FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration,

Bureau of Watershed Restoration

NORTHEAST DISTRICT • UPPER EAST COAST BASIN

Final TMDL Report

Nutrient TMDL for Tomoka River (Fresh Water), WBID 2634

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Contents

List of Tables

List of Figures

Websites

Florida Department of Environmental Protection, Bureau of Watershed Restoration

TMDL Program

http://www.dep.state.fl.us/water/tmdl/index.htm

Identification of Impaired Surface Waters Rule

http://www.dep.state.fl.us/water/tmdl/docs/AmendedIWR.pdf

STORET Program

http://www.dep.state.fl.us/water/storet/index.htm

2012 305(b) Report

http://www.dep.state.fl.us/water/docs/2012_integrated_report.pdf

Basin Assessment Report for the Upper East Coast Basin

http://www.dep.state.fl.us/water/basin411/uppereast/assessment.htm

U.S. Environmental Protection Agency, National STORET Program

http://www.epa.gov/storet/

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Load (TMDL) for nutrients for the Tomoka River in the Halifax River Planning Unit of the Upper East Coast Basin. The segment was verified as impaired for nutrients based on chlorophyll a during the second cycle, and was included on the Verified List of impaired waters for the Upper East Coast Basin that was adopted by Secretarial Order on February 7, 2012. Based on the median TN/TP ratio of 18.1, total nitrogen and total phosphorus were identified as co-limiting nutrients. This TMDL establishes the allowable loadings to this portion of the Tomoka River that would restore the waterbody so that it meets its applicable water quality criterion for nutrients.

1.2 Identification of Waterbody

The Tomoka River, located in Volusia County, originates in wetlands southwest of Daytona Beach and flows north until it turns northeast and enters the Halifax River north of Ormond Beach. For assessment purposes, the Tomoka River has been divided into a fresh water and a marine segment. This TMDL addresses the fresh water portion of the Tomoka River. The fresh water segment of the Tomoka River is approximately 13.6 miles long, with a watershed area of approximately 30 square miles. Interstate 95 crosses the Tomoka River and through the watershed, while Interstate 4 intersects the southern portion of the watershed (**Figure 1.1)**.

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Upper East Coast Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. This TMDL addresses WBID 2634, the fresh water segment of the Tomoka River for nutrients (**Figure 1.2)**.

The Tomoka River watershed is part of the Halifax River Planning Unit. Planning units are groups of smaller watersheds (WBIDs) that are part of a larger basin unit, in this case the Upper East Basin. The Halifax River Planning Unit consists of 56 WBIDs. **Figure 1.3** shows the locations of these WBIDs and the Halifax River's location in the planning unit.

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

Figure 1.1. Location of the Tomoka River (WBID 2634) in Volusia County

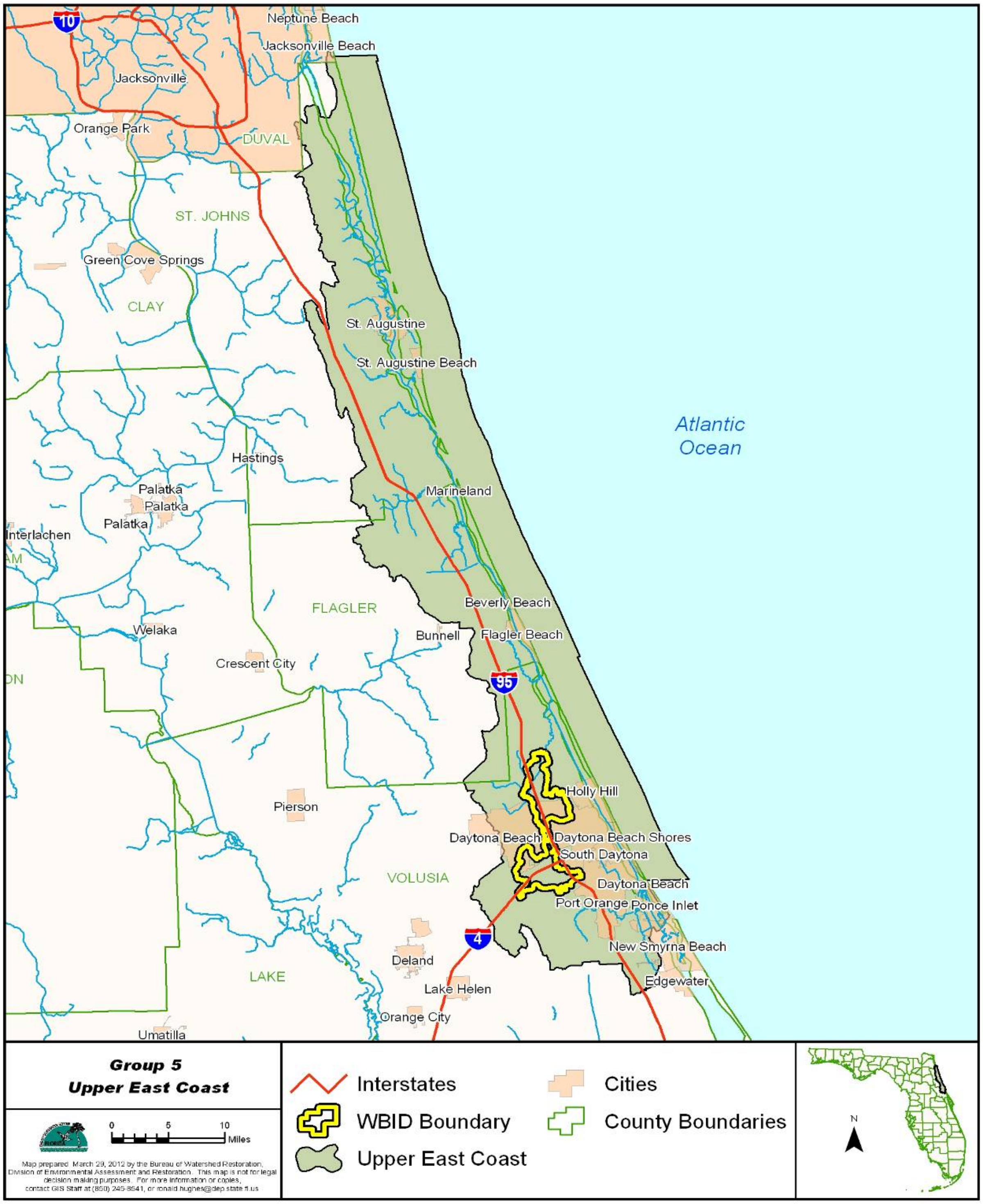
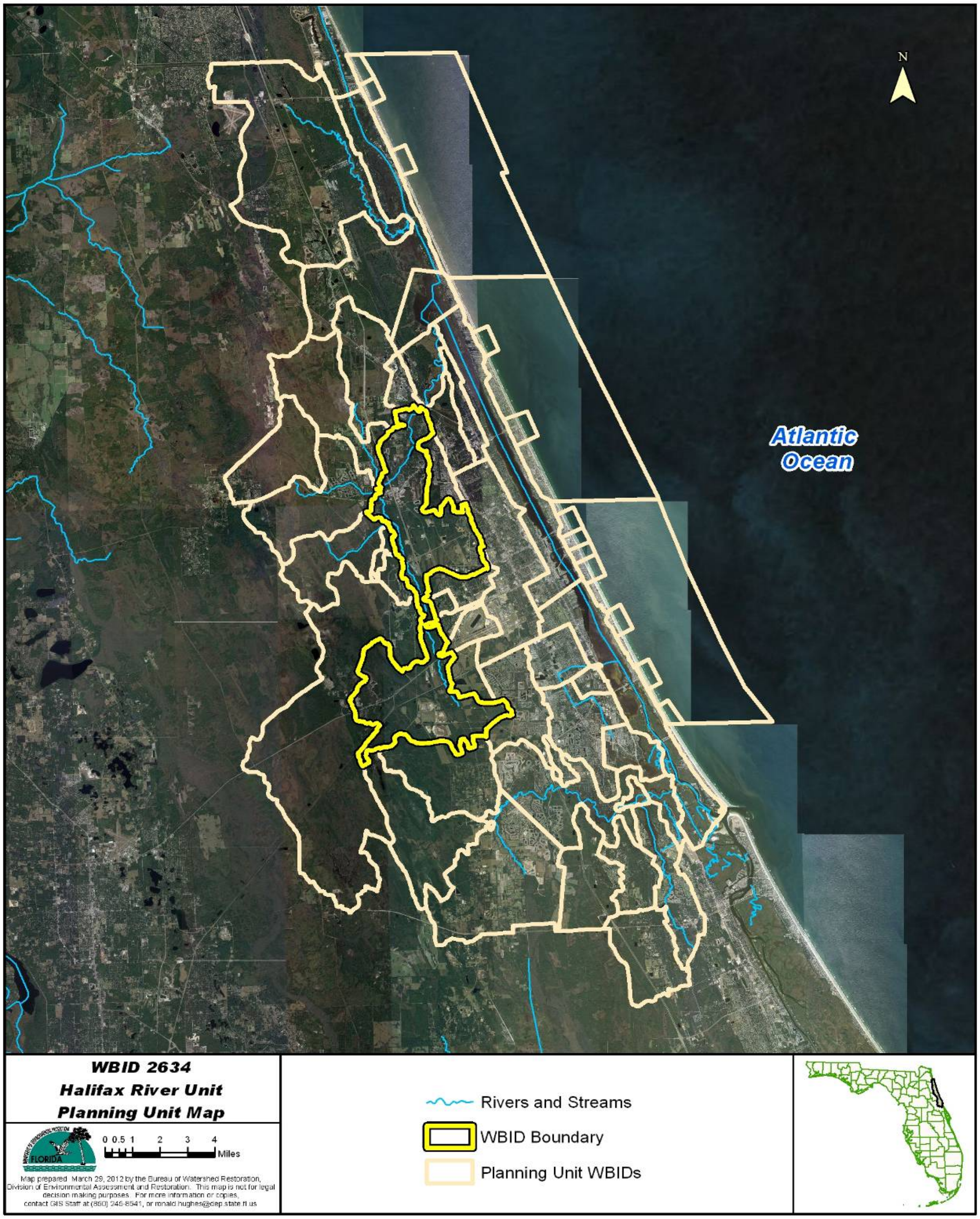


Figure 1.2. Location of the Tomoka River (WBID 2634) in Volusia County and Major Hydrological Features in the Area

Figure 1.3. WBIDs in the Halifax River Planning Unit



Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida's 1998 303(d) list included 15 waterbodies and 50 parameters in the Upper East Coast Basin. However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in the Tomoka River watershed and has verified that this fresh water waterbody segment is impaired for nutrients, based on data in the Department's IWR database. **Tables 2.1** and **2.2** summarize the corrected chlorophyll a (CHLAC) data for the verification period, which for Cycle 2 of the Group 5 waters was January 1, 2004, through June 30, 2011.

The IWR listing threshold for nutrients in estuaries was based on exceeding the historic minimum chlorophyll annual average of 3 µg/L by more than 50 percent in at least two consecutive years (2008 – 2010).

Possible relationships between chl*a* and other water quality parameters are further assessed in Chapter 5, using the complete historical dataset.

Table 2.1. Summary of Corrected Chlorophyll *a* (CHLAC) Monitoring Data for Tomoka River (WBID 2634) During the Verified Period (January 1, 2004 – June 30, 2011)

-

Parameter	CHLAC (µg/L)
Total number of samples	237
IWR-annual average threshold for the Verified List (50% above historic minimum)	5
Number of observed exceedances (yrs)	2
Number of observed nonexceedances (yrs)	4
Number of seasons during which samples were collected	4
Lowest individual observation (µg/L)	1
Highest individual observation (µg/L)	28
Median TN/TP ratio for 186 observations	18.1
Possible causative pollutant by IWR	TN and TP
FINAL ASSESSMENT:	**Impaired**

Table 2.2. Summary of Annual Average CHLAC for the Cycle 2 Verified Period (January 1, 2004 – June 30, 2011)

CHLAC is in µg/L.

Year	Number of Samples	Minimum	Maximum	Annual Mean	Mean Precipitation (inches)
2004	15	2.4	15.5	2	62.97
2005	36	1.0	12.2	2	65.77
2006	17	2.0	7.3	1	31.36
2007	16	2.2	12.6	1	45.02
2008	64	1.2	10.0	10	42.67
2009	50	1.6	21.0	11	50.3
2010	33	2.4	28.0	6	39.39
2011	6	3.4	7.8		48.71

Precipitation based on Daytona International Airport (Appendix G)

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criteria Applicable to the TMDL

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

The Tomoka River (WBID 2634) is a Class III fresh water waterbody, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the impairment addressed by this TMDL is for nutrients.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

The nutrient criterion in Rule 62-302, F.A.C., is expressed as a narrative:

Nutrients:

In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna [Note: For Class III waters in the Everglades Protection Area, this criterion has been numerically interpreted for phosphorus in Section 62-302.540, F.A.C.].

To assess whether this narrative criterion was being exceeded, the IWR provides thresholds for nutrient impairment in estuaries based on annual average chl*a* levels. The following language is found in Rule 62-303, F.A.C.:

62-303.351 Nutrients in Streams.

A stream or stream segment shall be included on the planning list for nutrients if the following biological imbalances are observed:

(1) Algal mats are present in sufficient quantities to pose a nuisance or hinder reproduction of a threatened or endangered species, or

(2) Annual mean chlorophyll a concentrations are greater than 20 µg/L or if data indicate annual mean chlorophyll a values have increased by more than 50% over historical values for at least two consecutive years.

62-303.450 Interpretation of Narrative Nutrient Criteria.

(1) A water shall be placed on the verified list for impairment due to nutrients if there are sufficient data from the last five years preceding the planning list assessment, combined with historical data (if needed to establish historical chlorophyll a levels or historical TSIs), to meet the data sufficiency requirements of subsection 62-303.350(2), FA.C. If there are insufficient data, additional data shall be collected as needed to meet the requirements. Once these additional data are collected, the Department shall determine if there is sufficient information to develop a site-specific threshold that better reflects conditions beyond which an imbalance in flora or fauna occurs in the water segment. If there is sufficient information, the Department shall re-evaluate the data using the site-specific thresholds. If there is insufficient information, the Department shall re-evaluate the data using the thresholds provided in Rules 62-303.351-.353, F.A.C., for streams, lakes, and estuaries, respectively. In any case, the Department shall limit its analysis to the use of data collected during the five years preceding the planning list assessment and the additional data collected in the second phase. If alternative thresholds are used for the analysis, the Department shall provide the thresholds for the record and document how the alternative threshold better represents conditions beyond which an imbalance in flora or fauna is expected to occur.

62-303.350 Interpretation of Narrative Nutrient Criteria

(3) When comparing changes in chlorophyll a or TSI values to historical levels, historical levels shall be based on the lowest five-year average for the period of record. To calculate a five-year average, there must be annual means from at least three years of the five-year period.

The annual average chl*a* concentrations in 2008, 2009, and 2010 exceeded the historic minimum of 3.0 µg/L (1999 – 2003) by 50% or greater, and, based on the TN/TP ratio, nitrogen and phosphorus were identified as co-limiting nutrients.

Chapter 4: ASSESSMENT OF SOURCES

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either “point sources” or “nonpoint sources.” Historically, the term “point sources” has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term “nonpoint sources” was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from failing septic systems; and atmospheric deposition.

However, the 1987 amendments to the Clean Water Act redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA’s National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, including those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with Clean Water Act definitions, the term “point source” will be used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES stormwater discharges and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Potential Sources of Nutrients in the Tomoka River Watershed

4.2.1 Point Sources

There is one NPDES wastewater facility that discharges directly into this portion of the Tomoka River. The Tomoka Farms Road Landfill (FL0037877) has a design discharge of 0.11 MGD. Over the January 2000 through March 2012 period (202 months), there were 16 months when discharge occurred. The average of the reported monthly maximum discharge events was 0.89 MGD. Daily maximum concentrations of TN and TP were reported for October 2011 and were 0.93 mg/L and < 0.05 mg/L, respectively.

Municipal Separate Storm Sewer System Permittees

Portions of the Tomoka River fall within the boundaries of several Phase II municipal separate storm sewer system (MS4) permits. These include the Phase II permits for the City of Daytona

Beach (FLR04E0115) and Volusia County (FLR04E033). The Florida Department of Transportation District 5 is a co-permittee with Volusia County (FLR04E024).

4.2.2 Land Uses and Nonpoint Sources

Nutrient loadings to the Tomoka River are generated from nonpoint sources in the watershed. These potential sources include loadings from surface runoff, ground water inflow, and septic tanks.

Land Uses

The spatial distribution and acreage of different land use categories were identified using the SJRWMD's year 2004 land use coverage contained in the Department's geographic information system (GIS) library. Land use categories in the watershed were aggregated using the Level 3 land use codes and tabulated in **Table 4.1**. **Figure 4.1** shows the principal land uses in the watershed at the Level 1 land use code. The SJRWMD's year 2009 land use coverage was also compared to the 2004 coverage and there were insignificant differences between the two periods.

As shown in **Table 4.1**, the total area of the Tomoka River watershed (WBID 2634) is about 19,053 acres. Water and wetlands represents approximately 32 percent of the watershed with forested land uses accounting for approximately 30 of the watershed. Residential land use accounts for approximately 11 percent of the watershed with nearly 8 percent of the watershed classified as medium density residential. Agricultural and rangeland land uses represented 10 percent of the watershed area.

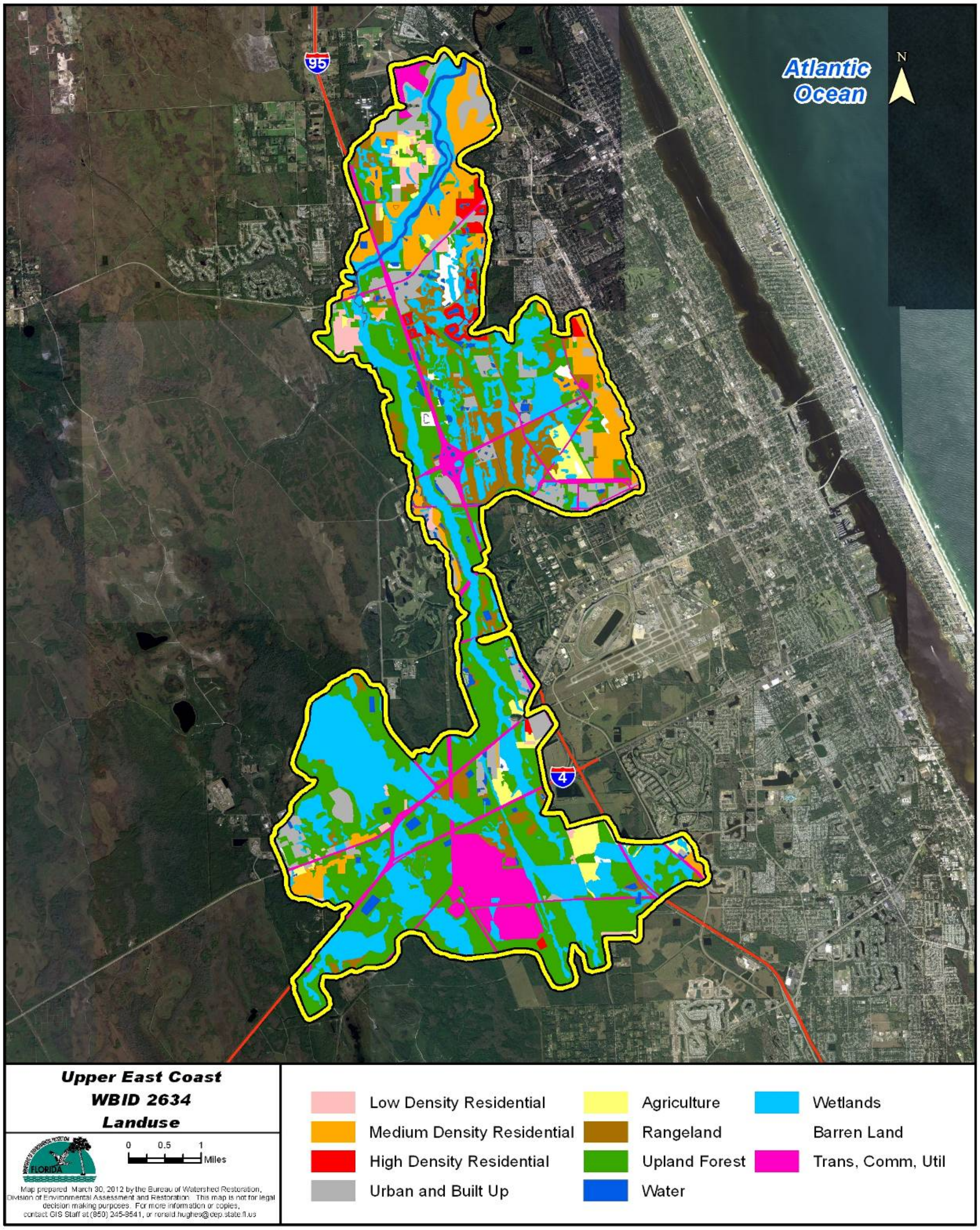
Table 4.1. Classification of Land Use Categories in the Tomoka River Watershed

Level 3 Land Use Code	Attribute	Acres	% of Total
1100	Residential, low density - less than 2 dwelling units/acre	251.03	1.32
1180	Rural residential	64.62	0.34
1190	Low density under construction	9.13	0.05
1200	Residential, medium density - 2-5 dwelling units/acre	1421.69	7.46
1290	Medium Density Under Construction	47.6	0.25
1300	Residential, high density - 6 or more dwelling units/acre	252.61	1.33
1400	Commercial and services	670.77	3.52
1490	Commercial & services under construction	39.84	0.21
1550	Other light industrial	66.85	0.35
1600	Extractive	24.35	0.13
1620	Sand and Gravel Pits	11.48	0.06
1660	Holding ponds	49.3	0.26
1700	Institutional	190.8	1.00

Level 3 Land Use Code	Attribute	Acres	% of Total
1820	Holding ponds	242.63	1.27
1860	Institutional	29.82	0.16
1900	Open land	14.89	0.08
2110	Improved pastures (monoculture, planted forage crops)	331.8	1.74
2130	Woodland pastures	46.5	0.24
2150	Field crops	123.54	0.65
2210	Citrus Groves <Orange, grapefruit, tangerines, etc.>	0.92	0.00
3100	Herbaceous upland nonforested	659.46	3.46
3200	Shrub and brushland (wax myrtle or saw palmetto, occasionally scrub	273.6	1.44
3300	Mixed upland nonforested/Mixed Rangeland	455.78	2.39
4110	Pine flatwoods	2654.8	13.93
4120	Longleaf pine - xeric oak	21.3	0.11
4130	Sand pine	113.88	0.60
4200	Upland hardwood forests	49.97	0.26
4340	Upland mixed coniferous/hardwood	741.84	3.89
4410	Coniferous pine	916.86	4.81
4430	Forest regeneration areas	1,294.39	6.79
5100	Streams and waterways	156.92	0.82
5300	Reservoirs - pits, retention ponds, dams	357.58	1.88
6110	Bay swamp (if distinct)	284.82	1.49
6170	Mixed wetland hardwoods	1,602.09	8.41
6181	Willow and Elderberry	38.4	0.20
6210	Cypress	193.06	1.01
6220	Pond Pine	1.35	0.01
6250	Hydric pine flatwoods	848.9	4.46
6300	Wetland forested mixed	1,492.25	7.83
6410	Fresh water marshes	82.66	0.43
6420	Saltwater marshes	72.19	0.38
6430	Wet prairies	296.98	1.56
6440	Emergent aquatic vegetation	14.27	0.07
6460	Treeless Hydric Savanna/Mixed scrub-shrub wetland	573.72	3.01
7400	Disturbed land	21.45	0.11
7410	Rural land in transition without positive indicators of intended activity	137.77	0.72
7420	Borrow Areas	20.84	0.11
7430	Spoil areas	12.42	0.07
8110	Airports	95.99	0.50
8140	Roads and highways (divided 4-lanes with medians)	670.26	3.52
8200	Communications	8.65	0.05
8320	Electrical power transmission lines	244.13	1.28
8350	Solid Waste Disposal	749.56	3.93

Level 3 Land Use Code	Attribute	Acres	% of Total
8370	Surface water collection basins	4.6	0.02
	SUM	**19,052.9**	**100.00**

Figure 4.1. Principal Land Uses in the Tomoka River Watershed



Soil Characteristics

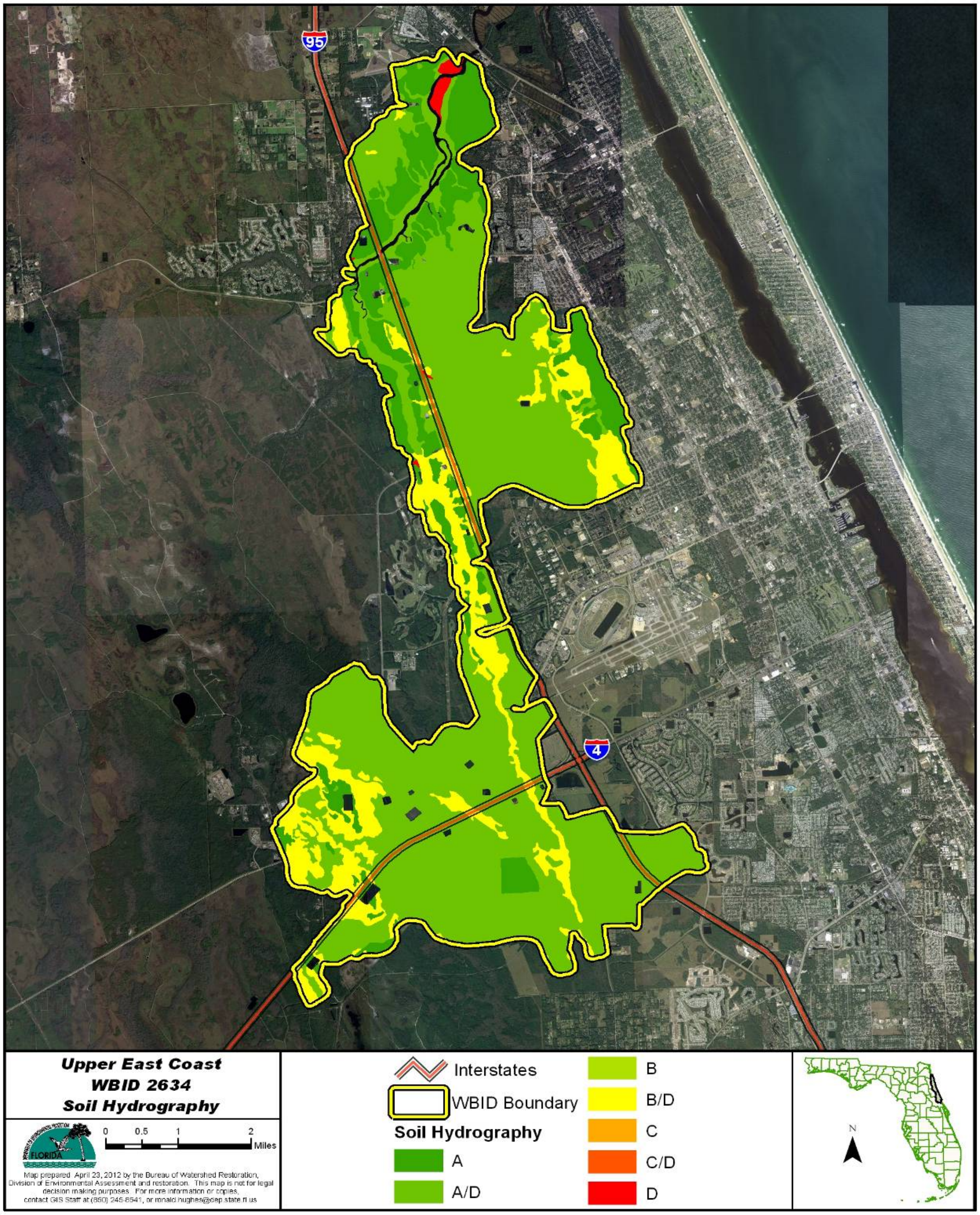
The Soil Survey Geographic Database (SSURGO) in the Department's GIS database from the SJRWMD was accessed to provide coverage of hydrologic soil groups in the Tomoka River watershed (**Figure 4.2**). **Table 4.2** briefly describes the major hydrology soil classes. As seen in **Figure 4.2**, soil group A/D was the most common in the watershed

Table 4.2. Description of Hydrologic Soil Classes from the SSURGO Database

Hydrology Class	Description
A	Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures.
B	Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures.
C	Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures
D	Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures.
Dual hydrologic soil groups	Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

Source: USDA NRCS, Part 630 Hydrology National Engineering Handbook , Chapter 7 Hydrologic Soil Groups, January 2009

Figure 4.2 Hydrologic Soil Groups Distribution in the Tomoka River Watershed



Population

The 2010 U.S. Census block data was used to estimate the human population in the Tomoka River watershed. Total population data for census blocks covering the Tomoka River watershed was clipped using GIS to estimate the population within the watershed based on the fraction of the block contained within the watershed. This yielded an estimated population of 13,452 in the Tomoka River watershed. Based on an average of 2.51 persons per household in Volusia County (U.S Census) there was an estimated 5,359 occupied residential units within the WBID boundary.

Septic Tanks

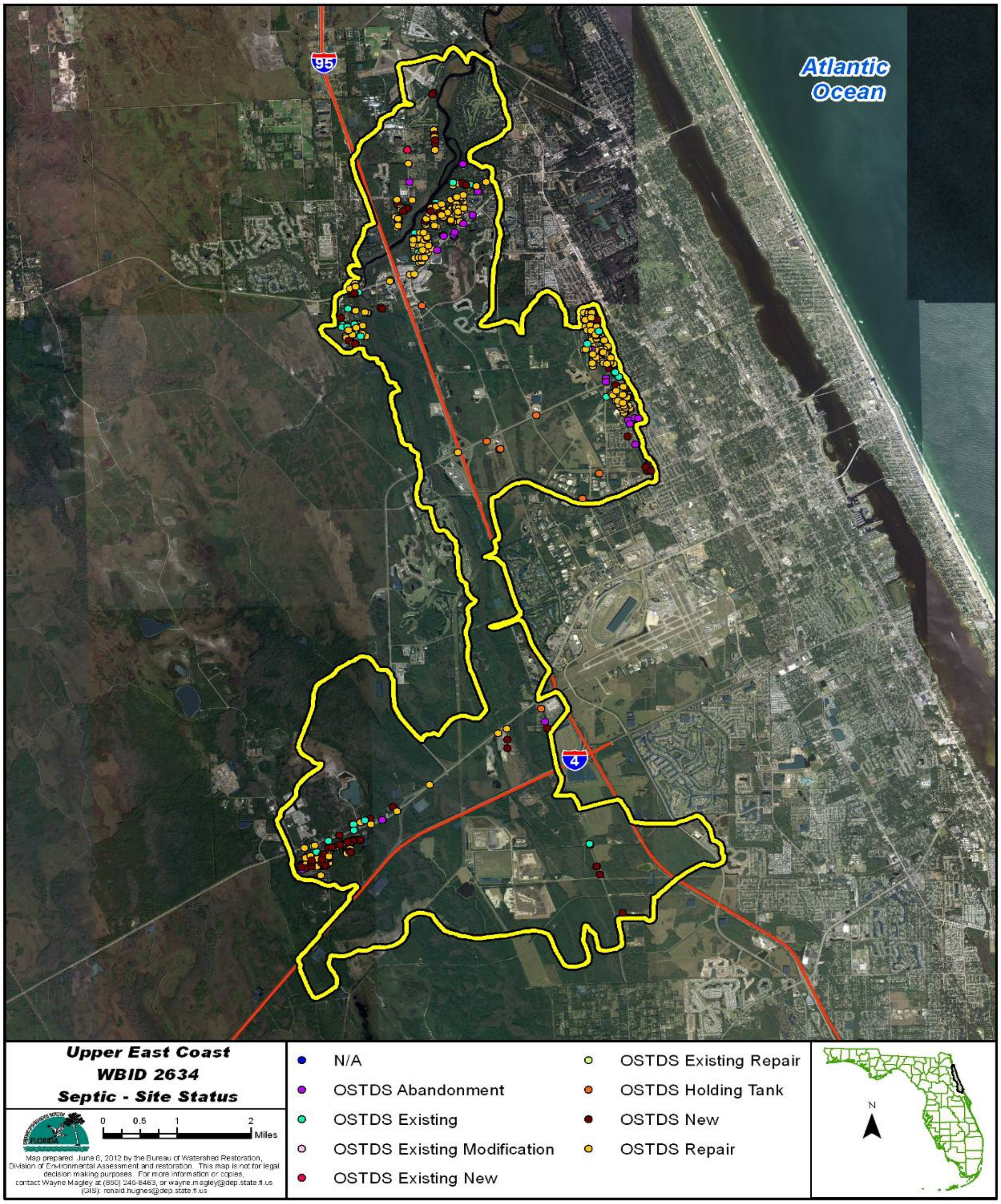
Based on the Florida Department of Health January 2012 GIS coverage of onsite sewage treatment disposal systems (OSTDS), there were approximately 643 septic tanks located in the watershed (**Figure 4.3**). Using 70 gallons/day/person (EPA, 1999), and drainfield total nitrogen (TN) and total phosphorus (TP) concentrations of 36 mg/L and 15 mg/L, respectively, potential annual ground water loads of TN and TP were calculated. This is a screening level calculation, and soil types, the age of the system, vegetation, proximity to a receiving water, and other factors will influence the degree of attenuation of this load (**Table 4.3**).

Table 4.3. Estimated Nitrogen and Phosphorus Annual Loading from Septic Tanks in the Tomoka River Watershed

Estimated No. Households on Septic	Estimated No. Persons Per Household[1]	Gallons/ Person/ Day[2]	TN in Drainfield (mg/L)	TP in Drainfield (mg/L)	Estimated Annual TN Load (lbs/yr)	Estimated Annual TP Load (lbs/yr)
643	2.51	70	36	15	12,388	5,161

[1] U.S Census Bureau;
[2] EPA, 1999.

Figure 4.3. Onsite SewageTreatment Disposal Systems in the Tomoka River Watershed



4.3 Source Summary

4.3.1 Summary of Nutrient Loadings to Tomoka River from Point Sources

Section 4.2.1 provided information on the one point source discharge in the watershed (i.e., the Tomoka Farms Road Landfill). A conservative approach was used to estimate annual TN and TP loads based on discharge monitoring reports. For each month in which a discharge was reported, a load was calculated assuming that the daily maximum reported discharge occurred for the whole month and that TN and TP concentrations in the discharge were equal to 0.93 mg/L and 0.05 mg/L, respectively (**Table 4.4**).

Table 4.4. Estimated Annual Average Discharge, TN and TP Loads from the Tomoka Farms Road Landfill

YEAR	DISCHARGE (MG/ACRE-FT)	TN LOAD (LBS/YR)	TP LOAD (LBS/YR)
1999	0	0	0
2000	0	0	0
2001	60/186	469	25
2002	0	0	0
2003	0	0	0
2004	0	0	0
2005	0	0	0
2006	0	0	0
2007	0	0	0
2008	75/231	584	31
2009	135/414	1048	56
2010	95/293	741	40
2011	23/72	182	10

4.3.2 Summary of Nutrient Loadings to Tomoka River from Nonpoint Sources

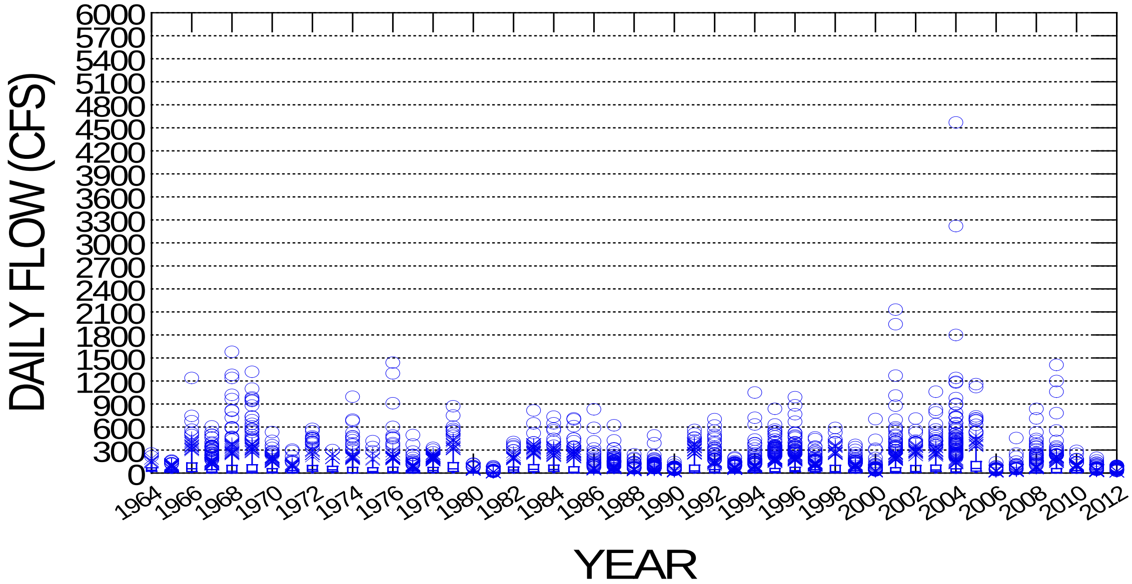
As part of EPA's efforts to establish numeric nutrient criteria for Florida's estuaries, Tetra Tech setup a watershed model (LSPC) to estimate nutrient loadings to the Mantanzas and Halifax River estuaries. The model simulation covered the 1997 – 2009 period. Ms. Erin Lincoln (Tetra Tech, personal communication, 5/2/2012) provided model outputs of daily flow, TN concentration, TP concentrations, TN loads, and TP loads based on HUC 12 delineations. Daily flows and nutrient loads were summed by year to obtain estimates of annual nitrogen and phosphorus loadings from the Tomoka watershed (**Table 4.5**). These estimates did not include potential contribution of the marine segment of the Tomoka River. **Appendix C** describes the calibration of the LSPC watershed model. The USGS gage on the Tomoka River on the downstream side of the LPGA Boulevard bridge near Holly Hill (02247510) was used in the calibration of the watershed model. A box plot of daily flows by year is graphed in **Figure 4.4**. Daily flows ranged between 0 and 4,570 cfs, with 25th, median, and 75th percentile values of 4.6, 15, and 63 cfs, respectively.

Table 4.5. Estimated Annual Average LSPC Derived Discharge, TN, TP Loads and Concentrations from the Tomoka River Watershed

YEAR	DISCHARGE (ACRE-FT)	TN LOAD (LBS/YR)	TP LOAD (LBS/YR)	MEAN TN (MG/L)	MEAN TP (MG/L)	RAINFALL (INCHES/YR)
1997	77293	255465	19606	1.18	0.095	54.69
1998	76406	265739	17446	1.27	0.102	40.51
1999	37663	133992	14093	1.32	0.120	46.37
2000	37612	128705	11952	1.25	0.111	40.16
2001	167150	529670	32105	1.18	0.083	58.27
2002	94904	300034	19138	1.10	0.077	59.94
2003	135629	438091	24496	1.14	0.075	57.3
2004	173117	562603	34182	1.12	0.079	62.97
2005	260400	848249	49287	1.17	0.065	65.77
2006	49006	153621	11584	1.12	0.086	31.36
2007	40967	127797	11092	1.26	0.099	45.02
2008	108896	350285	21926	1.19	0.089	42.67
2009	94333	309810	20410	1.11	0.091	50.3
AVERAGE	**104106**	**338774**	**22101**	**1.19**	**0.090**	**50.41**

Precipitation based on Daytona International Airport (Appendix G)

Figure 4.4. Box Plot of Average Daily Flow for the Tomoka River near Holly Hill (USGS gage 02247510)



Chapter 5: DETERMINATION OF ASSIMILATIVE CAPACITY

5.1 Determination of Loading Capacity

5.1.1 Data Used in the Determination of the TMDL

There are sixty-three sampling stations in the watershed, of which fifty-eight have historical CHLAC observations (**Figure 5.1**). Thirty-three of those sites had only one CHLAC observation. **Table 5.1** contains summary information on each of the stations (N represents the number of CHLAC observations). **Table 5.2** provides a statistical summary of CHLAC observations at each station, and **Appendix B** contains historical CHLAC, temperature (TEMPC), TN, TP, and TSS available observations from sampling sites in WBID 2634 from 1968 through 2011. **Figure 5.2** displays the historical CHLAC observations over time. The simple linear regression of CHLAC versus sampling date in **Figure 5.2** was not significant at an alpha (α) level of 0.05. **Appendix F** contains plots of CHLAC by year, season, and station,

Elevated levels of CHLAC during June 2008 are shown in **Figure 5.2**. Seven of the highest eleven historical CHLAC measurements were reported at the seven randomized ambient monitoring stations (21FLGW 34952 – 34958) collected between June 17 – 19, 2008 in the northern most 4.64 miles of the Tomoka River WBID 2634 segment. CHLAC concentrations ranged from 48 to 450 µg/L at these stations. Salinities reported at these stations during this period ranged between 21.4 and 24.1 ppt. With respect to historical CHLAC measurements, the 75^{th}, 80^{th}, and 90^{th} percentiles are 3.1 µg/L, 4.5 µg/L, and 13.7 µg/L, respectively. Similarly, based on historical salinity measurements the 75^{th}, 80^{th} and 90^{th} percentiles are 0.23 ppt, 0.60 ppt, and 10.52 ppt, respectively.

Figures 5.3 through **5.6** present historical TN, TP, Color, and Total Suspended Solids (TSS) observations, respectively. Linear regressions of each parameter versus sampling date indicated that none of the regressions were significant at an α level of 0.05. **Appendix F** contains additional plots by season, station, and year. A statistical summary of major water quality parameters from the available data is presented in **Table 5.3**.

Table 5.1. Sampling Station Summary for the Tomoka River Watershed

Station	STORET ID	Station Owner	Years With Data	N
CANAL TO TOMOKA @ 265 CHEROKEE RD	21FLA 27010429FLA	FDEP	2009	5
TOMOKA RIVER BETWEEN AIRPORT DITCH AND ISLAND	21FLA 27010572	FDEP	1985 - 1986	7
TOMOKA RIVER EAST FORK AROUND ISLAND	21FLA 27010573	FDEP	1985 - 1986	7
TOMOKA RIVER AT INTERSTATE 95 BRIDGE	21FLA 27010574	FDEP	1985 - 1986	7
TOMOKA RIVER AT STATE ROUTE 40 BRIDGE	21FLA 27010578	FDEP	1985 - 2009	11
TOMOKA RIVER AT ELEVENTH STREET BRIDGE	21FLA 27010579	FDEP	1985 - 1998	9
TOMOKA RIVER AT RIVER BEND PARK	21FLA 27010923	FDEP	2009	5
TOMOKA RIVER AT LPGA BLVD.	21FLA 27010924	FDEP	2009	5
TOMOKA RIVER @ 1-4	21FLCEN 27010075	FDEP	2005	1
TOMOKA RIVER AT INTERSTATE 95 BRIDGE	21FLCEN 27010574	FDEP	2005	1
TOMOKA RIVER AT 11TH STREET BRIDGE	21FLCEN 27010579	FDEP	2000 - 2010	11
TOMOKA RIVER AT U.S. HIGHWAY 92	21FLCEN 27010596	FDEP	2000 - 2005	3
TOMOKA RIVER AT SR 40 (TOMOKA ROAD)	21FLCEN 27010830	FDEP	2005	4
TOMOKA RIVER AT U.S. HIGHWAY 92	21FLGW 34921	FDEP	2008	1
SJ7-LR-2003 TOMOKA RIVER	21FLGW 34929	FDEP	2008	1
SJ7-LR-2004 TOMOKA RIVER	21FLGW 34930	FDEP	2008	1
SJ7-LR-2009 TOMOKA RIVER	21FLGW 34931	FDEP	2008	1
SJ7-LR-2010 TOMOKA RIVER	21FLGW 34932	FDEP	2008	1
SJ7-LR-2015 TOMOKA RIVER	21FLGW 34933	FDEP	2008	1
SJ7-LR-2017 TOMOKA RIVER	21FLGW 34934	FDEP	2008	1
SJ7-LR-2019 TOMOKA RIVER	21FLGW 34935	FDEP	2008	1
SJ7-LR-2024 TOMOKA RIVER	21FLGW 34936	FDEP	2008	1
SJ7-LR-2029 TOMOKA RIVER	21FLGW 34937	FDEP	2008	1
SJ7-LR-2032 TOMOKA RIVER	21FLGW 34938	FDEP	2008	1
SJ7-LR-2034 TOMOKA RIVER	21FLGW 34939	FDEP	2008	1
SJ7-LR-2039 TOMOKA RIVER	21FLGW 34940	FDEP	2008	1
SJ7-LR-2040 TOMOKA RIVER	21FLGW 34941	FDEP	2008	1
SJ7-LR-2043 TOMOKA RIVER	21FLGW 34942	FDEP	2008	1
SJ7-LR-2044 TOMOKA RIVER	21FLGW 34943	FDEP	2008	1
SJ7-LR-2049 TOMOKA RIVER	21FLGW 34944	FDEP	2008	1

Station	STORET ID	Station Owner	Years With Data	N
SJ7-LR-2050 TOMOKA RIVER	21FLGW 34945	FDEP	2008	1
SJ7-LR-2053 TOMOKA RIVER	21FLGW 34946	FDEP	2008	1
SJ7-LR-2054 TOMOKA RIVER	21FLGW 34947	FDEP	2008	1
SJ7-LR-2055 TOMOKA RIVER	21FLGW 34948	FDEP	2008	1
SJ7-LR-2060 TOMOKA RIVER	21FLGW 34949	FDEP	2008	1
SJ7-LR-2064 TOMOKA RIVER	21FLGW 34950	FDEP	2008	1
SJ7-LR-2069 TOMOKA RIVER	21FLGW 34951	FDEP	2008	1
SJ7-LR-2072 TOMOKA RIVER	21FLGW 34952	FDEP	2008	1
SJ7-LR-2074 TOMOKA RIVER	21FLGW 34953	FDEP	2008	1
SJ7-LR-2080 TOMOKA RIVER	21FLGW 34954	FDEP	2008	1
SJ7-LR-2083 TOMOKA RIVER	21FLGW 34955	FDEP	2008	1
SJ7-LR-2084 TOMOKA RIVER	21FLGW 34956	FDEP	2008	1
SJ7-LR-2089 TOMOKA RIVER	21FLGW 34957	FDEP	2008	1
SJ7-LR-2091 TOMOKA RIVER	21FLGW 34958	FDEP	2008	1
TOMOKA RIVER AT ELEVENTH STREET BRIDGE	21FLGW 3516	FDEP	1998 - 2011	143
TOMOKA RIVER AT 11TH STREET BRIDGE	21FLSJWM27010579	SJRWMD	1995 - 1998	22
TOMOKA RIVER UPSTREAM AT U.S. 92 BRIDGE	21FLSJWMNCBTR05	SJRWMD	2005 - 2006	5
TOMOKA RIVER EAST BRIDGE ON POWERLINE ACCESS NEAR LPGA GOLF	21FLSJWMNCBTR06	SJRWMD	2008 - 2011	42
TOMOKA RIVER @ 11TH STREET BRIDGE	21FLSJWMTR11	SJRWMD	1993 - 1995	10
TOMOKA RIVER UPSTREAM OF S.R. 40 BRIDGE	21FLVEMDTR03	Volusia County	1993 - 1998	54
TOMOKA RIVER UPSTREAM OF 11TH ST. BRIDGE	21FLVEMDTR04	Volusia County	1993 - 1998	51
TOMOKA RIVER UPSTREAM OF U.S. 92 BRIDGE	21FLVEMDTR05	Volusia County	1993 - 1998	30
TOMOKA RIVER FROM UPSTREAM SIDE OF S.R. 40	21FLVEMDVC-077	Volusia County	1999 - 2011	78
TOMOKA RIVER, FROM UPSTREAM SIDE OF LPGA BLVD.	21FLVEMDVC-078	Volusia County	1999 - 2011	71
TOMOKA RIVER FROM UPSTREAM SIDE OF U.S. 92	21FLVEMDVC-079	Volusia County	1999 - 2006	26
TOMOKA RIVER @ 11TH STREET	21FLWPB 20010739	FDEP	2003	6
TOMOKA RIVER @ STATE HIGHWAY 40	21FLWPB 20010740	FDEP	2003	6
TOMOKA RIVER AT CR216A (WBID 2634)	21FLWQSPVOL358LR	FDEP	2005	3

Table 5.2. Statistical Summary of Historical CHLAC Data for Tomoka River

Station	N	Minimum	Maximum	Median	Mean
CANAL TO TOMOKA @ 265 CHEROKEE RD	5	2.8	9.2	7.5	6.1
TOMOKA RIVER BETWEEN AIRPORT DITCH AND ISLAND	7	1.2	39.9	4.5	11.6
TOMOKA RIVER EAST FORK AROUND ISLAND	7	1.0	84.3	4.3	15.1
TOMOKA RIVER AT INTERSTATE 95 BRIDGE	7	1.0	18.9	1.4	6.6
TOMOKA RIVER AT STATE ROUTE 40 BRIDGE	11	1.0	20.0	2.0	4.1
TOMOKA RIVER AT ELEVENTH STREET BRIDGE	9	1.0	2.9	1.0	1.5
TOMOKA RIVER AT RIVER BEND PARK	5	8.0	26.0	13.0	15.1
TOMOKA RIVER AT LPGA BLVD.	5	1.0	3.9	1.8	2.2
TOMOKA RIVER @ 1-4	1	2.4	2.4	2.4	2.4
TOMOKA RIVER AT INTERSTATE 95 BRIDGE	1	1.4	1.4	1.4	1.4
TOMOKA RIVER AT 11TH STREET BRIDGE	11	1.0	2.9	1.4	1.5
TOMOKA RIVER AT U.S. HIGHWAY 92	3	2.8	6.2	3.2	4.1
TOMOKA RIVER AT SR 40 (TOMOKA ROAD)	4	1.4	5.6	1.4	2.4
TOMOKA RIVER AT U.S. HIGHWAY 92	1	1.0	1.0	1.0	1.0
SJ7-LR-2003 TOMOKA RIVER	1	28.0	28.0	28.0	28.0
SJ7-LR-2004 TOMOKA RIVER	1	18.0	18.0	18.0	18.0
SJ7-LR-2009 TOMOKA RIVER	1	2.1	2.1	2.1	2.1
SJ7-LR-2010 TOMOKA RIVER	1	9.4	9.4	9.4	9.4
SJ7-LR-2015 TOMOKA RIVER	1	11.0	11.0	11.0	11.0
SJ7-LR-2017 TOMOKA RIVER	1	7.0	7.0	7.0	7.0
SJ7-LR-2019 TOMOKA RIVER	1	23.0	23.0	23.0	23.0
SJ7-LR-2024 TOMOKA RIVER	1	19.0	19.0	19.0	19.0
SJ7-LR-2029 TOMOKA RIVER	1	2.6	2.6	2.6	2.6
SJ7-LR-2032 TOMOKA RIVER	1	22.0	22.0	22.0	22.0

Station	N	Minimum	Maximum	Median	Mean
SJ7-LR-2034 TOMOKA RIVER	1	10.0	10.0	10.0	10.0
SJ7-LR-2039 TOMOKA RIVER	1	19.0	19.0	19.0	19.0
SJ7-LR-2040 TOMOKA RIVER	1	14.0	14.0	14.0	14.0
SJ7-LR-2043 TOMOKA RIVER	1	7.3	7.3	7.3	7.3
SJ7-LR-2044 TOMOKA RIVER	1	17.0	17.0	17.0	17.0
SJ7-LR-2049 TOMOKA RIVER	1	4.4	4.4	4.4	4.4
SJ7-LR-2050 TOMOKA RIVER	1	12.0	12.0	12.0	12.0
SJ7-LR-2053 TOMOKA RIVER	1	10.0	10.0	10.0	10.0
SJ7-LR-2054 TOMOKA RIVER	1	10.0	10.0	10.0	10.0
SJ7-LR-2055 TOMOKA RIVER	1	1.0	1.0	1.0	1.0
SJ7-LR-2060 TOMOKA RIVER	1	15.0	15.0	15.0	15.0
SJ7-LR-2064 TOMOKA RIVER	1	22.0	22.0	22.0	22.0
SJ7-LR-2069 TOMOKA RIVER	1	4.5	4.5	4.5	4.5
SJ7-LR-2072 TOMOKA RIVER	1	120.0	120.0	120.0	120.0
SJ7-LR-2074 TOMOKA RIVER	1	450.0	450.0	450.0	450.0
SJ7-LR-2080 TOMOKA RIVER	1	98.0	98.0	98.0	98.0
SJ7-LR-2083 TOMOKA RIVER	1	65.0	65.0	65.0	65.0
SJ7-LR-2084 TOMOKA RIVER	1	48.0	48.0	48.0	48.0
SJ7-LR-2089 TOMOKA RIVER	1	49.0	49.0	49.0	49.0
SJ7-LR-2091 TOMOKA RIVER	1	210.0	210.0	210.0	210.0
TOMOKA RIVER AT ELEVENTH STREET BRIDGE	143	1.0	7.7	1.0	1.3
TOMOKA RIVER AT 11TH STREET BRIDGE	22	1.0	5.6	1.0	1.7
TOMOKA RIVER UPSTREAM AT U.S. 92 BRIDGE	5	1.0	1.3	1.1	1.1
TOMOKA RIVER EAST BRIDGE ON POWERLINE ACCESS NEAR LPGA GOLF	42	1.0	356.8	1.2	13.7
TOMOKA RIVER @ 11TH STREET BRIDGE	10	1.0	6.2	1.5	2.1

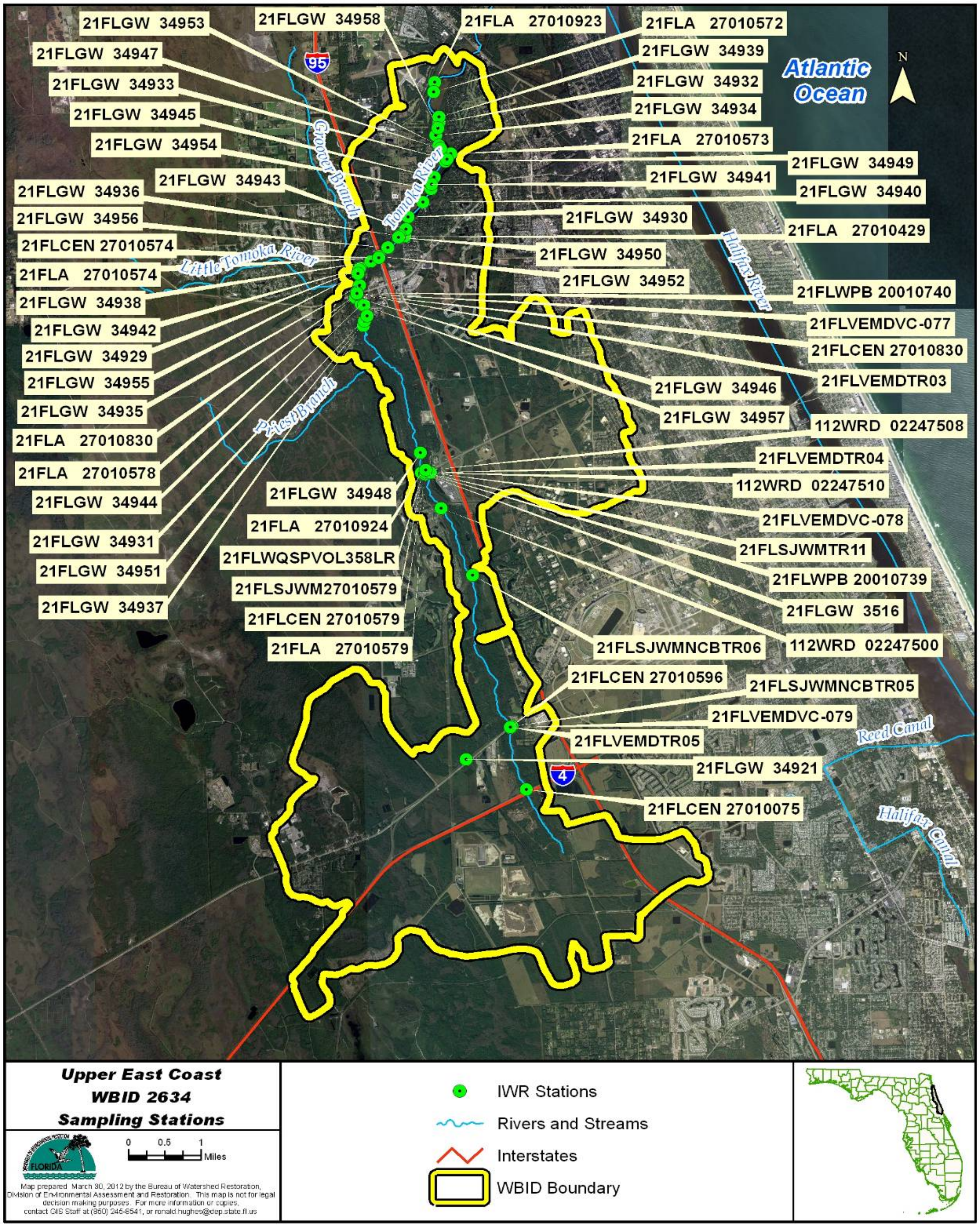
Station	N	Minimum	Maximum	Median	Mean
TOMOKA RIVER UPSTREAM OF S.R. 40 BRIDGE	54	1.0	36.6	1.1	5.3
TOMOKA RIVER UPSTREAM OF 11TH ST. BRIDGE	51	1.0	4.2	1.0	1.2
TOMOKA RIVER UPSTREAM OF U.S. 92 BRIDGE	30	1.0	17.3	1.4	3.0
TOMOKA RIVER FROM UPSTREAM SIDE OF S.R. 40	78	1.0	200.6	3.0	9.7
TOMOKA RIVER, FROM UPSTREAM SIDE OF LPGA BLVD.	71	1.0	3.7	1.0	1.1
TOMOKA RIVER FROM UPSTREAM SIDE OF U.S. 92	26	1.0	160.7	3.2	20.8
TOMOKA RIVER @ 11TH STREET	6	1.0	2.0	1.0	1.2
TOMOKA RIVER @ STATE HIGHWAY 40	6	1.0	18.6	3.5	7.3
TOMOKA RIVER AT CR216A (WBID 2634)	3	1.0	1.1	1.0	1.0

CHLAC concentrations are µg/L.

