CHAPTER 10: POLLUTANT LOADING AND REMOVAL MODEL

10.1 Overview

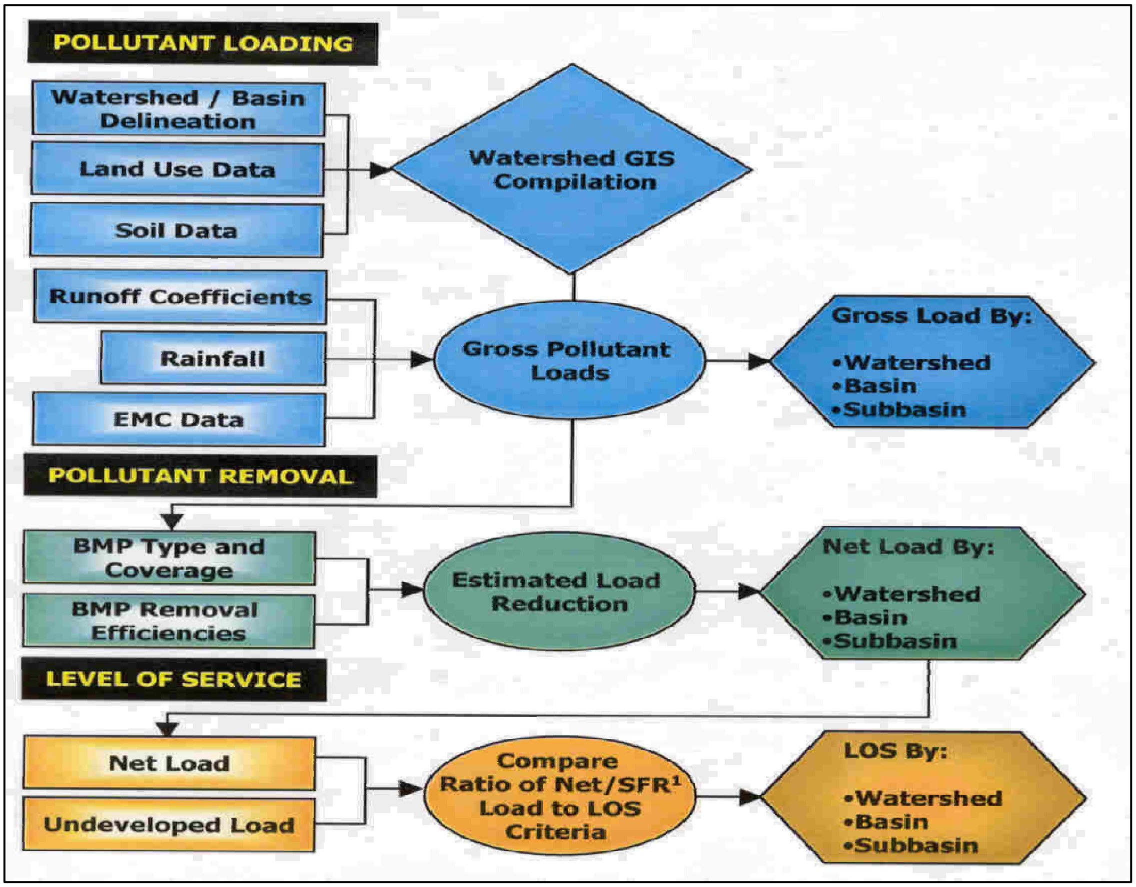
Potential water quality impacts resulting from stormwater runoff in the Rocky/Brushy Creek watershed were evaluated using the Pollutant Loading and Removal Model previously developed by Parsons Engineering Science, Inc. in conjunction with the Hillsborough County Public Works/Stormwater Management Section.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

- Estimate the potential water quality impacts resulting from the most current (2004) land use mapping and soils conditions
- Evaluate the reduction in potential loading due to the existing best management practices (BMP) within the watershed
- Evaluate future water quality conditions based on potential improvements or alternatives within a given 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.

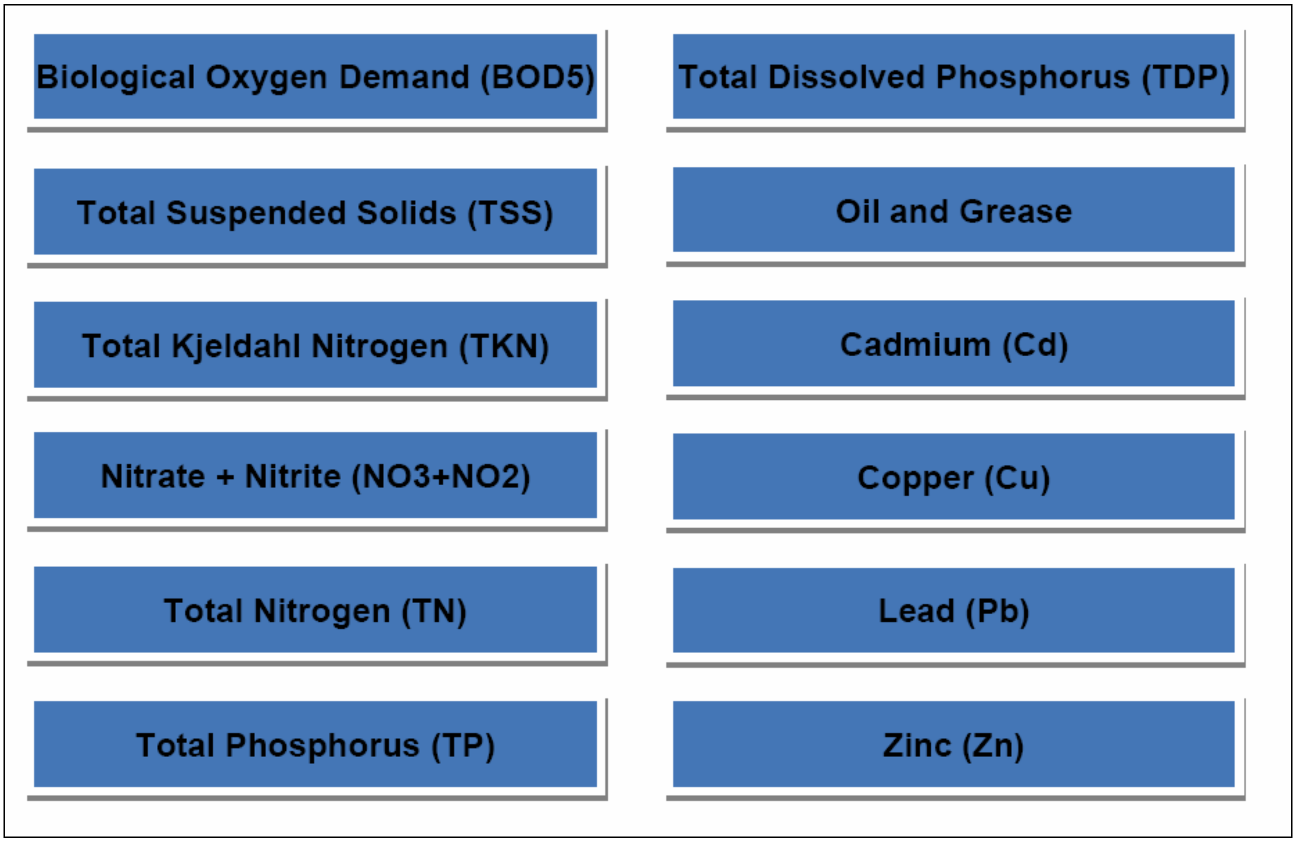


Figure 10-2 Pollutants Evaluated in the Pollutant Loading and Removal Model

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.

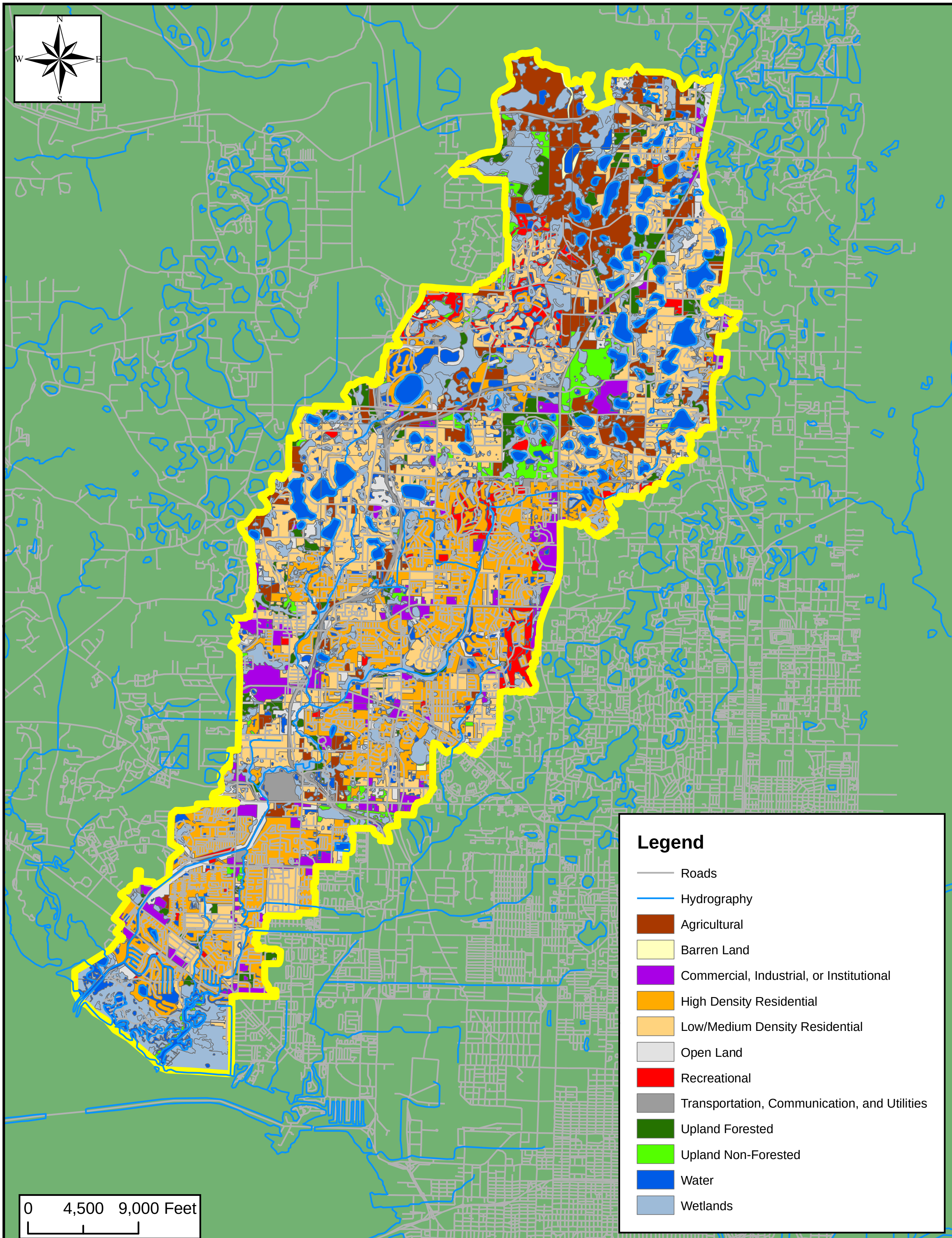
The land use categories evaluated for the pollutant loading model include:

- 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 Rocky/Brushy 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 Rocky/Brushy Creek Watershed 2004 Land Use Distribution

Land Use	Total Square Miles	Acreage	Percentage
Agricultural	13,558,219	3,350	8.8%
Barren Land	273,229	68	0.2%
Commercial, Industrial, or Institutional	7,269,970	1,796	4.7%
High Density Residential	31,641,436	7,819	20.5%
Low/Medium Density Residential	32,515,517	8,034	21.0%
Open Land	4,589,587	1,134	3.0%
Recreational	4,040,360	998	2.6%
Transportation, Communication, and Utilities	5,718,736	1,413	3.7%
Upland Forested	4,899,920	1,211	3.2%
Upland Non-Forested	3,435,335	849	2.2%
Water	15,353,140	3,793.8	9.9%
Wetlands	31,275,485	7,728.3	20.2%
TOTAL	**154,570,936**	**38,195.3**	**100.0%**



Land Use Distribution in the Rocky/Brushy Creek Watershed (2004)

Figure 10-3

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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.

