1112146	689.7876302	0.63869225	8.302999253	5.109538002	14.0512295
490270	BROOKER	15.703	21.00573996	0.340379036	57.11503967	1085.185754	61.79847292	16.04932615	77.84779907	22.90313091	16.10644119	61.68424284	0.05711504	0.742495516	0.456920317	1.256530873
490280	BROOKER	63.846	92.06311104	0.366909877	250.3214954	4756.108413	270.847858	70.34034021	341.1881983	100.3789197	70.59066171	270.3472151	0.250321495	3.25417944	2.002571963	5.507072899
490290	BROOKER	131.155	170.1633054	0.330132675	462.6775328	8790.873124	500.6170905	130.0123867	630.6294772	185.5336907	130.4750643	499.6917355	0.462677533	6.014807927	3.701420263	10.17890572
490300	BROOKER	6.012	7.60794552	0.322	20.68616059	393.0370513	22.38242576	5.812811127	28.19523689	8.295150398	5.833497287	22.34105344	0.020686161	0.268920088	0.165489285	0.455095533
490310	BROOKER	17.954	23.98744668	0.339961903	65.22236166	1239.224872	70.57509532	18.32748363	88.89807895	26.15416703	18.39270599	70.4401506	0.065222362	0.847890702	0.521778893	1.434891957
490320	BROOKER	61.591	82.20953994	0.339634979	223.5294326	4247.05922	241.8588461	62.81177056	304.6706167	89.63530248	63.0353	241.4117872	0.223529433	2.905882624	1.788235461	4.917647517
490330	BROOKER	12.206	16.33413324	0.340510241	44.41284476	843.8440505	48.05469803	12.48000938	60.53470741	17.80955075	12.52442222	47.96587234	0.044412845	0.577366982	0.355302758	0.977082585
490340	BROOKER	44.08	58.41680118	0.337212477	158.8364858	3017.89323	171.8610776	44.63305251	216.4941301	63.6934308	44.79188899	171.5434047	0.158836486	2.064874315	1.270691886	3.494402687
490350	BROOKER	10.737	15.3126162	0.362889075	41.63531889	791.0710589	45.04941504	11.69952461	56.74893964	16.69576287	11.74115993	44.9661444	0.041635319	0.541259146	0.333082551	0.915977016
490370	BROOKER	82.531	105.597811	0.325570658	287.1226233	5455.329843	310.6666784	80.68145715	391.3481356	115.1361719	80.96857977	310.0924332	0.287122623	3.732594103	2.296980987	6.316697713
490390	BROOKER	105.894	140.7337048	0.33816933	382.6578424	7270.499006	414.0357855	107.5268537	521.5626392	153.4457948	107.9095116	413.2704698	0.382657842	4.974551952	3.06126274	8.418472534
490400	BROOKER	43.439	60.21182082	0.352703193	163.7171812	3110.626442	177.14199	46.00452791	223.1465179	65.65058965	46.16824509	176.8145557	0.163717181	2.128323355	1.309737449	3.601777986
490410	BROOKER	55.63	73.84102152	0.337750566	200.7752586	3814.729914	217.2388298	56.41784768	273.6566775	80.51087871	56.61862294	216.8372793	0.200775259	2.610078362	1.606202069	4.41705569
490420	BROOKER	388.515	554.9198121	0.363437628	1508.8384	28667.92961	1632.563149	423.9835905	2056.54674	605.0441986	425.4924289	1629.545472	1.5088384	19.61489921	12.0707072	33.19444481
490430	BROOKER	312.957	469.0947783	0.381402362	1275.478365	24234.08894	1380.067591	358.4094207	1738.477012	511.4668246	359.6848991	1377.516635	1.275478365	16.58121875	10.20382692	28.06052404
490440	BROOKER	66.019	95.83903932	0.369386449	260.5883222	4951.178122	281.9565646	73.22531854	355.1818832	104.4959172	73.48590686	281.435388	0.260588322	3.387648189	2.084706578	5.732943088
490450	BROOKER	512.335	728.8856401	0.362003541	1981.855071	37655.24634	2144.367186	556.9012748	2701.268461	794.7238833	558.8831299	2140.403476	1.981855071	25.76411592	15.85484056	43.60811155
490460	BROOKER	84.629	124.954071	0.375697799	339.752693	6455.301167	367.6124138	95.47050674	463.0829206	136.2408299	95.81025943	366.9329085	0.339752693	4.416785009	2.718021544	7.474559246
490470	BROOKER	251.434	371.5071365	0.375967761	1010.135557	19192.57559	1092.966673	283.8480916	1376.814765	405.0643585	284.8582272	1090.946402	1.010135557	13.13176224	8.081084458	22.22298226
490480	BROOKER	118.015	169.6016298	0.365679202	461.1503253	8761.856181	498.964652	129.5832414	628.5478934	184.9212804	130.0443917	498.0423513	0.461150325	5.994954229	3.689202602	10.14530716
490490	BROOKER	191.601	286.4706022	0.380443124	778.9194686	14799.4699	842.7908651	218.8763707	1061.667236	312.3467069	219.6552902	841.2330261	0.778919469	10.12595309	6.231355749	17.13622831
490500	BROOKER	161.22	245.674632	0.387747358	667.9943852	12691.89332	722.7699248	187.7064222	910.4763471	267.8657485	188.3744166	721.433936	0.667994385	8.683927008	5.343955082	14.69587647
490510	BROOKER	37.804	55.78916388	0.375508306	151.6918858	2882.145831	164.1306205	42.62541992	206.7560404	60.82844622	42.77711181	163.8272367	0.151691886	1.971994516	1.213535087	3.337221489
490520	BROOKER	83.032	124.8000896	0.382451922	339.3340146	6447.346278	367.1594038	95.35285811	462.5122619	136.0729399	95.69219212	366.4807358	0.339334015	4.41134219	2.714672117	7.465348321
490530	BROOKER	85.019	120.1527703	0.359604606	326.6978576	6207.259295	353.487082	91.802098	445.28918	131.0058409	92.12879586	352.8336863	0.326697858	4.247072149	2.613582861	7.187352868
490540	BROOKER	30.814	43.29910905	0.357551275	117.7311695	2236.89222	127.3851254	33.08245862	160.467584	47.21019896	33.20018979	127.149663	0.117731169	1.530505203	0.941849356	2.590085728
490550	BROOKER	50.574	73.5253875	0.369928224	199.9170432	3798.423821	216.3102408	56.17668915	272.4869299	80.16673434	56.37660619	215.9104067	0.199917043	2.598921562	1.599336346	4.398174951
490560	BROOKER	297.169	435.5891113	0.372976064	1184.375767	22503.13957	1281.49458	332.8095905	1614.30417	474.9346825	333.9939662	1279.125828	1.184375767	15.39688497	9.475006135	26.05626687
490570	BROOKER	55.941	84.86762688	0.386028423	230.7568258	4384.379689	249.6788855	64.84266804	314.5215535	92.53348713	65.07342486	249.2173718	0.230756826	2.999838735	1.846054606	5.076650167
490580	BROOKER	1080.867	1655.598017	0.389753559	4501.605113	85530.49715	4870.736732	1264.951037	6135.687769	1805.14365	1269.452642	4861.733522	4.501605113	58.52086647	36.0128409	99.03531249
490590	BROOKER	337.195	500.7900514	0.377904459	1361.658466	25871.51086	1473.31446	382.626029	1855.940489	546.0250449	383.9876874	1470.591143	1.361658466	17.70156006	10.89326773	29.95648625
490600	BROOKER	74.211	109.2680576	0.374655738	297.1020996	5644.939892	321.4644717	83.48568998	404.9501617	119.1379419	83.78279208	320.8702675	0.2971021	3.862327294	2.376816797	6.53624619
490610	BROOKER	104.32	156.8576184	0.38260634	426.4990957	8103.482818	461.4720215	119.8462649	581.3182674	171.0261374	120.272745	460.6190234	0.426499096	5.544488244	3.411992766	9.382980105
490620	BROOKER	48.395	69.80897514	0.367044075	189.8120415	3606.428788	205.3766289	53.33718365	258.7138125	76.11462863	53.52699569	204.9970048	0.189812041	2.467556539	1.518496332	4.175864912
490630	BROOKER	89.739	131.3044637	0.372310868	357.0195415	6783.371289	386.2951439	100.3224912	486.6176351	143.1648362	100.6795107	385.5811049	0.357019542	4.64125404	2.856156332	7.854429914
490640	BROOKER	76.328	101.2087752	0.337397403	275.1887446	5228.586147	297.7542216	77.32803723	375.0822589	110.3506866	77.60322597	297.2038442	0.275188745	3.57745368	2.201509957	6.054152381
490650	BROOKER	156.3	231.9208542	0.377561996	630.5975801	11981.35402	682.3065817	177.19792	859.5045017	252.8696296	177.8285176	681.0453866	0.63059758	8.197768542	5.044780641	13.87314676
490660	BROOKER	43.661	59.78046402	0.348395914	162.5443131	3088.34195	175.8729468	45.67495199	221.5478988	65.18026957	45.83749631	175.5478582	0.162544313	2.113076071	1.300354505	3.575974889

Table 11-1 Pollutant Loads (lbs/year) by Subbasin based on Benchmark Conditions
(entire watershed comprised of single family untreated land use)

Subbasin ID	Basin ID	Area (acres)	Volume (acre-feet)	Runoff coefficient	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
490670	BROOKER	60.878	88.01072298	0.367860081	239.3029688	4546.756407	258.9258122	67.24413423	326.1699465	95.96049049	67.4834372	258.4472063	0.239302969	3.110938594	1.91442375	5.264665314
490680	BROOKER	17.324	23.92150128	0.351356269	65.04305476	1235.818041	70.37658525	18.27709839	88.65368364	26.08226496	18.34214144	70.24649914	0.065043055	0.845559712	0.520344438	1.430947205
490690	BROOKER	167.436	235.9137185	0.358518694	641.4542604	12187.63095	694.0535097	180.2486472	874.3021569	257.2231584	180.8901014	692.7706012	0.64145426	8.338905385	5.131634083	14.11199373
490700	BROOKER	86.246	121.5319174	0.358557522	330.4477869	6278.50795	357.5445054	92.85582811	450.4003335	132.5095625	93.18627589	356.8836098	0.330447787	4.295821229	2.643582295	7.269851311
490710	BROOKER	257.812	371.3678966	0.366529285	1009.756961	19185.38226	1092.557032	283.7417061	1376.298738	404.9125414	284.751463	1090.537518	1.009756961	13.12684049	8.078055689	22.21465315
490720	BROOKER	140.022	194.9239403	0.354222672	530.0022091	10070.04197	573.4623903	148.9306208	722.3930111	212.5308859	149.460623	572.4023859	0.530002209	6.890028719	4.240017673	11.6600486
490730	BROOKER	160.861	213.0746925	0.337045518	579.3544782	11007.73509	626.8615454	162.7986084	789.6601537	232.3211457	163.3779628	625.7028364	0.579354478	7.531608216	4.634835825	12.74579852
490740	BROOKER	80.571	106.137117	0.335193804	288.5890075	5483.191143	312.2533062	81.09351112	393.3468173	115.724192	81.38210013	311.6761282	0.288589008	3.751657098	2.30871206	6.348958166
490750	BROOKER	148.334	196.4822207	0.337046638	534.2392056	10150.54491	578.0468204	150.1212168	728.1680372	214.2299214	150.655456	576.978342	0.534239206	6.945109672	4.273913645	11.75326252
490760	BROOKER	187.701	270.2116852	0.366306807	734.7111385	13959.51163	794.9574518	206.4538299	1001.411282	294.6191665	207.188541	793.4880296	0.734711138	9.5512448	5.877689108	16.16364505
490770	BROOKER	751.256	1070.340974	0.362528077	2910.279159	55295.30401	3148.92205	817.7884436	3966.710493	1167.021943	820.6987227	3143.101491	2.910279159	37.83362906	23.28223327	64.02614149
490780	BROOKER	392.169	532.475366	0.34548859	1447.811489	27508.41829	1566.532031	406.8350284	1973.36706	580.5724071	408.2828399	1563.636408	1.447811489	18.82154936	11.58249191	31.85185276
490790	BROOKER	581.411	836.1793836	0.365951609	2273.588969	43198.19042	2460.023265	638.8785004	3098.901765	911.7091767	641.1520894	2455.476087	2.273588969	29.5566566	18.18871176	50.01895733
490800	BROOKER	134.402	176.7427896	0.334613473	480.5672858	9130.778431	519.9738033	135.0394073	655.0132106	192.7074816	135.5199746	519.0126687	0.480567286	6.247374716	3.844538287	10.57248029
491010	BROOKER	36.464	49.37139921	0.344523283	134.2418515	2550.595179	145.2496833	37.72196027	182.9716436	53.83098245	37.85620212	144.9811996	0.134241852	1.74514407	1.073934812	2.953320733
491040	BROOKER	59.46	77.18391882	0.330300605	209.8646653	3987.42864	227.0735678	58.97197094	286.0455387	84.15573077	59.1818356	226.6538385	0.209864665	2.728240648	1.678917322	4.617022636
491060	BROOKER	46.369	65.03732241	0.356896569	176.8378194	3359.918569	191.3385206	49.69142725	241.0299478	70.91196558	49.86826507	190.984845	0.176837819	2.298891652	1.414702555	3.890432027
491080	BROOKER	53.624	76.9863027	0.365310122	209.327343	3977.219516	226.4921851	58.82098337	285.3131685	83.94026453	59.03031071	226.0735304	0.209327343	2.721255458	1.674618744	4.605201545
491081	BROOKER	97.889	130.3139111	0.338738326	354.3262087	6732.197965	383.3809578	99.56566464	482.9466224	142.0848097	99.91999085	382.6723054	0.354326209	4.606240713	2.83460967	7.795176591
491100	BROOKER	159.508	234.8957109	0.374714127	638.6862769	12135.03926	691.0585516	179.4708438	870.5293954	256.113197	180.1095301	689.781179	0.638686277	8.302921599	5.109490215	14.05109809
491120	BROOKER	189.758	273.4601328	0.36669195	743.5437344	14127.33095	804.5143207	208.9357894	1013.45011	298.1610375	209.6793331	803.0272332	0.743543734	9.666068548	5.948349876	16.35796216
491140	BROOKER	35.58	53.9671923	0.385950253	146.7379076	2788.020244	158.770416	41.23335203	200.003768	58.84190094	41.38008994	158.4769402	0.146737908	1.907592799	1.173903261	3.228233967
491160	BROOKER	18.573	25.99238727	0.356099661	70.67383643	1342.802892	76.46909102	19.85934804	96.32843905	28.34020841	19.93002187	76.32774334	0.070673836	0.918759874	0.565390691	1.554824401
491180	BROOKER	89.918	131.0676104	0.370899453	356.3755327	6771.135121	385.5983264	100.1415247	485.7398511	142.9065886	100.4979002	384.8855753	0.356375533	4.632881925	2.851004262	7.840261719
491200	BROOKER	15.748	20.94550485	0.338433134	56.95125916	1082.073924	61.62126242	16.00330383	77.62456624	22.83745492	16.06025508	61.5073599	0.056951259	0.740366369	0.455610073	1.252927702
491220	BROOKER	125.616	177.134198	0.358810303	481.6315332	9150.999131	521.1253189	135.3384608	656.4637797	193.1342448	135.8200924	520.1620558	0.481631533	6.261209931	3.853052266	10.59589373
491240	BROOKER	74.591	112.9610118	0.385344881	307.1433181	5835.723044	332.3290702	86.30727238	418.6363425	123.1644706	86.6144157	331.7147835	0.307143318	3.992863135	2.457146545	6.757152998
491260	BROOKER	35.454	51.35419818	0.368568455	139.6331227	2653.029332	151.0830388	39.23690749	190.3199463	55.99288222	39.37654061	150.8037726	0.139633123	1.815230596	1.117064982	3.0719287
491280	BROOKER	247.96	381.0192732	0.390996407	1035.999253	19683.9858	1120.951191	291.11579	1412.066981	415.4357004	292.1517893	1118.879193	1.035999253	13.46799029	8.287994022	22.79198356
491300	BROOKER	191.561	289.4709293	0.384507937	787.0774197	14954.47097	851.6177681	221.1687549	1072.786523	315.6180453	221.9558324	850.0436133	0.78707742	10.23200646	6.296619358	17.31570323
491320	BROOKER	23.217	34.70907618	0.380403411	94.37469314	1793.11917	102.113418	26.51928877	128.6327068	37.84425195	26.61366347	101.9246686	0.094374693	1.226871011	0.754997545	2.076243249
491340	BROOKER	226.635	338.2134813	0.379726918	919.6094229	17472.57903	995.0173955	258.4102478	1253.427643	368.7633786	259.3298572	993.1781767	0.919609423	11.9549225	7.356875383	20.2314073
491360	BROOKER	19.608	25.82076024	0.335075887	70.207179	1333.936401	75.96416768	19.7282173	95.69238498	28.15307878	19.79842448	75.82375332	0.070207179	0.912693327	0.561657432	1.544557938
491380	BROOKER	102.625	140.8798929	0.349303786	383.055331	7278.051299	414.4658681	107.638548	522.1044162	153.6051877	108.0216033	413.6997575	0.383055331	4.979719303	3.064442648	8.427217282
491400	BROOKER	42.961	64.13644851	0.379872605	174.3883247	3313.378169	188.6881673	49.00311924	237.6912866	69.92971821	49.17750757	188.3393907	0.174388325	2.267048221	1.395106598	3.836543144
491420	BROOKER	349.476	513.2585384	0.373702735	1395.560539	26515.65024	1509.996503	392.1525115	1902.149015	559.6197762	393.548072	1507.205382	1.395560539	18.14228701	11.16448431	30.70233186
491440	BROOKER	215.404	329.6018924	0.389352872	896.1943352	17027.69237	969.6822707	251.8306082	1221.512879	359.3739284	252.7268025	967.889882	0.896194335	11.65052636	7.169554681	19.71627537
491460	BROOKER	26.954	39.96936153	0.377321399	108.6775174	2064.87283	117.5890738	30.53838238	148.1274562	43.57968446	30.6470599	117.3717188	0.108677517	1.412807726	0.869420139	2.390905382
491480	BROOKER	29.916	40.11036993	0.341161953	109.0609221	2072.15752	118.0039177	30.64611911	148.6500368	43.73342977	30.75518004	117.7857959	0.109060922	1.417791987	0.872487377	2.399340286
491500	BROOKER	341.108	519.0952015	0.38722426	1411.430546	26817.18038	1527.167851	396.6119835	1923.779834	565.983649	398.023414	1524.34499	1.411430546	18.3485971	11.29144437	31.05147202
491520	BROOKER	25.632	35.13686061	0.348809184	95.53784782	1815.219109	103.3719513	26.84613524	130.2180866	38.31067697	26.94167308	103.1808756	0.095537848	1.241992022	0.764302783	2.101832652
491540	BROOKER	75.655	112.5196021	0.378440843	305.9431159	5812.919202	331.0304514	85.97001557	417.000467	122.6831895	86.27595869	330.4185652	0.305943116	3.977260507	2.447544927	6.73074855
491560	BROOKER	105.032	148.9960268	0.360961183	405.1232661	7697.342055	438.3433739	113.8396378	552.1830116	162.4544297	114.244761	437.5331273	0.405123266	5.266602459	3.240986128	8.912711853
491580	BROOKER	261.845	406.5902898	0.395111952	1105.527374	21005.0201	1196.180618	310.653192	1506.83381	443.3164768	311.7587194	1193.969564	1.105527374	14.37185586	8.844218989	24.32160222
491600	BROOKER	133.424	192.6217149	0.367348895	523.7424107	9951.105804	566.6892884	147.1716174	713.8609058	210.0207067	147.6953598	565.6418036	0.523742411	6.80865134	4.189939286	11.52233304
491620	BROOKER	107.045	162.6769895	0.386693783	442.3220855	8404.119625	478.5924966	124.292506	602.8850026	177.3711563	124.7348281	477.7078524	0.442322086	5.750187112	3.538576684	9.731085882

Table 11-2 Subbasin Treatment Level of Service

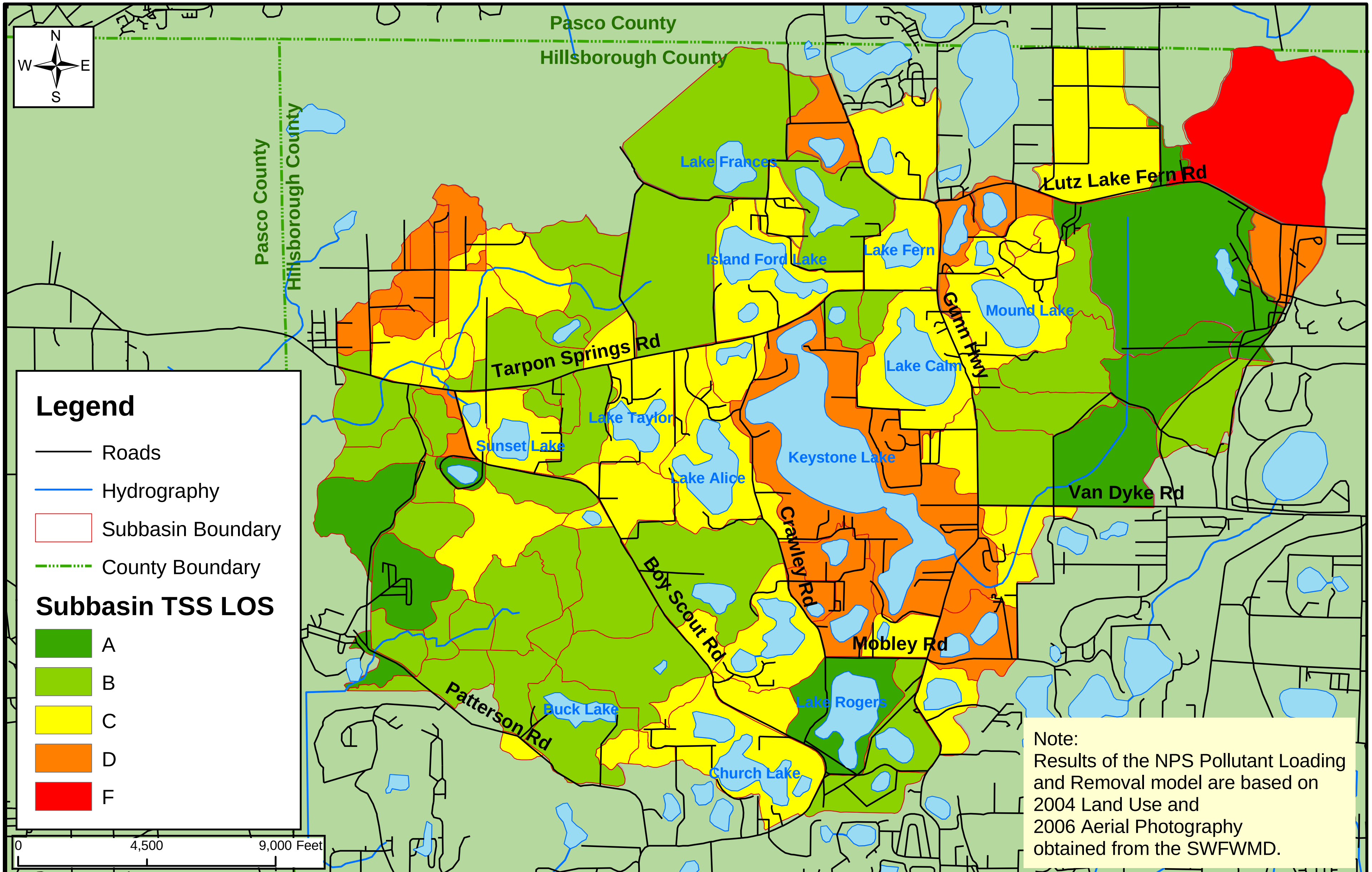
Subbasin ID	Basin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
490000	BROOKER	F	B	D	F	D	F	F	B	F	F	A	B
490010	BROOKER	F	B	D	F	D	F	F	B	F	F	A	B
490020	BROOKER	F	A	C	C	C	F	F	A	F	D	A	A
490030	BROOKER	F	B	D	F	D	F	F	A	F	F	A	B
490040	BROOKER	F	A	C	B	C	D	F	C	F	C	B	B
490050	BROOKER	F	A	D	D	D	F	F	B	F	F	A	B
490070	BROOKER	C	C	C	C	C	C	C	D	D	C	C	C
490080	BROOKER	B	B	B	B	B	B	B	B	B	B	B	B
490090	BROOKER	F	C	F	F	F	F	F	C	F	F	C	C
490100	BROOKER	D	D	D	D	D	D	D	D	D	D	D	D
490110	BROOKER	C	C	D	C	C	C	D	D	D	D	C	C
490120	BROOKER	F	B	F	F	F	F	F	C	F	F	B	C
490130	BROOKER	F	D	D	F	D	F	F	D	F	F	D	D
490140	BROOKER	D	B	C	C	C	B	B	B	C	B	B	B
490150	BROOKER	F	C	D	F	D	F	F	C	F	F	B	C
490160	BROOKER	F	C	C	C	C	D	D	C	F	C	C	C
490170	BROOKER	F	B	D	F	F	F	F	B	F	F	A	B
490180	BROOKER	F	B	C	C	C	F	F	B	F	D	B	B
490200	BROOKER	F	B	F	F	F	F	F	C	F	F	B	C
490210	BROOKER	F	C	C	C	C	D	D	C	F	C	C	C
490220	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
490230	BROOKER	F	C	C	D	C	F	D	C	F	D	B	C
490240	BROOKER	F	C	D	F	F	F	F	C	F	F	C	C
490250	BROOKER	F	C	D	F	F	F	F	C	F	F	C	C
490260	BROOKER	F	B	F	F	F	F	F	B	F	F	A	C
490270	BROOKER	F	B	F	F	F	F	F	C	F	F	B	C
490280	BROOKER	F	D	F	F	F	F	F	C	F	F	C	D
490290	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
490300	BROOKER	F	D	F	F	F	F	F	D	F	F	D	D
490310	BROOKER	F	C	D	D	D	F	F	C	F	D	C	C
490320	BROOKER	F	C	F	F	F	F	F	C	F	F	C	C
490330	BROOKER	D	D	D	D	D	D	D	D	D	D	D	D
490340	BROOKER	F	D	F	F	F	F	F	C	F	F	C	D
490350	BROOKER	F	D	F	F	F	F	F	D	F	F	D	D
490370	BROOKER	F	B	F	F	F	F	F	B	F	F	A	C
490390	BROOKER	F	C	F	F	F	F	F	B	F	F	A	C
490400	BROOKER	F	B	D	F	F	F	F	B	F	F	A	B
490410	BROOKER	F	B	F	F	F	F	F	B	F	F	A	B
490420	BROOKER	F	A	C	C	C	F	F	A	F	D	A	A
490430	BROOKER	F	C	C	D	C	F	D	C	F	D	C	C
490440	BROOKER	F	C	D	D	D	F	D	C	F	D	C	C
490450	BROOKER	F	B	D	F	F	F	F	B	F	F	A	B
490460	BROOKER	F	B	D	C	C	F	F	C	F	D	C	C
490470	BROOKER	F	B	D	F	D	F	F	B	F	F	B	B
490480	BROOKER	F	C	D	D	D	F	F	C	F	F	C	C

