Total Maximum Daily Loads

for

Dissolved Oxygen and Nutrients

In

Hillsborough River Basin

(includes TMDLs for Flint Creek, Cow House Creek, and Middle and Lower Hillsborough River)

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EPA United States Environmental Protection Agency

Region 4 serving the southeast

Table of Contents

List of Tables

List of Figures

DRAFT SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information
State: Florida
County: Hillsborough
Major River Basin: Tampa Bay Basin (HUC 03100205)

Waterbody (List ID)	Listing Year	Impairment(s)	Pollutant(s)
Flint Creek (WBID 1522A)	**1998**	**Dissolved Oxygen (DO)**	**TN, TP**
	1998	**Nutrients**	**TN, TP**
Cow House Creek (WBID 1534)	**1998**	**Dissolved Oxygen (DO)**	**TN, TP**
	1998	**Nutrients**	**TN, TP**
Middle Hillsborough River (WBID 1443B)	**1998**	**Dissolved Oxygen (DO)**	**TN, TP**
Lower Hillsborough River (WBID 1443E)	**1998**	**Nutrients**	**TN, TP**

2. TMDL Endpoints (i.e., Targets) for Class III Waters (fresh):
Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

3. Pollutant Load Reductions

WBID	Pollutant	WLA		LA (kg/day)	MOS	TMDL (kg/day)	Percent Reduction
		Continuous (kg/day)	MS4 (reduction)				
1443B	TN	0	30%	176	implicit	176	30%
	TP	0	30%	32	implicit	32	30%
1443E	TN	0	30%	255	implicit	255	30%
	TP	0	30%	43	implicit	43	30%
1522A	TN	0	30%	45	implicit	45	30%
	TP	0	30%	9	implicit	9	30%
1534	TN	0	30%	32	implicit	32	30%
	TP	0	30%	6	implicit	6	30%

4. Endangered Species (yes or blank): yes

5. EPA Lead on TMDL (EPA or blank): EPA

6. TMDL Considers Point Source, Nonpoint Source, or both: both

7. Major NPDES Discharges to surface waters: none

INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Florida Department of Environmental Protection (FDEP) has developed 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.]). 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 rule-making process, the Florida Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The TMDLs developed in this report are for impaired waters on the 1998 303(d) list but not on FDEP's verified list.

This TMDL is being established pursuant to EPA commitments in the 1999 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998) that TMDLs be developed for all of the impairments on the approved 1998 303(d) list.

PROBLEM DEFINITION

Flint Creek is on the 1998 303 (d) list for low dissolved oxygen and nutrients; Cow House Creek is on the 1998 303 (d) list for low dissolved oxygen and Lower Hillsborough river, WBID 1443 is on the 1998 303 (d) list for nutrients. This TMDL will address these impairments.

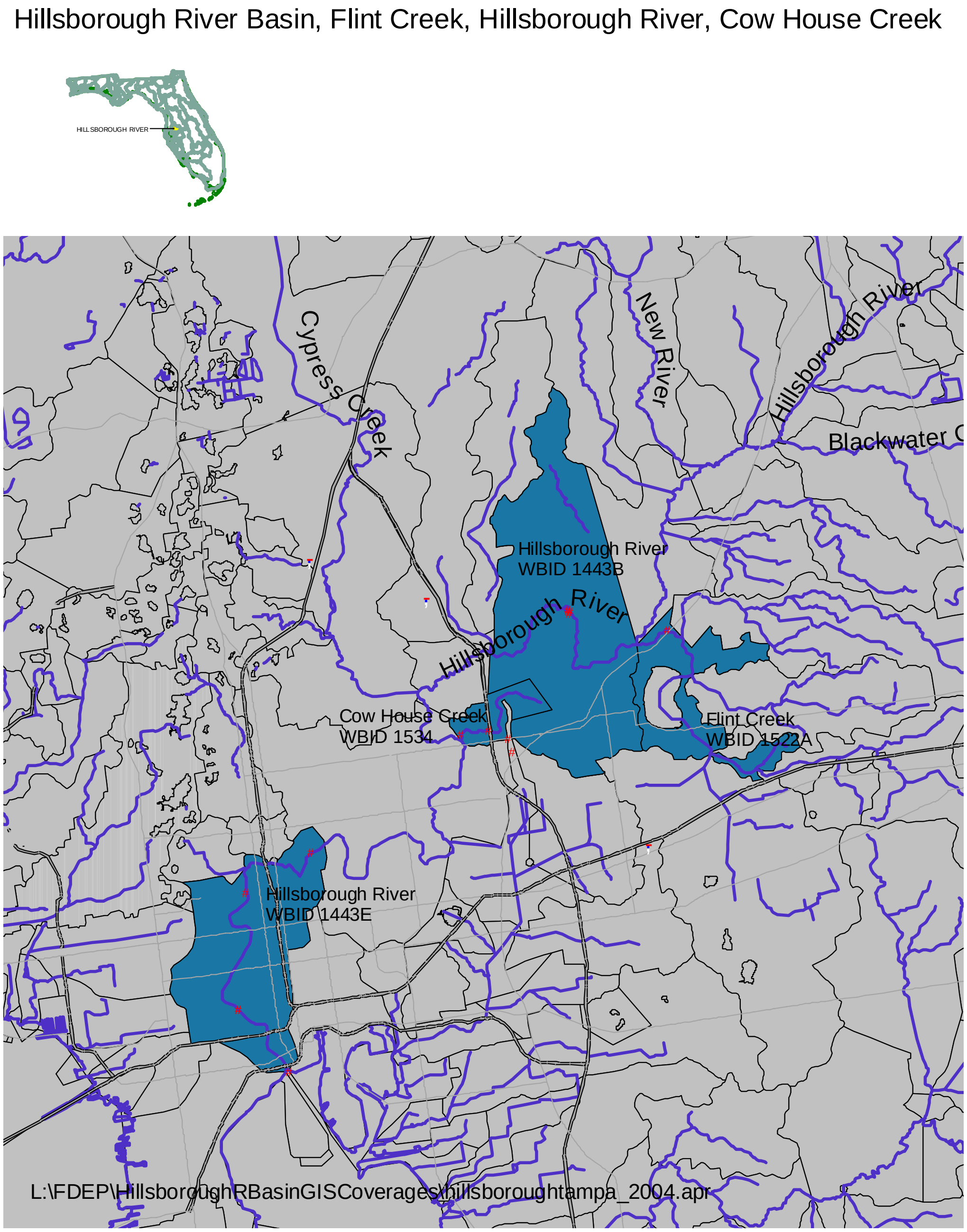


Figure 1: Flint Creek, Cow House Creek and Middle and Lower Hillsborough River Watersheds

WATERSHED DESCRIPTION

The FDEP Water Quality Assessment Report describes the Hillsborough River Basin, which begins east-northeast of Zephyrhills and drains 690 square miles before emptying into the upper Hillsborough Bay, a part of Tampa Bay. Its headwaters originate in the southwestern portion of the Green Swamp, where it also receives overflow from the Withlacoochee River. The river channel is not clearly defined until the river leaves the swamp. From there, it flows southwesterly 54 miles to upper Hillsborough Bay.

Perennially flowing tributaries to the Hillsborough River are Big Ditch and Flint Creek. Intermittent streams are Indian Creek, New River, Two Hole Branch, Basset Branch, Hollomans Branch, Clay Gully, Trout Creek, Blackwater Creek, and Cypress Creek. High floodwaters are diverted from the Hillsborough River at the confluence of Trout Creek and upstream of the Tampa Reservoir Dam through the Tampa Bypass Canal to McKay Bay.

Channelization has extended Sixmile Creek west and north to intersect the Hillsborough River at two points, the confluence of Trout Creek and near the midpoint of the Tampa Reservoir, which supplies drinking water to the city of Tampa. The modified Sixmile Creek was then renamed the Tampa Bypass Canal, which comprises two canals. The Harney Canal (C-136) runs from the Tampa Reservoir to join the second and longer canal, C-135, which connects the Hillsborough River at Trout Creek and Palm River. Both canals control flooding in the city of Tampa. Urban and built-up areas dominate the landscape in the southern quarter of the planning unit, which includes the urban and suburban areas of Tampa, Plant City, and Lakeland. In the upper half of the planning unit (to the north), urban and suburban areas appear as an east-west band encompassing Zephyrhills, Wesley Chapel, and Land O' Lakes. Together, urban and built-up lands comprise 25 percent of the total area. Within the region, which is characterized by expanding population growth and land development, large areas of swamps and forested uplands remain undeveloped along portions of the Hillsborough River and its principal tributaries. Together with other undeveloped lands, natural lands (uplands and wetlands) comprise 39 percent of the planning unit.