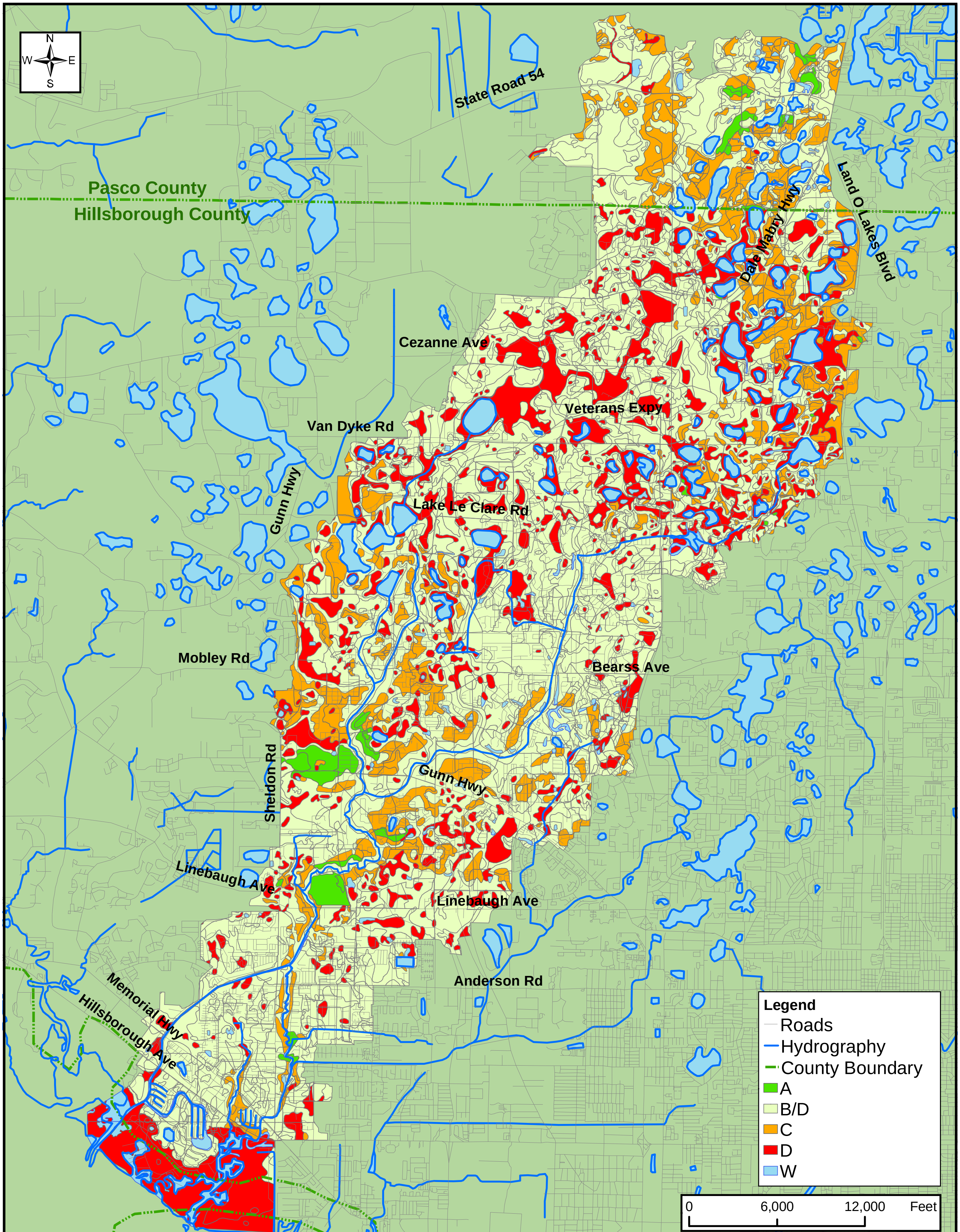
- **Group C** (moderately high runoff potential): Soils that have a slow infiltration rate when thoroughly wetted and a slow rate of water transmission. The soils under this group have a typical maximum infiltration rate of 5 in/hr when dry and 0.25 in/hr when saturated.

- **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 Rocky/Brushy Creek watershed. Table 10-2 presents a summary of the percent coverages of each of the hydrologic groups in the watershed.

Table 10-2 Rocky/Brushy Creek Watershed Soil Hydrologic Group Distribution

Soil Hydrologic Group	Acreage	Percentage
A	600	1.57%
B/D	23,713	62.08%
C	4,916	12.87%
D	6,550	17.15%
Undetermined	5	0.01%
Water	2,416	6.33%
Total	**38,201**	**100.00%**



Hydrologic Soil Groups in the Rocky/Brushy 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

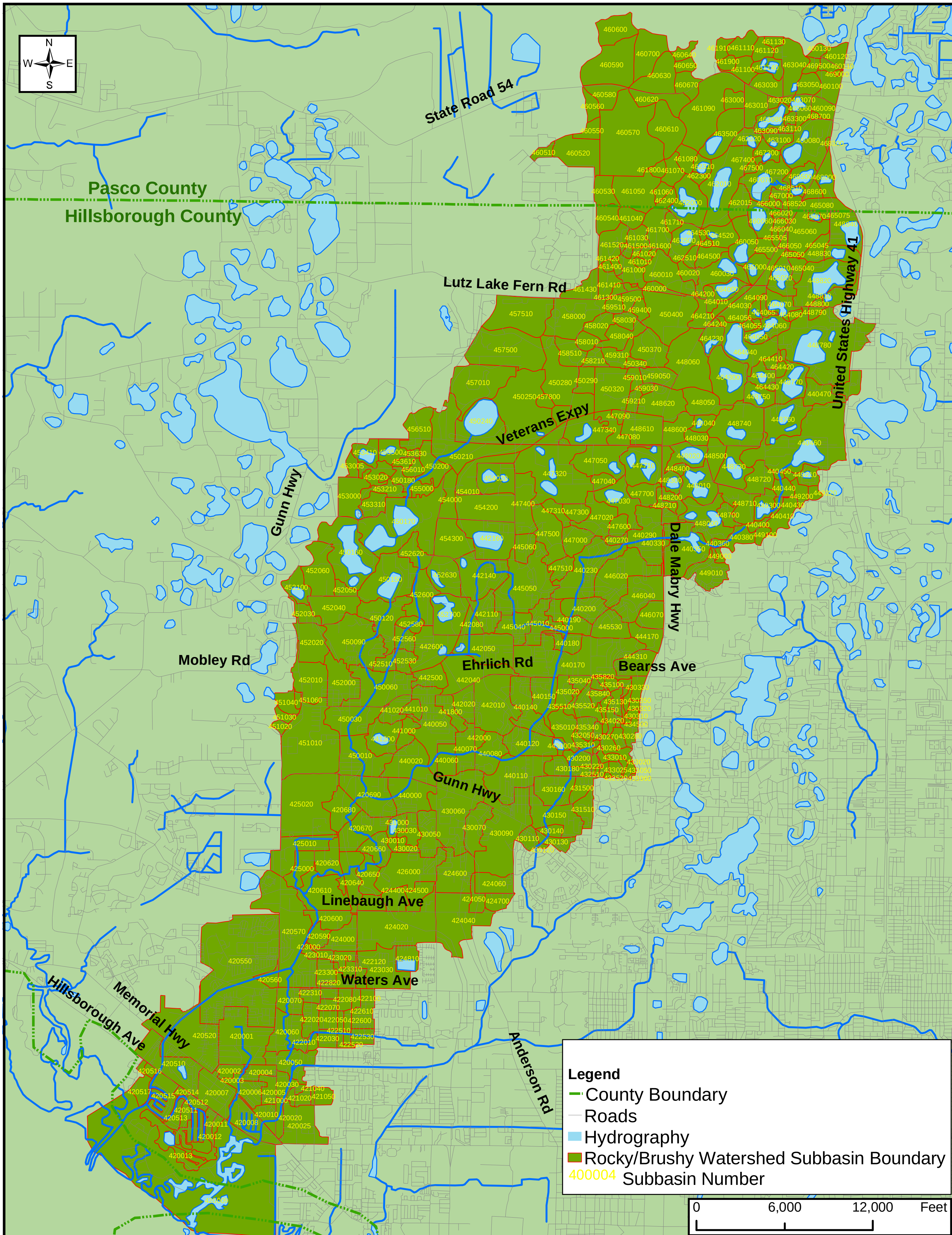
During the hydraulic analyses described earlier in Chapter 4, the Rocky/Brushy Creek watershed was divided into 474 subbasins representing approximately 38,202 acres (Figure 10-5). The model described herein was run at the subbasin level (to provide a fine level of detail) by comparing hydrologic, hydraulic, and runoff water quality characteristics of the watershed. The subbasins range in size from approximately 2 acres to more than 1,500 acres with an average size of about 80 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 Rocky/Brushy Creek Watershed

Figure 10-5

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

	NPDES Conventional WQ (mg/l)								NPDES Metals (mg/l)			
Land Use	**BOD_5**	**TSS**	**TKN**	**NO_3 $+NO_2$**	**TN**	**TP**	**TDP**	**Oil and Grease**	**Cd**	**Cu**	**Pb**	**Zn**
Low/Medium Density Residential	1.00	19.00	1.082	0.281	1.363	0.401	0.282	1.080	0.001	0.013	0.008	0.022
High Density Residential	2.60	29.00	1.368	0.679	2.047	1.337	0.552	1.073	0.001	0.047	0.006	0.058
Light Industrial	2.87	18.20	2.088	0.187	2.275	0.332	0.187	3.663	0.001	0.024	0.006	0.096
Agricultural	18.30	12.70	2.167	0.803	2.970	2.349	1.223	0.500	0.013	0.041	0.003	0.017
Commercial	2.67	22.92	1.645	0.387	2.032	0.279	0.157	0.650	0.001	0.018	0.004	0.026
Institutional	2.67	22.92	1.645	0.387	2.032	0.279	0.157	0.650	0.001	0.018	0.004	0.026
Highway/Utility	24.00	261.00	2.990	1.140	4.130	0.120	0.300	0.400	0.040	0.103	0.960	0.410
Recreational	3.80	11.10	2.090	0.508	2.598	0.050	0.130	0.900	0.007	0.041	0.006	0.004
Open Land	3.80	11.10	2.090	0.508	2.598	0.050	0.130	0.900	0.001	0.001	0.001	0.006
Extractive (Mining)/Disturbed	28.94	13.20	3.500	0.030	3.530	0.194	0.134	0.900	0.001	0.001	0.001	0.006
Upland Forest	0	0	0	0	0	0	0	0	0	0	0	0
Wetland Forest	0	0	0	0	0	0	0	0	0	0	0	0
Wetland Non-Forested	0	0	0	0	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0	0	0	0	0

Note:

1. FLUCCS code (FDOT 1985) ending in "0" indicates Level 1 (includes all subcategories).
2. Stormwater characterization stations for NPDES permit (Hills. Co., 1993); "NA" - not analyzed.

NPDES parameters: BOD5, COD, TSS, TDS, TKN, NO3+NO2, TP, DP, O&G; cadmium, copper, lead, zinc.

All EMC values without footnotes were obtained from samples collected for the Hills. Co. NPDES Permit Application (1994).

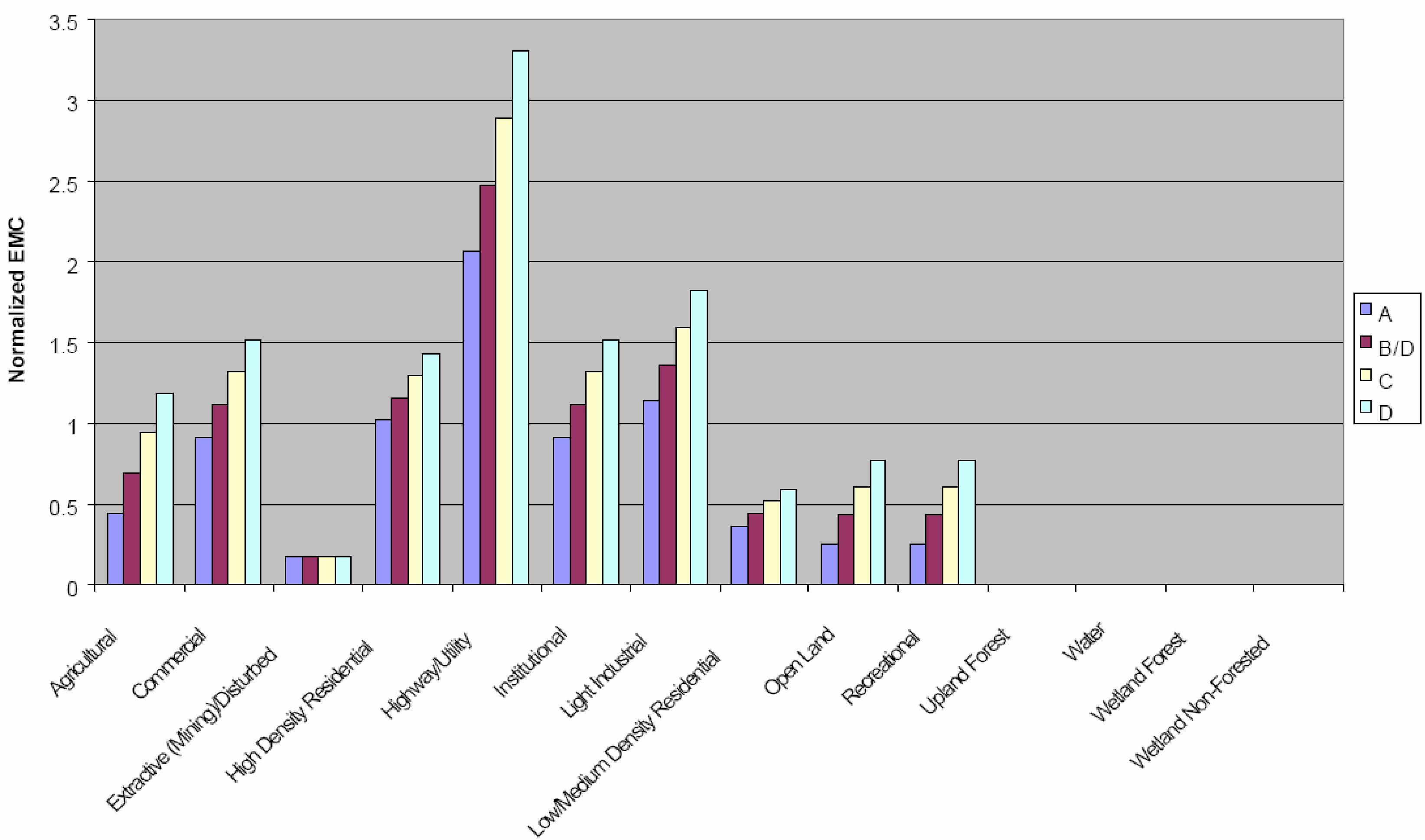
For parameters not detected in all samples, EMCs were calculated using one-half the reporting limit for nondetects.