Table 5.3. Summary Statistics for Major Water Quality Parameters Measured in Tomoka River

PARAMETER	N	MIN	25%	MEDIAN	MEAN	75%	MAX
BOD (mg/L)	71	0.4	0.8	1.4	1.7	2.0	6.1
CHLAC (µg/L)	654	0.0	1.0	1.1	6.9	3.1	450.0
COLOR (PT-CO)	670	5	85	160	236	320	1200
COND (uS/cm)	690	0	172	315	4308	483	76100
DO (mg/L)	696	0.00	3.19	4.51	4.53	5.82	19.19
DOSAT (%)	243	0.00	38.65	53.90	51.99	66.00	133.00
NH4 (mg/L)	312	0.001	0.018	0.028	0.060	0.047	1.500
NO3O2 (mg/L)	649	0.000	0.019	0.038	0.051	0.060	0.640
PH (su)	729	4.04	6.75	7.04	6.97	7.30	8.43
SALINITY (PPT)	588	0.00	0.10	0.15	2.83	0.23	233.00
SD (m)	553	0.0	0.4	0.5	0.6	0.8	25.0
TEMPC (^{o}C)	738	3.50	17.59	22.00	21.43	25.53	35.00
TN (mg/L)	628	0.15	0.79	1.01	1.15	1.33	4.52
TP (mg/L)	649	0.01	0.04	0.05	0.10	0.09	4.20
TSS (mg/L)	579	0	2	4	4	5	55
TURBIDITY (NTU)	642	1	2	3	4	4	84
INORGP (mg/L)	516	0.001	0.015	0.024	0.033	0.036	0.457
INORGN (mg/L)	304	0.01	0.05	0.08	0.12	0.11	1.52
TN/TP RATIO	601	0.00	11.96	17.96	22.87	28.51	153.40
INORGNINORGP	200	0.39	2.26	3.27	5.98	4.99	99.09

Figure 5.1. Historical Sampling Sites in the Tomoka River Watershed



28

Figure 5.2. Historical CHLAC Observations for the Tomoka River

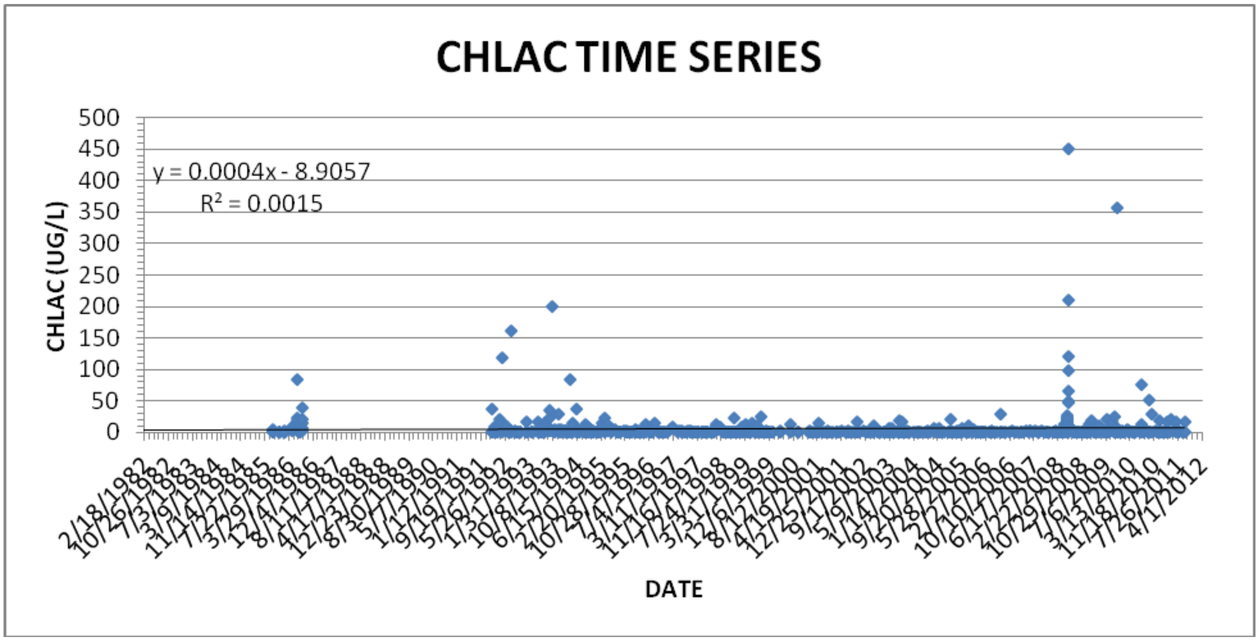


Figure 5.3. Historical TN Observations for the Tomoka River

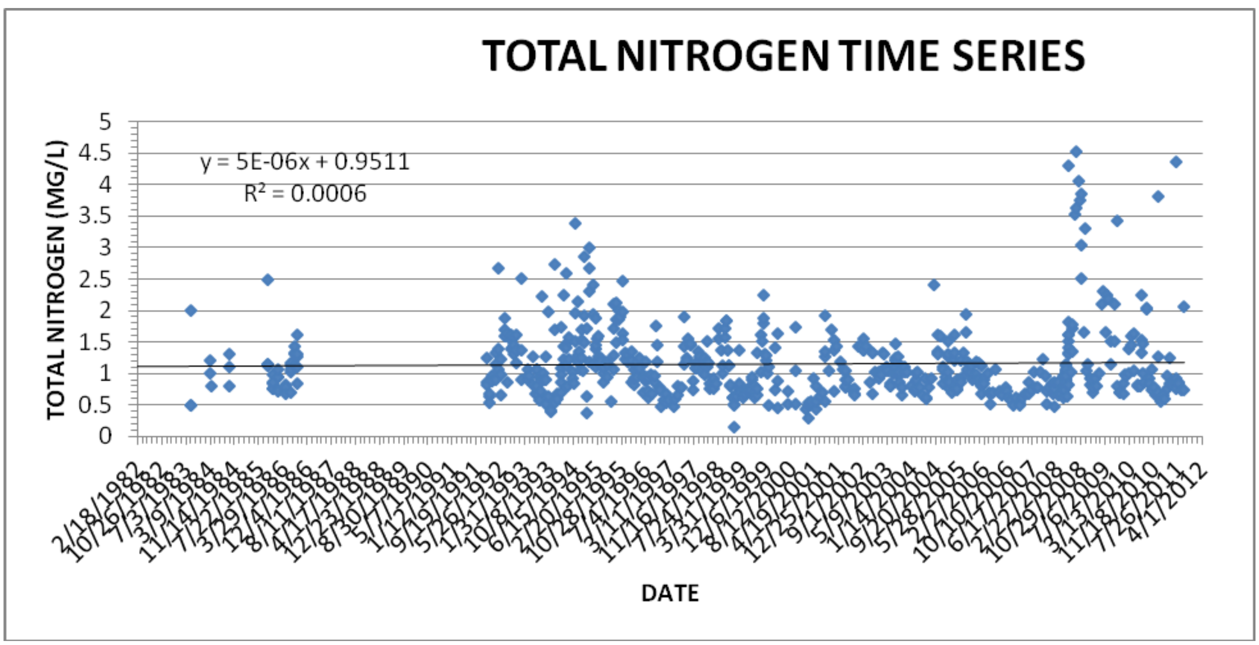


Figure 5.4. Historical TP Observations for the Tomoka River

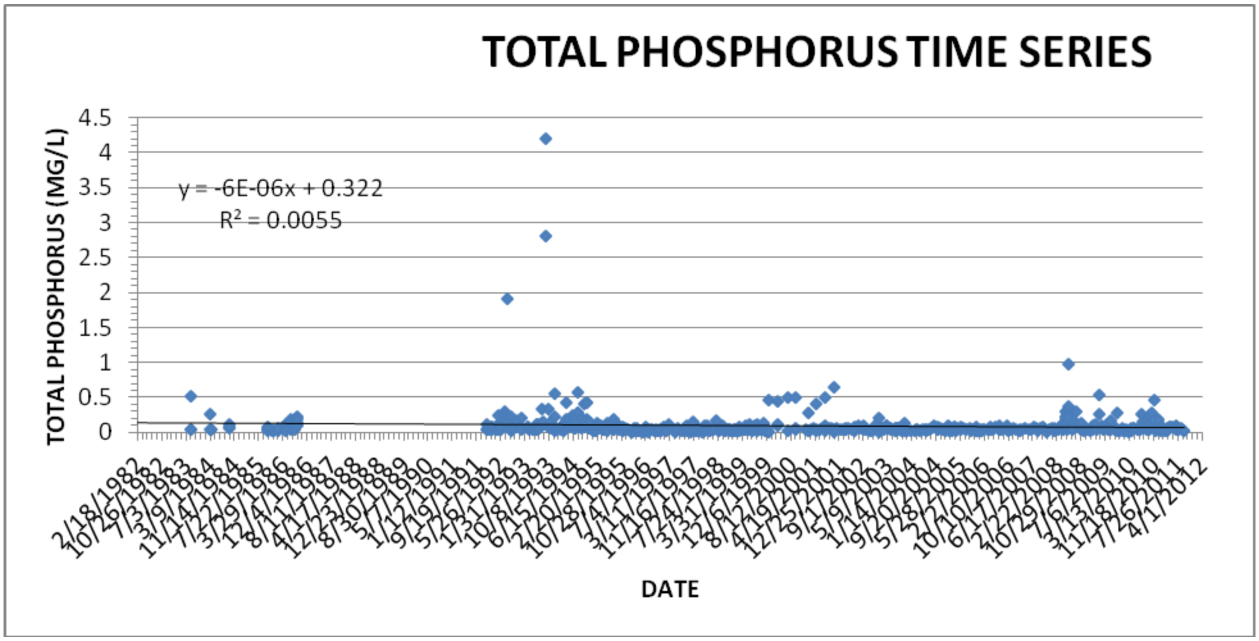


Figure 5.5. Historical Color Observations for the Tomoka River

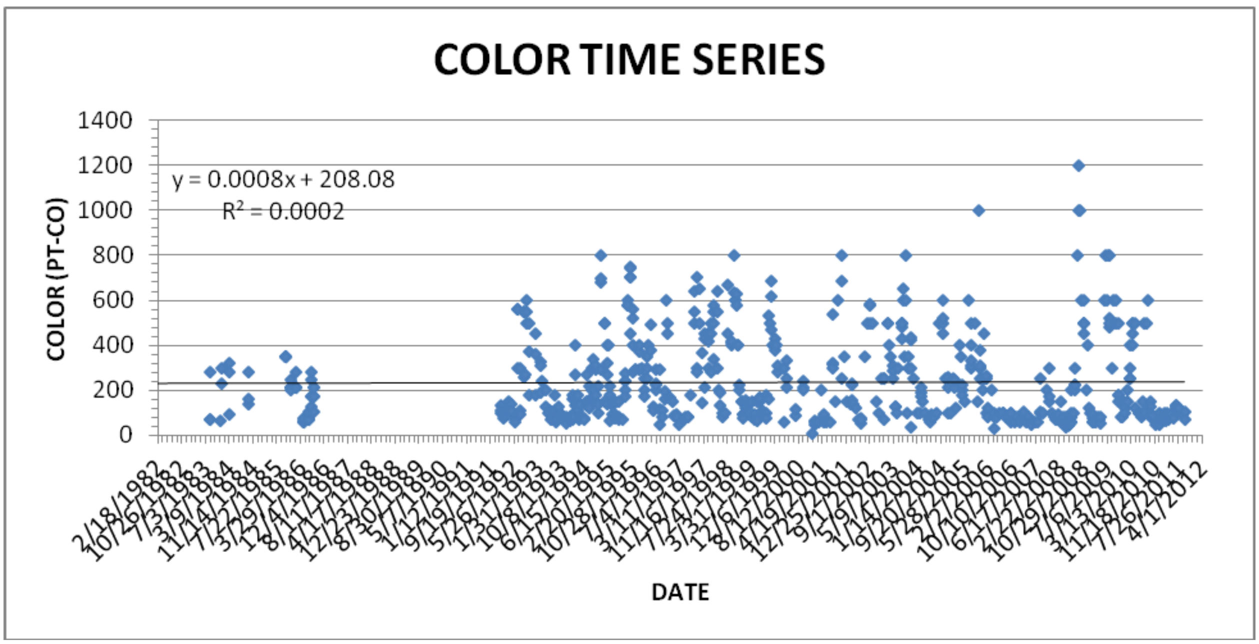
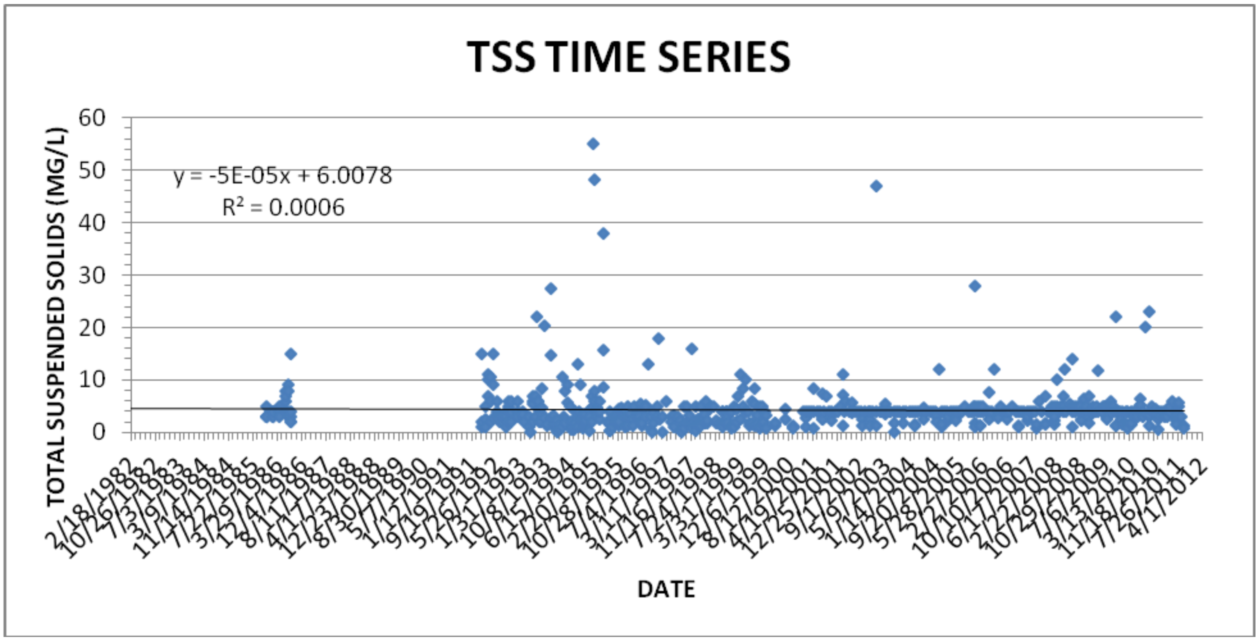


Figure 5.6. Historical Total Suspended Solids Observations for the Tomoka River



Available CHLAC, TN, and TP measurements were also summarized by year (**Tables 5.4–5.6**). Annual means were based on the IWR methodology that based the average on quarterly averages. A nonparametric test (Kruskal-Wallis) was applied to the CHLAC, INORGN, TN, INORGP, TP, COND, Color, and TSS datasets to determine whether there were significant differences among seasons (**Appendix D**). At an α level of 0.05, differences were significant among seasons all the parameters. A similar test for differences among years was significant for all the parameters (**Appendix E**).

Table 5.4. Statistical Summary of Historical CHLAC Data by Year for the Tomoka River

Year	N	Minimum	Maximum	Median	Mean
1985	9	1.0	4.3	1.0	
1986	24	1.0	84.3	4.4	
1992	34	1.0	160.7	1.4	11.2
1993	31	1.0	200.6	2.3	13.6
1994	40	1.0	84.7	1.6	5.8

Year	N	Minimum	Maximum	Median	Mean
1995	35	1.0	22.0	1.0	3.3
1996	33	1.0	15.4	1.0	2.3
1997	21	1.0	8.2	1.0	2.3
1998	36	1.0	23.9	1.0	2.5
1999	35	1.0	25.2	1.1	3.7
2000	10	1.0	13.1	1.1	2.7
2001	21	1.0	14.4	1.0	1.8
2002	19	1.0	16.8	1.0	2.6
2003	33	1.0	18.6	1.0	2.2
2004	20	1.0	7.7	1.0	1.9
2005	43	1.0	21.6	1.4	2.4
2006	21	1.0	28.5	1.0	2.6
2007	19	1.0	2.5	1.0	1.3
2008	64	1.0	450.0	2.4	10.2
2009	50	1.0	356.8	2.6	11.4
2010	33	1.0	76.0	1.3	6.4
2011	24	1.0	21.5	1.3	5.9

CHLAC concentrations are µg/L.
Blank cells in the mean column represent cases where data were not collected in each of the four quarters.

Table 5.5 Statistical Summary of Historical TN Data by Year for the Tomoka River

Year	N	Minimum	Maximum	Median	Mean
1975	1	0.70	0.70	0.70	
1983	3	0.49	2.00	0.49	
1984	6	0.80	1.30	1.05	
1985	10	0.75	2.48	1.06	

Year	N	Minimum	Maximum	Median	Mean
1986	25	0.67	1.61	1.06	
1992	33	0.53	2.68	1.24	1.26
1993	33	0.39	2.74	0.91	1.08
1994	42	0.37	3.38	1.32	1.47
1995	37	0.56	2.47	1.40	1.48
1996	34	0.47	1.75	0.96	1.01
1997	22	0.48	1.90	0.98	0.92
1998	35	0.62	1.85	1.13	1.17
1999	35	0.15	2.24	0.78	0.93
2000	12	0.46	1.73	0.81	0.91
2001	21	0.29	1.91	0.72	0.91
2002	21	0.65	1.56	1.05	1.06
2003	32	0.67	1.48	1.02	1.02
2004	22	0.60	2.40	0.92	1.06
2005	38	0.69	1.94	1.01	1.08
2006	19	0.50	1.13	0.70	0.73
2007	17	0.50	1.24	0.74	0.76
2008	60	0.48	4.52	0.97	1.82
2009	21	0.69	3.42	1.14	1.40
2010	27	0.66	2.25	1.00	1.13
2011	22	0.56	4.36	0.83	1.19

TN concentrations are mg/L.
Blank cells in the mean column represent cases where data were not collected in each of the four quarters.

Table 5.6. Statistical Summary of Historical TP Data by Year for the Tomoka River

Year	N	Minimum	Maximum	Median	Mean
1968	1	0.130	0.130	0.130	
1969	1	0.114	0.114	0.114	
1970	1	0.068	0.068	0.068	
1971	1	0.117	0.117	0.117	
1975	1	0.090	0.090	0.090	
1983	3	0.050	0.520	0.050	
1984	6	0.050	0.260	0.070	
1985	10	0.020	0.070	0.030	
1986	25	0.020	0.230	0.090	
1992	34	0.020	1.910	0.090	0.149
1993	28	0.020	4.200	0.095	0.335
1994	42	0.025	0.570	0.104	0.152
1995	37	0.015	0.180	0.067	0.071
1996	34	0.010	0.070	0.030	0.032
1997	22	0.010	0.150	0.031	0.047
1998	37	0.010	0.170	0.040	0.048
1999	35	0.023	0.140	0.040	0.053
2000	10	0.010	0.495	0.105	0.228
2001	21	0.010	0.640	0.052	0.123
2002	19	0.019	0.093	0.050	0.050
2003	34	0.010	0.210	0.051	0.059
2004	20	0.020	0.091	0.040	0.046
2005	38	0.020	0.091	0.050	0.050
2006	23	0.020	0.100	0.045	0.051

Year	N	Minimum	Maximum	Median	Mean
2007	18	0.010	0.081	0.042	0.043
2008	63	0.020	0.970	0.110	0.100
2009	30	0.028	0.540	0.050	0.093
2010	33	0.010	0.470	0.048	0.084
2011	22	0.020	0.180	0.057	0.057

TP concentrations are mg/L.
Blank cells in the mean column represent cases where data were not collected in each of the four quarters.

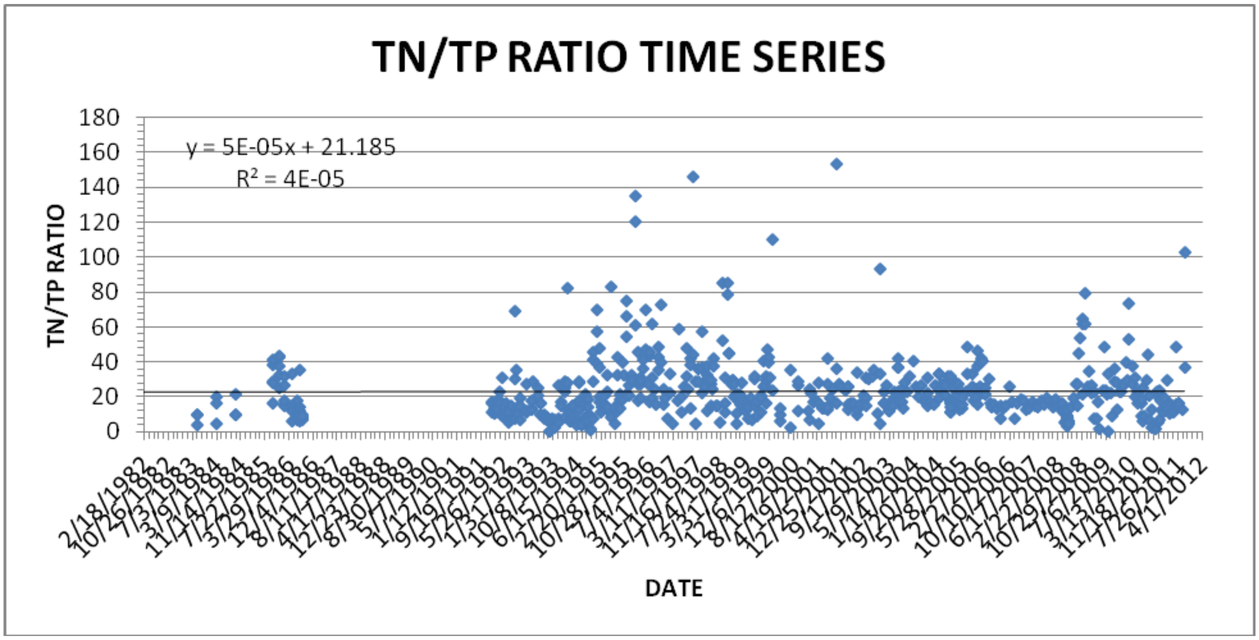
5.1.2 TMDL Development Process

As part of evaluating potential relationships between CHLAC and other variables, rainfall records for the Daytona International Airport (**Appendix J**) were used to determine rainfall amounts associated with individual sampling dates. Rainfall recorded on the day of sampling (PRECIP), the cumulative total for the day of and the previous two days (V3DAY), the cumulative total for the day of and the previous six days (V7DAY), the cumulative total for the day of and the previous thirteen days (V14DAY), and the cumulative total for the day of and the previous twenty days (V21DAY) were all paired with the respective water quality parameter observation.

A Spearman correlation matrix was used to assess potential relationships between CHLAC and other water quality parameters (**Appendix G**). At an alpha (α) level of 0.05, correlations between CHLAC, COND, SALINITY, water temperature (TEMPC), NO3O2, TN, TP, TSS, TURBIDITY, V14DAY, V21DAY, and daily streamflow were significant. A simple linear regression of CHLAC versus SALINITY explained nearly 10 percent of the variance in CHLAC while the regression with TN also explained nearly 10 percent of the variance in CHLAC (**Appendix I**).

The impairment listing identified TN and TP as co-limiting nutrients. **Figure 5.7** illustrates the time series of the TN/TP ratio. Although the trend line indicates an increase in the TN/TP ratio, the regression was not significant at an alpha (α) level of 0.05 (p=0.872). A similar plot of the INORGN/INORGP ratio had a slope of 0.00007. Summary statistics for the ratio's can be found in **Table 5.3**. Based on the INORGN/INORGP ratio, it appeared that inorganic forms of nitrogen were typically limiting compared to inorganic phosphorus (75% value was 4.99).

Figure 5.7. Historical Time Series of the TN/TP Ratio for the Tomoka River



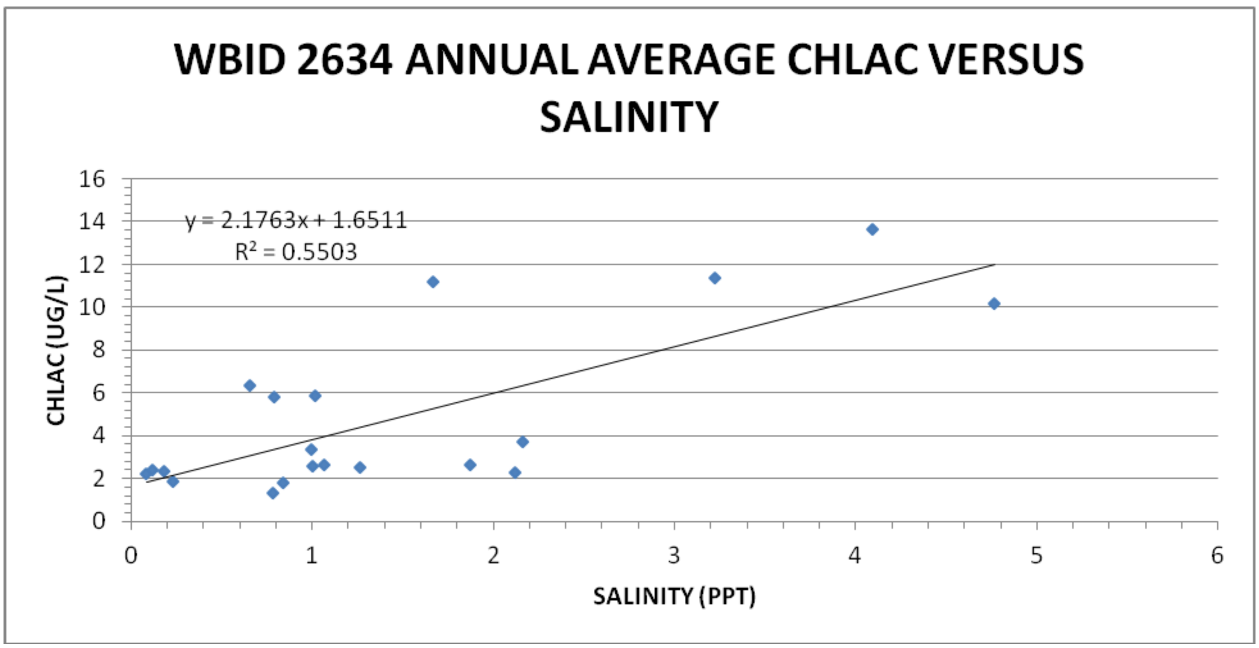
As the impairment for nutrients was based on an annual average for CHLAC, annual averages for water quality parameters were also calculated using available data and linear regressions were performed. The calculations of annual averages followed the methodology described in the IWR for the calculation of annual CHLAC averages.

Based on simple linear regression using annual averages, correlations between CHLAC and COND, SALINITY, NH4, INORGN, TN, and TP were significant at an alpha (α) level of 0.05 (**Appendix JI**). Approximately 55 percent of the variance in the annual average CHLAC was explained with the annual average SALINITY concentration. Annual average NH4 explained nearly 48 percent (INORGN explained 46 percent) of the variance in the annual average CHLAC concentrations. TN and TP explained 32 percent and 37 percent of the variance, respectively. INORGP regressions with CHLAC were significant at an alpha (α) level of 0.05. Simple linear regressions with annual average CHLAC concentrations versus the model predicted annual average TN and TP watershed loads (**Table 4.5**) were not significant at an alpha (α) level of 0.05 (**Appendix J**).

Although the regression between CHLAC and annual rainfall was not significant ($r^2 = 0.130$, p=0.118), annual rainfall patterns were examined further to evaluate whether there were cumulative effects due to reduced rainfall. Annual rainfall totals over the 1937 through 2011 were ranked (**Appendix K**). With the exception of 2009 (50.3 inches), rainfall totals over the 2008 – 2011 period were below the long-term annual average of 49.63 inches. To evaluate the longer term effects of below average rainfall years, an annual rainfall deficit was calculated based on the long-term average. The cumulative effect of deficits was calculated by summing over a three-year (current year and two previous years) and a five-year (current year and the four previous years) period. Simple linear regressions of the annual average CHLAC versus the three-year cumulative and five-year cumulative deficits were significant at an alpha (α) level of 0.05 (**Appendix J**). Plots of the annual rainfall deficit and cumulative three and five-year deficits can be found in **Appendix K**. As seen in the plots, following the high rainfall in 2005 (65.77 inches), the cumulative three and five-year deficits increased sharply.

In seventeen of the twenty years for which annual averages for salinity were calculated, the annual average salinity was below 2.7 ppt and represented fresh water conditions. In those seventeen years, the maximum annual average CHLAC concentration was 11.2 µg/L with thirteen of the years averaging less than 3.8 µg/L. For the three years where the annual average salinity exceeded 3 ppt (1993, 2008, and 2009), annual average CHLAC concentrations were between 10.2 and 13.6 µg/L. The annual average CHLAC concentration in 2010 was 6.4 µg/L and the annual average salinity was 0.7 ppt. This is illustrated in **Figure 5.8**.

Figure 5.8. Annual Average CHLA versus Salinity for the Tomoka River



.
As discussed in Section 5.1.1, thirty-three of the fifty-eight stations with CHLAC had only one observation. Patterns of CHLAC, SALINITY, TN, and TP were further explored at three long-term stations that were sampled over the 1998 – 2011 period. The following plots (**Figures 5.9 – 5.12**) illustrate conditions at stations 21FLGW 3516, 21FLVEMDVC-077, and 21FLVEMDVC-078. Stations 21FLVEMDVC-078 and 21FLGW 3516 are located near the LPGA Blvd crossing of the Tomoka River, approximately 2.9 miles south of the 21FLVEMDVC-077 station near SR

40 (**Figure 5.1**). Both CHLAC and SALINITY levels at the 21FLVEMDVC-077 site are elevated relative to the two sites to the south. Thirty percent of the reported salinity measurements at 21FLVEMDVC-077 represented predominantly marine conditions. In contrast, the maximum salinities at stations 21FLVEMDVC-078 and 21FLGW 3516 were both less than 0.5 ppt. Between 30 and 40 percent of the CHLAC observations at station 21FLVEMDVC-077 exceeded 5 µg/L. Approximately 45 percent of the period of record salinity observations reported for stations in the WBID located at or above SR 40 represented predominantly marine conditions, suggesting some tidal transport into this portion of the Tomoka.

Figure 5.9. CHLA Time Series for Three Long-term Stations in the Tomoka River

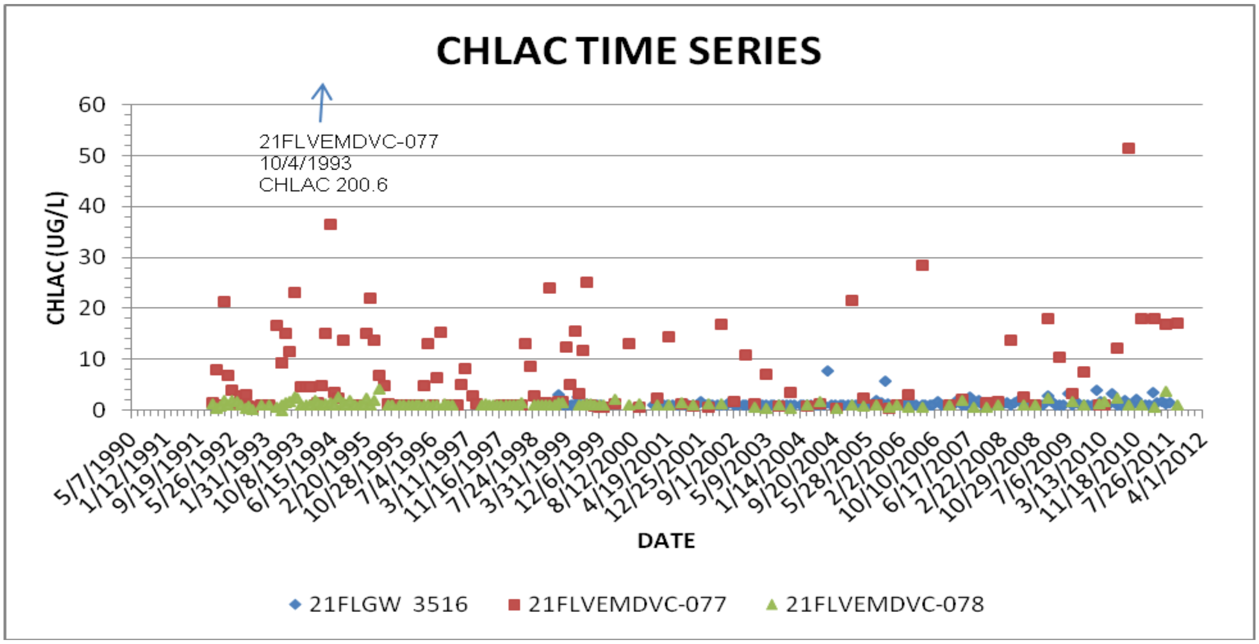


Figure 5.10. Total Nitrogen Time Series for Three Long-term Stations in the Tomoka River

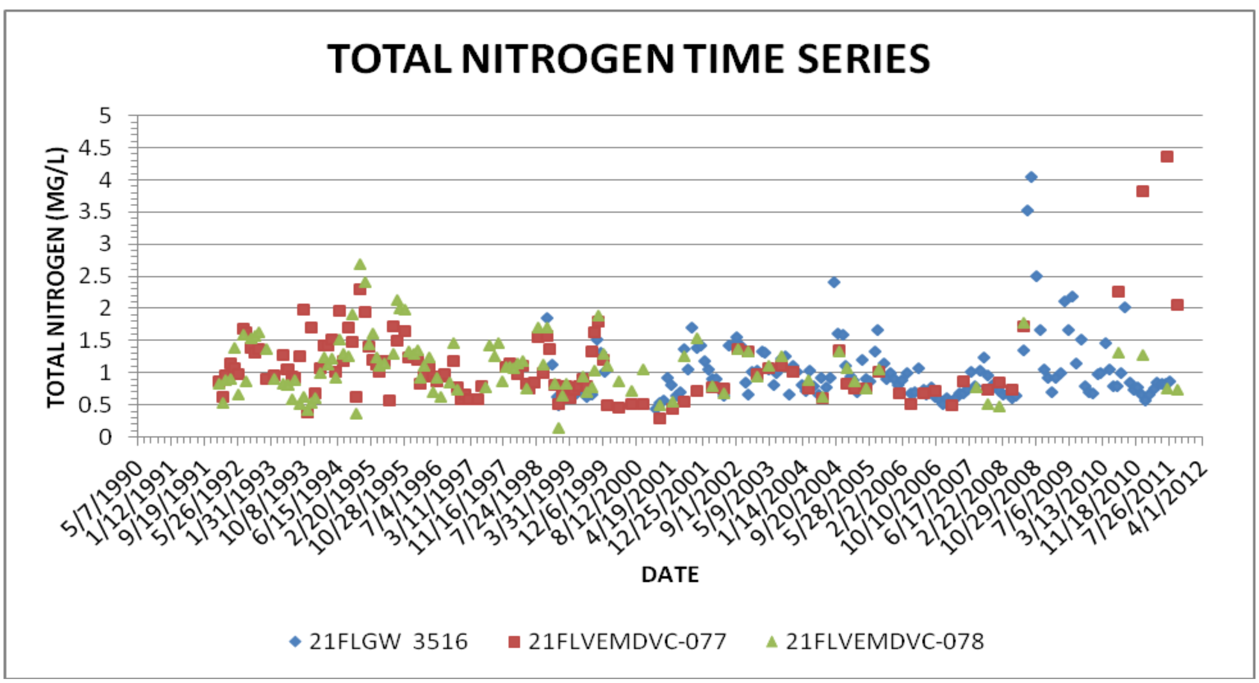


Figure 5.11. Total Phosphorus Time Series for Three Long-term Stations in the Tomoka River

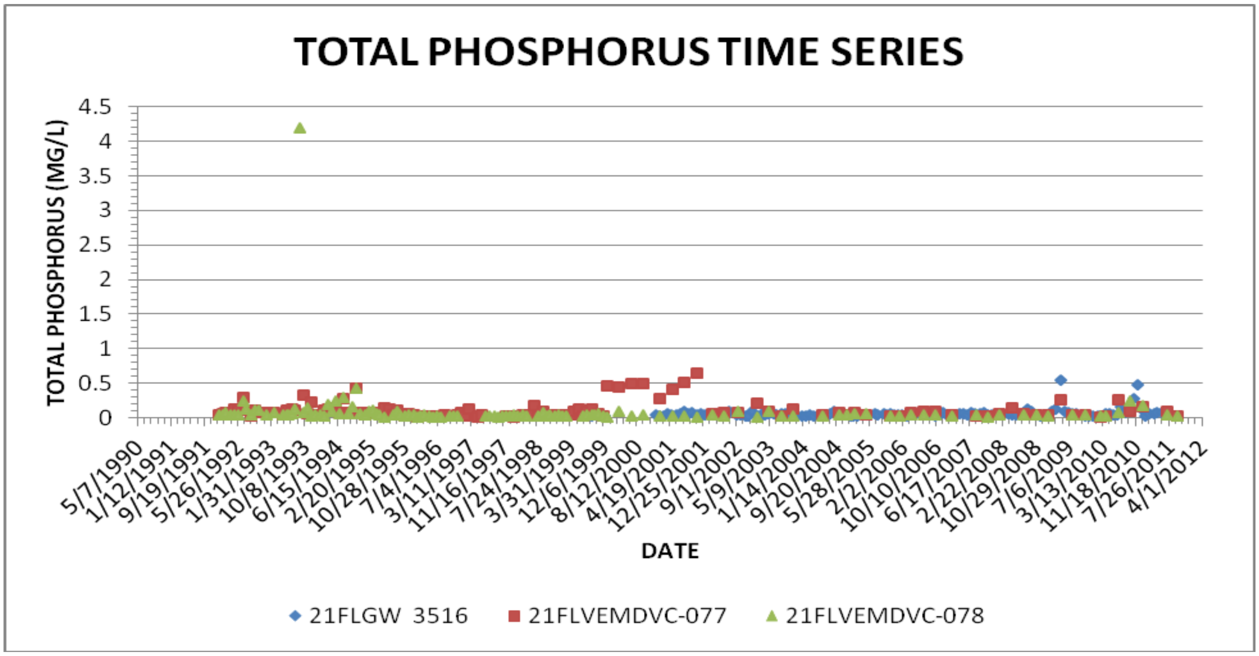
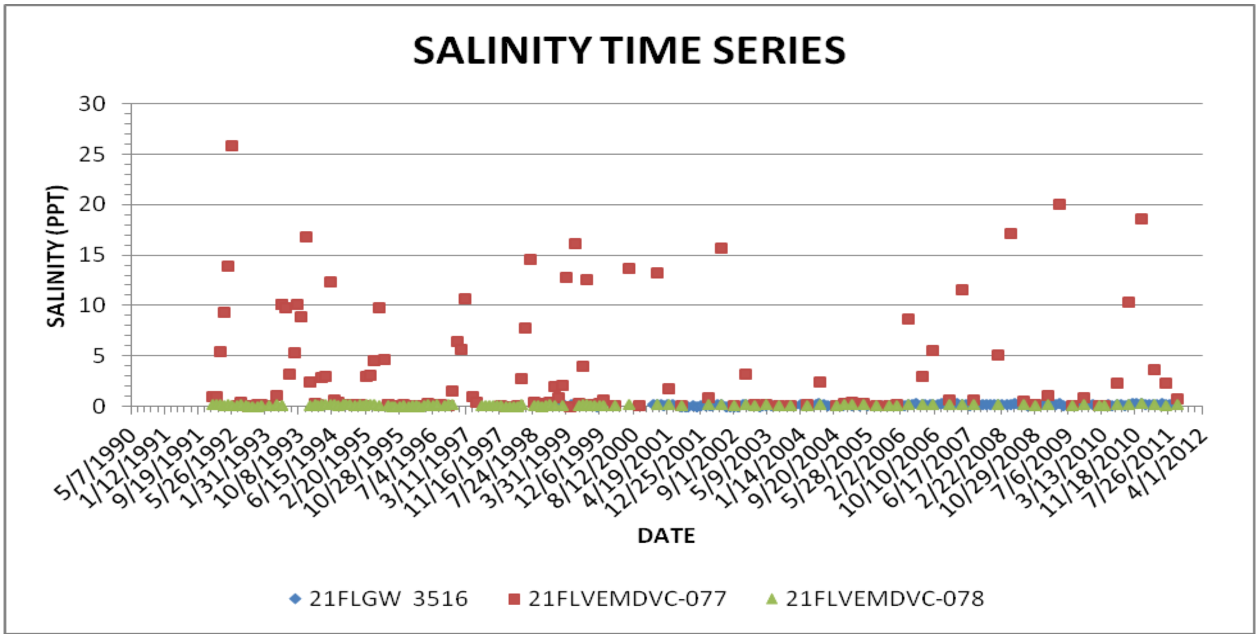
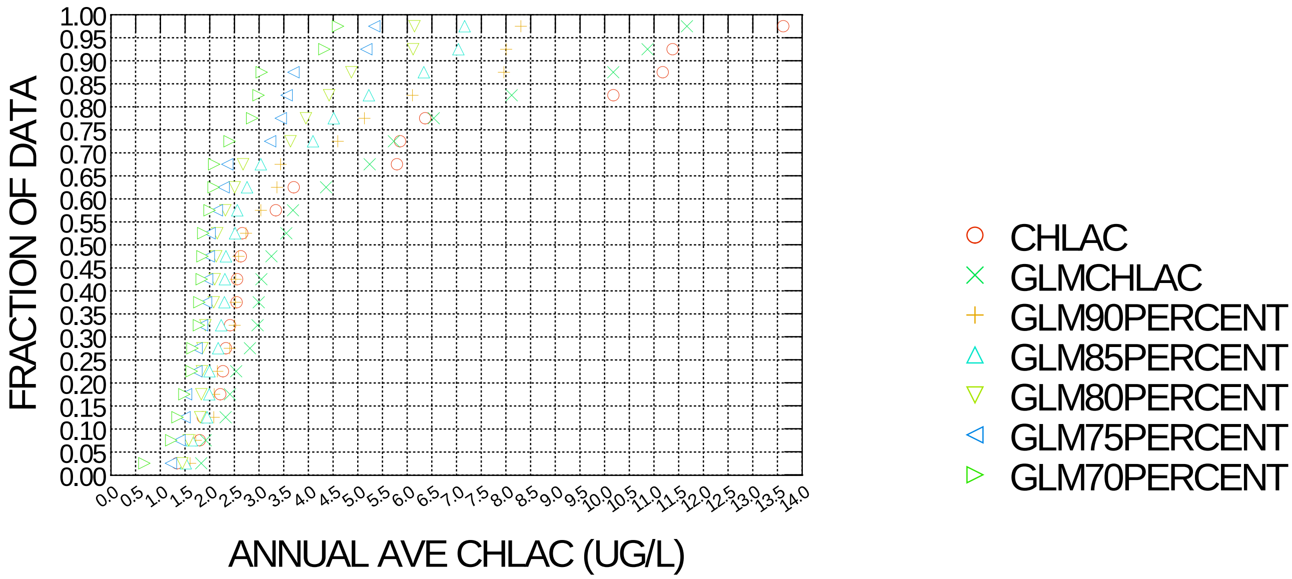


Figure 5.12. Salinity Time Series for Three Long-term Stations in the Tomoka River



As the nutrient impairment listing was based on exceeding an annual average CHLA concentration of 5 µg/L for two consecutive years, a target annual average CHLAC concentration of 4.5 µg/L was considered as an appropriate protective target and used to develop nutrient reductions. Correlations between annual average concentrations of CHLAC and inorganic nitrogen (as well as NH4), TN, and TP were significant. A general linear model GLM) that included TN and TP explained nearly 67 percent of the variance in annual average CHLAC concentrations (**Appendix J**). As discussed earlier and illustrated in Figure 5.7, TN/TP ratios indicated co-limitation of nitrogen and phosphorus. Therefore, similar reductions to TN and TP were applied with the GLM until annual average CHLAC concentrations were less than 4.5 µg/L (**Figure 5.13**).

Figure 5.13. General Linear Model of Annual Average CHLAC versus TN and TP in the Tomoka River



Annual average TN concentrations over the 1992 – 2011 period ranged between 0.73 mg/L (2006) and 1.82 mg/L (2008) with an overall average of 1.12 mg/L. Over the same period, TP concentrations ranged between 0.032 mg/L (1996) and 0.335 mg/L (1993) with an overall average of 0.094 mg/L. Applying a thirty percent reduction (GLM70PERCENT) to the annual average TN concentrations yielded a range between 0.51 mg/L and 1.27 mg/L, with an overall average of 0.78 mg/L. Application of the thirty percent reduction to the annual average TP concentrations yielded a range between 0.022 mg/L and 0.234 mg/L, with an overall average of 0.065 mg/L. The annual average TN and TP concentrations of 0.78 mg/L and 0.065 mg/L, respectively were used as the nutrient targets in the TMDL to achieve an annual CHLAC target of 4.5 µg/L or less. Use of the averages addresses year-to-year variations in nutrient levels observed historically in the watershed.

Over the September 1992 to May 2012 period, 24 stream condition index (SCI) assessments have been conducted in this WBID. The SCI uses 10 metrics to evaluate the biological health of the macroinvertebrate community. All twenty-four assessments have concluded that the biological community is healthy with good or excellent ratings. Reductions in TN ,TP and CHLAC concentrations are not expected to adversely affect the existing biological community.

Estimated watershed TN and TP concentrations and loads were provided by Tetra Tech (**Table 4.5)** for the 1997 – 2009 period. Predicted annnual average TN concentrations over the simulation period ranged from 1.10 mg/L to 1.32 mg/L, with an overall average of 1.19 mg/L. Annual TN loadings ranged from 127,797 lbs/yr to 848,249 lbs/yr, with an overall average of 338,774 lbs/yr. Predicted annnual average TP concentrations over the simulation period ranged from 0.065 mg/L to 0.120 mg/L, with an overall average of 0.090 mg/L. Annual TP loadings ranged from 11,092 lbs/yr to 49,287 lbs/yr, with an overall average of 22,101 lbs/yr. Simple linear regressions of the model predicted annual average TN load or TP load versus the annual average CHLAC concentration were not significant at an α level of 0.05, so a TMDL-related load associated with a 30 percent reduction in annual average TN or TP concentrations were not calculated using the model.

5.1.3 Critical Conditions/Seasonality

Nonparametric tests (Kruskal-Wallis) were presented in **Appendices C** and **D** that illustrated significant differences in CHLAC and nutrients on both a seasonal and annual basis. The nutrient impairment was based on annual average CHLAC concentrations exceeding a historic minimum by 50 percent or more over two consecutive years. The methodology used for calculating an annual average is based on computing individual seasonal averages. Consequently, seasonality is incorporated into the process of assessment and TMDL development. Reductions in TN and TP were based on setting a CHLAC target and corresponding TN and TP concentrations below the historic minimum chlorophyll listing threshold.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (Wasteload Allocations, or WLAs), nonpoint source loads (Load Allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\mathbf{TMDL} = \sum \square \mathrm{WLAs} + \sum \square \mathrm{LAs} + \mathbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\mathbf{TMDL} \cong \sum \square \mathrm{WLAs}_{\mathbf{wastewater}} + \sum \square \mathrm{WLAs}_{\mathbf{NPDES\ Stormwater}} + \sum \square \mathrm{LAs} + \mathrm{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of BMPs.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or **other appropriate measure**. The nutrient TMDL for the Tomoka River is expressed in terms of a percent reduction in total nitrogen and total phosphorus nutrient criteria and corresponding concentrations (**Table 6.1**).

Table 6.1. TMDL Components for Tomoka River

WBID	Parameter	TMDL[1] (mg/L)	WLA	WLA	LA (% Reduction)[2]	MOS
			Wastewater (mg/L)	NPDES Stormwater (% Reduction)[1]		
2634	TN	0.78	N/A	30%	30%	Implicit
2634	TP	0.065	N/A	30%	30%	Implicit

[1] Nutrient concentrations represent annual averages
[2] As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.

6.2 Load Allocation

Total nitrogen and total phosphorus reductions of 30 percent are required from nonpoint sources. It should be noted that the load allocation includes loading from stormwater discharges that are not part of the NPDES Stormwater Program.