Throughout most of the rest of the planning unit, particularly in the upper reaches of its tributaries, land uses are primarily rangeland, pasture, and agriculture, including citrus groves and row crops. The greatest acreages of citrus are found around Land O' Lakes, in the Plant City/Dover/Seffner area south and east of Lake Thonotosassa, in the area around Lakeland, and in a wide area north of Zephyrhills. Generally, the northern and central portions of the watershed are rural, while the southern portions are mainly urban and industrial. However, suburban development radiating from major urban areas such as Tampa is spreading into rural areas.

Additional information about the river's hydrology and geology are available in the Basin Status Report for the Tampa Bay Tributaries Basin (Florida Department of Environmental Protection, 2003). For assessment purposes, the Florida Department of Environmental Protection (the Department) has divided the Tampa Bay Tributaries Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. The Hillsborough River has been divided into WBIDs or segments.

The Flint Creek segment (WBID 1522A) is third order stream located in Hillsborough County and has a surface area of 4.2 square miles, and an overall drainage area of 60 square miles. The river is 2.3 miles in length and flows from Lake Thonotosassa to the Hillsborough River. The Flint Creek System lies between U.S. Highway 301 to the north, and Lake Thonotosassa to the southeast. Flint Creek receives discharge from Lake Thonotosassa, the Campbell Branch System and the Antioch Branch System. The system originates at the SWFWMD lake-level control structure for Lake Thonotosassa, which is located near the northeast corner of the Lake. From that point, the system flows due east and then turns to the north where it receives discharge from the Campbell Branch System. It is essentially an open channel at this point with steep side slopes and a muddy, silty bottom. The system, for most of its distance, traverses rural lands. Further north, near Knights-Griffin Road, the system receives discharge from the Antioch Branch System. The surface water flows are then passed under the Knights-Griffin Road bridge and toward a large wetland located immediately south of U.S. Highway 301. This southern wetland then connects, via two bridge openings under U.S. Highway 301, to the outfall, which is the Lower Hillsborough River Flood Detention Area and subsequently, the Hillsborough River further to the north (Hillsborough County Public Works Department, 2002). Along its length, Flint Creek exhibits characteristics associated with riverine aquatic environments. Flint Creek is a Class III water body, whose designated uses under Rule 62-302.400, Florida Administrative Code (F.A.C.), include human recreation and the “propagation and maintenance of a healthy, well-balanced population of fish and wildlife.”

Lower Hillsborough River (WBID 1443E) is located in the northern portion of the city of Tampa, a city of 303,447 (2000 U.S. Census); Cow House Creek (WBID 1534) is a tributary to Hillsborough River located below the confluence with Flint Creek; and Middle Hillsborough River WBID 1443B is a section of the Hillsborough river about midway between the mouth and headwaters. See Figure 1

Additional information about these creeks’ hydrology and geology are available in the Basin Status Report for the Tampa Bay Tributaries Basin (Florida Department of Environmental Protection, March 2003) and the Pemberton Creek and Baker Canal Area Stormwater Management Master Plan (Hillsborough County Pubic Works Department, 2002).

WATER QUALITY STANDARD AND TARGET IDENTIFICATION

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)

Waterbodies in the Hillsborough River Basin are classified as freshwater Class III waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria are as follows:

Nutrients

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.] 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 and fauna [Section 62.302530 F.A.C.].

The IWR provides a threshold for nutrient impairment for streams and estuaries based on annual average chlorophyll *a* levels, these thresholds are not standards and need not be used as the nutrient-related water quality target for TMDLs. In fact, in recognition that the IWR thresholds were developed using statewide average conditions, the IWR (Section 62-303.450, F.A.C.) specifically allows the use of alternative, site-specific thresholds that more accurately reflect conditions beyond which an imbalance in flora or fauna occurs in the waterbody.

As there were no site-specific thresholds for nutrient impairment available for Flint Creek, Cow House Creek and Hillsborough River, the water quality targets used to determine the TMDL for this system were nutrient impairment for freshwater streams is assessed by determining if annual average chlorophyll *a* values exceed 20 μg/L. For developing these TMDLs, the water quality target is an annual average total nitrogen (TN) and total phosphorous (TP) concentrations that yield an annual average chlorophyll *a* value of 20 μg/L.

Dissolved Oxygen (DO)

Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

Ambient Water Quality Data Flint Creek, WBID 1402:

Table 1 Flint Creek Water Quality Data Summary Statistics

WBID 1402

Parameter	Obs	Max	Min	Mean	StDev	Median
Dissolved Oxygen (mg/l)	472	12.59	0.10	2.68	1.69	2.4
Chlorophyll A (mg/l)	56	27.40	0.10	5.30	7.53	1.90
Phosphorus Total as P (mg/l)	264	0.53	0.01	0.07	0.06	0.06
Nitrogen Total as N (mg/l)	342	3.79	0.58	1.43	0.61	1.3