"BDL" - indicates below detection limits for all Hills. Co. samples collected for a particular land use.

For pollutants not reported by Hills. Co. (1994), 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).

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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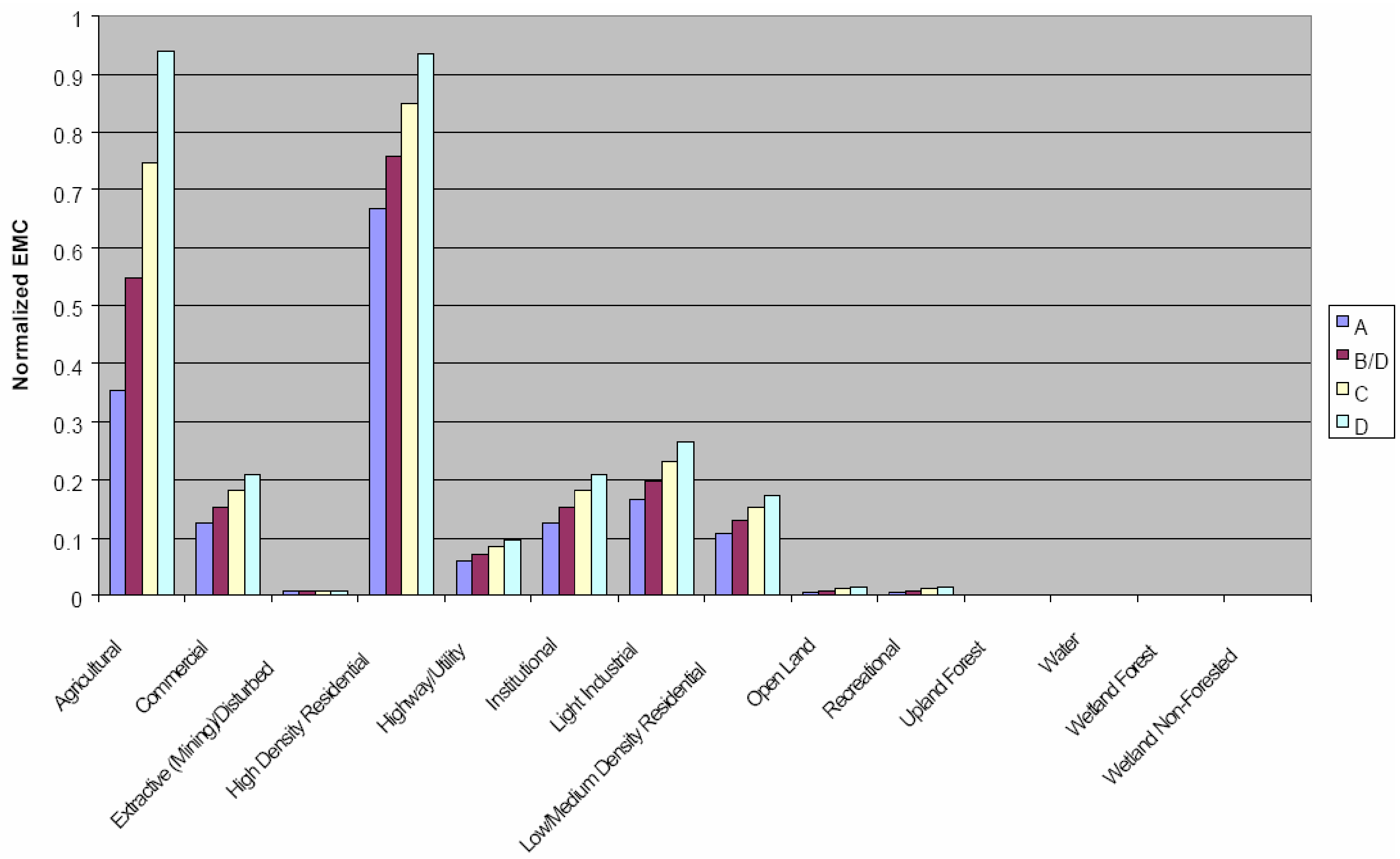
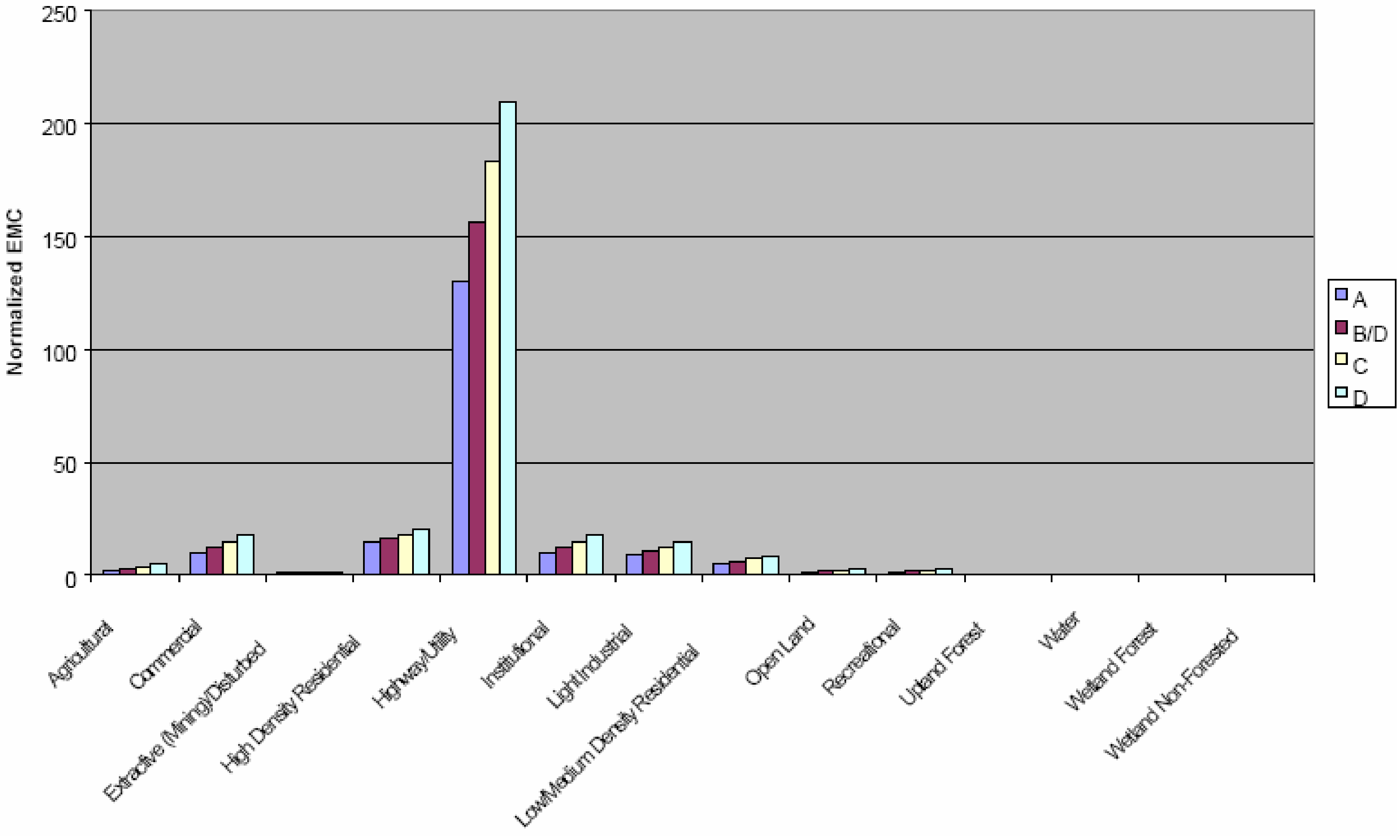


Total Phosphorus Loading Potential by Land Use and Hydrologic Group

Figure 10-7



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

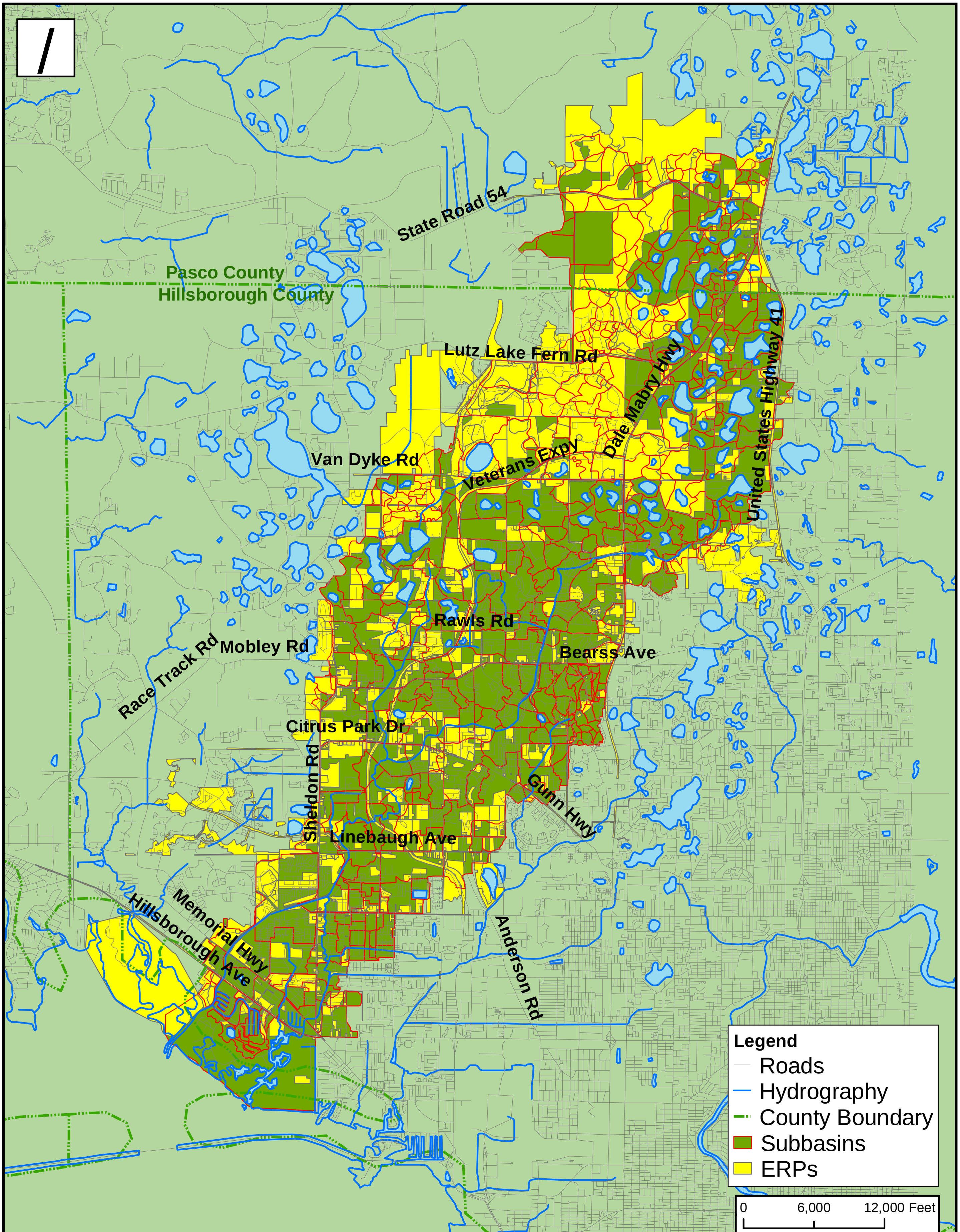
Source:

[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 Rocky/Brushy 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)

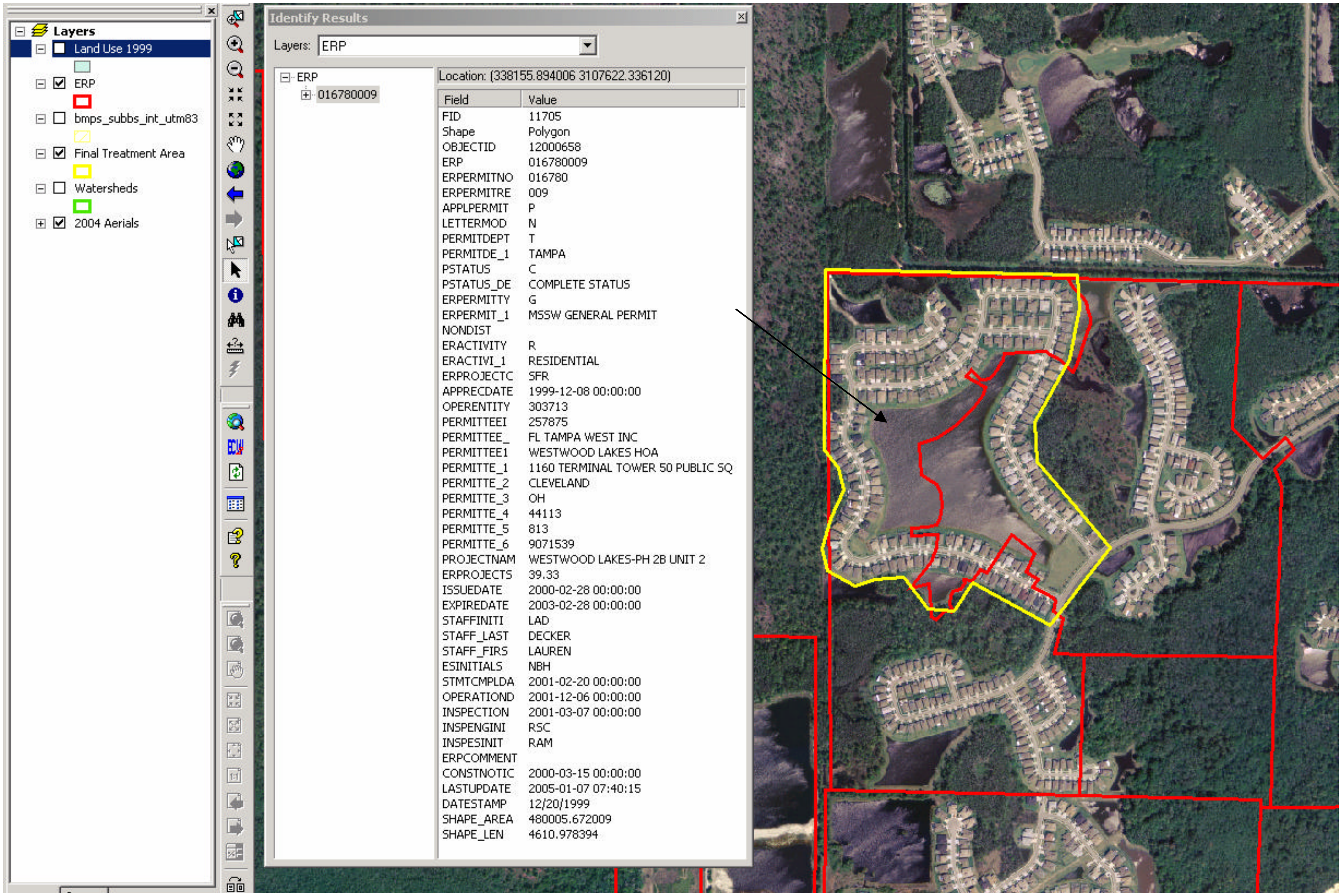
The percent of treated area within a subbasin for a particular land use was estimated by utilizing all of the available resources to pinpoint treatment ponds, treatment ditches and other recognized treatment practices. For this model, only those treatment areas that were man-made were considered. Although 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 1,254 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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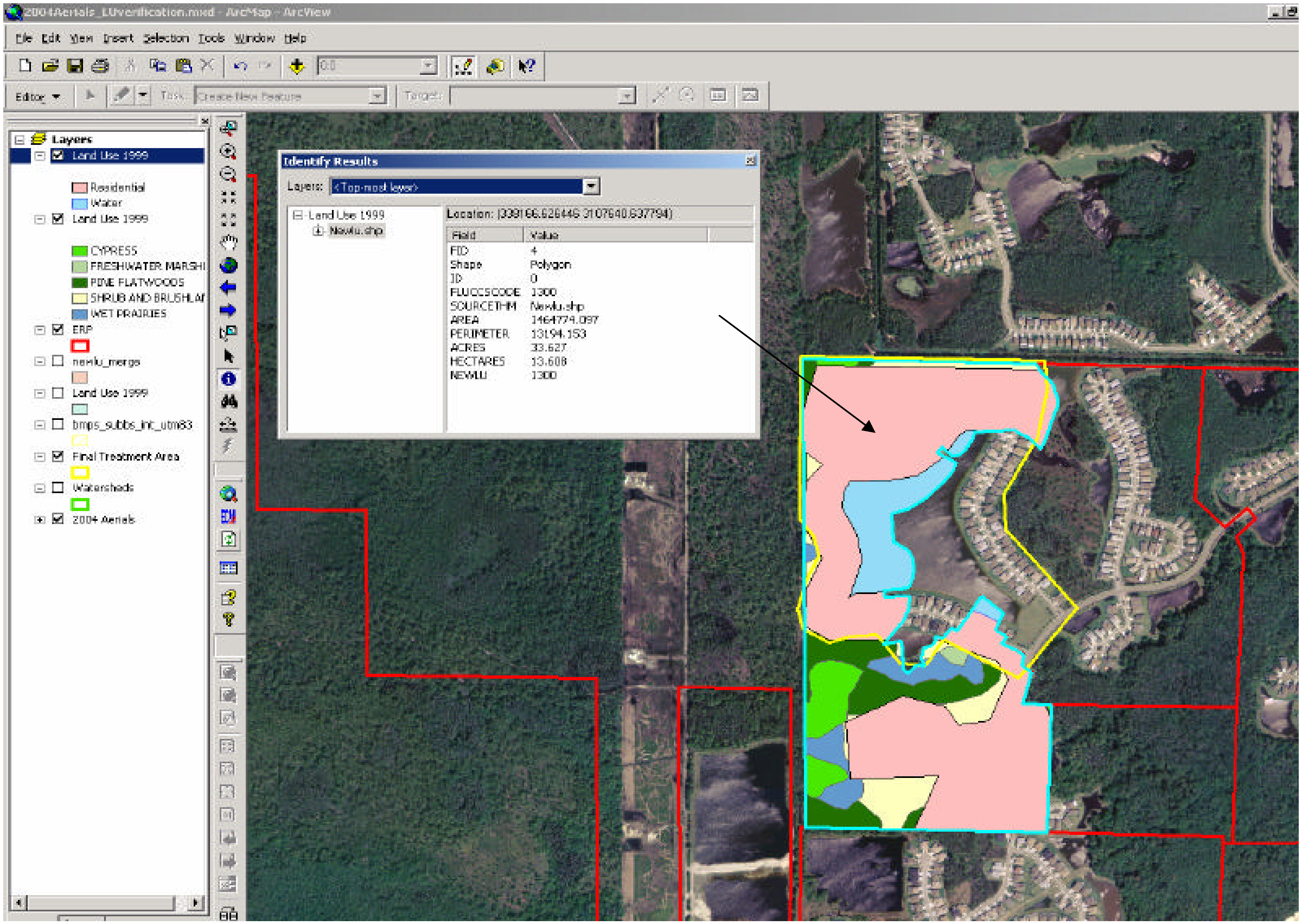
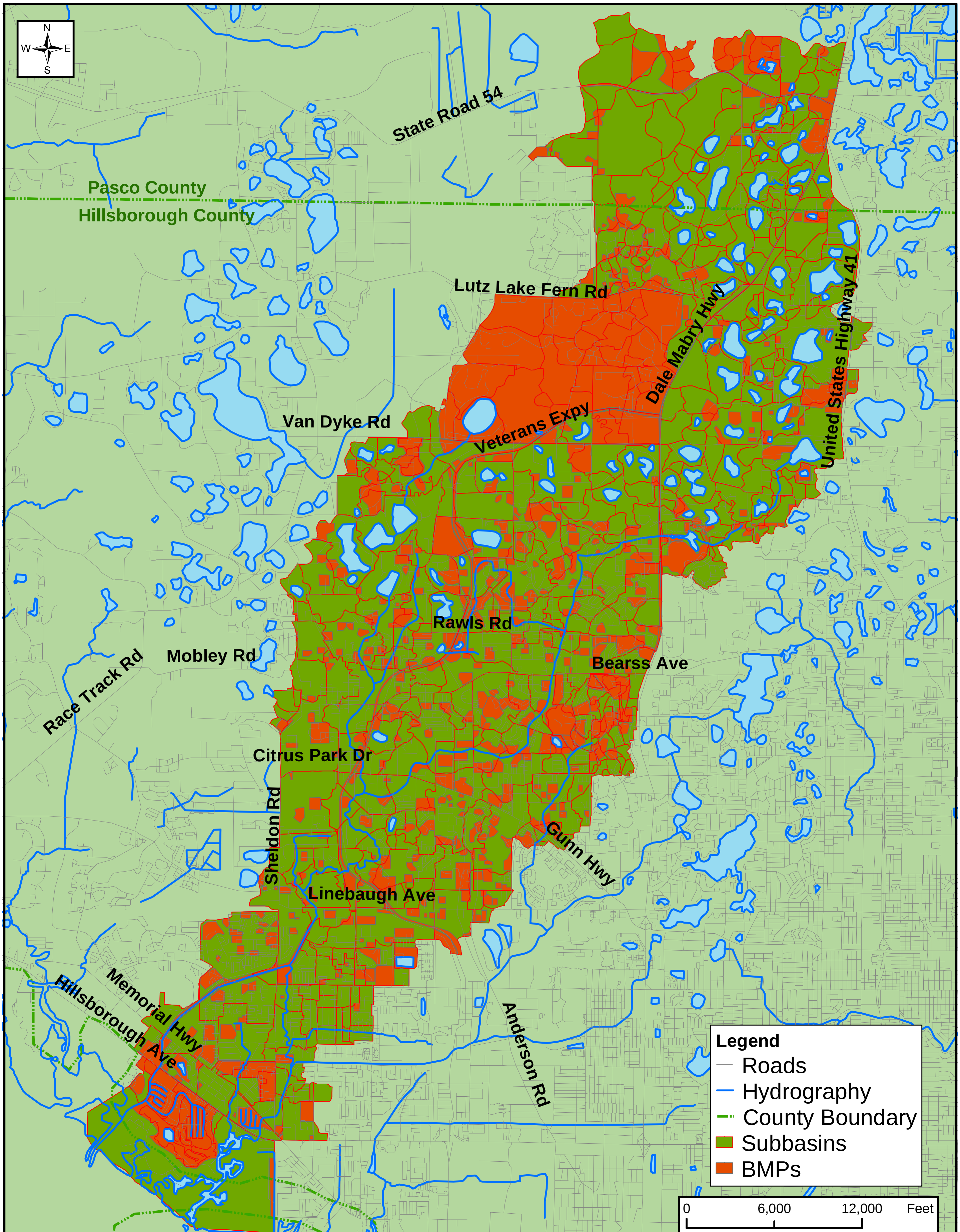


Identification of Treatment Areas

Figure 10-11



Digitized Locations of BMPs and Treatment Areas in the Rocky/Brushy 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) be 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.

BMPs identified in the Rocky/Brushy Creek watershed were either retention ponds or grass swales. Distinct concentrations of ERP locations and BMPs were observed in the northern portion of the watershed, north of the Van Dyke Road and west of the Dale Mabry Highway. A number of wet detention ponds were found in residential areas that are currently under construction, including neighborhoods along Lutz Lake Fern Road and Van Dyke Road, as well as existing neighborhoods located throughout the watershed.

It is important to note that the pollutant loads generated from this modeling effort are based on the 2004 aerial photography and 2004 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_I = $(0.227)(P)(CF)(Rv_I)(C_I)(A_I)$

where:

L_I = annual pollutant load per basin (lb/yr)
P = annual average precipitation (in/yr)
Rv_I = weighted average runoff coefficient based on impervious area
C_I = event mean concentration of pollutant (mg/L)
A_I = 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.