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

There is currently one permitted NPDES discharge in the Tomoka River watershed. Based on discharge monitoring reports, the Tomoka Farms Road Landfill (FL0037877) has an infrequent discharge to the Tomoka River and the reported TN and TP concentrations are below the target concentration.

6.3.2 NPDES Stormwater Discharges

Several Phase II municipal separate storm sewer system (MS4) permits cover portions of the watershed, including permits for the City of Daytona Beach (FLR04E0115) and Volusia County (FLR04E033. The Florida Department of Transportation District 5 is a co-permittee with Volusia County (FLR04E024). It should be noted that any MS4 permittee is only responsible for reducing the loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL. An MOS was included in the TMDL by setting an annual CHLAC target concentration of 4.5 µg/L which was below the historic minimum listing threshold and applying a 30 percent reduction to annual average TN and TP concentrations. The 30 percent reduction was based on application of a general linear model to achieve annual average CHLAC concentrations below 4.5 µg/L. The assessment process would require at least two consecutive years CHLAC at or above 5 µg/L before being listed as impaired for nutrients.

Chapter 7: NEXT STEPS: IMPLEMENTATION PLAN DEVELOPMENT AND BEYOND

7.1 Basin Management Action Plan

Following the adoption of this TMDL by rule, the Department will determine the best course of action regarding its implementation. Depending upon the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. **Often** this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. Basin Management Action Plans are the primary mechanism through which TMDLs are implemented in Florida [see Subsection 403.067(7) F.S.]. A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include:

- Water quality goals (based directly on the TMDL);
- Refined source identification;
- Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);
- A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;
- A description of further research, data collection, or source identification needed in order to achieve the TMDL;
- Timetables for implementation;
- Implementation funding mechanisms;
- An evaluation of future increases in pollutant loading due to population growth;
- Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and
- Stakeholder statements of commitment (typically a local government resolution).

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies, improved internal communication within local governments, applied high-quality science and local information in managing water resources, clarified obligations of wastewater point source, MS4 and non-MS4 stakeholders in TMDL implementation, enhanced transparency in DEP decision-making, and built strong relationships between DEP and local stakeholders that have benefited other program areas.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Rule 62-40, F.A.C. In 1994, the Department's stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations.

Rule 62-40 also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, stormwater PLRGs have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal Clean Water Act Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in 1990. These stormwater discharges include certain discharges that are associated with industrial activities designated by specific standard industrial classification (SIC) codes, construction sites disturbing 5 or more acres of land, and master drainage systems of local governments with a population above 100,000, which are better known as MS4s. However, because the master drainage systems of most local governments in Florida are interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 urban water control districts, and the Florida Department of Transportation throughout the 15 counties meeting the population criteria. The Department received authorization to implement the NPDES stormwater program in 2000.

An important difference between the federal NPDES and the state's stormwater/environmental resource permitting programs is that the NPDES Program covers both new and existing discharges, while the state's program focus on new discharges only. Additionally, Phase II of the NPDES Program, implemented in 2003, expands the need for these permits to construction sites between 1 and 5 acres, and to local governments with as few as 1,000 people. While these urban stormwater discharges are now technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that all MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Historical Corrected Chla, TEMP, TN, TP, and TSS Observations in Palm Coast, 1968–2011

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
112WRD 02247510	05/03/1968		26		0.1304	
112WRD 02247510	05/01/1969		21		0.1141	
112WRD 02247510	05/15/1970		23		0.0685	
112WRD 02247510	05/14/1971		25.5		0.1174	
112WRD 02247510	11/14/1973		16.5			
112WRD 02247510	01/04/1974		19			
112WRD 02247510	02/22/1974		18.5			
112WRD 02247510	04/19/1974		19.5			
112WRD 02247510	06/19/1974		27			
112WRD 02247510	08/05/1974		24			
21FLA 27010830	03/18/1975		21.2	0.704	0.09	4
112WRD 02247510	10/31/1979		20.5			
112WRD 02247510	01/07/1980		12			
112WRD 02247510	02/20/1980		13			
112WRD 02247510	04/16/1980		17			
112WRD 02247510	06/09/1980		27.5			
112WRD 02247510	08/06/1980		26			
112WRD 02247510	10/01/1980		26.5			
112WRD 02247510	12/02/1980		15			
112WRD 02247510	01/20/1981		8.5			
112WRD 02247510	03/28/1981		19			
112WRD 02247510	05/21/1981		24			
112WRD 02247510	07/10/1981		27			
112WRD 02247510	10/27/1981		24			
112WRD 02247510	12/17/1981		14.5			
112WRD 02247510	02/09/1982		18			
112WRD 02247510	04/13/1982		19.5			
112WRD 02247510	06/07/1982		28			
112WRD 02247510	07/26/1982		25.5			
112WRD 02247510	10/12/1982		22			
112WRD 02247510	01/06/1983		15			
112WRD 02247510	03/09/1983		14.5			
112WRD 02247510	03/31/1983		18			
112WRD 02247510	06/16/1983		23.5			
112WRD 02247500	08/18/1983			2	0.52	
112WRD 02247508	08/18/1983		25.5	0.49	0.05	
112WRD 02247510	08/18/1983			0.49	0.05	
112WRD 02247500	03/09/1984		13.5	1.2	0.26	
112WRD 02247510	03/09/1984		14.5	1	0.05	

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
112WRD 02247508	03/15/1984		19	0.8	0.05	
112WRD 02247500	09/28/1984			1.3	0.06	
112WRD 02247508	09/28/1984			1.1	0.11	
112WRD 02247510	09/28/1984			0.8	0.08	
21FLA 27010573	10/22/1985	1	25.6	1.13	0.04	
21FLA 27010574	10/22/1985	1.43	24.3	1.15	0.03	
21FLA 27010578	10/22/1985	2.57	24	1.13	0.07	
21FLA 27010572	10/22/1985	4.28	25.5	1.14	0.04	
21FLA 27010579	10/22/1985		25	2.48	0.06	
21FLA 27010573	12/16/1985	1	15.7	0.85	0.02	3
21FLA 27010574	12/16/1985	1	13.2	0.75	0.02	5
21FLA 27010578	12/16/1985	1	12.8	0.75	0.03	3
21FLA 27010579	12/16/1985	1	12	0.87	0.02	3
21FLA 27010572	12/16/1985	1.18	15.7	0.98	0.03	3
21FLA 27010578	02/11/1986	1	19.8	0.71	0.04	3
21FLA 27010579	02/11/1986	1	19	1.06	0.04	4
21FLA 27010573	02/11/1986	1.28	19.5	0.95	0.06	4
21FLA 27010574	02/11/1986	1.28	19.2	0.73	0.05	3
21FLA 27010572	02/11/1986	1.71	19.4	0.95	0.03	3
21FLA 27010573	04/28/1986	4.28	25.1	0.71	0.05	4
21FLA 27010574	04/28/1986	7.91	23.9	0.82	0.07	5
21FLA 27010572	04/28/1986	4.49	23.6	0.75	0.05	4
21FLA 27010578	04/28/1986	7.7	24	0.77	0.12	4
21FLA 27010579	04/28/1986	1.92	23	0.67	0.02	3
21FLA 27010579	06/23/1986	1.92	26	0.7	0.04	4
21FLA 27010573	06/23/1986	84.3	29.5	1.16	0.18	8
21FLA 27010578	06/23/1986		30.3	1.07	0.09	4
21FLA 27010572	06/23/1986	22	28.9	1.12	0.15	6
21FLA 27010574	06/23/1986	18.9	30.1	1.03	0.13	7
21FLA 27010579	07/28/1986	1	25.5	1.43	0.04	3
21FLA 27010573	07/28/1986	7.7	28.6	1.3	0.09	8
21FLA 27010574	07/28/1986	1	27.5	1.33	0.11	4
21FLA 27010572	07/28/1986	7.48	28.9	1.12	0.18	9
21FLA 27010578	07/28/1986	1.07	28	1.13	0.12	3
21FLA 27010579	08/25/1986	2.85	28	0.84	0.09	15
21FLA 27010578	08/25/1986	20	28	1.3	0.18	4
21FLA 27010573	08/25/1986	6.42	31.6	1.26	0.13	3
21FLA 27010572	08/25/1986	39.9	35	1.11	0.14	2
21FLA 27010574	08/25/1986	15	29.3	1.61	0.23	2
21FLVEMDVC-079	01/06/1992	37.7	14.5	1.24	0.11	15
21FLVEMDVC-078	01/06/1992	1.2	14.3	0.82	0.05	2
21FLVEMDVC-077	01/06/1992	1.5	14.1	0.87	0.05	1
21FLVEMDVC-078	02/03/1992	1	12.32	0.53	0.04	2.5

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDVC-079	02/03/1992	2	12.83	0.68	0.06	1
21FLVEMDVC-077	02/03/1992	8	13.29	0.63	0.06	5
21FLVEMDVC-079	03/02/1992	1	20.08	0.89	0.05	7
21FLVEMDVC-078	03/02/1992	1	16.1	0.88	0.07	10
21FLVEMDVC-077	03/02/1992	1	18.86	0.96	0.08	11
21FLVEMDVC-078	04/06/1992	1.8	17.2	0.9	0.05	2
21FLVEMDVC-079	04/06/1992	13.6	16.9	1.33	0.08	6
21FLVEMDVC-077	04/06/1992	21.4	20.36	1.14	0.05	10.5
21FLVEMDVC-078	05/04/1992	1.1	20.63	1.38	0.045	2.75
21FLVEMDVC-079	05/04/1992	118.3	23.1	2.68	0.25	15
21FLVEMDVC-077	05/04/1992	6.8	25.37	1.07	0.12	9
21FLVEMDVC-078	06/01/1992	1.8	23.3	0.66	0.04	3
21FLVEMDVC-079	06/01/1992	11.6	3.5	1.23	0.1	6
21FLVEMDVC-077	06/01/1992	3.8	25.2	0.98	0.11	4
21FLVEMDVC-077	07/06/1992	1.11	28	1.69	0.3	3
21FLVEMDVC-078	07/06/1992	1.6	26.7	1.59	0.24	2
21FLVEMDVC-079	07/06/1992	3.15	26.1	1.87	0.17	2.5
21FLVEMDVC-078	08/03/1992	1	25.5	0.87	0.13	3
21FLVEMDVC-077	08/03/1992	2.79	28.6	1.63	0.11	2
21FLVEMDVC-079	08/03/1992	160.7			1.91	
21FLVEMDVC-078	09/09/1992	1	24	1.53	0.05	4
21FLVEMDVC-079	09/09/1992	1	24.1	1.62	0.22	3
21FLVEMDVC-077	09/09/1992	3	27	1.38	0.02	1
21FLA 27010579	09/22/1992	1	25	1.42	0.04	2
21FLVEMDVC-079	10/05/1992	1	23.1	1.461	0.15	4
21FLVEMDVC-078	10/05/1992	1	23	1.571	0.11	5
21FLVEMDVC-077	10/05/1992	1	23	1.311	0.11	6
21FLVEMDVC-078	11/02/1992	1	20.28	1.62	0.11	2
21FLVEMDVC-079	11/02/1992	1	20.31	1.17	0.17	6
21FLVEMDVC-077	11/02/1992	1	20.43	1.36	0.07	4
21FLVEMDVC-078	12/07/1992		15.32			
21FLVEMDVC-079	12/07/1992		14.59			
21FLVEMDVC-077	12/07/1992		14.46			
21FLVEMDTR04	01/04/1993	1	19.85	1.36	0.05	3
21FLVEMDTR05	01/04/1993	17.3	19.85	2.502	0.21	6
21FLVEMDTR03	01/04/1993	1	18.9	0.896	0.08	4
21FLVEMDTR05	03/01/1993	1	12.52	1.0715	0.06	3.5
21FLVEMDTR04	03/01/1993	1	11.91	0.9015	0.07	4
21FLVEMDTR03	03/01/1993	1	12.59	0.9615	0.07	3
21FLA 27010579	03/16/1993	1	13.1	0.97	0.034	2
21FLVEMDVC-078	05/03/1993	1	20.6	0.827	0.04	1
21FLVEMDVC-077	05/03/1993	16.55	21.6	1.273	0.05	3
21FLSJWMTR11	05/19/1993		23.5	0.68		0

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDVC-078	06/07/1993		32	0.802	0.05	6
21FLVEMDVC-077	06/07/1993	9.2	30	1.06	0.11	2
21FLVEMDTR04	06/08/1993	1	32	0.8015	0.05	5.5
21FLVEMDTR03	06/08/1993	9.2	30	1.06	0.11	2
21FLSJWMTR11	06/16/1993	1	25.1	0.663		7
21FLVEMDVC-077	07/07/1993	15.15	30.32	0.938	0.12	7
21FLVEMDVC-078	07/07/1993	1.38	26.13	0.584	0.06	3
21FLSJWMTR11	07/14/1993	4.3	25.6	0.714		22
21FLVEMDVC-079	08/02/1993	5.52	27.8	2.2315	0.33	6
21FLVEMDVC-077	08/02/1993	11.5	29.2	0.917	0.11	6
21FLVEMDVC-078	08/02/1993	1.79	26.7	0.875	0.13	4.5
21FLA 27010579	08/17/1993	2.21	25	0.995	0.15	1.98
21FLSJWMTR11	08/25/1993		24.8	0.906		2
21FLVEMDVC-079	09/08/1993	34.25	26.18	0.8915	2.8	4.8
21FLVEMDVC-077	09/08/1993	23.18	29.58	1.258		8.4
21FLVEMDVC-078	09/08/1993	2.53	24.35	0.519	4.2	3.6
21FLVEMDVC-077	10/04/1993	200.59	27.86	1.9815	0.33	20.4
21FLVEMDVC-078	10/04/1993	2.32	23.55	0.629	0.08	2.8
21FLVEMDVC-077	11/01/1993	4.49	21.18	0.389	0.06	1.2
21FLVEMDVC-078	11/01/1993	1	12.2	0.4115	0.15	1.6
21FLVEMDVC-079	12/06/1993	28.58	18.11	2.741	0.55	27.5
21FLVEMDVC-077	12/06/1993	4.49	21.56	1.703	0.23	14.8
21FLVEMDVC-078	12/06/1993	1	15.92	0.5315	0.02	2.7
21FLVEMDTR04	01/03/1994	1.025	16.235	0.5965	0.04	3.2
21FLVEMDVC-079	01/03/1994		16.71			
21FLVEMDTR03	01/03/1994	4.49	16.53	0.672	0.04	1.6
21FLVEMDTR05	02/07/1994	3.1	18.3	1.7415	0.07	1.5
21FLVEMDTR04	02/07/1994	1.93	17.75	0.989	0.035	2.25
21FLVEMDTR03	02/07/1994	1.01	16.3	1.075	0.04	0.5
21FLSJWMTR11	02/10/1994	1.871	19.1	0.695	0.085	0
21FLA 27010579	02/15/1994		15.9	0.86	0.038	2.3
21FLVEMDTR04	03/07/1994	1.485	16.85	1.237	0.025	1.5
21FLVEMDTR05	03/07/1994	1.44	17.7	2.2415	0.08	0.5
21FLVEMDTR03	03/07/1994	1.35	17.1	1.425	0.11	1.5
21FLVEMDVC-079	04/04/1994	84.74	18	2.5815	0.42	10.5
21FLVEMDVC-078	04/04/1994	1	18	1.119	0.19	1
21FLVEMDVC-077	04/04/1994	4.85	20.6	1.416	0.13	1
21FLSJWMTR11	04/20/1994	1	22.1	0.804	0.108	3
21FLVEMDTR04	05/02/1994	1.16	23	1.221	0.085	1.75
21FLVEMDTR05	05/02/1994	12.02	23	1.576	0.19	8
21FLVEMDTR03	05/02/1994	15.07	26	1.513	0.1	2.5
21FLVEMDTR04	06/06/1994	1.51	24	0.9255	0.24	5.75
21FLVEMDTR03	06/06/1994	36.58	29	1.017	0.15	9

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLSJWMTR11	06/30/1994	1	26.7	0.834	0.065	5
21FLVEMDTR05	07/06/1994	1.99	25	3.383	0.19	0.5
21FLVEMDTR04	07/06/1994	1	25	1.5085	0.06	2
21FLVEMDTR03	07/06/1994	3.43	25	1.964	0.07	2
21FLVEMDTR04	08/01/1994	2.61	25	1.294	0.285	1.5
21FLVEMDTR05	08/01/1994	1.62	24	2.137	0.57	1
21FLVEMDTR03	08/01/1994	2.24	26	1.182	0.28	0.5
21FLA 27010579	08/23/1994		23.9	1.355	0.083	1.67
21FLSJWMTR11	08/24/1994	1.069	24.5	1.07	0.139	4
21FLVEMDTR05	09/07/1994	2.85	22	1.541	0.21	3
21FLVEMDTR04	09/07/1994	1.44	23	1.253	0.065	13
21FLVEMDTR03	09/07/1994	13.65	26	1.7	0.08	1
21FLSJWMTR11	09/28/1994	2.138	23.4	1.049	0.112	4
21FLVEMDTR05	10/03/1994	8.19	24	2.854	0.41	9
21FLVEMDTR04	10/03/1994	1	24	1.9105	0.16	2.3
21FLVEMDTR03	10/03/1994	1.03	24	1.482	0.08	2.5
21FLVEMDTR03	11/01/1994	1	22	0.631	0.42	0.8
21FLVEMDTR04	11/01/1994	1.96	22	0.365	0.425	2
21FLVEMDTR05	11/01/1994	4.33	22	1.712	0.19	3.5
21FLVEMDTR03	12/05/1994	1	21	2.3	0.08	1.8
21FLVEMDTR04	12/05/1994	1	21	2.681	0.065	2.15
21FLVEMDTR05	12/05/1994	1.63	21	1.182	0.16	3.5
21FLSJWMTR11	12/05/1994	1	21.4	3.001	0.066	1
21FLVEMDTR04	01/09/1995	1	10	2.404	0.035	3
21FLVEMDTR03	01/09/1995	1	13	1.946	0.05	4.3
21FLVEMDTR05	01/09/1995	1	11	1.152	0.02	0.4
21FLA 27010579	01/31/1995		11	1.87	0.039	
21FLVEMDTR03	02/06/1995	1	11	1.398	0.07	4.7
21FLVEMDTR04	02/06/1995	1	9.5	1.45	0.085	6.95
21FLVEMDTR05	02/06/1995	5.21	9	1.102	0.03	2
21FLSJWMTR11	02/20/1995	6.237	16.9	1.55	0.139	55
21FLVEMDTR04	03/06/1995	2.35	18	1.6005	0.115	48.2
21FLVEMDTR05	03/06/1995	8.06	18	1.266	0.09	8
21FLVEMDTR03	03/06/1995	15.07	18	1.204	0.07	6
21FLVEMDTR04	04/03/1995	1	15	1.244	0.06	2.9
21FLVEMDTR05	04/03/1995	3	13	1.193	0.09	4.21
21FLVEMDTR03	04/03/1995	22.02	21	1.117	0.07	4.75
21FLSJWMTR11	04/24/1995	1.871	24.6	0.868	0.038	6
21FLVEMDTR04	05/01/1995	1.925	22	1.1115	0.035	3.9
21FLVEMDTR03	05/01/1995	13.73	26	1.012	0.07	2.5
21FLVEMDTR04	06/05/1995	4.2	25	1.141	0.015	15.75
21FLVEMDTR03	06/05/1995	6.71	29	1.183	0.14	8.5
21FLSJWM27010579	06/05/1995	1	25.7	0.951	0.093	38

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDTR03	07/10/1995	4.87	31	0.559	0.12	2
21FLVEMDTR04	08/07/1995	1	25	1.29	0.04	1.54
21FLVEMDTR05	08/07/1995	1	25	2.102	0.18	2
21FLVEMDTR03	08/07/1995	1.34	27			0.2
21FLVEMDVC-077	08/07/1995	1.34	27	1.72	0.04	0.2
21FLSJWM27010579	08/08/1995	1	25.9	1.067	0.067	4
21FLVEMDTR04	09/05/1995	1	25.6	2.1215	0.1	1
21FLVEMDTR03	09/05/1995	1	25.5	1.502	0.11	2.67
21FLVEMDTR05	09/05/1995	1	25.9	1.862	0.1	1
21FLVEMDTR04	10/02/1995		25	1.9935	0.05	2.65
21FLVEMDVC-077	10/02/1995		26			2
21FLVEMDTR03	10/02/1995		26			2
21FLVEMDTR05	10/02/1995		26	1.863	0.1	2.7
21FLSJWM27010579	10/10/1995	2.35	26	1.892	0.058	2
21FLVEMDTR04	11/06/1995	1	19	1.974	0.03	2.2
21FLVEMDTR05	11/06/1995	3.1	19	1.524	0.07	4.5
21FLVEMDTR03	11/06/1995	1	20	1.644	0.03	1.33
21FLSJWM27010579	11/07/1995	1	20.7	2.472	0.033	2
21FLVEMDTR04	12/04/1995	1	17	1.327	0.05	4.8
21FLVEMDTR03	12/04/1995	1	17	1.23	0.06	4
21FLVEMDTR04	01/08/1996	1	9	1.298	0.04	2.75
21FLVEMDTR03	01/08/1996	1	9	1.264	0.04	4.25
21FLVEMDTR05	01/08/1996	1.05	10	1.193	0.04	1
21FLSJWM27010579	02/07/1996	5.34	9.8	0.8545	0.014	5
21FLVEMDTR03	02/12/1996	1	16	1.207	0.01	1.3
21FLVEMDTR04	02/12/1996	1	13	1.348	0.01	2.9
21FLVEMDTR03	03/04/1996	1	14	0.823	0.03	2.8
21FLVEMDTR04	03/04/1996	1	13	0.918	0.02	3.8
21FLVEMDTR05	03/04/1996	1.71	13	1.072	0.06	3.8
21FLVEMDTR04	04/01/1996	1.05	19	1.106	0.04	2.4
21FLVEMDTR05	04/01/1996	1	20	1.134	0.06	1.4
21FLVEMDTR03	04/01/1996	1.05	19	0.939	0.03	2.6
21FLSJWM27010579	04/09/1996	1	16.7	1.176	0.04	5
21FLVEMDTR04	05/06/1996	1	22	1.246	0.03	3
21FLVEMDTR03	05/06/1996	4.7	25	1.083	0.03	3.8
21FLVEMDTR04	06/03/1996	1.12	21	0.701	0.01	3
21FLVEMDTR03	06/03/1996	12.99	24	0.946	0.02	3.7
21FLSJWM27010579	06/25/1996	1.835	26.8	0.9555	0.035	5.5
21FLVEMDTR03	07/08/1996	1	24	0.874	0.02	2.2
21FLVEMDTR05	07/08/1996	1	24	1.188	0.07	1.8
21FLVEMDTR04	07/08/1996	1	24	0.916	0.02	1.2
21FLVEMDTR04	08/05/1996	1	25	0.621	0.01	3
21FLVEMDTR03	08/05/1996	6.35	29	0.935	0.03	5.2

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLSJWM27010579	08/07/1996	1	27.2	0.722	0.038	5
21FLVEMDTR03	09/03/1996	15.35	24	0.98	0.04	13
21FLA 27010579	09/09/1996		24.09	0.678	0.043	
21FLVEMDTR05	10/07/1996	1	22	0.972	0.02	0.5
21FLVEMDTR04	10/07/1996	1.31	23	0.854	0.02	3
21FLSJWM27010579	10/14/1996	1.2		1.747	0.049	0
21FLVEMDTR03	11/04/1996	1	20	1.189	0.03	4
21FLVEMDTR04	11/04/1996	1	18	1.456	0.02	1.8
21FLVEMDTR04	12/02/1996	1	17	0.734	0.03	3
21FLVEMDTR03	12/02/1996	1	18	0.78	0.05	5
21FLSJWM27010579	12/18/1996	1	16.1	0.473	0.025	18
21FLVEMDTR03	01/06/1997	1	19	0.581	0.08	2.5
21FLVEMDTR03	02/03/1997	5.07	17	0.668	0.02	3
21FLSJWM27010579	02/04/1997		14.6	0.541	0.024	0
21FLVEMDTR03	03/03/1997	8.24	22	0.58	0.12	6
21FLSJWM27010579	04/28/1997	1	22	0.477	0.027	3
21FLVEMDTR03	05/05/1997	2.72	22	0.588	0.01	2
21FLVEMDTR03	06/02/1997	1.18	22	0.793	0.04	3.2
21FLSJWM27010579	06/02/1997	2.2	24.1	0.66	0.059	1
21FLVEMDTR04	07/07/1997	1	24	0.773	0.03	3
21FLVEMDTR05	08/04/1997	1.03	25	1.898	0.06	0.4
21FLVEMDTR04	08/04/1997	1.22	25	1.432	0.03	2.2
21FLSJWM27010579	08/13/1997	3.1	27.3	1.139	0.046	0
21FLVEMDTR05	09/08/1997	1	22	1.204	0.09	0.8
21FLVEMDTR04	09/08/1997	1	22	1.255	0.03	1.6
21FLSJWM27010579	09/09/1997	2	23.5	1.543	0.04	5
21FLVEMDTR04	10/06/1997	1	22	1.464	0.01	1.8
21FLSJWM27010579	10/06/1997	1	23.1	1.4435	0.0325	5
21FLVEMDTR04	11/03/1997	1	18	0.874	0.03	1.6
21FLVEMDTR05	11/03/1997	1.29	19	0.731	0.15	3.2
21FLVEMDTR03	12/01/1997	1	18.7	1.093	0.03	1.6
21FLVEMDTR04	12/01/1997	1	16.9	1.091	0.03	0.8
21FLSJWM27010579	12/01/1997	1	17.5	1.173	0.041	16
21FLVEMDTR03	01/05/1998	1	16	1.152	0.02	1.2
21FLVEMDTR04	01/05/1998	1	16	1.091	0.03	1.4
21FLVEMDTR05	01/05/1998	1	17	1.347	0.06	0.4
21FLSJWM27010579	01/12/1998	1	13.8	1.259	0.034	5
21FLVEMDTR03	02/02/1998	1	14		0.01	2.6
21FLVEMDTR04	02/02/1998	1	15	1.068	0.04	2.4
21FLVEMDTR05	02/02/1998	1	14	1.03	0.04	1.2
21FLVEMDTR03	03/02/1998	1	16.54	0.975	0.03	2.2
21FLVEMDTR04	03/02/1998	1	16.43	1.138	0.03	1.8
21FLVEMDTR05	03/02/1998	1	17.47	1.198	0.1	1.4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLSJWM27010579	03/03/1998	1	14.8	1.244	0.0415	5
21FLVEMDTR04	04/06/1998	1	17.87	1.183	0.04	1.8
21FLVEMDTR03	04/06/1998	1	20.67	1.103	0.04	3.4
21FLVEMDTR05	04/06/1998	1	17.59	1.517	0.1	1.9
21FLSJWM27010579	04/20/1998	1	22.85	1.164	0.048	6
21FLVEMDTR04	05/04/1998	1.43	20.2	0.752	0.02	2.3
21FLVEMDTR03	05/04/1998	1	23.42	0.835	0.02	1.9
21FLVEMDTR03	06/01/1998	13.07	29.74	0.757	0.05	4.5
21FLSJWM27010579	06/10/1998	5.605	25.5	0.914	0.062	5
21FLVEMDTR03	07/06/1998	8.65	30.61	0.849	0.17	4.9
21FLVEMDTR04	08/03/1998	1	25.64	1.71	0.02	2.3
21FLVEMDTR03	08/03/1998	2.86	26.84	1.561	0.03	1.9
21FLA 27010579	08/31/1998		25.35	1.377	0.044	
21FLVEMDTR04	09/08/1998	1	25.46	1.1234	0.07	1.9
21FLVEMDTR03	09/08/1998	1	26.54	0.994	0.09	1.6
21FLVEMDTR03	10/05/1998	1	25.29	1.572	0.02	1.6
21FLVEMDTR04	10/05/1998	1	25.36	1.706	0.02	1
21FLSJWM27010579	10/14/1998	1	23.6	1.846	0.041	4
21FLGW 3516	10/14/1998	1	23.6	1.846	0.041	4
21FLVEMDTR04	11/02/1998	1	20.18		0.05	1.8
21FLVEMDTR03	11/02/1998	1.55	21.32	1.368	0.05	2.2
21FLSJWM27010579	11/19/1998		22.5	1.134	0.038	4
21FLGW 3516	11/19/1998	1	22.5	1.134	0.038	4
21FLVEMDTR04	12/02/1998	1	19.75	0.821	0.03	1.9
21FLVEMDTR03	12/02/1998	23.94	19.72	0.804	0.04	3
21FLGW 3516	12/21/1998	1	18.6	0.624	0.03	4
21FLSJWM27010579	12/21/1998	1	18.6	0.624	0.03	4
21FLVEMDVC-078	01/04/1999	1	12.005	0.147	0.034	0.8
21FLVEMDVC-077	01/04/1999	1	15.005	0.517	0.05	1.3
21FLGW 3516	01/05/1999	1	9.4	0.502	0.023	4
21FLVEMDVC-077	02/01/1999	1.64	18.94	0.686	0.04	1
21FLVEMDVC-078	02/01/1999	1.45		0.64	0.03	1
21FLGW 3516	02/04/1999	3	20.5	0.639	0.041	5
21FLVEMDVC-078	03/01/1999	1.47	14.26	0.836	0.03	2
21FLVEMDVC-077	03/01/1999	1.77	16.38	0.784	0.05	2
21FLVEMDVC-079	03/01/1999	8.9		1.376	0.07	4.4
21FLGW 3516	03/15/1999	1	16.3	0.706	0.04	7
21FLVEMDVC-077	04/05/1999	12.44	25.36	0.613	0.05	2.6
21FLGW 3516	04/15/1999	1	21.9	0.687	0.042	11
21FLVEMDVC-077	05/03/1999	4.95	18.19	0.734	0.1	8.3
21FLGW 3516	05/06/1999	1	20.5	0.668	0.047	5
21FLGW 3516	06/02/1999	1	23.5	0.721	0.038	10
21FLVEMDVC-077	06/07/1999	15.6	28.57	0.787	0.12	4.1

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDVC-078	06/07/1999					
21FLGW 3516	07/01/1999	2.67	21.1	0.737	0.049	4
21FLVEMDVC-078	07/06/1999	1.1	25.33	0.947	0.03	1.9
21FLVEMDVC-077	07/06/1999	3.2	25.76	0.908	0.03	1.4
21FLVEMDVC-079	08/02/1999		28.16			
21FLVEMDVC-078	08/02/1999	1	27.14	0.702	0.04	1.8
21FLVEMDVC-077	08/02/1999	11.72	31	0.795	0.09	1.6
21FLGW 3516	08/04/1999	1	25.7	0.619	0.036	6
21FLVEMDVC-078	09/07/1999	1.3	24.49	0.766	0.04	1.2
21FLGW 3516	09/07/1999	1.28	24.3	0.66	0.032	5.5
21FLVEMDVC-077	09/07/1999	25.2	29.48	1.328	0.12	8.3
21FLVEMDVC-079	09/07/1999					
21FLVEMDVC-078	10/04/1999	1.2	24.86	1.029	0.04	1.6
21FLVEMDVC-077	10/04/1999	1	25.07	1.624	0.04	3.2
21FLVEMDVC-079	10/04/1999		24.82			
21FLGW 3516	10/20/1999	1.06	22.9	1.509	0.056	5
21FLVEMDVC-077	11/01/1999	1	21.9	1.792	0.06	1
21FLVEMDVC-078	11/01/1999	1	22.05	1.887	0.06	0.7
21FLVEMDVC-079	11/01/1999	2.6	21.82	2.24	0.14	1
21FLGW 3516	11/15/1999	1	18.1	1.318	0.028	5
21FLVEMDVC-078	12/06/1999	1	17.12	1.285	0.03	2
21FLVEMDVC-079	12/06/1999		16.46			
21FLVEMDVC-077	12/06/1999	1	17.16	1.197	0.03	1.2
21FLGW 3516	12/16/1999	1.12	16.3	1.011	0.033	4
21FLVEMDVC-078	01/03/2000	1	14.4	1.105	0.01	3.2
21FLVEMDVC-077	01/03/2000	1	15.06	0.4975	0.465	0.7
21FLCEN 27010579	03/06/2000			0.742		
21FLCEN 27010596	03/06/2000			1.404		
21FLVEMDVC-077	04/03/2000	1.14	21.18	0.459	0.45	1.3
21FLVEMDVC-079	04/03/2000	1.4	20.93	1.625	0.12	1.8
21FLVEMDVC-078	04/03/2000	2.14	20.65	0.872	0.09	1.7
21FLVEMDVC-078	07/10/2000	1	24.4	0.714	0.02	2.6
21FLVEMDVC-077	07/10/2000	13.05	31.22	0.5075	0.495	4.4
21FLVEMDVC-077	10/02/2000	1	23.32	0.5155	0.495	1.3
21FLVEMDVC-079	10/02/2000	1	22.93	1.731	0.06	0.8
21FLVEMDVC-078	10/02/2000	1.16	22.93	1.054	0.04	1
21FLGW 3516	01/10/2001	1	7.3	0.429	0.037	4
21FLVEMDVC-078	02/05/2001	1	13.29	0.485	0.02	1
21FLVEMDVC-077	02/05/2001	2.24	17.39	0.2935	0.28	2.8
21FLGW 3516	02/06/2001	1	11.2	0.539	0.024	4
21FLGW 3516	03/08/2001	1	12.3	0.563	0.033	4
21FLGW 3516	04/03/2001	1	15.9	0.916	0.052	4
21FLGW 3516	05/02/2001	1	19.8	0.803	0.049	4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDVC-078	05/07/2001	1	19.52	0.556	0.02	0.8
21FLVEMDVC-077	05/07/2001	14.39	23.59	0.4285	0.415	8.4
21FLGW 3516	06/06/2001	1	24.9	0.647	0.048	4
21FLGW 3516	07/09/2001	1	25.4	0.694	0.052	4
21FLVEMDVC-079	08/06/2001	1.65	24.6	1.911	0.07	2.5
21FLVEMDVC-077	08/06/2001	1.2	24.61	0.5475	0.505	7.5
21FLVEMDVC-078	08/06/2001	1.53	24.67	1.262	0.03	2.5
21FLGW 3516	08/09/2001	1.2	26	1.359	0.097	4
21FLGW 3516	09/05/2001	1	26.1	1.05	0.054	7
21FLGW 3516	10/02/2001	1	19.8	1.704	0.069	4
21FLVEMDVC-077	11/05/2001	1	22.08	0.7214	0.64	3.5
21FLVEMDVC-078	11/05/2001	1	21.09	1.534	0.01	2.2
21FLGW 3516	11/07/2001	1	18.8	1.377	0.038	4
21FLGW 3516	12/04/2001	1	19.8	1.424	0.052	4
21FLGW 3516	01/02/2002	1.7	12.4	1.188	0.046	4
21FLGW 3516	02/07/2002	1	17.4	1.058	0.045	5
21FLVEMDVC-079	03/04/2002	3.2	15.8	1.0486	0.04	1.2
21FLVEMDVC-078	03/04/2002	1.33	15.5	0.7959	0.05	7.2
21FLVEMDVC-077	03/04/2002	1	16.43	0.7782	0.06	11
21FLGW 3516	03/07/2002	1	14.3	0.909	0.035	4
21FLGW 3516	04/01/2002	1	21.4	0.899	0.054	6
21FLGW 3516	05/02/2002	1	22.8	0.73	0.045	4
21FLVEMDVC-078	06/03/2002	1.27	24.49	0.6775	0.02	3.8
21FLVEMDVC-077	06/03/2002	16.78	30	0.7533	0.08	5.6
21FLGW 3516	06/04/2002	1	25.5	0.648	0.05	4
21FLGW 3516	07/08/2002	1	25.4	1.425	0.093	4
21FLGW 3516	08/06/2002	1.7	26.1	1.43	0.069	4
21FLGW 3516	09/05/2002	1	25.5	1.556	0.05	4
21FLVEMDVC-078	09/09/2002		25.45	1.366	0.09	1.4
21FLVEMDVC-077	09/09/2002	1.59	25.83	1.367	0.07	2.4
21FLGW 3516	10/03/2002	1	24.5	1.432	0.047	4
21FLGW 3516	11/14/2002	1	17.4	0.852	0.027	4
21FLVEMDVC-078	12/02/2002		11.71	1.331		1.4
21FLVEMDVC-077	12/02/2002	10.77	17.15	1.337		2.4
21FLGW 3516	12/03/2002	1	12.2	0.669	0.019	4
21FLGW 3516	01/02/2003	1	15.7	1.019	0.1	4
21FLVEMDVC-078	02/03/2003	1	12.38	0.932	0.01	1.3
21FLGW 3516	02/03/2003	1	14.8	1.028	0.031	4
21FLVEMDVC-079	02/03/2003		11.47			
21FLVEMDVC-077	02/03/2003	1.31	13.08	0.976	0.21	47
21FLWPB 20010739	03/12/2003	1	19.7	1.051	0.063	
21FLWPB 20010740	03/12/2003	1	19.7	0.986	0.06	
21FLGW 3516	03/19/2003	1	21.85	1.321	0.057	4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLGW 3516	04/03/2003	1	18.52	1.312	0.049	4
21FLVEMDVC-078	05/05/2003	1	23.57	1.101	0.09	3.5
21FLVEMDVC-077	05/05/2003	7.07	26.51	1.071	0.09	5.5
21FLGW 3516	05/07/2003	1	24.5	1.05	0.066	4
21FLWPB 20010739	06/04/2003	1.36	23.7	0.79	0.044	
21FLWPB 20010740	06/04/2003	5.94	24.9	0.85	0.052	
21FLGW 3516	06/10/2003	1	25.48	0.804	0.053	4
21FLGW 3516	07/02/2003	1	25.3	1	0.044	4
21FLVEMDVC-079	08/04/2003	1.08	25.47	1.477	0.04	
21FLVEMDVC-078	08/04/2003	1	25.56	1.255	0.03	1.8
21FLVEMDVC-077	08/04/2003	1	26.56	1.114	0.03	0
21FLGW 3516	08/05/2003	1	25.2	1.21	0.054	4
21FLCEN 27010579	08/06/2003		25.08	1.215	0.053	
21FLWPB 20010740	08/13/2003	1.09	25.6	1.001	0.05	
21FLWPB 20010739	08/13/2003	1.96	25.7	1.178	0.066	
21FLWPB 20010739	08/26/2003	1	27	0.969	0.048	
21FLWPB 20010740	08/26/2003	18.55	26.12	1	0.056	
21FLGW 3516	09/02/2003	1	26.4	1.259	0.055	4
21FLWPB 20010739	09/15/2003	1	25.3	1.031	0.042	
21FLWPB 20010740	09/15/2003	16.28	25.2	0.857	0.051	
21FLGW 3516	10/02/2003	1	22.8	0.665	0.05	4
21FLWPB 20010739	10/09/2003	1	23.17		0.032	
21FLWPB 20010740	10/09/2003	1	23.01	0.782	0.028	
21FLVEMDVC-078	11/03/2003	1	23.08		0.03	1.9
21FLVEMDVC-077	11/03/2003	3.51	23.51	1.02	0.13	3.4
21FLVEMDVC-079	11/03/2003		23.12			
21FLGW 3516	11/04/2003	1	24.81	1.112	0.049	4
21FLGW 3516	12/04/2003	1	17.96	1.02	0.032	4
21FLGW 3516	01/13/2004	1	11.2	0.806	0.02	4
21FLGW 3516	02/10/2004	1	17.12	0.72	0.028	4
21FLVEMDVC-078	03/01/2004	1	15.12	0.892		1.5
21FLVEMDVC-079	03/01/2004	1	15.09	1.006	0.05	1.2
21FLVEMDVC-077	03/01/2004	1	14.285	0.751		1.2
21FLGW 3516	03/08/2004	1	18.8	1.032	0.041	4
21FLGW 3516	04/05/2004	1	15.39	0.788	0.03	4
21FLGW 3516	05/10/2004	1	20.86	0.658	0.038	4
21FLGW 3516	06/02/2004	1	25.76	0.93	0.042	4
21FLVEMDVC-078	06/07/2004	1.67	23.34	0.623	0.02	2.5
21FLVEMDVC-077	06/07/2004	1.23	24.14	0.599	0.04	4.6
21FLGW 3516	07/06/2004	1	25.3	0.776	0.045	4
21FLGW 3516	08/09/2004	7.7	26.08	0.915	0.058	4
21FLGW 3516	09/01/2004	1.1	26.67	2.404	0.091	4
21FLGW 3516	10/05/2004	1.1	25.975	1.617	0.069	4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLVEMDVC-078	10/11/2004	1	24.41	1.333	0.04	3
21FLVEMDVC-079	10/11/2004	6.82	24.52	1.317	0.04	2
21FLVEMDVC-077	10/11/2004	1	24.54	1.348	0.07	3.7
21FLGW 3516	11/08/2004	1	19.025	1.59	0.058	12
21FLGW 3516	12/01/2004	1	18.51	1.1	0.04	4
21FLVEMDVC-078	12/06/2004		15.96	1.064	0.04	1.5
21FLVEMDVC-077	12/06/2004		15.17	0.834	0.04	1
21FLGW 3516	01/04/2005	1	15.865	0.946	0.03	4
21FLCEN 27010830	01/31/2005	1.4	15.7	1.029	0.062	
21FLCEN 27010574	01/31/2005	1.4	15	1.27	0.072	
21FLCEN 27010579	01/31/2005	1.4	13.2	0.877	0.079	
21FLCEN 27010075	01/31/2005	2.4	14.8	1.515	0.091	
21FLCEN 27010596	01/31/2005	3.175	12.7	1.304	0.072	
21FLGW 3516	02/01/2005	1	12.23	0.882	0.028	4
21FLVEMDVC-078	02/07/2005	1.01	14.99	0.86	0.06	3
21FLVEMDVC-077	02/07/2005	21.63	14.35	0.759	0.07	2.3
21FLGW 3516	03/02/2005	1	12.98	0.694	0.028	4
21FLGW 3516	04/04/2005	1	16.66	1.207	0.043	4
21FLCEN 27010579	04/07/2005	1.44	20.76	1.32	0.072	
21FLCEN 27010596	04/07/2005	2.81	21.67	1.62	0.075	
21FLCEN 27010075	04/07/2005		21.25			
21FLCEN 27010830	04/07/2005		20.88			
21FLWQSPVOL358LR	04/14/2005		20.02			
21FLWQSPVOL358LR	04/19/2005	1	18.01	0.81	0.03	
21FLVEMDVC-079	05/02/2005		20.46			
21FLVEMDVC-078	05/02/2005	1	20.49	0.75	0.06	2.2
21FLGW 3516	05/02/2005	1	20.505	0.901	0.038	4
21FLVEMDVC-077	05/02/2005	2.3	21.19	0.746	0.05	2.7
21FLGW 3516	06/02/2005	1	23.74	0.865	0.045	4
21FLCEN 27010579	06/02/2005	2.92	23.9	0.932	0.069	
21FLCEN 27010596	06/02/2005	6.17	23.8	1.204	0.079	
21FLCEN 27010075	06/02/2005		23.3			
21FLCEN 27010830	06/02/2005		23.8			
21FLGW 3516	07/07/2005	1.2	27.87	1.336	0.059	4
21FLCEN 27010579	07/27/2005	1.52	26.2			
21FLCEN 27010830	07/27/2005	5.56	25.8			
21FLWQSPVOL358LR	07/29/2005		27.46			
21FLGW 3516	08/02/2005	1.9	26.435	1.66	0.05	5
21FLWQSPVOL358LR	08/02/2005	1	26.065	1.94	0.04	
21FLVEMDVC-077	08/08/2005	1.04	25.5	1.023		
21FLVEMDVC-078	08/08/2005	1	26	1.06		
21FLVEMDVC-079	08/08/2005	9.86	25.7	1.186		
21FLGW 3516	09/12/2005	1.4	25.5	1.147	0.052	4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLCEN 27010579	09/21/2005	1.4	26	1.031	0.031	
21FLCEN 27010830	09/21/2005	1.4	25.9	1.122	0.044	
21FLCEN 27010075	09/21/2005		25.7			
21FLCEN 27010596	09/21/2005		25.81			
21FLGW 3516	10/06/2005	5.6	25.735	0.898	0.05	4
21FLSJWMNCBTR05	10/26/2005	1	16.36	0.9274	0.0379	5
21FLGW 3516	11/02/2005	1.2	19.765	0.988	0.051	4
21FLSJWMNCBTR05	11/07/2005	1.3083	21	1.178	0.0751	5
21FLVEMDVC-077	11/07/2005	1	20.09		0.03	28
21FLVEMDVC-078	11/07/2005	1	19.96		0.02	1.8
21FLVEMDVC-079	11/07/2005	1.42	20.46		0.06	1
21FLCEN 27010579	11/15/2005	1.4	19.7	0.992	0.0215	
21FLCEN 27010830	11/15/2005	1.4	20.9	0.9	0.024	
21FLCEN 27010596	11/15/2005		20.1			
21FLSJWMNCBTR05	12/05/2005	1.2905	15.93	1.1608	0.0291	5
21FLGW 3516	12/06/2005	1	17.65	0.907	0.035	4
21FLWQSPVOL358LR	12/15/2005		14.42			
21FLWQSPVOL358LR	12/19/2005	1.1	15.37	0.84	0.02	
21FLGW 3516	01/04/2006	1	16.52	0.806	0.036	4
21FLSJWMNCBTR05	01/09/2006	1	8.63	1.1329	0.0279	5
21FLVEMDVC-078	01/09/2006	1	10.36		0.02	1.3
21FLVEMDVC-079	01/09/2006		9.46			
21FLVEMDVC-077	01/09/2006	1	10.01	0.677	0.02	1.3
21FLSJWMNCBTR05	02/01/2006	1.1481	13	0.8403	0.0386	5
21FLGW 3516	02/01/2006	1	12.7	0.893	0.036	4
21FLGW 3516	03/07/2006	1	16.04	0.995	0.033	4
21FLCEN 27010579	03/29/2006	1.4	15.2	0.69	0.042	
21FLVEMDVC-078	04/03/2006	1	19.51		0.05	2.4
21FLGW 3516	04/03/2006	1	20.145	0.68	0.048	4
21FLVEMDVC-077	04/03/2006	3.08	21.63	0.51	0.08	7.6
21FLGW 3516	05/01/2006	1	19.99	0.702	0.045	4
21FLGW 3516	06/01/2006	1	24.97	1.066	0.08	12
21FLVEMDVC-078	07/10/2006	1	25.11		0.05	2.8
21FLGW 3516	07/10/2006	1	24.675	0.726	0.05	4
21FLVEMDVC-077	07/10/2006	28.48	27.37	0.688	0.09	3.2
21FLGW 3516	08/02/2006	1	26.27	0.667	0.05	5
21FLGW 3516	09/06/2006	1	25.55	0.774	0.052	4
21FLVEMDVC-078	10/02/2006		21.94		0.04	2.5
21FLVEMDVC-077	10/02/2006		28.97	0.71	0.1	3.9
21FLGW 3516	10/03/2006	1	22.62	0.62	0.024	4
21FLGW 3516	11/02/2006	1.7	20.655	0.584	0.034	4
21FLGW 3516	12/04/2006	1	19.79	0.504	0.068	5
21FLGW 3516	01/03/2007	1	18.73	0.608	0.038	4

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLGW 3516	02/01/2007	1	14.03	0.541	0.029	4
21FLVEMDVC-078	02/05/2007	1	13.03		0.03	1.1
21FLVEMDVC-077	02/05/2007	1	14.12	0.5	0.04	1.3
21FLGW 3516	03/06/2007	1	13.87	0.611	0.034	4
21FLGW 3516	04/02/2007	1.9	19.705	0.682	0.053	4
21FLGW 3516	05/03/2007	1	21.155	0.673	0.051	4
21FLVEMDVC-078	05/07/2007	1.83	19.6			3
21FLVEMDVC-077	05/07/2007	2.2	24.86	0.868		2.3
21FLGW 3516	06/06/2007	1.1	23.97	0.742	0.043	4
21FLGW 3516	07/05/2007	2.5	25.06	1.017	0.07	4
21FLGW 3516	07/30/2007	1	26.195	0.788	0.056	4
21FLVEMDVC-078	08/06/2007	1	26.79	0.774	0.04	1.5
21FLVEMDVC-077	08/06/2007		28.33		0.02	0.7
21FLGW 3516	09/05/2007	1.9	25.36	1.027	0.057	6
21FLGW 3516	10/04/2007	1	26.31	1.236	0.081	4
21FLGW 3516	11/01/2007	1.4	23.43	0.959	0.05	7
21FLVEMDVC-078	11/05/2007	1	17.76	0.52	0.01	1.6
21FLVEMDVC-077	11/05/2007	1.35	19.65	0.727	0.02	1.7
21FLGW 3516	12/03/2007	1	20.11	0.786	0.045	4
21FLGW 3516	01/02/2008	1	13.705	0.847	0.061	4
21FLSJWMNCBTR06	01/14/2008	1	16.56	0.6846	0.0388	5
21FLSJWMNCBTR06	02/04/2008	1	21.3	0.7539	0.0409	5
21FLVEMDVC-078	02/04/2008	1	18.09	0.483	0.04	2.9
21FLGW 3516	02/04/2008	1	18.945	0.708	0.046	4
21FLVEMDVC-077	02/04/2008	1.61	19.31	0.854	0.06	2.2
21FLVEMDVC-TR6	02/04/2008				0.02	1.6
21FLGW 3516	03/03/2008	1	15.11	0.666	0.042	10
21FLSJWMNCBTR06	03/10/2008	1.4685	16.98	0.8582	0.054	5
21FLGW 3516	04/02/2008	1.5	20.375	0.671	0.056	4
21FLSJWMNCBTR06	04/14/2008	1	15.7	0.7878	0.0493	5
21FLSJWMNCBTR06	05/05/2008	13.795	24.4	0.9605	0.0926	5
21FLVEMDVC-077	05/05/2008	13.71	25.75	0.734	0.14	6.9
21FLGW 3516	05/06/2008	1	20.12	0.612	0.047	4
21FLCEN 27010579	05/20/2008	2.4	23.6	0.748	0.13	12
21FLGW 34941	05/27/2008	14	27.63	0.866	0.11	
21FLGW 34950	05/27/2008	22	27.88	1.116	0.12	
21FLGW 34943	05/27/2008	17	27.84	1.017	0.12	
21FLGW 34930	05/27/2008	18	27.87	0.911	0.12	
21FLGW 34940	05/27/2008	19	27.57	0.911	0.11	
21FLGW 34945	05/27/2008	12	27.39	0.974	0.12	
21FLGW 34947	05/27/2008	10	27.295	0.937	0.11	
21FLGW 34949	05/27/2008	15	27.145	0.963	0.11	
21FLGW 34933	05/27/2008	11	27.055	0.966	0.12	

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLGW 34934	05/27/2008	7	27.145	0.9	0.12	
21FLGW 34932	05/27/2008	9.4	27.395	0.936	0.11	
21FLGW 34939	05/27/2008	10	27.335	0.844	0.1	
21FLGW 34937	05/28/2008	2.6	27.155	1.069	0.3	
21FLGW 34931	05/28/2008	2.1	27.055	0.942	0.29	
21FLGW 34946	05/28/2008	10	28.195	0.972	0.21	
21FLGW 34944	05/28/2008	4.4	28.37	0.97	0.22	
21FLGW 34942	05/28/2008	7.3	28.035	0.856	0.16	
21FLGW 34935	05/28/2008	23	28.33	1.149	0.23	
21FLGW 34929	05/28/2008	28	28.255	1.053	0.17	
21FLGW 34938	05/28/2008	22	28.035	0.899	0.13	
21FLGW 34936	05/28/2008	19	27.875	0.968	0.12	
21FLGW 3516	06/03/2008	1.4	23.825	0.644	0.05	4
21FLGW 34948	06/16/2008	1	24.29	0.826	0.082	
21FLGW 34951	06/17/2008	4.5	29.47	1.329	0.26	
21FLGW 34957	06/17/2008	49	29.695	1.418	0.3	
21FLGW 34955	06/17/2008	65	30.685	1.508	0.27	
21FLGW 34954	06/19/2008	98	30.12	1.608	0.29	
21FLGW 34952	06/19/2008	120	31.14	1.614	0.28	
21FLGW 34953	06/19/2008	450	30.1	4.308	0.97	
21FLGW 34958	06/19/2008	210	30.22	1.808	0.37	
21FLGW 34956	06/19/2008	48	30.71	1.316	0.22	
21FLGW 3516	07/01/2008	2	24.01			
21FLSJWMNCBTR06	07/15/2008	5.8073	27.24	1.0223	0.0714	5.5
21FLGW 3516	08/04/2008	1	25.92	1.352	0.071	4
21FLSJWMNCBTR06	08/04/2008	1	27.6			5
21FLVEMDVC-078	08/04/2008	1	25.53	1.782	0.05	14
21FLVEMDVC-077	08/04/2008	2.47	26.08	1.716	0.06	1
21FLGW 3516	09/03/2008	1	26.78	3.53	0.13	4
21FLSJWMNCBTR06	09/09/2008	1	27.55	3.6308	0.1313	5
21FLGW 34921	09/15/2008	1	26.21	4.52	0.3	
21FLGW 3516	09/30/2008	1	24.29	4.05	0.09	5
21FLSJWMNCBTR06	10/15/2008	1	24.8	3.7495	0.0696	5
21FLSJWMNCBTR06	11/03/2008	1	20.2	3.8434	0.0623	5
21FLGW 3516	11/03/2008	1	19.11	2.51	0.039	4
21FLVEMDVC-078	11/04/2008	1	19.41		0.04	2.2
21FLVEMDVC-077	11/04/2008	1	19.84		0.05	2.5
21FLCEN 27010579	11/06/2008	1	18.6	3.04	0.14	4
21FLGW 3516	12/02/2008	1	13.76	1.66	0.027	4
21FLSJWMNCBTR06	12/10/2008	1	19.18	3.3076	0.0415	6.5
21FLGW 3516	12/30/2008	1	16.06	1.047	0.041	4
21FLSJWMNCBTR06	01/07/2009	1	18.27	1.1551	0.0335	5
21FLA 27010924	01/13/2009	1.6	15.8			