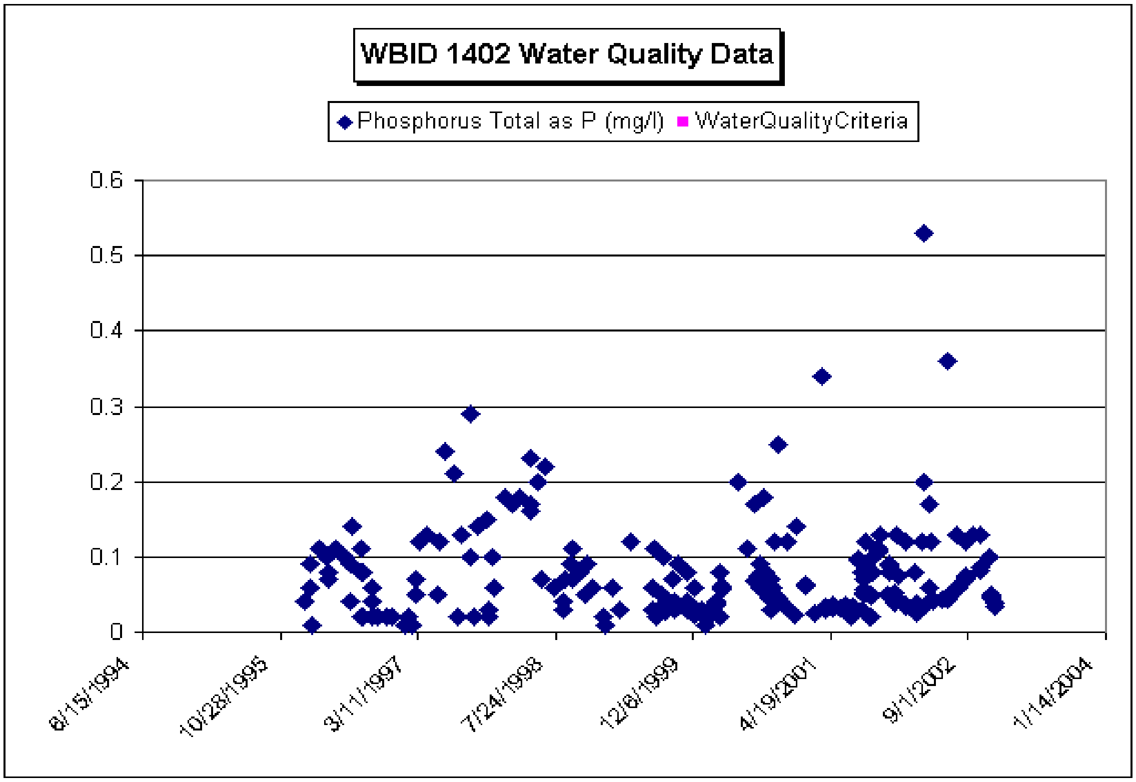


Figure 2 Flint Creek Total Phosphorous

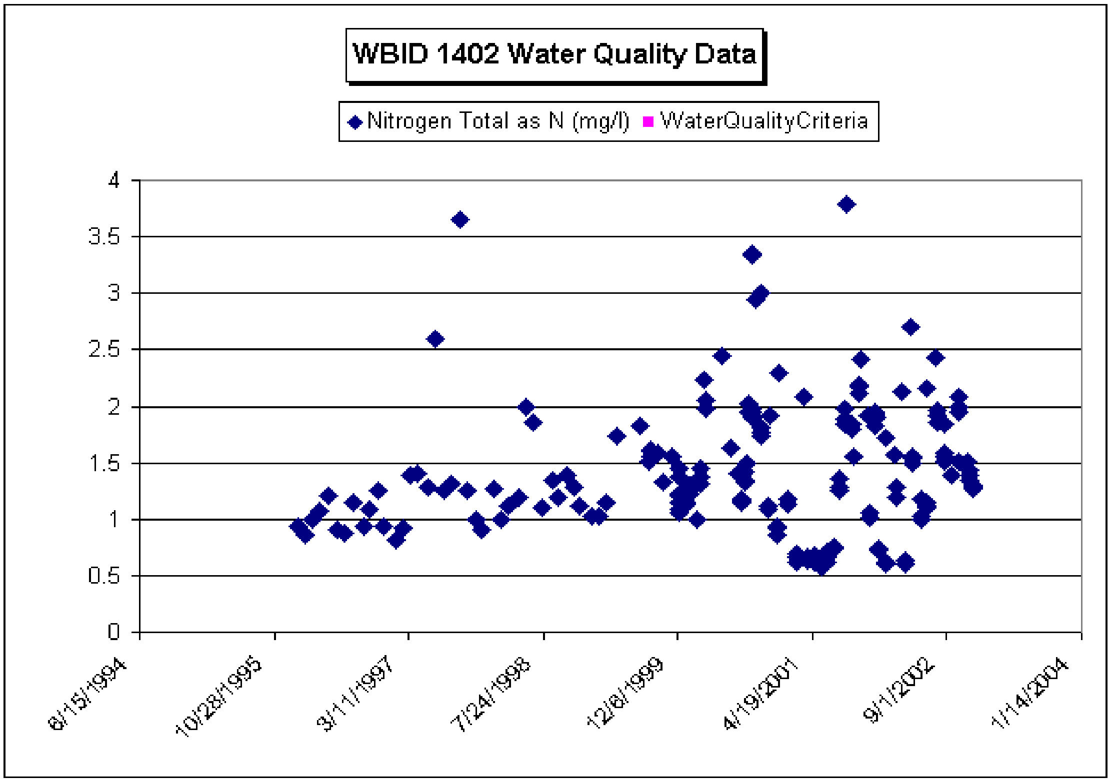


Figure 3 Flint Creek Total Nitrogen

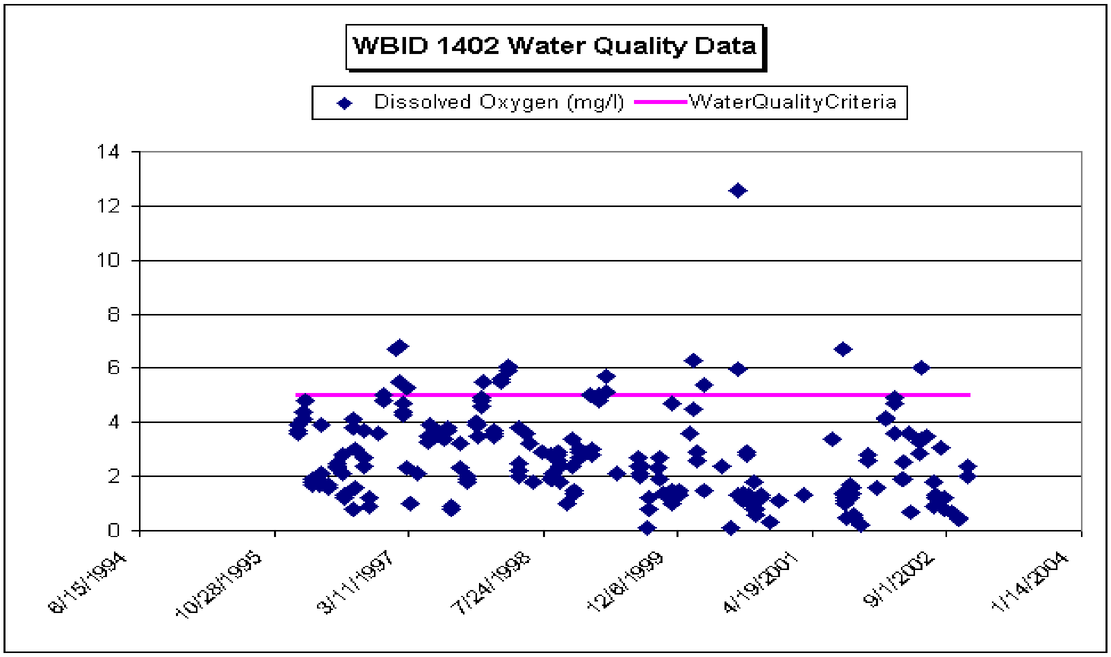


Figure 4 Flint Creek Dissolve Oxygen

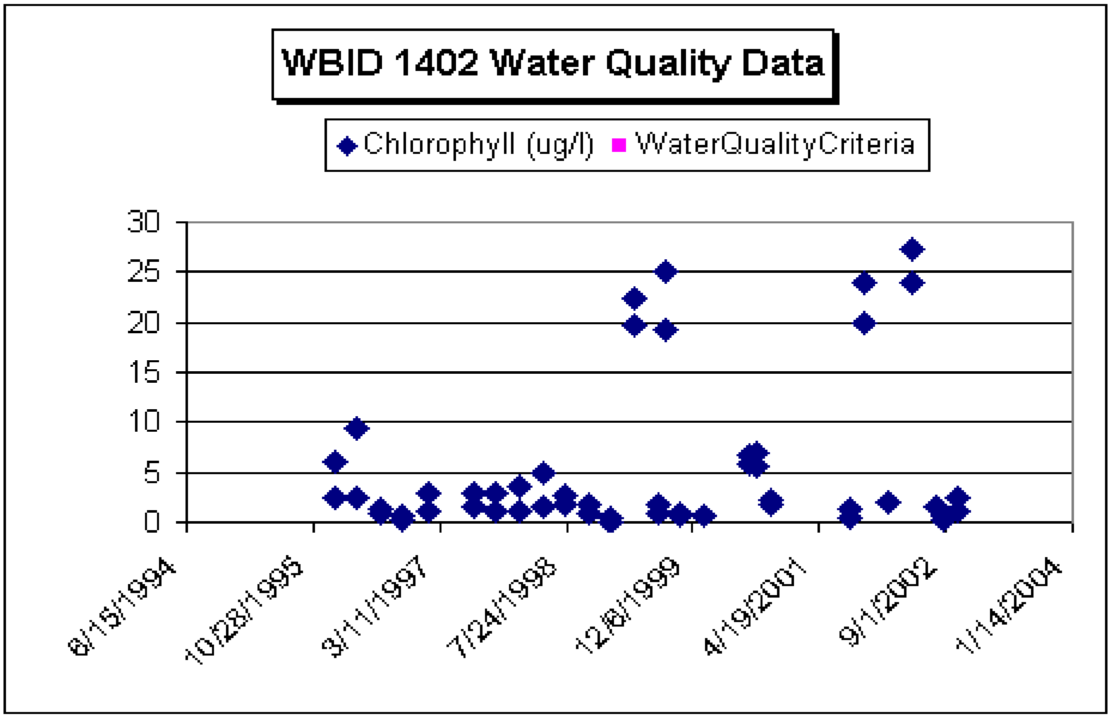


Figure 5 Flint Creek Chl-a

Ambient Water Quality Data Middle Hillsborough River, WBID 1443B

Table 2 Middle Hillsborough River Water Quality Data Summary Statistics

WBID 1443B

Parameter	Obs	Max	Min	Mean	StDev	Median
Dissolved Oxygen (mg/l)	116	8.20	1.49	5.07	1.74	5.05
Chlorophyll A (mg/l)	10	2.50	0.85	1.06	0.52	0.85
Phosphorus Total as P (mg/l)	172	0.755	0.036	0.205	0.162	0.131
Nitrogen Total as N (mg/l)	236	1.89	0.44	1.01	0.37	0.945

