Appendix A:

Modeling Report

Six Mile Creek

(Tampa, FL)

WBIDs: 1536 B & F

Nutrients and Dissolved Oxygen

September 30, 2009

Region4 serving the southeast

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1. Watershed Description

Six Mile Creek (Tampa) is in the Tampa Bay tributary planning unit and is located in Hillsborough County. WBID 1536 B & F were listed as not attaining its designated uses on Florida's 1998 303(d) list for Nutrients and Dissolved Oxygen. Figure 1 provides the location of Six Mile Creek (Tampa).

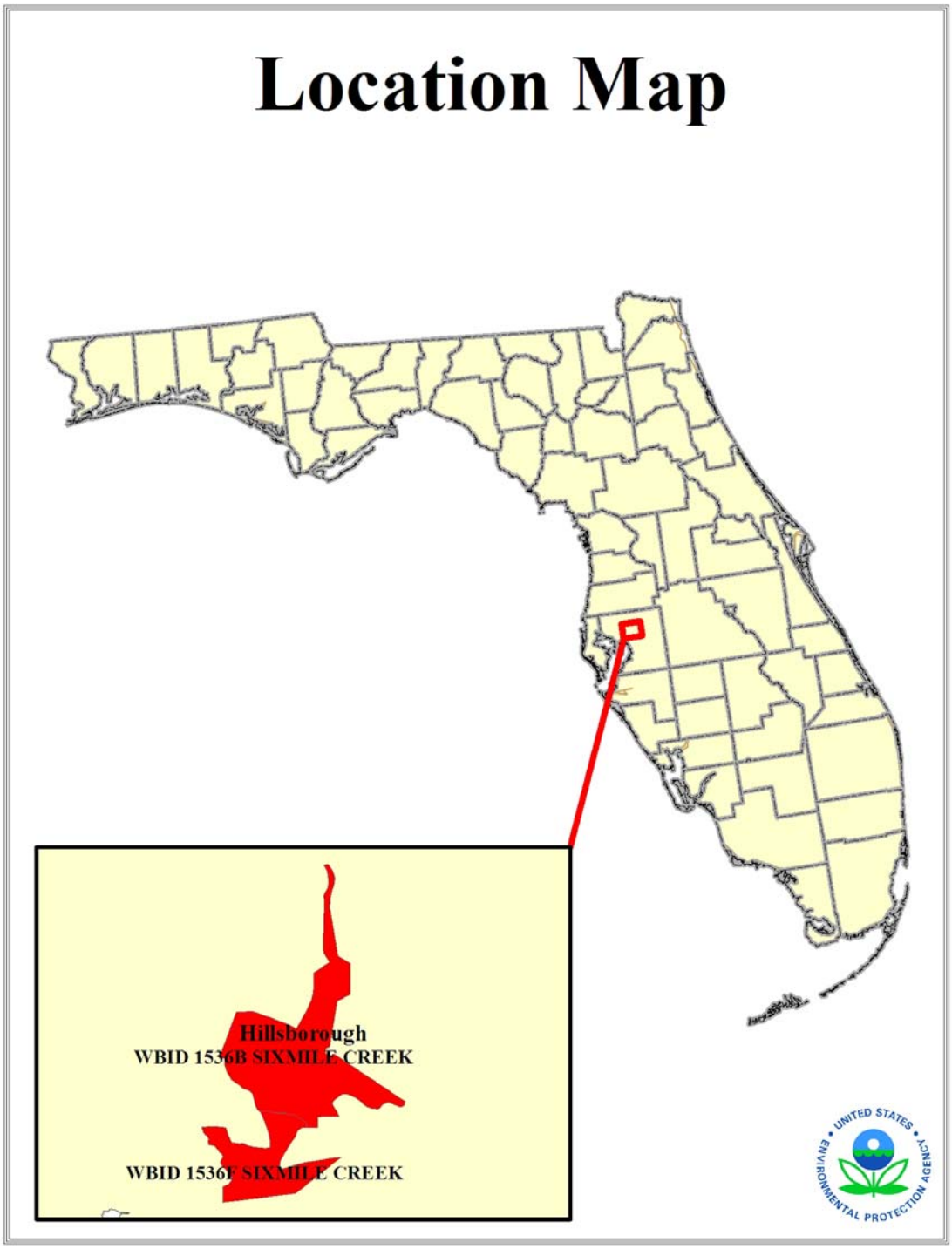

Figure 1 Location Map Six Mile Creek (Tampa)

The landuse distribution for the Six Mile Creek (Tampa) and watershed is presented in Table 1.