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLA 27010578	01/13/2009	2	17.8			
21FLA 27010429FLA	01/13/2009	7.5	18.4			
21FLA 27010923	01/13/2009	13	18.2			
21FLVEMDVC-078	02/02/2009	2.25	13.77		0.03	1.8
21FLSJWMNCBTR06	02/02/2009	4.2275	14.3	0.8188	0.037	3
21FLVEMDVC-077	02/02/2009	17.92	13.43		0.04	6.8
21FLGW 3516	02/03/2009	2.8	13.395	0.92	0.035	4
21FLA 27010924	02/11/2009	1.8	14.3			
21FLA 27010578	02/11/2009	4.1	17.1			
21FLA 27010923	02/11/2009	8	17.3			
21FLA 27010429FLA	02/11/2009	7.7	17.8			
21FLSJWMNCBTR06	03/04/2009	1	18.9	0.7857	0.0341	5
21FLGW 3516	03/04/2009	1.6	12.445	0.698	0.09	4
21FLGW 3516	04/01/2009	1.1	19.72	0.92	0.12	4
21FLA 27010924	04/14/2009	3.9	19.33			
21FLA 27010578	04/14/2009	3.7	24.01			
21FLA 27010923	04/14/2009	8.5	23.5			
21FLA 27010429FLA	04/14/2009	9.2	23.93			
21FLSJWMNCBTR06	04/15/2009	2.5899	21.1	0.7986	0.0472	5
21FLVEMDVC-077	05/04/2009	10.46	27		0.26	11.7
21FLGW 3516	05/05/2009	1.1	22.225	0.998	0.54	4
21FLGW 3516	06/02/2009	1	24.935	2.108	0.089	4
21FLSJWMNCBTR06	06/16/2009	1.2015	26.39	2.3077	0.0472	5
21FLGW 3516	07/07/2009	3.3	26.385	1.66	0.071	5
21FLA 27010429FLA	07/15/2009	3.3	26.29			
21FLA 27010923	07/15/2009	20	28.62			
21FLA 27010578	07/15/2009	1.4	25.76			
21FLA 27010924	07/15/2009	2.7	25.37			
21FLSJWMNCBTR06	07/20/2009	1.7889	25.05	2.2476	0.1066	5
21FLSJWMNCBTR06	08/03/2009	1	27.8		0.0442	5
21FLVEMDVC-078	08/03/2009	1.65	27.76		0.05	2.6
21FLVEMDVC-077	08/03/2009	3.27	26.96		0.05	2.8
21FLGW 3516	08/04/2009	1	26.035	2.19	0.066	5
21FLGW 3516	09/03/2009	1.7	24.74	1.143	0.051	6
21FLSJWMNCBTR06	09/08/2009	16.688	26.4	1.5032	0.1615	5
21FLSJWMNCBTR06	09/09/2009					
21FLA 27010923	09/16/2009		29.5			
21FLGW 3516	10/06/2009	1	24.3	1.51	0.042	5
21FLSJWMNCBTR06	10/07/2009	3.5817	25.5	2.1026	0.0727	4
21FLA 27010924	10/08/2009	1	25.4			
21FLA 27010578	10/08/2009	1	25.2			
21FLA 27010429FLA	10/08/2009	2.8	26.9			
21FLA 27010923	10/08/2009	26	28.5			

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLSJWMNCBTR06	11/02/2009	356.85	23.4	3.4203	0.2731	22
21FLVEMDVC-078	11/02/2009	1	22.16		0.04	1.3
21FLVEMDVC-077	11/02/2009	7.52	23.03		0.05	1.4
21FLGW 3516	11/04/2009	1	21.045	0.793	0.028	4
21FLGW 3516	12/02/2009	1	17.265	0.697	0.03	4
21FLA 27010924	12/09/2009		21.2			
21FLA 27010923	12/09/2009		21.83			
21FLA 27010429FLA	12/09/2009		20.2			
21FLCEN 27010579	12/09/2009	1.1	20.6	0.69	0.03	4
21FLSJWMNCBTR06	12/28/2009	3.204	13.91		0.0519	2.5
21FLGW 3516	01/07/2010	1	5.9	0.679	0.025	4
21FLSJWMNCBTR06	01/11/2010	1	6.24	0.837	0.0319	1.45
21FLSJWMNCBTR06	02/01/2010	3.0371	15.26	0.986	0.0248	1.45
21FLGW 3516	02/10/2010	3.8	12.39	0.971	0.033	4
21FLSJWMNCBTR06	03/01/2010	2.1761	14.9	1.381	0.0189	1.45
21FLVEMDVC-078	03/01/2010	1.34	12.27		0.02	0.8
21FLVEMDVC-077	03/01/2010	1	11.53		0.01	1.2
21FLGW 3516	03/04/2010	1.7	10.655	1.004	0.019	4
21FLSJWMNCBTR06	04/05/2010	1	20.9	1.5966	0.0425	1.45
21FLVEMDVC-077	04/05/2010	1	19.54		0.03	1.58
21FLVEMDVC-078	04/05/2010	1.6	19.36		0.03	1.89
21FLGW 3516	04/07/2010	1.3	19.58	1.453	0.053	4
21FLSJWMNCBTR06	05/03/2010	1	26.2	1.6284	0.0529	2.9
21FLGW 3516	05/04/2010	1	24.6	1.05	0.052	4
21FLGW 3516	06/02/2010	3.3	24.71	0.791	0.048	4
21FLSJWMNCBTR06	06/08/2010	2.4297	27.76	0.8234	0.0363	2.9
21FLGW 3516	07/06/2010	1	24.83	0.791	0.042	4
21FLSJWMNCBTR06	07/12/2010	75.962	27.4	1.5276	0.0923	6.5
21FLVEMDVC-078	07/12/2010	2.44	26.15	1.32	0.07	5.3
21FLVEMDVC-077	07/12/2010	12.15	29.87	2.254	0.26	5.1
21FLGW 3516	08/02/2010	1	26.08	1	0.16	4
21FLSJWMNCBTR06	08/02/2010	1.869	28.4	1.465	0.0581	2.9
21FLCEN 27010579	08/09/2010	1	26.9	0.86	0.093	
21FLGW 3516	09/02/2010	1.8	24.59	2.02	0.068	20
21FLSJWMNCBTR06	09/13/2010	1	27.6	2.0339	0.046	3.5
21FLSJWMNCBTR06	10/04/2010	1	21.05	0.9308	0.0448	2.9
21FLVEMDVC-078	10/04/2010	1	20.46		0.25	1.3
21FLVEMDVC-077	10/04/2010	51.34	28.2		0.1	3.3
21FLGW 3516	10/06/2010	1	19.16	0.849	0.12	23
21FLGW 3516	11/02/2010	1	20.03	0.738	0.28	4
21FLSJWMNCBTR06	11/03/2010	29.682	23.2	1.0616	0.0826	5
21FLGW 3516	12/02/2010	2.2	12.755	0.78	0.47	4
21FLSJWMNCBTR06	12/15/2010	1.4377	8.8	0.6599	0.0291	4.5

Station	Sample Date	Corr Chla (µg/L)	Temp (ºC)	TN (mg/l)	TP (mg/L)	TSS (mg/Ll)
21FLGW 3516	01/04/2011	1	12.15	0.659	0.12	4
21FLSJWMNCBTR06	01/10/2011	1	15.5	0.6882	0.0362	3.5
21FLVEMDVC-078	01/10/2011	1	13.39	1.276	0.18	0.5
21FLVEMDVC-077	01/10/2011	18.06	15.52	3.819	0.16	2.6
21FLGW 3516	02/02/2011	1.1	16.92	0.564	0.032	4
21FLSJWMNCBTR06	02/09/2011	1.068	15.6	0.6331	0.05	2.9
21FLGW 3516	03/02/2011	1.1	18.02	0.654	0.06	4
21FLSJWMNCBTR06	03/16/2011	1	17.7	0.6023	0.031	2.9
21FLGW 3516	04/05/2011	3.4	20.48	0.76	0.057	4
21FLSJWMNCBTR06	04/06/2011	1.1748	18.1	0.958	0.0323	2.9
21FLVEMDVC-078	04/11/2011	1	21.88			
21FLVEMDVC-077	04/11/2011	17.86	24.97			
21FLGW 3516	05/03/2011	1.5	21.68	0.848	0.079	4
21FLSJWMNCBTR06	05/11/2011	21.467	26.7	1.2494	0.0814	5
21FLGW 3516	06/06/2011	1.7	23.92	0.831	0.074	6
21FLGW 3516	07/05/2011	1.2	26.065	0.832	0.057	4
21FLVEMDVC-078	07/11/2011	3.67	26.09	0.762	0.05	1.6
21FLSJWMNCBTR06	07/11/2011	3.7647	27.8	0.9147	0.0669	2.9
21FLVEMDVC-077	07/11/2011	16.92	26.3	4.357	0.09	2.2
21FLSJWMNCBTR06	08/03/2011	2.3763	28.6	0.8417	0.0504	5.8
21FLGW 3516	08/03/2011	1.4	25.685	0.864	0.053	5
21FLSJWMNCBTR06	09/07/2011	1	26.8	0.7362	0.0571	2.9
21FLVEMDVC-078	10/03/2011	1	20	0.742	0.02	0.7
21FLVEMDVC-077	10/03/2011	17.1	26.04	2.058	0.02	1.2

Appendix C: LSPC Modeling Methodology, Daytona Watershed

An LSPC model was utilized to estimate the nutrient loads within and discharge from the Daytona watershed, which included loads from Guana, Pellicer, and Tomoka Rivers.
The Loading Simulation Program in C++ (LSPC) is a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by USEPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the USEPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the USEPA TMDL Modeling Toolbox. LSPC was used to simulate runoff (flow, biological oxygen demand, total nitrogen, total phosphorus and dissolved oxygen) from the land surface using a daily timestep for current and natural conditions. LSPC provided tributary flows and temperature to the EFDC estuary models and tributary water quality concentrations to WASP7 estuary models.

In order to evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of sub-watersheds for each of the models. The sub-watersheds for the Daytona Watershed model were developed using the 12-digit hydrologic unit code (HUC12) watershed data layer and the Geological Survey (USGS) National Hydrograph Dataset (NHD) (Figure 1.1).

The LSPC model has a representative reach defined for each sub-watershed, and the main channel stem within each sub-watershed was used as the representative reach. The characteristics for each reach included the length and slope of the reach, the channel geometry and the connectivity between the sub-watersheds. Length and slope data for each reach were obtained using the USGS DEM and NHD data.

The attributes supplied for each reach were used to develop a function table (FTABLE) that describes the hydrology of the stream reach by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. The assumption of a fixed depth, area, volume, outflow relationship rules out cases where the flow reverses direction or where one reach influences another upstream of it in a time-dependent way.

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loadings. The FDEP Level III Florida Land Use, specifically the St. Johns River Water Management District (SJRWMD) 2004 dataset, was used to determine the land use representation. The National Landuse Coverage Dataset (NLCD) was used to develop the impervious land use representations.

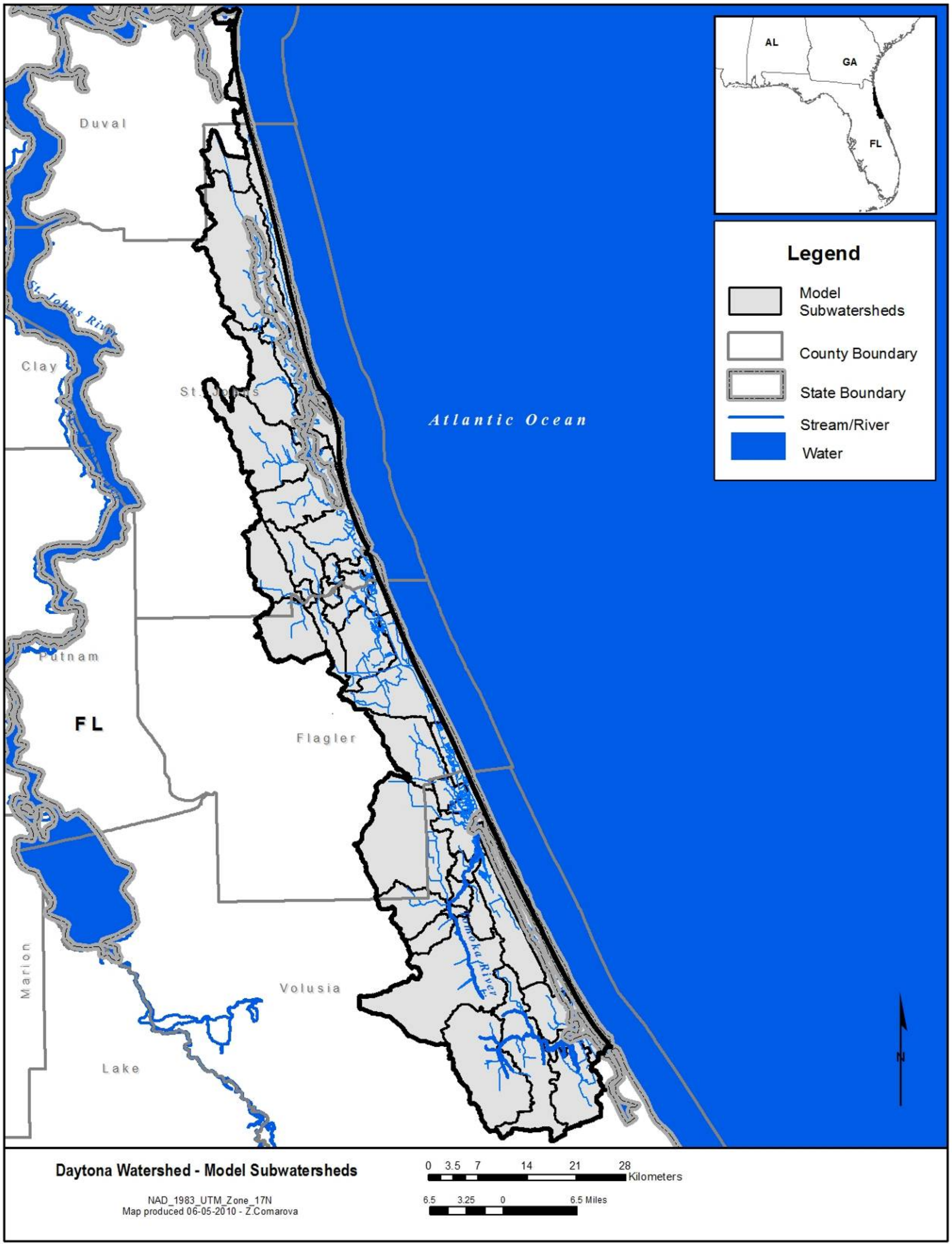

Figure 1.1 LSPC sub-watershed boundaries for the Daytona Watershed

The SJRWMD coverage utilized a variety of land use classes which were grouped and re-classified into 18 land use categories: beaches/dune/mud, open water, utility swaths, developed open space, developed low intensity, developed medium intensity, developed high intensity, clear-cut/sparse, quarries/strip mines, deciduous forest, evergreen forest, mixed forest, golf courses, pasture, row crop, forested wetland, non-forested wetland (salt/brackish), and non-forested wetland (freshwater). The LSPC model requires division of land uses in each sub-watershed into separate pervious and impervious land units. The NLCD 2006 percent impervious coverage was used to determine the percent impervious area associated with each land use category. Any impervious areas associated with utility swaths, developed open space, and developed low intensity, were grouped together and placed into a new land use category named *low intensity development impervious*. Impervious areas associated with medium intensity development and high intensity development were kept separate and placed into two new categories for *medium intensity development impervious and high intensity development impervious*, respectively. Finally, any impervious area not already accounted for in the three developed impervious categories, were grouped together into a fourth new category for all remaining impervious land use (Figure 1.2).

Soil data for the Florida watersheds was obtained from the Soil Survey Geographic Database (SSURGO). The database was produced and distributed by the Natural Resources Conservation Service (NRCS). The SSURGO data was used to determine the total area that each hydrologic soil group covered within each sub-watershed. The sub-watersheds were represented by the hydrologic soil group that had the highest percentage of coverage within the boundaries of the sub-watershed. There dominant soil groups in Daytona are D and D-type soils (B/D), which have a high water table due to characteristics such as slow infiltration rates or shallow soils over an impervious layer (Figure 1.3).

Facilities permitted under the National Pollutant Discharge Elimination System (NPDES) are, by definition, considered point sources. The NPDES geographic information system (GIS) coverages, provided by FDEP were adopted as the starting point for the evaluation of point sources for the Florida watershed models and reflected discharges as of December 2009. In areas where data was incomplete, data from EPA-PCS was used. Following data collection, any remaining gaps in the data that were three months or less were filled by averaging data from before and after gap months. If the gaps in the data were larger than three months the long term average was supplied. Stormwater discharges, such as MS4s, were not input directly into the model but were assumed to be included in the urban land use loading. Point sources that were designated as reuse facilities were not input directly into the model, but were accounted for in the adjustment of the hydrologic calibration parameters. Point sources directly discharging to the Daytona Watershed that were included in the watershed model are shown in Figure 1.4.

In the watershed models, nonpoint source loadings and hydrological conditions are dependent on weather conditions. Hourly data from weather stations within the boundaries of, or in close proximity to, the sub-watersheds were applied to the watershed model. A weather data forcing file was generated in ASCII format (*.air) for each meteorological station used in the hydrological evaluations in LSPC. Each meteorological station file contained atmospheric data used in modeling the hydrological processes. These data included precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data are used directly, or calculated from the observed data. The Daytona Watershed model weather stations contained data from 1996 through 2009.

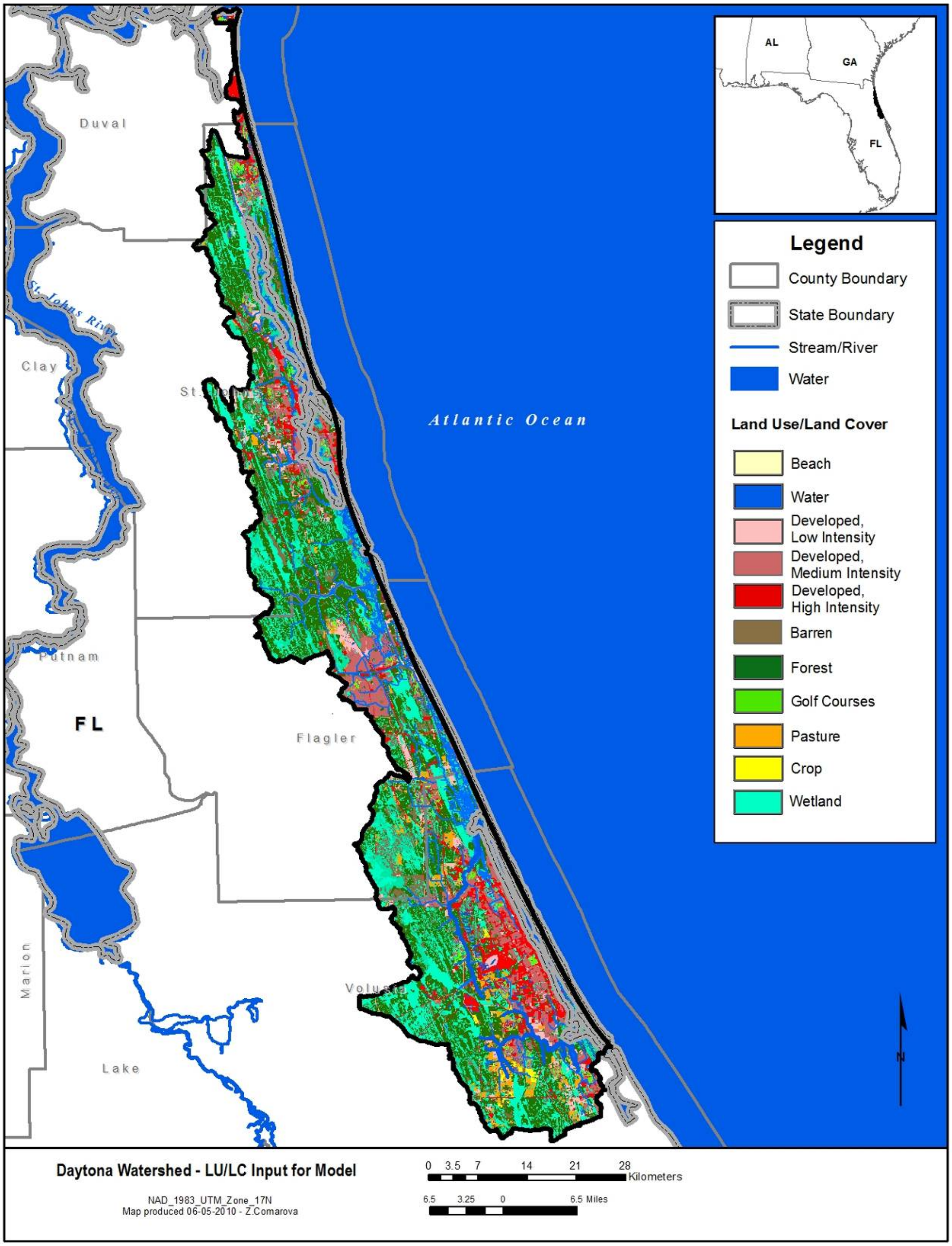

Figure 1.2 Re-classified SJRWMD 2004 land use coverage of the Daytona watershed.

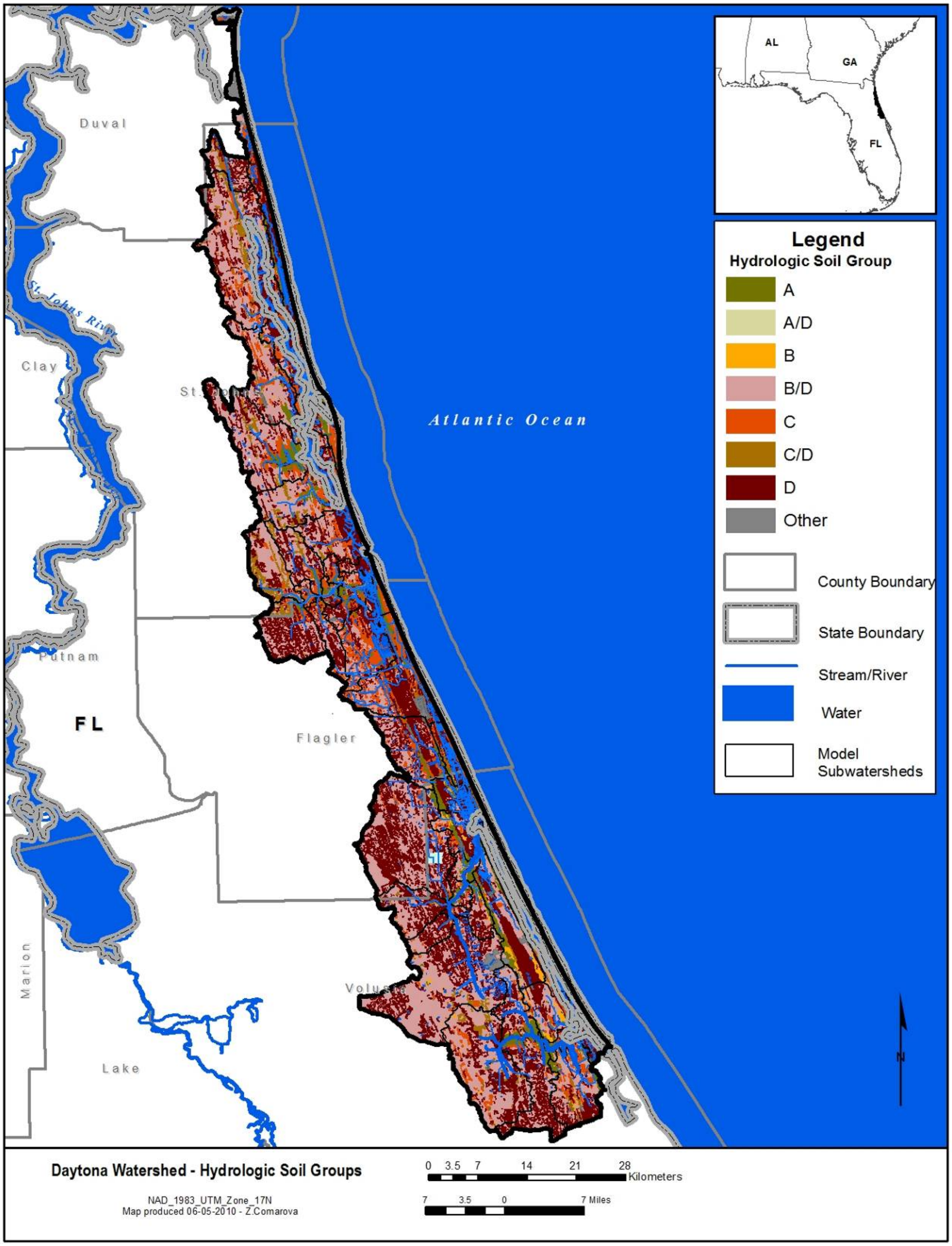

Figure 1.3 Hydrologic soils group for the Daytona Watershed

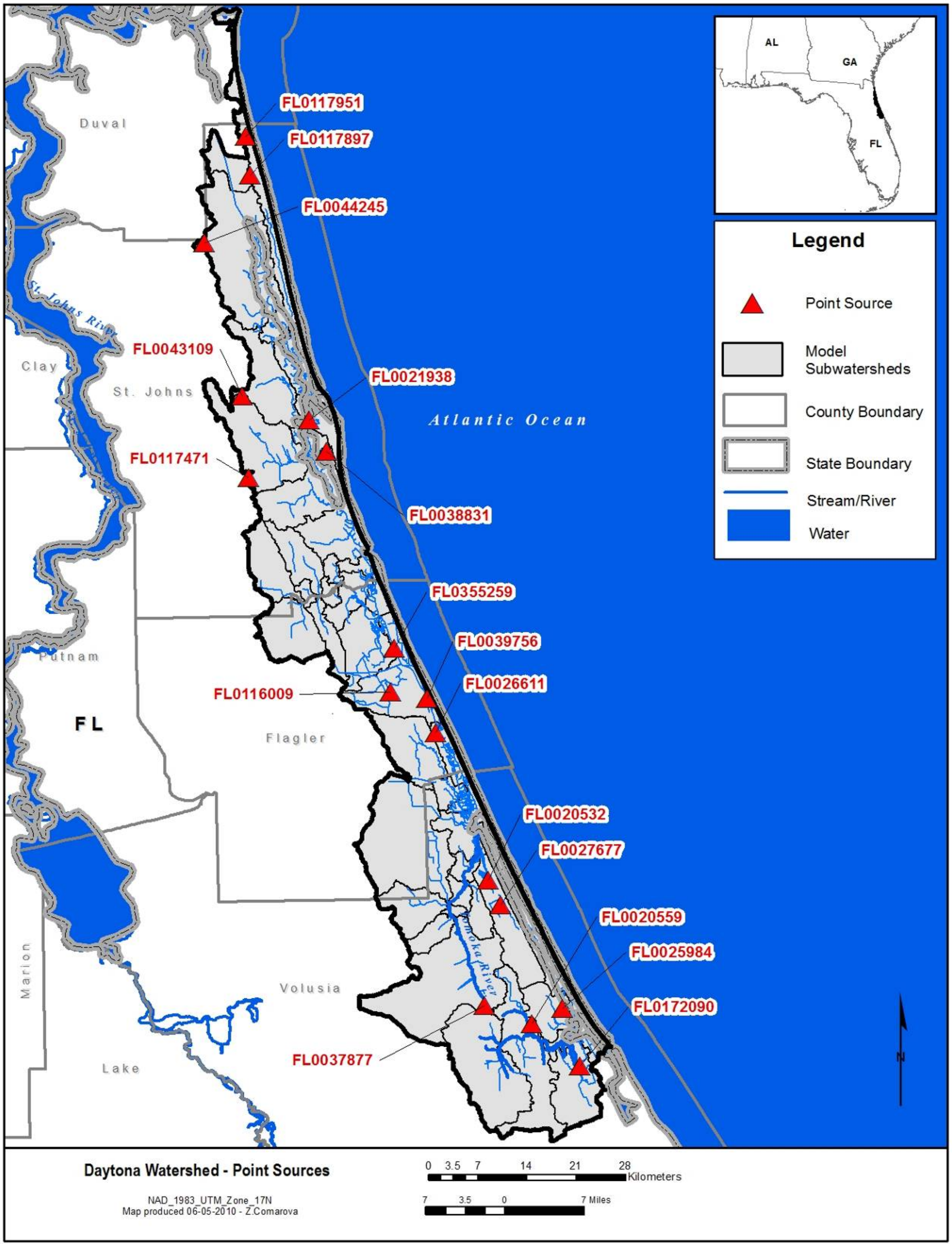

Figure 1.4 Point Sources included in the Daytona Watershed Model

Table 1.1 Meteorological stations used in the Daytona watershed model.

Station ID	LSPC ID	Station Name	Elevation	County	Latitude	Longitude
082150	1	Daytona Beach	29	Volusia, FL	29.1903	-81.0636
082158	2	Daytona Beach Intl Airport	31	Volusia, FL	29.1828	-81.0483
084366	3	Jacksonville Beach	10	Duval, FL	30.2900	-81.3922
086767	4	Palm Coast 6 NE	5	Flagler, FL	29.6347	-81.2061
087826	5	St. Augustine Lighthouse	12	St. Johns FL	29.8875	-81.2917

The calibration of the LSPC watershed hydrology model involved comparing simulated stream flows to the USGS flow stations. The calibration of the hydrologic parameters was performed from January 1, 1997 through December 31, 2009. The best available gages were used as hydrology calibration stations.

LSPC's algorithms are identical to those in the Hydrologic Simulation Program FORTRAN (HSPF). The LSPC/HSPF modules used to represent watershed hydrology include PWATER (water budget simulation for pervious land units) and IWATER (water budget simulation for impervious land units). A detailed description of relevant hydrological algorithms is presented in the HSPF (v12) User's Manual (Bicknell et al. 2004).

Calibration parameters were adjusted within the BASINS Technical Note 6 typical minimum and maximum ranges for both hydrologic soil group and land use. Parameters were not adjusted outside the possible minimum and maximum ranges. To calibrate, information on the watersheds' topography, geology, climate, land use, and anthropogenic influences was researched. Parameters were adjusted within reasonable constraints until an acceptable agreement was achieved between simulated and observed stream flow. Model parameters adjusted included: evapo-transpiration, infiltration, upper and lower zone storage, ground water storage, losses to the deep ground water system, and Manning's roughness coefficient "n."

A rating system was applied to the calibration and validations stations to determine the overall calibration success. A weighted score was assigned to simulated verse observed errors, with total flow, storm flow, and low flow volumes having the greatest weight. The summation of the weighted scores was assigned a qualitative descriptor of Very Good (VG), Good (G), Fair (F), or Poor (P). The highest possible score was 80 and the lowest possible score was 20. Scores from 80-76 were rated as VG, 75-56 G, 55-36 F, and 35-20 P.

Hydrologic calibration results are presented in Figure 1.5 through 1.10 and Tables 1.2 and 1.3.

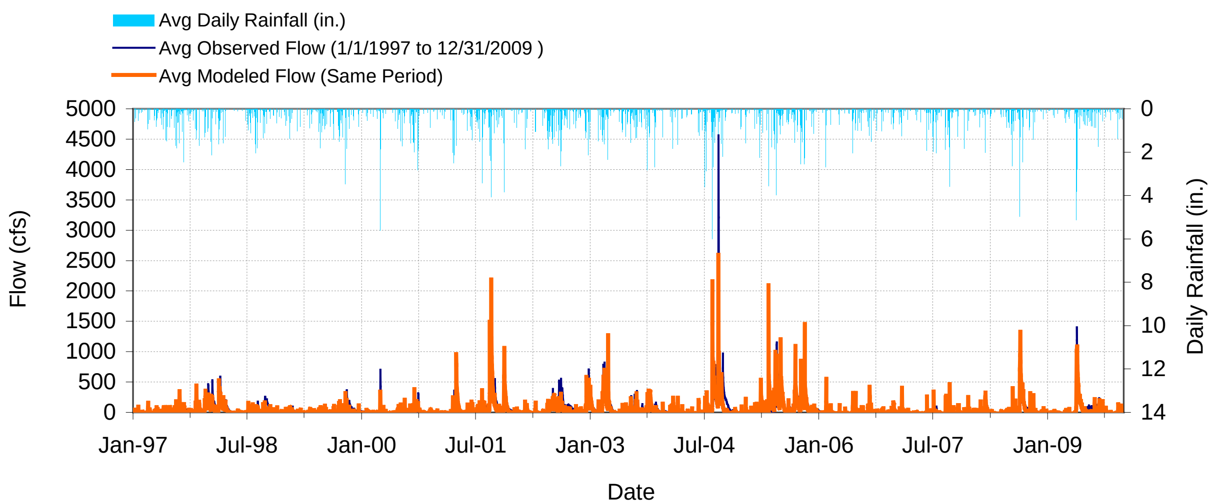

Figure 1.5 Mean daily flow: Model Outlet 120015 vs. USGS 02247510

Tomoka River near Holly Hill, FL.

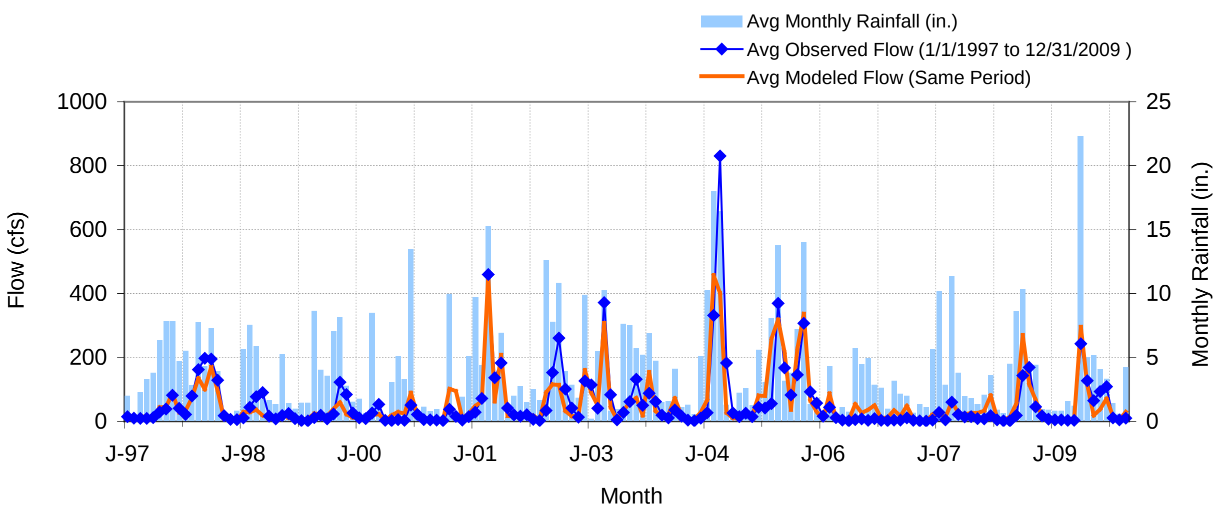

Figure 1.6 Mean monthly flow: Model Outlet 120015 vs. USGS 02247510

Tomoka River near Holly Hill, FL.

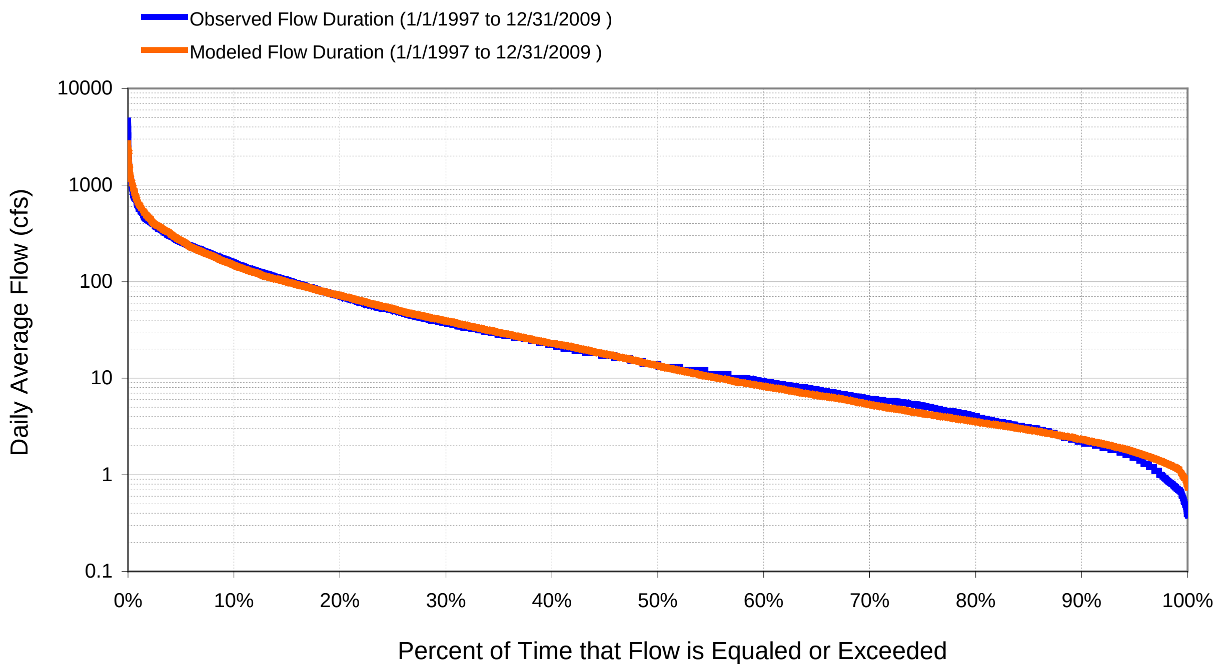

Figure 1.7 Flow exceedence: Model Outlet 120015 vs. USGS 02247510

Tomoka River near Holly Hill, FL.

Table 1.3 Summary statistics: Model Outlet 120015 vs. USGS 02247510 Tomoka River near Holly Hill, FL.

LSPC Simulated Flow		Observed Flow Gage		
REACH OUTFLOW FROM SUBBASIN 120015		USGS 02247510 TOMOKA RIVER NEAR HOLLY HILL, FL		
13-Year Analysis Period: 1/1/1997 - 12/31/2009 Flow volumes are (inches/year) for upstream drainage area		Hydrologic Unit Code: 3080201 Latitude: 29.21748099 Longitude: -81.1086687 Drainage Area (sq-mi): 76.8		
Total Simulated In-stream Flow:	**10.09**	Total Observed In-stream Flow:		**10.20**
Total of simulated highest 10% flows:	**6.16**	Total of Observed highest 10% flows:		**6.14**
Total of Simulated lowest 50% flows:	**0.45**	Total of Observed Lowest 50% flows:		**0.50**
Simulated Summer Flow Volume (months 7-9):	**4.15**	Observed Summer Flow Volume (7-9):		**4.56**
Simulated Fall Flow Volume (months 10-12):	**2.11**	Observed Fall Flow Volume (10-12):		**2.51**
Simulated Winter Flow Volume (months 1-3):	**1.86**	Observed Winter Flow Volume (1-3):		**1.76**
Simulated Spring Flow Volume (months 4-6):	**1.97**	Observed Spring Flow Volume (4-6):		**1.38**
Total Simulated Storm Volume:	**4.22**	Total Observed Storm Volume:		**2.95**
Simulated Summer Storm Volume (7-9):	**1.76**	Observed Summer Storm Volume (7-9):		**1.44**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	*Score*	
Error in total volume:	-1.07	10	16	
Error in 50% lowest flows:	**-10.09**	10	9	
Error in 10% highest flows:	0.20	15	12	
Seasonal volume error - Summer:	-8.89	30	8	
Seasonal volume error - Fall:	-15.90	30	8	
Seasonal volume error - Winter:	5.81	30	8	
Seasonal volume error - Spring:	**42.90**	30	4	
Error in storm volumes:	**43.01**	20	1	
Error in summer storm volumes:	22.56	50	4	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.250	Total Score	70	
Baseline adjusted coefficient (Garrick), E':	0.362	Rating	G	

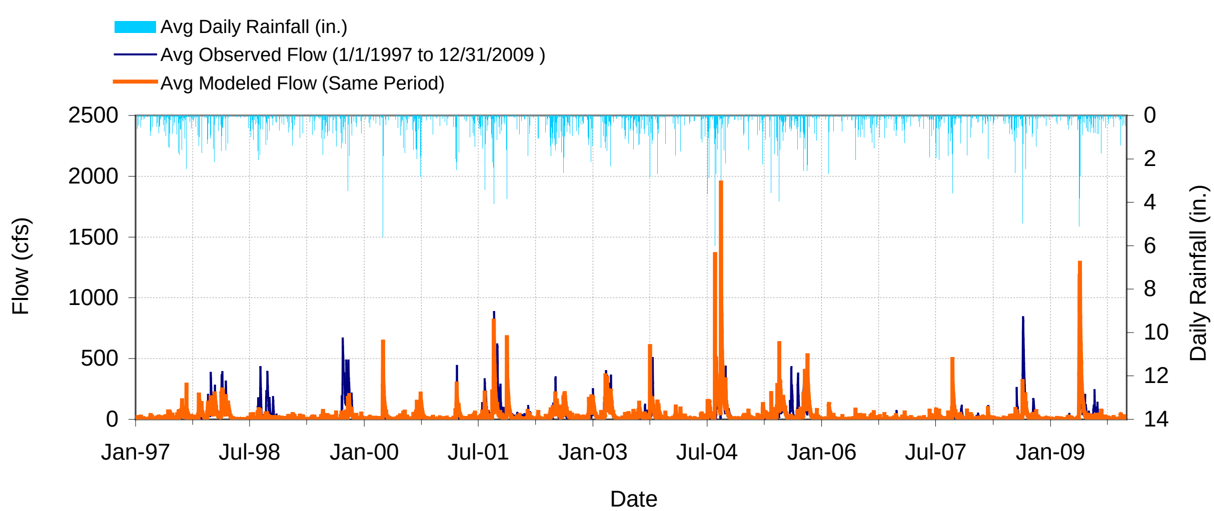

Figure 1.8 Mean daily flow: Model Outlet 120007 vs. USGS 02248000

Spruce Creek near Samsula, FL.

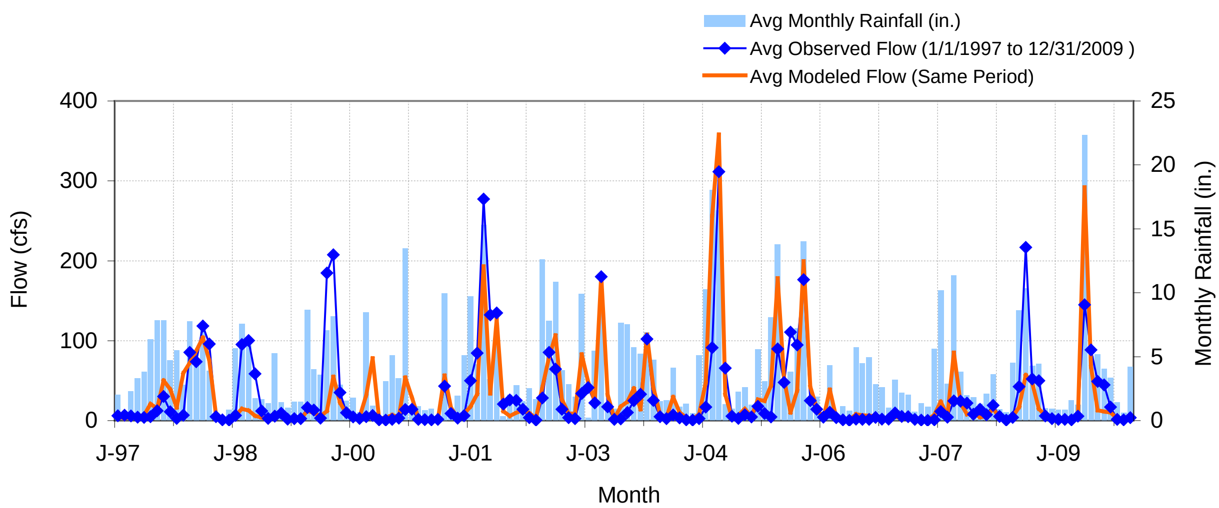

Figure 1.9 Mean monthly flow: Model Outlet 120007 vs. USGS 02248000

Spruce Creek near Samsula, FL.

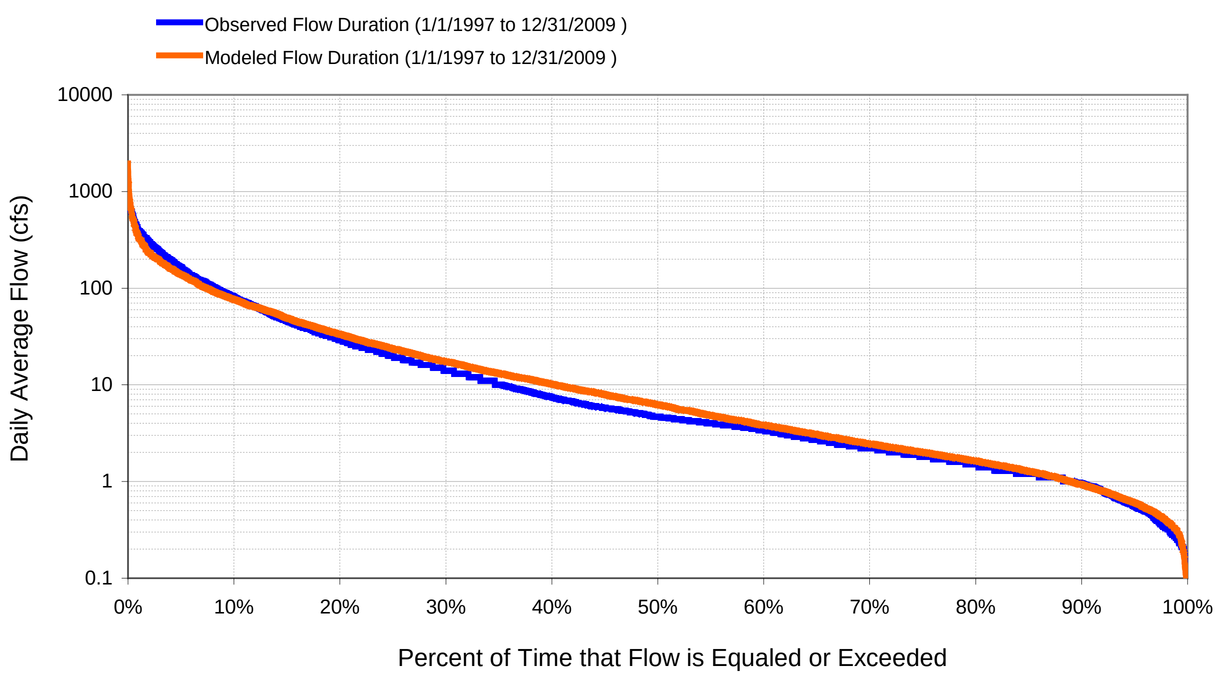

Figure 1.10 Flow exceedence: Model Outlet 120007 vs. USGS 02248000

Spruce Creek near Samsula, FL.

Table 1.4 Summary statistics: Model Outlet 120007 vs. USGS 02248000 Spruce Creek near Samsula, FL.

LSPC Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM SUBBASIN 120007 13-Year Analysis Period: 1/1/1997 - 12/31/2009 Flow volumes are (inches/year) for upstream drainage area		USGS 02248000 SPRUCE CREEK NEAR SAMSULA, FL Hydrologic Unit Code: 3080201 Latitude: 29.05081845 Longitude: -81.0464455 Drainage Area (sq-mi): 33.4	
Total Simulated In-stream Flow:	**12.29**	Total Observed In-stream Flow:	**12.73**
Total of simulated highest 10% flows:	**7.88**	Total of Observed highest 10% flows:	**8.83**
Total of Simulated lowest 50% flows:	**0.48**	Total of Observed Lowest 50% flows:	**0.42**
Simulated Summer Flow Volume (months 7-9):	**4.75**	Observed Summer Flow Volume (7-9):	**5.91**
Simulated Fall Flow Volume (months 10-12):	**2.89**	Observed Fall Flow Volume (10-12):	**3.48**
Simulated Winter Flow Volume (months 1-3):	**2.23**	Observed Winter Flow Volume (1-3):	**2.09**
Simulated Spring Flow Volume (months 4-6):	**2.43**	Observed Spring Flow Volume (4-6):	**1.25**
Total Simulated Storm Volume:	**4.12**	Total Observed Storm Volume:	**4.58**
Simulated Summer Storm Volume (7-9):	**1.71**	Observed Summer Storm Volume (7-9):	**2.10**

Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	*S core*	
Error in total volume:	-3.47	10	16	
Error in 50% lowest flows:	**15.18**	10	6	
Error in 10% highest flows:	-10.82	15	12	
Seasonal volume error - Summer:	-19.67	30	8	
Seasonal volume error - Fall:	-17.12	30	8	
Seasonal volume error - Winter:	6.64	30	8	
Seasonal volume error - Spring:	**93.90**	30	2	
Error in storm volumes:	-10.05	20	4	
Error in summer storm volumes:	-18.54	50	4	
Nash-Sutcliffe Coefficient of Efficiency, E:	0.227	Total Score	68	
Baseline adjusted coefficient (Garrick), E':	0.404	Rating	G	

The calibration of the LSPC water quality model involved comparing simulated water quality concentration and loads to the measured water quality concentrations and loads. The calibration of the water quality parameters was performed from January 1, 1997 through December 31, 2009. Water quality stations used for model calibration were co-located with hydrology stations used for model calibration.

LSPC models water quality parameters by using algorithms identical to those in the Hydrologic Simulation Program FORTRAN (HSPF). The LSPC/HSPF modules used to represent water temperature include PSTEMP (soil temperature) and HTRCH (heat exchange and water temperature). The LSPC/HSPF modules used to represent dissolved oxygen include PWTGAS (pervious water temperature and dissolved gas concentrations), IWTGAS (impervious water temperature and dissolved gas concentrations), and OXRX (primary DO and BOD balances). The LSPC/HSPF modules used to represent sediment include SEDMNT (pervious production and removal of sediment), SOLIDS (accumulation and removal of solids), and SEDTRN (behavior of inorganic sediment). The LSPC/HSPF module used to represent nutrients was GQUAL. A detailed description of relevant temperature algorithms is presented in the HSPF (v12) User's Manual (Bicknell et al. 2004).

Initial water quality parameters were based on previous modeling efforts in the Chattahoochee and Flint River Basins along with information in BASINS Technical Notes 8 and Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling (USEPA 2006 and USEPA 1985). Information on TN and TP loading and application rates for specific land uses was used to determine initial TN and TP accumulation rates and interflow and ground water concentrations. Water quality parameters were adjusted within accepted minimum and maximum ranges for each hydrologic soil group, land use, and reach group.

Temperature, DO, and BOD were calibrated simultaneously because the DO algorithms require water temperature, and the DO and BOD algorithms are interrelated. Temperature was calibrated by adjusting surface and interflow temperature slopes and intercepts, ground water temperature, and radiation coefficients until the simulated data closely matched observed. Following temperature calibration, dissolved oxygen and biological oxygen demand were calibrated by adjusting reaeration, DO interflow and ground water concentration, BOD decay rate, BOD settling rate, and benthic oxygen demand. Sediment was calibrated by adjusting detachment, scour, and build-up/wash-off coefficients. The nutrient constituents were modeled by build-up/wash-off and assigning land use associated concentrations in ground water and interflow. Adjustments were made to monthly accumulation rate, monthly storage limit, interflow concentration, and ground water concentration for TN and TP until the simulated data was in range with the observed field data.

Both visual and statistical metrics were utilized during calibration. Visual calibration was accomplished by matching the trends in the measured water quality concentration data. Loading metrics, including annual loading percent error, were utilized for statistical calibration. Annual loading was only analyzed when two or more water quality samples were taken in a given year, and measured flow data was collected that year. If no measured flow data was collected but the contributing area of the water quality station had similar land uses and soil types as the contributing area of a neighboring hydrology station, weighted measured flow was used to calculate the loadings. A rating system was applied to the percent error of the average annual loadings at the calibration and validations stations to determine the overall calibration success. The average annual loading percent error was assigned a qualitative descriptor of Very Good (VG), Good (G), Fair (F), or Poor (P). Scores from ±0-40% were rated as VG, ±40-90% G, ±90-150% F, and ±150-500% P.

Nutrient concentration and loading calibration results are presented in Figures 1.11 through 1.22 and Tables 1.4 through 1.7.