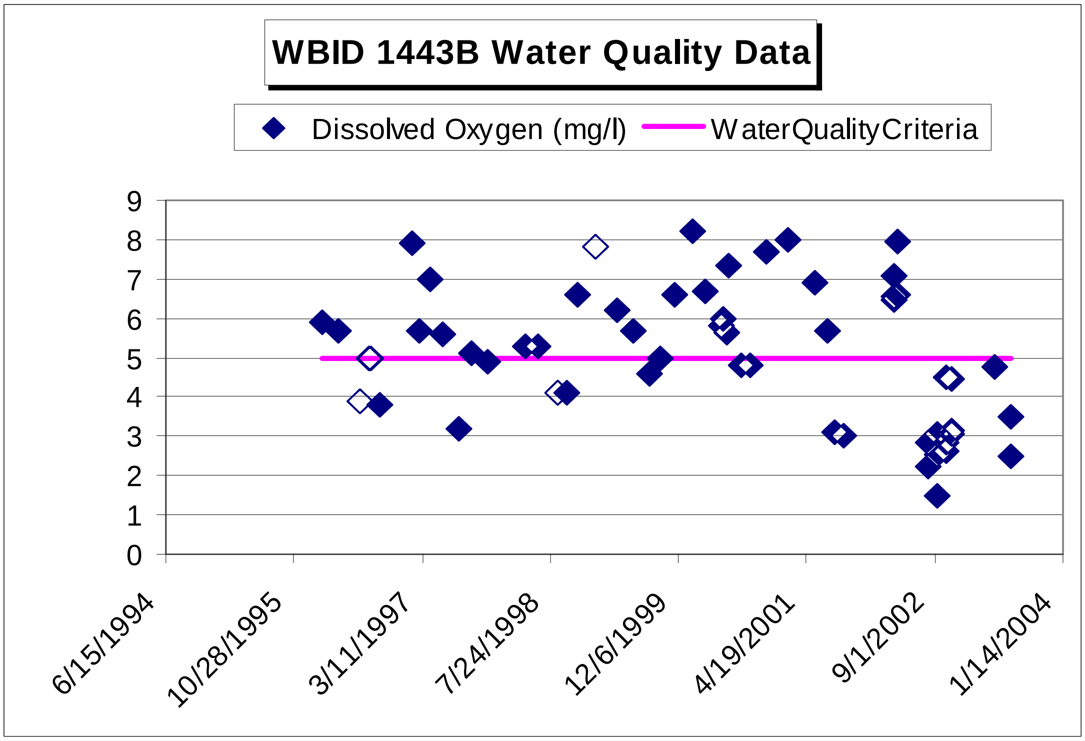


Figure 6 Middle Hillsborough River Dissolved Oxygen

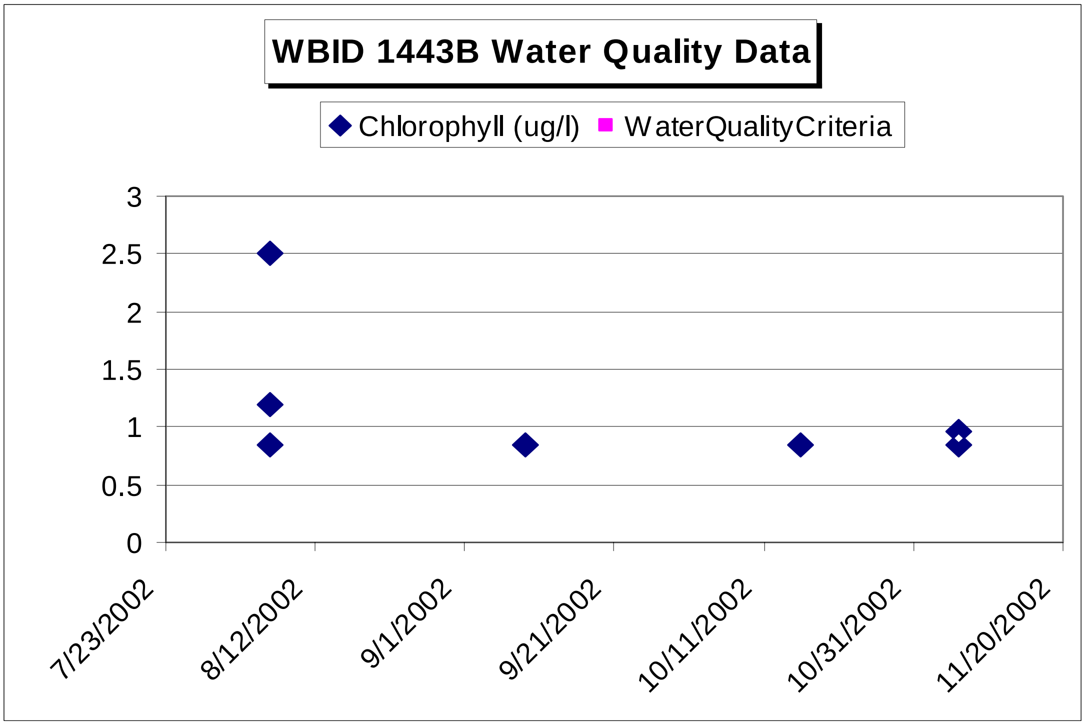


Figure 7 Middle Hillsborough River Chl-a

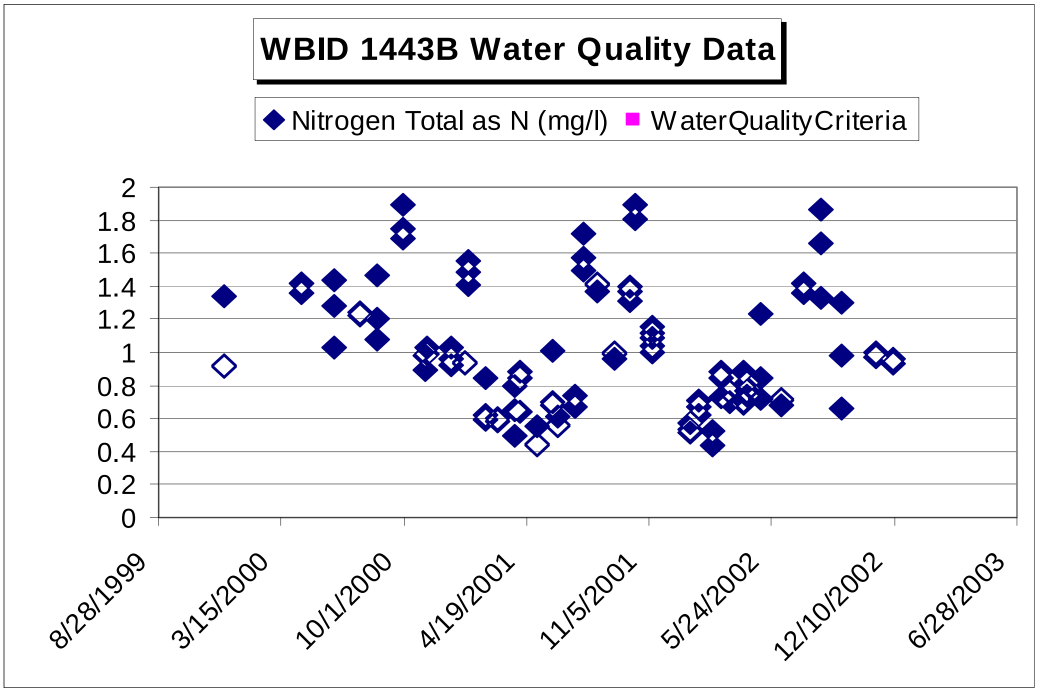


Figure 8 Middle Hillsborough River Total Nitrogen

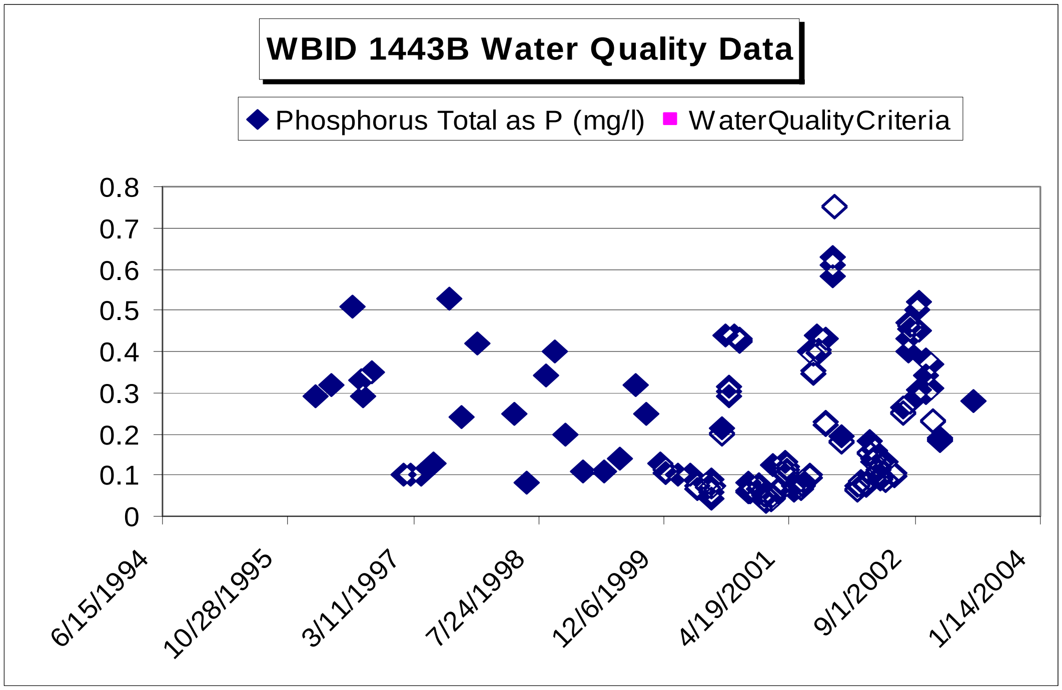


Figure 9 Middle Hillsborough River Total Phosphorus

Ambient Water Quality Data Cow House Creek WBID 1534

Table 3 Cow House Creek Water Quality Data Summary Statistics

WBID 1534

Parameter	Obs	Max	Min	Mean	StDev	Median
Dissolved Oxygen (mg/l)	44	9.53	0.60	2.91	2.38	2.37
Chlorophyll A (mg/l)	15	70.00	0.85	12.01	19.16	3.6
Phosphorus Total as P (mg/l)	21	0.86	0.05	0.46	0.26	0.48
Nitrogen Total as N (mg/l)	26	2.21	0.29	1.33	0.52	1.32