Table 1 Landuse Distribution in Six Mile Creek (Tampa) Watershed

Land Use Name	Area (ac)	Portion of Watershed (%)
AGRICULTURE	1645.7	9.52
BARREN LAND	20.5	0.12
RANGELAND	66.9	0.39
TRANSPORTATION, COMMUNICATION AND UTILITIES	1524.4	8.82
UPLAND FORESTS	833.6	4.82
URBAN AND BUILT-UP	10714.1	61.96
WATER	869.3	5.03
WETLANDS	1618.1	9.36
Totals	17292.7	100

2. TMDL Targets

The TMDL target to be evaluated in this modeling report is to meet the Six Mile Creek (Tampa) dissolved oxygen standard of 5 mg/l.

3. Modeling Approach

A coupled watershed and water quality modeling framework was used to simulate biological oxygen demand (BOD), nutrients (total nitrogen and total phosphorus), and chlorophyll a (Chla) and dissolved oxygen dissolved oxygen for the time period of 2002 through 2008. The watershed model provides daily runoff, nutrient and BOD loadings from the Jane Green Watersheds. The predicted results from the LSPC model are transferred forward to the receiving waterbody model Water Quality Analysis Simulation Program (WASP 7.3) (USEPA, 2007). The WASP model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen, phosphorus, chlorophyll a and dissolved oxygen. Both LSPC and WASP will be calibrated to current conditions, a natural condition. The WASP model will be used to determine the percent reduction in loadings that would be needed to meet water quality standards.

3.1. Six Mile Creek (Tampa) Watershed Model

The goal of this watershed modeling effort is to estimate runoff (flow), nutrient (total nitrogen & total phosphorus) and BOD loads and concentrations from the upstream watersheds flowing into Six Mile Creek (Tampa). The Loading Simulation Program C++ (LSPC) as the watershed model.

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality on land 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 EPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the U.S. Environmental Protection Agency (EPA) 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 EPA TMDL Modeling Toolbox.

3.1.1. Six Mile Creek (Tampa) Watershed Delineation and Landuse

The surrounding watershed that drains directly to the Six Mile Creek (Tampa) is presented in Figure 2. This WBID was delineated into 5 LSPC sub basins to simulate the runoff and pollutant loads.