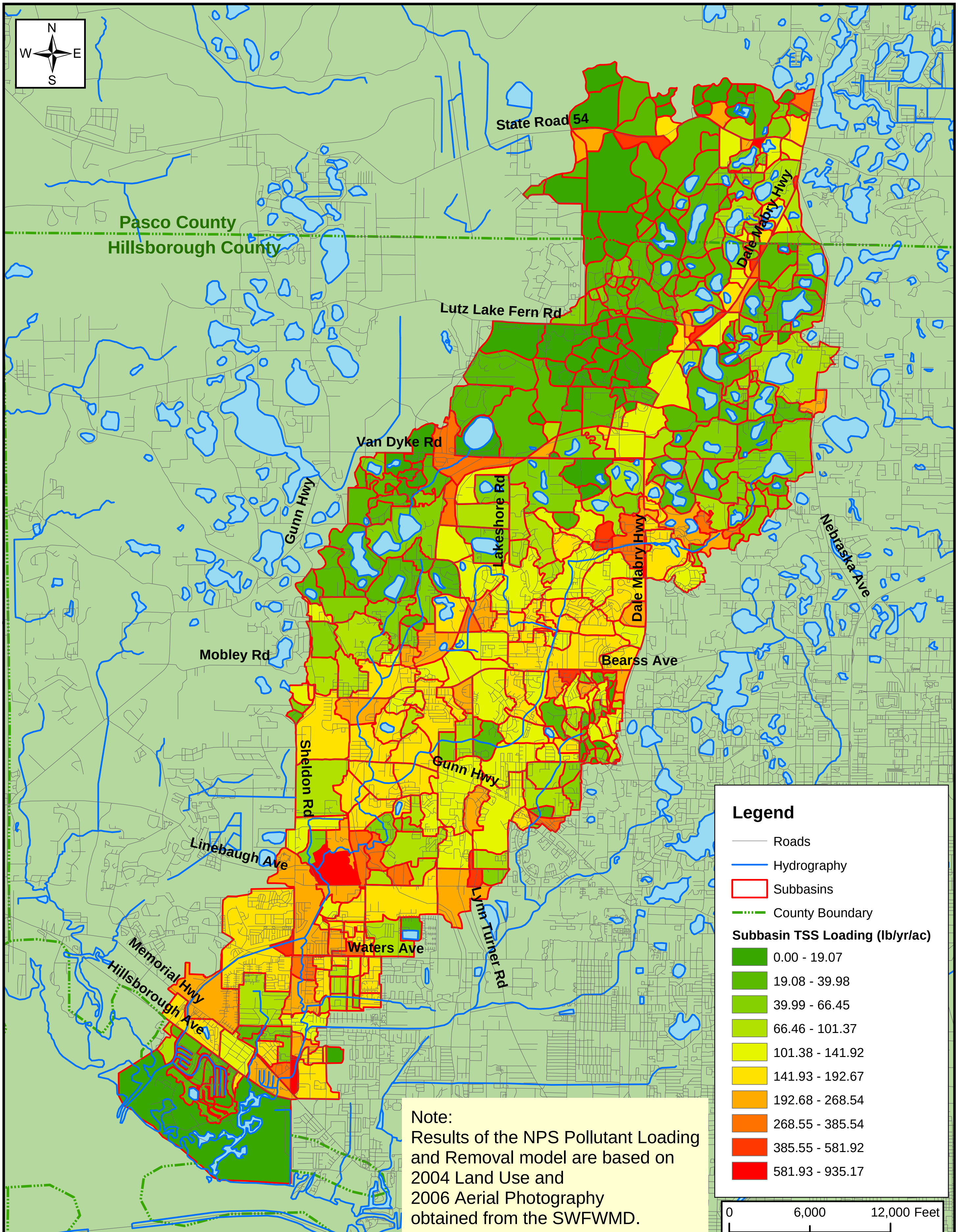
10.3.2 Annual Net Pollutant Loads

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 Rocky/Brushy Creek Watershed (lb/yr)

BOD5	TSS	TKN	NO3 +NO2	TN	TP	TDP	Oil and Grease	Cd	Cu	Pb	Zn
543,026	3,459,927	168,466	49,592	216,510	89,191	50,422	106,293	571	3,903	6,838	5,809

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 Rocky/Brushy 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 Rocky/Brushy Creek Watershed

Figure 10-13

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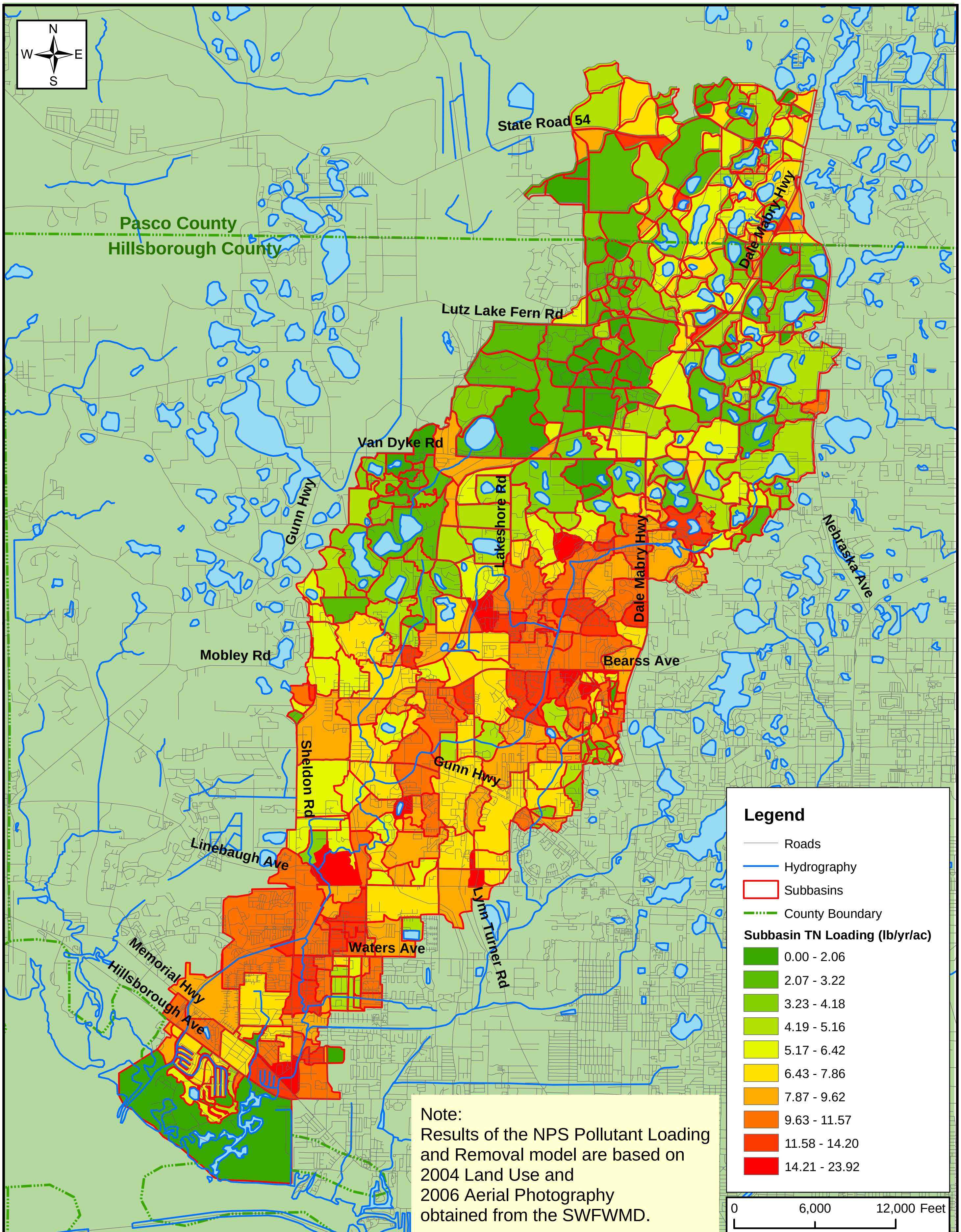

Subbasin Loads for TN (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-14

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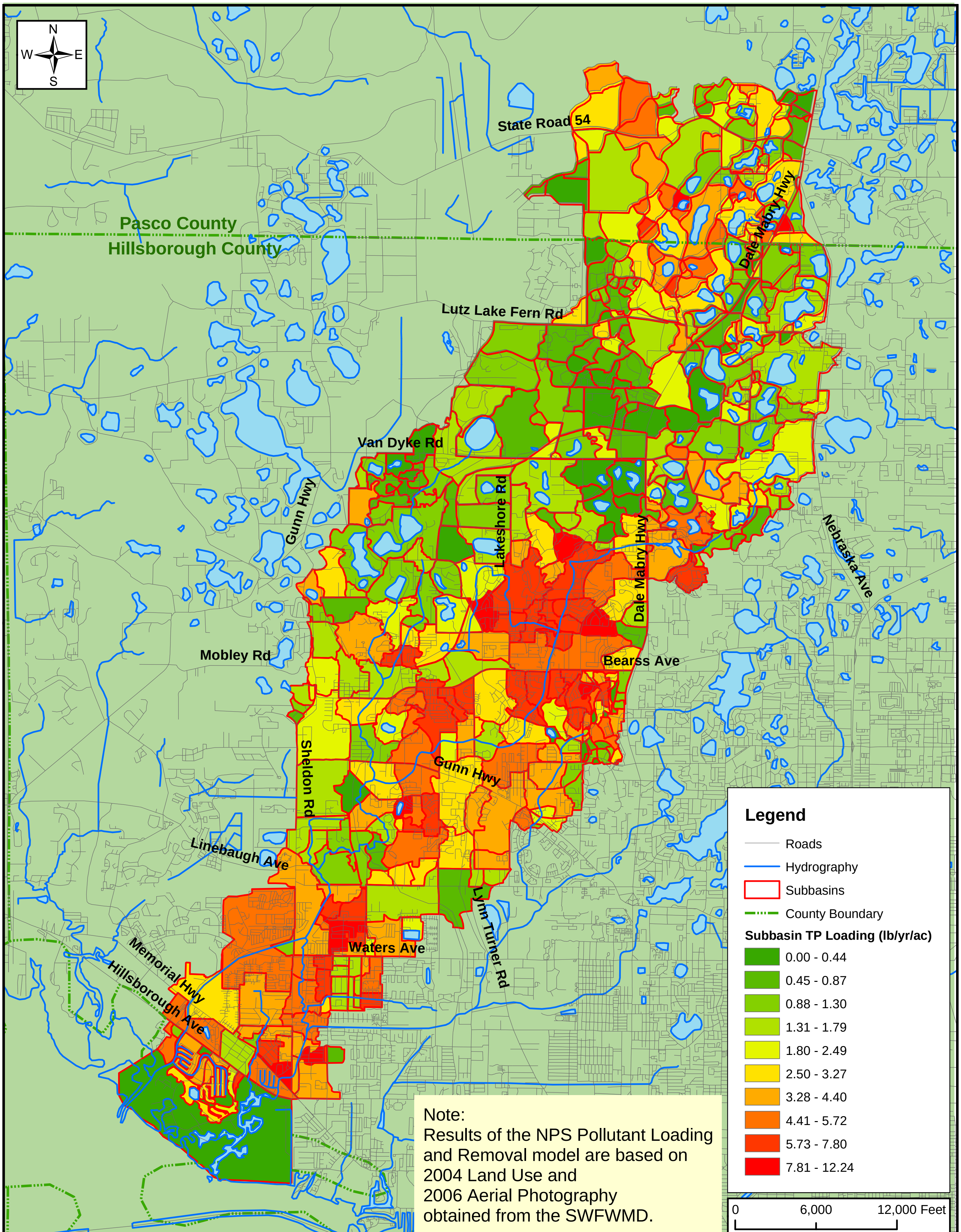

Subbasin Loads for TP (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-15

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Total Suspended Solids

Total suspended solids loading values were greatest in subbasins that contained high density residential and highway/utility land uses (Figure 10-13). Rocky/Brushy Creek watershed is characterized by highly developed areas. It contains a number of densely populated neighborhoods, large commercial and institutional polygons, and a number of major highways. These 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 and highway/utilities land use within the watershed. For example, subbasins located to the west of Dale Mabry Highway and to the north of Bearss Avenue belong to Northdale, while subbasins to the east of Sheldon Road fall into the Citrus Park area. Figure 10-7 previously illustrated that the highway/utilities land use category exhibit the highest degree of loading for TSS out of all other land use types. Rocky/Brushy Creek watershed contains over 1,200 acres of highway/utilities land use category, which represents only 3.23% of the entire watershed, yet is responsible for over 47 percent of the entire TSS load for the watershed.

The high percentage of coverage for residential land use within the watershed (over 40 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 Rocky/Brushy Creek watershed.