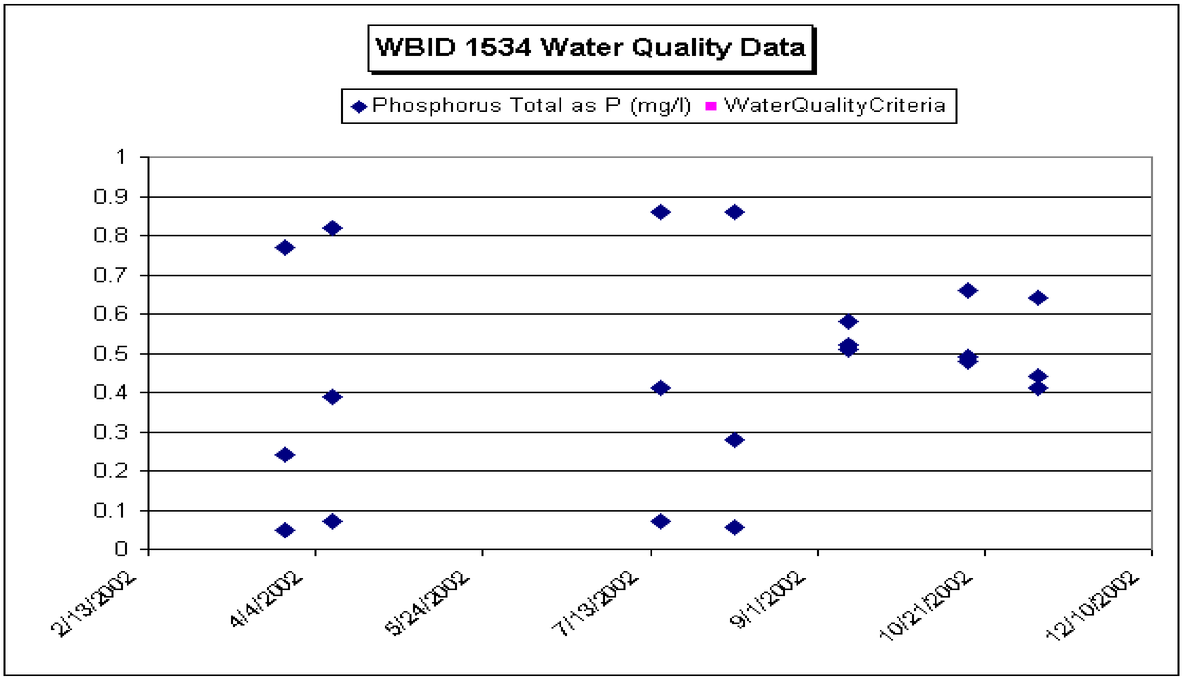


Figure 10 Cow House Creek Total Phosphorous

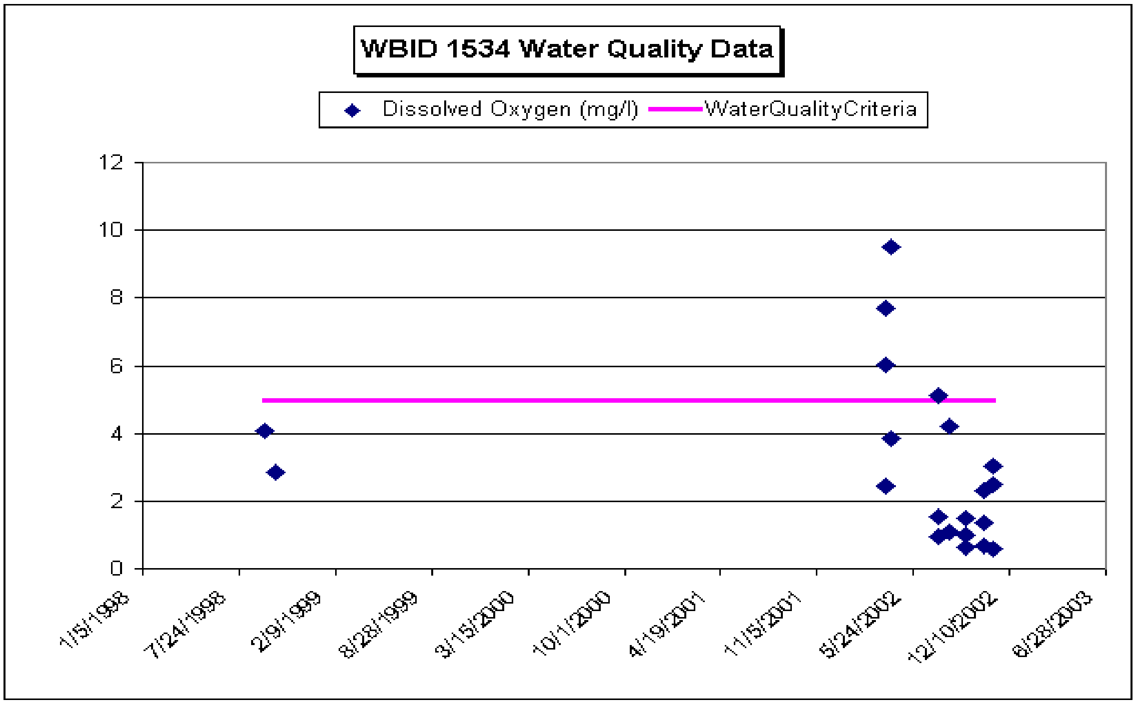


Figure 11 Cow House Creek Dissolved Oxygen

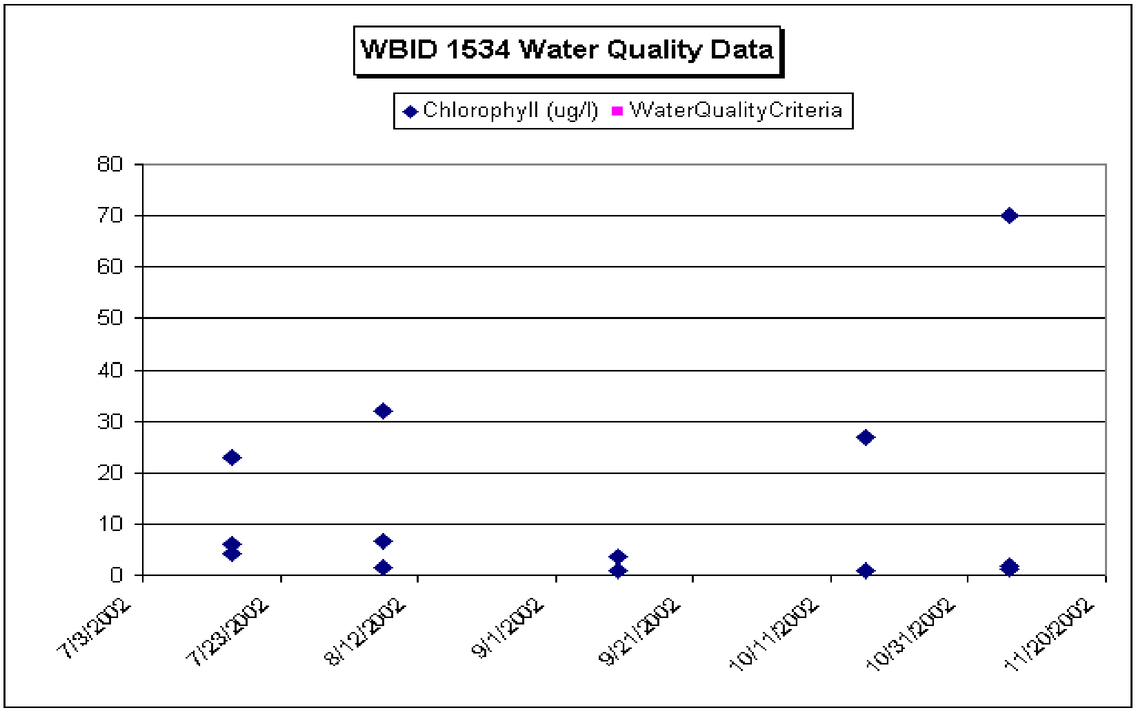


Figure 12 Cow House Creek Chl-a

Ambient Water Quality Data Lower Hillsborough River WBID 1443E:

Table 4 Lower Hillsborough River Water Quality Data Summary Statistics

WBID 1443E

Parameter	Obs	Max	Min	Mean	StDev	Median