Table 11-2 Subbasin Treatment Level of Service

Subbasin ID	Basin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
490490	BROOKER	F	C	D	D	D	F	F	C	F	D	C	C
490500	BROOKER	F	B	F	F	F	F	F	B	F	F	A	C
490510	BROOKER	F	B	D	F	D	F	F	B	F	F	A	B
490520	BROOKER	F	C	D	F	D	F	F	C	F	F	C	C
490530	BROOKER	F	C	D	D	D	F	F	C	F	D	C	C
490540	BROOKER	F	C	D	F	D	F	F	C	F	F	C	C
490550	BROOKER	F	C	D	D	D	F	F	C	F	D	C	C
490560	BROOKER	F	C	D	D	D	F	F	B	F	F	B	C
490570	BROOKER	F	D	D	D	D	F	F	D	F	D	D	D
490580	BROOKER	F	C	C	D	C	F	D	C	F	D	B	C
490590	BROOKER	F	C	D	F	D	F	F	B	F	F	B	C
490600	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
490610	BROOKER	F	C	C	D	D	D	D	C	F	D	C	C
490620	BROOKER	F	C	D	D	D	F	D	D	F	D	C	C
490630	BROOKER	F	C	D	F	D	F	F	C	F	F	C	D
490640	BROOKER	F	C	D	D	D	F	F	C	F	F	C	C
490650	BROOKER	F	C	D	F	D	F	F	C	F	F	B	C
490660	BROOKER	F	C	F	F	F	F	F	C	F	F	B	C
490670	BROOKER	F	C	C	C	C	D	D	C	F	C	C	C
490680	BROOKER	C	C	D	B	C	C	D	D	D	C	C	C
490690	BROOKER	F	B	C	D	C	F	D	B	F	D	C	B
490700	BROOKER	F	C	F	F	F	F	F	C	F	F	F	D
490710	BROOKER	F	A	B	B	B	C	B	A	D	B	A	A
490720	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
490730	BROOKER	F	B	F	F	F	F	F	B	F	F	A	B
490740	BROOKER	F	A	D	C	D	F	F	B	F	D	A	A
490750	BROOKER	B	A	A	A	A	A	A	A	A	A	A	A
490760	BROOKER	F	A	B	C	B	D	C	A	F	C	A	A
490770	BROOKER	F	A	B	B	B	C	C	A	F	B	A	A
490780	BROOKER	F	C	C	C	C	D	D	C	F	C	C	C
490790	BROOKER	F	C	C	C	C	F	D	A	F	D	F	C
490800	BROOKER	D	A	C	A	B	A	B	C	F	C	B	A
491010	BROOKER	F	A	D	B	D	C	C	C	F	F	B	B
491040	BROOKER	F	B	F	F	F	F	F	C	F	F	B	B
491060	BROOKER	F	B	F	F	F	F	F	B	F	F	A	C
491080	BROOKER	F	B	D	F	F	F	F	B	F	F	A	B
491081	BROOKER	F	B	F	F	F	F	F	B	F	F	B	B
491100	BROOKER	F	C	D	F	D	F	F	B	F	F	B	C
491120	BROOKER	F	C	D	F	F	F	F	C	F	F	C	C
491140	BROOKER	C	A	C	A	C	B	C	C	C	C	B	B
491160	BROOKER	F	D	D	D	D	D	D	D	D	D	D	D
491180	BROOKER	F	C	C	D	C	F	D	C	F	D	B	C
491200	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
491220	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
491240	BROOKER	D	D	D	D	D	D	D	D	D	D	D	D

Table 11-2 Subbasin Treatment Level of Service

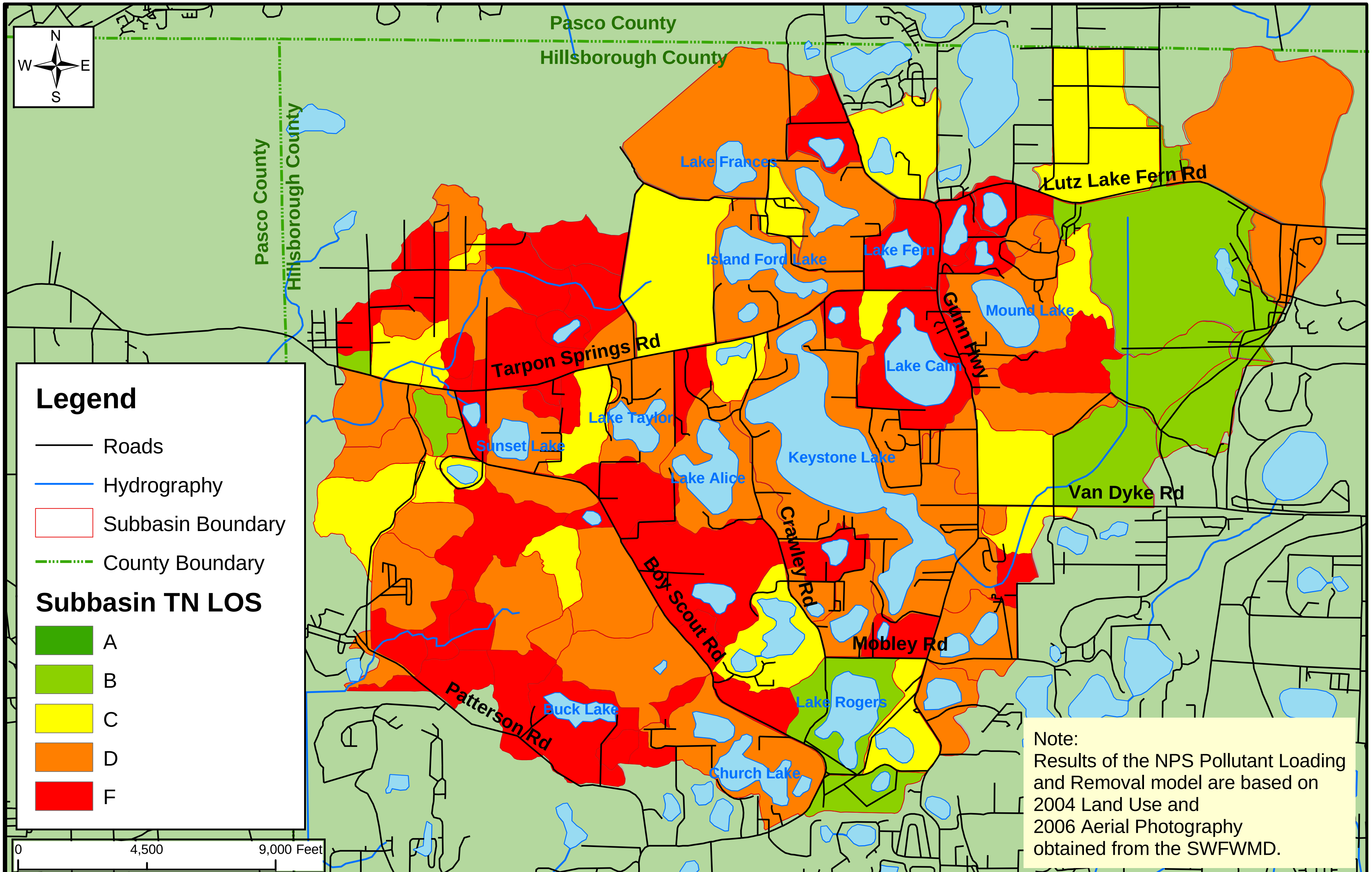
Subbasin ID	Basin ID	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
491260	BROOKER	F	B	D	F	D	F	F	B	F	F	B	C
491280	BROOKER	F	B	D	D	D	F	F	B	F	D	A	B
491300	BROOKER	F	B	D	D	D	F	F	B	F	F	B	B
491320	BROOKER	F	D	D	F	D	F	F	D	F	F	D	D
491340	BROOKER	F	B	D	F	F	F	F	B	F	F	B	C
491360	BROOKER	F	C	F	F	F	F	F	B	F	F	A	C
491380	BROOKER	F	B	F	F	F	F	F	B	F	F	A	C
491400	BROOKER	F	D	F	F	F	F	F	C	F	F	C	D
491420	BROOKER	F	C	D	D	D	F	F	C	F	F	C	C
491440	BROOKER	F	C	C	C	C	D	C	C	F	C	C	C
491460	BROOKER	F	C	F	F	F	F	F	C	F	F	C	C
491480	BROOKER	F	C	F	F	F	F	F	B	F	F	B	C
491500	BROOKER	F	B	C	D	C	F	D	B	F	D	B	C
491520	BROOKER	F	C	F	F	F	F	F	C	F	F	C	D
491540	BROOKER	F	C	F	F	F	F	F	C	F	F	B	C
491560	BROOKER	F	B	B	C	B	C	C	A	F	C	A	B
491580	BROOKER	B	A	A	A	A	A	A	A	A	A	A	A
491600	BROOKER	C	B	B	B	B	B	B	B	B	B	B	B
491620	BROOKER	F	C	D	D	D	F	F	B	F	F	B	C



Water Quality Treatment Level of Service by Subbasin for Brooker Creek Watershed: TSS

Figure 11-1

AYRES ASSOCIATES



Water Quality Treatment Level of Service by Subbasin for Brooker Creek Watershed: TN

Figure 11-2

AYRES ASSOCIATES

The remaining subbasins with low scores were primarily dominated by agriculture and/or low density residential land uses. The distribution of poor scores was consistent with total nitrogen loading calculations for representative stations based on actual concentration and discharge data described in Chapter 7.

Total Phosphorus

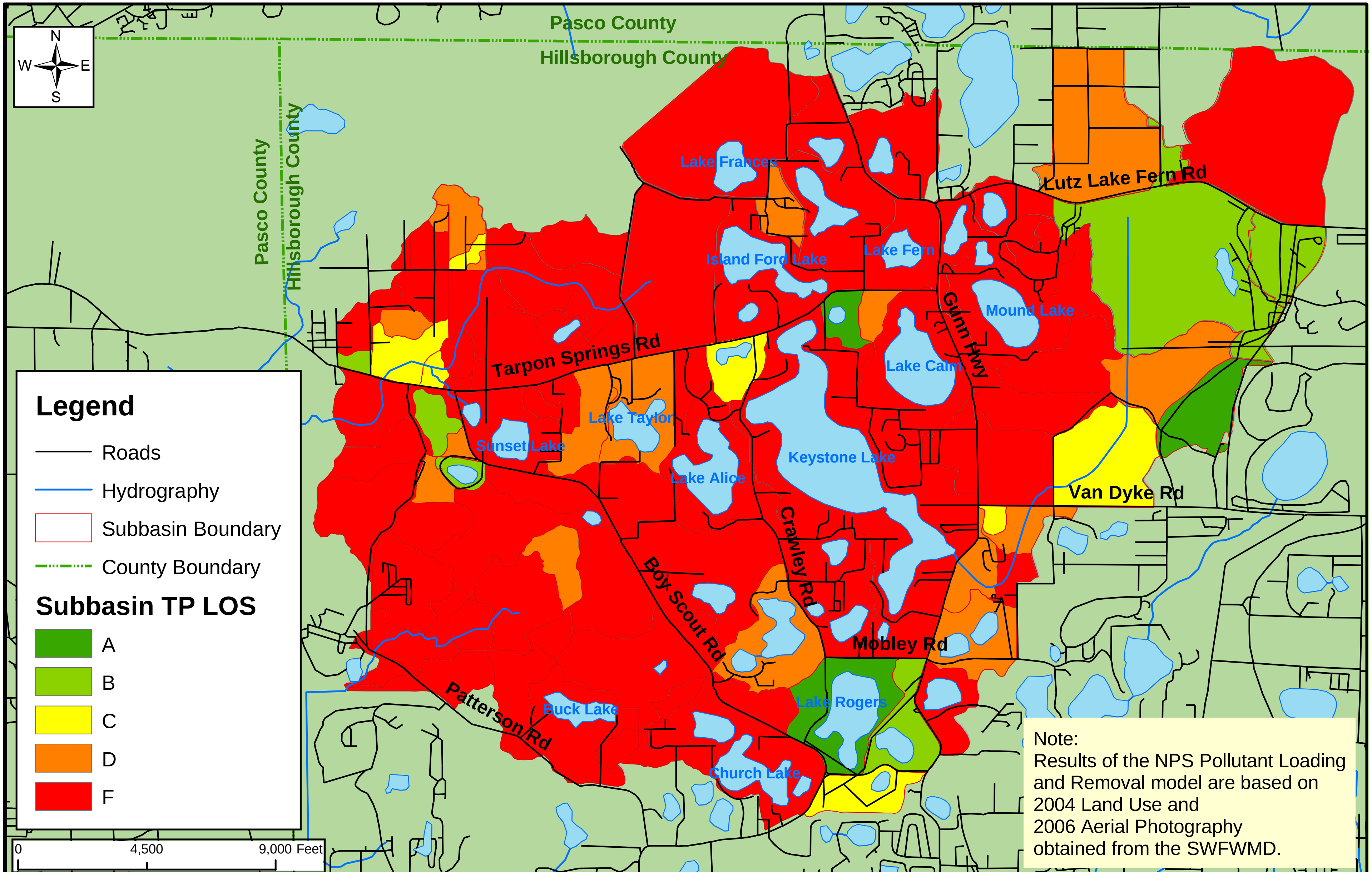
The only subbasins containing concentration of A LOS scores for total phosphorus are located in the eastern portion of the watershed, as well as the southern portion of the Brooker Creek watershed (subbasin containing Lake Rogers) (Figure 11-3). These areas are almost entirely comprised of forested wetlands, upland forest or open land. A few scattered subbasins with LOS scores of B are located in the south and to the west of the watershed (subbasins containing Breckenridge Lake and Garden Lake). These subbasins include water and low density residential lands. The remaining areas were dominated by F scores due to the presence of either agricultural or high-density residential land uses.

Overall Water Quality

The overall LOS score for the entire watershed is a D (using an average score for all parameters combined). The greatest concentration of D and F scores for total nitrogen, total phosphorus, and TSS, was located in the central region of the watershed primarily surrounding the Keystone Lake, as well as nearby residential areas. These areas are predominantly comprised of various density residential and agricultural uses. These land uses contribute large quantities of various pollutants into surface water bodies. The overall low LOS score for the entire watershed (D) indicates that many subbasins surrounding large areas of contiguous remnant natural systems have been developed to some degree, resulting in low LOS scores for seemingly large undeveloped subwatershed.

Unless appropriate treatment measures are implemented, continued loading to surface waters in the watershed, eventually, into Old Tampa Bay may result in significant water quality degradation in the future. Efforts to reduce loading of pollutants to the Brooker Creek and its tributaries, lakes, sinkholes, and groundwater should be incorporated into future management activities for the watershed. Future efforts to reduce pollutant loading may include: implementation of local and regional stormwater best management practices (BMPs - wet detention ponds, baffle boxes, alum treatment, etc.), low impact development, source reduction (e.g., education programs for home and business owners to reduce fertilizers and illicit discharges), improved wastewater treatment practices (extending centralized sewer systems to areas treated by on-site disposal systems or septic tanks), and restoration/conservation of natural lands and riparian buffer areas to reduce current and future pollutant loads.

In order to determine the magnitude of pollutant load reduction needed to achieve an LOS score of A, differences between net loads (from Chapter 10) and benchmark loads that would result in an LOS score of A were calculated (Table 11-3). It was observed that average reductions of pollutants would need to be very high (>72%) for all 12 parameters to achieve A scores.



Water Quality Treatment Level of Service by Subbasin for Brooker Creek Watershed: TP

Figure 11-3

AYRES ASSOCIATES

Considering the removal efficiencies of the available stormwater BMPs, achieving these goals would require an extremely aggressive implementation program. In some cases, it may not even be possible to achieve the extent of reduction needed if the options are limited to the BMPs considered in this model. For example, the Brooker Creek watershed exhibited low LOS scores for total nitrogen. Figure 11-4 compares the percent reduction of TN loading in the Brooker Creek watershed necessary to achieve an LOS score of A with the removal efficiencies of various BMPs. The load reduction required to achieve an LOS score of A in this subwatershed is over 74%. Only with the best BMP available in the model for total nitrogen (percolation), such reduction can theoretically be achieved. For some individual subbasins, the load reduction required to achieve an LOS score of A is over 80%. This means that if all of the runoff in those subbasins were treated through percolation ponds, only 80% reduction in loading would be realized as opposed to the higher percent reduction that would be necessary to achieve an LOS A designation.

Table 11-3 Estimated Pollutant Loads (lbs/year/acre) and Percent Reductions Needed to Equal LOS A Loads for Brooker Creek Watershed

	BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
Benchmark Loads	3.94	74.87	4.26	1.11	5.37	1.58	1.11	4.26	0.00	0.05	0.03	0.09
Allowable Load to Achieve LOS A	0.78	14.90	0.85	0.22	1.07	0.31	0.22	0.85	0.00	0.01	0.01	0.02
Net Loads Based on Existing Land Use and Treatment	17.48	29.74	3.14	0.97	4.09	2.42	1.36	1.54	0.01	0.05	0.01	0.04
Percent Reduction Required to Achieve LOS A	96%	50%	73%	77%	74%	87%	84%	45%	94%	80%	56%	53%
Load Reduction Required to Achieve LOS A	**16.69**	**14.84**	**2.29**	**0.75**	**3.02**	**2.10**	**1.14**	**0.69**	**0.01**	**0.04**	**0.01**	**0.02**

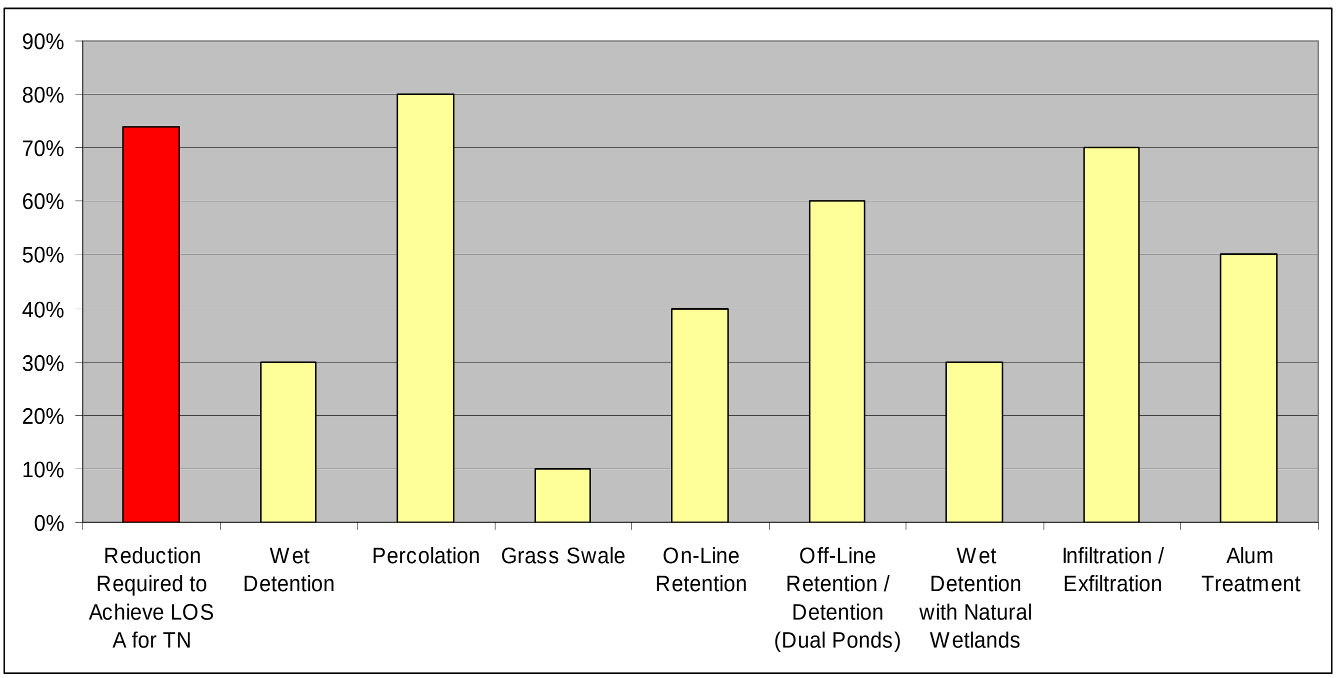
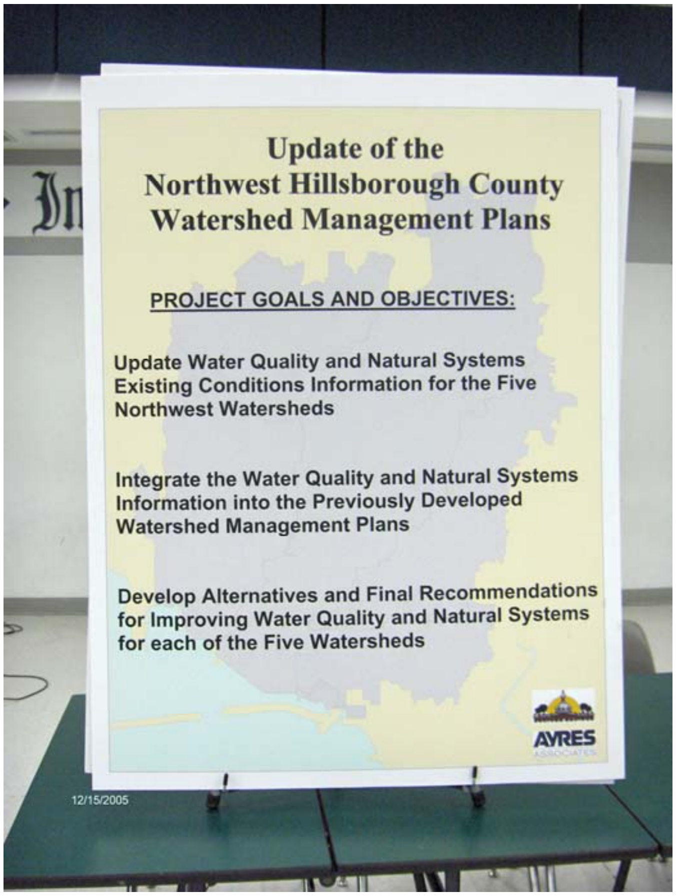


Figure 11-4 Comparison of the Reduction required to achieve an LOS A Designation for the Watershed with the Removal Efficiencies of Various Best Management Practices for TN

CHAPTER 12: PUBLIC MEETING

The first public meeting was held on December 14, 2005 at Sickles High School (Hillsborough County, Florida). The meeting began at approximately 6:30 p.m. and ended at approximately 8:30 p.m. EDT.