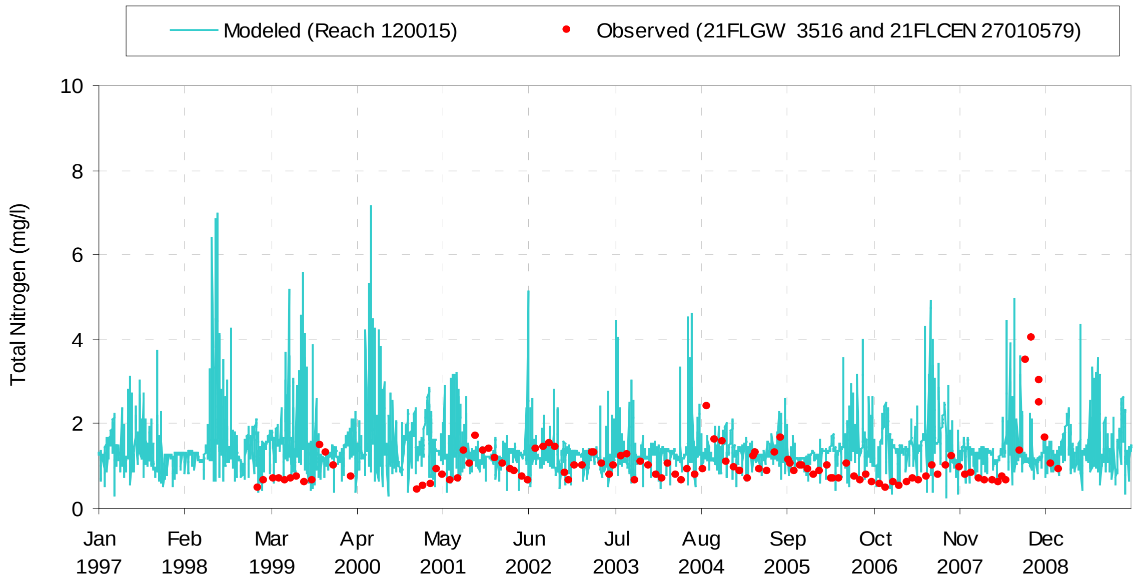

Figure 1.11 Modeled vs. observed total nitrogen (mg/L) at 21FLGW 3516 and 21FLCEN 27010579.

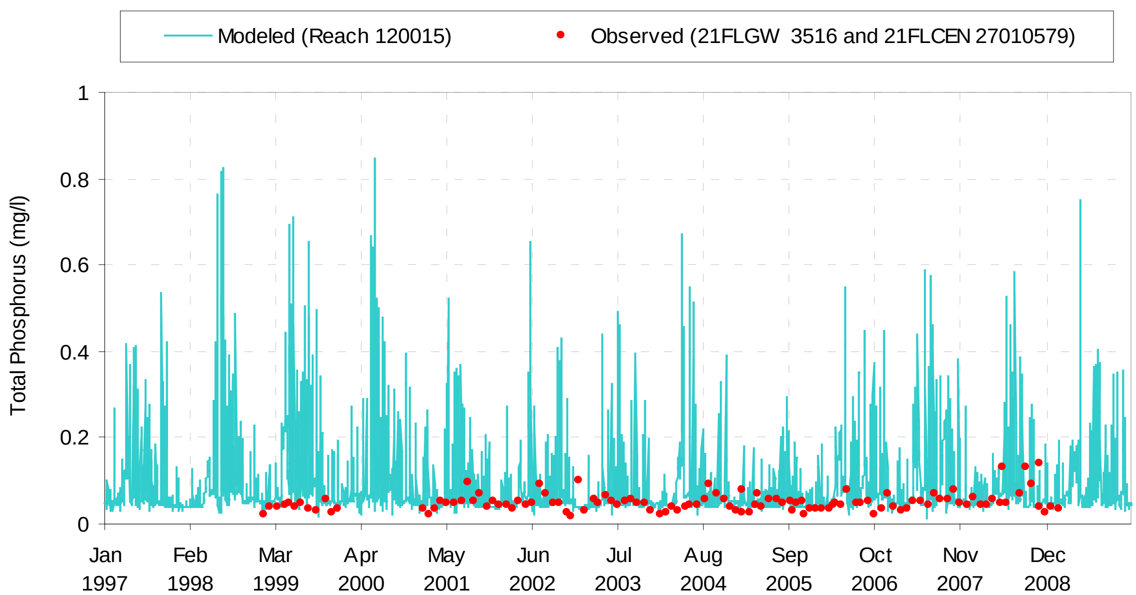

Figure 1.12 Modeled vs. observed total phosphorus (mg/L) at 21FLGW 3516 and 21FLCEN 27010579.

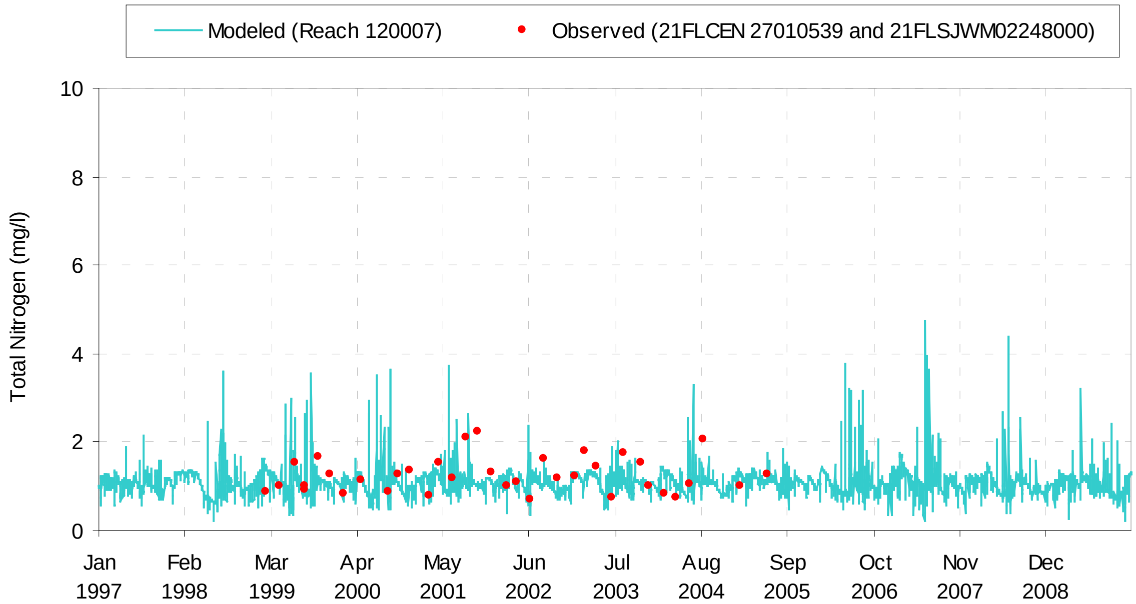

Figure 1.13 Modeled vs. observed total nitrogen (mg/L) at 21FLCEN 27010539 and 21FLSJWM02248000.

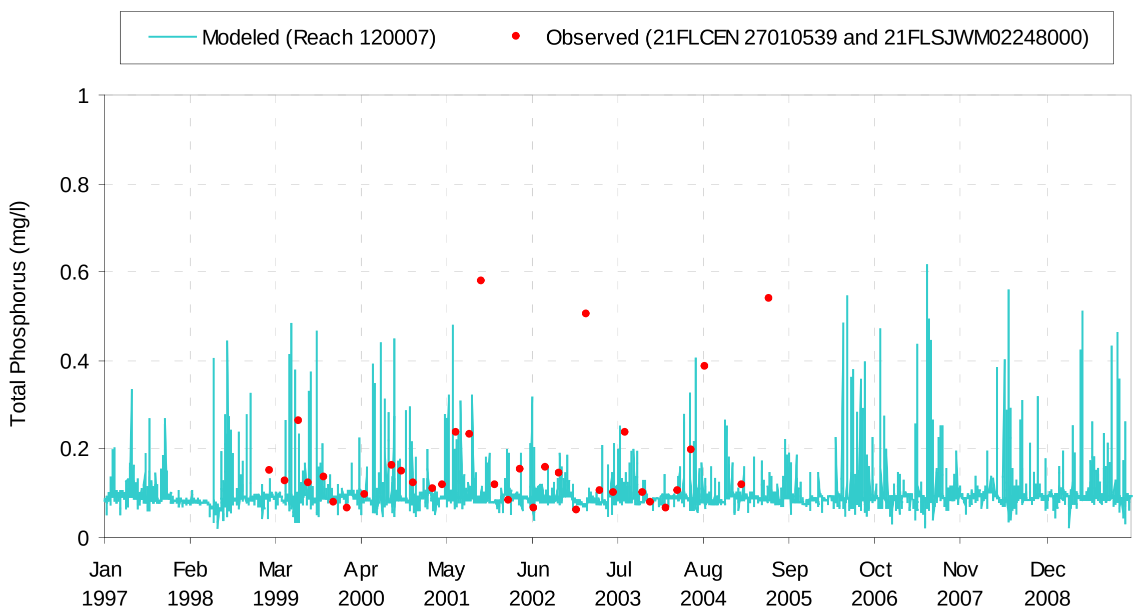

Figure 1.14 Modeled vs. observed total phosphorus (mg/L) at 21FLCEN 27010539 and 21FLSJWM02248000.

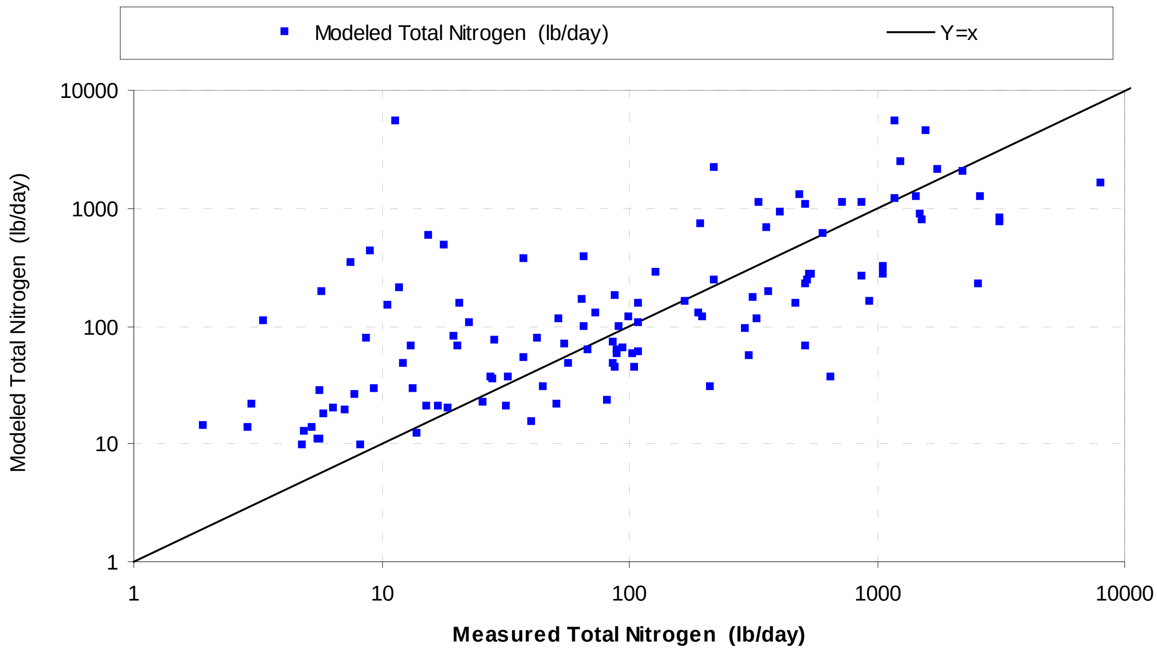

Figure 1.15 Total nitrogen (mg/l) load scatter plot at 21FLGW 3516 and 21FLCEN 27010579.

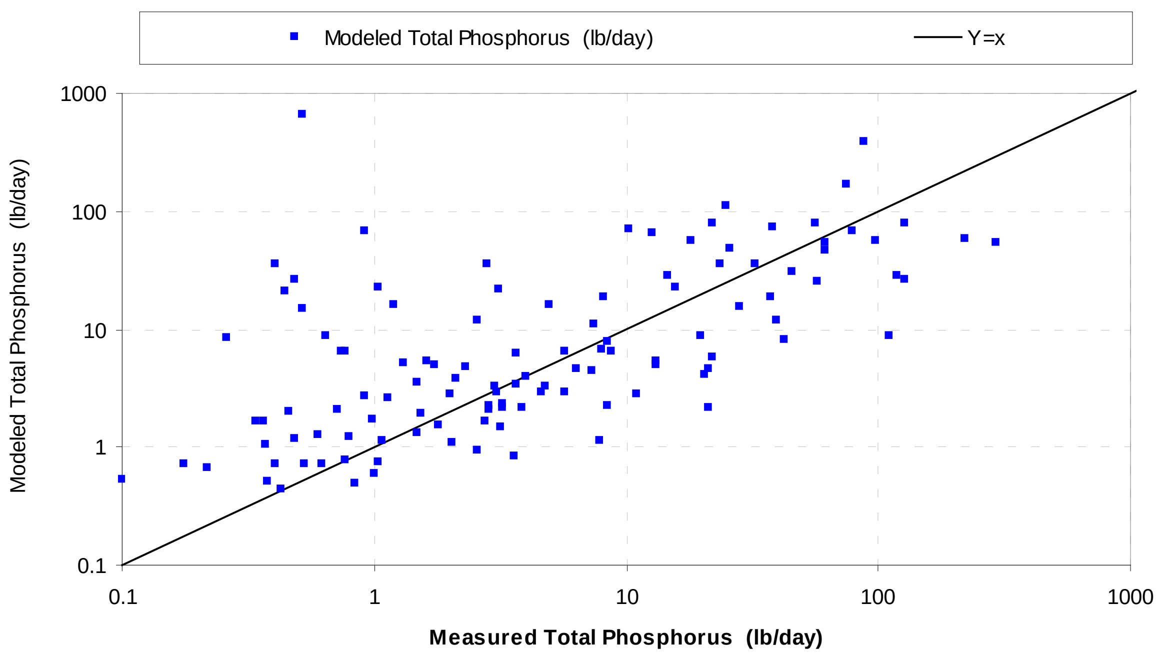

Figure 1.16 Total phosphorus (mg/l) load scatter plot at 21FLGW 3516 and 21FLCEN 27010579.

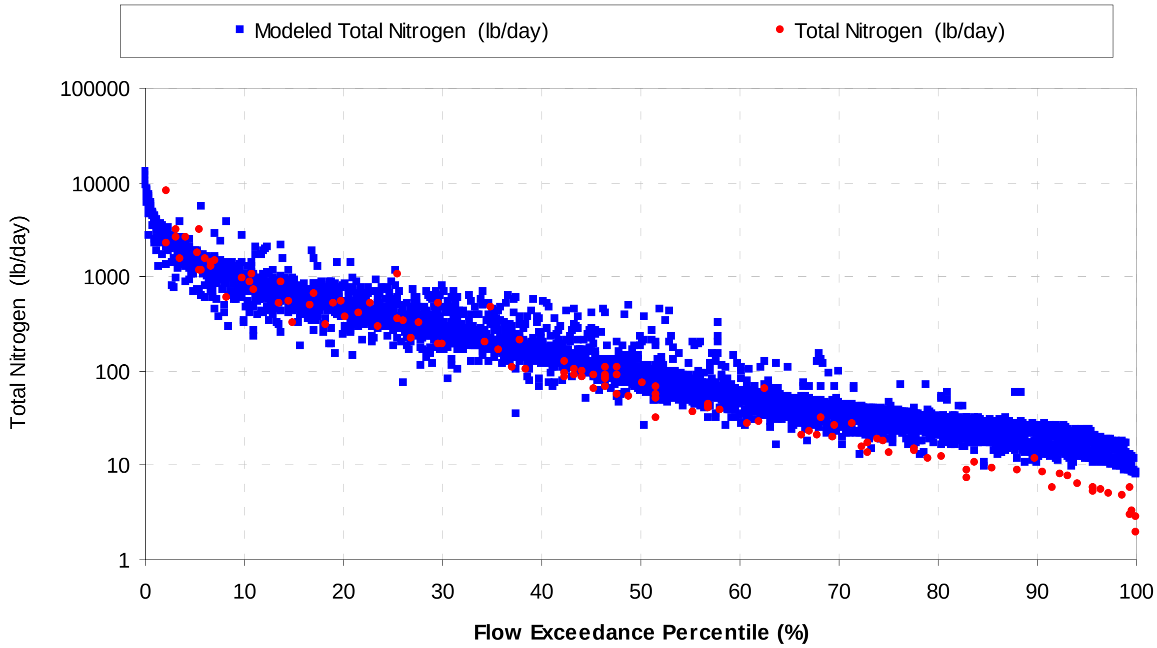

Figure 1.17 Total nitrogen (mg/L) load duration curve at 21FLGW 3516 and 21FLCEN 27010579.

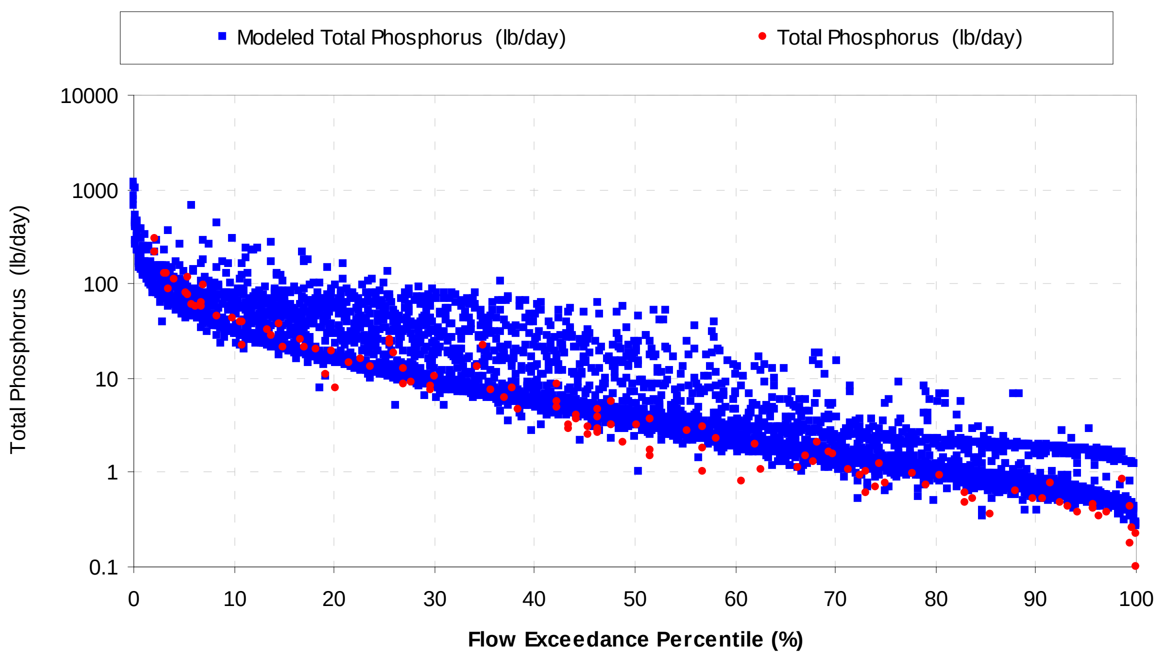

Figure 1.18 Total phosphorus (mg/L) load duration curve at 21FLGW 3516 and 21FLCEN 27010579.

Table 1.4 Total nitrogen (lb/year) percent error for measured and modeled loading by year at 21FLGW 3516 and 21FLCEN 27010579.

Rating of % Error was Very Good

Year	Measured TN (lb/year)	Modeled TN (lb/year)	% Error
1999	65,823	57,694	-12.4
2000	20,510	54,931	167.8
2001	217,319	209,770	-3.5
2002	170,835	126,810	-25.8
2003	200,075	179,481	-10.3
2004	447,592	222,788	-50.2
2005	250,005	334,621	33.9
2006	14,820	66,834	351.0
2007	26,375	57,432	117.8
2008	209,614	142,172	-32.2
2009	103,072	124,330	20.6
Average	156,913	143,351	-8.6

Table 1.5 Total phosphorus (lb/year) percent error for measured and modeled loading by year at 21FLGW 3516 and 21FLCEN 27010579.

Rating of % Error was Very Good

Year	Measured TP (lb/year)	Modeled TP (lb/year)	% Error
1999	2,428	5,353	120.5
2000	1,113	4,459	300.7
2001	9,510	11,052	16.2
2002	8,501	7,084	-16.7
2003	9,399	8,837	-6.0
2004	18,250	12,059	-33.9
2005	11,603	16,828	45.0
2006	720	4,169	478.8
2007	1,637	4,454	172.0
2008	7,209	7,792	8.1
2009	3,922	7,281	85.7
Average	6,754	8,124	20.3

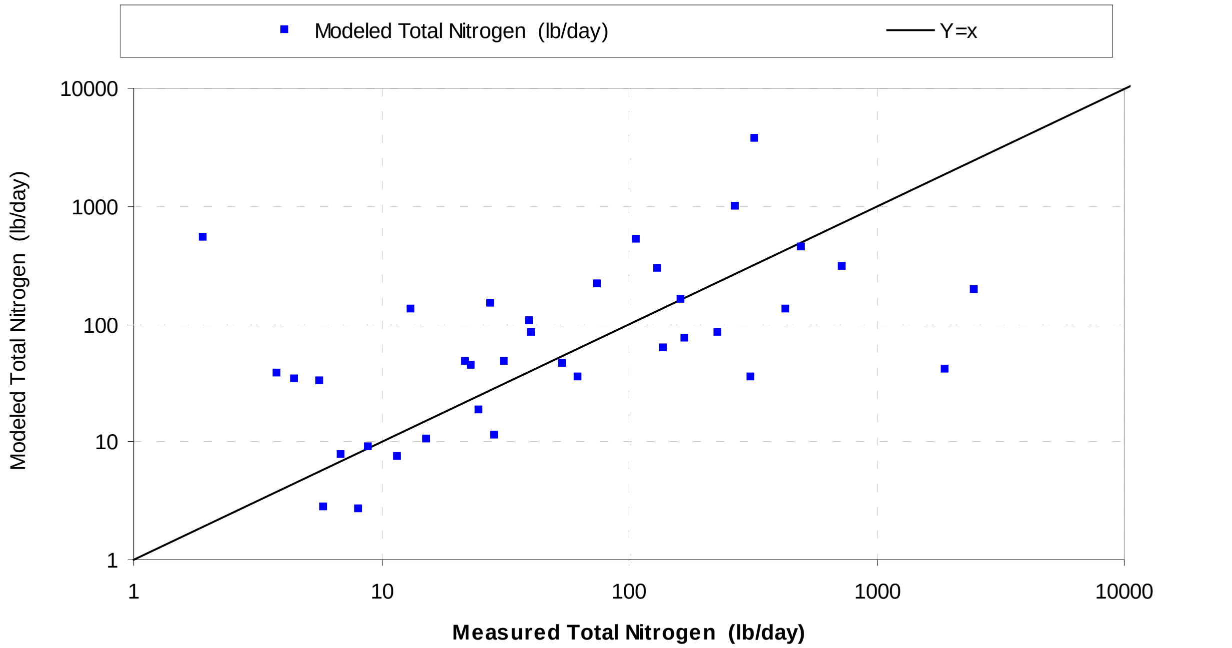

Figure 1.19 Total nitrogen (mg/L) load scatter plot at 21FLCEN 27010539 and 21FLSJWM02248000.

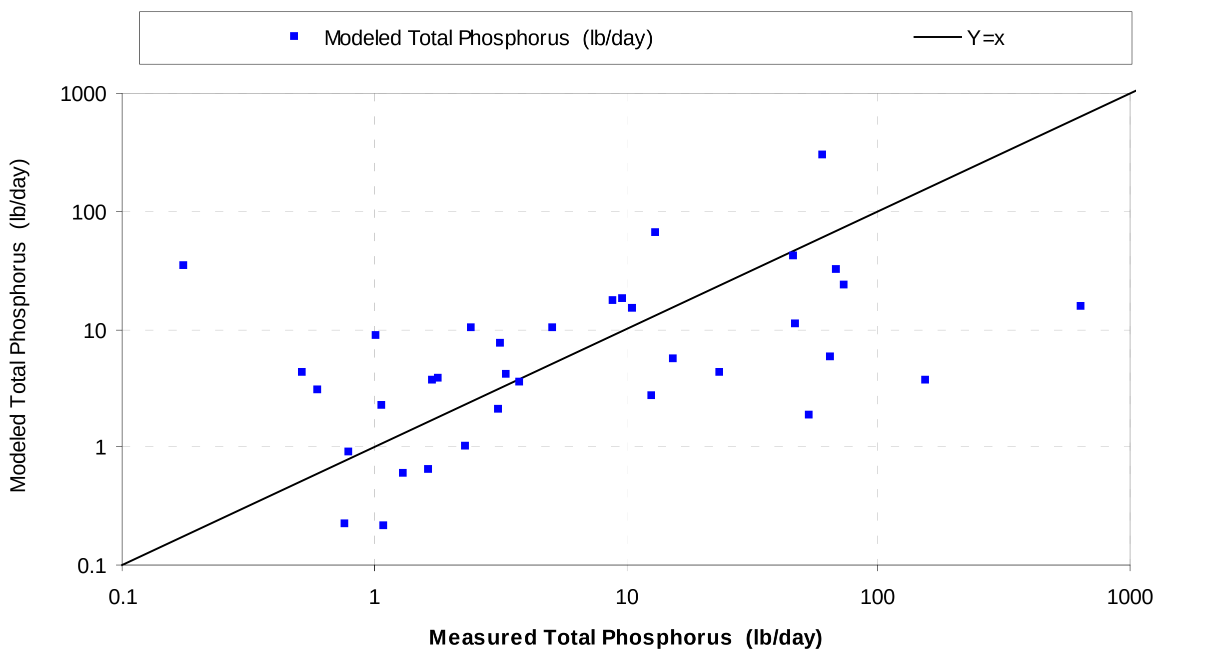

Figure 1.20 Total phosphorus (mg/l) load scatter plot at 21FLCEN 27010539 and 21FLSJWM02248000.

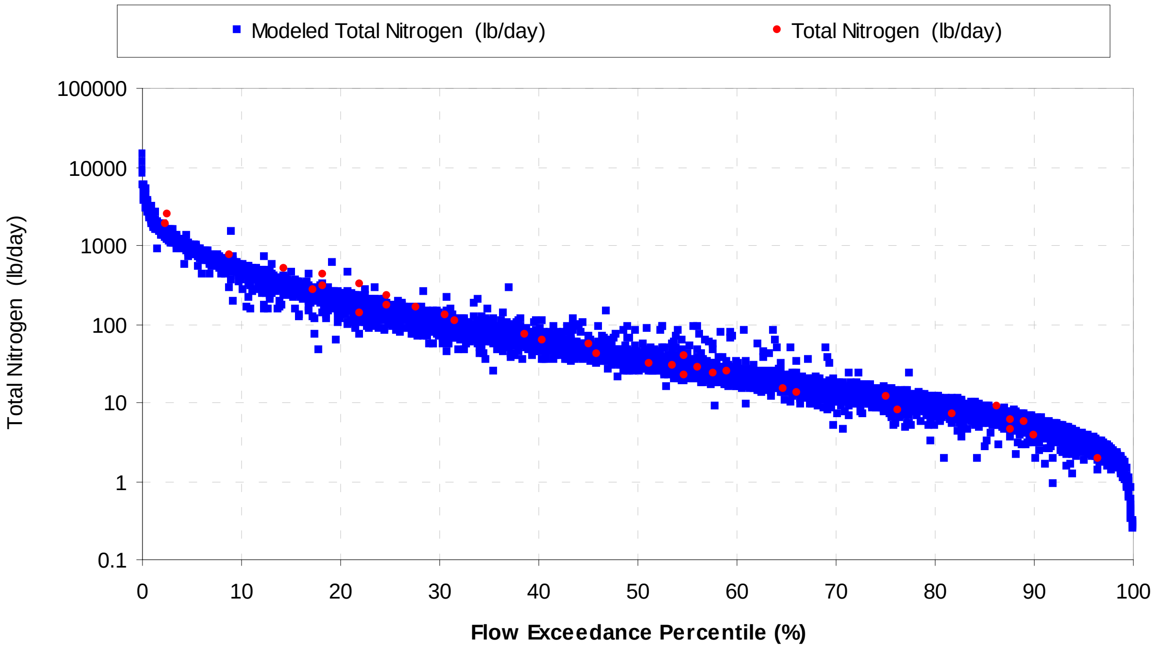

Figure 1.21 Total nitrogen (mg/L) load duration curve at 21FLCEN 27010539 and 21FLSJWM02248000.

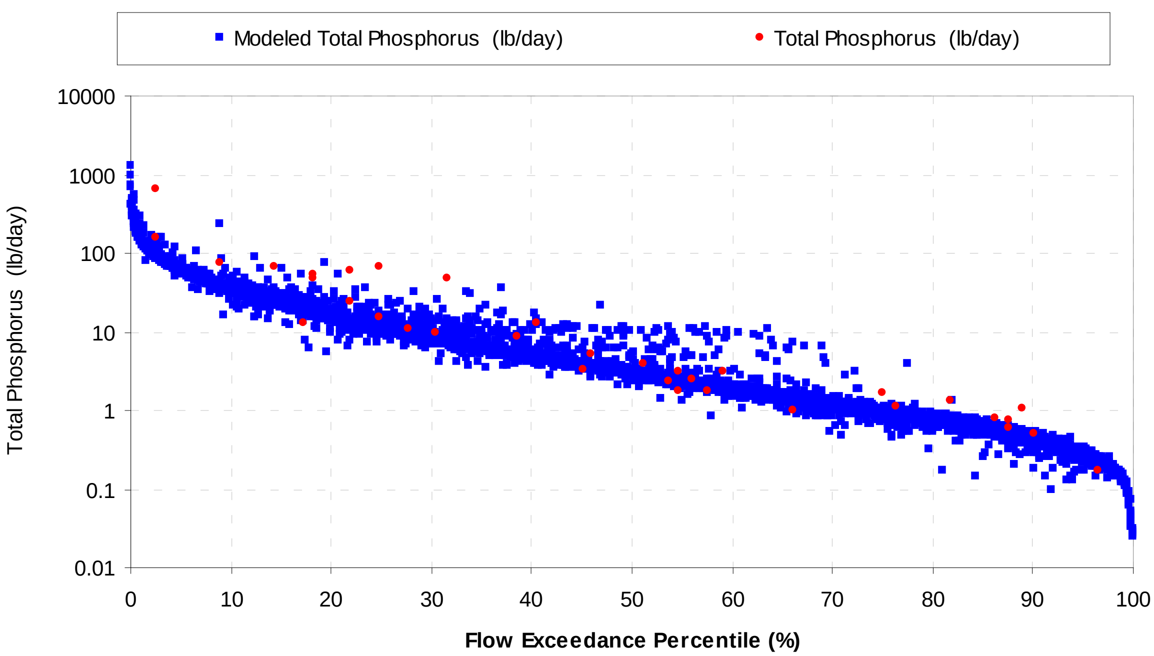

Figure 1.22 Total phosphorus (mg/L) load duration curve at 21FLCEN 27010539 and 21FLSJWM02248000.

Table 1.6 Total nitrogen (lb/year) percent error for measured and modeled loading by year at 21FLCEN 27010539 and 21FLSJWM02248000.

Rating of % Error was Very Good

Year	Measured TN (lb/year)	Modeled TN (lb/year)	% Error
1999	119,768	26,204	-78.1
2000	9,961	42,424	325.9
2001	242,469	94,435	-61.1
2002	60,424	74,404	23.1
2003	118,289	108,736	-8.1
2004	151,387	145,047	-4.2
2005	123,844	124,677	0.7
2006			
2007			
2008			
2009			
Average	118,020	87,989	-25.4

Table 1.7 Total phosphorus (lb/year) percent error for measured and modeled loading by year at 21FLCEN 27010539 and 21FLSJWM02248000.

Rating of % Error was Good

Year	Measured TP (lb/year)	Modeled TP (lb/year)	% Error
1999	11,010	2,371	-78.5
2000	1,149	3,265	184.2
2001	45,523	7,424	-83.7
2002	5,675	5,882	3.7
2003	15,842	7,964	-49.7
2004	27,323	11,279	-58.7
2005	52,024	9,700	-81.4
2006			
2007			
2008			
2009			
Average	22,649	6,841	-69.8

References

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Appendix D: Kruskal–Wallis Analysis of Corrected Chla, INORGN, TN, INORGP, TP, COND, Color, and TSS, Observations versus Season in Tomoka River

Kruskal-Wallis One-Way Analysis of Variance for 653 cases
Dependent variable is CHLAC
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	152	39067.000
SPRING	177	71389.500
SUMMER	163	57242.000
WINTER	161	45832.500

Kruskal-Wallis Test Statistic = 67.338
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 304 cases
Dependent variable is INORGN
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	61	9441.500
SPRING	97	14949.000
SUMMER	74	13161.000
WINTER	72	8808.500

Kruskal-Wallis Test Statistic = 14.706
Probability is 0.002 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 628 cases
Dependent variable is TN
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	143	52120.500
SPRING	169	46003.500
SUMMER	161	59771.500
WINTER	155	39610.500

Kruskal-Wallis Test Statistic = 52.148
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 516 cases
Dependent variable is INORGP
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	126	31418.000
SPRING	122	32279.500
SUMMER	133	44591.500
WINTER	135	25097.000

Kruskal-Wallis Test Statistic = 67.983
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 649 cases
Dependent variable is TP
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	155	42957.500
SPRING	174	66618.000
SUMMER	161	61525.000
WINTER	159	39824.500

Kruskal-Wallis Test Statistic = 66.861
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 690 cases
Dependent variable is COND
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	172	49848.000
SPRING	188	83505.000
SUMMER	167	48929.500
WINTER	163	56112.500

Kruskal-Wallis Test Statistic = 71.091
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 670 cases
Dependent variable is COLOR
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	163	70276.000
SPRING	180	38738.000
SUMMER	168	67110.500
WINTER	159	48660.500

Kruskal-Wallis Test Statistic = 131.497
Probability is 0.000 assuming Chi-square distribution with 3 df

Kruskal-Wallis One-Way Analysis of Variance for 579 cases
Dependent variable is TSS
Grouping variable is SEASON$

Group	Count	Rank Sum
FALL	149	40442.500
SPRING	137	46416.000
SUMMER	144	41185.500
WINTER	149	39866.000

Kruskal-Wallis Test Statistic = 16.512
Probability is 0.001 assuming Chi-square distribution with 3 df

Appendix E: Kruskal–Wallis Analysis of Corrected Chla, INORGN, TN, INORGP, TP, COND, Color, and TSS Observations versus Year in Tomoka River

Kruskal-Wallis One-Way Analysis of Variance for 653 cases
Dependent variable is CHLAC
Grouping variable is YEAR

Group	Count	Rank Sum
1985	9	2466.000
1986	24	10924.000
1992	34	11996.500
1993	30	11996.500
1994	40	15456.500
1995	35	11249.000
1996	33	8622.000
1997	21	5969.000
1998	35	7823.500
1999	35	11314.000
2000	10	2833.500
2001	21	4815.500
2002	19	5284.000
2003	33	8088.500
2004	20	4626.500
2005	43	14241.000
2006	21	4670.000
2007	19	4946.500
2008	64	25597.000
2009	50	20808.500
2010	33	10885.000
2011	24	8918.000

Kruskal-Wallis Test Statistic = 95.752
Probability is 0.000 assuming Chi-square distribution with 21 df

Kruskal-Wallis One-Way Analysis of Variance for 304 cases
Dependent variable is INORGN
Grouping variable is YEAR

Group	Count	Rank Sum
1983	3	352.000
1984	6	1508.000
1993	4	553.000
1994	8	1235.000
1995	7	1658.500
1996	7	1294.000
1997	7	868.500
1998	11	1530.000
1999	12	1417.500
2000	2	240.500
2001	12	1426.500
2002	15	2497.000
2003	26	3292.000
2004	12	2462.000
2005	30	3037.000
2006	15	2149.500
2007	12	1489.000
2008	54	8426.000
2009	21	4039.000
2010	24	4900.000
2011	16	1985.000

Kruskal-Wallis Test Statistic = 53.362
Probability is 0.000 assuming Chi-square distribution with 20 df

Kruskal-Wallis One-Way Analysis of Variance for 628 cases
Dependent variable is TN
Grouping variable is YEAR

Group	Count	Rank Sum
1975	1	104.000
1983	3	614.000
1984	6	1890.000
1985	10	3151.000
1986	25	7528.000
1992	33	12528.500
1993	33	8902.500
1994	42	17531.000
1995	37	17252.500
1996	34	10081.000
1997	22	5956.500
1998	35	12746.000
1999	35	8208.500
2000	12	2842.500
2001	21	4762.500
2002	21	6530.000
2003	32	10392.000
2004	22	6281.500
2005	38	12344.000
2006	19	2666.000
2007	17	2601.500
2008	60	20622.000
2009	21	7765.000
2010	27	9068.500
2011	22	5137.000

Kruskal-Wallis Test Statistic = 106.426
Probability is 0.000 assuming Chi-square distribution with 24 df

Kruskal-Wallis One-Way Analysis of Variance for 516 cases
Dependent variable is INORGP
Grouping variable is YEAR

Group	Count	Rank Sum
1966	2	608.000
1967	1	516.000
1970	1	457.000
1971	1	499.000
1975	1	207.500
1983	3	619.000
1984	6	2005.000
1992	33	7515.500
1993	31	7822.500
1994	40	12090.500
1995	39	10058.000
1996	34	5681.500
1997	22	6642.500
1998	35	9796.500
1999	34	7843.500
2000	12	4450.500
2001	21	6481.000
2002	21	6453.500
2003	19	6035.500
2004	22	5338.000
2005	23	5158.000
2006	19	4010.500
2007	16	4655.500
2008	26	6625.500
2009	18	3257.500
2010	20	3740.500
2011	16	4818.000

Kruskal-Wallis Test Statistic = 60.416
Probability is 0.000 assuming Chi-square distribution with 26 df

Kruskal-Wallis One-Way Analysis of Variance for 649 cases
Dependent variable is TP
Grouping variable is YEAR

Group	Count	Rank Sum
1968	1	562.000
1969	1	531.000
1970	1	410.000
1971	1	533.000
1975	1	481.000
1983	3	1249.000
1984	6	2577.500
1985	10	1620.000
1986	25	10336.000
1992	34	14803.500
1993	28	12709.500
1994	42	19962.000
1995	37	12863.000
1996	34	4596.000
1997	22	4609.000
1998	37	7812.500
1999	35	8774.500
2000	10	4196.000
2001	21	6481.000
2002	19	5422.000
2003	34	10115.500
2004	20	4702.000
2005	38	10194.000
2006	23	5788.500
2007	18	4051.000
2008	63	28568.000
2009	30	9717.000
2010	33	9944.500
2011	22	7316.000

Kruskal-Wallis Test Statistic = 186.964
Probability is 0.000 assuming Chi-square distribution with 28 df

Kruskal-Wallis One-Way Analysis of Variance for 690 cases
Dependent variable is COND
Grouping variable is YEAR

Group	Count	Rank Sum
1964	2	178.500
1965	9	2729.500
1966	5	550.000
1967	1	478.000
1968	1	515.000
1969	1	387.000
1970	1	324.500
1971	1	330.000
1975	1	594.000
1981	1	406.000
1983	2	451.000
1984	2	539.000
1985	10	2327.000
1986	24	12134.000
1992	36	15226.500
1993	33	11937.500
1994	43	16386.000
1995	40	11949.500
1996	32	7627.000
1997	22	6288.500
1998	37	9391.000
1999	36	12912.500
2000	10	3108.500
2001	21	6869.500
2002	21	6245.500
2003	35	6384.000
2004	19	7252.500
2005	31	6370.000
2006	22	8193.500
2007	20	8418.000
2008	63	31352.000
2009	52	19724.000
2010	33	10821.000
2011	23	9994.500

Kruskal-Wallis Test Statistic = 149.061
Probability is 0.000 assuming Chi-square distribution with 33 df

Kruskal-Wallis One-Way Analysis of Variance for 670 cases
Dependent variable is COLOR
Grouping variable is YEAR

Group	Count	Rank Sum
1964	2	786.000
1965	9	2880.000
1966	5	2273.500
1967	1	221.000
1968	1	140.000
1969	1	333.500
1970	1	221.000
1975	1	50.000
1983	6	1604.000
1984	6	2237.500
1985	10	4566.500
1986	25	6635.000
1992	34	11656.000
1993	33	7968.000
1994	42	13857.000
1995	40	16902.000
1996	32	13075.000
1997	22	8408.500
1998	37	18618.000
1999	35	11459.500
2000	12	4466.500
2001	21	6323.000
2002	19	6695.500
2003	34	16091.000
2004	22	7399.000
2005	28	12893.500
2006	22	4630.000
2007	19	3734.000
2008	63	12964.500
2009	30	10667.000
2010	33	11008.500
2011	24	4020.500

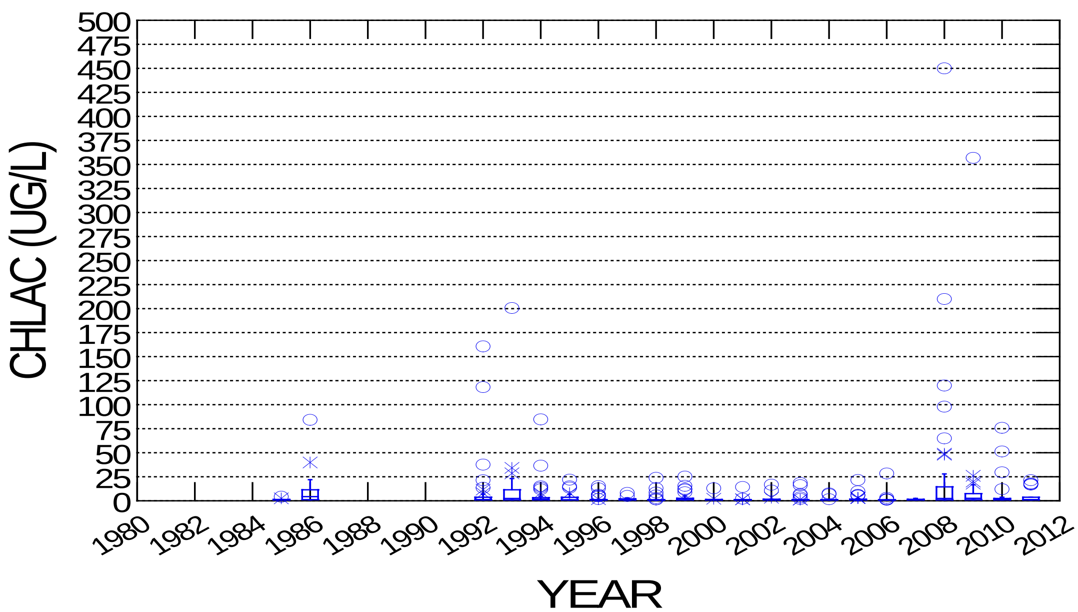
Kruskal-Wallis Test Statistic = 159.824
Probability is 0.000 assuming Chi-square distribution with 31 df

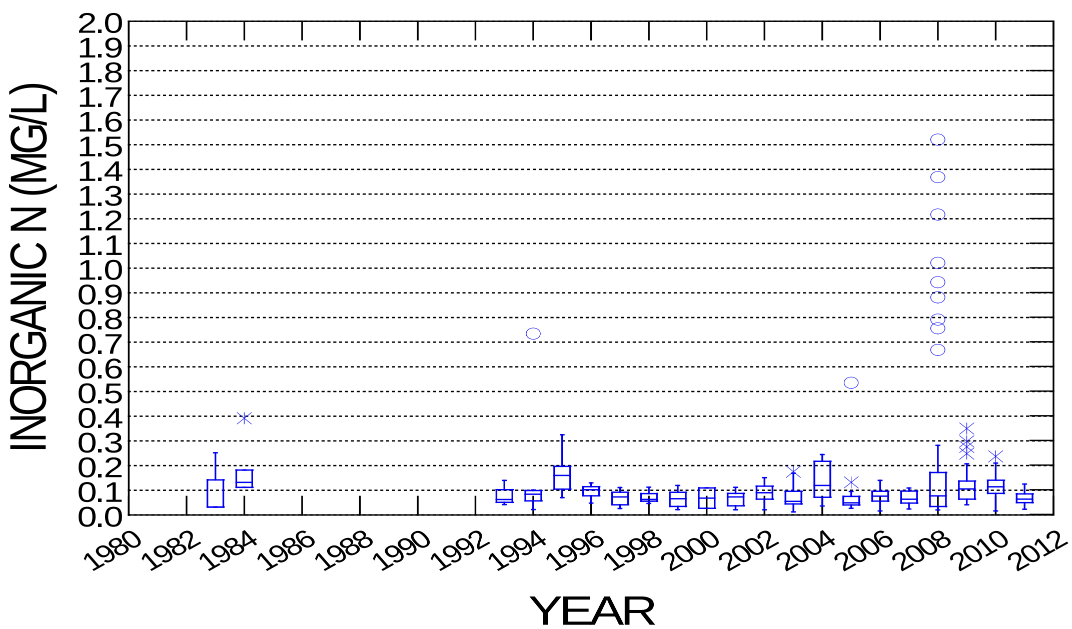
Kruskal-Wallis One-Way Analysis of Variance for 579 cases
Dependent variable is TSS
Grouping variable is YEAR

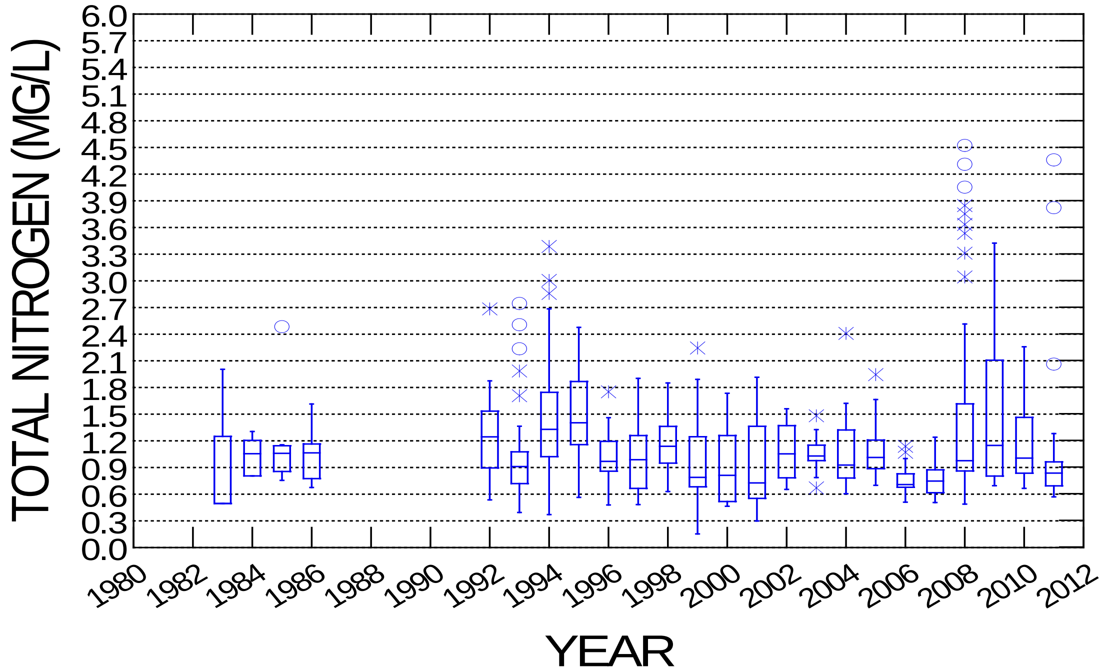
Group	Count	Rank Sum
1975	1	353.500
1985	5	1428.500
1986	25	8839.000
1992	33	10766.500
1993	33	10816.000
1994	42	8253.000
1995	39	11201.500
1996	33	8738.500
1997	22	4273.500
1998	36	7961.000
1999	35	9285.000
2000	10	1333.000
2001	21	6572.500
2002	21	6942.500
2003	20	6167.000
2004	22	6063.500
2005	22	7260.000
2006	22	7386.000
2007	20	5424.000
2008	33	12610.500
2009	30	11080.500
2010	32	9183.000
2011	22	5971.500

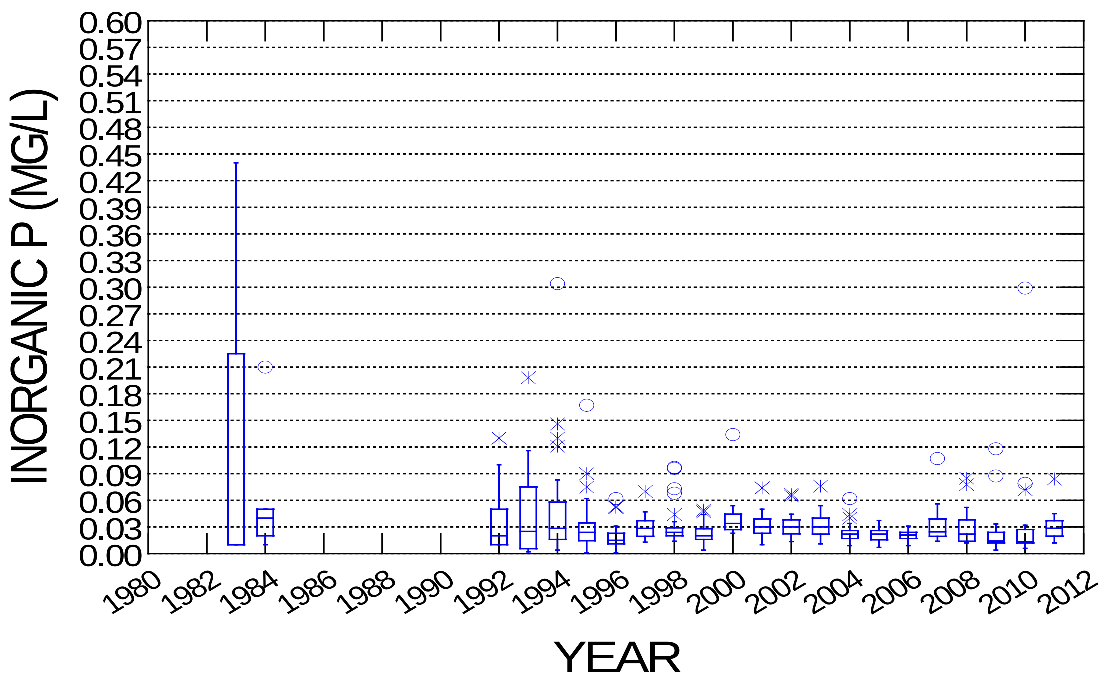
Kruskal-Wallis Test Statistic = 66.967
Probability is 0.000 assuming Chi-square distribution with 22 df

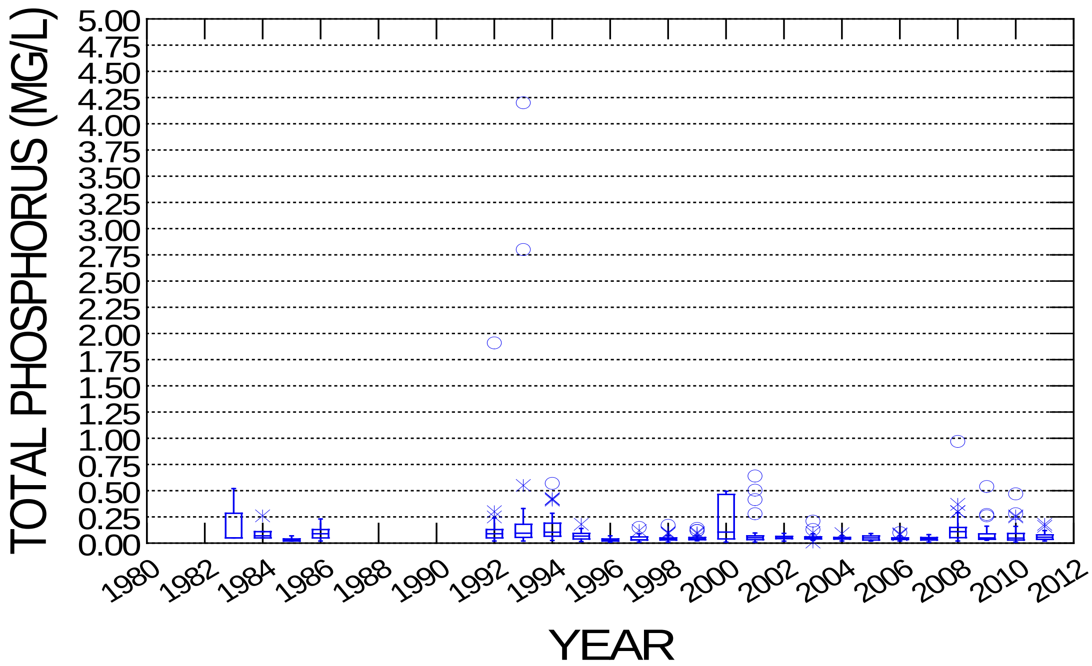
Appendix F: Chart of Corrected Chla, INORGN TN, INORGP, TP, Cond, Color, and TSS Observations by Year, Season, and Station, in Tomoka River