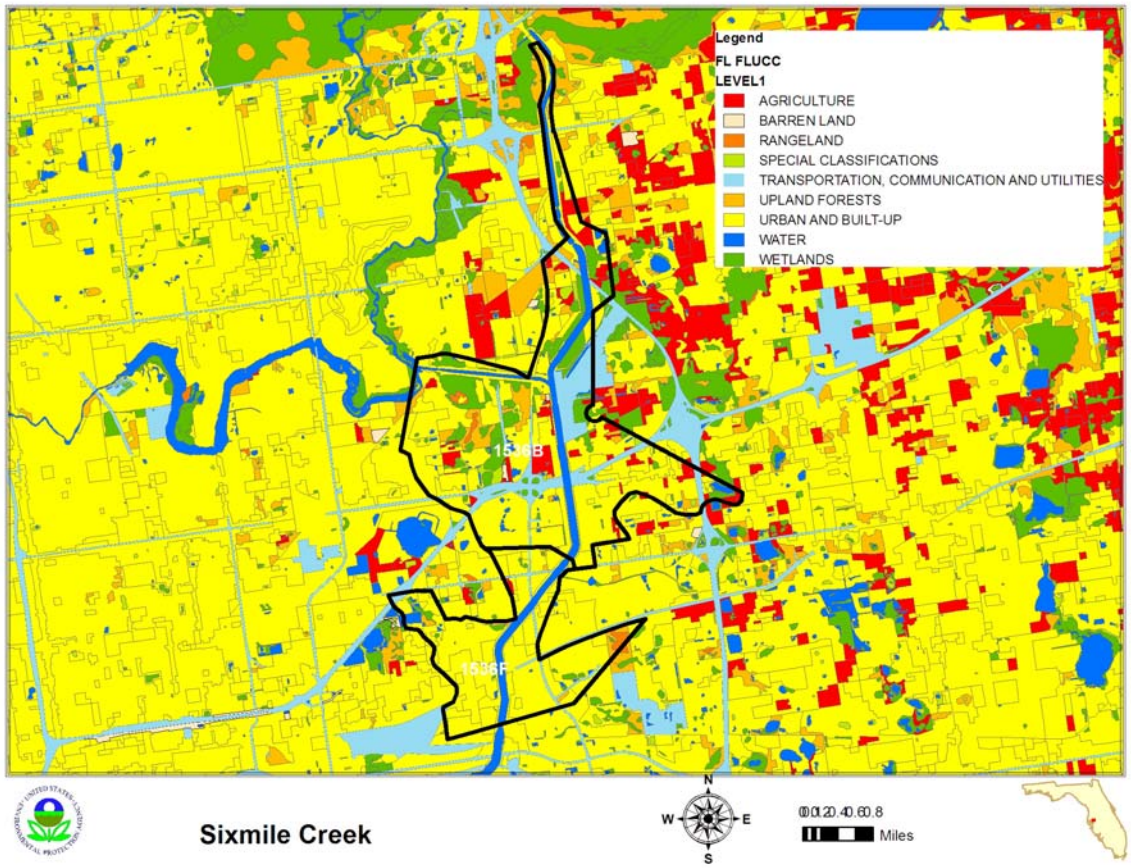

Figure 2 Six Mile Creek (Tampa) Watershed

3.2. Six Mile Creek (Tampa) Watershed Runoff

The LSPC watershed model was developed to simulate hydrologic runoff and pollutant loadings in response to recorded precipitation events.

3.2.1. Meteorological

Rainfall and other pertinent meteorological data was obtained from the National Weather Service (NWS) WBAN station number 12842**:** Tampa International Airport near Tampa, Florida.

Figure 3 provides a time series plot of daily rainfall for the simulation period.