A handout containing the project description, project history, and a list of project contacts was made available to the public (Appendix 12-1), along with comment forms.

The format of the public meeting was relatively informal and was conducted for the purposes of sharing information about the project and providing the public with information about the state of water quality in the Brooker Creek, Double Branch, Rocky/Brushy Creek, Sweetwater, and Lower Sweetwater watersheds. The meeting agenda included the following topics:

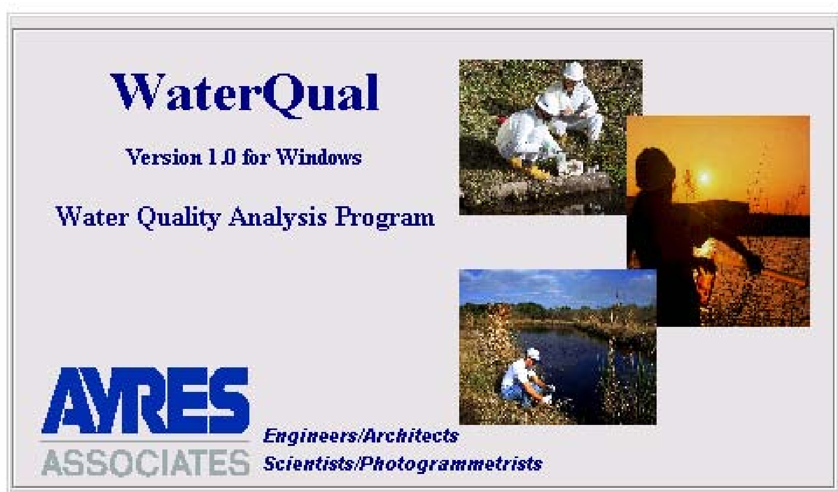
- Introduction
- Goals and objectives of the project
- Description and purpose of the project
- Brief description of other similar projects currently conducted in the area
- Description of the current state of water quality within the project area.
- Questions and answers
- Answering individual questions at the stations.

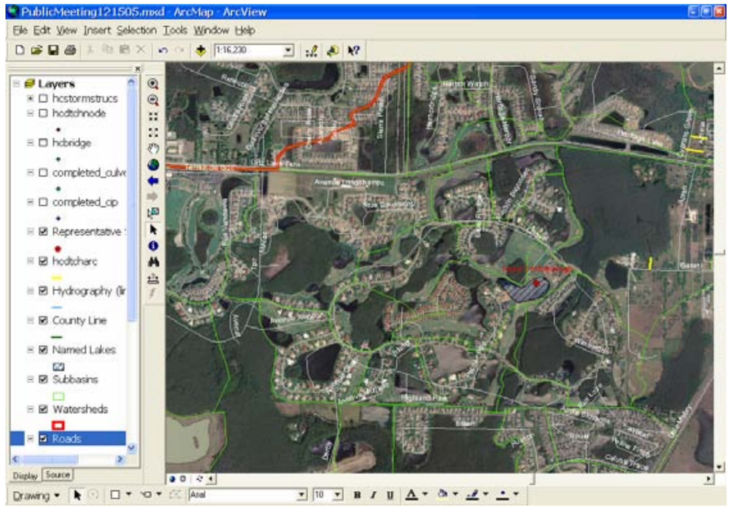
The first portion of the meeting was in the form of a speech, which helped acquaint the local residents with the water quality state of their watersheds and the objectives of the project. A number of poster-sized maps were positioned around the room.

They included:

- Goals and objectives of the project.
- Detailed location map of the project area.
- Aerial photography map of the project area.
- Brooker Creek watershed: location of selected water quality sampling stations and TSI and dissolved oxygen concentration graphs for those locations.
- Double Branch watershed: location of selected water quality sampling stations and TSI and dissolved oxygen concentration graphs for those locations.
- Rocky/Brushy Creek watershed: location of selected water quality sampling stations and TSI and dissolved oxygen concentration graphs for those locations.
- Sweetwater Creek watershed: location of selected water quality sampling stations and TSI and dissolved oxygen concentration graphs for those locations.
- Lower Sweetwater Creek watershed: location of selected water quality sampling stations and TSI and dissolved oxygen concentration graphs for those locations.

Two laptops with GIS capabilities were connected to projectors. One of them contained a GIS database with the following data layers: aerial photography, land use (1999), ELAPP, watershed and subbasin boundary, lakes, water quality stations, CIPs, culverts, and bridge locations. Knowing the name of a lake or a street intersection, an interested resident could obtain a variety of information about a specific area of concern. The second laptop was geared with the WaterQual, a software capable of quickly analyzing and graphically presenting water quality data for different contaminants. By obtaining the name of a water quality station from either the GIS database or one of the posters, an interested resident had an ability to view various historical and recent water quality data trends for a specific location.





Following the Hillsborough County personnel presentation regarding the general description of the project, as well as the state of water quality in the aforementioned watersheds, the floor was opened for questions. The residents of the area asked a number of interesting questions regarding various concerns. One participant asked about the impacts of leaking septic systems on water quality in the watershed. She also requested additional information regarding the preventive maintenance of her septic system that could prevent bacteria from entering ground and surface waters. Another resident requested additional description of the TMDL process. Other questions were pointing at the sufficiency of existing regulations for accidental or deliberate release of chemicals.

After the question and answer session, residents were encouraged to look at the posters and utilize the laptop stations that presented additional information about water quality in the area. Hillsborough County and Ayres Associates staff assumed positions at different stations around the room and spent the next hour answering individual questions of the meeting participants.

For further information about the state of the watershed, the public was encouraged to visit the Hillsborough County Watershed Atlas website at: http://www.hillsborough.wateratlas.usf.edu.

Hillsborough County
Florida

Office of the County Administrator
Patricia G. Bean

Update of the Northwest Hillsborough County Watershed Management Plans CIP 48515

Presented by
Your Stormwater Management Section

December 15, 2005, 6:30 p.m. at Sickles High School

Project Manager:	**David Glicksberg, P.G.**
Project Design Engineer:	**Hamid Bojd, Ph.D., P.E.**
Meeting Secretary:	**Pate Lavacca**
Transportation Maintenance:	**Andy Morris (West Unit)**
Moderator:	**Martin Montalvo**

Introduction:

County staff will be presenting information relative to this project and receiving community input. In order to convey the information in an efficient manner and maximize the use of your time, it is respectfully requested that all questions and comments be held until the end of the presentation. Everyone will have a chance to be heard. We will gladly stay as late as it takes to answer your questions and hear all your comments. Please write down your comments as we go along. At the end of our presentation ample time will be available to answer any questions and receive comments and suggestions

This document, the meeting summary, provides a brief history of the project and what the goals of this meeting are. Included with this handout are two additional documents. These documents are the Glossary and List of Abbreviations and the Proposed Projects Comment Sheet. The Glossary and List of Abbreviations has been provided in order to define and alleviate any confusion that may be involved with the use of technical and scientific terms. If any term should arise that has not been listed within this document, please do not hesitate to ask us to clarify. The Proposed Project Comment Sheet allows you, the citizen, to provide feedback regarding the project that will be presented here this evening.

Project History:

Hillsborough County Stormwater Management Section had previously conducted watershed plans for each of the watersheds within the northwest portion of the county. These watersheds include Brooker Creek, Double Branch, Rocky / Brushy Creek, Sweetwater Creek and Lower Sweetwater Creek. This first generation of watershed plans focused primarily on flooding and stormwater conveyance. Since these first generation plans were completed in 2000, the County has made strides to incorporate both water quality and natural systems into the next generation of watershed plans. These new plans both account for the existing water quality conditions but also account for and inventory any natural areas within each watershed.

Funding Source:

This project is funded as part of the Capital Improvement Program (CIP). This funding is collected with your real estate taxes as a stormwater fee and transferred into the CIP fund. The total budget for this project is $356,000.00 with $150,000 from the Southwest Florida Water Management District.

Project Description:

This project will incorporate the previously completed engineering portions of the watershed plans for Brooker Creek, Double Branch, Rocky / Brushy Creek, Sweetwater Creek and Lower Sweetwater Creek with the existing water quality and natural systems data. These new unified plans will then use the information gathered to develop recommended projects within each of the watersheds to address any deficiencies that are identified.

Important County Phone Numbers:

Community Relations Coordinator:	(813) 272-5275
Planning and Growth Management:	(813) 272-5920
Public Works/Engineering Division:	(813) 272-5912
Transportation Maintenance: West Service Unit:	(813) 554-5006
Stormwater Management Section:	(813) 272-5912
SWFWMD (Brooksville HQ)	(800) 423-1476
SWFWMD (Tampa Regulatory Office)	(813) 985-7481
Water Resource Team:	(813) 301-7206

THANKS FOR HELPING US SERVE YOU BETTER
Your Stormwater Management Section

GLOSSARY AND LIST OF ABBREVIATIONS

Aquifer – An underground source of water that contains enough saturated, permeable material (usually sand or limestone) to allow water to flow through it

Basin - An area in which water collects and pools for an extended period of time during a rain event

Berm - An edge or shoulder running alongside a road, canal, etc.

Bloom - Generally refers to a sudden increase in algae or other micro-organisms due to favorable growth conditions, such as high level of nutrients or suitable temperature.

Box Culvert – A man made structure, typically box shaped and open on two ends, designed to convey stormwater runoff.

Canal – An artificial or natural waterway or improved channel designed for conveying stormwater runoff.

Catch Basin - Inlet structure that is usually built at the curb line of a street which permits surface water runoff to flow into a storm sewer while retaining grit and debris below the invert elevations of the storm sewer pipes.

CCMP - Comprehensive Conservation and Management Plan for Tampa Bay by the National Estuary Program

Closed basin - A water basin which has no outfall

Confining layer - Impervious or low permeability layers generally found above and below an aquifer, these are usually limestone or clay or a mixture of both

Control structure – A structure or device designed to control water elevation by allowing water to released for the system when a designed water elevation is achieved

Cross drain – A pipe running perpendicular beneath a road

Crown - The top end elevation of a pipe or road

Culvert - A strategically placed pipe used to direct water from one point to another

CWA - Clean Water Act (United States)

CWM - Comprehensive Watershed Management Plan; implemented by SWFWMD

DCW - Delaney Creek Watershed

DEP - Department of Environmental Protection (Florida)

Detention area – An area designed to retain water only for a certain level or time, in which provides temporary storage and water quality treatment, i.e. a swale, ditch or pond

Discharge – The volume of water that passes a given location within a given period of time. Usually expressed in cubic feet per second

Ditch - A long narrow excavation made in the ground for the purpose of drainage or irrigation; the sides of a ditch are generally steeper than a swale

DOM - Dissolved Organic Matter

DRI - Development of Regional Impact

Driveway culvert – Driveway culverts or pipes, are normally placed in an open drainage system to gain access to a residence or place of business. In accordance with Ordinance No. 84-05, the property owner is responsible for the repair and replacement of the pipe and the culvert. The county will clean the pipe and maintain flow.

Ecosystem - An inter-related group of plants and animals that are distinct

ELAPP – Environmental Lands Acquisition and Protection Program; a program within Hillsborough County to purchase and restore environmentally sensitive lands.

End treatment – A structure located at one or both ends of a pipe system to provide structural support and prevent erosion

EPA - Environmental Protection Agency of the United States

EPC - Environmental Protection Commission of Hillsborough County

Exotic Species - A plant or animal that does not naturally occur in Hillsborough County and is generally introduced by man either on purpose or inadvertently

FAC - Florida Administrative Codes

Fecal Coliform & Total Coliform Total coliform are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm- and cold-blooded animals. They aid in the digestion of food. A specific subgroup of this collection is the fecal coliform bacteria, the most common member being *Escherichia coli* (*E. coli*). These organisms may be separated from the total coliform group by their ability to grow at elevated temperatures and are associated only with the fecal material of warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material.

FEMA- Federal Emergency Management Agency; an independent agency reporting to the President and tasked with responding to, planning for, recovering from and mitigating against disaster

Fragmentation - The carving up of an ecosystem into smaller pieces or fragments that usually can not provide all the advantages of the original larger system

GIS - Geographical Information Systems

Groundwater - Water, below the water table, that fills all the open areas of the underlying material

Headwall – A perpendicular end treatment for a stormwater pipe system

Herbaceous - A plant that contains no woody parts or a plant community that contains no woody trees or shrubs

Hydric soil - A soil that is saturated, flooded or ponded long enough during the growing season to develop conditions that favor the growth of wetland (hydrophytic) vegetation.

Hydrology - The study of the occurrence, distribution, and chemistry of all waters of the earth

Hydroperiod – The duration and time in which an area is inundate with water

Impervious - A material, such as concrete or asphalt, that does not allow water (or air or roots) to naturally penetrate into the soil

Inlet – Entry or collection point of water into a basin

Invert - The bottom end elevation of a pipe

Karst Geology - An area underlain by limestone which has dissolved to some degree and forms a depression, sinkhole or small basin

Lake - Relatively large bodies of natural or man-made standing water in which open water areas predominate over shallow vegetated areas.

Laterals - A pipe that extends from a main trunk line to carry stormwater from adjacent areas

LDC - Land Development Code for Hillsborough County

Listed Species - Plant or animal species that are designated (listed) as endangered, threatened or species of special concern by the federal and/or state government and therefore receive special protection under the law

Littoral Shelf - The ledge, usually in a lake, where the water level is shallow enough to allow the growth of either emergent or submerged plants

LOS - (Level of Service) The flood level designations contained within a Comprehensive Plan with A being the highest level and D being the lowest.

Level	HC Comprehensive Plan Definitions	Master Plan Interpretations
A	No significant street flooding	No flooding
B	No major residential yard flooding	Street flooding is 3" or more above the crown
C	No significant structure flooding	Site flooding is 6" or more
D	No limitation on flooding	Structure flooding

MFL - Minimum Flows and Levels

mg - Milligram or one-thousandth of a gram (1×10^{-4})

Mitigation area – Mitigation is an action or series of actions to offset the adverse impacts that would otherwise cause a regulated to fail to meet the criteria set forth in the Environmental Resource Permit. Mitigation consists of restoration, enhancement, creation, preservation, or a combination thereof of wetlands and upland plantings.

NEP - National Estuary Program of Tampa Bay

NGVD - National Geodetic Vertical Datum; a standardized method of measuring elevation

Non-point source pollution - Diffuse pollution that enters from multiple, rather than single sources and cannot be easily traced, such as acid rain or runoff from paved roads that carry oil and other pollutants

NPDES - National Pollutant Discharge Elimination System; A federal program for improving national water quality

Nuisance Species - Generally referring to plants; a plant that is native or naturally occurring in Hillsborough County but which is highly invasive or otherwise disruptive to natural communities

Nuisance Standing Water – Water that is less than 5 inches that may be an inconvenience to the property owner but not a threat to the property or person. This water may dissipate within 72 hours if the water table is not involved.

Open basin – A water basin which has one or more outfalls

Outfall – The place where a sewer, drain, or stream discharges; the outlet or structure through which reclaimed water or treated effluent is finally discharged to a receiving waterbody.

Percolation – The movement of water through the openings in rock or soil; the entrance of a portion of a stream flow into the channel materials to contribute to ground water replenishment

Permeability - The ability or rate at which water or other liquids can pass through something, such as water passing through various layers of soil

Point source discharge - Pollution originating from a specific area and usually discharged by an outfall pipe as from an industrial area or a stormwater drain from a roadside

Pop-off - a mechanism or device to release excess water from system after it has achieved a specified level or pressure, to pre-designed area or receiving body

Pond – Natural or man made bodies of water having defined boundaries and which can function to control, retain and convey stormwater runoff.

Receiving Body- The downstream waterbody that gets water from another contributing waterbody, i.e. Tampa Bay is the receiving body for the Hillsborough River

Retention area – An area designed to permanently contain stormwater, i.e. pond or lake

Roadside Ditch – A man-made conveyance to provide, during major/minor stormwater runoff events, temporary storage and conveyance of stormwater from associated roadway and adjacent properties.

SCS - United States Soil Conservation Service; now known as the Natural Resource Conservation Service (NRCS)

Seasonal High Groundwater Elevation -The elevation to which the groundwater can be expected to rise during a normal wet season.

Skimmer – A device that skims floating debris and oil from water before it discharges into the receiving water.

Storm Sewer – A collection of inlets, junction boxes and underground culverts or pipes that form a complete system to collect and convey water from several points to an outfall point.

Stormwater Runoff - Water that begins as rain or irrigation that flows over land; as a general rule as the water picks up nutrients, sediments and other chemical during this overland flow.

Swale – A low place in a tract of land; a valley like intersection of two slopes on a piece of land; the sides of swale are generally less steep than a ditch

SWIFTMUD or SWFWMD - Southwest Florida Water Management District; The state designated water management district responsible for regulating this regions water resources

TMDL - Total Maximum Daily Load, the sum of allowable discharges that can enter a water body or water shed area and includes point and non-point sources as well as a margin of safety.

Topography – The detailed mapping or charting of the features of an area (the lay of the land)

Tributaries – A stream contributing its flow to a larger stream or other body of water

TSI - Trophic State Index, a measure of water quality using total phosphorus concentration, chlorophyll concentration, nitrogen concentration and alternately Secchi Disk depth

TSS - Total suspended solids or the amount of particles in a unit of water

ug - Microgram or one millionth of a gram (1×10^{-6} gram)

USGS - United States Geological Service

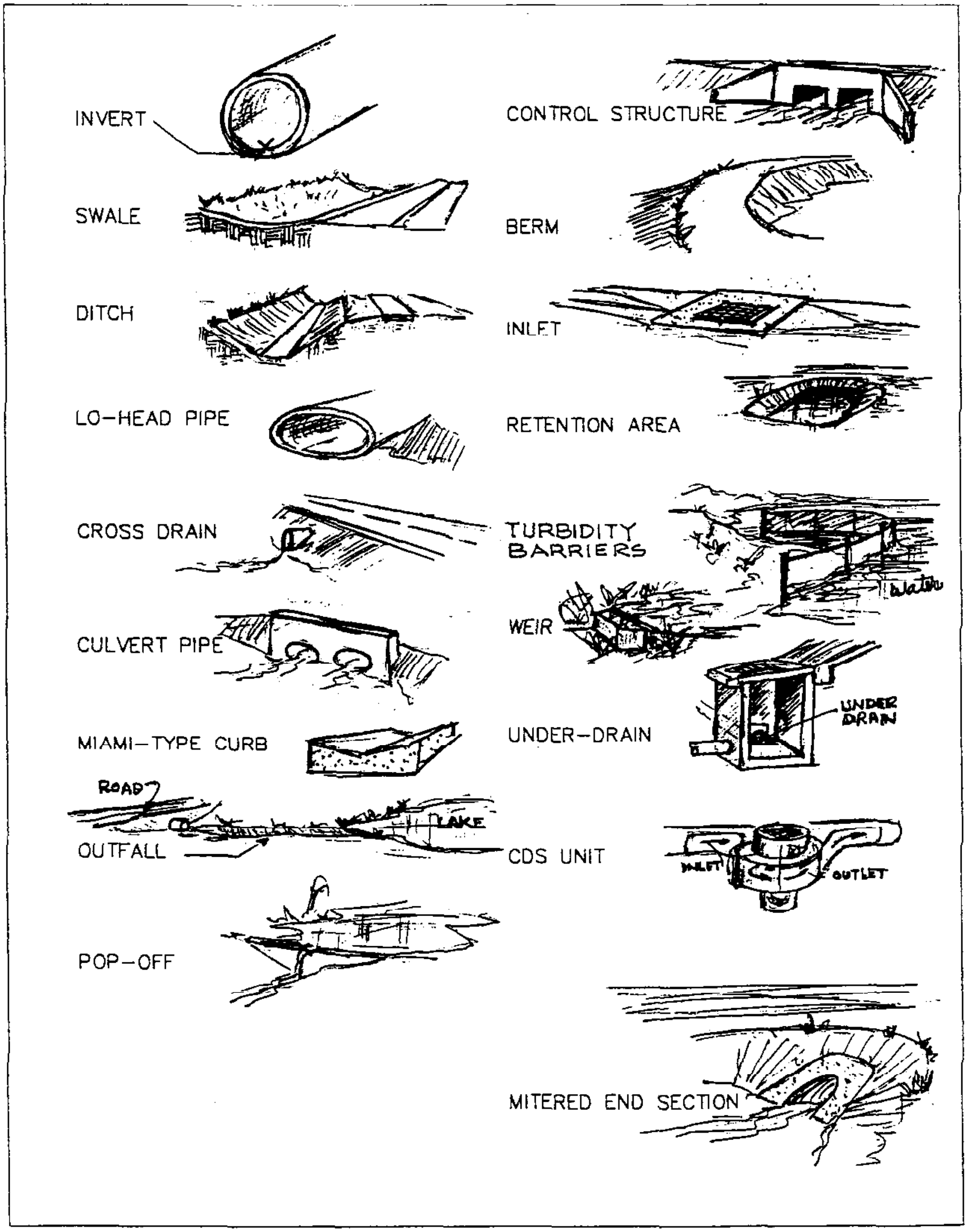
Water Control Structure – A man made device constructed of concrete, steel, earth, etc. Some have weir openings, skimmers, and small orifices for runoff or drain down. Others are much larger with a number of gates that open and close to control water flow.

Watershed – The land area that drains water to a particular stream, river, or lake.

Weir – A small dam in a river or stream; an obstruction placed across a stream to cause the water to pass through a particular opening

Wetland – Those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils.

WQI - Water Quality Index; a system of summarizing water quality of a stream using the parameters of water clarity, dissolved oxygen, oxygen-demanding substances, bacteria, nutrients and biological diversity.


INVERT
CONTROL STRUCTURE
SWALE
BERM
DITCH
INLET
LO-HEAD PIPE
RETENTION AREA
CROSS DRAIN
TURBIDITY BARRIERS
water
CULVERT PIPE
WEIR
MIAMI-TYPE CURB
UNDER-DRAIN
UNDER DRAIN
ROAD
LAKE
OUTFALL
CDS UNIT
INLET
OUTLET
POP-OFF
MITERED END SECTION

CHAPTER 13: IDENTIFICATION OF POTENTIAL SOURCES OF CONTAMINATION

13.1 Overview

This chapter describes the potential sources of contamination within the Brooker Creek watershed. Identifying sources of contamination for the area will facilitate prioritization of water quality improvement alternatives for the Brooker Creek watershed.

13.1.1 Dairy Farms

Dairy farming is an important part of Florida's agricultural industry. Milk and cattle sales from dairies contributed about $459 million to Florida's economy in 2001, about $45 million more than in 2000 (Geisy et al., 2003). However, some elements of today's agriculture, such as dairy farms tend to contribute large amounts of nutrients (primarily nitrogen and phosphorus) into the environment.

According to the US EPA, agriculture was reported to be the most common pollutant of rivers and streams. Nutrients were identified to be among the five leading pollutants causing water quality impairments in lakes, streams, and estuaries of the U.S. (US EPA, 2002).

While searching for potential sources of nutrients in the Brooker Creek watershed, we analyzed the existence and locations of dairy farms in the watershed. Eight dairy farm related facilities have been identified in the vicinity of Hillsborough County; however, none were located within the proximity to Brooker Creek watershed.

Figure 13-1 shows a map of the Tampa Bay area designating dairy farms in the area. Table 13-1 shows the corresponding numbers from the map which gives the names and addresses of these dairy farms.

While agriculture may still be a major contributor of nutrient pollution in the watershed and will be discussed in more detail in the next section of this chapter, dairy farms were not identified as major sources of pollution in the Brooker Creek watershed.