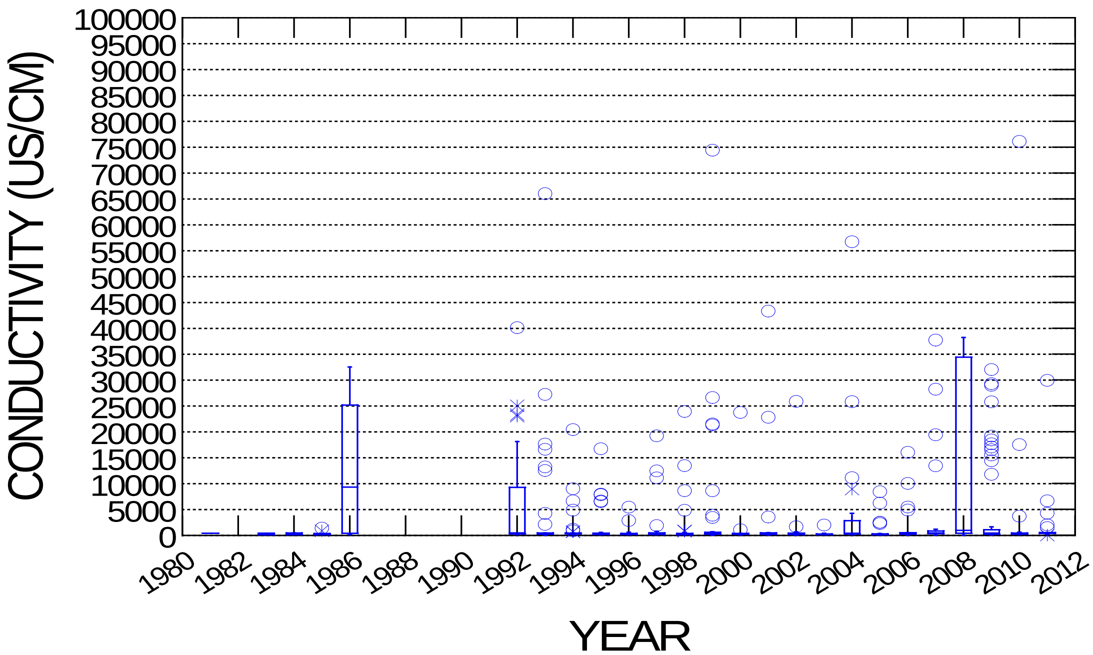


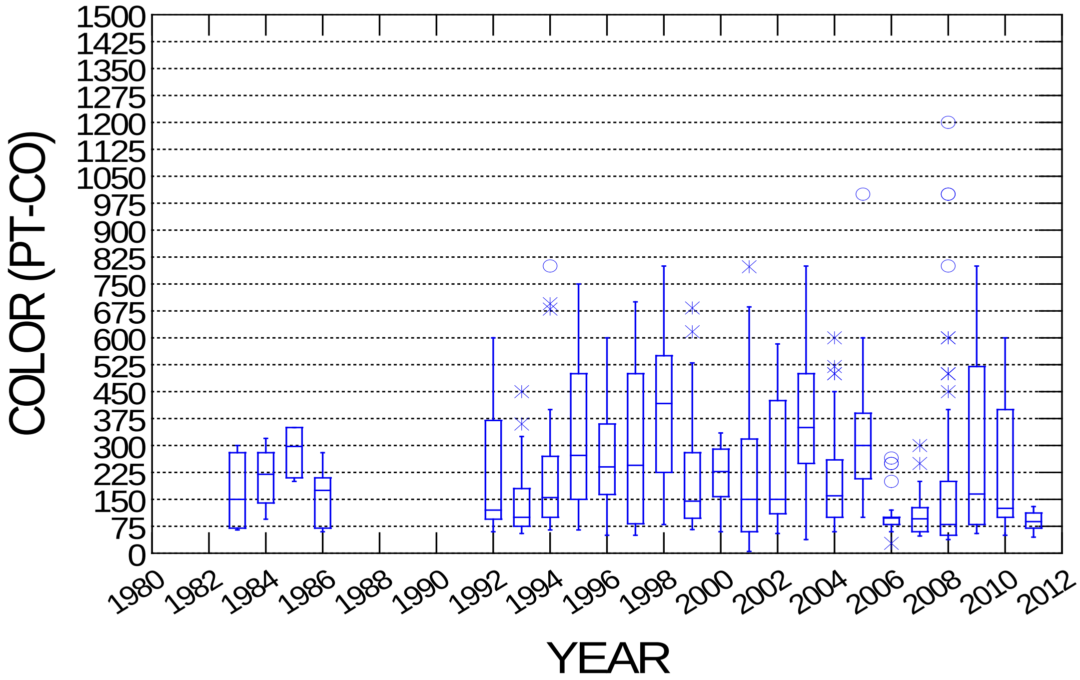


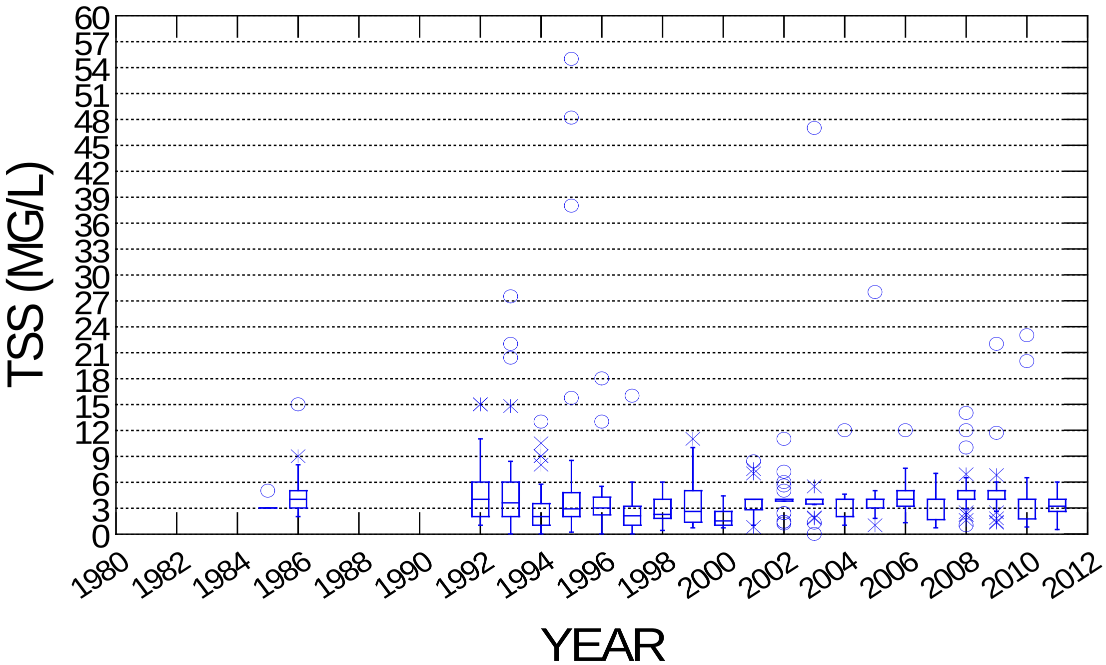

TOTAL NITROGEN (MG/L)
6.0
5.7
5.4
5.1
4.8
4.5
4.2
3.9
3.6
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
YEAR

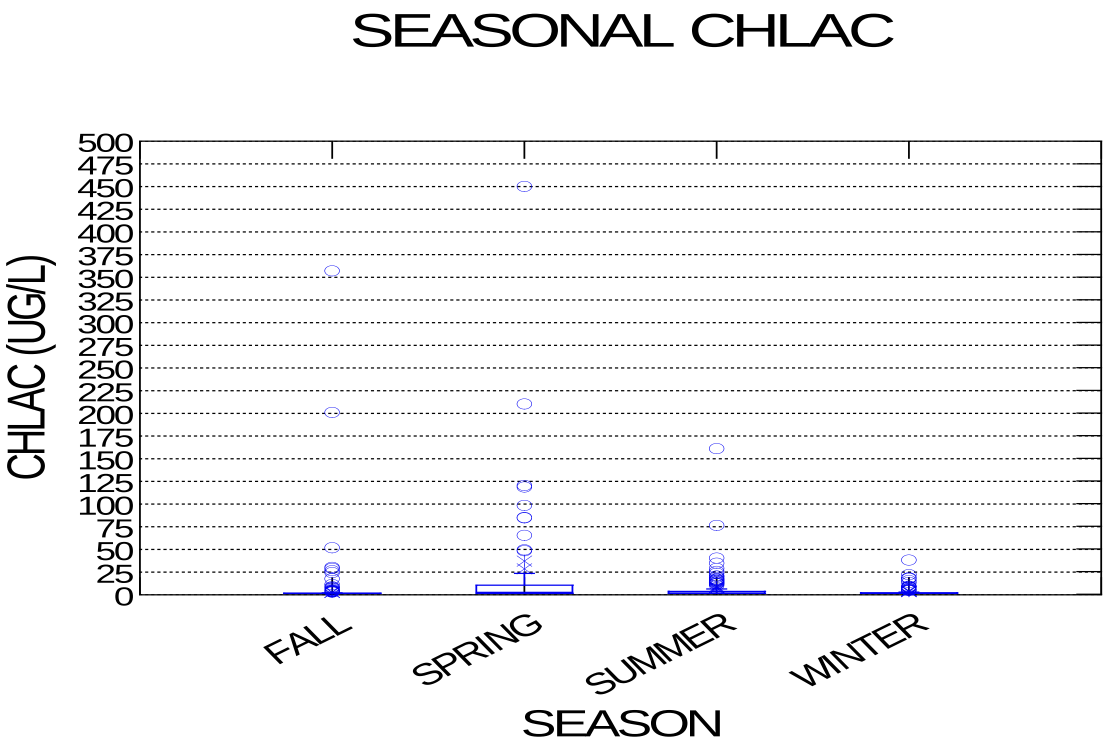

INORGANIC P (MG/L)
0.60
0.57
0.54
0.51
0.48
0.45
0.42
0.39
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
YEAR

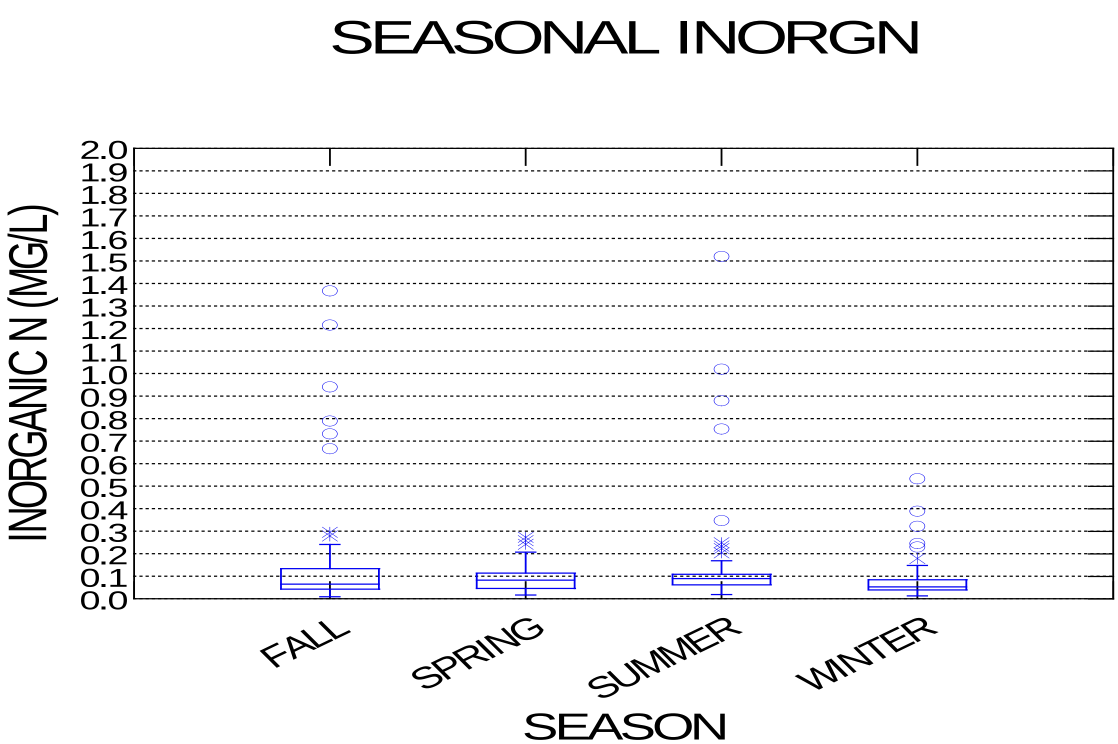

TOTAL PHOSPHORUS (MG/L)
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
YEAR

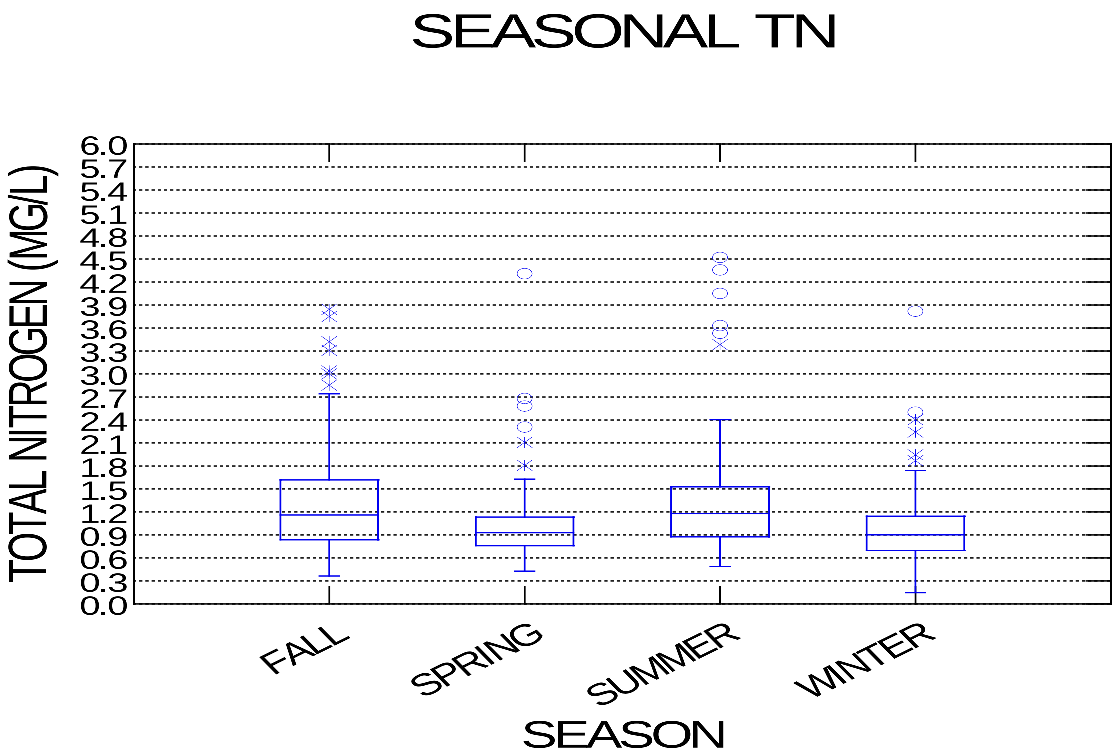

CONDUCTIVITY (US/CM)
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
YEAR

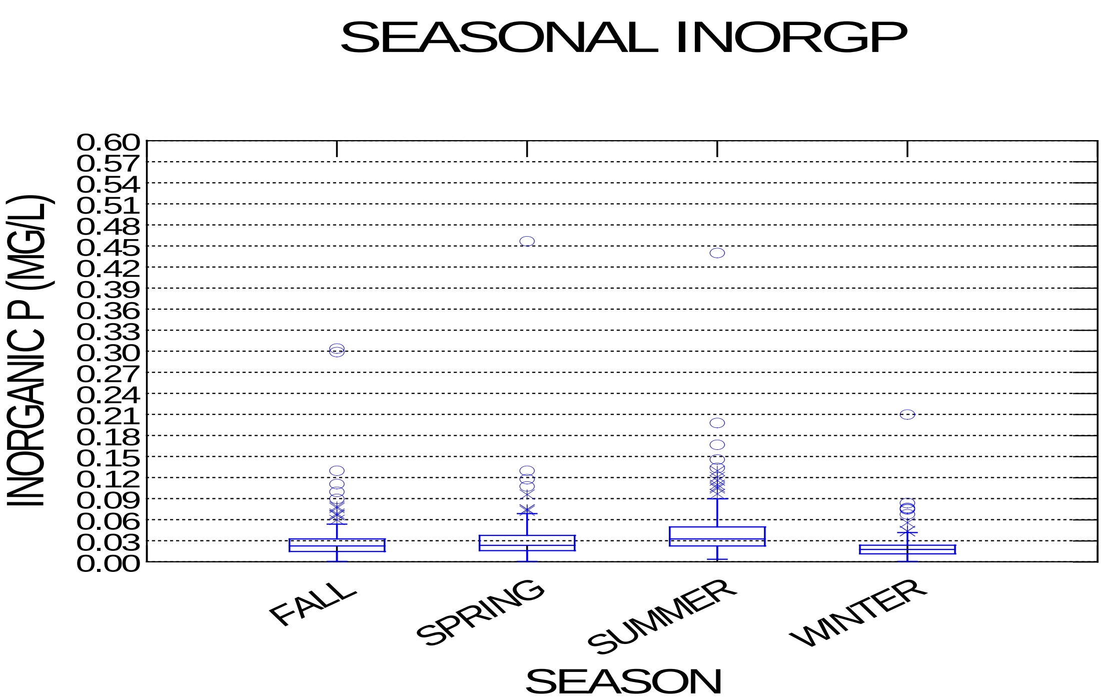

COLOR (PT-CO)
1500
1425
1350
1275
1200
1125
1050
975
900
825
750
675
600
525
450
375
300
225
150
75
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
YEAR

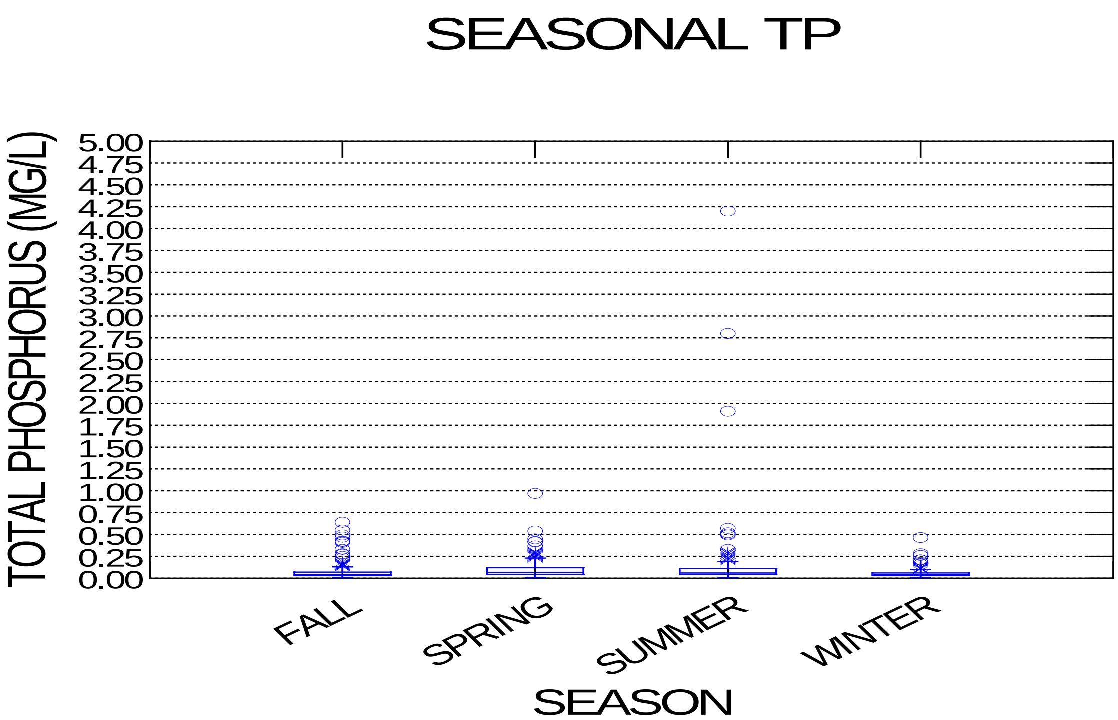

TSS (MG/L)
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012
YEAR

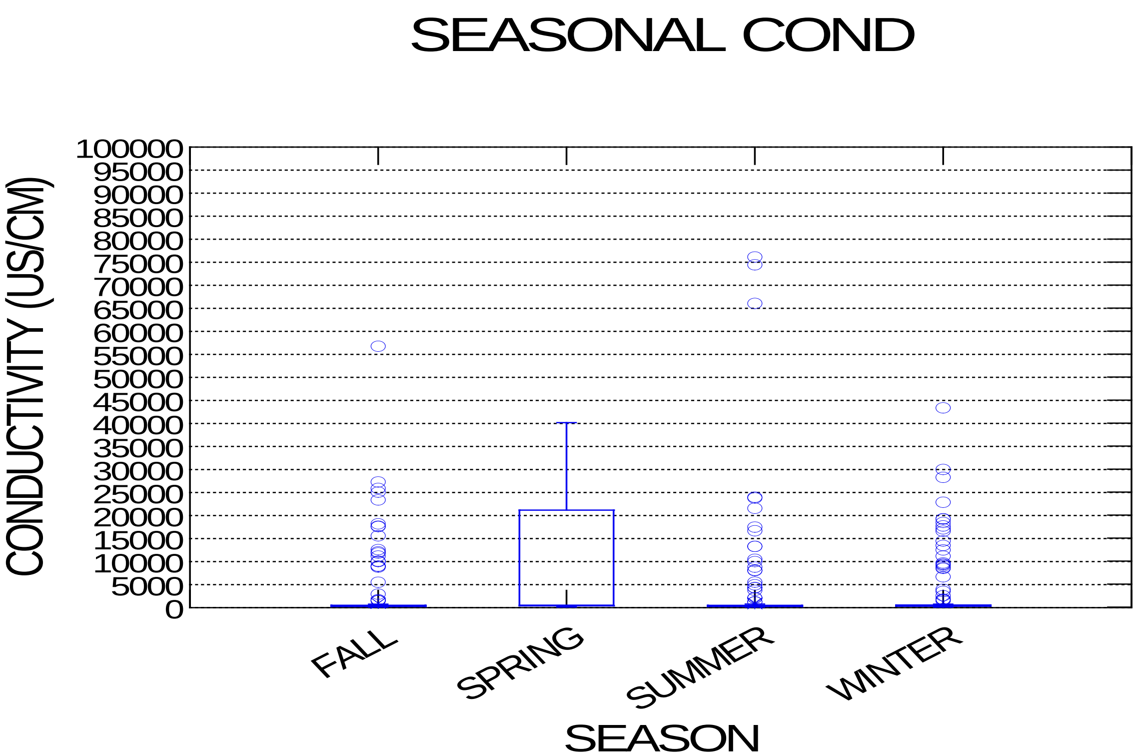

SEASONAL CHLAC
CHLAC (UG/L)
500
475
450
425
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
FALL
SPRING
SUMMER
WINTER
SEASON

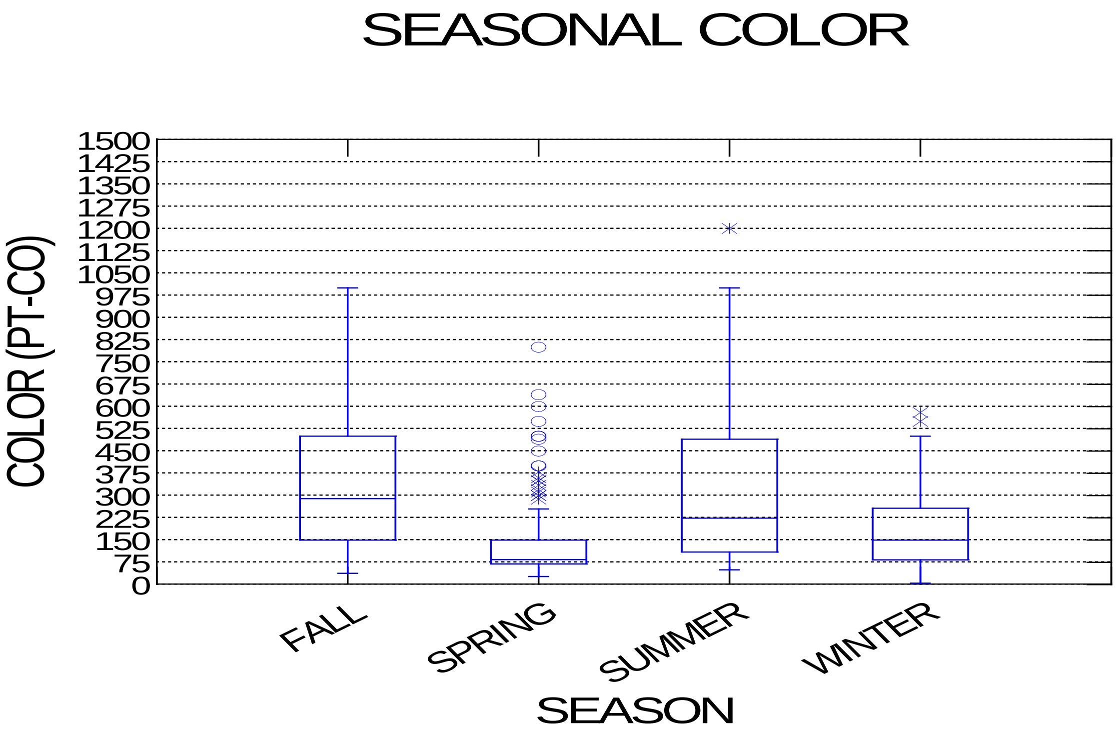

SEASONAL INORGN
INORGANIC N (MG/L)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
FALL
SPRING
SUMMER
WINTER
SEASON

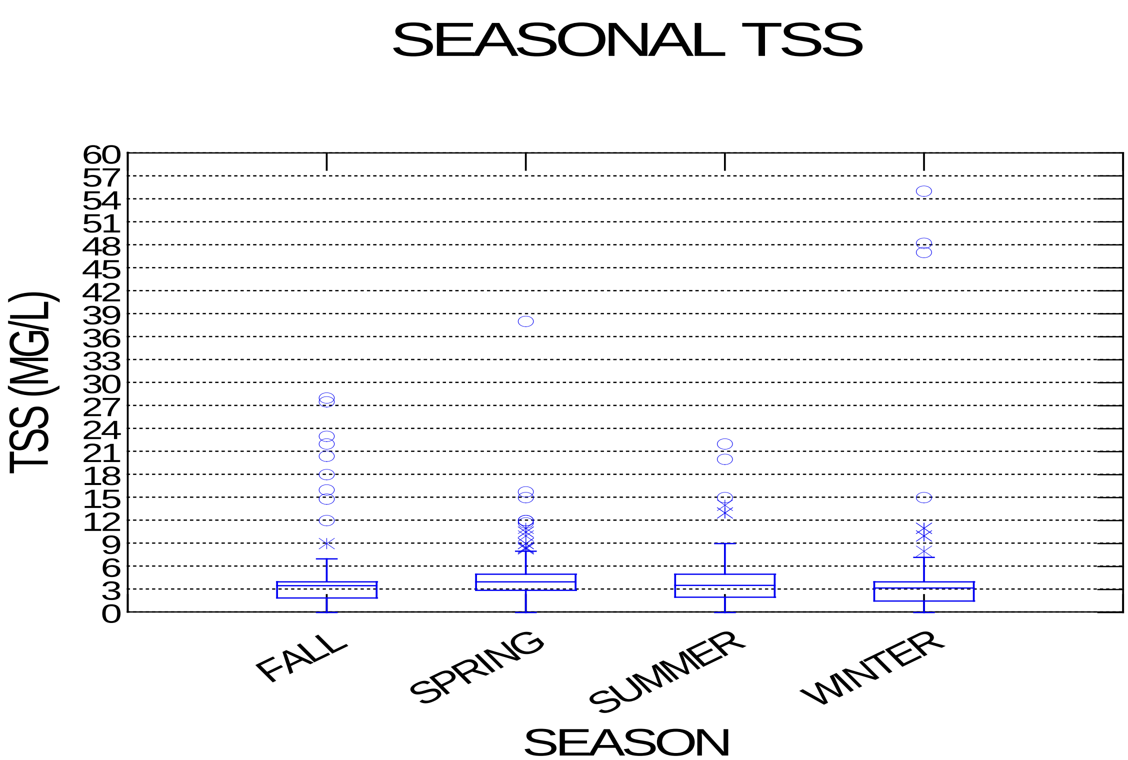

SEASONAL TN
TOTAL NITROGEN (MG/L)
6.0
5.7
5.4
5.1
4.8
4.5
4.2
3.9
3.6
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
0.0
FALL
SPRING
SUMMER
WINTER
SEASON

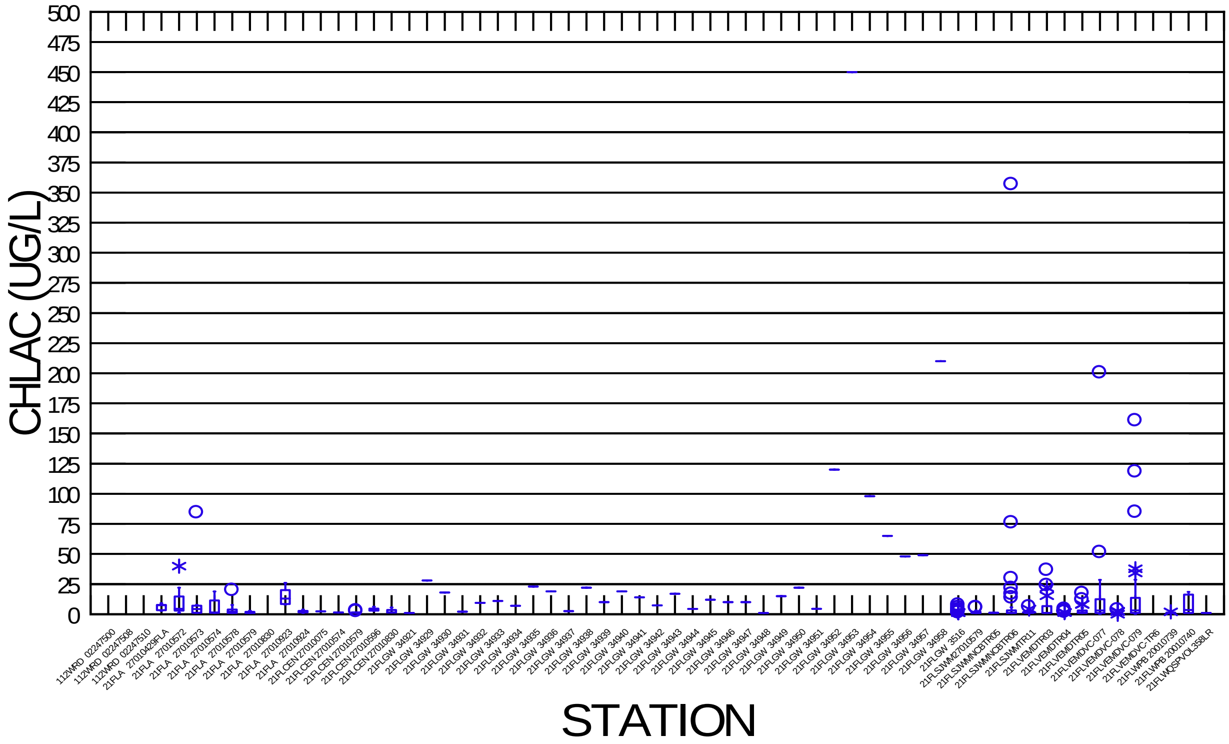

SEASONAL INORGP
INORGANIC P (MG/L)
0.60
0.57
0.54
0.51
0.48
0.45
0.42
0.39
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
FALL
SPRING
SUMMER
WINTER
SEASON

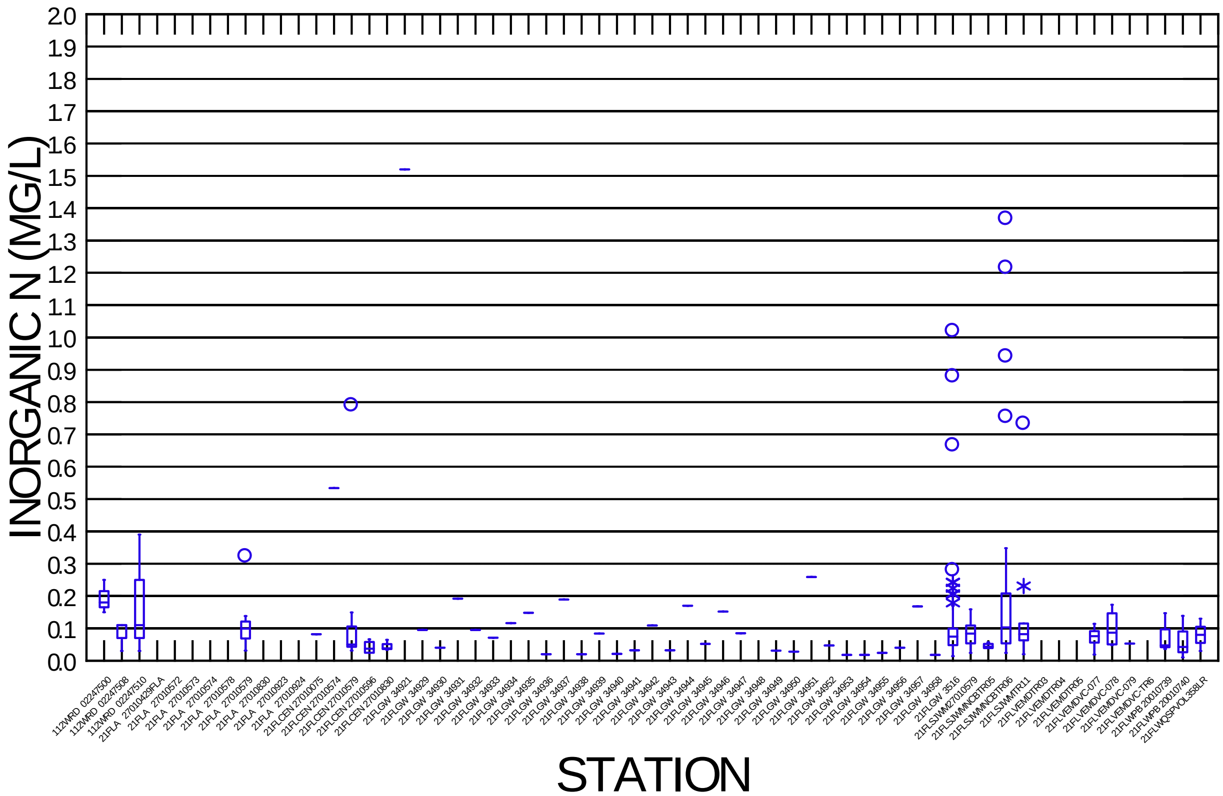

SEASONAL TP
TOTAL PHOSPHORUS (MG/L)
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
FALL
SPRING
SUMMER
WINTER
SEASON

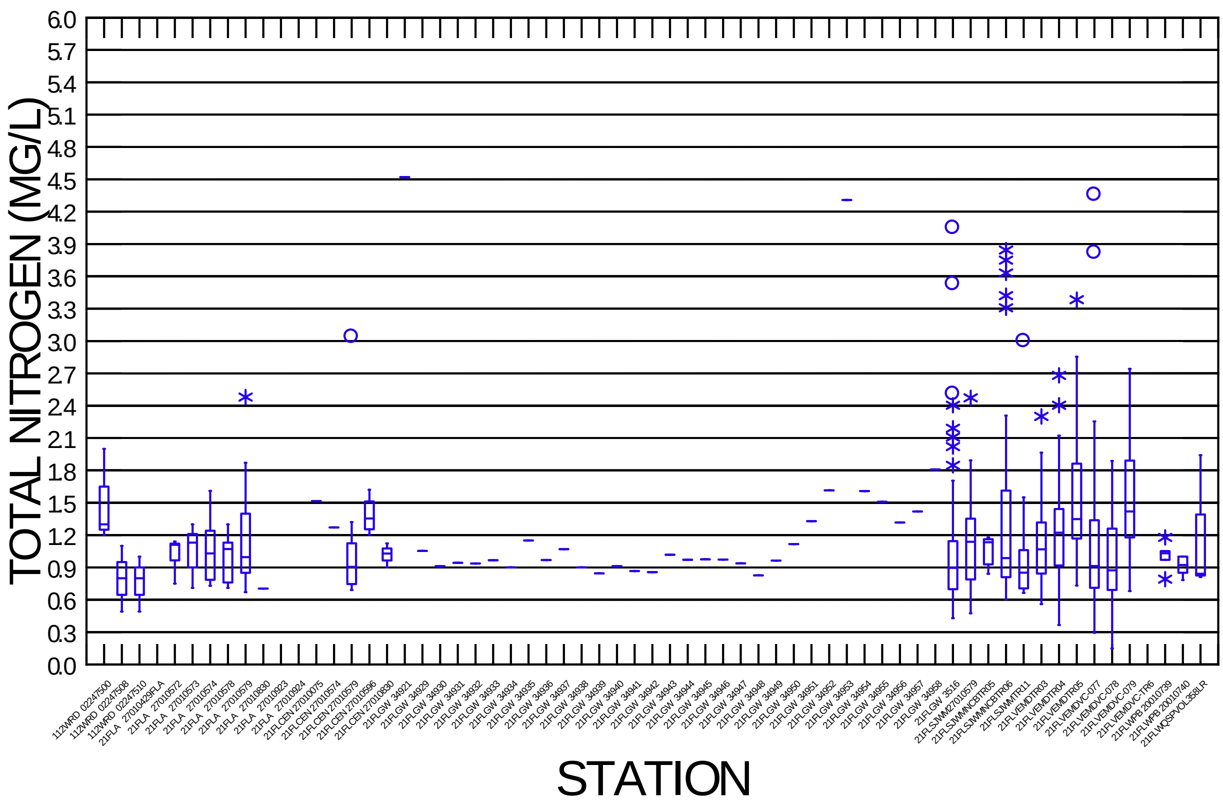

SEASONAL COND
CONDUCTIVITY (US/CM)
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
FALL
SPRING
SUMMER
WINTER
SEASON

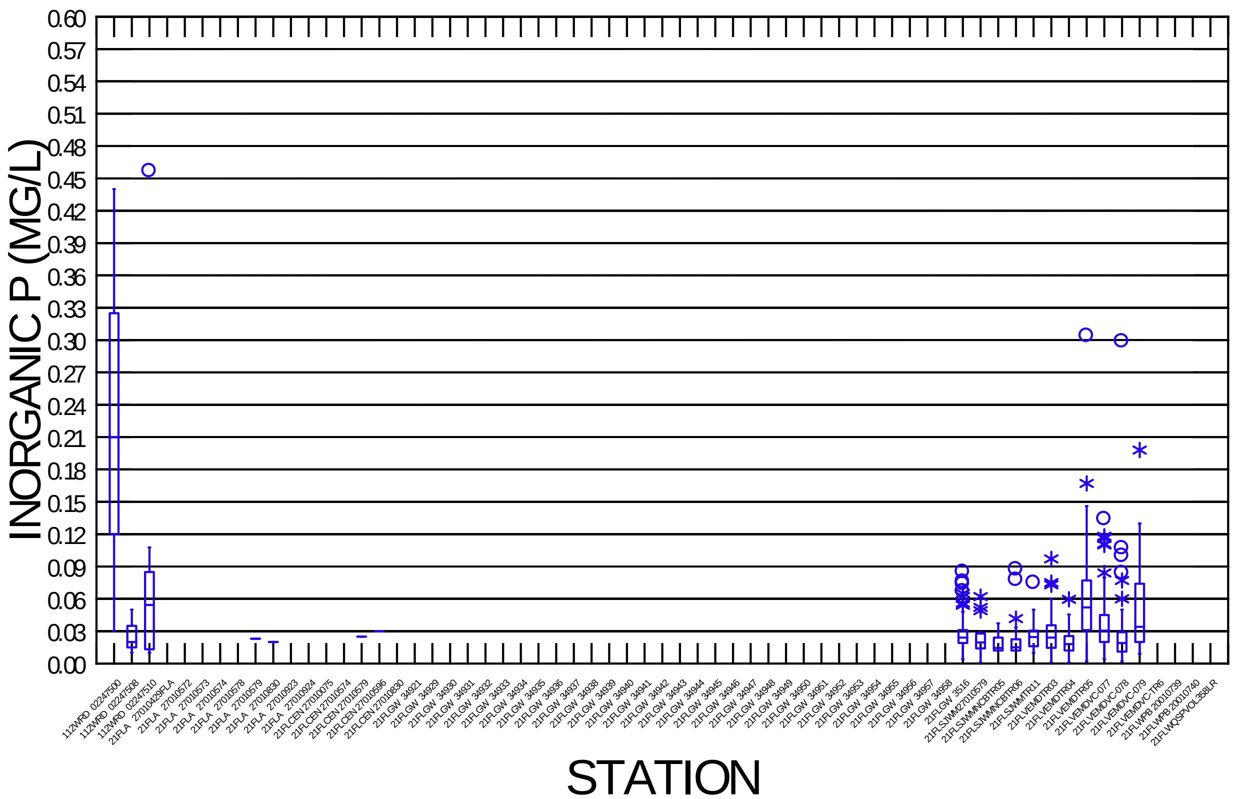

SEASONAL COLOR
COLOR (PT-CO)
1500
1425
1350
1275
1200
1125
1050
975
900
825
750
675
600
525
450
375
300
225
150
75
0
FALL
SPRING
SUMMER
WINTER
SEASON

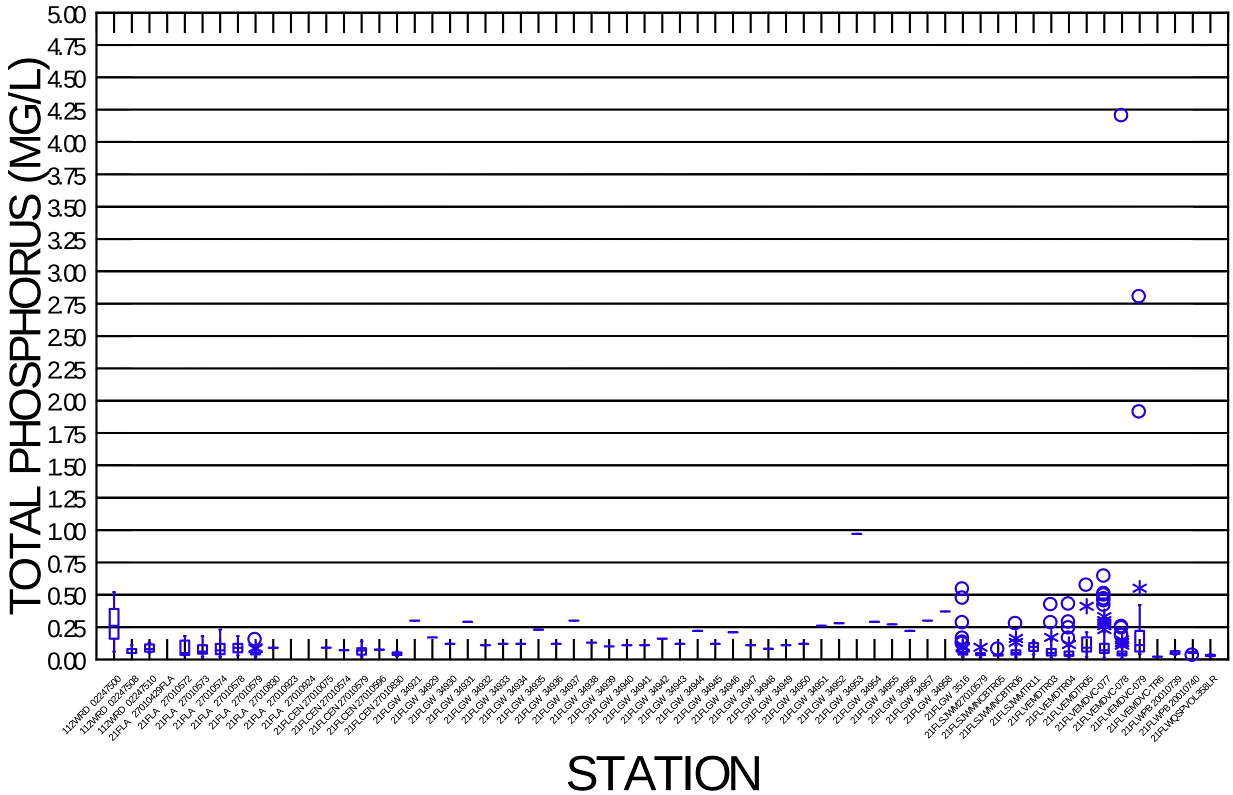

SEASONAL TSS
TSS (MG/L)
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
FALL
SPRING
SUMMER
WINTER
SEASON

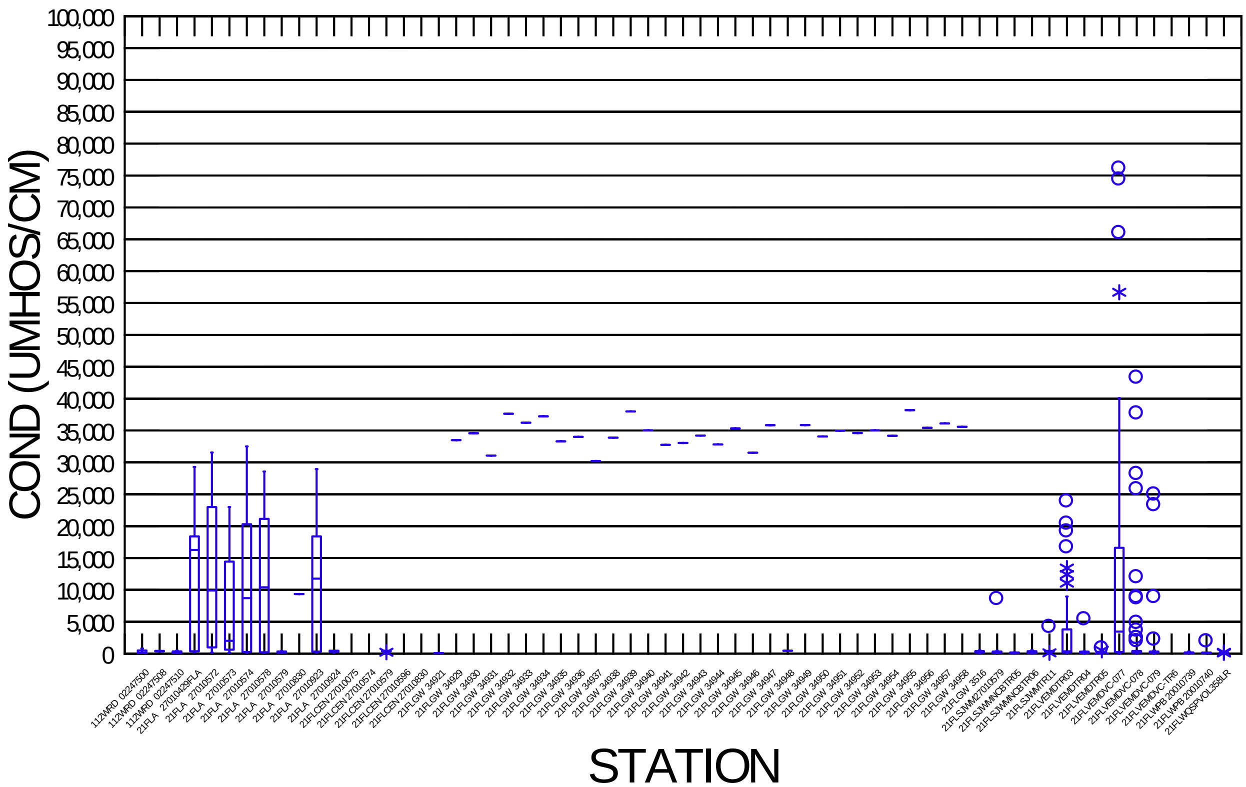

CHLAC (UG/L)
STATION

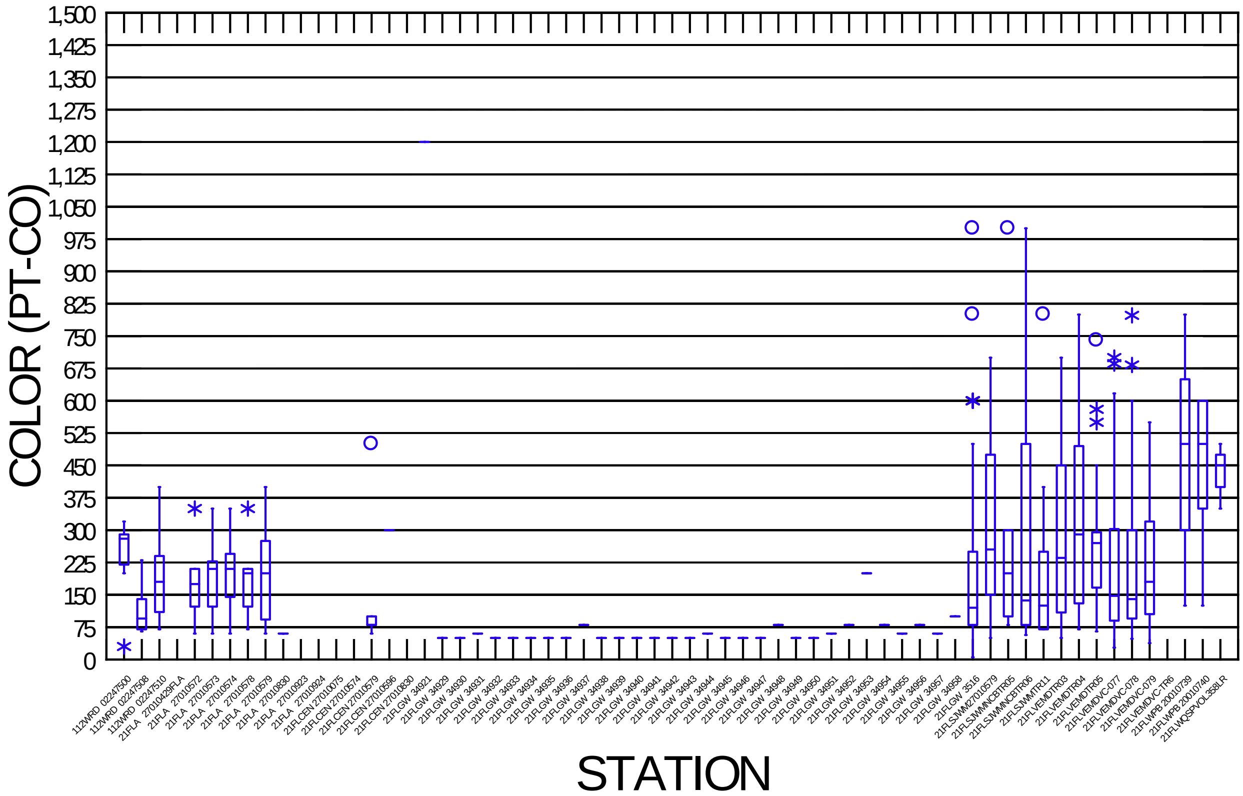

INORGANIC N (MG/L)
STATION

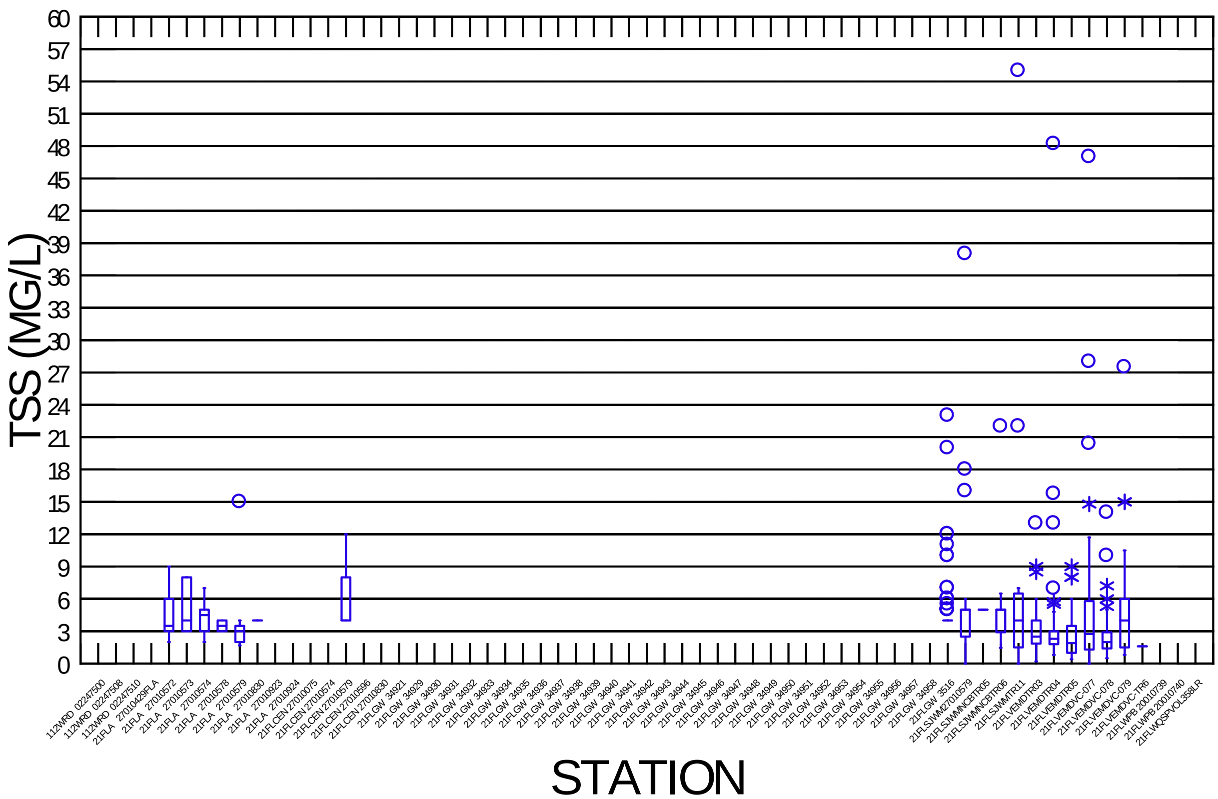

TOTAL NITROGEN (MG/L)
STATION


INORGANIC P (MG/L)
STATION

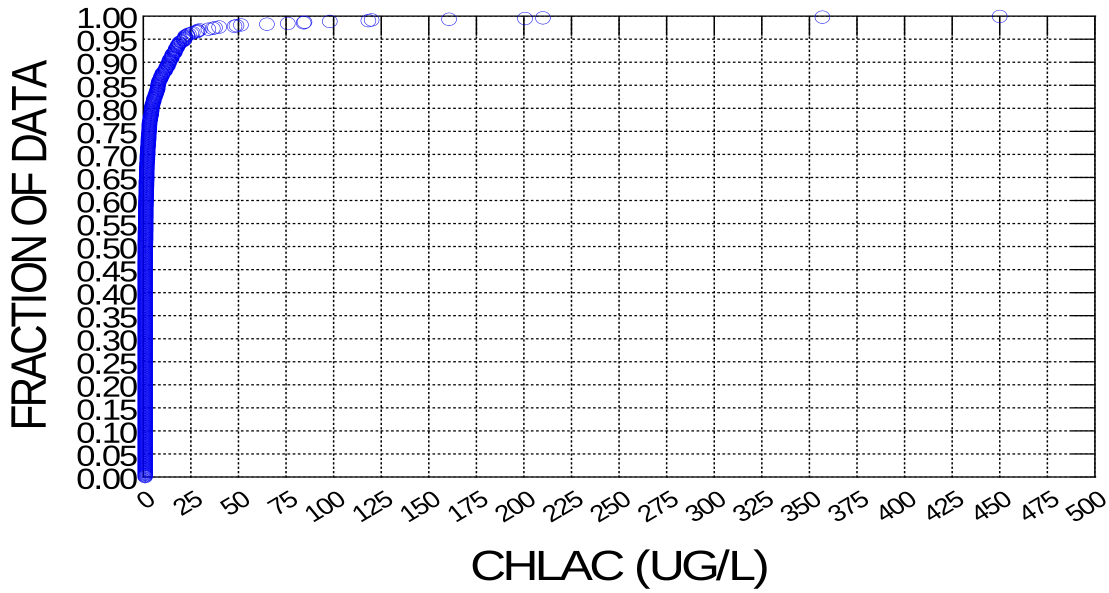

TOTAL PHOSPHORUS (MG/L)
5.00
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
STATION