Table 10-7 TSS Contribution from Various Land Uses within the Rocky/Brushy Creek Watershed

Land Use	Acreage	TSS Loading (lb/yr)	Percent of Land Use Cover	Percent of TSS Loading
Agricultural	3,360	104,097	8.80%	3.01%
Commercial	1,052	105,993	2.75%	3.06%
Extractive (Mining)/Disturbed	191	656	0.50%	0.02%
High Density Residential	7,781	1,035,395	20.37%	29.93%
Highway/Utility	1,233	1,651,073	3.23%	47.72%
Institutional	361	47,136	0.94%	1.36%
Light Industrial	90	8,399	0.24%	0.24%
Low/Medium Density Residential	7,935	439,886	20.77%	12.71%
Open Land	2,732	54,473	7.15%	1.57%
Recreational	973	12,818	2.55%	0.37%
Upland Forest	1,248	0	3.27%	0.00%
Water	3,515	0	9.20%	0.00%
Wetland Forest	5,939	0	15.55%	0.00%
Wetland Non-Forested	1,794	0	4.70%	0.00%
Grand Total	**38,203**	**3,459,927**	**100.00%**	**100.00%**

Lowest loading values were found in subbasins having less development. Subbasins to the north and east of the Rocky/Brushy Creek watershed primarily contain agricultural, wetlands, recreational, forested, low/medium density residential, and commercial land uses. 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 and central parts of the Rocky/Brushy 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. Residential, representing about 40% of the abovementioned subbasins, contributes approximately 57%, while highway/utilities land use adds additional 15% 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 northern portion of the watershed, as well as the southernmost subbasin. 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 Rocky/Brushy Creek Watershed

Land Use	Acreage	TN Loading (lb/yr)	Percent of Land Use Cover	Percent of TN Loading
Agricultural	3,360	26,697	8.80%	12.33%
Commercial	1,052	11,249	2.75%	5.20%
Extractive (Mining)/Disturbed	191	273	0.50%	0.13%
High Density Residential	7,781	86,822	20.37%	40.10%
Highway/Utility	1,233	32,204	3.23%	14.87%
Institutional	361	4,369	0.94%	2.02%
Light Industrial	90	1,234	0.24%	0.57%
Low/Medium Density Residential	7,935	35,870	20.77%	16.57%
Open Land	2,732	13,756	7.15%	6.35%
Recreational	973	4,036	2.55%	1.86%
Upland Forest	1,248	0	3.27%	0.00%
Water	3,515	0	9.20%	0.00%
Wetland Forest	5,939	0	15.55%	0.00%
Wetland Non-Forested	1,794	0	4.70%	0.00%
Grand Total	**38,203**	**216,510**	**100.00%**	**100.00%**

Total Phosphorus

Similarly to TN, for total phosphorus, greatest loading values were calculated for the southwestern and central parts of the Rocky/Brushy Creek watershed (Figure 10-15). Residential and agricultural areas were the major contributors of total phosphorus in these subbasins, accounting for over 95% 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 north and to the southernmost subbasin of the Rocky/Brushy 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 Rocky/Brushy Creek watershed

Land Use	Acreage	TP Loading (lb/yr)	Percent of Land Use Cover	Percent of TP Loading
Agricultural	3,360	20,703	8.80%	23.21%
Commercial	1,052	1,488	2.75%	1.67%
Extractive (Mining)/Disturbed	191	14	0.50%	0.02%
High Density Residential	7,781	54,714	20.37%	61.34%
Highway/Utility	1,233	899	3.23%	1.01%
Institutional	361	594	0.94%	0.67%
Light Industrial	90	174	0.24%	0.20%
Low/Medium Density Residential	7,935	10,271	20.77%	11.52%
Open Land	2,732	260	7.15%	0.29%
Recreational	973	73	2.55%	0.08%
Upland Forest	1,248	0	3.27%	0.00%
Water	3,515	0	9.20%	0.00%
Wetland Forest	5,939	0	15.55%	0.00%
Wetland Non-Forested	1,794	0	4.70%	0.00%
Grand Total	**38,203**	**89,191**	**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 Hillsborough County NPS Pollutant Loading and Removal 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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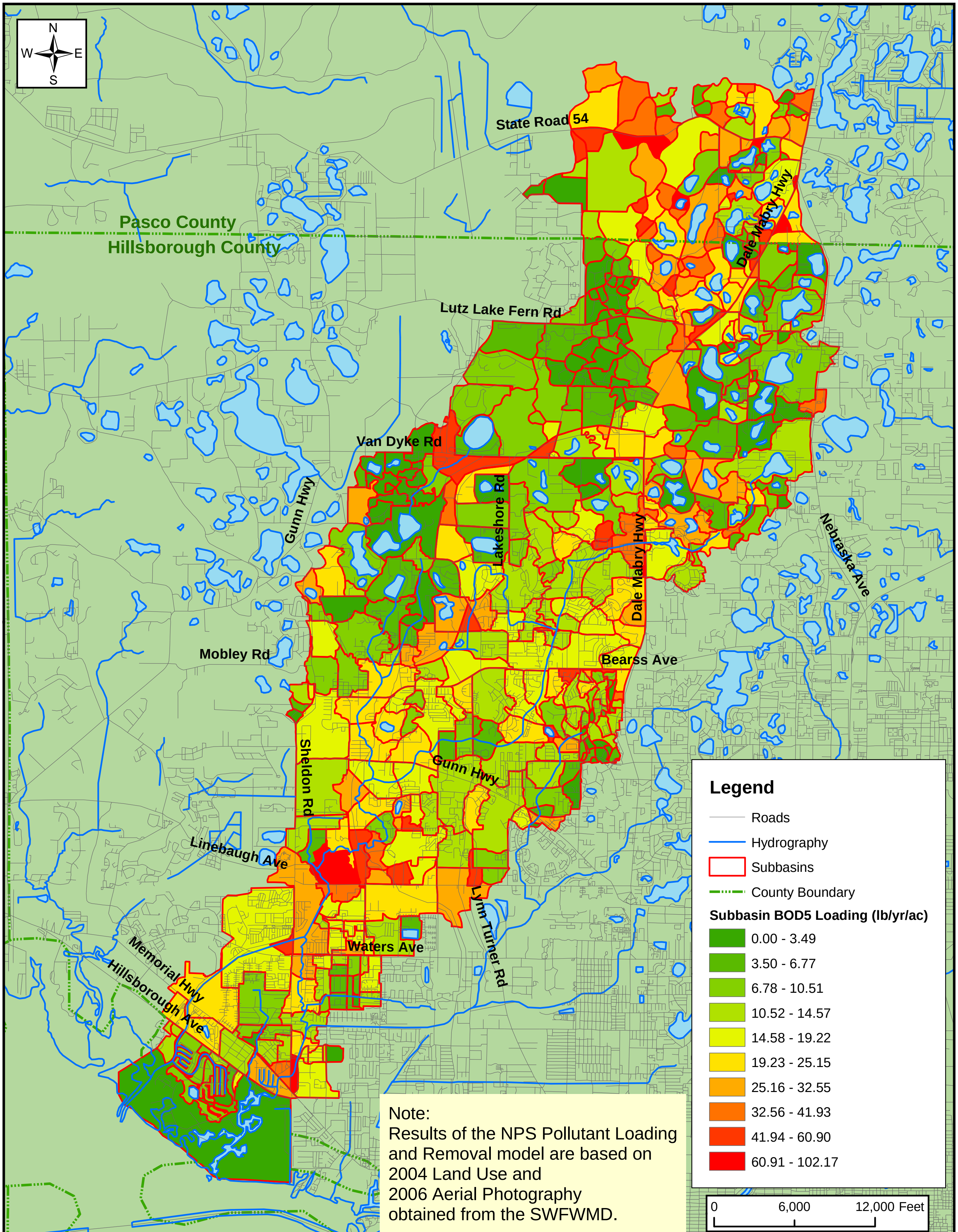

Subbasin Loads for BOD5 (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-A

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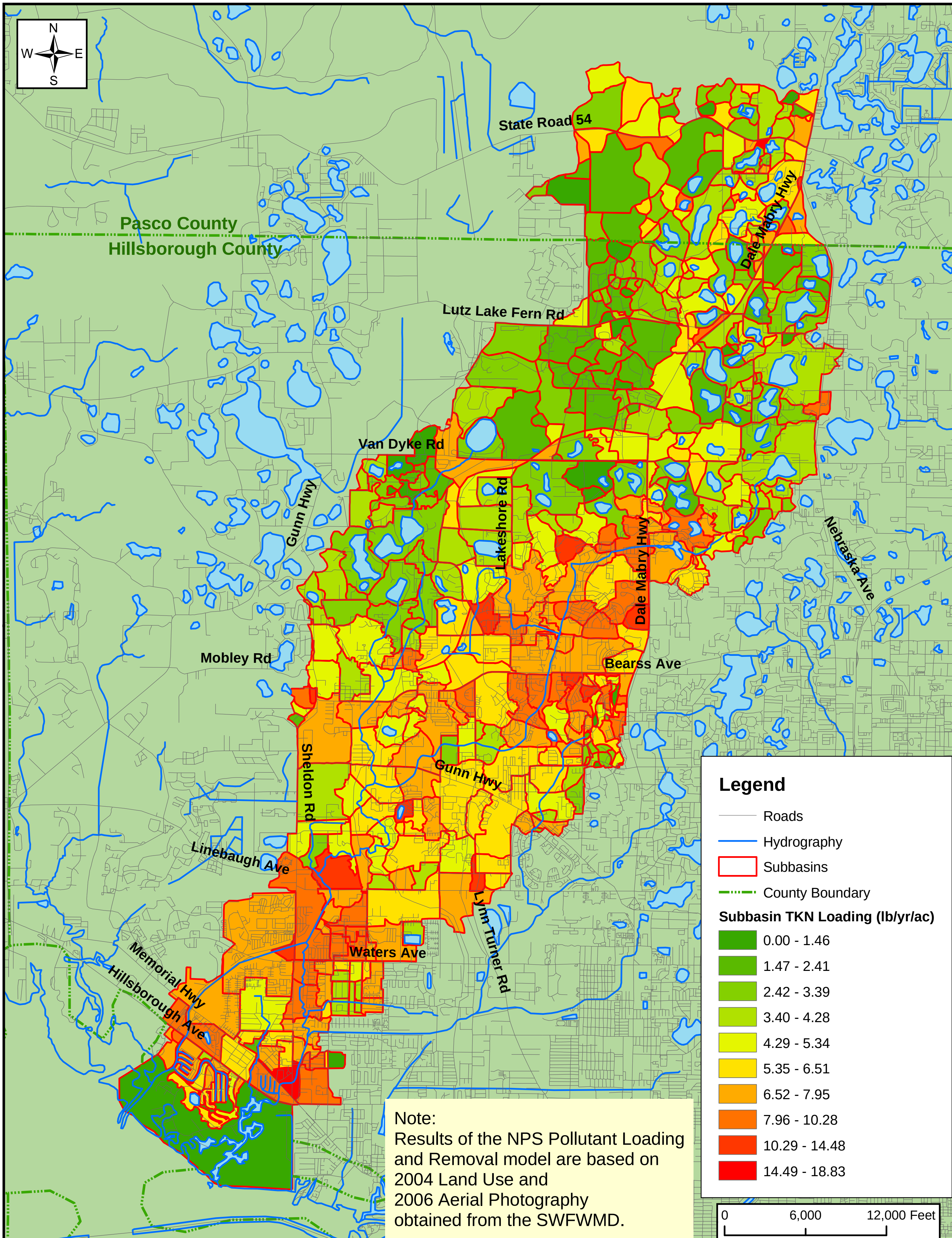