Dissolved Oxygen (mg/l)	1515	13.30	0.04	4.09	2.31	4.1
Chlorophyll A (mg/l)	679	306.00	0.00	19.30	28.00	11
Phosphorus Total as P (mg/l)	359	1.430	0.010	0.232	0.136	0.210
Nitrogen Total as N (mg/l)	470	2.43	0.27	1.03	0.37	0.95

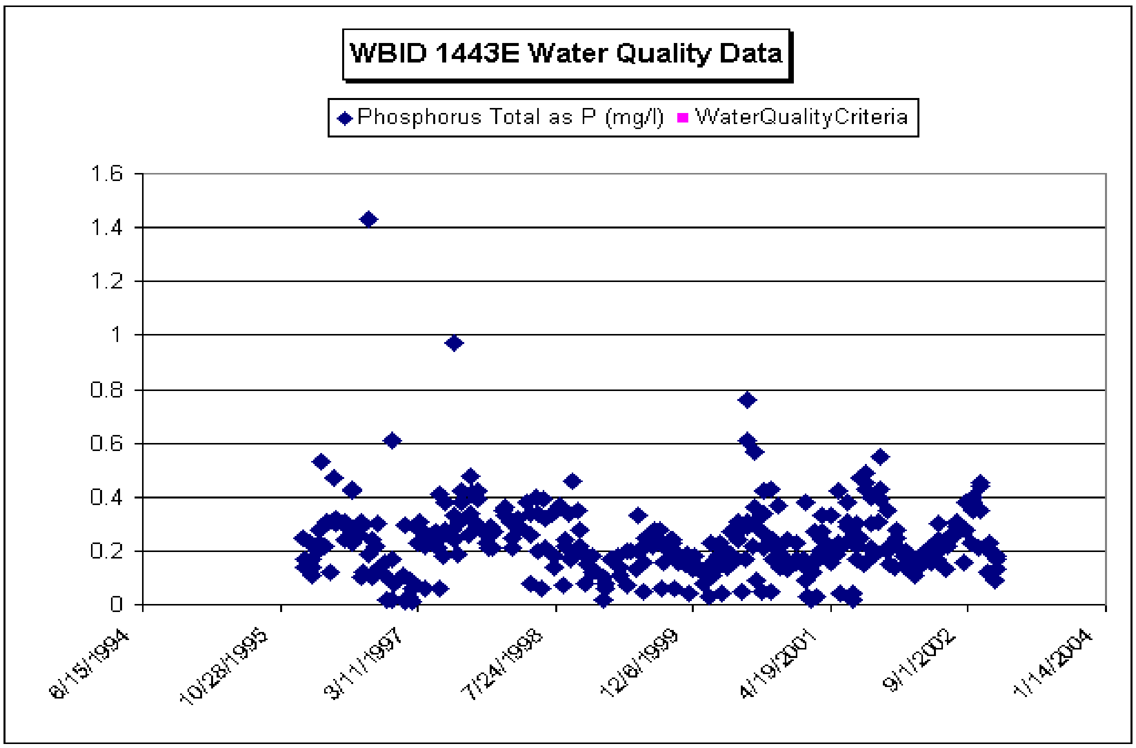


Figure 13 Lower Hillsborough River Total Phosphorous

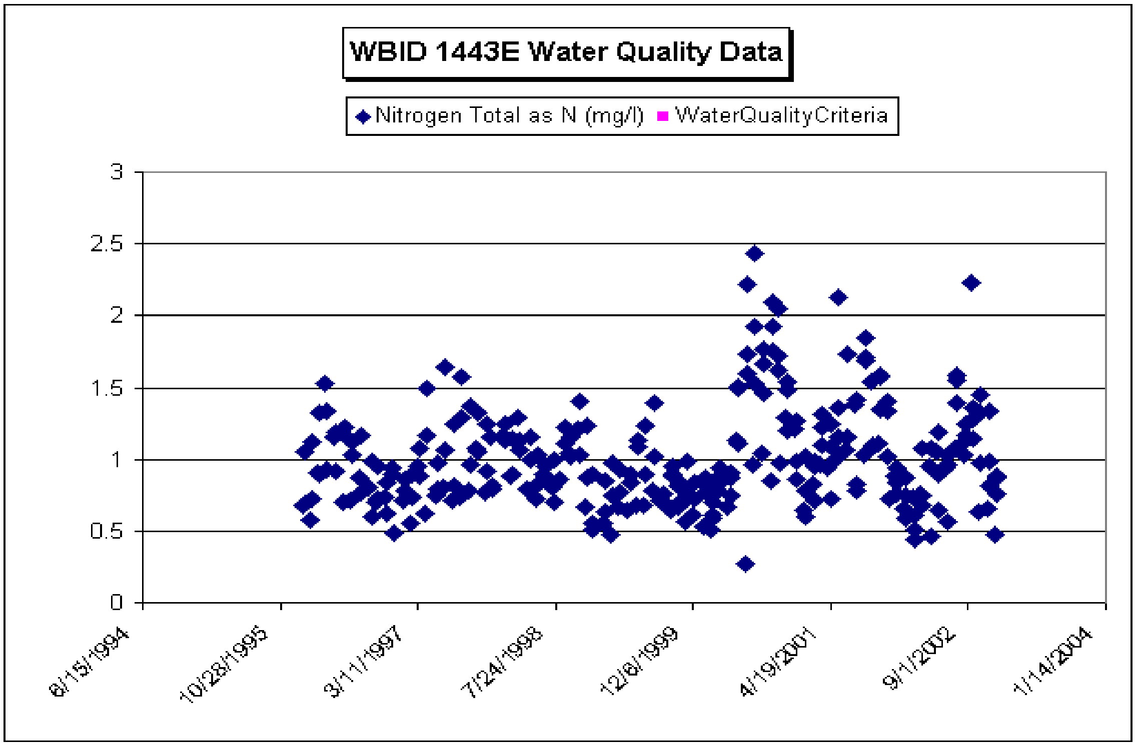
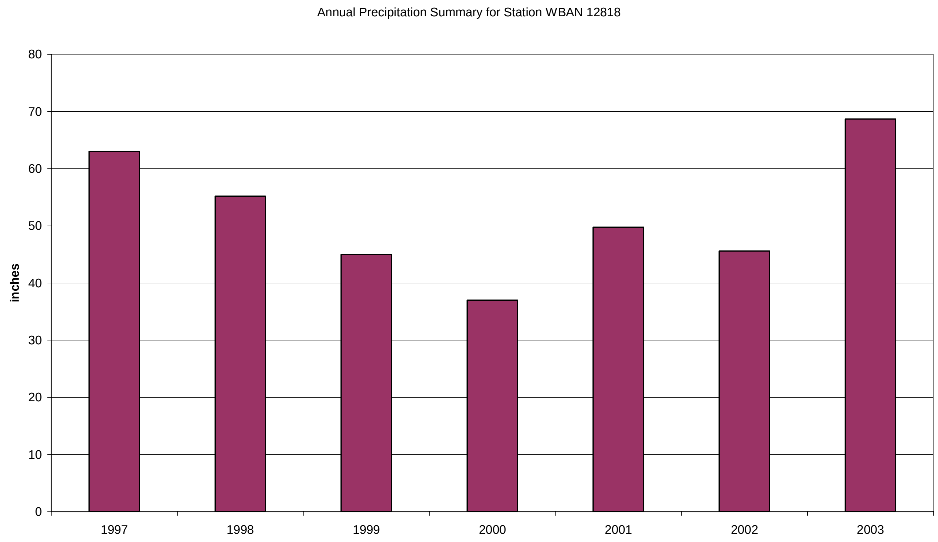