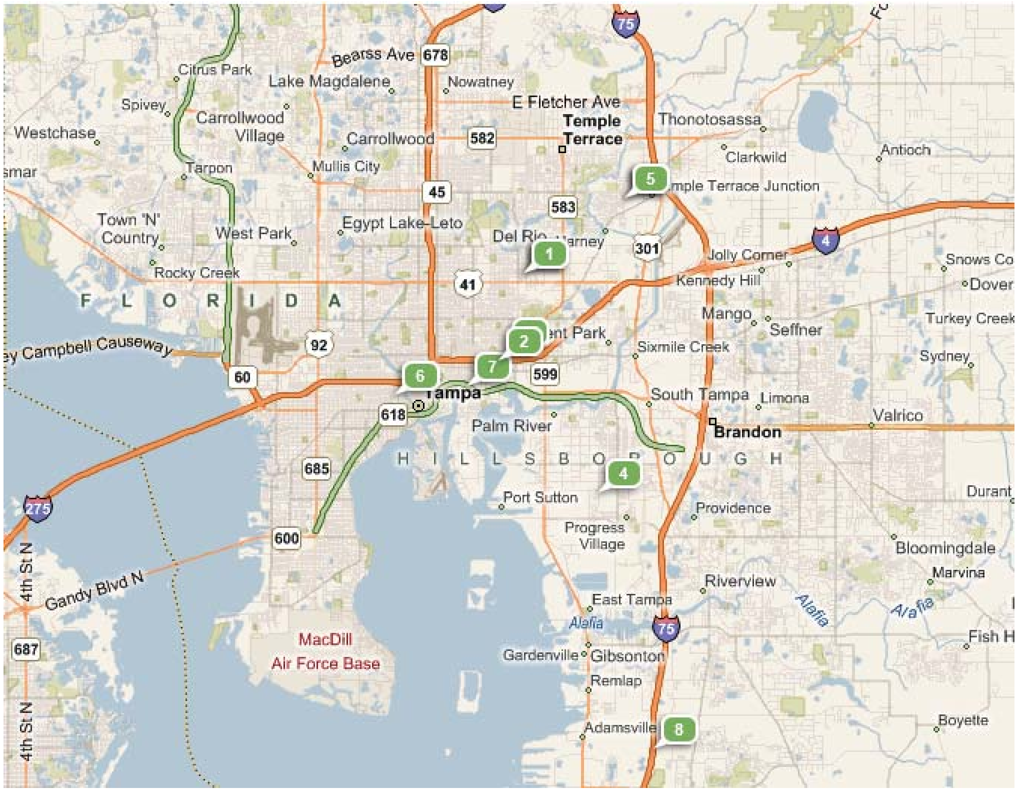


Figure 13-1 Location Map of Dairy Farms Located in the Tampa Bay Area

Table 13-1 Dairy Farm Name and Address from Location Map

1	Sweetheart Dairy & Foods	5610 North 50th Street Tampa, FL 33610
2	Sunny Florida Dairy Inc	2209 North 40th Street Tampa, FL 33605
3	TG Lee Foods	4219 E 19th Avenue Tampa, FL 33605
4	Tower Dairy No 1	4221 78th Street South Tampa, FL 33619
5	Gustafson Dairy	8601 Harney Road Tampa, FL 33637
6	Sunny Florida Dairy	Adamo Drive and N 28th Street Tampa, FL 33605
7	Aprile Farms	11513 Balm Riverview Road Tampa, FL 33602
8	Aprile Farms	9914 Cowley Road Tampa, FL 33602

13.1.2 High Pollutant Contributor Land Use Types

Brooker Creek watershed exhibits extremely high concentrations of a number of different pollutants, such as total nitrogen, total phosphorus, and total suspended solids.

The highest contributor of total nitrogen appears to be Highway/Utility land use category, following by Agricultural, Commercial, High Density Residential, Institutional, and Light Industrial land use types.

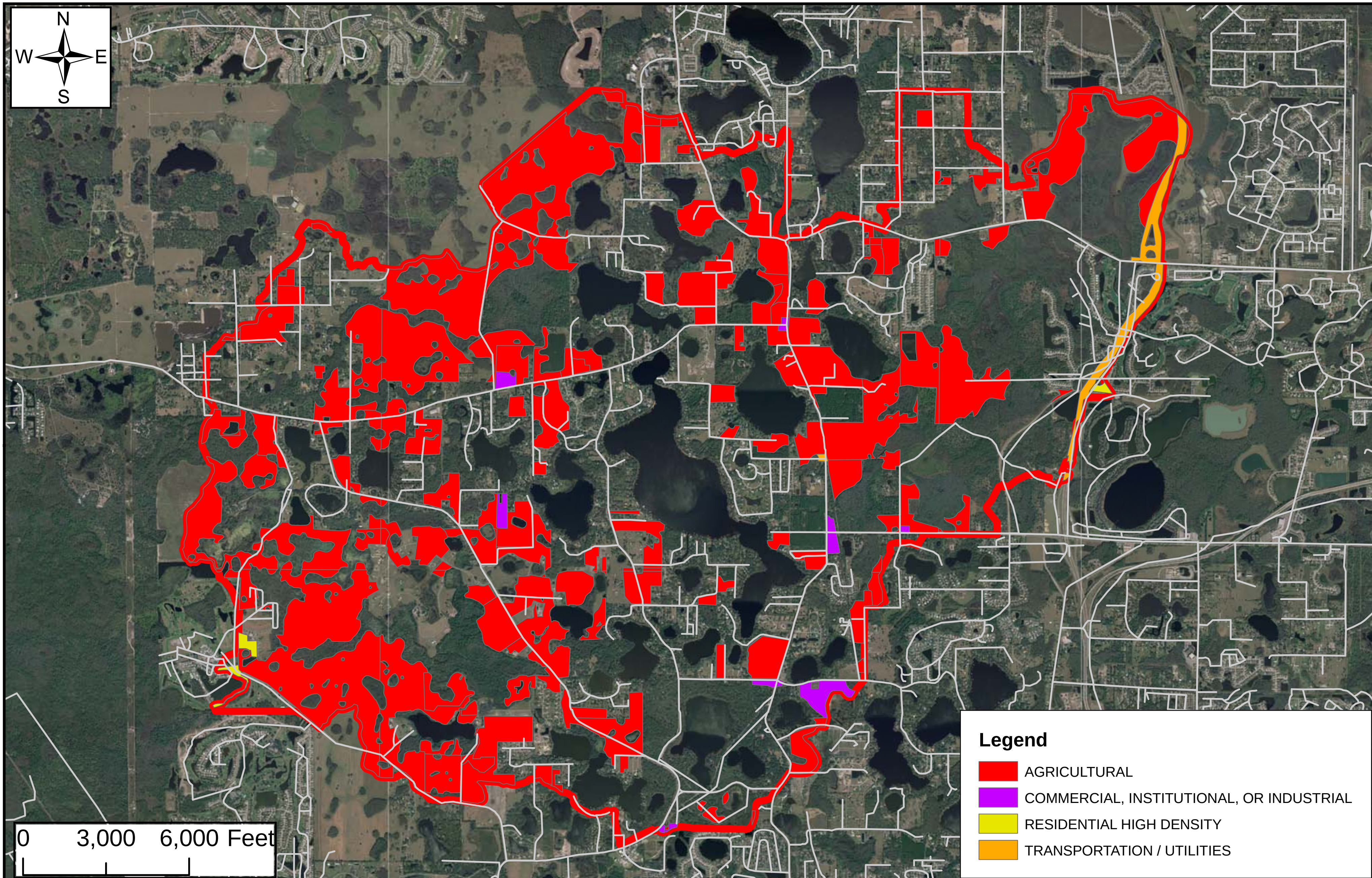
The highest contributors of total phosphorus are Agricultural and High Density Residential, while contribution of total suspended solids seems to depend largely on the presence of Highway/Utilities land use category.

This information is summarized in Table 13-2.

Table 13-2 High Pollutant Contributor Land Use Types per Individual Pollutants

	Total Nitrogen	Total Phosphorus	Total Suspended Solids
Highway/Utility	X		X
Agricultural	X	X	
Commercial	X		
High Den. Residential	X	X	
Institutional	X		
Light Industrial	X		

Figure 13-2 shows the distribution of high pollutant contributor land use types in the Brooker Creek watershed. It is evident from Figure 13-2 that the dominating high-pollutant contributor land use type for this watershed is agriculture. Large agricultural parcels are located around the entire watershed. The eastern part of the Brooker Creek watershed contains an area designated as transportation/utilities, while the center and western parts of the watershed contain small high-density residential and up-built (commercial, institutional, or industrial) land use types. In addition to agriculture, this watershed contains some wetlands or natural land uses.



High Pollutant Contributor Land Use Types in the Brooker Creek Watershed

Figure 13-2

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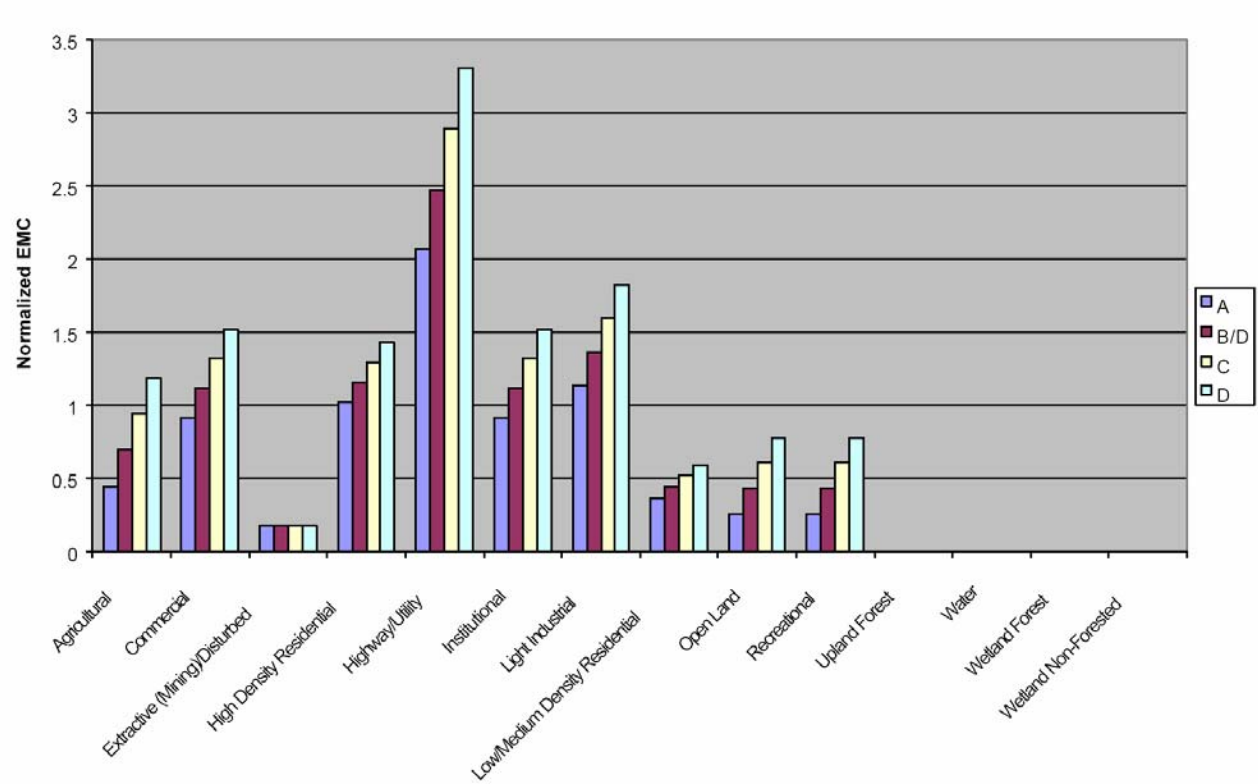
Total Nitrogen



Total Nitrogen Loading Potential by Land Use and Hydrologic Group

As evident from the bar graph above, which shows the total nitrogen loading potential by various land use types and hydrologic groups, the majority of total nitrogen is contributed by the Highway/Utilities land use category. Other significant TN contributors include up-built land use categories, such as commercial, high-density residential, institutional, and light industrial, as well as agricultural land use types.

Figure 13-3 shows the visual correlation between land use types and high concentrations of total nitrogen in the watershed. When comparing the TN LOS map with the land use distribution map, it is evident that subbasins containing high concentrations of total nitrogen correlate with the distribution of agricultural land use in the watershed. Such subbasins occur throughout the central and western parts of the Brooker Creek watershed.

Eastern and southern parts of the watershed exhibit low concentrations of TN, which is to be expected, because those areas are dominated by various natural land use types, such as upland forests, wetlands, and lakes.

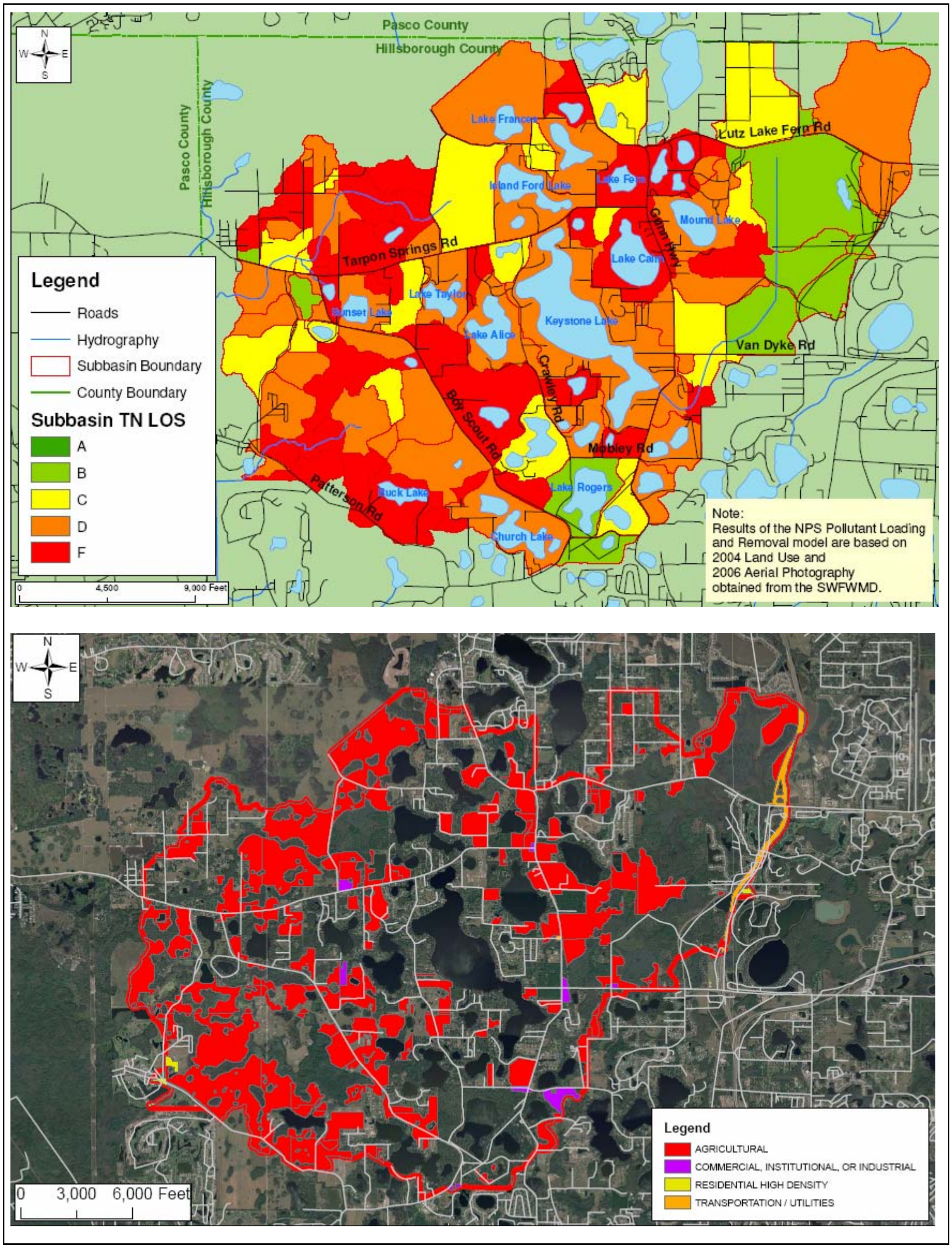
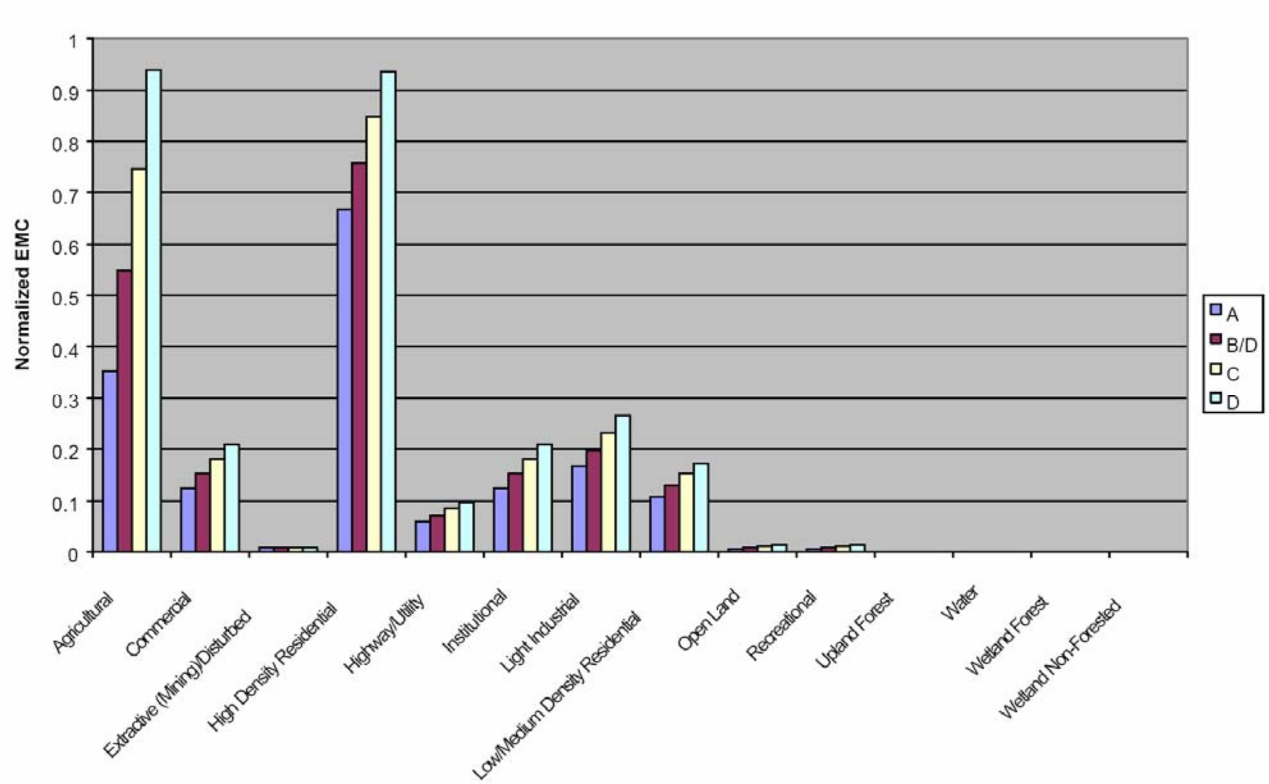


Figure 13-3 Visual Correlation between Land Use and High Concentrations of TN

Total Phosphorus



Total Phosphorus Loading Potential by Land Use and Hydrologic Group

In contrast to total nitrogen concentrations, total phosphorus seems to be high throughout the entire watershed. While TN is largely contributed by highway utilities, which is not one of the major land uses in the watershed, concentrations of TP are related to the agriculture and high density residential land uses in the watershed (see bar graph above).

When comparing the map of the total phosphorus level of service to the land use distribution map, the pattern is evident (Figure 13-4). Concentrations of total phosphorus are high throughout the entire watershed with the exception of large two parcels to the west and large two parcels to the south of the watershed. The few areas exhibiting low TP concentrations are dominated by lakes, wetlands, upland forest, and other naturally occurring land use types that do not contribute much TP. In contrast, the rest of the watershed is dominated by agriculture and various types of up-built land uses. According to the bar graph above, those are the land use categories that contribute TP into the Brooker Creek watershed.

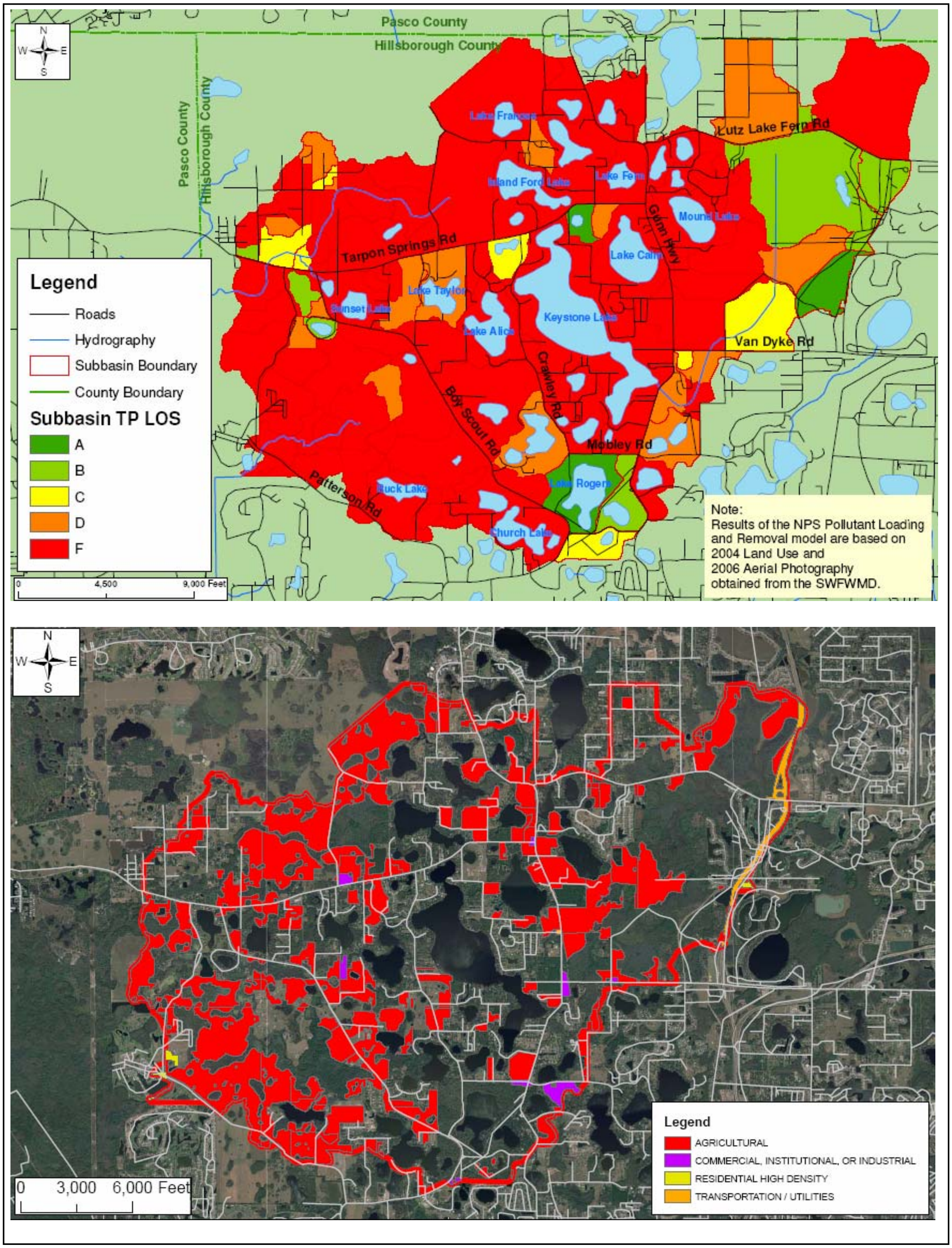
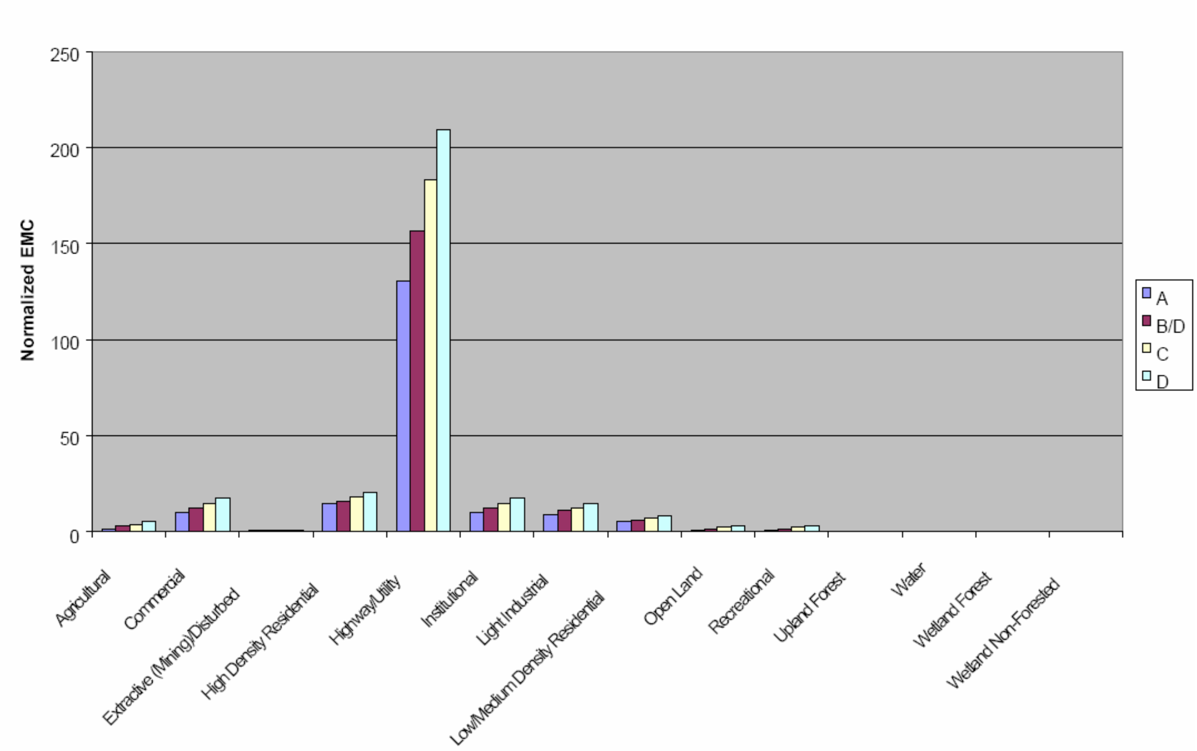


Figure 13-4 Visual Correlation between Land Use and High Concentrations of TP

Total Suspended Solids



Total Suspended Solids Loading Potential by Land Use and Hydrologic Group

Concentrations of total suspended solids seem to almost exclusively depend on existence of Highway/Utilities land use category. While LOS scores for TSS range from low to medium throughout the watershed, a subbasin located to the east of the Brooker Creek watershed exhibits TSS score of F. This phenomenon may be easily explained by presence of a section of the Veterans Expressway/Suncoast Parkway extending through the subbasin. While encompassing only a small area of the subbasin, this highway section contributes enough TSS to bring the score of the entire subbasin to F.