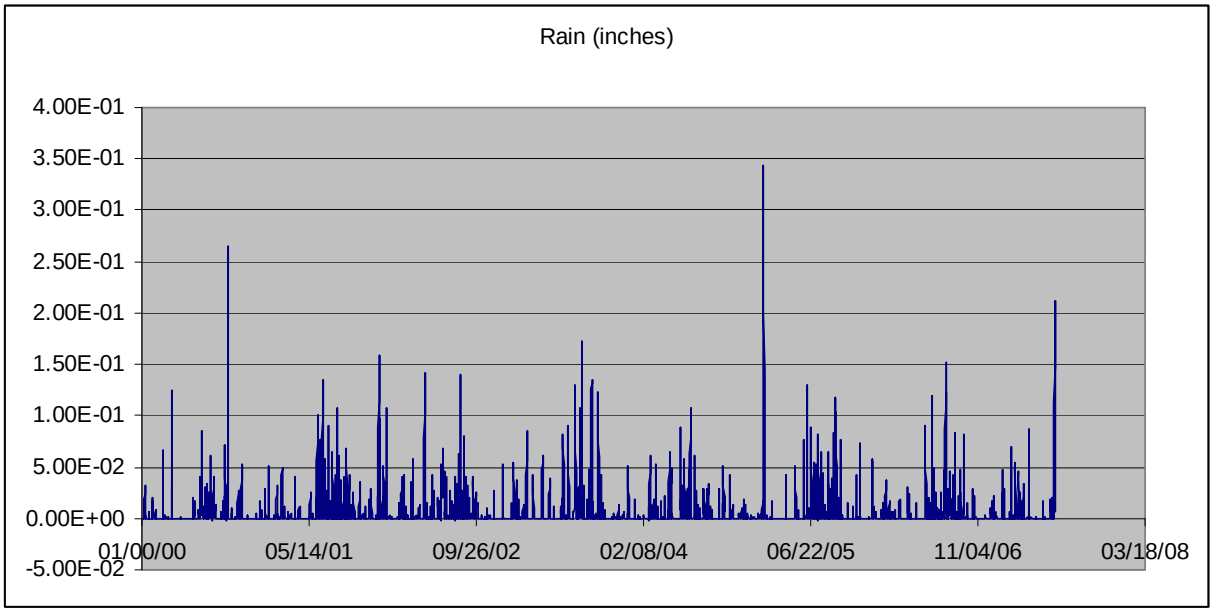

Figure 3 Rainfall for Six Mile Creek (Tampa)

Table 2 shows the annual average rainfall for each of the years simulated.

Table 2 Annual Rainfall

Year	Rainfall (Inches)
2001	**38**
2002	**61**
2003	**51**
2004	**59**
2005	**39**
2006	**57**
2007	**42**
2008	**23**

3.2.2. Flow

Flows were simulated for the Six Mile Creek (Tampa) watershed using the watershed model and the coefficients from the Alafia River LSPC model. Flows in the Six Mile

Creek (Tampa) watersheds were determined by the hydrology component of the LSPC watershed model. The hydrological values used to parameterize LSPC were taken from a previous application of the Hydrologic Simulation Program (FORTRAN) (HSPF) that was previously applied and calibrated for Sarasota County.

3.2.3. BOD and Nutrient Loadings

The pollutagraph was generated using event mean concentrations for total nitrogen, total phosphorus and BOD (Table 3). The initial EMC values were derived for each landuse type from Harpers Report (Harper, 1994) and Sarasota County modeling report (JEA 2005). Baseflow concentrations were derived from the USJR HSPF report (CDM 2007) and review of the Six Mile Creek (Tampa) data.

Table 3 Event Mean Concentration for Landuse Classifications

Landuse	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	BOD (mg/l)
Agriculture	4	1.1	8
Barren Land	4	1.1	8
Rangeland	2.2	0.34	8
Special Classification	2.2	0.3	10
Transporation	2.2	0.3	10
Upland Forest	1.02	0.16	3
Urban Area	1.5	1	10
Water	1.02	0.1	3
Wetlands	1.02	0.16	3

BOD and nutrient watershed runoff were determined using EMCs for surface water runoff and interflow runoff and baseflow concentrations for groundwater flow Table 4 provides the annual average total nitrogen, total phosphorus and BOD loads for the period of record 2002 thru 2008.

Table 4 Six Mile Creek (Tampa) Nutrient Loads (2002-2008)

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Six Mile Creek (Tampa) Watershed	55,893	12,148	319,068

3.3. Six Mile Creek (Tampa) Water Quality Model

The Six Mile Creek (Tampa) WASP water quality model integrates the predicted flows and loads from the LSPC model to simulate water quality responses in: nitrogen,

phosphorus, chlorophyll a and dissolved oxygen. A 11 segment WASP water quality model was setup to include the 5 Six Mile Creek (Tampa) sub basins and two lower end segments connecting Six Mile Creek (Tampa) to USJR.

3.3.1. WASP Model

The WASP water quality model uses the kinematic wave equation to simulate flow and velocity and the basic eutrophication module to predict dissolved oxygen and Chlorophyll a responses to the BOD, total nitrogen and total phosphorus loadings. Widths were taken from satellite imagery and depths from the measured water quality data. Table 5 provides the basic kinetic rates used in the model.