Figure 14 Lower Hillsborough River Total Nitrogen

Precipitation Data

NCDC meteorological stations in the Hillsborough River Basin include two WBAN stations and three COOP stations. These are WBAN 12818 Brooksville, WBAN 92802 Newport Ritchie, COOP 083986 Hillsborough River State Park, COOP 088783 Tampa Fowler Ave., and COOP 087205 Plant City. Annual summaries of the precipitation recorded at these stations shows wet and dry periods in the years from 1997 to 2003.


Annual Precipitation Summary for Station WBAN 12818
inches
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10
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30
40
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60
70
80
1997
1998
1999
2000
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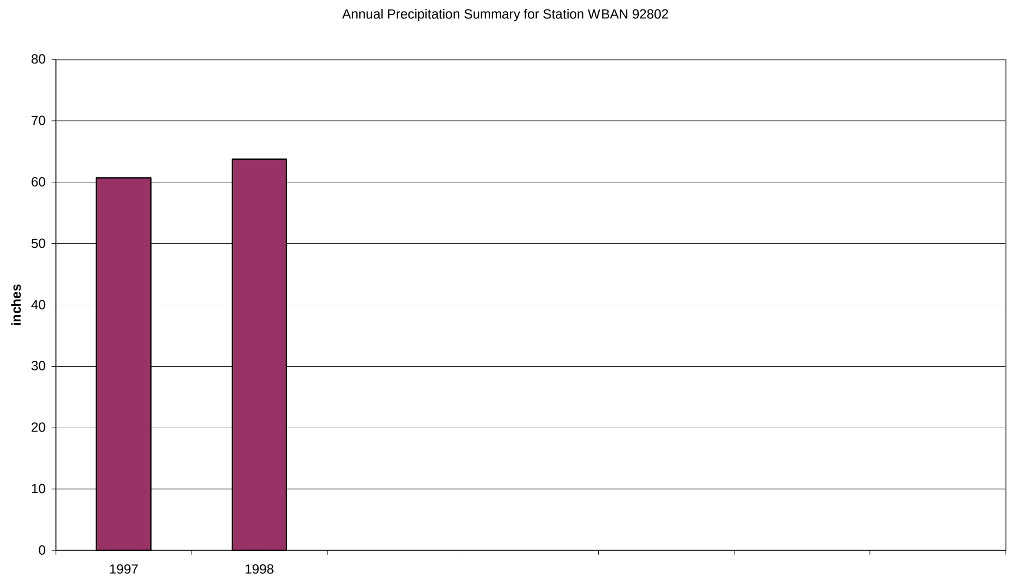
2002
2003


Annual Precipitation Summary for Station WBAN 92802
inches
0
10
20
30
40
50
60
70
80
1997
1998

Source Assessment

An important part of the TMDL analysis is the identification of sources or source categories in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities including certain urban stormwater discharges such as municipal separate storm sewer systems (MS4 areas), certain industrial facilities, and construction sites over one acre are storm water driven sources that are considered as "point sources" in this report.
Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance. These include nutrient runoff of agricultural fields and golf courses, septic tanks, and residential developments outside of MS4 areas.

Estimating Nonpoint Loadings

The Watershed Assessment Model (WAM) was utilized to estimate the flow, nutrients, total suspended solids, and BOD loads discharged from the Flint Creek watershed system. WAM (Soil and Water Engineering Technologies, Inc., 2004) is a Geographic Information Based (GIS) based model that allows engineers and planners to interactively simulate and assess the environmental effects of various land use changes and associated land use practices. The output from the WAM model was then used by the Watershed Assessment and Simulation Program (WASP) model to simulate the DO and Chl-a responses to nutrient loads within the watershed's TMDL listed WBID reaches.

Municipal Separate Storm Sewer System Permittees

Municipal separate storm sewer systems (MS4s) may discharge nutrients to waterbodies in response to storm events. To address stormwater discharges, the EPA developed the NPDES stormwater permitting program in two phases. Phase I, promulgated in 1990, addresses large and medium MS4s located in incorporated places and counties with populations of 100,000 or more. Phase II permitting began in 2003. Regulated Phase II MS4s, which are defined in Section 62-624.800, F.A.C., typically cover urbanized areas serving jurisdictions with a population of at least 10,000 or discharge into Class I or Class II waters, or Outstanding Florida Waters.

The stormwater collection systems in the Flint and Cow House Creeks and Hillsborough River watersheds, which are owned and operated by Hillsborough County in conjunction with the Florida Department of Transportation, are covered by Phase I MS4 permits.

Within the Tampa Bay Basin, the stormwater collection systems owned and operated by Plant City, Hillsborough County, and the Florida Department of Transportation for Hillsborough County are covered by an NPDES municipal separate storm sewer system (MS4) permit, FLS000006. Hillsborough County is the lead co-permittee for the watersheds. In October 2000, Hillsborough County drafted a watershed management plan involving berm construction, channel improvements, and structural upgrades for flood control and some water quality treatment. Other recommendations for the watersheds included beginning a study to identify areas or sources that discharge pathogens, and beginning to provide treatment through the implementation of best management practices (BMPs) to reduce the loadings.

The Hillsborough Planning and Growth Management Department is in the process of carrying out a septic tank study for the watersheds that identifies the location of septic tanks, assesses their impacts on water quality, and recommends management techniques to improve their efficiency.

ANALYTICAL APPROACH/ MODEL SELECTION AND DEVELOPMENT

Since these WBID was impaired for low DO and high Chl-a, a water quality simulation model of the complex DO processes was utilized to analyze and develop the TMDLs. Only seasonal trends of DO and Chl-a were simulated since DO and Chl-a violations of the standard were observed in the monthly trend monitoring data. The data show that DO meets the water quality standard upstream of the impaired WBID (in 1443D), while the impaired WBID 1443B has low DO.

Mechanistic Model Approach

WAM was utilized to simulate the watershed hydrology and water quality loads for most of the Hillsborough River Basin. WASP models were set up to examine the DO processes in the Flint Creek and Hillsborough River mainstem and the Cow House tributary. The WAM model was used to predict flows and nutrient loads which were then linked to the WASP models.

The following summary on of the WAM model is from EPA's Watershed and Water Quality Modeling Technical Support Center web site (http://www.epa.gov/athens/wwqtsc/WAMView.pdf). WAM's interface uses ESRI's ArcView 3.2a with Spatial Analyst 1.1 (or 2.0). WAM was developed to allow engineers and planners to assess the water quality of both surface water and groundwater based on land use, soils, climate, and other factors. The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. The WAM GIS-based coverages include land use, soils, topography, hydrography, basin and sub-basin boundaries, point sources and service area coverages, climate data, and land use and soils description files. The coverages are used to develop data that can be used in the simulation of a variety of physical and chemical processes.