The subbasin encompassing Keystone Lake also exhibits relatively low LOS score for TSS. While water does not contribute any TSS, land use surrounding the Keystone Lake consists of almost exclusively Low/Medium density residential. While this land use type is not one of the major contributors of TSS, it dominates the subbasin area, bringing the overall LOS score for TSS down to D.

The overall TSS trend is evident from the visual comparison of TSS LOS scores and high-pollutant contributing land use types (Figure 13-5). Subbasins with up-build land use types have lower LOS TSS scores than subbasins dominated by natural land uses.

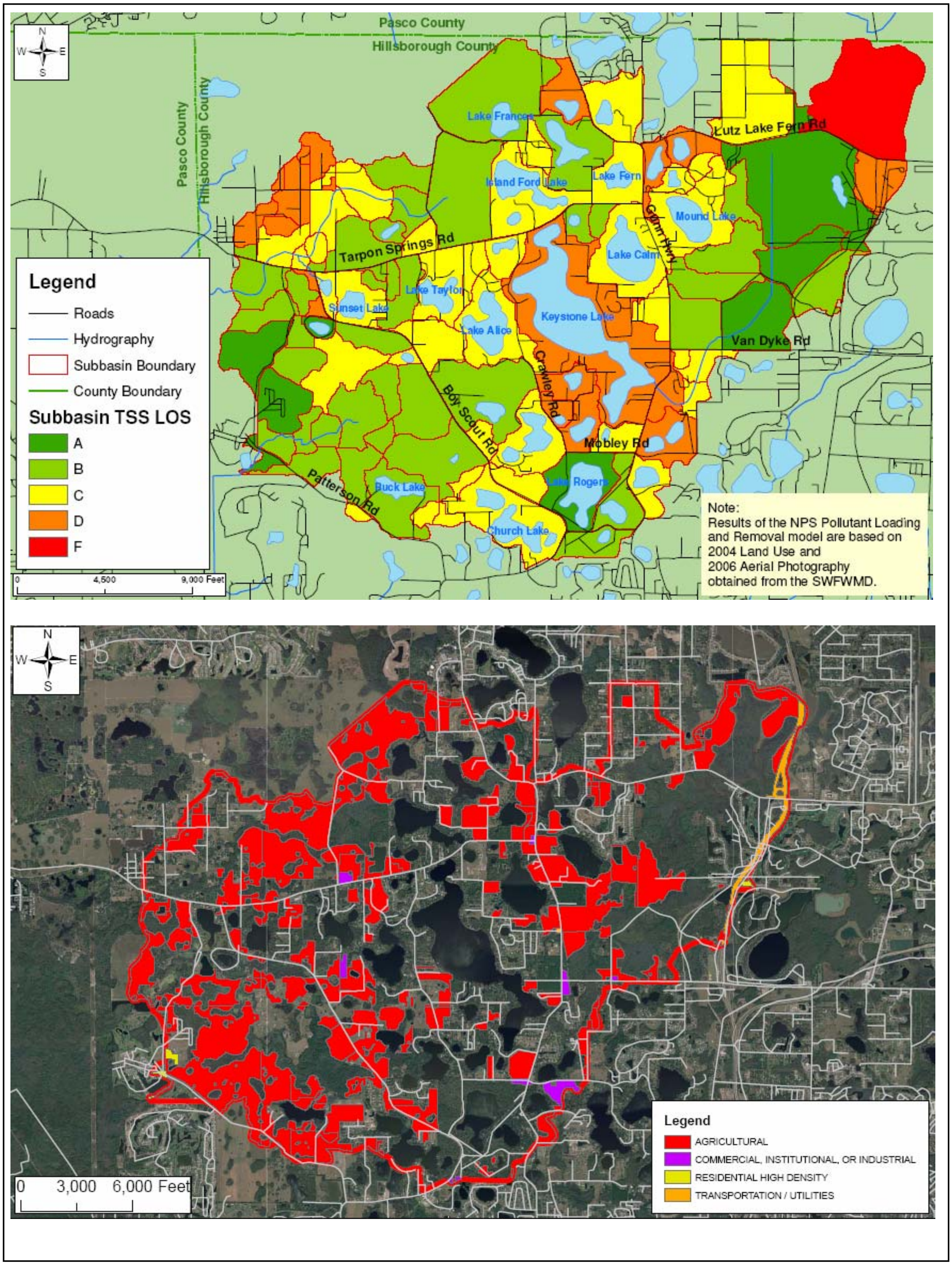


Figure 13-5 Visual Correlation between Land Use and High Concentrations of TSS

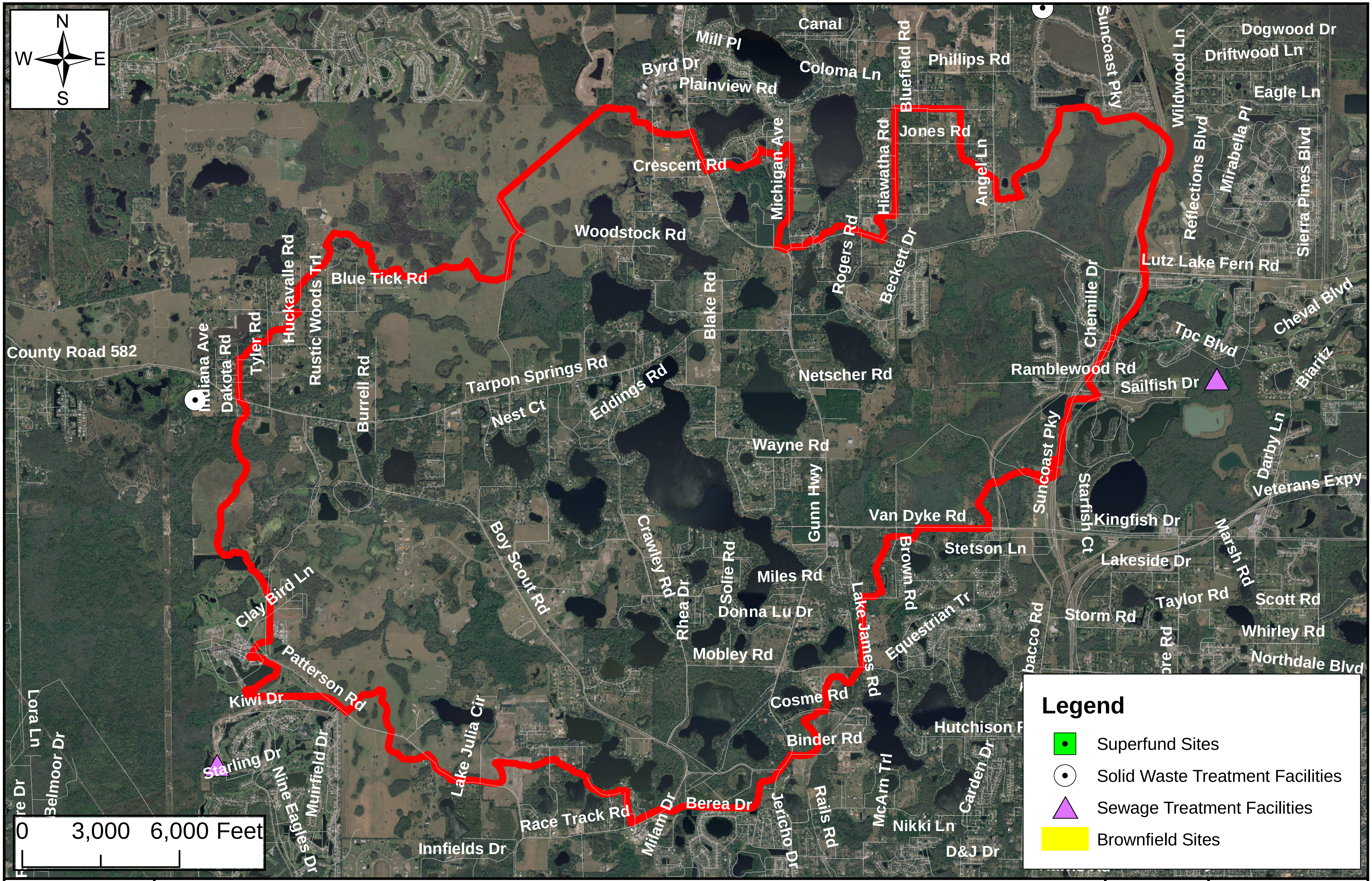
13.1.3 Other Contamination Sources - Brownfield Sites, Superfund sites, Sewage and Solid Waste Treatment Facilities

Figure 13-6 shows there are no Superfund sites, sewage or solid waste treatment facilities located within the Brooker Creek watershed. There are also no brownfield sites located within or near the watershed (Figure 13-7).

As evident from Figure 13-6, an old inactive solid waste treatment facility is located to the west of the watershed. This treatment facility is Charlie Martin Borrow Pit area located at State Road 582 and Pinellas County line. This activity has been inactive since December of 1984 and is currently on the Hillsborough County Old Landfill Investigation Program list.

In addition to the neighboring solid waster treatment facility, there are two sewage treatment facilities located within the watershed vicinity: the Eagles Wastewater Treatment Plant and a sewage treatment facility located on the Hillsborough County owned parcel at the end of Ramblewood Road.

As mentioned earlier, none of these facilities are present within the Brooker Creek watershed boundary or influence the water quality within the watershed.



Other Contamination Sources in the Brooker Creek Watershed

Figure 13-6

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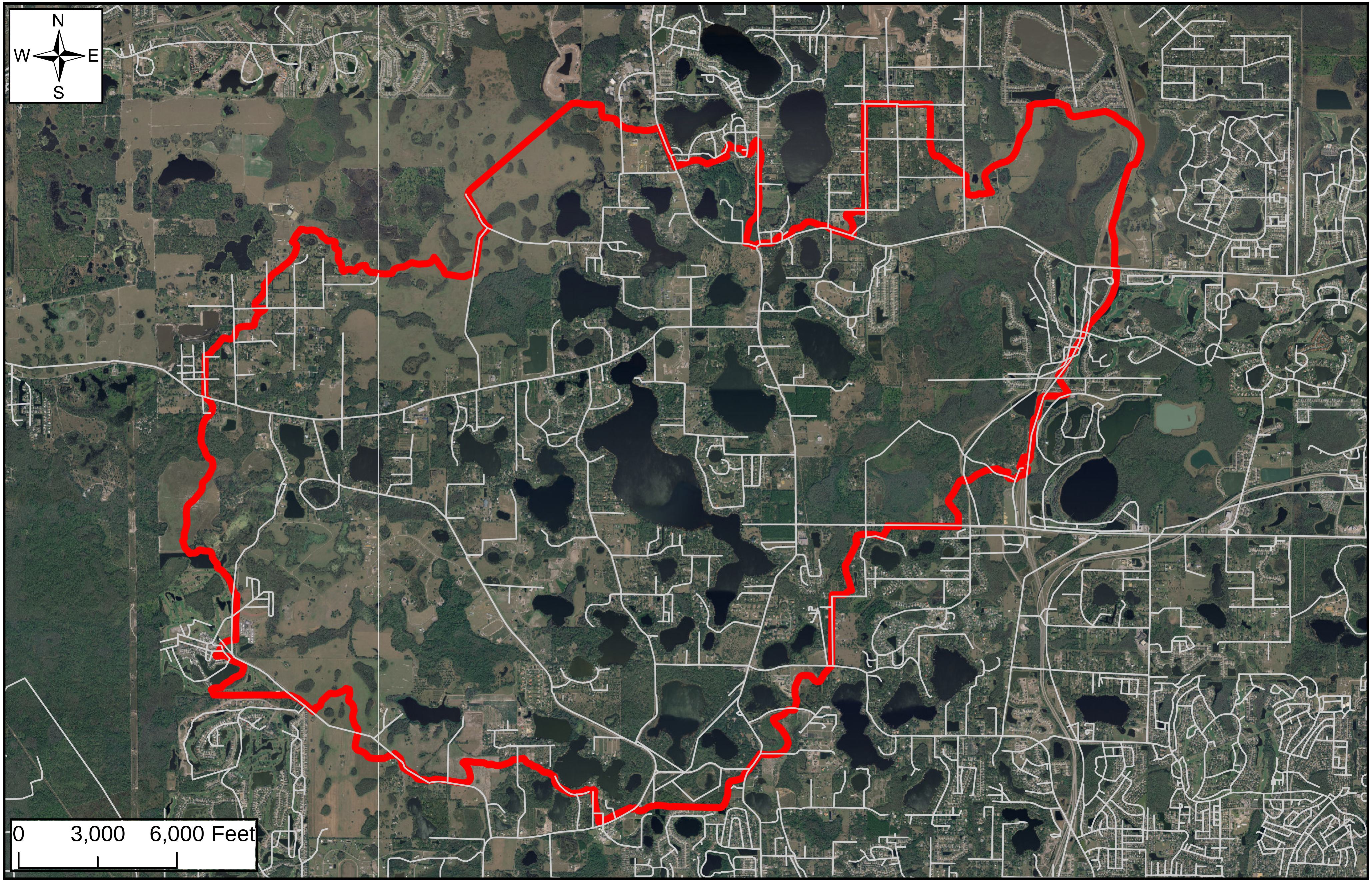


Brownfield Sites in the Brooker Creek Watershed

Figure 13-7

AYRES ASSOCIATES

13.2 Bibliography

The attached bibliography includes a list of references used for this study and additional references that could be cited by readers.

Giesy, R., de Vries, A., Zylstra, M., Kilmer, R., Bray, D., Webb, D. 2003. *Florida Dairy Farm Situation and Outlook 2003*. Department of Animal Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Document No. AN138. Gainesville, Florida.

US EPA, 2002. *Agriculture - Dairy Production*. Purdue Research Foundation, West Lafayette, Indiana. (~~http://www.epa.gov/agriculture/ag101/printdairy.html~~).

CHAPTER 14: SITE ANALYSIS FOR POTENTIAL STRUCTURAL ALTERNATIVES

14.1 Overview

This chapter describes a series of structural alternatives that could potentially be used to improve water quality and natural systems for the Brooker Creek watershed. A series of analyses were performed using GIS to strategically locate water quality and natural systems alternatives. The methods used to identify these projects are also described.

Water quality conditions were evaluated using the County's Water Quality Treatment Level of Service criteria and pollutant loading model. The alternatives have been developed to improve water quality and natural systems and address the goals of the county in these areas.

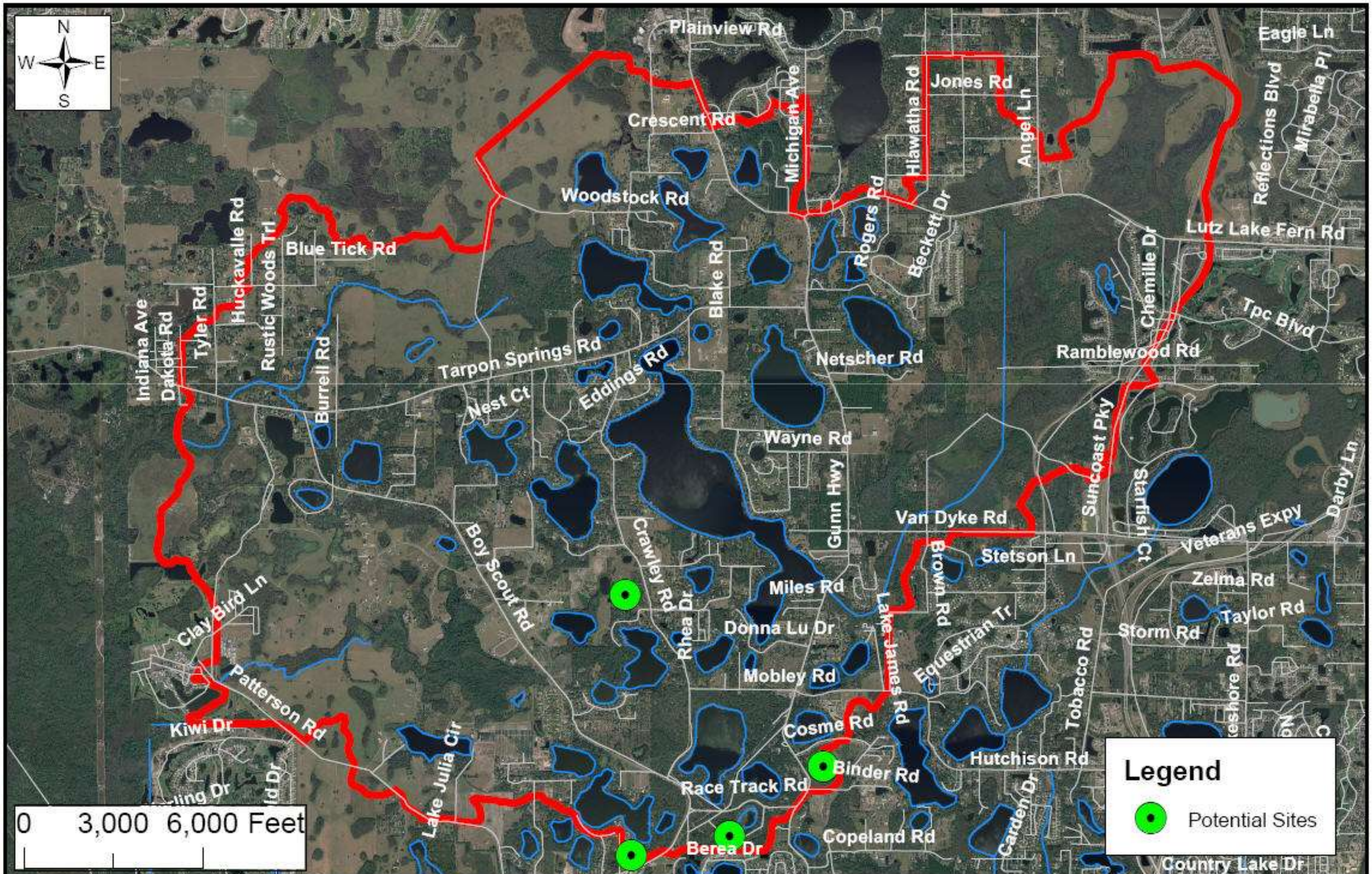
To facilitate locating undeveloped/open lands for construction of water quality treatment ponds, GIS land use data, and most recent aerial photography (2006) were used to identify the most suitable and cost-effective sites within the watershed.

A similar methodology was used to identify potential wetland restoration areas within the Brooker Creek watershed.

14.2 Identification and Prioritization of Sites

In order to determine the best possible locations for potential structural alternatives, analysis of the recent aerial photography (2006) of the area was conducted. The first step of the process involved visual identification of areas that could potentially serve as stormwater treatment locations or wetland restoration areas. In order to complete this task, aerial photographs were analyzed for location of areas/lands that appeared to be undeveloped and with sufficient areas suitable for installing a storm water basin. This analysis produced four locations for potential structural alternatives (Figure 14-1). This study did not include a comparative analysis for different types of treatment for water quality improvement (e.g., alum treatment, detention ponds).

In order to treat surface water effectively, it is beneficial to position alternatives in close proximity to a major stream network, in order to treat larger quantities of water. For completion of this task, the alternatives were prioritized based on their proximity to the major stream network. Using a variety of ArcView 8.3 spatial analysis functions, a 500-meter buffer was created around the major stream network. Next, locations of potential structural alternatives sites identified in the previous step of the process, were divided into two categories based on whether they fall within the 500-meter buffer or outside of the major stream network buffer.



Potential Project Locations in the Brooker Creek Watershed

Figure 14-1

AYRES ASSOCIATES

According to this step of the analysis, all four potential structural alternative locations identified earlier fell within 500 meters of the major stream network (Figure 14-2).

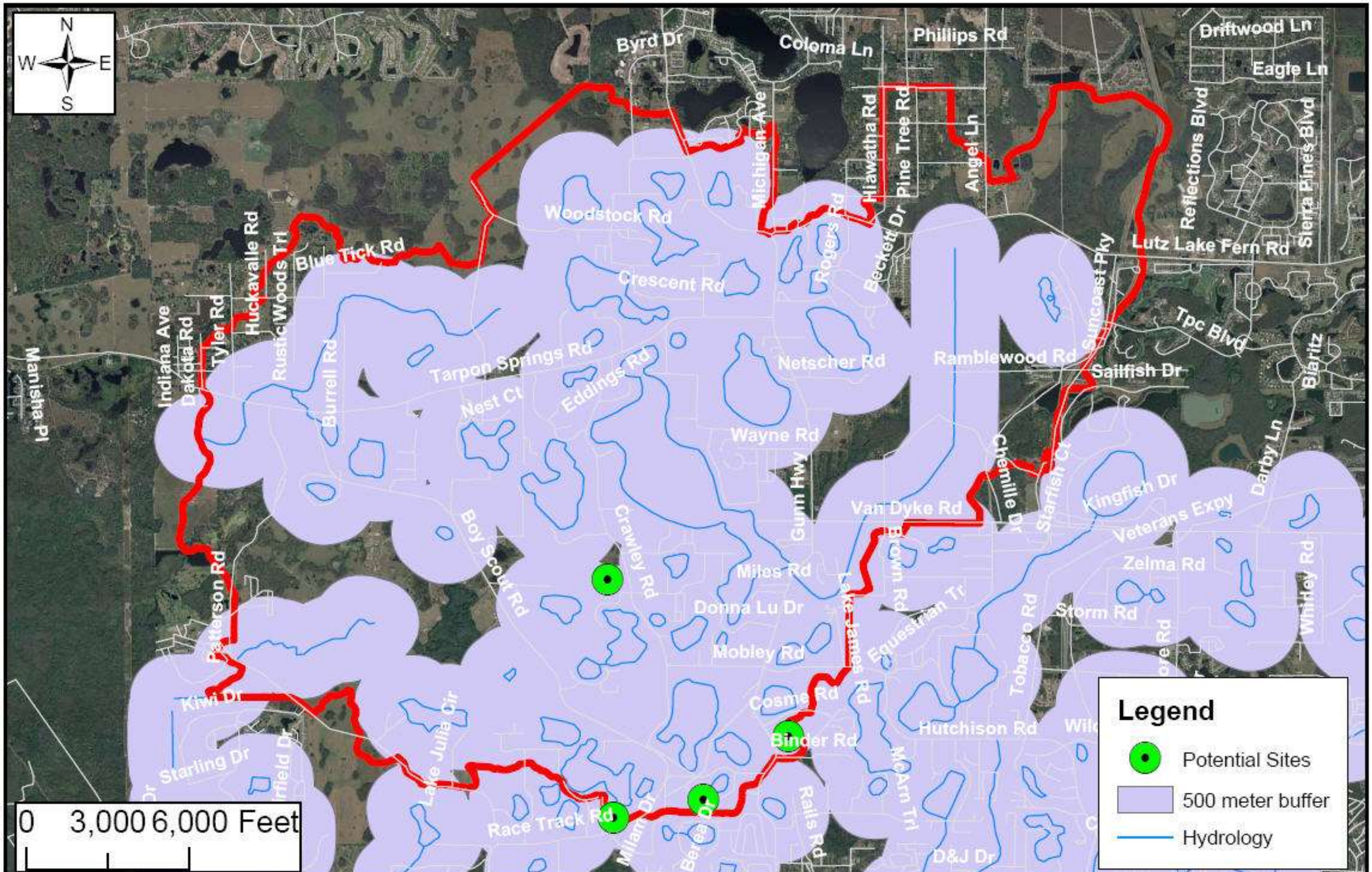
In order to verify that the sites we selected have no existing construction, land use information was used to identify locations classified as "open areas." In order to complete this task, the land use shapefile was analyzed and areas with FLUCFCS codes designating such land use categories as agricultural lands, open land, or upland forest were extracted as a separate layer. Next, four potential alternatives identified in the first step of the process were overlaid with the newly created "open areas" layer. Out of these locations, two fell within the "open areas" (Figure 14-3).