Subbasin Loads for TKN (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-B

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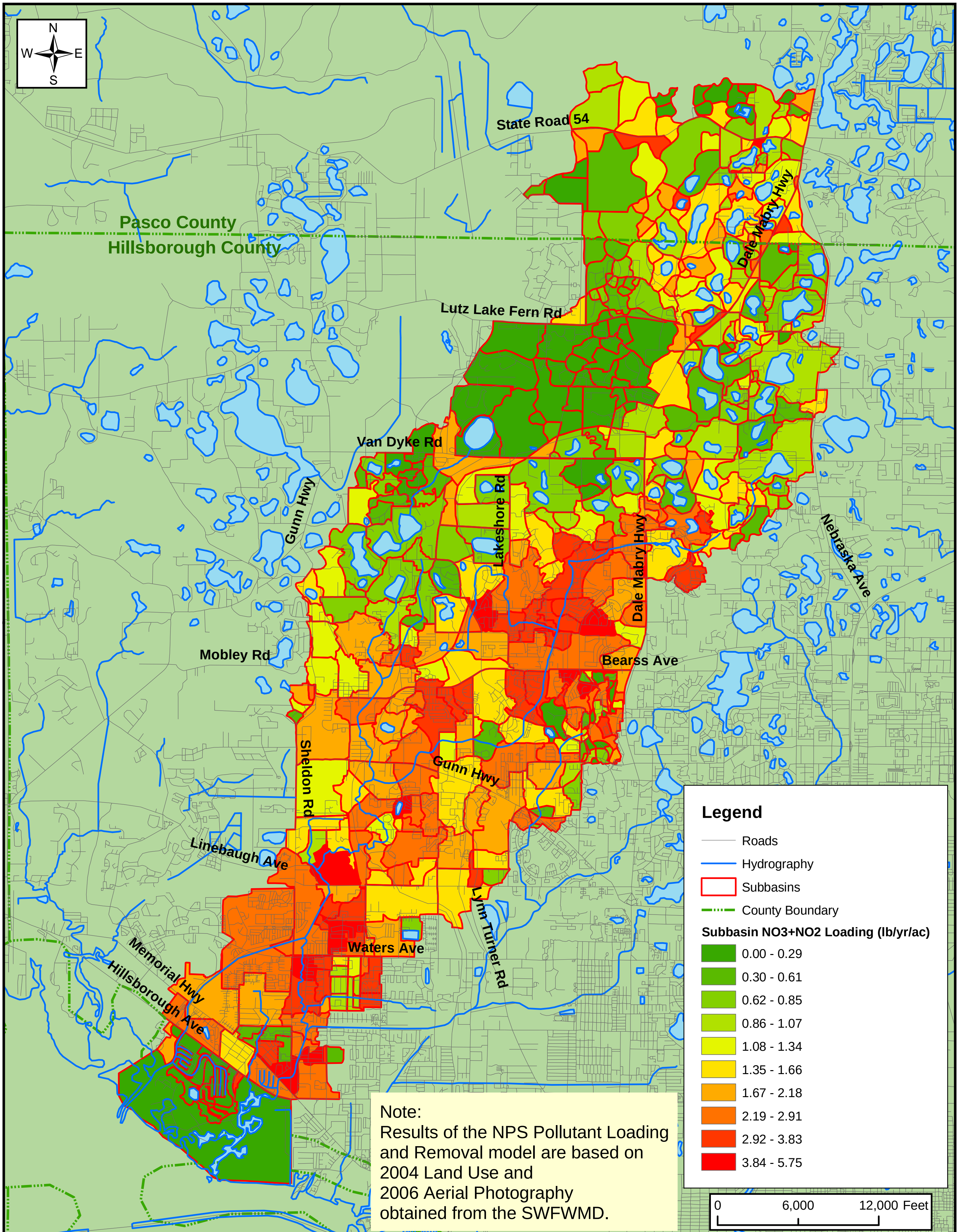

Subbasin Loads for Nitrate + Nitrite (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-C

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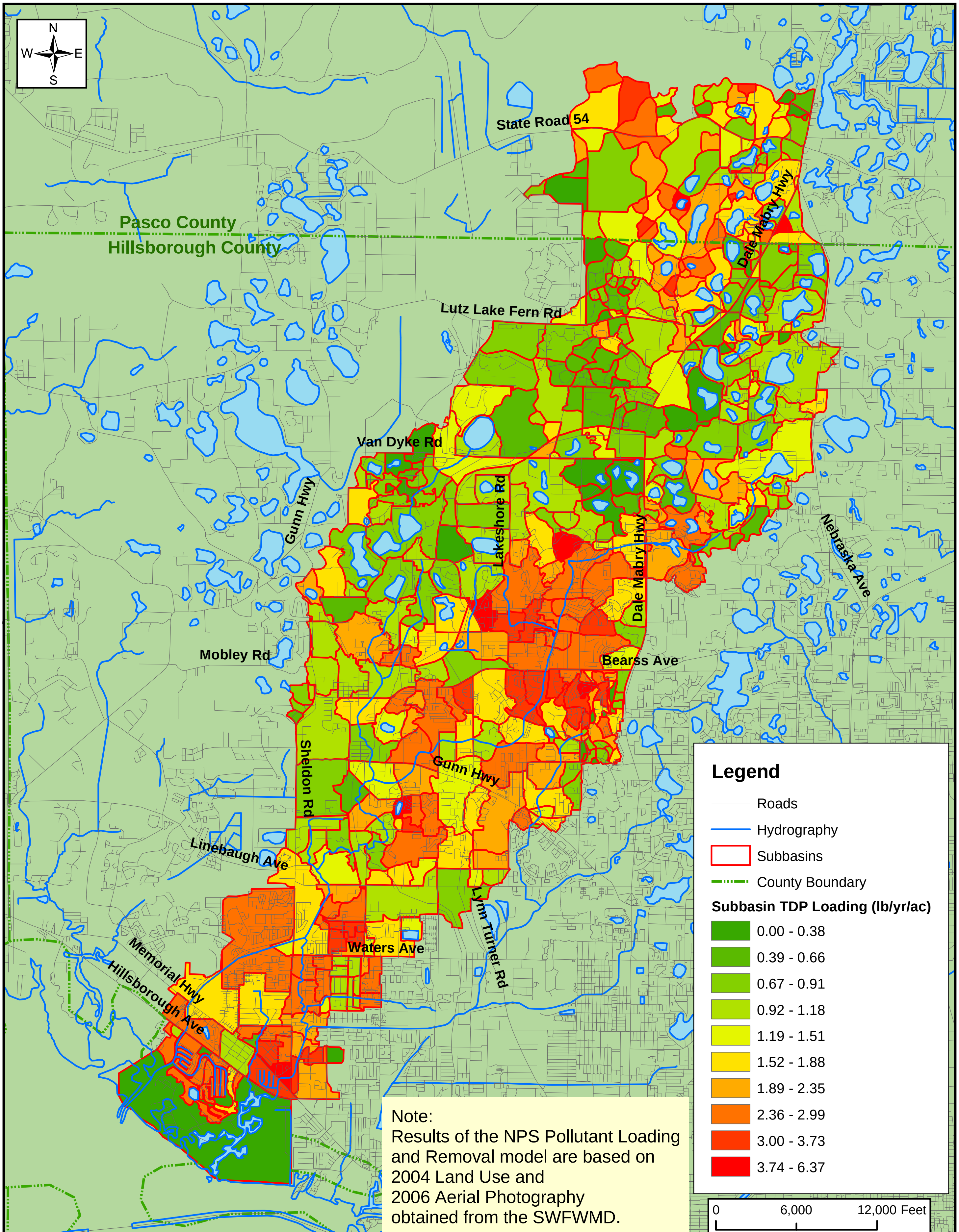

Subbasin Loads for TDP (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-D

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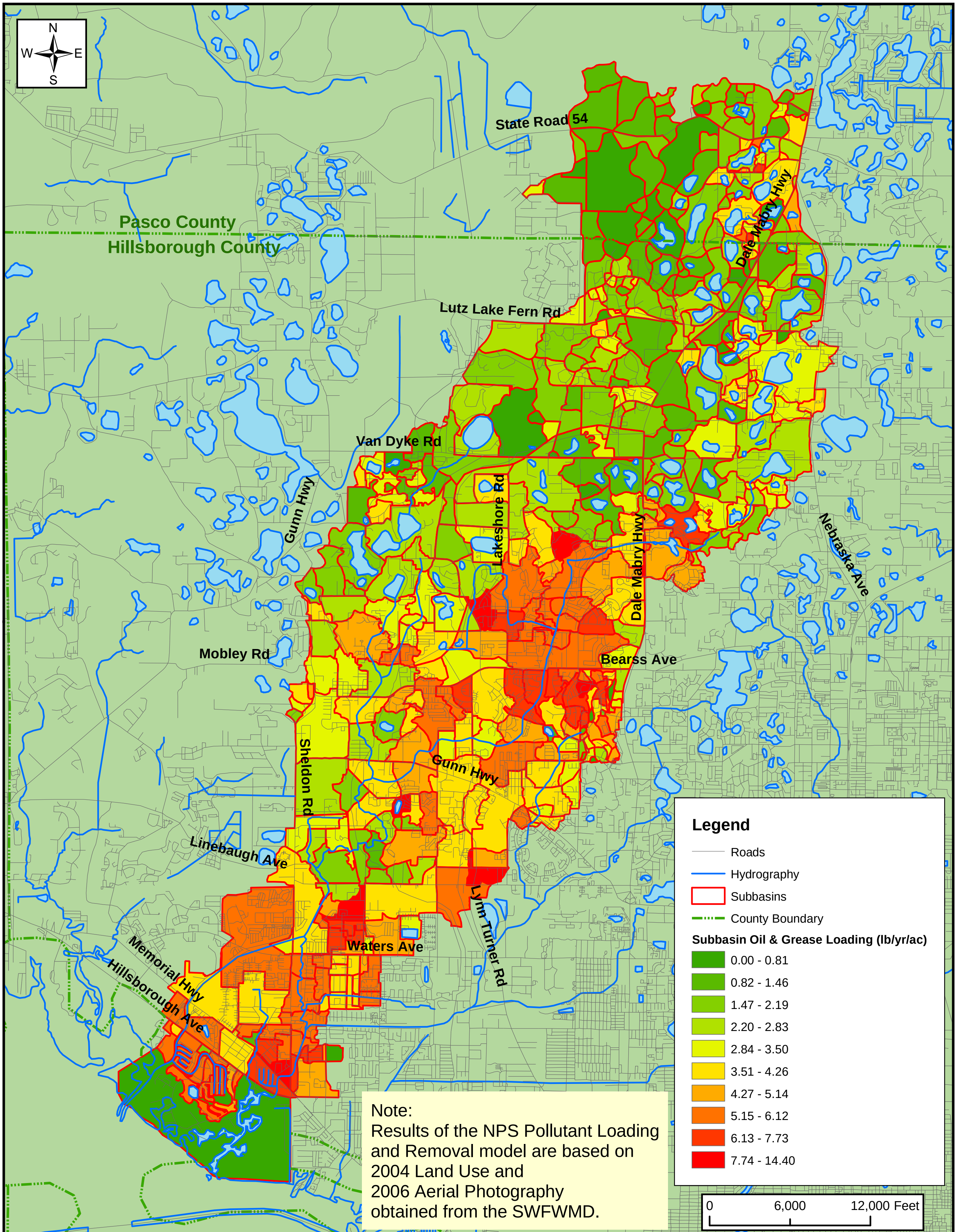

Subbasin Loads for Oil and Grease (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-E

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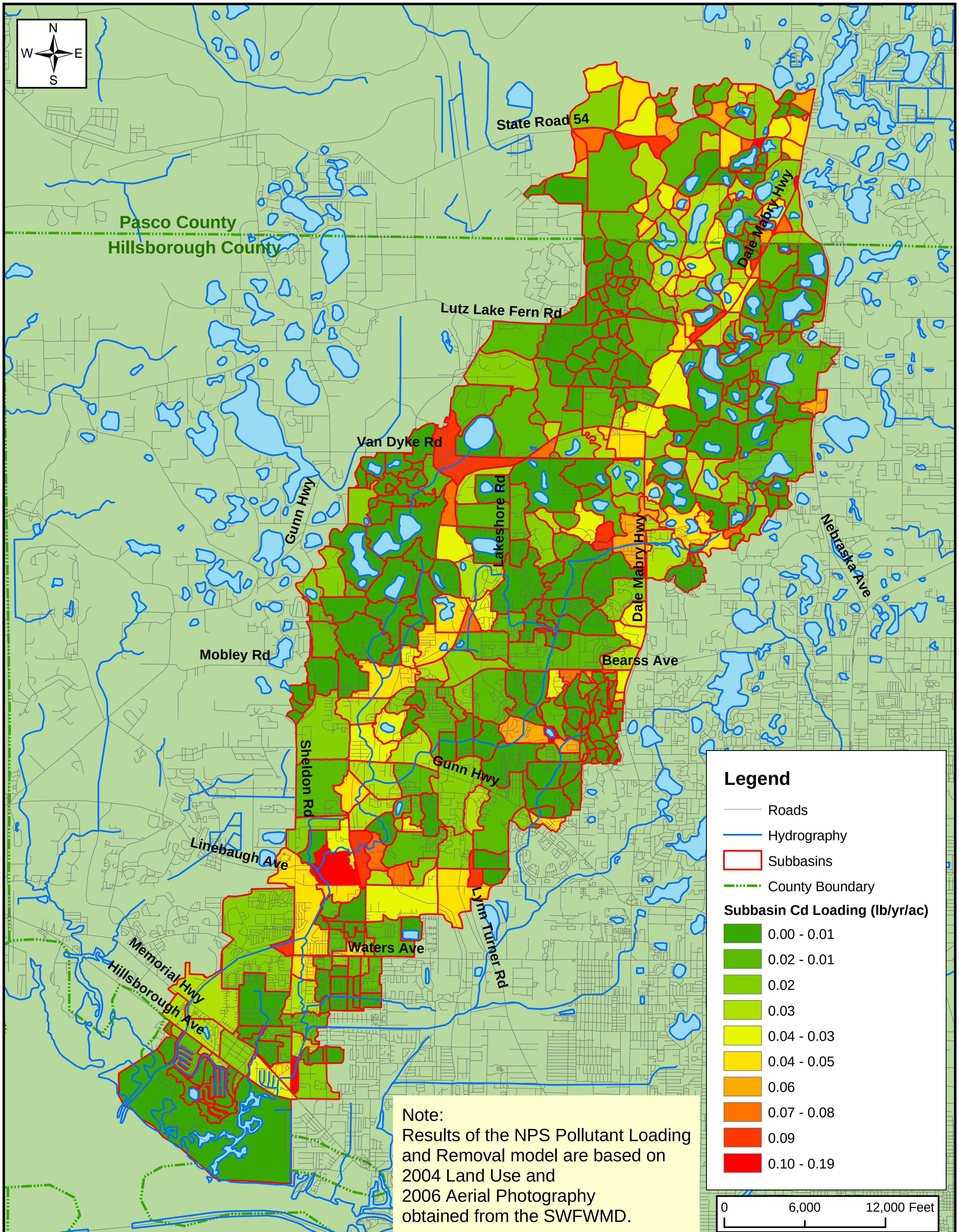