COND (UMHOS/CM)
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
STATION

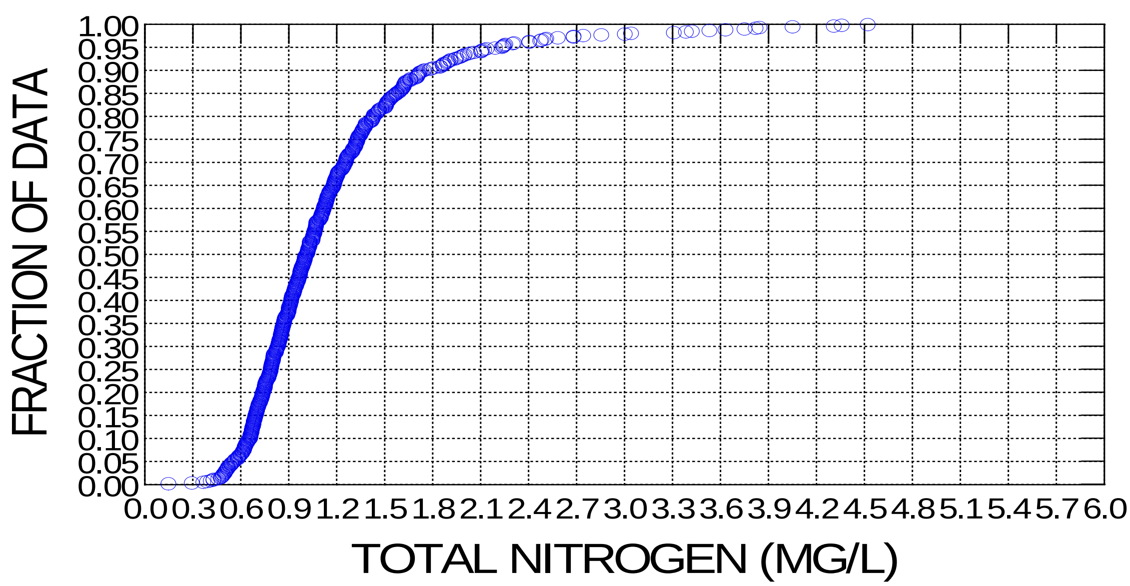

COLOR (PT-CO)
1,500
1,425
1,350
1,275
1,200
1,125
1,050
975
900
825
750
675
600
525
450
375
300
225
150
75
0
STATION

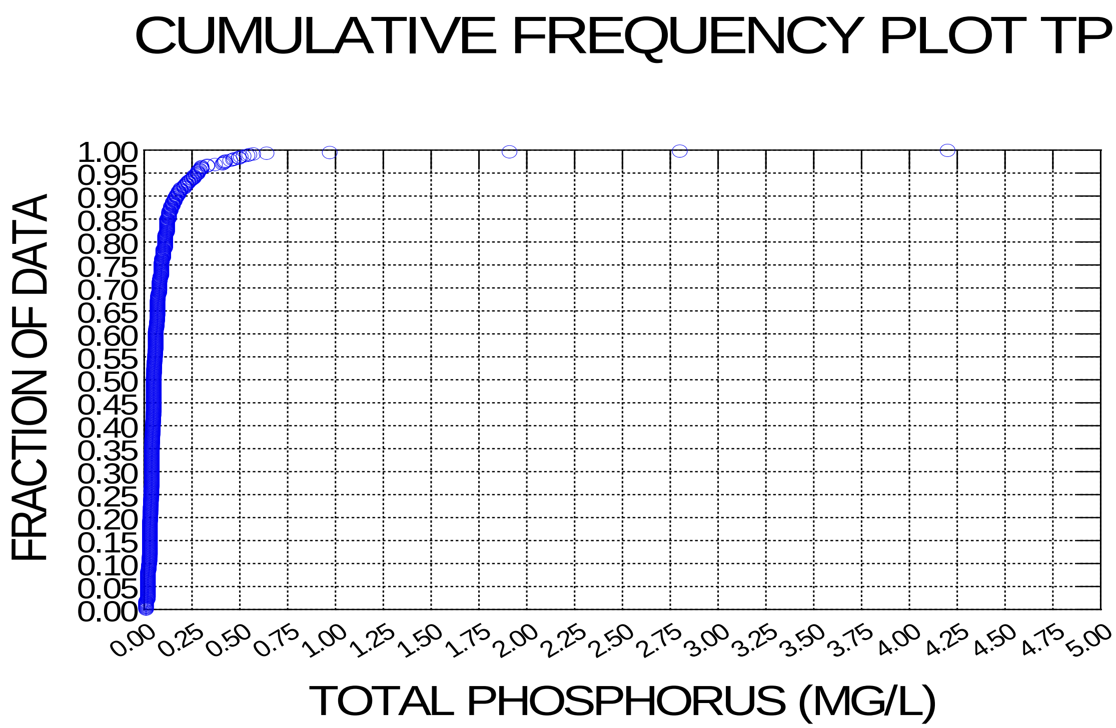

TSS (MG/L)
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
STATION

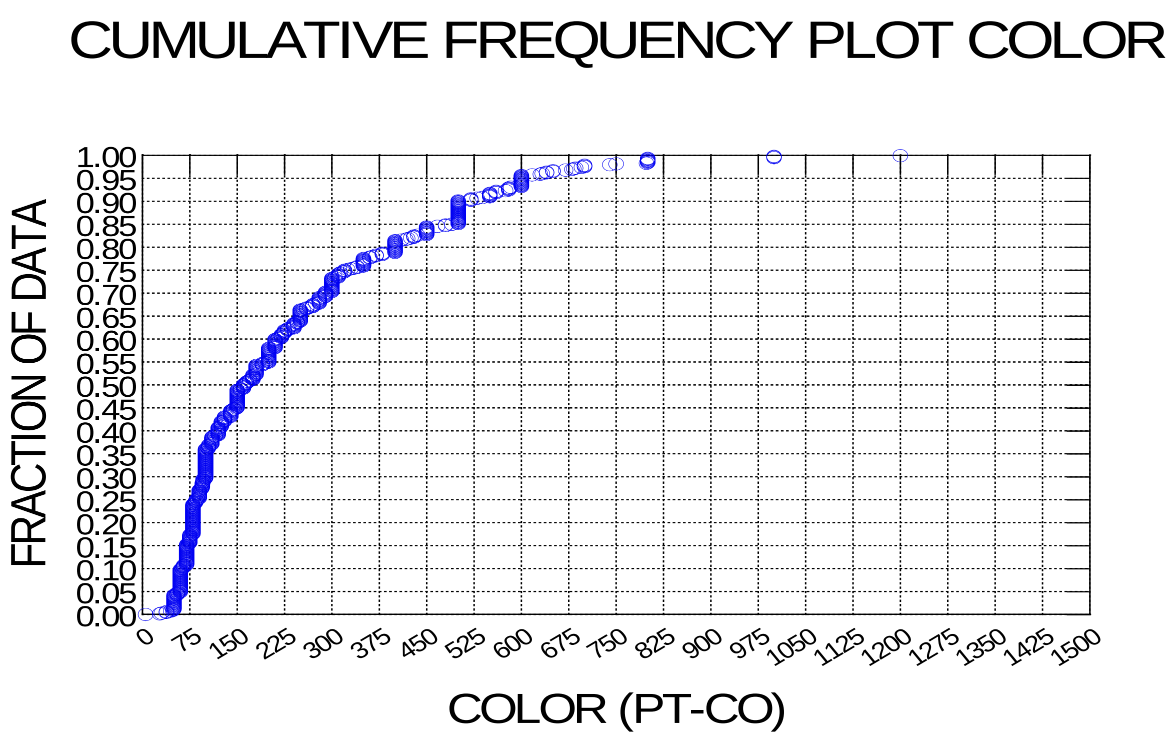
CUMULATIVE FREQUENCY PLOT CHLAC

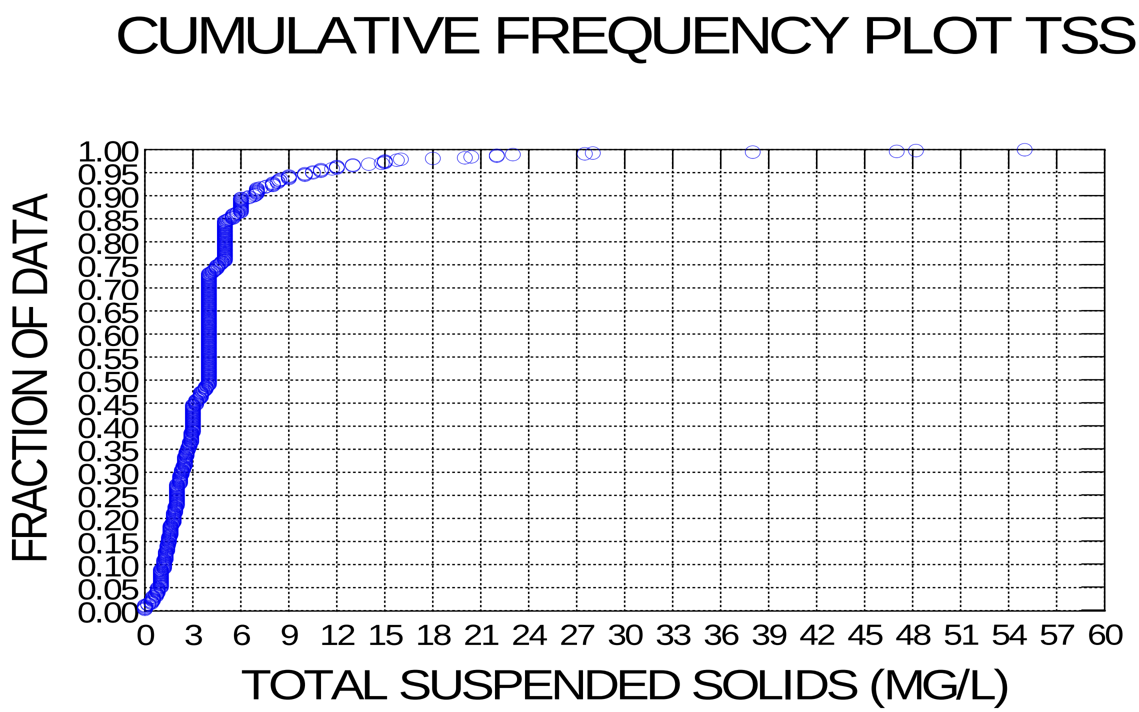


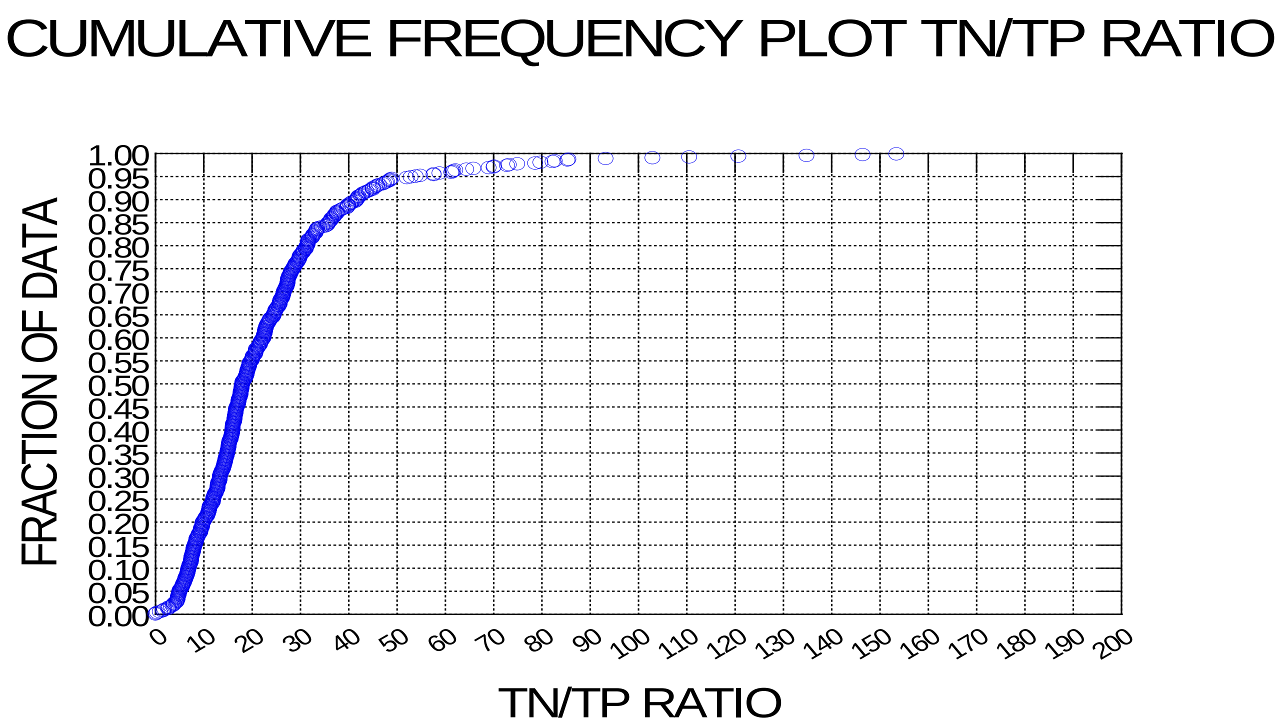
CUMULATIVE FREQUENCY PLOT TN



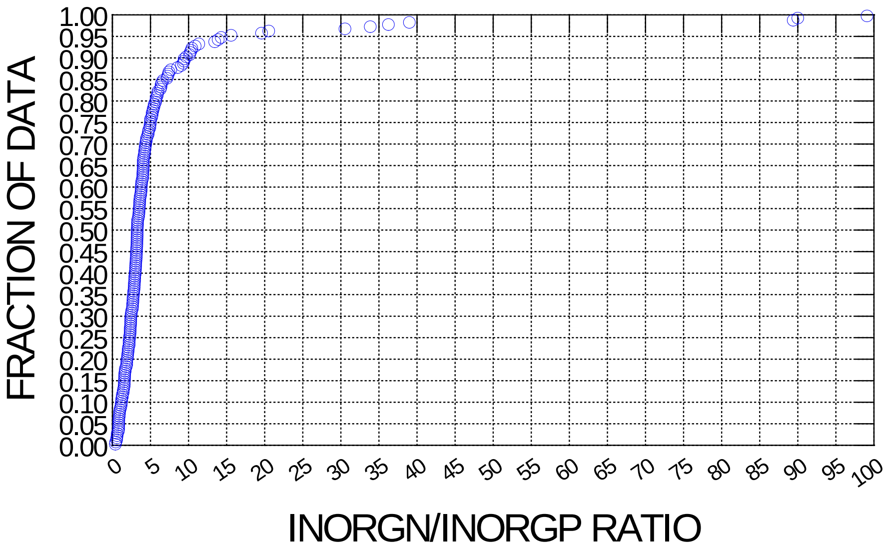

CUMULATIVE FREQUENCY PLOT TP
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00 3.25 3.50 3.75 4.00 4.25 4.50 4.75 5.00
TOTAL PHOSPHORUS (MG/L)


CUMULATIVE FREQUENCY PLOT COLOR
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 75 150 225 300 375 450 525 600 675 750 825 900 975 1050 1125 1200 1275 1350 1425 1500
COLOR (PT-CO)


CUMULATIVE FREQUENCY PLOT TSS
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60
TOTAL SUSPENDED SOLIDS (MG/L)


CUMULATIVE FREQUENCY PLOT TN/TP RATIO
FRACTION OF DATA
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
TN/TP RATIO

CUMULATIVE FREQUENCY PLOT INORGN/INORGP RATIO



Appendix G: Monthly and Annual Precipitation at Daytona International Airport, 1937–2011

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1937	2.22	4.73	4.14	2.69	2.59	2.96	5.64	7.72	7.96	5.69	7.43	1.52	55.29
1938	0.73	3.18	1.69	1.04	1.96	2.84	8.36	2.82	8.14	3.23	3.93	1.37	39.29
1939	1.09	0.45	1.48	5.29	2.4	6.96	9.53	5.78	7.67	2.83	0.45	1.16	45.09
1940	1.65	2.24	1.98	2.45	0.97	5.21	8.53	4.44	8.59	0.04	0.16	4.3	40.56
1941	3.42	4.4	2.01	3.11	1.32	7.29	11.46	6.56	2.86	13.68	7.47	3.72	67.3
1942	2.15	2.52	5.68	0.98	2.35	10.12	2.38	3.73	6.54	2.67	1.06	2.22	42.4
1943	1.51	0.18	6.57	2.86	3.09	4.35	11.01	10.47	11.71	7.14	0.55	0.67	60.11
1944	1.28	0.29	7.21	2.87	0.45	8.27	14.58	9.33	6.46	4.4	0.55	0.12	55.81
1945	3.62	0.88	0.41	1.53	1.56	7	7.45	6.83	9.65	5.14	0.79	4.5	49.36
1946	1.62	2.98	1.76	0.49	2.8	4.23	8.17	10.21	10.75	3.87	2.81	0.61	50.3
1947	0.78	6.04	5.29	5.31	4.82	13.43	8.65	6.97	5.75	5.72	1.98	0.9	65.64
1948	4.52	1.22	5.13	2.37	0.49	2.4	10.43	7.33	9.82	8.29	1.07	1.93	55
1949	0.37	1.95	2.01	7.12	1.4	4.24	5.97	11.46	6.26	3.65	1.86	3.93	50.22
1950	0.15	0.59	3.53	2.79	2.13	6.45	5.56	3.88	5.86	13	0.74	2.54	47.22
1951	0.77	2.46	1.18	3.28	2.53	2.66	3.8	4.19	14.02	8.54	3.15	2.88	49.46
1952	0.66	6.76	3.01	1.66	4.39	1.35	1.25	9.02	11.92	5.41	1.96	0.71	48.1
1953	1.75	3.35	7.75	4.97	1.46	1.37	8.67	19.89	10	12.93	2.3	4.85	79.29
1954	0.37	0.86	2.33	6.29	3.21	2.35	3.5	3.04	1.88	4.91	3.98	1.24	33.96
1955	2.47	1.43	1.84	1.78	1.55	7.76	5.67	2.64	6.66	3.17	2.61	1.22	38.8
1956	2.55	0.9	0.25	2.42	2.48	7.41	3.01	4.06	1.94	5.82	0.46	0.06	31.36
1957	0.97	1.62	3.13	1.73	5.65	4.23	10.53	4.01	10.65	1.8	0.82	1.34	46.48
1958	3.94	4.73	5.52	2.24	2.27	6.06	1.96	4	2.19	8.52	1.77	1.95	45.15
1959	4.53	2.13	7.7	3.17	2.4	8.13	5.68	3.6	5.26	7.12	4.26	2.26	56.24
1960	1.16	9.13	7.52	0.76	0.62	10.75	8.7	6.84	10.96	0.97	0.53	1.24	59.18
1961	1.96	3.7	1.17	2.16	2.39	6.81	5.16	7.68	3.2	2.25	2.85	0.73	40.06
1962	0.9	0.82	1.82	0.78	0.16	7.96	10.04	8.5	8.84	3.57	2.49	0.71	46.59
1963	2.91	5.83	1.46	1.4	6.82	7.42	6.89	2.01	5.43	2.71	7.98	2.17	53.03
1964	5.29	2.65	4.84	3.61	2.58	4.73	7.67	10.81	11.39	3.54	3.13	2.52	62.76
1965	2.22	3	3.05	1	0.08	9	3.72	2.97	4.33	3.65	0.97	2.14	36.13
1966	2.89	5.58	0.36	2.56	6.77	15.19	7.09	7.93	4.49	4.6	1.19	1.6	60.25
1967	1.26	3.98	0.31	0	0.73	7.51	9.04	3.02	5.56	0.19	0	2.98	34.58
1968	0.42	1.73	1.79	0.4	4.79	14.38	6.25	11.09	6.07	7.44	2.43	1.38	58.17
1969	1.53	2.03	2.74	0.12	6.47	2.47	2.61	9.4	8.89	6.97	1.96	5.03	50.22
1970	3.94	3.79	3.59	2.08	1.68	2.62	3.65	3.61	3.54	3.87	0.31	0.72	33.4
1971	0.61	5.48	2	2.57	3.12	4.73	3.2	3.97	7.2	9.53	1.33	2.49	46.23
1972	2.37	3.97	6.66	1.41	4.02	7.06	3.22	8.29	0.42	3.08	10.96	2.48	53.94
1973	4.66	2.02	2.63	3.09	2.41	4.32	4.69	7.58	5.14	4.4	0.75	2.54	44.23
1974	0.3	1.1	3.19	0.44	2.66	8.65	6.31	9.96	10.5	1.42	0.48	2.2	47.21
1975	1.66	2.27	1.52	2.96	2.99	9	6.89	3.16	6.61	5.84	1.46	0.83	45.19
1976	0.6	0.7	2.03	4.27	12.33	11.14	1.07	3.8	5.1	1.9	3.38	6	52.32

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1977	4.69	2.45	1.43	0.41	4.61	1.15	2.23	7.91	6.55	1.46	3.04	4.74	40.67
1978	2.89	5.98	2.31	3.3	0.56	7.48	5.53	7.99	4.63	8.31	0.07	4.89	53.94
1979	7.1	1.94	4.08	3.96	6.13	3.03	11.69	5.24	15.2	2.13	7.96	0.56	69.02
1980	3.75	0.76	2.41	2.54	3.62	5.57	5.82	4.13	1.83	2.42	3.12	1.39	37.36
1981	0.32	5.54	3	0.29	1.74	1.03	4.69	7.19	7.59	1.08	2.57	4.64	39.68
1982	2.46	2.08	5.81	6.04	4.68	8.29	5.31	3.21	4.96	3.23	1.58	2.53	50.18
1983	2.51	5.96	7.71	6.17	3.86	6.37	1.92	6.82	8.57	10.11	2.01	11.98	73.99
1984	1.46	3.44	1.31	5.29	6.04	2.84	6.77	4.02	10.73	1.09	3.52	0.2	46.71
1985	0.79	0.58	1.49	3.14	3.42	6.81	2.16	9.83	10.62	4.08	0.41	2.05	45.38
1986	7.16	1.28	1.85	0.44	0.99	3.5	14.43	3.47	3.58	3.47	5.08	2.76	48.01
1987	2.21	6.64	7.94	0.28	2.65	3.81	2.78	4.89	5.63	2.77	5.87	0.25	45.72
1988	5.36	1.72	4.57	1.68	1.78	2.39	2.94	4.79	6.81	1.24	6.7	0.93	40.91
1989	6.82	0.64	2.01	2.92	2.02	1.84	2.44	4.47	5.04	11.64	0.88	3.93	44.65
1990	1.42	5.61	1.94	1.48	1.45	2.71	5.85	7	1.61	5.88	0.83	0.34	36.12
1991	2.25	1.65	8.11	5.57	6.79	12.67	11.97	7.6	5.52	2.94	0.61	1.51	67.19
1992	2.42	1.71	2.28	2.81	3.13	10.64	0.16	8.86	6.57	5.21	2.15	0.47	46.41
1993	4.29	3.02	5.56	0.33	0.65	2.19	5.05	2.66	2.74	5.53	1.83	1.86	35.71
1994	5.6	2.66	3.44	5.05	3.09	6.54	6.91	7.08	5.93	4.72	12.91	2.71	66.64
1995	1.53	1.39	2.01	1.34	1.26	6.61	6.59	10.71	14.13	3.99	1.44	3.44	54.44
1996	5.53	1.32	12.15	2.22	2.28	11.35	1.9	5.7	3.92	11.15	0.96	2.01	60.49
1997	2.03	0.46	2.3	3.3	3.77	6.38	7.69	7.91	4.78	5.29	3.02	7.76	54.69
1998	4.33	7.25	3.97	0.14	0.16	0.83	5.63	7.56	5.79	1.84	1.66	1.35	40.51
1999	4.88	1.81	1.01	1.48	1.47	8.54	4.03	3.58	7.05	7.84	3.12	1.56	46.37
2000	1.8	0.65	8.48	1.15	0.32	3.08	5.09	3.17	13.55	0.93	1.14	0.8	40.16
2001	0.88	0.38	9.98	0.28	1.77	5.26	9.55	3.57	16.11	3.22	6.92	0.35	58.27
2002	2.01	2.76	1.51	2.53	1.66	12.3	7.35	11.56	3.86	2.94	1.85	9.61	59.94
2003	0.51	5.17	10.57	0.81	0.96	7.05	7.3	6.55	4.15	7.95	4.75	1.53	57.3
2004	1.25	4.47	1.1	1.19	0.49	5.2	10.34	17.96	16.46	1.34	0.93	2.24	62.97
2005	2.6	1.25	5.51	3.17	7.97	13.67	2.73	4.29	7.35	13.51	1.87	1.85	65.77
2006	0.24	4.33	0.08	1.11	0.78	5.72	4.48	4.81	2.97	2.53	1.1	3.21	31.36
2007	1.53	2.64	0.7	1.34	0.91	5.78	10.23	2.88	11.36	3.49	2.32	1.84	45.02
2008	1.3	2.12	3.2	1.34	0.63	3.64	9.48	10.33	4.29	4.45	0.96	0.93	42.67
2009	0.82	0.8	1.39	1.47	22.33	5.03	5.19	3.77	3.65	1.44	0.6	3.81	50.3
2010	5.92	3.92	6.2	1.04	4.74	2.86	3.88	5.83	3.49	0.18	0.95	0.38	39.39
2011	4.37	1.2	5.55	0.46	0.65	12.29	3.15	5.75	6.23	5.88	0.1	3.08	48.71
AVG	2.44	2.79	3.62	2.32	2.99	6.20	6.15	6.48	6.98	4.78	2.52	2.36	49.63

Rainfall is in inches, and represents data from DIA.

Appendix H: Spearman Correlation Matrix Analysis for Water Quality Parameters in Tomoka River

Spearman correlation matrix

	CHLAC	CHLORIDE	COLOR	COND	NH4
CHLAC	1.000				
CHLORIDE	-0.012	1.000			
COLOR	-0.326	-0.707	1.000		
COND	0.407	0.895	-0.682	1.000	
NH4	0.078	-0.194	0.212	-0.183	1.000
NO3O2	-0.174	0.142	0.093	0.006	0.324
SALINITY	0.446	0.920	-0.688	0.841	-0.203
SO4	0.007	0.483	-0.601	0.573	-0.188
TEMPC	0.381	-0.164	-0.024	0.135	0.174
TKN	0.110	-0.603	0.613	-0.344	0.386
TN	0.088	-0.582	0.615	-0.333	0.401
TOC	-0.022	-0.654	0.887	-0.756	0.373
TP	0.434	-0.046	-0.133	0.275	0.283
TSS	0.161	0.038	-0.210	0.124	-0.058
TURB	0.117	0.038	0.072	-0.025	0.032
INORGP	0.156	-0.224	0.093	0.021	0.049
INORGN	-0.062	-0.011	0.226	-0.115	0.745
PRECP	0.047	-0.053	0.068	0.006	-0.004
V3DAY	0.034	-0.254	0.104	-0.113	-0.066
V7DAY	0.059	-0.338	0.132	-0.181	-0.004
V14DAY	-0.028	-0.521	0.300	-0.344	0.013
V21DAY	-0.099	-0.611	0.430	-0.419	0.023

	NO3O2	SALINITY	SO4	TEMPC	TKN
NO3O2	1.000				
SALINITY	0.005	1.000			
SO4	0.067	0.604	1.000		
TEMPC	0.112	0.152	-0.143	1.000	
TKN	-0.040	-0.328	-0.568	0.200	1.000
TN	0.043	-0.327	-0.564	0.208	0.994
TOC	-0.044	-0.736	-0.570	0.108	0.837
TP	-0.084	0.275	-0.037	0.426	0.255
TSS	-0.022	0.062	-0.053	0.123	-0.023
TURB	0.101	-0.063	0.016	0.001	0.137
INORGP	0.000	0.023	-0.199	0.418	0.240
INORGN	0.796	-0.149	-0.075	0.169	0.246
PRECP	0.062	-0.039	0.112	0.147	0.086
V3DAY	-0.024	-0.132	0.085	0.128	0.072
V7DAY	-0.054	-0.165	0.106	0.192	0.074
V14DAY	-0.093	-0.319	-0.063	0.218	0.182
V21DAY	-0.082	-0.386	-0.127	0.204	0.274

Spearman correlation matrix (cont.)

	TN	TOC	TP	TSS	TURB
TN	1.000				
TOC	0.826	1.000			
TP	0.266	0.046	1.000		
TSS	-0.025	-0.018	0.235	1.000	
TURB	0.152	-0.124	0.155	0.366	1.000
INORGP	0.281	0.197	0.445	0.013	-0.022
INORGN	0.325	0.188	0.237	0.043	0.119
PRECP	0.099	0.021	0.063	-0.015	0.017
V3DAY	0.071	0.012	0.015	-0.048	0.087
V7DAY	0.068	0.009	0.077	-0.094	0.085
V14DAY	0.173	0.207	0.031	-0.158	0.052
V21DAY	0.273	0.340	0.001	-0.223	0.019

	INORGP	INORGN	PRECP	V3DAY	V7DAY
INORGP	1.000				
INORGN	0.176	1.000			
PRECP	0.091	0.059	1.000		
V3DAY	0.085	-0.015	0.565	1.000	
V7DAY	0.125	-0.088	0.307	0.615	1.000
V14DAY	0.226	-0.053	0.210	0.468	0.728
V21DAY	0.286	-0.055	0.188	0.423	0.633

	V14DAY	V21DAY
V14DAY	1.000	
V21DAY	0.860	1.000

Pairwise frequency table

	CHLAC	CHLORIDE	COLOR	COND	NH4
CHLAC	653				
CHLORIDE	180	224			
COLOR	612	222	670		
COND	622	211	644	690	
NH4	291	197	298	286	312
NO3O2	616	199	630	612	308
SALINITY	558	141	544	573	227
SO4	178	221	221	208	197
TEMPC	649	198	641	675	304
TKN	620	199	634	617	311
TN	596	199	609	596	309
TOC	178	177	182	180	180
TP	615	197	630	613	308
TSS	558	183	572	563	237
TURB	611	188	624	620	285
INORGP	484	158	510	494	206
INORGN	284	197	290	278	304
PRECP	653	224	670	690	312
V3DAY	653	224	670	690	312
V7DAY	653	224	670	690	312
V14DAY	653	224	670	690	312
V21DAY	653	224	670	690	312

	NO3O2	SALINITY	SO4	TEMPC	TKN
NO3O2	649				
SALINITY	537	587			
SO4	199	140	222		
TEMPC	638	587	196	738	
TKN	640	542	199	643	654
TN	623	517	199	618	626
TOC	182	138	176	181	182
TP	629	537	197	639	640
TSS	562	507	182	575	569
TURB	617	549	188	636	624
INORGP	505	438	156	504	501
INORGN	304	224	197	296	304
PRECP	649	587	222	738	654
V3DAY	649	587	222	738	654
V7DAY	649	587	222	738	654
V14DAY	649	587	222	738	654
V21DAY	649	587	222	738	654

Pairwise frequency table (cont.)

	TN	TOC	TP	TSS	TURB
TN	628				
TOC	182	182			
TP	613	178	649		
TSS	544	179	564	579	
TURB	597	177	617	574	642
INORGP	480	139	493	492	493
INORGN	304	180	300	234	278
PRECP	628	182	649	579	642
V3DAY	628	182	649	579	642
V7DAY	628	182	649	579	642
V14DAY	628	182	649	579	642
V21DAY	628	182	649	579	642

	INORGP	INORGN	PRECP	V3DAY	V7DAY
INORGP	516				
INORGN	203	304			
PRECP	516	304	771		
V3DAY	516	304	771	771	
V7DAY	516	304	771	771	771
V14DAY	516	304	771	771	771
V21DAY	516	304	771	771	771

	V14DAY	V21DAY
V14DAY	771	
V21DAY	771	771

Appendix I: Linear Regression Analysis of CHLAC Observations versus COND, SALINITY, TEMPC, Nutrients, TSS, TURBIDITY, V14DAY, V21DAY, and FLOW in Tomoka River

Dep Var: CHLAC N: 622 Multiple R: 0.269 Squared multiple R: 0.073

Adjusted squared multiple R: 0.071 Standard error of estimate: 26.902

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.600	1.172	0.000	.	3.072	0.002
COND	0.001	0.000	0.269	1.000	6.967	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	35134.003	1	35134.003	48.546	0.000
Residual	448711.787	620	723.729		

*** WARNING ***
Case 97 is an outlier (Studentized Residual = 15.456)
Case 410 is an outlier (Studentized Residual = 4.316)
Case 451 has large leverage (Leverage = 0.041)
Case 487 has large leverage (Leverage = 0.076)
Case 497 has large leverage (Leverage = 0.057)
Case 499 has large leverage (Leverage = 0.073)
Case 525 is an outlier (Studentized Residual = 7.140)
Case 574 is an outlier (Studentized Residual = 20.389)
Case 577 is an outlier (Studentized Residual = 7.040)

Durbin-Watson D Statistic 2.040
First Order Autocorrelation -0.020

Dep Var: CHLAC N: 558 Multiple R: 0.309 Squared multiple R: 0.095

Adjusted squared multiple R: 0.094 Standard error of estimate: 28.004

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.562	1.287	0.000	.	2.767	0.006
SALINITY	1.540	0.201	0.309	1.000	7.651	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	45910.254	1	45910.254	58.544	0.000
Residual	436019.270	556	784.207		

*** WARNING ***
Case 97 is an outlier (Studentized Residual = 14.936)
Case 410 is an outlier (Studentized Residual = 4.150)
Case 525 is an outlier (Studentized Residual = 6.751)
Case 574 is an outlier (Studentized Residual = 19.195)
Case 577 is an outlier (Studentized Residual = 6.433)

Durbin-Watson D Statistic 2.066
First Order Autocorrelation -0.035

Dep Var: CHLAC   N: 649   Multiple R: 0.191   Squared multiple R: 0.036

Adjusted squared multiple R: 0.035   Standard error of estimate: 26.869

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-14.559	4.420	0.000	.	-3.294	0.001
TEMPC	0.989	0.200	0.191	1.000	4.944	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	17644.051	1	17644.051	24.439	0.000
Residual	467110.255	647	721.963		

*** WARNING ***
Case 97 is an outlier (Studentized Residual = 15.070)
Case 410 is an outlier (Studentized Residual = 4.149)
Case 525 is an outlier (Studentized Residual = 7.270)
Case 574 is an outlier (Studentized Residual = 21.058)
Case 577 is an outlier (Studentized Residual = 7.577)

Durbin-Watson D Statistic 1.923
First Order Autocorrelation 0.038

Dep Var: CHLAC   N: 616   Multiple R: 0.095   Squared multiple R: 0.009

Adjusted squared multiple R: 0.007   Standard error of estimate: 28.610

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.213	1.473	0.000	.	6.256	0.000
NO3O2	-43.746	18.414	-0.095	1.000	-2.376	0.018

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4619.881	1	4619.881	5.644	0.018
Residual	502582.416	614	818.538		

*** WARNING ***
Case 76 has large leverage (Leverage = 0.031)
Case 97 is an outlier (Studentized Residual = 14.009)
Case 115 has large leverage (Leverage = 0.138)
Case 251 has large leverage (Leverage = 0.132)
Case 267 has large leverage (Leverage = 0.039)
Case 275 has large leverage (Leverage = 0.048)
Case 525 is an outlier (Studentized Residual = 6.954)
Case 574 is an outlier (Studentized Residual = 19.719)
Case 577 is an outlier (Studentized Residual = 7.335)
Case 652 is an outlier (Studentized Residual = 5.439)
Case 660 has large leverage (Leverage = 0.146)
Case 666 has large leverage (Leverage = 0.086)

Durbin-Watson D Statistic 1.883
First Order Autocorrelation 0.058

Dep Var: CHLAC   N: 596   Multiple R: 0.307   Squared multiple R: 0.095

Adjusted squared multiple R: 0.093   Standard error of estimate: 27.073

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-10.302	2.438	0.000	.	-4.225	0.000
TN	14.861	1.887	0.307	1.000	7.876	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	45464.141	1	45464.141	62.027	0.000
Residual	435384.499	594	732.971		

*** WARNING ***
Case 61 has large leverage (Leverage = 0.032)
Case 66 has large leverage (Leverage = 0.057)
Case 76 has large leverage (Leverage = 0.034)
Case 91 has large leverage (Leverage = 0.043)
Case 97 is an outlier (Studentized Residual = 13.539)
Case 115 has large leverage (Leverage = 0.037)
Case 486 has large leverage (Leverage = 0.052)
Case 525 is an outlier (Studentized Residual = 6.984)
Case 552 has large leverage (Leverage = 0.036)
Case 574 has large leverage (Leverage = 0.050)
Case 574 is an outlier (Studentized Residual = 19.053)
Case 577 is an outlier (Studentized Residual = 7.482)

Durbin-Watson D Statistic 1.787
First Order Autocorrelation 0.106

Dep Var: CHLAC   N: 615   Multiple R: 0.269   Squared multiple R: 0.072

Adjusted squared multiple R: 0.071   Standard error of estimate: 27.698

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.713	1.211	0.000	.	3.065	0.002
TP	33.296	4.820	0.269	1.000	6.908	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	36610.857	1	36610.857	47.722	0.000
Residual	470271.200	613	767.163		

*** WARNING ***
Case 97 is an outlier (Studentized Residual = 14.372)
Case 245 has large leverage (Leverage = 0.223)
Case 525 is an outlier (Studentized Residual = 6.979)
Case 574 is an outlier (Studentized Residual = 19.108)
Case 577 is an outlier (Studentized Residual = 7.311)
Case 636 has large leverage (Leverage = 0.511)
Case 636 is an outlier (Studentized Residual = -7.614)
Case 636 has large influence (Cook distance = 27.751)
Case 652 has large leverage (Leverage = 0.101)

Durbin-Watson D Statistic 1.908
First Order Autocorrelation 0.046

Dep Var: CHLAC   N: 558   Multiple R: 0.254   Squared multiple R: 0.065

Adjusted squared multiple R: 0.063   Standard error of estimate: 18.926

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.572	1.064	0.000	.	0.537	0.591
TSS	1.000	0.161	0.254	1.000	6.194	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	13742.446	1	13742.446	38.368	0.000
Residual	199146.513	556	358.177		

*** WARNING ***
Case 72 has large leverage (Leverage = 0.043)
Case 97 is an outlier (Studentized Residual = 27.413)
Case 244 has large leverage (Leverage = 0.041)
Case 289 has large leverage (Leverage = 0.134)
Case 376 has large leverage (Leverage = 0.142)
Case 410 is an outlier (Studentized Residual = 5.603)
Case 525 is an outlier (Studentized Residual = 10.488)
Case 535 is an outlier (Studentized Residual = 4.063)
Case 626 has large leverage (Leverage = 0.084)
Case 644 has large leverage (Leverage = 0.188)

Durbin-Watson D Statistic 1.911
First Order Autocorrelation 0.043

Dep Var: CHLAC   N: 611   Multiple R: 0.190   Squared multiple R: 0.036

Adjusted squared multiple R: 0.035   Standard error of estimate: 28.324

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.664	1.348	0.000	.	2.718	0.007
TURB	0.893	0.187	0.190	1.000	4.785	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	18368.330	1	18368.330	22.896	0.000
Residual	488568.568	609	802.247		

*** WARNING ***
Case 97 is an outlier (Studentized Residual = 13.880)
Case 246 has large leverage (Leverage = 0.062)
Case 289 has large leverage (Leverage = 0.281)
Case 376 has large leverage (Leverage = 0.154)
Case 525 is an outlier (Studentized Residual = 6.704)
Case 547 has large leverage (Leverage = 0.072)
Case 574 is an outlier (Studentized Residual = 19.517)
Case 577 is an outlier (Studentized Residual = 7.313)
Case 644 has large leverage (Leverage = 0.215)
Case 652 is an outlier (Studentized Residual = 4.897)

Durbin-Watson D Statistic 1.870
First Order Autocorrelation 0.065

Dep Var: CHLAC N: 653 Multiple R: 0.090 Squared multiple R: 0.008

Adjusted squared multiple R: 0.007 Standard error of estimate: 27.834

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	9.335	1.520	0.000	.	6.143	0.000
V14DAY	-1.263	0.546	-0.090	1.000	-2.315	0.021

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4150.933	1	4150.933	5.358	0.021
Residual	504361.304	651	774.749		

*** WARNING ***
Case 16 has large leverage (Leverage = 0.039)
Case 77 has large leverage (Leverage = 0.039)
Case 97 is an outlier (Studentized Residual = 14.374)
Case 525 is an outlier (Studentized Residual = 7.155)
Case 574 is an outlier (Studentized Residual = 20.281)
Case 577 is an outlier (Studentized Residual = 7.559)
Case 594 has large leverage (Leverage = 0.039)
Case 595 has large leverage (Leverage = 0.039)
Case 652 is an outlier (Studentized Residual = 5.581)

Durbin-Watson D Statistic 1.875
First Order Autocorrelation 0.062

Dep Var: CHLAC N: 653 Multiple R: 0.105 Squared multiple R: 0.011

Adjusted squared multiple R: 0.009 Standard error of estimate: 27.795

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	10.004	1.591	0.000	.	6.288	0.000
V21DAY	-1.076	0.400	-0.105	1.000	-2.688	0.007

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	5582.036	1	5582.036	7.225	0.007
Residual	502930.202	651	772.550		

*** WARNING ***
Case 77 has large leverage (Leverage = 0.074)
Case 97 is an outlier (Studentized Residual = 14.370)
Case 525 is an outlier (Studentized Residual = 7.191)
Case 574 is an outlier (Studentized Residual = 20.303)
Case 577 is an outlier (Studentized Residual = 7.557)
Case 652 is an outlier (Studentized Residual = 5.563)

Durbin-Watson D Statistic 1.884
First Order Autocorrelation 0.058

Dep Var: CHLAC   N: 653   Multiple R: 0.099   Squared multiple R: 0.010

Adjusted squared multiple R: 0.008   Standard error of estimate: 27.811

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	8.491	1.260	0.000	.	6.741	0.000
FLOW	-0.032	0.013	-0.099	1.000	-2.537	0.011

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4977.252	1	4977.252	6.435	0.011
Residual	503534.985	651	773.479		

*** WARNING ***
Case 56 has large leverage (Leverage = 0.121)
Case 57 has large leverage (Leverage = 0.121)
Case 61 has large leverage (Leverage = 0.075)
Case 62 has large leverage (Leverage = 0.075)
Case 63 has large leverage (Leverage = 0.075)
Case 122 is an outlier (Studentized Residual = 5.609)
Case 127 has large leverage (Leverage = 0.038)
Case 128 has large leverage (Leverage = 0.038)
Case 129 has large leverage (Leverage = 0.038)
Case 162 is an outlier (Studentized Residual = 7.178)
Case 278 has large leverage (Leverage = 0.080)
Case 279 has large leverage (Leverage = 0.080)
Case 444 has large leverage (Leverage = 0.029)
Case 445 has large leverage (Leverage = 0.029)
Case 538 has large leverage (Leverage = 0.032)
Case 638 is an outlier (Studentized Residual = 20.299)
Case 639 is an outlier (Studentized Residual = 7.561)
Case 647 has large leverage (Leverage = 0.029)
Case 705 is an outlier (Studentized Residual = 14.396)

Durbin-Watson D Statistic 1.322
First Order Autocorrelation 0.339

Appendix J: Linear Regression Analysis of Annual Average CHLAC Observations versus COND, SALINITY, TEMPC, Nutrients, Rainfall, Rainfall Deficits, and Annual Stream Flow in Tomoka River

Dep Var: CHLAC N: 20 Multiple R: 0.562 Squared multiple R: 0.315

Adjusted squared multiple R: 0.277 Standard error of estimate: 3.219

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.422	1.376	0.000	.	1.033	0.315
COND	0.001	0.000	0.562	1.000	2.880	0.010

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	85.926	1	85.926	8.292	0.010
Residual	186.523	18	10.362		

*** WARNING ***
Case 2 is an outlier (Studentized Residual = 2.754)

Durbin-Watson D Statistic 0.965
First Order Autocorrelation 0.466

Dep Var: CHLAC N: 16 Multiple R: 0.680 Squared multiple R: 0.462

Adjusted squared multiple R: 0.423 Standard error of estimate: 2.286

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.172	0.977	0.000	.	1.200	0.250
INORGN	23.144	6.677	0.680	1.000	3.466	0.004

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	62.759	1	62.759	12.014	0.004
Residual	73.135	14	5.224		

*** WARNING ***
Case 17 has large leverage (Leverage = 0.746)
Case 18 is an outlier (Studentized Residual = 6.378)

Durbin-Watson D Statistic 1.291
First Order Autocorrelation 0.304

Dep Var: CHLAC N: 16 Multiple R: 0.692 Squared multiple R: 0.479

Adjusted squared multiple R: 0.441 Standard error of estimate: 2.249

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.059	0.765	0.000	.	2.691	0.018
NH4	31.313	8.733	0.692	1.000	3.586	0.003

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	65.056	1	65.056	12.857	0.003
Residual	70.839	14	5.060		

*** WARNING ***
Case 17 has large leverage (Leverage = 0.751)
Case 18 is an outlier (Studentized Residual = 5.860)

Durbin-Watson D Statistic 1.238
First Order Autocorrelation 0.311

Dep Var: CHLAC N: 20 Multiple R: 0.177 Squared multiple R: 0.031

Adjusted squared multiple R: 0.000 Standard error of estimate: 3.829

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.353	2.081	0.000	.	1.611	0.125
NO3O2	28.355	37.158	0.177	1.000	0.763	0.455

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	8.537	1	8.537	0.582	0.455
Residual	263.911	18	14.662		

*** WARNING ***
Case 2 is an outlier (Studentized Residual = 3.334)
Case 17 has large leverage (Leverage = 0.657)

Durbin-Watson D Statistic 0.673
First Order Autocorrelation 0.571

Dep Var: CHLAC N: 20 Multiple R: 0.742 Squared multiple R: 0.550

Adjusted squared multiple R: 0.525 Standard error of estimate: 2.609

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.651	0.889	0.000	.	1.857	0.080
SALINITY	2.176	0.464	0.742	1.000	4.693	0.000

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	149.922	1	149.922	22.025	0.000
Residual	122.526	18	6.807		

*** WARNING ***
Case 17 has large leverage (Leverage = 0.398)

Durbin-Watson D Statistic 0.600
First Order Autocorrelation 0.542

Dep Var: CHLAC N: 20 Multiple R: 0.401 Squared multiple R: 0.161

Adjusted squared multiple R: 0.115 Standard error of estimate: 3.563

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-30.558	19.034	0.000	.	-1.605	0.126
TEMPC	1.676	0.902	0.401	1.000	1.859	0.079

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	43.894	1	43.894	3.457	0.079
Residual	228.555	18	12.697		

*** WARNING ***
Case 1 is an outlier (Studentized Residual = 2.890)

Durbin-Watson D Statistic 0.676
First Order Autocorrelation 0.517

Dep Var: CHLAC N: 20 Multiple R: 0.566 Squared multiple R: 0.320

Adjusted squared multiple R: 0.282 Standard error of estimate: 3.208

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-4.258	3.193	0.000	.	-1.334	0.199
TN	8.099	2.782	0.566	1.000	2.911	0.009

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	87.217	1	87.217	8.475	0.009
Residual	185.231	18	10.291		

*** WARNING ***
Case 2 is an outlier (Studentized Residual = 3.923)
Case 17 has large leverage (Leverage = 0.420)

Durbin-Watson D Statistic 1.121
First Order Autocorrelation 0.364

Dep Var: CHLAC N: 20 Multiple R: 0.608 Squared multiple R: 0.370

Adjusted squared multiple R: 0.335 Standard error of estimate: 3.088

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	1.930	1.120	0.000	.	1.723	0.102
TP	30.671	9.431	0.608	1.000	3.252	0.004

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	100.840	1	100.840	10.577	0.004
Residual	171.608	18	9.534		

*** WARNING ***
Case 2 has large leverage (Leverage = 0.595)

Durbin-Watson D Statistic 0.875
First Order Autocorrelation 0.485

Dep Var: CHLAC N: 13 Multiple R: 0.068 Squared multiple R: 0.005

Adjusted squared multiple R: 0.000 Standard error of estimate: 3.353

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.006	1.809	0.000	.	2.214	0.049
TNLOAD	-0.000	0.000	-0.068	1.000	-0.225	0.826

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.571	1	0.571	0.051	0.826
Residual	123.648	11	11.241		

*** WARNING ***
Case 14 has large leverage (Leverage = 0.562)
Case 18 is an outlier (Studentized Residual = 3.285)

Durbin-Watson D Statistic 0.720
First Order Autocorrelation 0.392

Dep Var: CHLAC N: 13 Multiple R: 0.079 Squared multiple R: 0.006

Adjusted squared multiple R: 0.000 Standard error of estimate: 3.350

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	4.170	2.168	0.000	.	1.924	0.081
TPLOAD	-0.000	0.000	-0.079	1.000	-0.263	0.798

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.774	1	0.774	0.069	0.798
Residual	123.446	11	11.222		

*** WARNING ***
Case 14 has large leverage (Leverage = 0.594)
Case 18 is an outlier (Studentized Residual = 3.284)

Durbin-Watson D Statistic 0.727
First Order Autocorrelation 0.389

Dep Var: CHLAC   N: 20   Multiple R: 0.361   Squared multiple R: 0.130

Adjusted squared multiple R: 0.082   Standard error of estimate: 3.629

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	11.469	4.145	0.000	.	2.767	0.013
RAINFALL	-0.132	0.081	-0.361	1.000	-1.641	0.118

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	35.446	1	35.446	2.692	0.118
Residual	237.003	18	13.167		

Durbin-Watson D Statistic 0.788
First Order Autocorrelation 0.532

Dep Var: CHLAC   N: 20   Multiple R: 0.467   Squared multiple R: 0.218

Adjusted squared multiple R: 0.175   Standard error of estimate: 3.440

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.167	0.786	0.000	.	6.570	0.000
CUM3YRDEFICI	-0.095	0.042	-0.467	1.000	-2.241	0.038

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	59.450	1	59.450	5.024	0.038
Residual	212.999	18	11.833		

*** WARNING ***
Case 2 is an outlier (Studentized Residual = 3.072)

Durbin-Watson D Statistic 0.876
First Order Autocorrelation 0.475

Dep Var: CHLAC   N: 20   Multiple R: 0.586   Squared multiple R: 0.343

Adjusted squared multiple R: 0.306   Standard error of estimate: 3.154

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	5.410	0.733	0.000	.	7.384	0.000
CUM5YRDEFIC	-0.099	0.032	-0.586	1.000	-3.065	0.007

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	93.443	1	93.443	9.396	0.007
Residual	179.006	18	9.945		

Durbin-Watson D Statistic   1.062
First Order Autocorrelation   0.404

Dep Var: CHLAC   N: 20   Multiple R: 0.328   Squared multiple R: 0.108

Adjusted squared multiple R: 0.058   Standard error of estimate: 3.675

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	6.717	1.537	0.000	.	4.370	0.000
ANNUALFLOW	-0.037	0.025	-0.328	1.000	-1.476	0.157