Whenever identifying a location for a new structural alternative, it is more appropriate to select parcels that are owned by the government and not private entities. Land acquisition process for the purpose of water quality and water quantity improvement is a process that is not only lengthy, but also very costly. Based on this fact, the alternatives were further prioritized based on their ownership. Hillsborough county parcels layer was used to identify lands that belong to governmental entities. In order to complete this task, we identified the Department of Revenue (DOR) Land Use codes that represent lands owned by the government (Governmental DOR Codes range between 80 and 89).

Once a new layer of "Governmentally owned lands" was extracted, we were able to separate the original four potential structural alternatives sites based on their ownership (governmentally owned lands vs. all others). This process identified one potential parcel under government ownership that could potentially be utilized for stormwater treatment and wetland improvement purposes (Figure 14-4).

In order to identify the final selections, the results of all the steps of the aforementioned analysis were combined. In other words, while prioritizing the original four potential structural alternatives locations, more importance and consideration was given to locations that fell within the 500-meter buffer of the major stream network, that belonged to the "open areas" land use types, and that are owned by the governmental entities. This analysis produced one final parcel that belonged to all three categories and were further considered for field analysis (Figure 14-5).

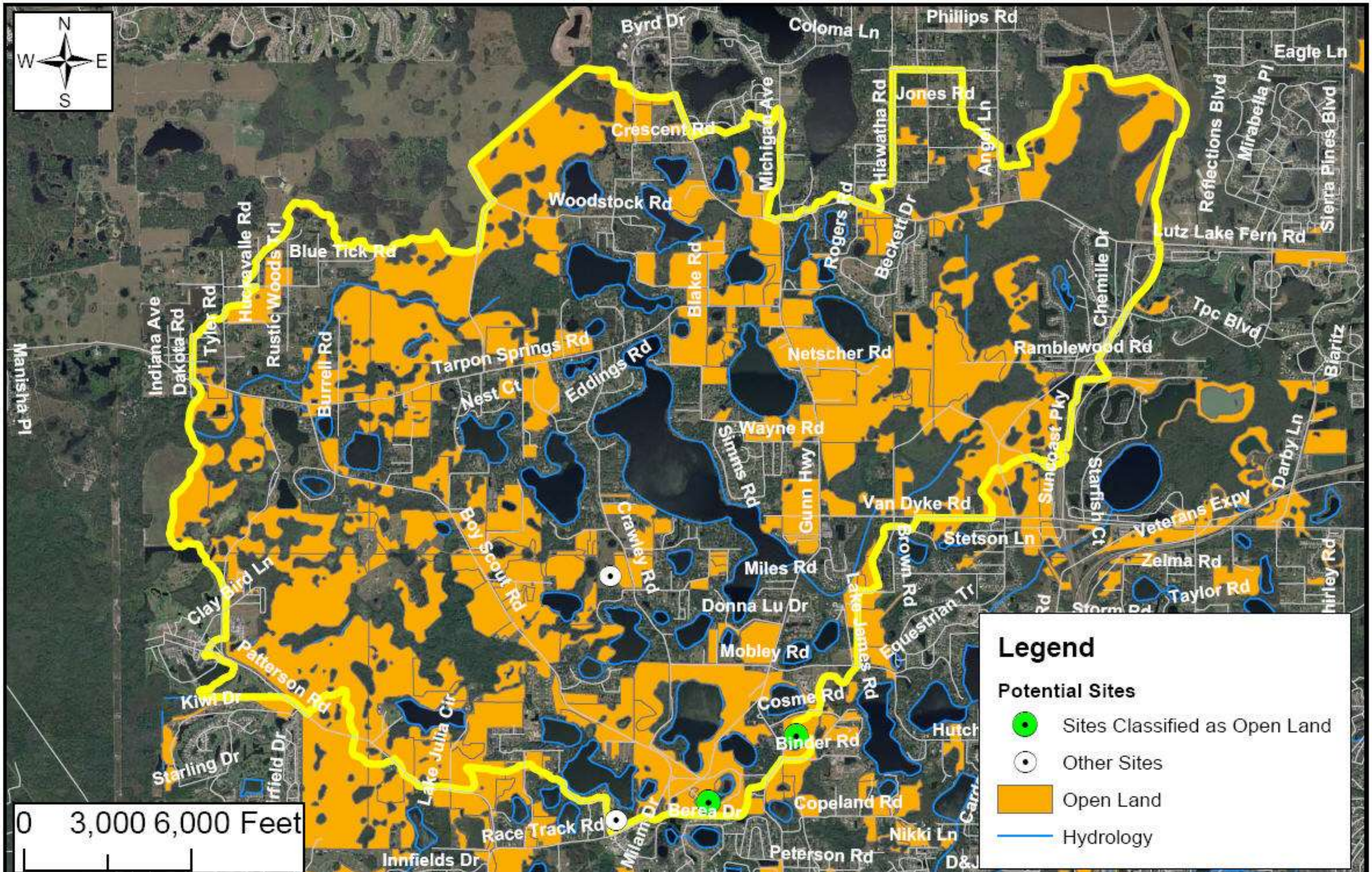
Because of the small number of potential sites, field inspection was conducted for all four of the originally selected locations.



Brooker Creek Watershed - 500 meter Buffer from Streams

Figure 14-2

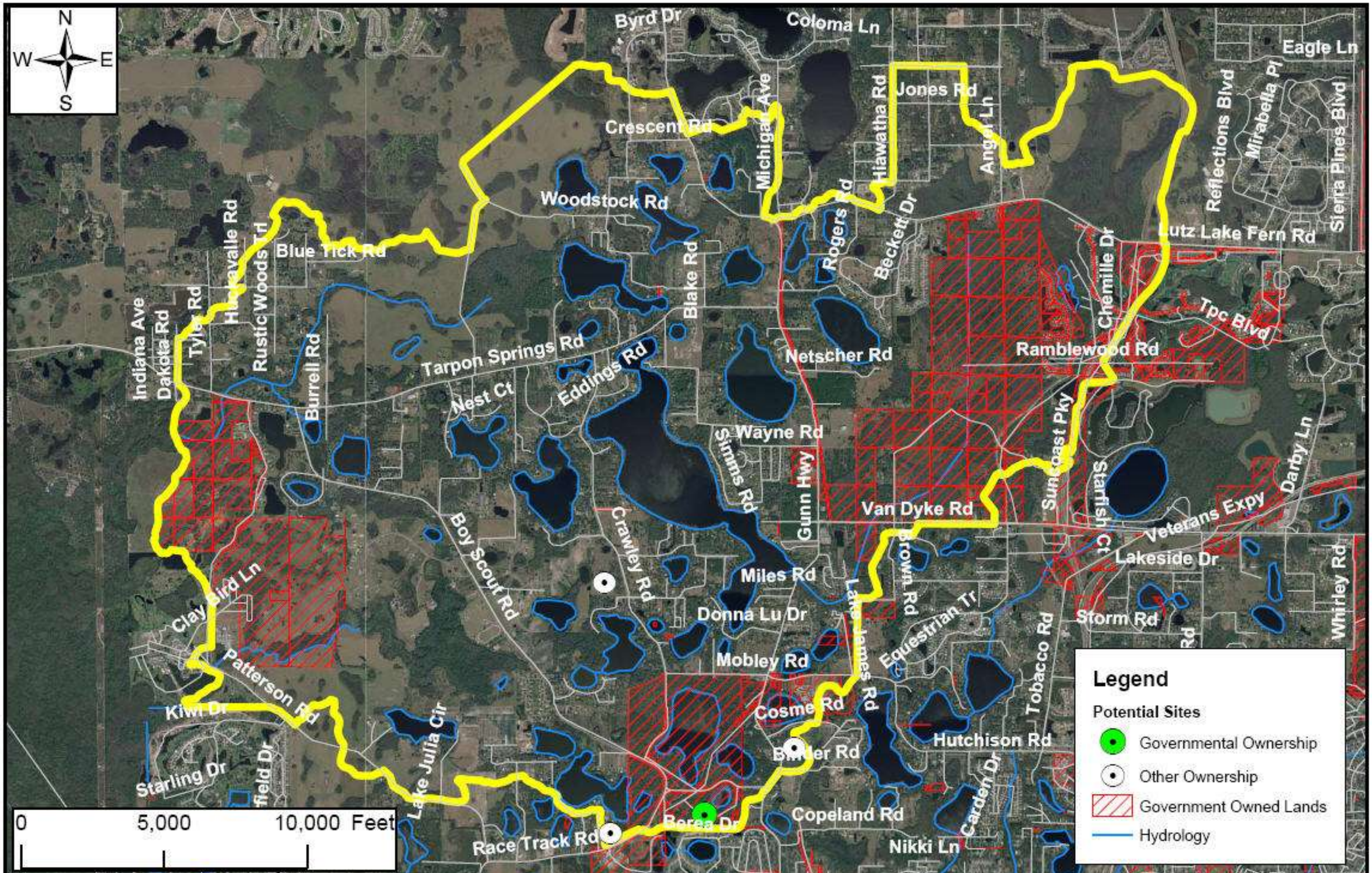
AYRES ASSOCIATES



Brooker Creek Watershed - Open Areas

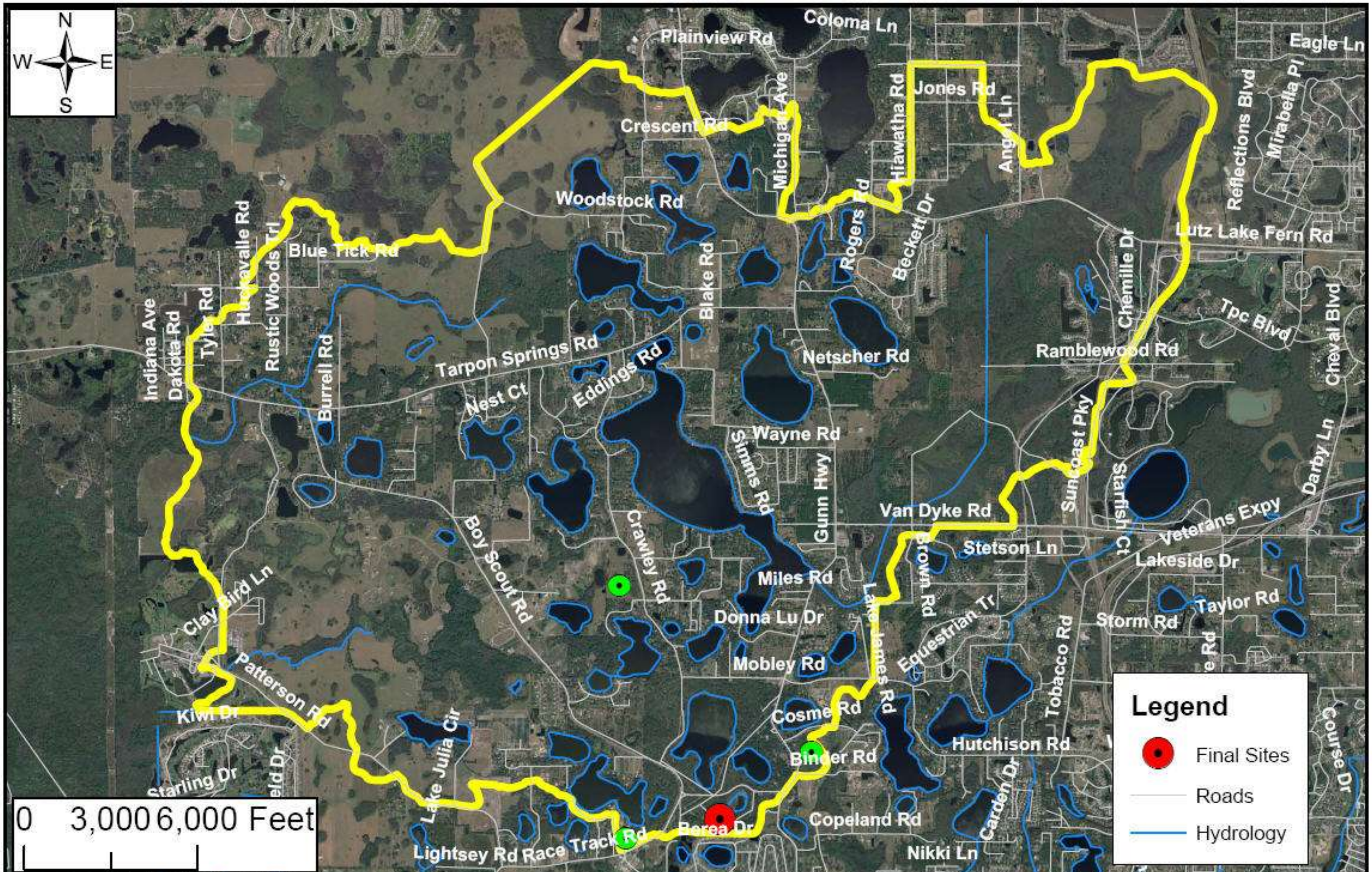
Figure 14-3

AYRES ASSOCIATES



Brooker Creek Watershed - Government Owned Lands

Figure 14-4



Brooker Creek Watershed - Final Selection

Figure 14-5

AYRES ASSOCIATES

14.2.1 Potential Project Site 1: Gator Hole

Potential project site 1 is located in the south-central portion of the Brooker Creek watershed (Figure 14-6). It is represented by a relatively large parcel located along Race Track Road and at the end of Gator Hole Road. The parcel is located to the south of Church Lake and right across the street of what seems to be a small water treatment facility. A large residential neighborhood is visible to southeast of the proposed location.

From an aerial photography, the parcel appears to be open with a small wetland system directly across the Gator Hole Road. This area may offer an opportunity for water retention or expansion of an existing wetland. Field inspection will be conducted in order to further investigate the possibility for a future water quality alternative.

14.2.2 Potential Project Site 2: TBW

Potential project site 2 is located in the south-central portion of the Brooker Creek watershed (in close proximity to site 1) (Figure 14-7). As the aerial image of the area illustrates, this parcel is large in size (over 30 acres) and encompasses a wetland area. The parcel is located in the southeastern corner of Race Track Road and Boy Scout Road. It is located across the street from Lake Rodgers Park. Major lakes located in close proximity to the parcel include Lake Rogers, Lake Raleigh, and Grace Lake.

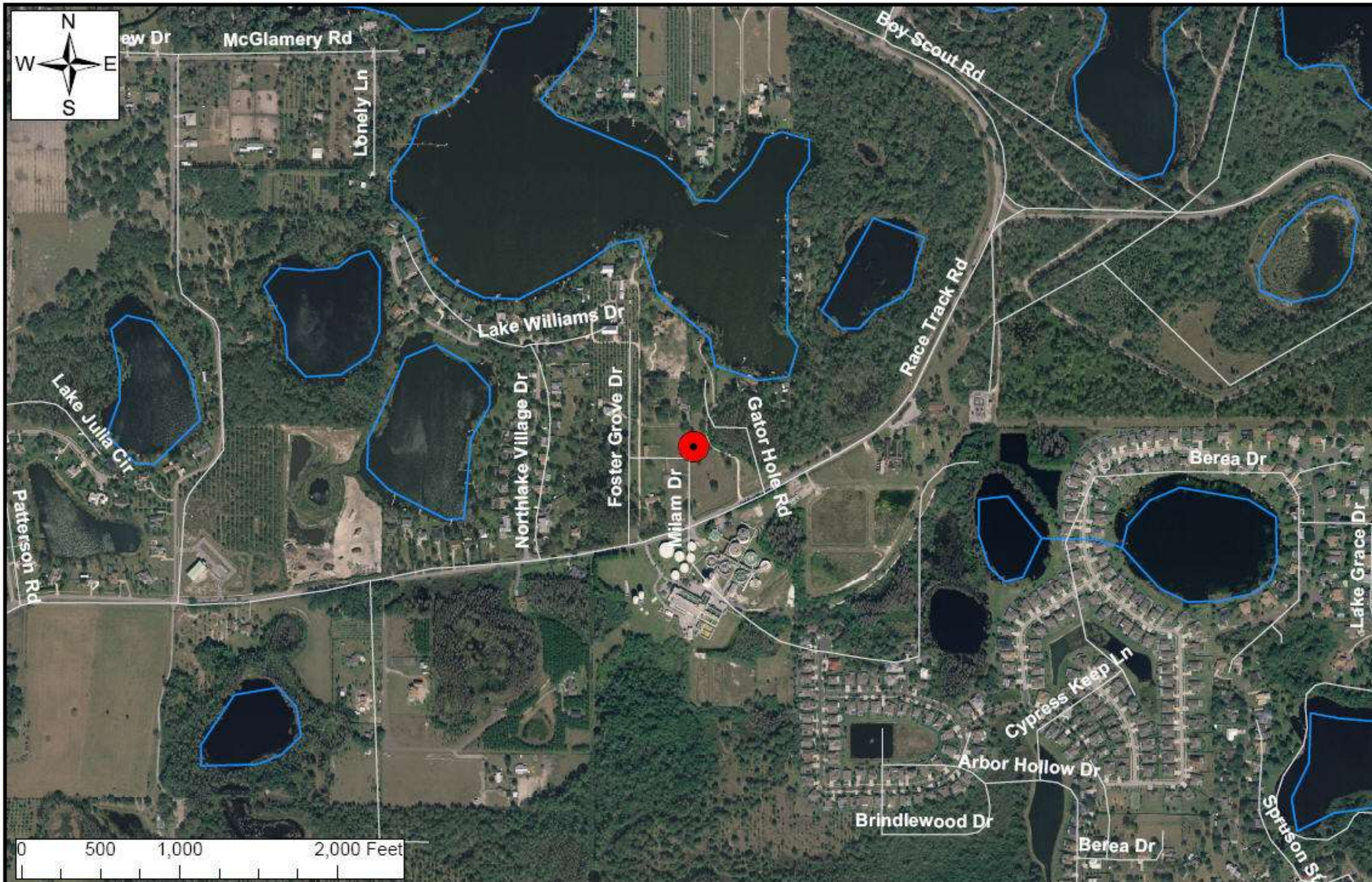
Identification of an existing wetland may provide an additional opportunity for wetland expansion and improvement. This parcel is in close proximity to stream network and is under governmental ownership, which makes it an ideal candidate for a potential project location; it will be field inspected during the next stage of the project.

14.2.3 Potential Project Site 3: Binder

Potential project site 3 is also located in the south-central portion of the Brooker Creek watershed (Figure 14-8). This parcel is located in the northeastern corner of Gunn Highway and Binder Road. The nearest major intersection is Gunn Highway and Race Track Road. While this parcel is not governmentally owned, it is represented by a large open area within close proximity to a stream network. A small wetland may be located in the northwestern corner of the parcel, which may provide an opportunity for wetland improvement. Due to small number of potential project sites available in the Brooker Creek watershed, every location will be field inspected.

14.2.4 Potential Project Site 4: Rainbow

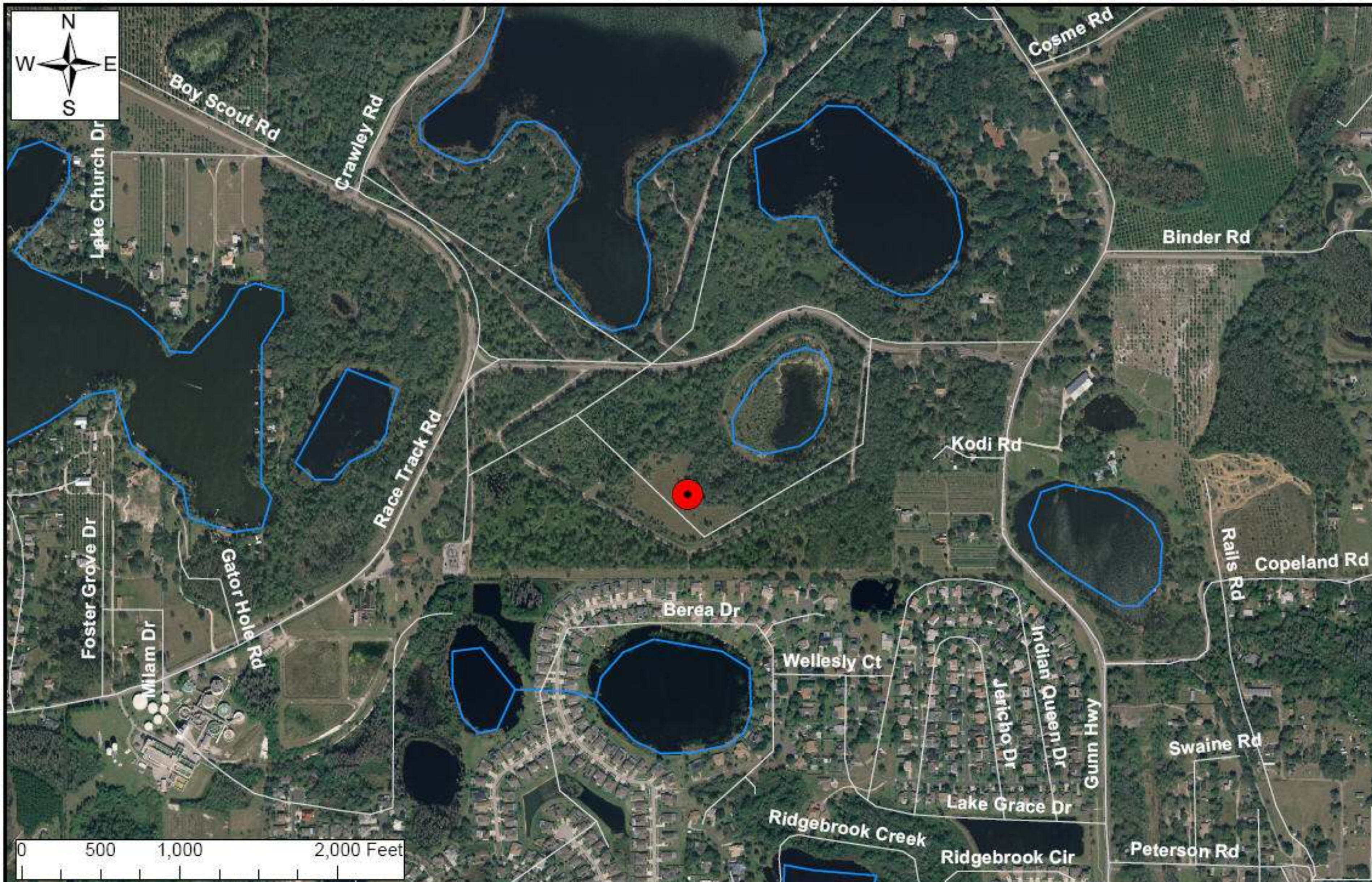
Potential project site 4 is located in the central portion of the Brooker Creek watershed (Figure 14-9). This parcel is located in the northwestern corner of the intersection of Crawley Road and Roberts Road, north of Rainbow Lake. The parcel is approximately 10 acres in size and is surrounded by mostly agricultural land. There is not much industry located in the area.