Subbasin Loads for Cadmium (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-F

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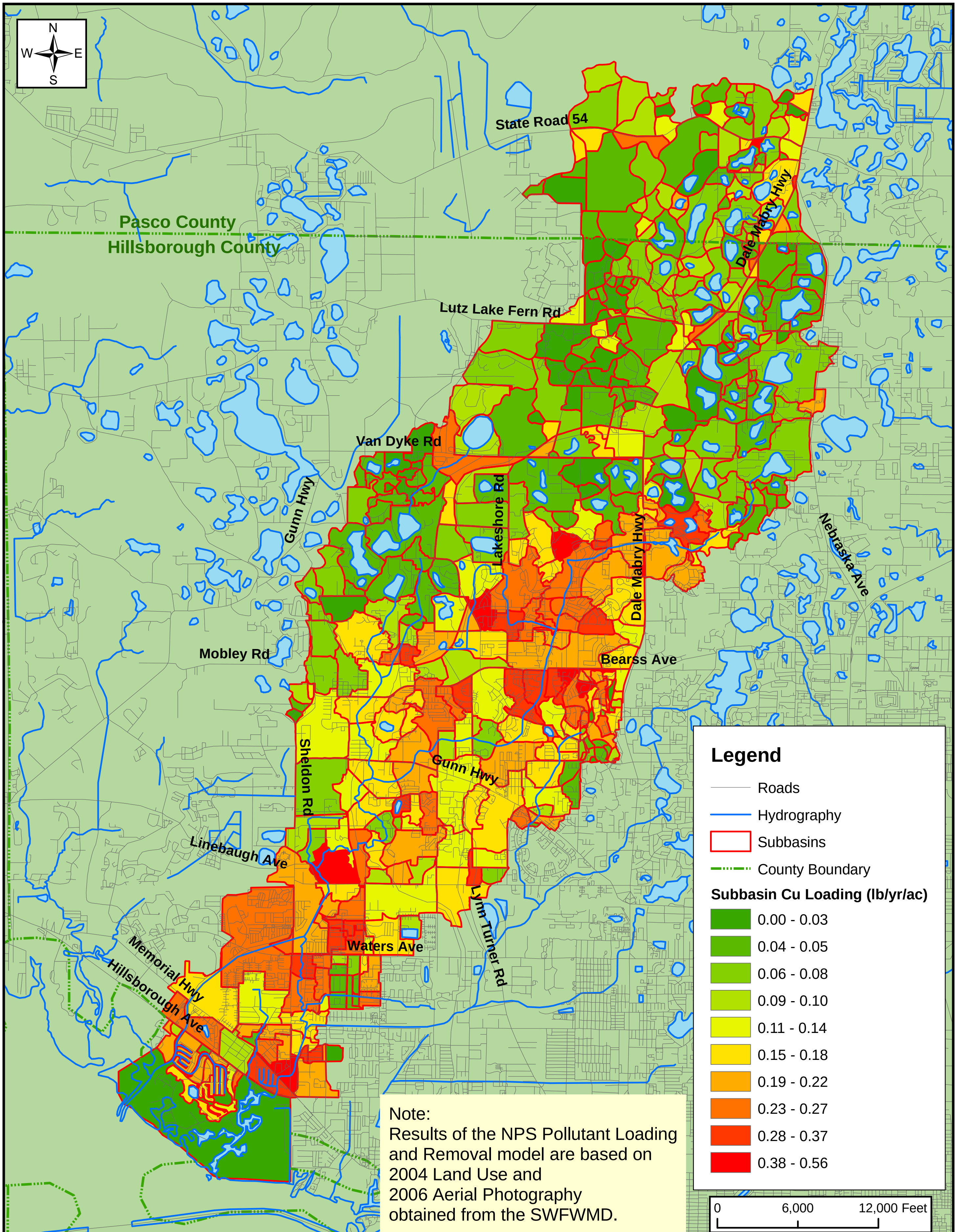

Subbasin Loads for Copper (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-G

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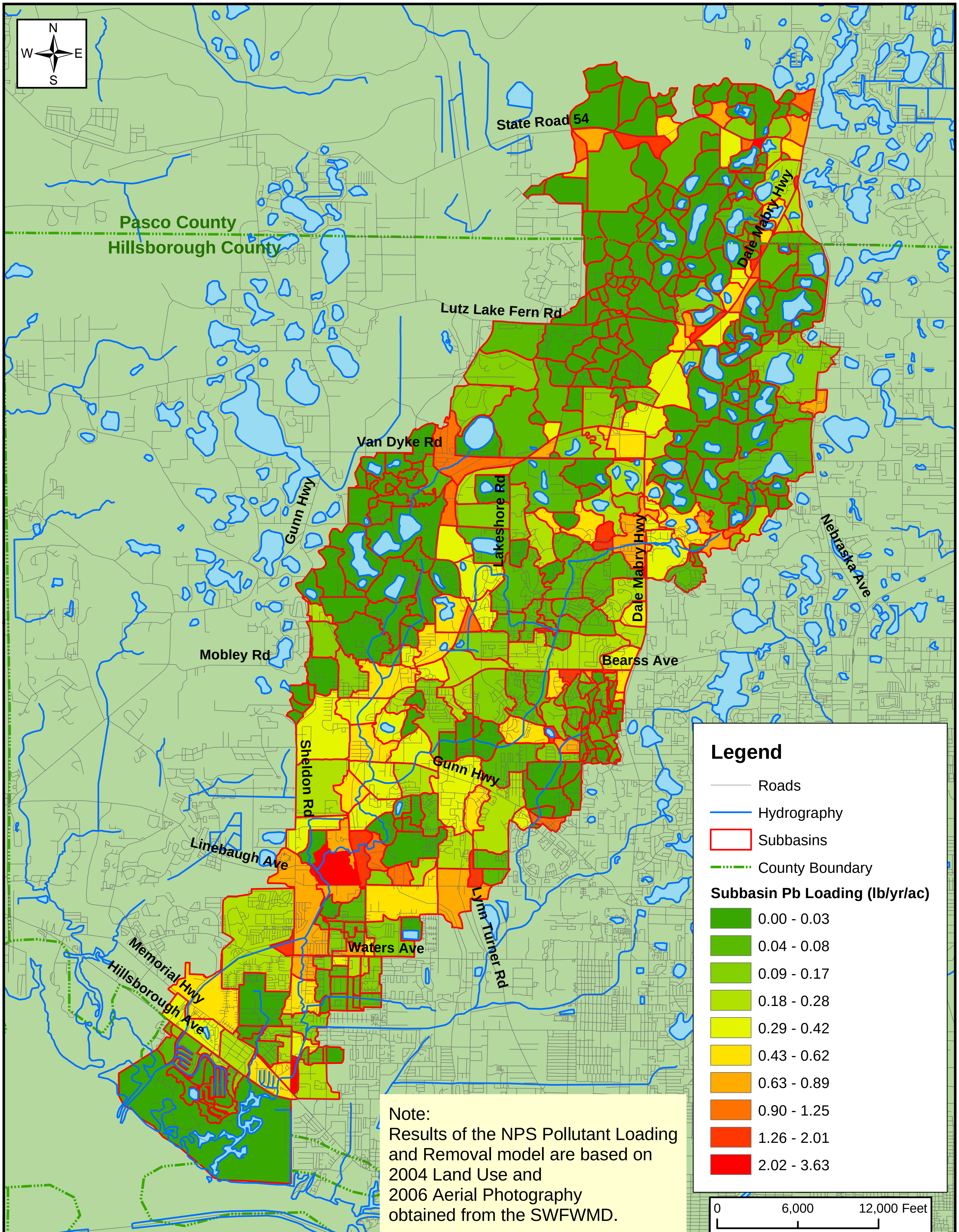

Subbasin Loads for Lead (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-H

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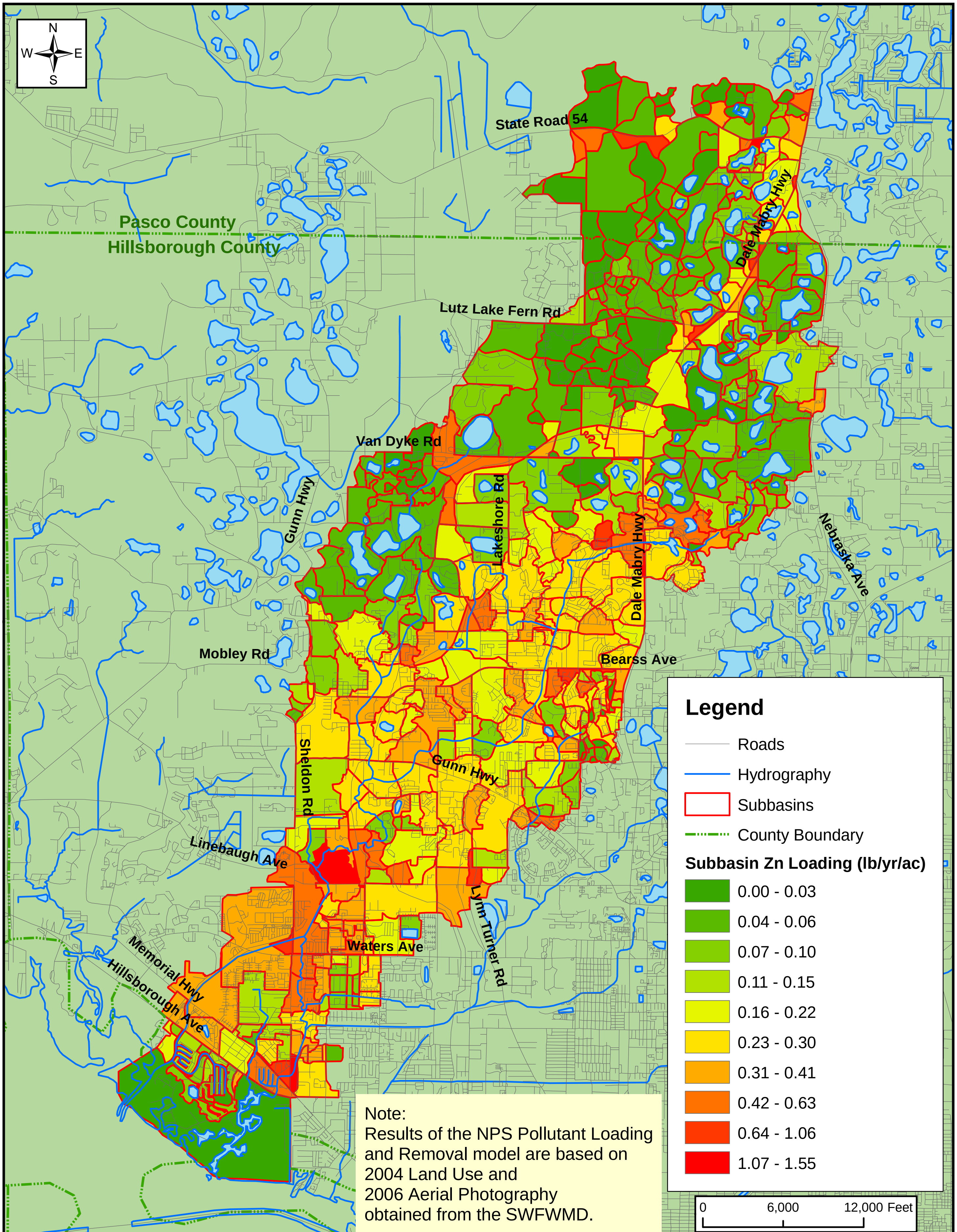

Subbasin Loads for Zinc (lb/yr/acre) in the Rocky/Brushy Creek Watershed

Figure 10-I

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