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	29.399	1	29.399	2.177	0.157
Residual	243.050	18	13.503		

Durbin-Watson D Statistic   0.891
First Order Autocorrelation   0.476

Dep Var: CHLAC N: 20 Multiple R: 0.815 Squared multiple R: 0.665

Adjusted squared multiple R: 0.602 Standard error of estimate: 2.389

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.453	6.081	0.000	.	0.403	0.692
TN	-0.892	5.828	-0.062	0.126	-0.153	0.880
TP	-62.029	60.932	-1.230	0.014	-1.018	0.324
TP*TN	85.625	57.701	1.941	0.012	1.484	0.157

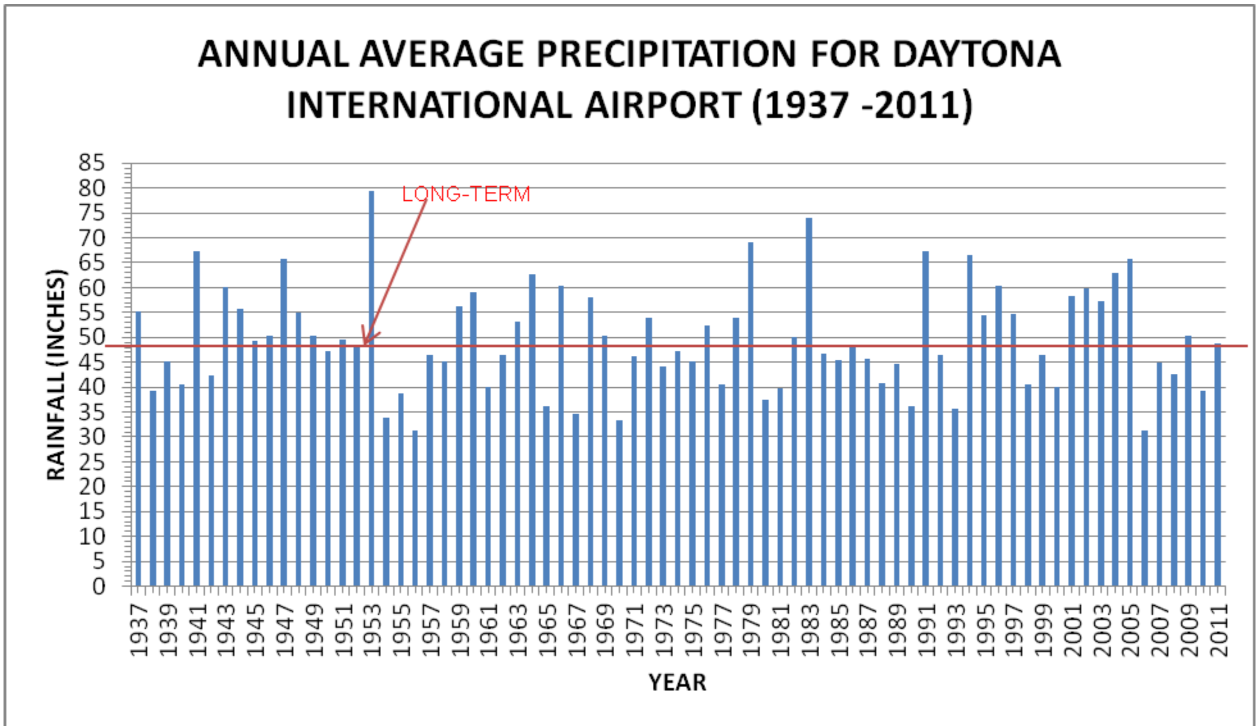
Analysis of Variance

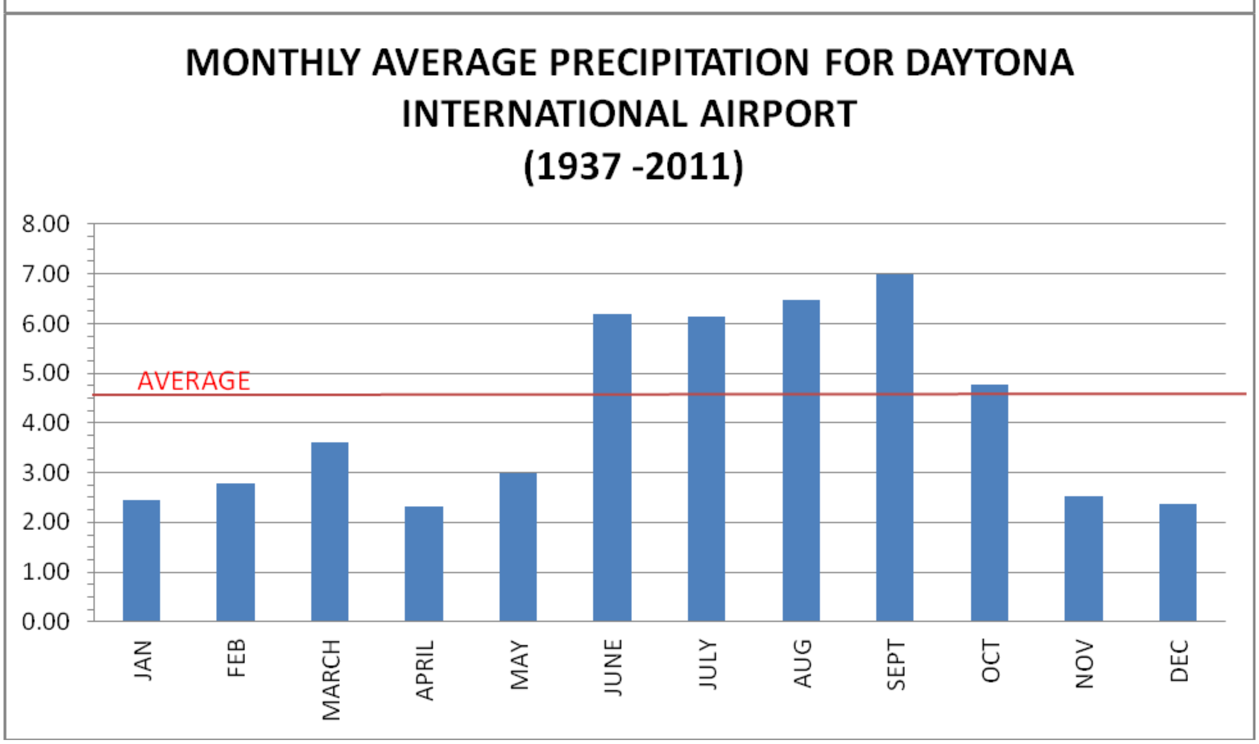
Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	181.101	3	60.367	10.574	0.000
Residual	91.348	16	5.709		

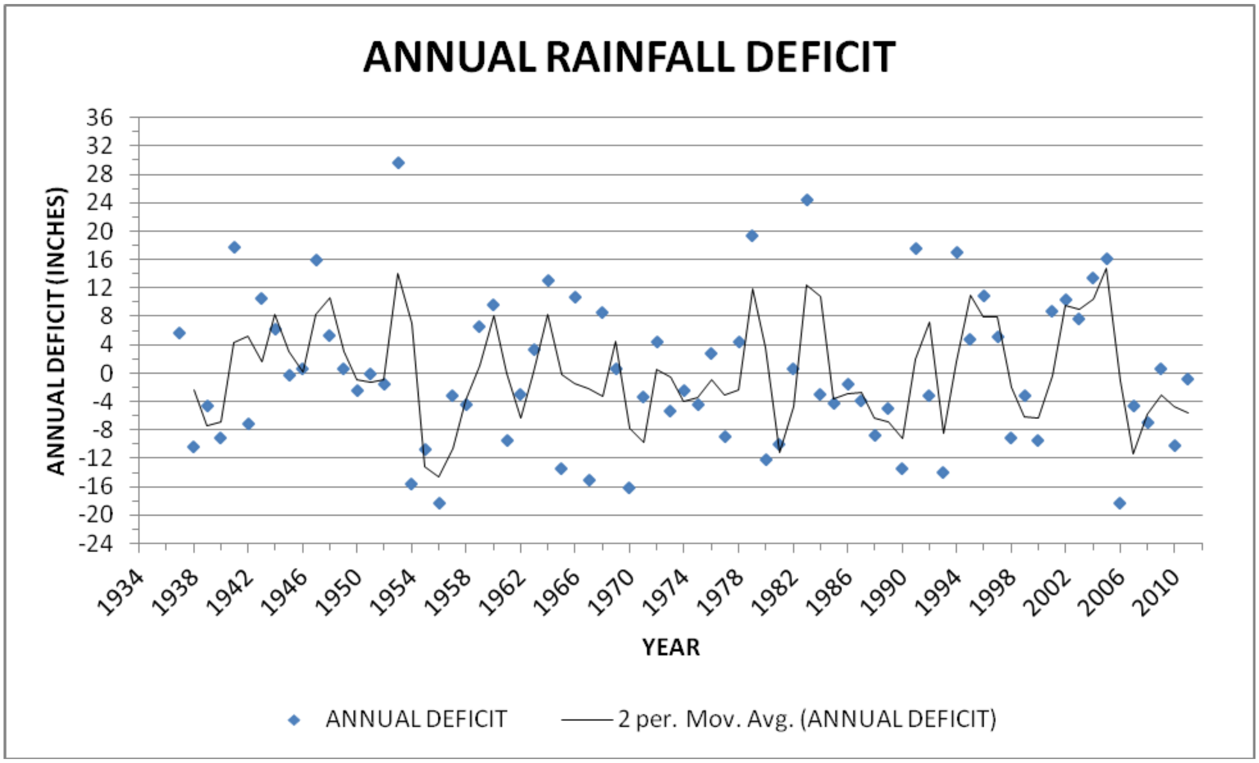
*** WARNING ***
Case 2 has large leverage (Leverage = 0.625)
Case 3 is an outlier (Studentized Residual = -4.009)

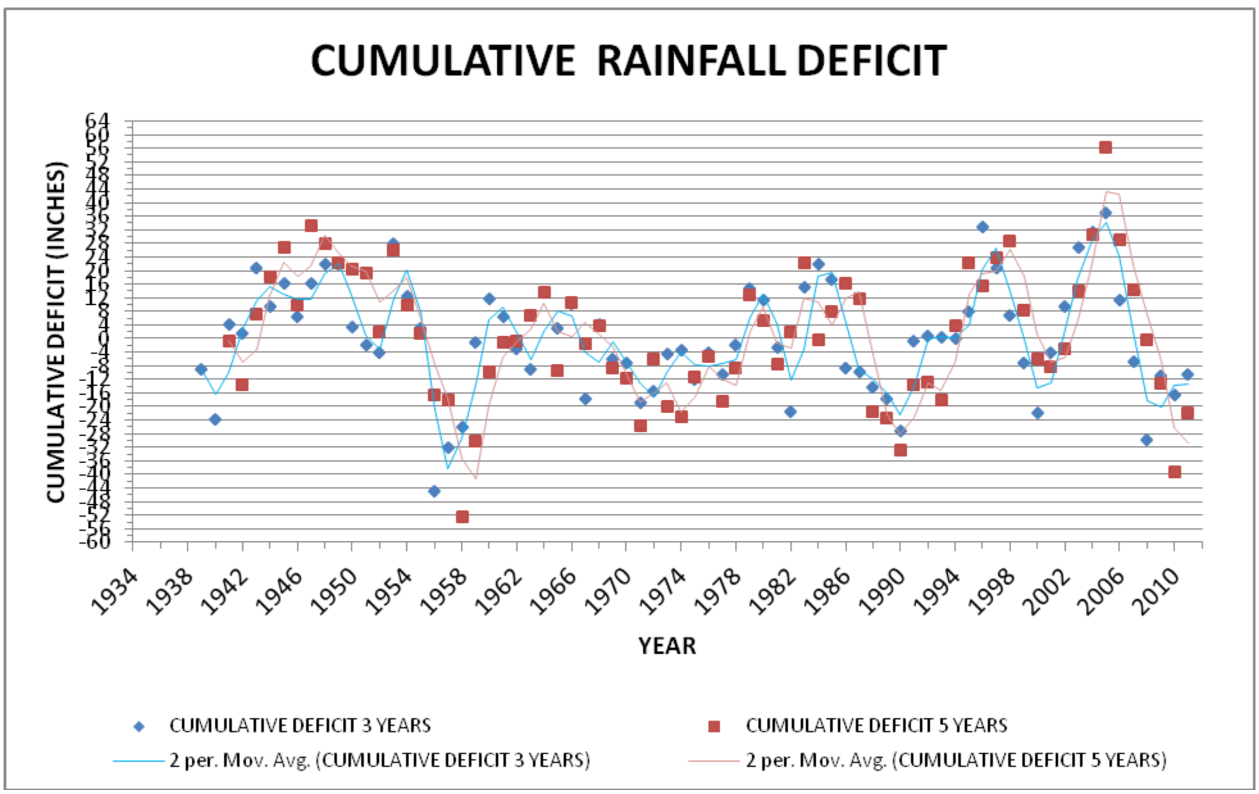
Durbin-Watson D Statistic 1.310
First Order Autocorrelation 0.268

Appendix K: Annual and Monthly Average Precipitation Plots for Daytona International Airport






ANNUAL RAINFALL DEFICIT
ANNUAL DEFICIT (INCHES)
YEAR
ANNUAL DEFICIT
2 per. Mov. Avg. (ANNUAL DEFICIT)


CUMULATIVE RAINFALL DEFICIT
CUMULATIVE DEFICIT (INCHES)
YEAR
CUMULATIVE DEFICIT 3 YEARS
CUMULATIVE DEFICIT 5 YEARS
2 per. Mov. Avg. (CUMULATIVE DEFICIT 3 YEARS)
2 per. Mov. Avg. (CUMULATIVE DEFICIT 5 YEARS)

YEAR	ANNUAL TOTAL (INCHES)	RANK	PERCENTILE
1956	31.36	1	1.33%
2006	31.36	2	2.67%
1970	33.4	3	4.00%
1954	33.96	4	5.33%
1967	34.58	5	6.67%
1993	35.71	6	8.00%
1990	36.12	7	9.33%
1965	36.13	8	10.67%
1980	37.36	9	12.00%
1955	38.8	10	13.33%
1938	39.29	11	14.67%
2010	39.39	12	16.00%
1981	39.68	13	17.33%
1961	40.06	14	18.67%
2000	40.16	15	20.00%
1998	40.51	16	21.33%
1940	40.56	17	22.67%
1977	40.67	18	24.00%
1988	40.91	19	25.33%
1942	42.4	20	26.67%
2008	42.67	21	28.00%
1973	44.23	22	29.33%
1989	44.65	23	30.67%
2007	45.02	24	32.00%
1939	45.09	25	33.33%
1958	45.15	26	34.67%
1975	45.19	27	36.00%
1985	45.38	28	37.33%
1987	45.72	29	38.67%
1971	46.23	30	40.00%
1999	46.37	31	41.33%
1992	46.41	32	42.67%
1957	46.48	33	44.00%
1962	46.59	34	45.33%

YEAR	ANNUAL TOTAL (INCHES)	RANK	PERCENTILE
1984	46.71	35	46.67%
1974	47.21	36	48.00%
1950	47.22	37	49.33%
1986	48.01	38	50.67%
1952	48.1	39	52.00%
2011	48.71	40	53.33%
1945	49.36	41	54.67%
1951	49.46	42	56.00%
1982	50.18	43	57.33%
1949	50.22	44	58.67%
1969	50.22	45	60.00%
1946	50.3	46	61.33%
2009	50.3	47	62.67%
1976	52.32	48	64.00%
1963	53.03	49	65.33%
1972	53.94	50	66.67%
1978	53.94	51	68.00%
1995	54.44	52	69.33%
1997	54.69	53	70.67%
1948	55	54	72.00%
1937	55.29	55	73.33%
1944	55.81	56	74.67%
1959	56.24	57	76.00%
2003	57.3	58	77.33%
1968	58.17	59	78.67%
2001	58.27	60	80.00%
1960	59.18	61	81.33%
2002	59.94	62	82.67%
1943	60.11	63	84.00%
1966	60.25	64	85.33%
1996	60.49	65	86.67%
1964	62.76	66	88.00%
2004	62.97	67	89.33%
1947	65.64	68	90.67%
2005	65.77	69	92.00%

YEAR	ANNUAL TOTAL (INCHES)	RANK	PERCENTILE
1994	66.64	70	93.33%
1991	67.19	71	94.67%
1941	67.3	72	96.00%
1979	69.02	73	97.33%
1983	73.99	74	98.67%
1953	79.29	75	100.00%

Appendix L: Response to Comments from September 2012 Workshop

Ms. Kelly Young –Volusia County Environmental Health Lab (9/26/ 2012) email

Good afternoon!
The attached file contains data to hopefully add to, and in some cases detract from the data used to determine the Halifax and Tomoka TMDLs. It was determined that some data that could have been used to support the credibility of some data was never submitted to Storet, and a portion of that data is within the attached file. Unfortunately, much of this data is no longer available in its original form, and the only information available is from spreadsheets with no qualifier code information. Several values for chlorophyll and total nitrogen should not be used for determining TMDLs due to this lack of information. Some obvious unreliable data has been set in bold text, but please use your best scientific judgement on using the data attached. More data is to follow when I get additional results from the City of Daytona Beach Water Testing Lab. Please note that the data included in the file's tab 'City of Daytona Beach data' is from the city lab, and tabs 'Halifax' and 'Tomoka' each have a column indicating the lab that processed the sample for the particular parameter listed. The city lab collects and processes (except for chlorophyll) samples monthly from the Daytona area of the Halifax river which includes stations HL08, HL09, HL10, HL11, HL11a, HL12, HL12a, and 13a. Originally, the only data available from this monthly collection was occasionally field data and chlorophyll data (as I was the one processing these samples for chlorophyll in the VCEH lab, and I began including this data along with the other data I sent to Storet). The other tabs in the file (Halifax and Tomoka) are a group effort project. Samples from the Tomoka and Halifax were collected monthly until the year 2000. Since then, they have been collected quarterly. The City of Daytona Beach lab collected all samples for the Tomoka River and stations HL01 through HL10. The city lab also processed all samples for TP, TKN, Turbidity, and TSS. The Volusia County Environmental Health lab (VCEH) collected stations HL11-20 and processed all other parameters. I'm sorry for the format of the attached files, however I'm in the process of putting it into a more user friendly format and will send that as soon as I can. I hope to provide additional info soon. Sorry for the delay.
Sincerely,
Kelly Young

Response:

We really appreciate the time and effort you spent compiling water quality data collected by both the City of Daytona Beach and Volusia County. I have used your spreadsheet to add additional water quality observations to the data base used in the draft TMDL that had not been included in Florida STORET as well as correct some data errors that were present in data obtained from Florida STORET. Analyses presented in the draft TMDL were rerun using the updated data base and are reflected in this revised TMDL.

Comments prepared on behalf of FDOT by Applied Technology and Management, Inc.

COMMENTS ON
FDEP Proposed Total Maximum Daily Load for Nutrients
Tomoka River, Fresh Water (WBID 2634)

September 21, 2012

TMDL SUMMARY

TMDL Waste Load and Load Allocation for Tomoka River (Fresh Water) (WBID 2634)

Parameter	WLA Wastewater (lbs/year)	WLA NPDES Stormwater (% Reduction)[1]	Load Allocation (% Reduction)	Margin of Safety	TMDL (mg/L)
TN	**NA[a]**	**22**	**22**	**Implicit**	**1.22**

a NA – Not Applicable
b – As the TMDL represents a percent reduction, it also complies with EPA requirements to express the TMDL on a daily basis.

The Total Maximum Daily Load (TMDL) was determined using an analysis of the empirical relationship of the trends in long-term corrected Chlorophyll *a* (CHLAC) and the corresponding total nitrogen (TN) concentrations in the fresh water segment of Tomoka River. More specifically, statistical analyses were performed to develop a predictive relationship between annual average CHLAC concentrations and the corresponding annual average TN concentrations. Using the regression model, the target TN concentration for waterbody segment (WBID) 2634, 1.22 milligrams per liter (mg/L), was estimated as the concentration that corresponds to CHLAC target concentration of 4.5 micrograms per liter (µg/L). A cumulative frequency plot of annual average TN in WBID 2634 indicates this corresponds to a TN reduction of 22 percent.

SUMMARY OF FINDINGS

The following are the key issues identified in this review of the TMDL proposal.

1. The TMDL report presents the results of extensive statistical analyses of the available water quality and rainfall data. The analyses concluded that the most significant relationships existed between CHLAC-salinity and CHLAC-TN, with most of the variation in CHLAC concentration explained by salinity. Linear regressions of CHLAC versus sampling date indicated an increasing trend in CHLAC [significant at an alpha level (α) of 0.05], while the regression of TN versus sampling date was not significant (α = 0.05). Regressions of CHLAC with long-term rainfall deficits were significant (α = 0.05). Given the correlation of CHLAC with salinity and with long-term rainfall deficits, it would seem that WBID hydrology may play a larger role in CHLAC concentrations than nutrients. The U.S. Geological Survey (USGS) has a long-term discharge monitoring station (USGS 02247510 TOMOKA RIVER NEAR HOLLY HILL, FL) located at LPGA Blvd., which is approximately the mid-point of the WBID. It is suggested that this flow record be used to perform additional statistical analyses to evaluate water quality responses and relationships. While the analyses using salinity and rainfall deficit provides insights into WBID water quality during drought periods, using the flow record would provide a more direct analysis of the relationship of watershed hydrologic condition and WBID water quality.

Response:

Based upon additional water quality data provided by Volusia County from sampling conducted by the City of Daytona Beach that had not been included in Florida STORET and well as some data error corrections, data analyses presented in the draft TMDL were rerun using the updated data set. As was the case in the draft, the most significant relationships using individual observations existed between CHLAC-salinity and CHLAC-TN, however, both TN and Salinity each explained approximately 10 percent of the variance in CHLAC. CHLAC versus sampling date did not indicate an increasing trend that was significant (Figure 5.2).

As suggested, daily flow data from the USGS gage on the Tomoka River at the LPGA Boulevard was incorporated into the data set. The simple linear regression of flow versus CHLAC observations was significant at an α level of 0.05 but only explained 1 percent of the variance in CHLAC. A simple linear regression of annual average CHLAC concentrations versus annual average daily flow was not significant.

2. The TMDL report discusses the possibility of tidal transport downstream of State Road 40, as evidenced by periods of high salinity in this reach. Based on the CHLAC-salinity relationship presented on Figure 5.8 and the time series plots presented on Figures 5.9 through 5.12, these episodic periods of high salinity, with accompanying higher CHLAC levels occurring during drought periods where tidal transport in the lower reaches is more likely, may be biasing the CHLAC statistics upward. The conclusions of the report would be strengthened if statistical analyses of the data were presented when the entire Tomoka River reach was considered fresh and the potential of tidal transport is minimal. This would clarify that the impairment is due to a watershed issue, and that the proposed TN reduction would eliminate the impairment.

Response:
The updated data set was divided into fresh and marine subsets based on salinity and/or conductance (marine: salinity > 2.7 ppt, or conductance > 5000 umhos/cm). There were 545 CHLAC observations in the fresh water subset and 95 CHLAC observations in the marine water subset (there were also 14 observations that had insufficient information to classify). Sixty-three of the ninety-five CHLAC observations under marine conditions occurred in the spring period (30 of which occurred in Spring 2008). The following table summarizes the subsets by year.

Year	Total	Fresh	Marine
1985	9	9	0
1986	24	12	12
1992	34	30	4
1993	31	22	9
1994	40	37	3
1995	35	30	5
1996	33	33	0
1997	21	18	3
1998	36	33	3
1999	35	31	4
2000	10	9	1
2001	21	20	1
2002	19	17	2
2003	33	33	0

Year	Total	Fresh	Marine
2004	20	20	0
2005	43	31	0
2006	21	19	2
2007	19	16	1
2008	64	32	31
2009	50	40	10
2010	33	31	2
2011	24	22	2

Annual average CHLAC, TN, and TP concentrations based on the fresh water data subset were calculated using the same methodology as described in the TMDL document. The following table compares the CHLAC, TN, and TP annual averages based on the fresh water subset to the complete data set.

Year	Fresh Water Subset	Fresh Water Subset	Fresh Water Subset	Complete Data Set	Complete Data Set	Complete Data Set
	CHLAC (µg/L)	TN (mg/L)	TP (mg/L)	CHLAC (µg/L)	TN (mg/L)	TP (mg/L)
1992	12.5	1.28	0.149	11.2	1.26	0.149
1993	6.0	1.03	0.402	13.6	1.08	0.335
1994	5.5	1.47	0.156	5.8	1.47	0.152
1995	1.9	1.52	0.067	3.3	1.48	0.071
1996	2.3	1.01	0.032	2.3	1.01	0.032
1997		0.90	0.038	2.3	0.92	0.047
1998	1.8	1.20	0.043	2.5	1.17	0.048
1999	1.8	0.91	0.046	3.7	0.93	0.053
2000	1.2	0.90	0.169	2.7	0.91	0.228
2001	1.7	0.92	0.110	1.8	0.91	0.123
2002	1.2	1.05	0.048	2.6	1.06	0.050
2003	2.2	1.02	0.059	2.2	1.02	0.059
2004	1.9	1.06	0.046	1.9	1.06	0.046
2005	2.5	1.05	0.047	2.4	1.08	0.050
2006	1.1	0.74	0.045	2.6	0.73	0.051
2007	1.3	0.79	0.048	1.3	0.76	0.043
2008	1.6	1.79	0.074	10.2	1.82	0.100
2009	10.4	1.40	0.089	11.4	1.40	0.093
2010	5.2	1.13	0.088	6.4	1.13	0.084
2011	4.9	1.10	0.055	5.9	1.19	0.057

Annual average concentrations for TN and TP were very comparable between the two data sets. With respect to CHLAC, in two years (1992 and 2005) the fresh water annual average CHLAC was higher than that of the complete data set. The largest differences occurred in 1993 (7.6 µg/L) and 2008 (8.6 µg/L). The TMDL document discussed sampling events in 2008 that contributed to this large difference. In the twenty years that were compared, annual differences in CHLAC were 1 µg/L or less 55 percent of the time and the difference was 1.5 µg/L or less in 80 percent of the cases.

As indicated in the document, elevated salinity levels in the upper portion of the WBID indicate tidal transport. Lower fresh water flows in the Tomoka River influence the upstream extent of marine conditions which also increases the residence time of nutrients and the opportunity for algal production.

3. The TMDL report states that based on a cumulative frequency plot of annual average TN concentrations (Figure 5.14) approximately 78 percent of the annual TN averages were less than 1.22 mg/L. The TMDL requires a 22 percent reduction in the annual average TN concentration to meet an annual average CHLAC target of 4.5 µg/L or lower in the Tomoka watershed. The way the cumulative frequency plot is used to calculate the required percent reduction in annual average nitrogen concentration seems to imply that this TN concentration target is to be met all the time, although statistically, that is not what is actually being expressed. If so, this would seem to be in conflict with the numeric nutrient criteria, which provided for natural variability (i.e., one exceedance every 3 years). This section of the TMDL report should be expanded to better explain what is expected with respect to achieving the annual average TN concentration target.

Response:

Based upon additional data the analyses were rerun and significant correlations were identified between CHLAC and both TN and TP. A general linear model that included both TN and TP was used to establish reductions in both TN and TP that would achieve an annual average CHLAC target of 4.5 µg/L. The resulting TN and TP concentrations represent an average concentration based on applying a 30 percent reduction to the annual average concentration for each year. Language was added to indicate that use of the average incorporates year to year variations in historic nutrient concentrations. A footnote was also added to Table 6.1 to indicate that the TN and TP concentrations represent annual average values. At this time an effective date for the application of numeric nutrient criteria for Florida streams has not been identified.

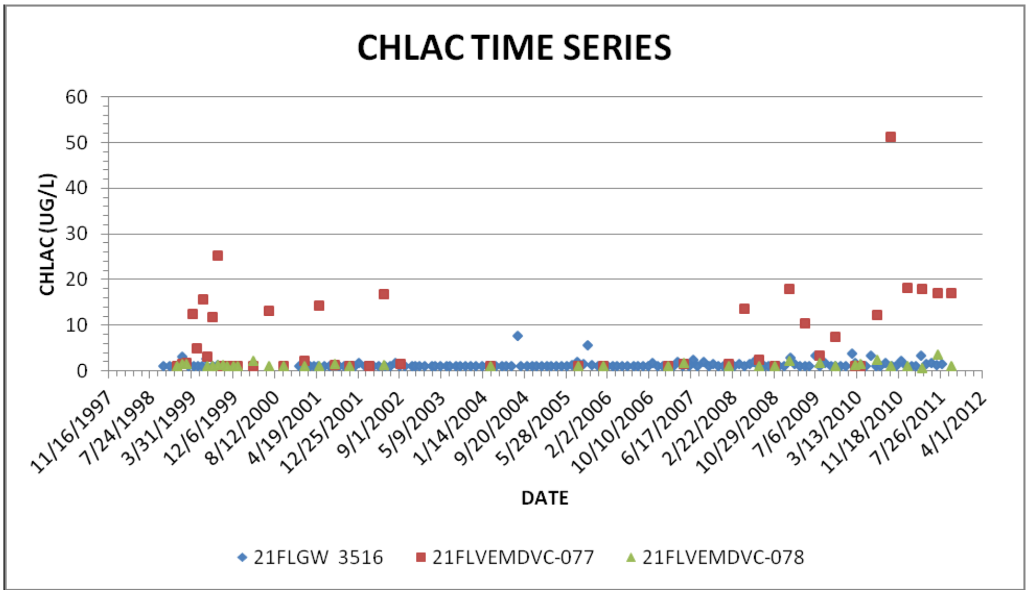
4. Page 40 indicates that the annual average TN concentrations over the 1994 – 2011 period ranged between 0.22 mg/L (2000) and 1.91 mg/L (2008), with an overall average of 1.07 mg/L. According to Table 5.5, this minimum TN concentration occurred in1995, although other locations where the data are presented seem to validate the occurrence in 2000. Table 5.5 as well as any graphics that utilize that data should be checked to confirm they are correct.

Response:

There was an error in Table 5.5 for the mean TN concentration in 1995. The table has been updated based on the updated data set.

5. The TMDL report would benefit from some discussion comparing the period from which the target CHLAC concentration was calculated (1999-2003) and the verification period (2004-2011). Using data from the long-term station at LPGA Blvd (USGS 02247510 TOMOKA RIVER NEAR HOLLY HILL, FL), plots of flow (Figure 1) and various durations of moving averages (Figure 2) along with Weibull plotting position analysis indicate that the verification period has both the wettest and driest 2-yr periods (based on 2-yr moving averages of daily flow) in the period of record (1965-present). The 2006-2011 time period is hydrologically one of the driest periods found in the data record. The wettest

period (2004-2005) was immediately followed by the second-driest (2006-2007). It was in 2008, two years after the beginning of the drought, when the higher CHLAC concentrations started to occur. The 1999-2000 dry period was similar to but not quite as severe as the 2006-2007 dry period. A similar pattern of high CHLAC concentration also occurred during the 1999-2000 drought. A noticeable difference between the two periods of high CHLAC measurements was that one occurred during the dry period (1999-2000) and the other occurred following the dry period (2006-2007). The question is whether it is appropriate to use the target CHLAC concentration developed from the 1999-2003 time period for the 2004-2011 verification period. Some discussion of this would be of benefit in the final report.



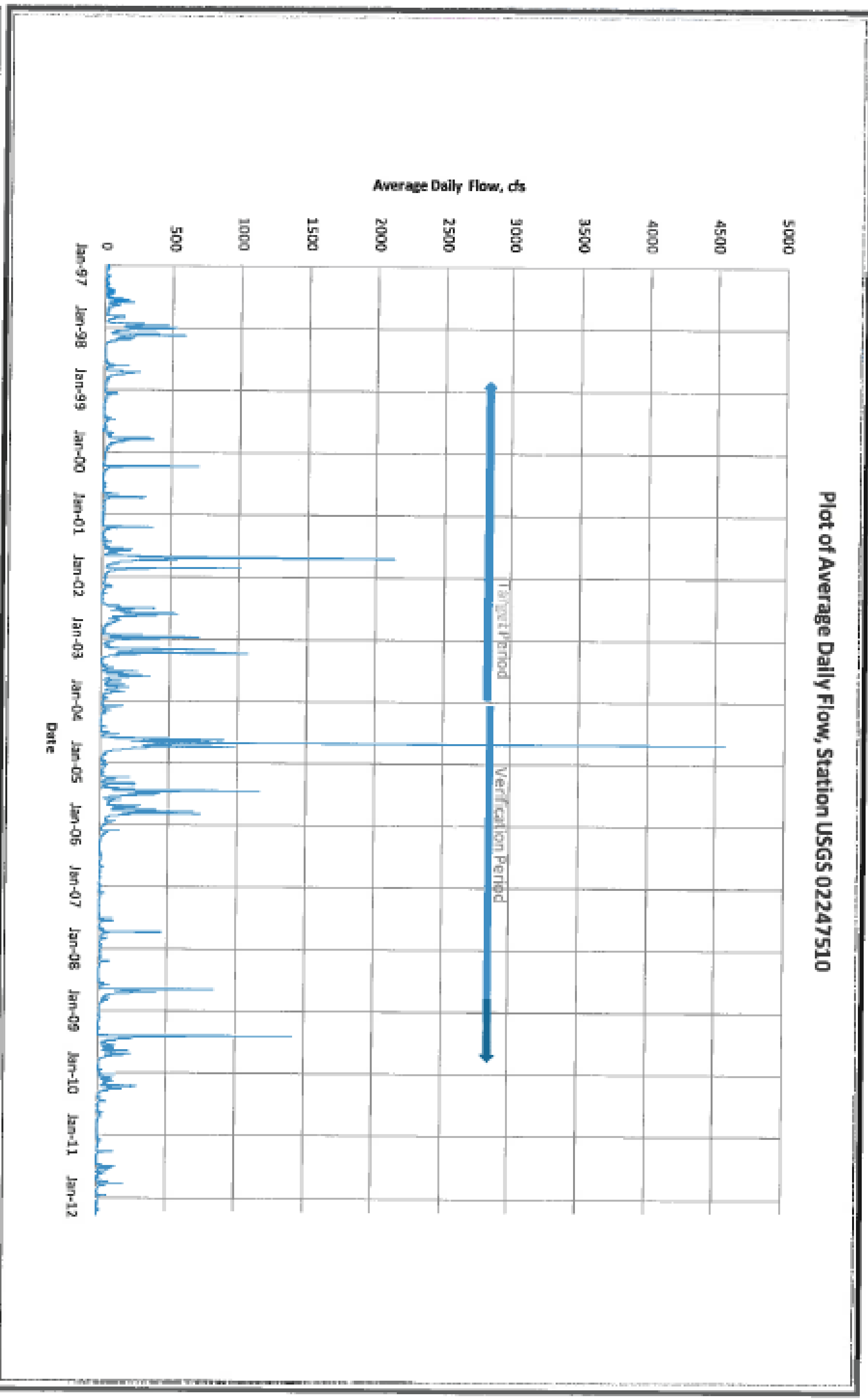


Figure 1
Plot of Average Daily Flow, Station USGS 02247510

APPLIED TECHNOLOGY & MANAGEMENT

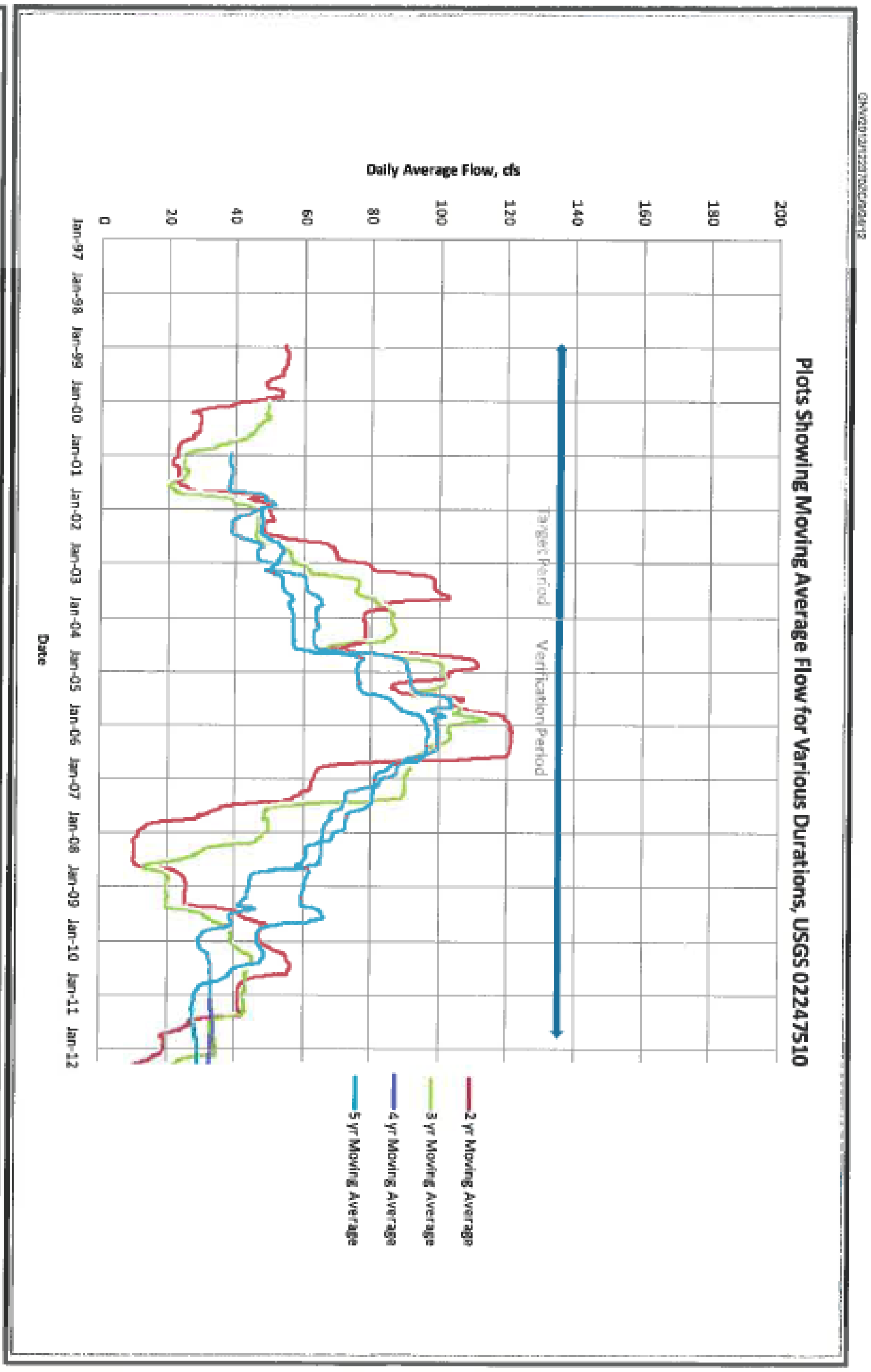


Figure 2
Plots Showing Moving Average Flow for Various Durations, USGS 02247510

Response:
Text from the Impaired Waters Rule describing the calculation of the historic minimum CHLAC concentration has been added to Chapter three. During the development of the Impaired

Waters Rule language, the Technical Advisory Committee recommended that assessment of a potential nutrient impairment based on chlorophyll should include several measures, including a change from historical conditions. Calculation of a historic minimum based on a five year period was considered an appropriate method that incorporated temporal fluctuations in rainfall and discharge. The historic minimum also had to be exceeded by 50 percent or more in two consecutive lists inorder to be listed.

Annual rainfall totals for the 1999 – 2003 period indicated below average rainfall in 1999 and 2000 followed by three years of above average rainfall. In 1998, rainfall was below the long-term average. Annual average CHLAC concentrations in the 2008 -2011 period all exceeded 5 µg/L and ranged between 5.9 µg/L (2011) and 11.4 µg/L (2009). Daily average flows from the USGS gaging station over the 1999 – 2003 period averaged 56.8 cfs while flows ovr the 2008 – 2011 period averaged 33 cfs. The long-term daily average is approximately 53 cfs. Over the 1995 – 2007 period, annual average CHLAC concentrations were all below 3.8 µg/L, including the second driest period of 2006 – 2007 as noted in the comment.

Recommendation**:** ***The primary recommendations are as follows. First, additional statistical analyses should be performed to evaluate water quality responses and relationships using the USGS flow record at Station 02247510. While the analyses using salinity and rainfall deficit provide insights into WBID water quality during drought periods, using the flow record would provide a more direct analysis of the relationship of watershed hydrologic condition and WBID water quality. Second, statistical analyses of the data should be presented for when the entire Tomoka River reach was considered fresh and the potential of tidal transport is minimal. This would clarify that the impairment is due to a watershed issue and that the proposed TN reduction would eliminate the impairment.***

> *Response: The Department appreciates the recommendations and these have been addressed in other parts of the document.*

Appendix M: Response to Comments from April 2013 Workshop

Comments from Kelly Young Environmental Specialist, Volusia County Environmental Health Lab
Wedneday April 10, 2013

Kelly A. Young
Environmental Specialist
Volusia County Environmental Health Lab
1250 Indian Lake Rd.
Daytona Beach, FL 32124
Phone (386) 248-1781

Hi all!
The latest Draft TMDL for the Tomoka has a few data points which were processed by the City of Daytona Beach which should be excluded from calculations for the TMDL. These were collected and processed in conjunction with the Halifax points that were also questionable. The station is 21FLVEMDVC-077, locally referred to as TR03, a saline station. I would disregard the TN and TP results from that station from the following dates:
7/12/2010
10/4/2010
1/10/2011
7/11/2011
10/3/2011
I do not know that the other station listed, 21FLVEMDVC-078 (locally TR04, typically processed as fresh water) was diluted for analyses, maybe Bob can confirm this?... but if it were diluted for processing, then I would disregard the TN and TP for the same dates listed above.
Hope to see you all on Friday!
-Kelly

Response:

Total nitrogen and TP observations reported for station 21FLVEMDVC-077 for the dates cited were removed from the data set (2 TN and 3 TP values) and the General Linear Model (GLM) was rerun. There was a slight change in the coefficients of the GLM and the revised model explained 65 percent of the variance in the annual average CHLAC (old model r^2 = 0.66). Under the revised GLM, a thirty percent reduction in both TN and TP was still required to achieve annual average CHLAC concentrations of less than 4.5 ug/L. Ranges in TN and TP annual averages as well as the TN and TP nutrient targets were unchanged from the earlier GLM.

Dep Var: CHLAC N: 20 Multiple R: 0.808 Squared multiple R: 0.653

Adjusted squared multiple R: 0.588 Standard error of estimate: 2.431

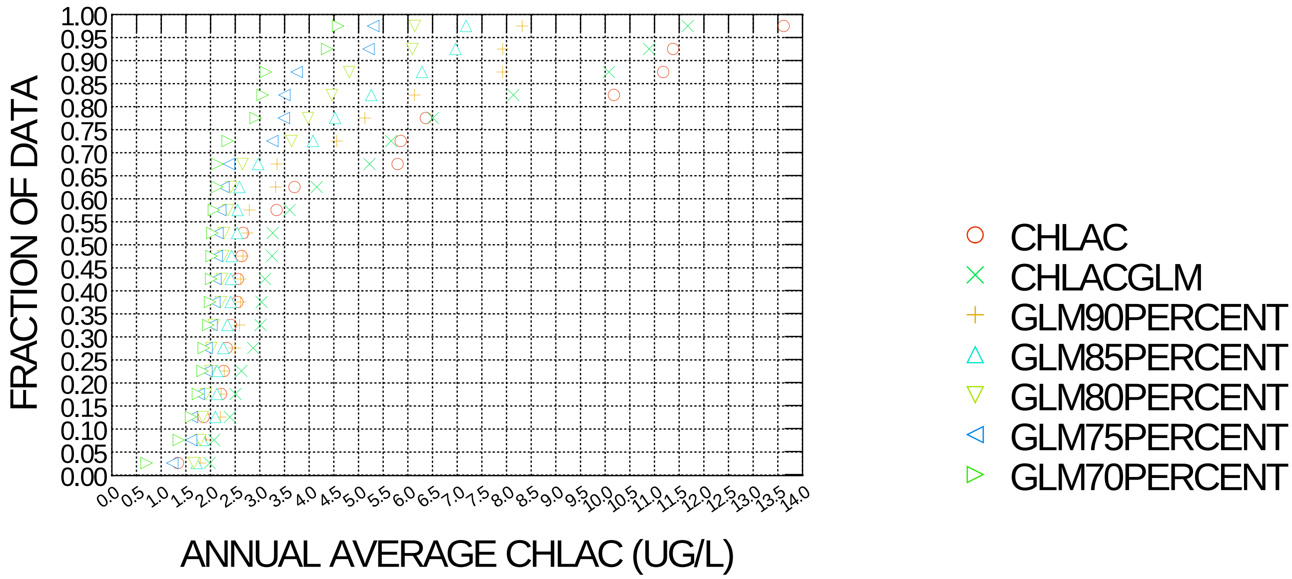
Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	3.023	6.267	0.000	.	0.482	0.636
TN	-1.378	6.029	-0.096	0.123	-0.229	0.822
TP	-65.449	62.664	-1.300	0.014	-1.044	0.312
TP*TN	88.690	59.423	2.017	0.012	1.493	0.155

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	177.922	3	59.307	10.039	0.001
Residual	94.526	16	5.908		

*** WARNING ***
Case 2 has large leverage (Leverage = 0.627)
Case 3 is an outlier (Studentized Residual = -3.914)
Case 9 has large leverage (Leverage = 0.531)

Durbin-Watson D Statistic 1.238
First Order Autocorrelation 0.296



Comments from John C. Gamble, Interim Operations Manager, Volusia County Public Works
Tuesday 4/16/2013

John C. Gamble
Interim Operations Manager
Volusia County Public Works
123 W. Indiana Ave.
DeLand, FL 32720-4262
386-736-5965 X15527 DeLand

Jan & Wayne,

1. Any stormwater modeling in Volusia County done since 2007 is to use the LiDAR data collected by the county in 2006. This is a publicly available data set and is the best available data that we are aware of. Use of USGS DEMs are not acceptable for stormwater modeling in this county.

Response:

It is our understanding that the LSPC model used for the Daytona watershed developed sub-watersheds using the 12-digit hydrologic unit code (HUC12) watershed data layer and the Geological Survey (USGS) National Hydrograph Dataset (NHD). Length and slope for the main channel reach within each sub-watershed were obtained using the USGS DEM and NHD data (Appendix C). The USGS DEM was from the National Elevation Dataset (http://ned.usgs.gov/). Based on the dataset viewer under the data source index, it appears that the best available NED resolution for Volusia County was 1/9 arc second (~3 meter). According to the website the hierarchy of data sources is:

NED source data are selected from an ever-growing inventory of standard production USGS Digital Elevation Model (DEM's), and also from an increasing number of datasets that are project- or agency-specific. The first consideration is always given to quality. Selections are made according to the following ranking, listed in order of descending priority:

1. High-resolution data, typically derived from lidar or digital photogrammetry, and often with edited water bodies. If collected at a ground sample distance no coarser than 5 meters, such data may also be offered within the NED at a resolution of 1/9th arc-second.

2. Moderate-resolution data, other than that compiled from cartographic contours. These data may also be derived from lidar or digital photogrammetry, or less often by Interferometric Synthetic Aperture Radar IFSAR. A typical ground sample distance is 10 meters, though it is commonly called "1/3 arc-second data".

3. 10-meter DEM's derived from cartographic contours and mapped hydrography. Most often, such data are produced by or for the USGS as a standard elevation product, and they currently account for the bulk of the NED.

4. 30-meter cartographically derived DEM's. Similar in most respects to their 10-meter counterparts, though usually of lower overall quality.

5. 30-meter photogrammetrically derived DEM's. These are the oldest DEM's in the 7.5-minute series. These data were derived directly from stereo photography, either by a human operator or by an early form of electronic image correlation. They are badly marred by production artifacts that are addressed to the greatest practical extent by digital filtering within the NED production process.

6. 2-arc-second DEMs are a standard USGS product. They are derived from cartographic contours at a scale of 1:63,360 over the state of Alaska, and a scale of 1:100,000 elsewhere.

7. 1-arc-second Shuttle Radar Topography Mission (SRTM) data, to date, are only used in preference to 3 arc-second data in the Aleutian Islands.

8. 3-arc-second DEMs are another standard USGS product, and are generally only used within the NED as a source of fill values over large water bodies.

In both the Halifax and Tomoka River nutrient TMDLs, the estimated LSPC watershed TN and TP annual loads were not used to set nutrient reductions.

2. Two studies done since the LiDAR collection, using that data, have been completed in that area: Nova Canal basin (borders on Tomoka and part of Halifax) and Daytona International Airport Stormwater Master Plan (borders on Tomoka). Both of these studies were done by CDMSmith and should define the eastern boundary of the Tomoka River basin and define part of the Halifax Basin. An additional study done by Taylor Engineering for FIRMs for FEMA, included the basin east of Nova Road in Holly Hill/Ormond Beach area.

Response:

Comment noted. That information will be provided to EPA for consideration in their watershed model of the Daytona basin.

3. I would encourage you to closely review the water quality collected after the May 2009 Storm that dumped 20-30 inches of rain from New Smyrna Beach to Ormond Beach for a three day period. This would seem to be an extreme event and should be excluded from the calculations.

Response:

Linear regressions of annual average CHLAC concentrations versus water quality parameters considered in Appendix J were rerun with 2009 excluded. Results were similar to those presented in Appendix J. The analysis of CHLAC versus TN is presented below. Substituting the target annual average CHLAC concentration of 9 ug/L yields a TN annual average concentration of 1.11 mg/L. The previous analysis that included 2009 resulted in an annual average TN concentration of 1.13 mg/L.

Dep Var: CHLACAVE N: 15 Multiple R: 0.673 Squared multiple R: 0.453

Adjusted squared multiple R: 0.411 Standard error of estimate: 1.620

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.816	1.895	0.000	.	0.431	0.674
TNAVE	7.355	2.242	0.673	1.000	3.281	0.006

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	28.251	1	28.251	10.767	0.006
Residual	34.111	13	2.624		

*** WARNING ***
Case 15 has large leverage (Leverage = 0.626)

Durbin-Watson D Statistic 1.357
First Order Autocorrelation 0.274

4. Tomoka River water quality testing should not be under minimum flow conditions. We believe sampling during drought conditions does not reflect discharge conditions and should not be included in the TMDL calculations. During drought conditions, there is little or no flow at the southern end. Although the water may be sampled at the bridge, should this data be used if the river is not discharging (flowing).

Response:

The impacts to receiving waters from point and nonpoint source contributions under a variety of wet and dry weather conditions are captured under the TMDL process. In the case of the Tomoka River TMDL, annual average CHLAC, TN, and TP concentrations over the 1992 – 2011 period were used to establish the TMDL. Over the 1992 through 2011 period, the long-term annual rainfall average was exceeded in 10 years and there were 10 years that were below the long-term average of 49.63 inches. If portions of a stream or river are dry and sampling occurs in isolated pools we would not consider results from such sampling events to be representative of the system. If, however, there is water throughout the stream length (whether standing or flowing) when sampling occurs, there is little justification to exclude that information from the larger data set.

Comments from Robin Cook, Regulatory Compliance Officer, Utilities Department, City of Daytona Beach Friday 4/26/2013

Robin Cook
Regulatory Compliance Officer
Utilities Department
City of Daytona Beach
386-671-8885- office
386-671-5901 - desktop fax
407-314-5743 - cell

Ms. Mandrup-Poulsen,

Thank you for the opportunity to provide comments. As such the City of Daytona Beach offers the following:

As we stated during the meeting on April 12, CODB staff was very concerned that the May 2009 significant rain event was not thoroughly considered in the evaluation of the TMDL for the Halifax River. The rain began on May 17 , 2009. As we informed FDEP staff, the rain lasted several days and left standing water for several weeks afterward. This standing water was no doubt contaminated in some way. The run-off from this event undoubtedly continued to effect water quality in the Halifax River for a period that would have been seen in the sampling event.

Response:

Please refer to the response to comment 3 from Mr. Gamble.

Also, it seems a bit suspect that the County Landfill had zero discharge for that many years and then it started discharging and has continued to have some annual discharge every year since. What change in operations led to the change in discharge characteristics?

Response:

According to the Tomoka Farms Road Landfill permit, water from the South External Canal is pumped into the swale going east along the landfill access road. The landfill access road swale is designated as ground water discharge (G-001). The NPDES surface water discharge system designated D-001 is at the eastern end of the roadside swale where a control structure limits discharge to periods following heavy rainfall. Discharge is to a wetland area on the north side of the access road which then flows north to the headwaters of the Tomoka River. The permit authorizes only conditional surface water discharge under heavy rainfall situations (10 year 24 hour storm event (7.5 inches) or chronic rainfall event equivalent to 10 year 24 hour event). During the 2005 – 2010 permit cycle, the landfill access swale was partially filled into to accommodate the construction of a new Scale House.

Permit renewal information provided in support of the permit that was issued in February 2011 identified 9 separate discharge events that occurred over the May 2007 through April 2010 period. Eight of the nine discharge events occurred following large rainfall events. Discharge during one event (July 28, 2009 – August 2009) was due to construction activities at the North Cell that required reductions in water levels to allow repair of the North Cell Leachate Collection System.

Florida Department of Environmental Protection
Division of Water Resource Management
Bureau of Watershed Management
2600 Blair Stone Road, Mail Station 3565
Tallahassee, Florida 32399-2400
www.dep.state.fl.us/water/