Potential Project Site 1: Gator Hole

Figure 14-6

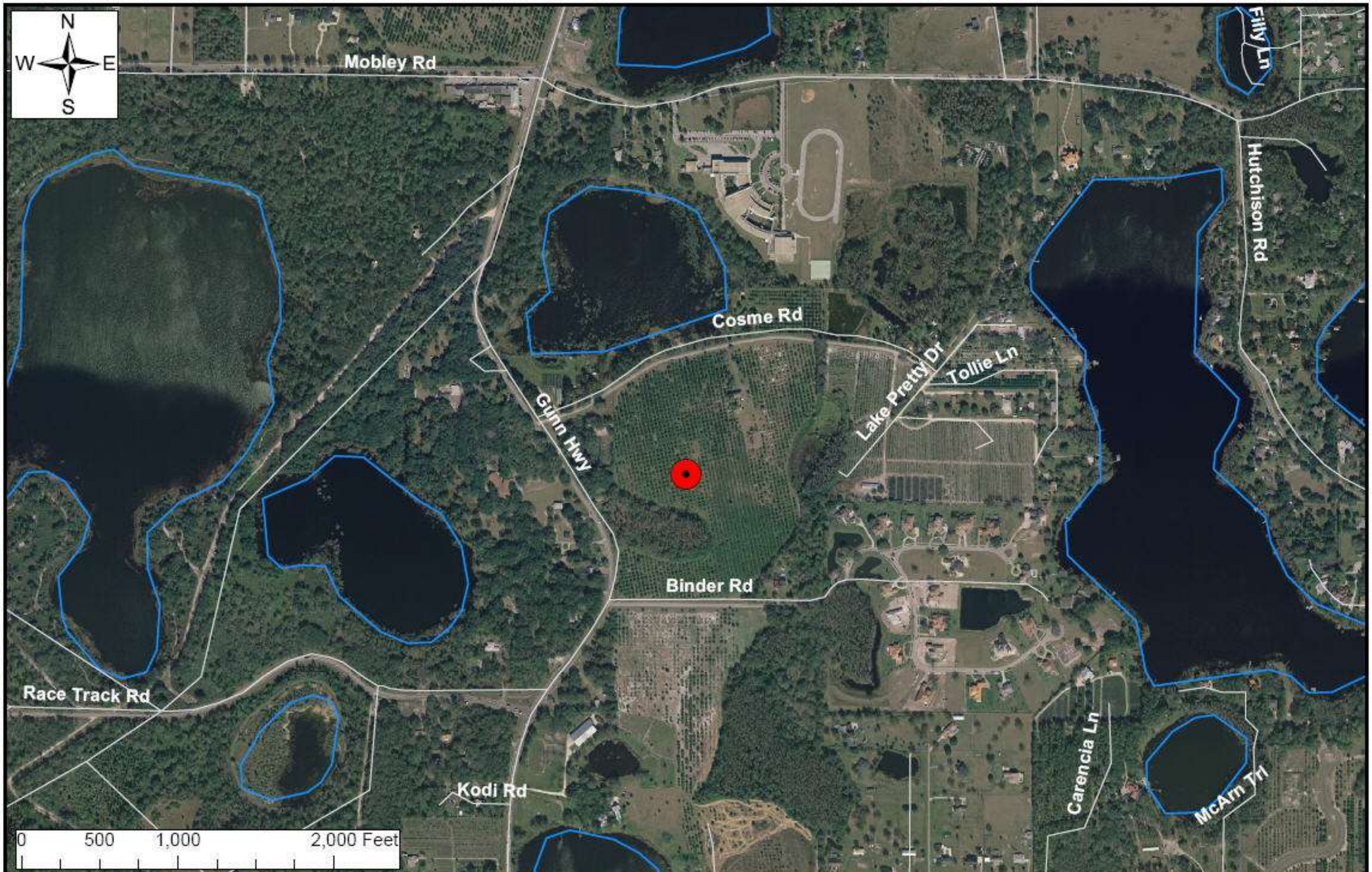
AYRES ASSOCIATES



Potential Project Site 2: TBW

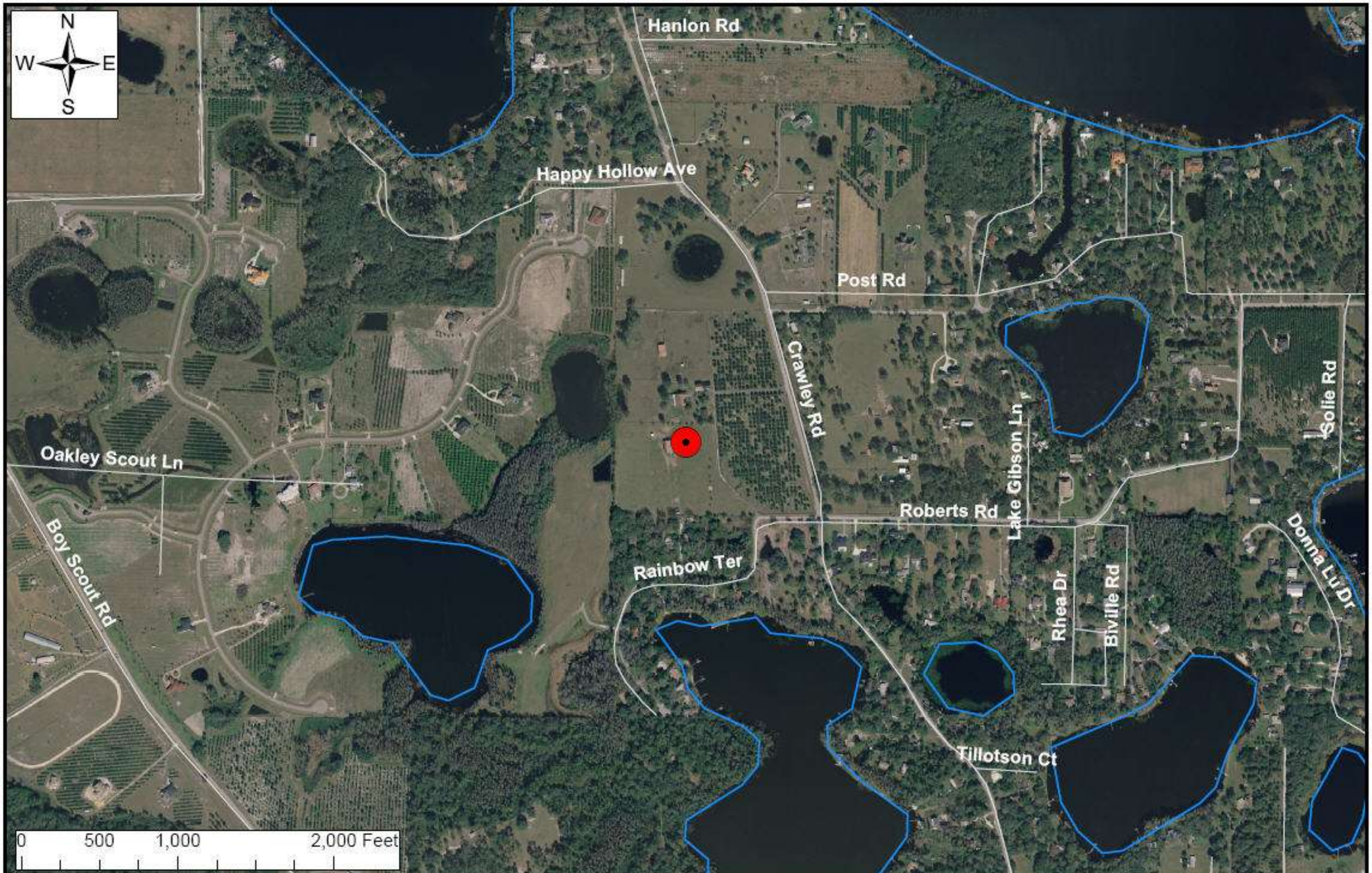
Figure 14-7

AYRES ASSOCIATES



Potential Project Site 3: Binder

Figure 14-8



Potential Project Site 4: Rainbow

Figure 14-9

AYRES ASSOCIATES

This site is located near stream network. The land use in this location is classified as either Open Land or Agricultural. This parcel is not governmentally owned, therefore land acquisition may be necessary, but considering a limited number of potential project location in the Brooker Creek watershed, every location will be field inspected. In addition, according to the aerial photography, there is a possibility of a small wetland located along the Rainbow Terrace, which may provide an opportunity for wetland improvement.

14.3 Field Inspection of Potential Sites

14.3.1 Potential Project Site 1: Gator Hole

While in theory the Gator Hole location presented an ideal location for development of a storm water treatment system, the field visit confirmed that the site is already under development. This parcel contains construction of a new residential property and, therefore, is no longer considered as one of the potential locations for structural alternatives.

14.3.2 Potential Project Site 2: TBW

Field inspection of the second location identified that the large parcel is the property of City of St. Petersburg. While review of the aerial photography and other GIS information offered reasons to believe this location would provide an opportunity for a structural water quality alternative, the field visit proved that the area is a part of Tampa Bay Water's Cosme-Odessa wellfield. This area is therefore no longer considered as one of the potential locations for structural alternatives.

14.3.3 Potential Project Site 3: Binder

This project site is located in the corner of Cosme Road and Gunn Highway and is under private ownership. The site identified is located to the west of an orange grove. The parcel also contains a private residence; however, the area located to the south of Cosme Road may provide an opportunity for water retention. This area of land is open with a few large trees. No wetland feature is visible and a tree nursery is located across the street of Cosme Road. This location will be recommended as a structural alternative during the final recommendation phase of the project. See Chapter 15 for location detail and cost analysis.

14.3.4 Potential Project Site 4: Rainbow

This site is located at the intersection of Crawley Road and Roberts Road, along Rainbow Terrace. This parcel is large enough to encompass a structural BMP. The size and location of the parcel make it an acceptable location for a small treatment pond. This location is adjacent to an agricultural property and a horse farm. In addition, there is a possibility of a small wetland located in the back of the parcel. This location is fenced off due to its private ownership. Land acquisition costs will be considered during the final cost analysis; see Chapter 15 for further site details.

This is another location that will be recommended as a structural alternative during the final recommendation phase of the project. This location may not only provide an opportunity for a wetland improvement/expansion project, but also become a home to a new treatment pond.

CHAPTER 15: FINAL RECOMMENDATIONS

15.1 Overview

This chapter describes the final recommendations of the alternatives that were developed for water quality and natural systems for the Brooker Creek watershed. Generally, two different sets of BMPs may be applied to reduce stormwater impact and/or improve water quality: (1) non-structural BMPs; and (2) structural BMPs. A combination of these two techniques may also be used. One of the most important elements of non-structural BMPs is public education. It focuses on preventative measures while structural BMPs mostly relies on existing or constructed systems for treating stormwater. Following are two sets of discussions associated with water quality improvement.

The first point of discussion will cover various resources for public education. An important part of a watershed management plan is public support and to help promote a greater awareness within the community regarding the importance of minimizing stormwater impacts by focusing on preventative measures.

The second section will discuss the proposed alternatives based on the series of analyses that were performed using GIS to strategically locate stormwater quality improvement facilities and natural systems alternatives enhancements.

15.2 Public Education

Various toolboxes, documents, programs, and information are available at the national agency level down to local governments regarding information on watersheds, water quality, stormwater runoff, and BMPs, which are designed to educate and inform the general public and students and faculty at educational institutions.

US EPA Watershed Outreach
http://www.epa.gov/owow/watershed/outreach/outreachnonjs.html

The Nonpoint Source (NPS) Outreach Toolbox is intended for use by state and local agencies and other organizations interested in educating the public on nonpoint source pollution or stormwater runoff. The Toolbox contains a variety of resources to help develop an effective and targeted outreach campaign.

US EPA - Public Education and Outreach on Stormwater Impacts

Because stormwater runoff is generated from dispersed land surfaces--pavements, yards, driveways, and roofs--efforts to control stormwater pollution must consider individual, household, and public behaviors and activities that can generate pollution from these surfaces.

Florida Department of Environmental Protection - Best Management Practices, Public Information, and Environmental Education Resources

http://www.dep.state.fl.us/Water/nonpoint/pubs.htm

Reports, brochures, handouts, videos, and training aids are available to governments, teachers, general public with ideas and resources to reduce and educate about non-point source pollution in Florida.

Southwest Florida Water Management District

http://www.swfwmd.state.fl.us/

SWFWMD has various educational and public education programs relating to watersheds and how to improve water quality.

Tampa Bay Water

http://www.tampabaywater.org/conservation/conservation.aspx

TBW website has links to documents regarding water conservation that will give ideas to member governments and the public in making a difference in conserving the region's water resources.

Pinellas County – Department of Environmental Management

http://www.pinellascounty.org/Environment/default.htm

The Water Resources Management Section is dedicated to public outreach and education. The sites offers outreach activities that range from answering citizens' questions and concern about their aquatic environment to formal presentations.

Hillsborough County Watershed Atlas

http://www.hillsborough.wateratlas.usf.edu/

The education section is geared towards educating the public about water resources and has links to access various documents, citizen based water management organizations, and classroom tools. There is an area for educators regarding watersheds and water quality with student activities and the general education section has documents and links to help citizens understand the data on the Atlas and teach about maintaining the health of area waterbodies.

Hillsborough County Stormwater Public Education Awareness Campaign (SPEAC)
This is an educational outreach program in which volunteers do monitoring, education, and restoration such as The Lake Management Program (LaMP), Streamwaterwatch, Adopt-A-Pond, Stormwater Ecologist, and Officer Snook.

Hillsborough County – Public Works- Adopt-A-Pond
http://www.hillsboroughcounty.org/publicworks/engineering/stormwater/adoptapond.cfm

Hillsborough County encourages the local community to take care of area lakes, creeks, and ponds. They feel the restoration or rehabilitation of stormwater ponds is essential to the health of local lakes, creeks, rivers and bays. This program educates the public about aquatic vegetation that can stabilize a pond and remove pollutants in order to help maintain water quality. The Adopt-A-Pond program shows how a properly designed pond may have increased wildlife habitat, recreation areas, and aesthetic views.

15.3 Proposed Alternatives

As is the case for most watershed management plans for water quality improvements and environmental enhancements, a combination of measures consisting of structural and non-structural alternatives are applicable depending on availability of resources and cost-effectiveness. Unless a comprehensive hydraulic and water quality analysis is performed, it will be difficult to determine the effectiveness of BMPs in improving water quality accurately. Nevertheless, these BMPs are expected to improve water quality.

15.3.1 Structural BMPs

In Chapter 14, a number of locations for potential structural BMPs were analyzed based on the following parameters:

- Visual identification
- Proximity to steam network
- Land availability
- Property ownership

After field review of every location described in Chapter 14, two feasible locations for potential alternative sites were recommended for further consideration. This chapter contains a Summary Sheet for the two locations described earlier:

- BCC1 – Binder
- BCC2 – Rainbow

Summary sheets, located at the end of the chapter, contain such information as general description of the site based on the field visit, site location map in relationship to the Brooker Creek watershed, aerial view of the proposed site, and a cost estimate for pond installation at the proposed site.

The cost estimate is based on the following assumptions:

- The costs are limited to the pond installation
- Ponds are assumed to be 5 feet deep, covering the largest possible area in the selected parcels

In addition, the cost estimates include sod covering a buffer of 30 ft around the pond perimeter, an inlet and outlet structure (just a rough market average price), a silt fence around the construction area, and a fence around the pond and gate.

Cost estimates are based on August 16, 2007 Hillsborough County Unit Price (WORCS), and as noted, some unit costs are based on estimated market prices. If a pre-design analysis is required, its associated cost needs to be added to project cost (approximately 15 to 20 percent of the total project cost).

It should be noted that since a water quality analysis could not be performed as part of this project, it is recommended that such a task be performed during the design process. The results of such analysis may suggest adjustments to sizing of the system, consequently changing the project cost. Furthermore, the availability of recommended sites may change over time. Therefore, prior to initiating any project, a complete investigation is recommended to identify legal, financial, and other constraints that could not be identified under this study.

15.3.2 Non-Structural BMPs/Public Outreach and Education

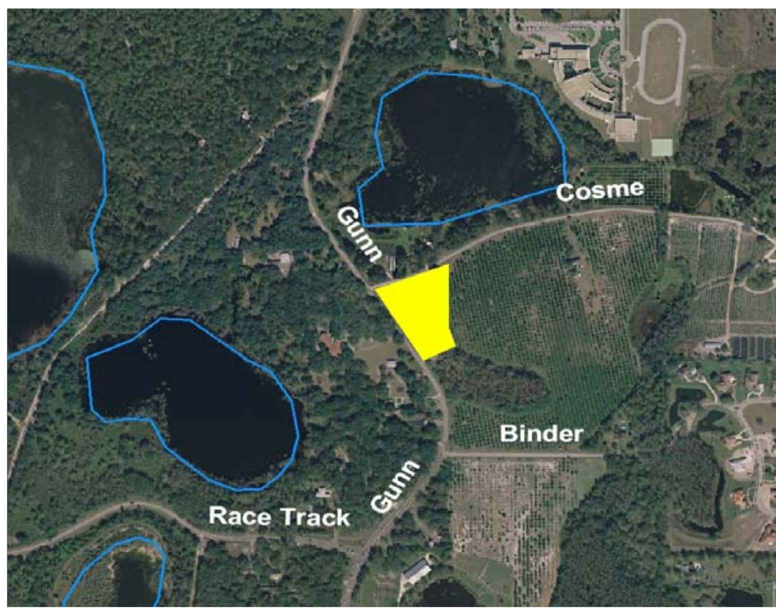
There are various state and local agencies that provide educational and outreach materials for the public at large and academic institutions. Experience has shown that teaching student populations from early years in elementary school is the most effective way of producing citizens who are respectful of quality of life issues and the environment. It is recommended that the County form a partnership with schools to provide them with educational materials to assist teachers in classroom instruction. The County should also provide volunteer staff to participate in teaching days during the academic year to explain the importance of preventing water pollution and improving water quality to the students and teachers.

BCC-1 Binder

This project site is located in the corner of Cosme Road and Gunn Highway and is under private ownership. The site identified is located to the west of an orange grove. The parcel also contains a private residence; however, the area located to the south of Cosme Road may provide and opportunity for water retention. This area of land is open with a few large trees. No wetland feature is visible and a tree nursery is located across the street of Cosme Road.

This location is suitable for a structural alternative.

Site Photo & Location Map



CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST

ITEM#	DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST	NOTES
101-1	MOBILIZATION	LS	$ 19,000.00	1	$ 19,000.00	(1)
102-1	MAINTENANCE OF TRAFFIC	LS	$ 3,000.00	1	$ 3,000.00	(1)
110-1-1	CLEARING AND GRUBBING	AC	$ 11,000.00	4.46	$ 49,082.00	(2)
104-13	SILT FENCE STAKED	LF	$ 1.63	1,900	$ 3,097.00	(1)
120-1	EXCAVATION REGULAR	CY	$ 10.73	35,993	$ 386,206.94	(1)
550-2	FENCING, TYPE B	LF	$ 17.00	2,000	$ 34,000.00	(1)
550-76-162	FENCE GATE (TYPE B) (DOUBLE 8') (16' OPENING)	EA	$ 977.73	1	$ 977.73	(1)
575-1-1	SODDING (BAHIA)	SY	$ 3.43	6,667	$ 22,866.67	(1)
	INLET STRUCTURE	EA	$ 12,000.00	1	$ 12,000.00	(2)
	OUTLET STRUCTURE	EA	$ 15,000.00	1	$ 15,000.00	(2)

CONSTRUCTION SUBTOTAL	$ 545,230.34
CONTINGENCIES (20%)	$ 109,046.07
CONSTRUCTION COST	$ 654,276.41
ENGINEERING SERVICES (25% OF CONSTRUCTION COST)	$ 163,569.10
SURVEY AND GEOTECHNICAL SERVICES (15% OF CONSTRUCTION COST)	$ 98,141.46
ACQUISITION COST	$ 161,714.00
TOTAL	**$ 1,077,700.97**

(1) UNIT COSTS ARE BASED ON THE August 16, 2007 HILLSBOROUGH COUNTY UNIT PRICE (WORCS)
(2) UNIT COSTS ARE BASED ON THE ESTIMATED AVERAGE MARKET PRICE

BCC-2 Rainbow

This site is located at the intersection of Crawley Road and Roberts Road, along the Rainbow Terrace. The size and location of the parcel make it an acceptable location for a small treatment pond. This location is adjacent to an agricultural property and a horse farm. In addition, there is a possibility of a small wetland located in the back of the parcel. This location is fenced off due to its private ownership; land acquisition costs will be considered during the final cost analysis.

This location may not only provide an opportunity for a wetland improvement/expansion project, but also become a home to a new treatment pond.

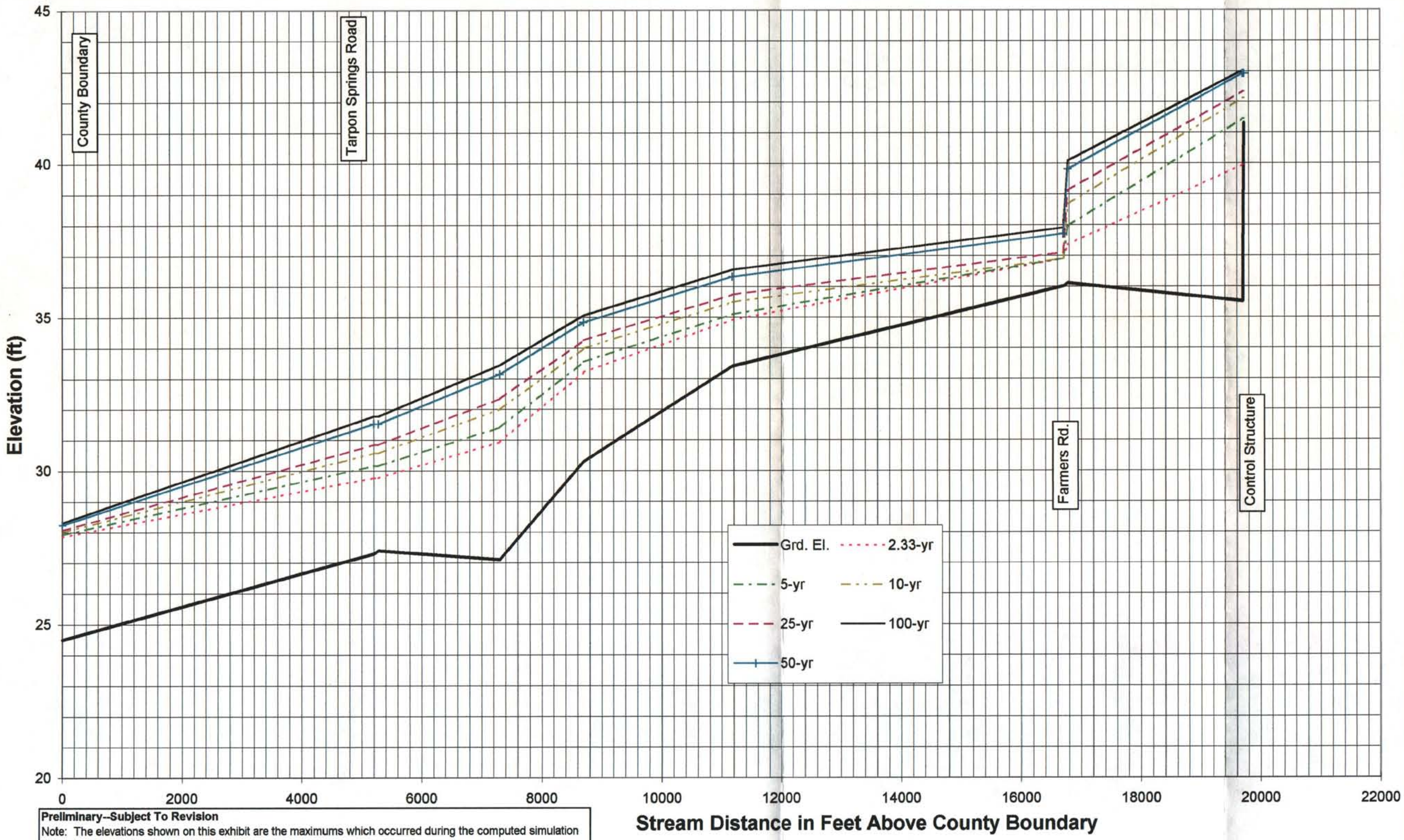
Site Photo & Location Map

CONCEPTUAL OPINION OF PROBABLE CONSTRUCTION COST						
ITEM#	DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST	NOTES
101-1	MOBILIZATION	LS	$ 19,000.00	1	$ 19,000.00	(1)
102-1	MAINTENANCE OF TRAFFIC	LS	$ 3,000.00	1	$ 3,000.00	(1)
110-1-1	CLEARING AND GRUBBING	AC	$ 11,000.00	3.86	$ 42,504.00	(2)
104-13	SILT FENCE STAKED	LF	$ 1.63	1,600	$ 2,608.00	(1)
120-1	EXCAVATION REGULAR	CY	$ 10.73	31,169	$ 334,447.25	(1)
550-2	FENCING, TYPE B	LF	$ 17.00	1,700	$ 28,900.00	(1)
550-76-162	FENCE GATE (TYPE B) (DOUBLE 8') (16' OPENING)	EA	$ 977.73	1	$ 977.73	(1)
575-1-1	SODDING (BAHIA)	SY	$ 3.43	5,667	$ 19,436.67	(1)
	INLET STRUCTURE	EA	$ 12,000.00	1	$ 12,000.00	(2)
	OUTLET STRUCTURE	EA	$ 15,000.00	1	$ 15,000.00	(2)

CONSTRUCTION SUBTOTAL	$ 477,873.65
CONTINGENCIES (20%)	$ 95,574.73
CONSTRUCTION COST	$ 573,448.38
ENGINEERING SERVICES (25% OF CONSTRUCTION COST)	$ 143,362.09
SURVEY AND GEOTECHNICAL SERVICES (15% OF CONSTRUCTION COST)	$ 86,017.26
ACQUISITION COST	$ 66,605.00
TOTAL	$ 869,432.73