WAM was developed based on a grid cell representation of the watershed. The grid cell representation allows for the identification of surface and groundwater flow and phosphorus concentrations for each cell. The model then “routes” the surface water and groundwater flows from the cells to assess the flow and phosphorus levels throughout the watershed. The model simulates the following elements: surface water and ground water flow allowing for the assessment of flow and pollutant loading for a tributary reach at both the daily and hourly time increment as necessary; water quality including particulate and soluble phosphorus, particulate and soluble nitrogen (NO3, NH4, and organic N), total suspended solids, and biological oxygen demand.

WAM was linked to WASP (SWET, 2003), which enables the simulation of dissolved oxygen and chlorophyll-a. The WAM model simulates the hydrology of the watershed using other imbedded models including “Groundwater Loading Effects of Agricultural Management Systems” (GLEAMS; Knisel, 1993), “Everglades Agricultural Area Model” (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning’s flow equation based technique (Jacobson et al., 1998). Attenuation is based on the flow rate, characteristics of the flow path, and the distance of travel. The model provides many features that improve its ability to simulate the physical features in the generation of flows and loadings including:

- Flow structures simulation
- Generation of typical farms
- BMPs
- Rain zones built into unique cells, definitions, which use NEXRAD Data
- Full erosion/deposition and in-stream routing –is used with ponds and reservoirs
- Closed basins and depressions are simulated
- Separate simulation of vegetative areas in residential and urban
- Simulation of point sources with service areas
- Urban retention ponds
- Impervious sediment buildup/washoff
- Shoreline reaches for more precise delivery to rivers, lakes, and estuaries
- Wildlife diversity within wetlands
- Spatial map of areas having wetland assimilation protection
- Indexing submodels for BOD, bacteria, and toxins

The overall operation of the model is managed by the ArcView-based interface. The interface allows the user to view available data, modify land use conditions, execute the model, and view results.

In order to evaluate the effect of nutrients and other oxygen demanding substances on DO and Chl-a processes a Water Quality Analysis Simulation Program (WASP) model was setup for this river segment. The Water Quality Analysis Simulation Program version 7 (WASP6) is an enhancement of the original WASP (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988). This model helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP7 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program.

Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP6 comes with two such models -- TOXI for toxicants and EUTRO for conventional water quality. Earlier versions of WASP have been used to examine eutrophication of Tampa Bay; phosphorus loading to Lake Okeechobee; eutrophication of the Neuse River and estuary; eutrophication and PCB pollution of the Great Lakes (Thomann, 1975; Thomann et al., 1976; Thomann et al, 1979; Di Toro and Connolly, 1980), eutrophication of the Potomac Estuary (Thomann and Fitzpatrick, 1982), kepone pollution of the James River Estuary (O'Connor et al., 1983), volatile organic pollution of the Delaware Estuary (Ambrose, 1987), and heavy metal pollution of the Deep River, North Carolina (JRB, 1984). In addition to these, numerous applications are listed in Di Toro et al., 1983.

The flexibility afforded by the Water Quality Analysis Simulation Program is unique. WASP6 permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions. The eutrophication module of WASP6 was applied to the Hillsborough River in this study.

Water quality concentrations and temperature from the water quality stations near the headwaters of Hillsborough River were entered as the upstream boundary conditions. Flow, depth, and velocity data predicted by the WAM model was used in the WASP models. Solar radiation data was obtained on the University of Florida Institute of Food and Agricultural Sciences, Florida Automated Weather Network world-wide-web site http://fawn.ifas.ufl.edu/. The Apopka weather station data was used in this modeling project. Sediment oxygen demand (SOD) can be a major contributor to low D.O. SOD measurements in the nearby Alafai River range from 1.2 to over 7 grams/square meter/day, (Measured Sediment Oxygen Demand Rates, USEPA). SOD measurements in the Ocklawaha River Basin's Rice Creek upstream of the Georgia Pacific Mill discharge range from 1.5 to 3.0. A SOD rate of 1.5 was used in this WASP model for Hillsborough River. Incremental BOD and nutrient loads were entered into WASP from the results of the WAM model.

Estimate 1999 to 2003 Watershed Loads

The estimated existing nutrient and BOD loads from the watersheds of concern are in Table 1.

Table 5 Estimated Watershed Loads

Estimated Watershed loads for Hillsborough River WBID

1443B

Year	TN (kg/d)	TP (kg/d)	BOD (kg/d)	Annual Average Flow (m3/s)
1999	361	71	478	3.88
2000	427	92	527	4.07
2001	763	148	1064	8.05
2002	690	114	764	7.30
2003	688	109	790	9.39

Estimated Watershed loads for Hillsborough River WBID 1443E

Year	TN (kg/d)	TP (kg/d)	BOD (kg/d)	Annual Average Flow (m3/s)
1999	432	81	528	4.35
2000	587	109	727	5.08
2001	1132	201	1560	11.37
2002	997	155	1116	10.25
2003	1101	163	1186	13.64

Estimated Watershed loads for Flint Creek WBID 1522A

Year	TN (kg/d)	TP (kg/d)	BOD (kg/d)	Annual Average Flow (m3/s)
1999	95	18	142	0.84
2000	127	26	151	1.00
2001	192	42	317	1.53
2002	153	28	190	1.27
2003	176	37	204	1.74

Estimated Watershed loads for Cow House Creek WBID 1534

Year	TN (kg/d)	TP (kg/d)	BOD (kg/d)	Annual Average Flow (m3/s)
1994	115	25	132	1.25
1995	96	17	105	1.05
1996	87	16	96	1.02
1997	113	28	156	1.16
1998	160	32	202	1.80
1999	63	13	86	0.61
2000	73	17	95	0.64
2001	130	26	176	1.25
2002	116	19	127	1.15
2003	121	21	136	1.51

Another important factor controlling the DO and Chl-a in the listed watersheds are the nutrient concentrations being discharged from Lake Thonotosassa. Average 1997 to 2002 nutrient concentrations are:

- Organic Nitrogen: 3.0 mg/l

- Organic Phosphorous: 0.4 mg/l

Total Maximum Daily Loads

There are no continuous discharging point sources in the watersheds, therefore the TMDL consist of only municipal storm water sources, non point source and background nutrient loads.

Initial model runs indicated nutrient reduction was needed to meet both the DO and nutrient / Chl-a targets. Included in these reductions were the nutrient loads were from Lake Thonotosassa. The nutrient and Chl-a concentrations released from Lake Thonotosassa into Flint Creek then through the Hillsborough River impact the DO and Chl-a concentrations in the watersheds of concern. The Tampa Bay SWMM plan has Pollutant Load Reduction Goal for Lake Thonotosassa that require the following annual concentrations:

- Chl-a : 20 µg/l
- Organic Nitrogen: 1.2 mg/l
- Organic Phosphorous: 0.07 mg/l

These concentrations and resulting loadings were incorporated into the TMDL model.

In addition, 30 percent reductions in the nitrogen and phosphorous watershed loadings to the Flint Creek, Cow House Creek and Middle and Lower Hillsborough River are needed to meet the DO and Chl-a targets in each of the listed waterbodies This percent reduction to be applied to both the non point source watershed nutrient loads and to the municipal separate storm sewer systems (MS4s) nutrient loads. Below is the specific annual average load, resulting from a 30 percent reduction needed for the impaired watersheds.

Table 6 TMDL Watershed Loads (average annual)

WBID	Pollutant	WLA		LA (kg/day)	MOS	TMDL (kg/day)	Percent Reduction
		Continuous (kg/day)	MS4 (reduction)				
1443B	TN	0	30%	176	implicit	176	30%
	TP	0	30%	32	implicit	32	30%
1443E	TN	0	30%	255	implicit	255	30%
	TP	0	30%	43	implicit	43	30%
1522A	TN	0	30%	45	implicit	45	30%
	TP	0	30%	9	implicit	9	30%
1534	TN	0	30%	32	implicit	32	30%
	TP	0	30%	6	implicit	6	30%

CRITICAL CONDITIONS and MARGIN OF SAFETY

Critical conditions and Margin of safety were considered by analyzing a seven year period containing wet, normal, and dry conditions. Since these impaired waters receive both storm water driven loads and continuous flow loads, both wet events and dry events were analyzed.

SEASONAL VARIATION

Seasonal variation was considered by analyzing a seven year period containing wet, normal, and dry conditions.

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