(1) UNIT COSTS ARE BASED ON THE August 16, 2007 HILLSBOROUGH COUNTY UNIT PRICE (WORCS)
(2) UNIT COSTS ARE BASED ON THE ESTIMATED AVERAGE MARKET PRICE

EXHIBIT 1
Water Surface Profiles
Brooker Creek Existing Conditions



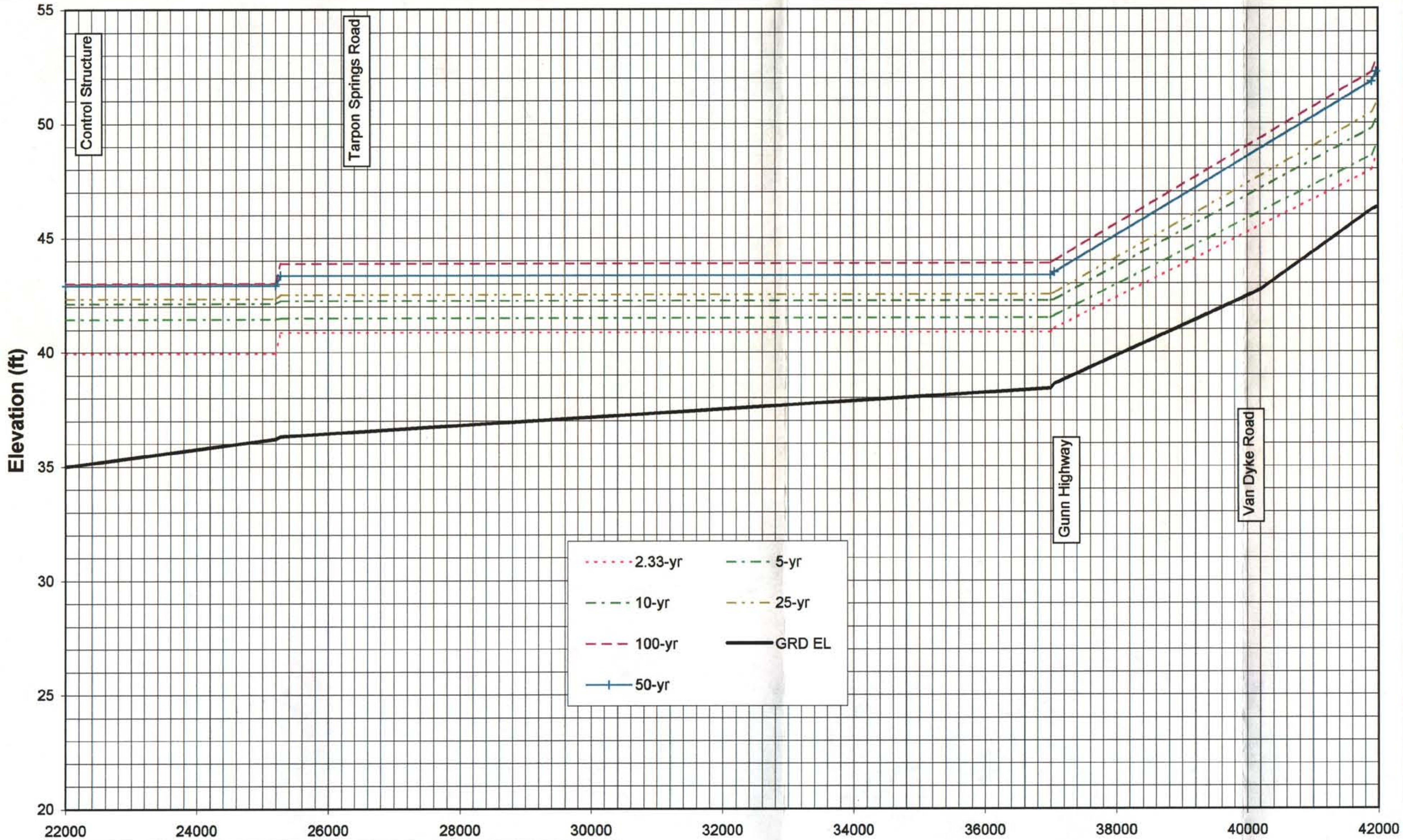
Preliminary--Subject To Revision
Note: The elevations shown on this exhibit are the maximums which occurred during the computed simulation period and do not define instantaneous profiles. These profiles are based on results from the Hillsborough County Modified SWMM Model. The SWMM model runs were based on an assumed tailwater condition at the County boundary.

Exhibit1

Brooker Creek
Computed Water Surface Profiles
Sheet 1 of 2

Brooker Creek

Existing Conditions Model
(July 1998)



Preliminary--Subject To Revision
Note: The elevations shown on this exhibit are the maximums which occurred during the computed simulation period and do not define instantaneous profiles. These profiles are based on results from the Hillsborough County Modified SWMM Model. The SWMM model runs were based on an assumed tailwater condition at the County boundary.

Exhibit1

Brooker Creek
Computed Water Surface Profiles
Sheet 2 of 2

Brooker Creek

Existing Conditions Model
(July 1998)

EXHIBIT 2
Water Surface Profiles
Brooker Creek Existing Conditions

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EXHIBIT 3
Lake Surface Elevation
Existing Conditions (1 of 5)

Exhibit 3

Lake Surface Elevations

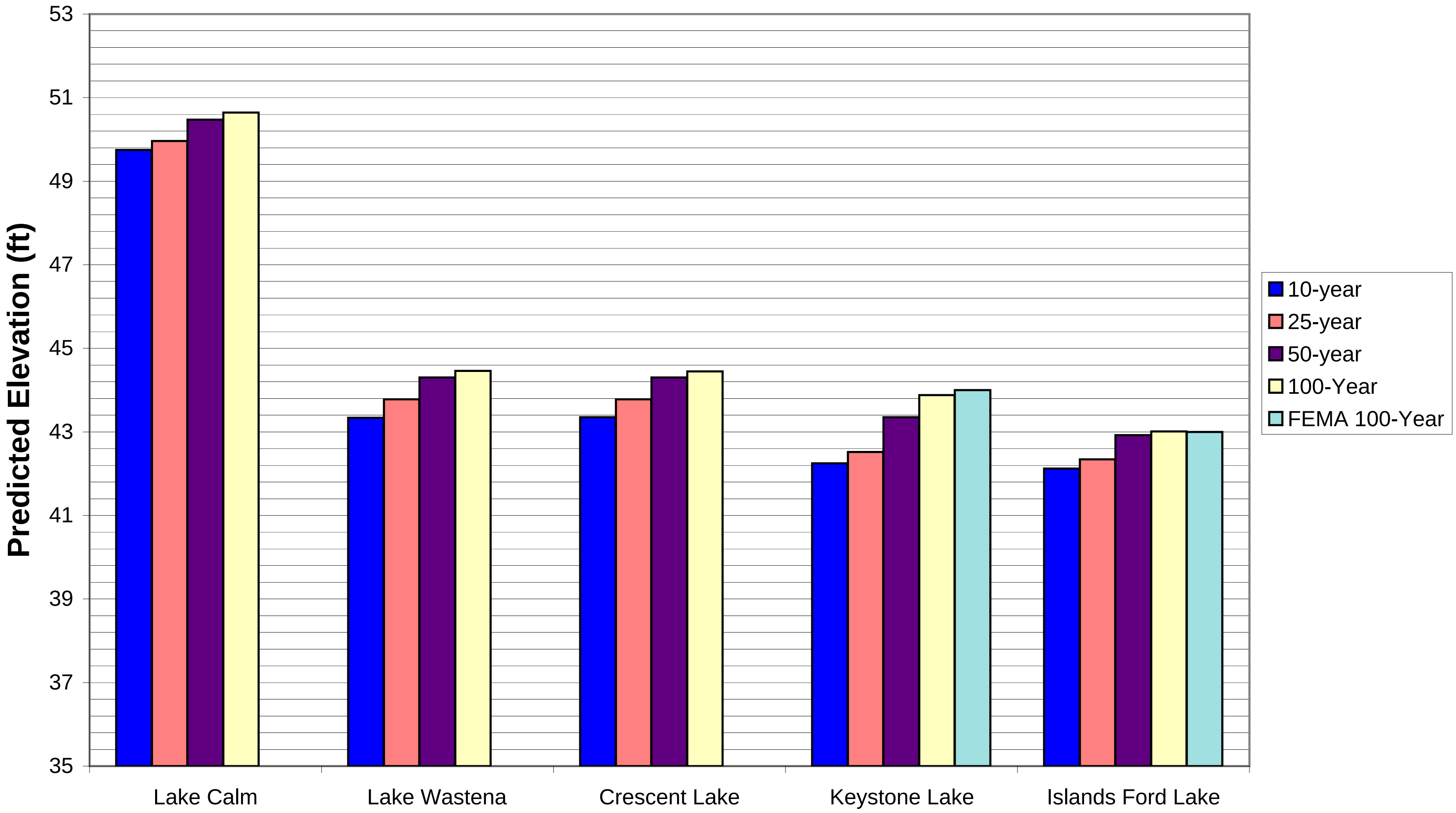

EXHIBIT 4
Lake Surface Elevation
Existing Conditions (2 of 5)

Exhibit 4

Lake Surface Elevations

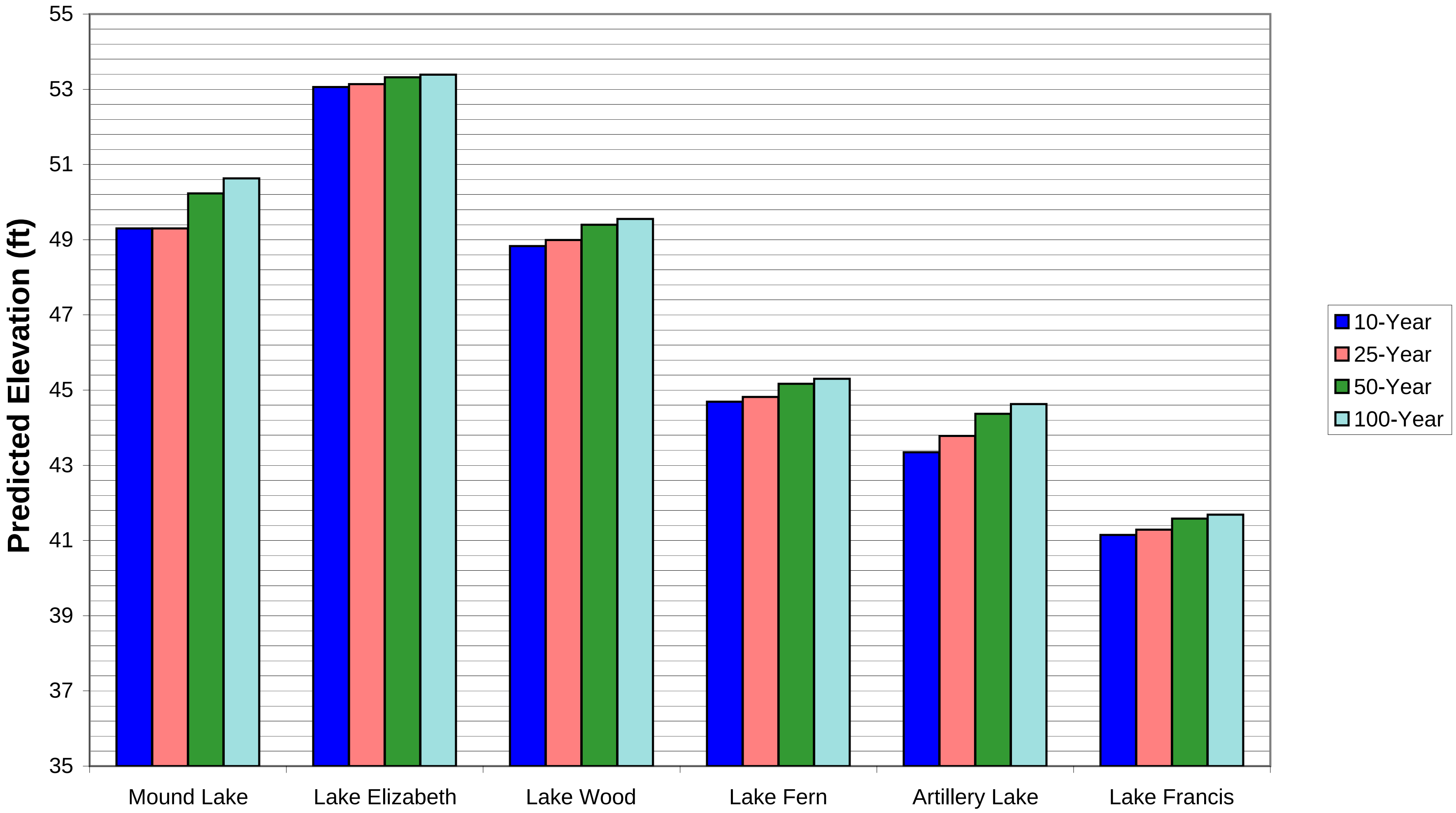

EXHIBIT 5
Lake Surface Elevation
Existing Conditions (3 of 5)

Exhibit 5

Lake Surface Elevations

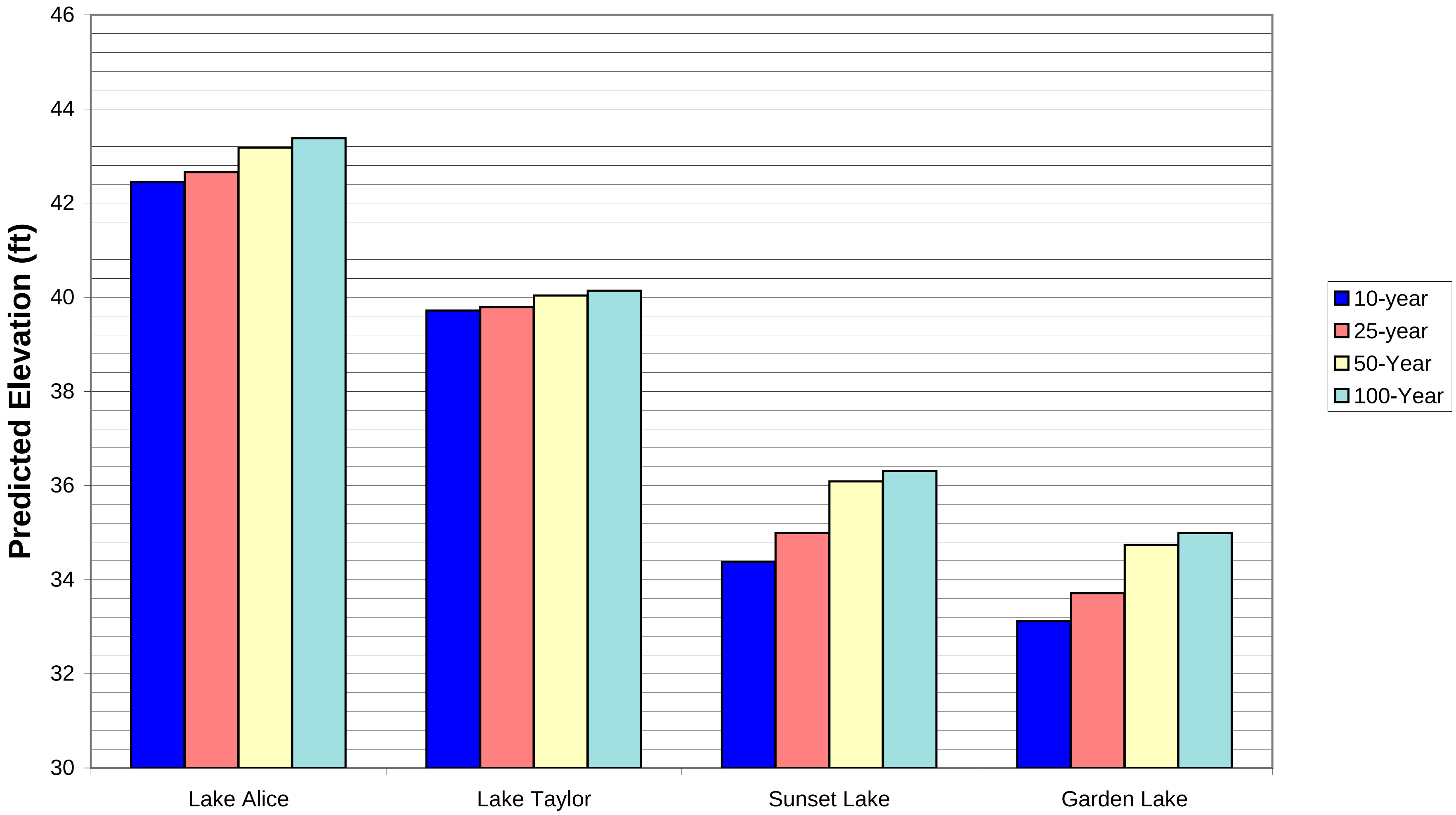

EXHIBIT 6
Lake Surface Elevation
Existing Conditions (4 of 5)

Exhibit 6

Lake Surface Elevations

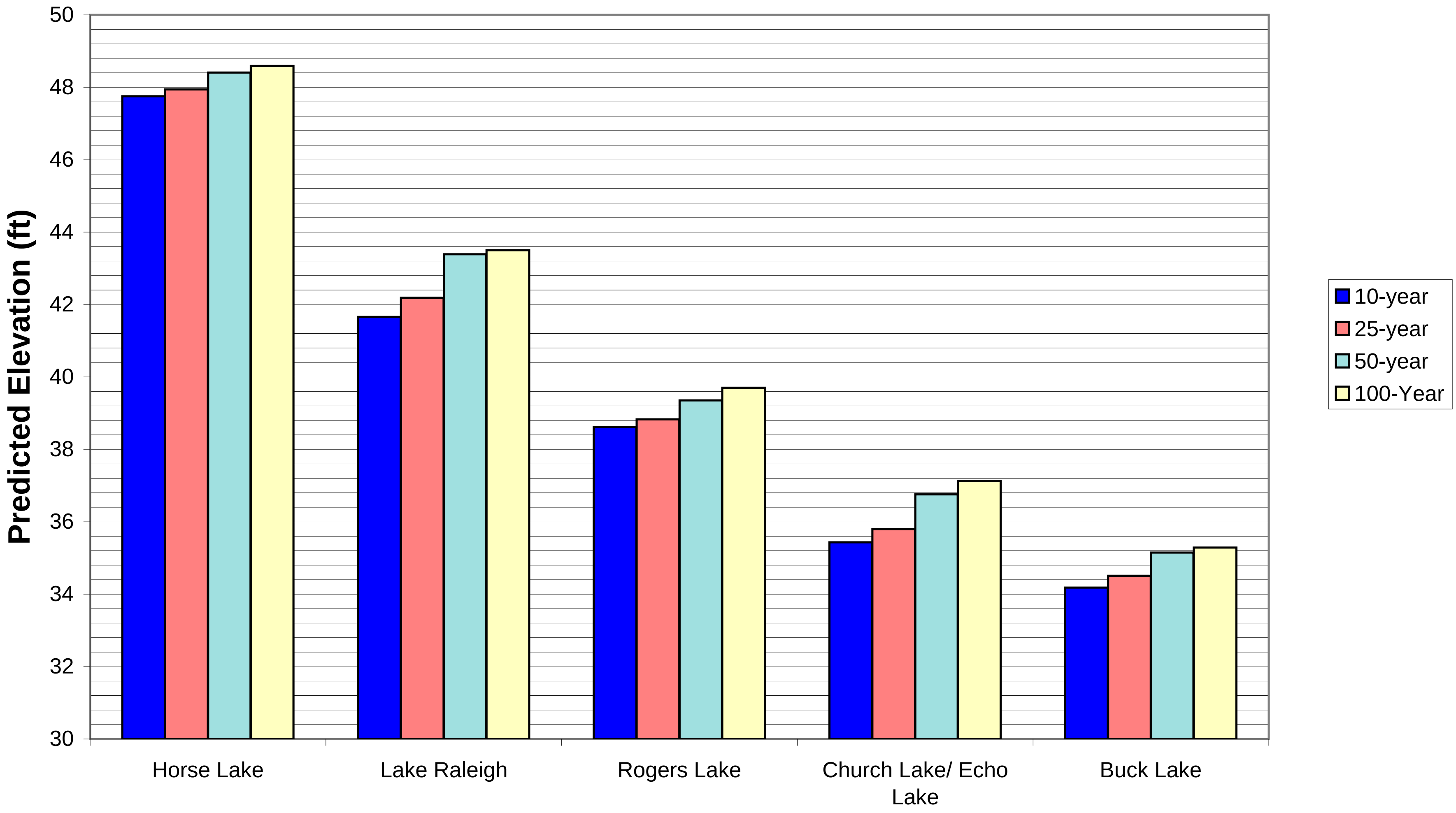

EXHIBIT 7
Lake Surface Elevation
Existing Conditions (5 of 5)

Exhibit 7

Lake Surface Elevations

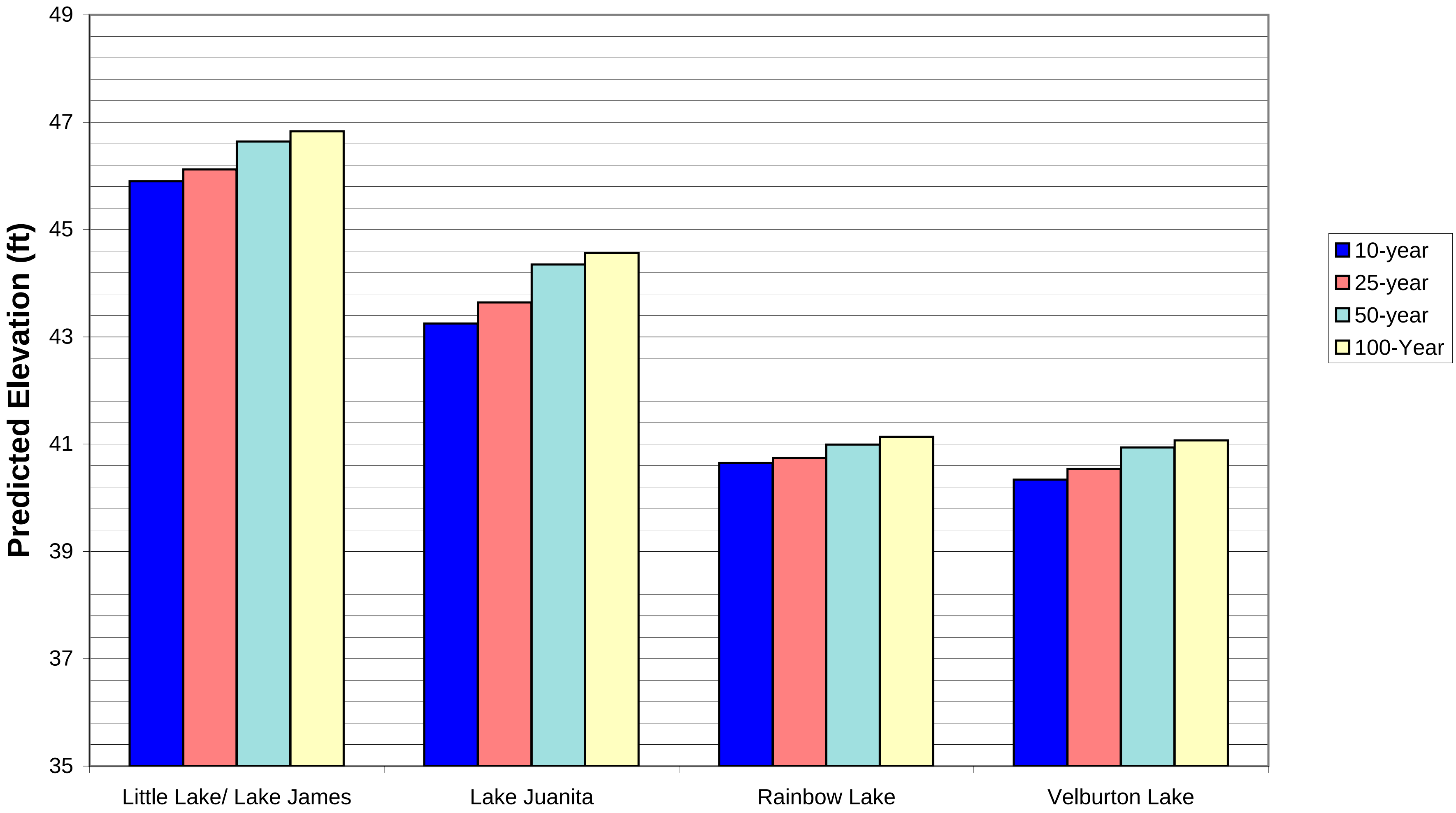

EXHIBIT 8
Brooker Creek Area Link-Node and Subbasin Map

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