Table 5 WASP Kinetic Rates

WASP Kinetic Parameters	Value
Global Reaeration Rate Constant @ 20 °C (per day)	0.2
Sediment Oxygen Demand (g/m2/day)	1.5 to 3 for stream segments
Phytoplankton Maximum Growth Rate Constant @20 °C (per day)	3
Phytoplankton Carbon to Chlorophyll Ratio	60
BOD (1) Decay Rate Constant @20 °C (per day)	0.06
Ammonia, nitrate, phosphorus rates @20 °C (per day)	0.05 to 0.1

The Six Mile Creek (Tampa) WASP model predictions were compared to Six Mile Creek (Tampa) water quality data stations 21FLSJWMJGS and 21FLSJWMUSJ055.

Table 6 provides the annual average calibration summary of the comparison between the WASP Six Mile Creek (Tampa) segment and the Six Mile Creek (Tampa) Station for total nitrogen, total phosphorus, chlorophyll a and dissolved oxygen. Figures 5 to 8 illustrates the comparisons of model results and data at the same location.

Table 6 Model Calibration Summary

Six Mile Creek (Tampa) 21FLHILL147	**2002–2008 Data Average**	**2002-2008 Model Average**
Total Nitrogen (mg/l)	0.91	0.94
Total Phosphorus (mg/l)	0.21	0.24
DO (mg/l)	6.0	5.7

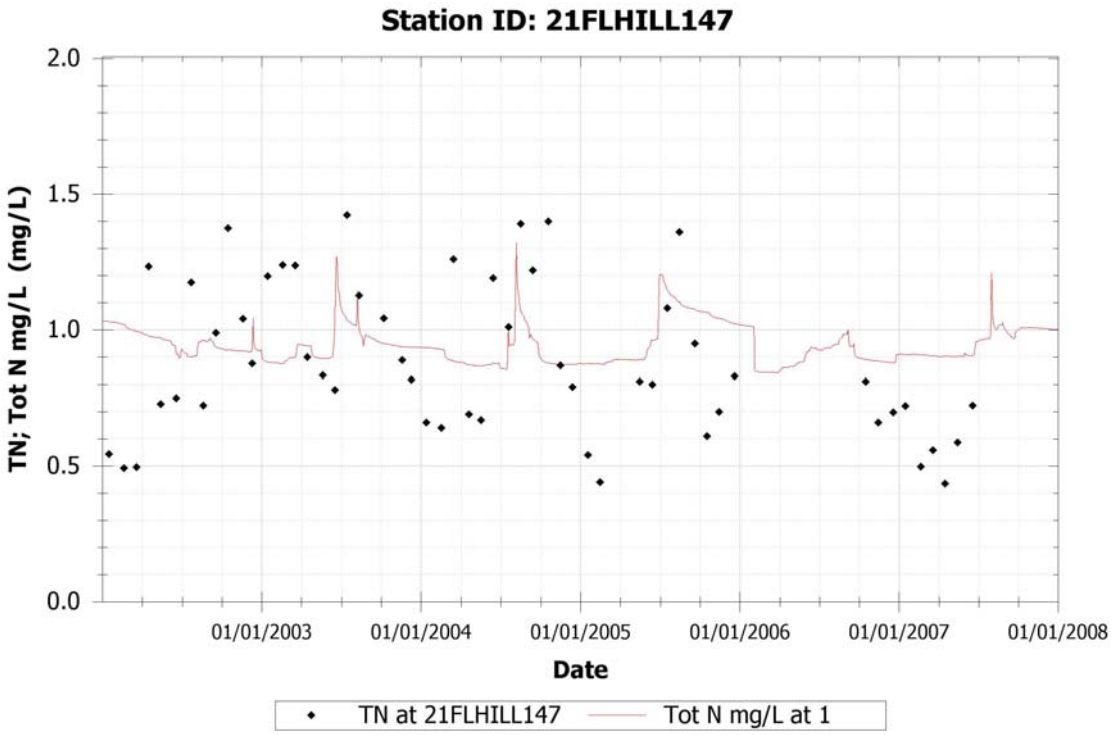

Figure 4 WASP Calibration for Total Nitrogen in Six Mile Creek (Tampa)

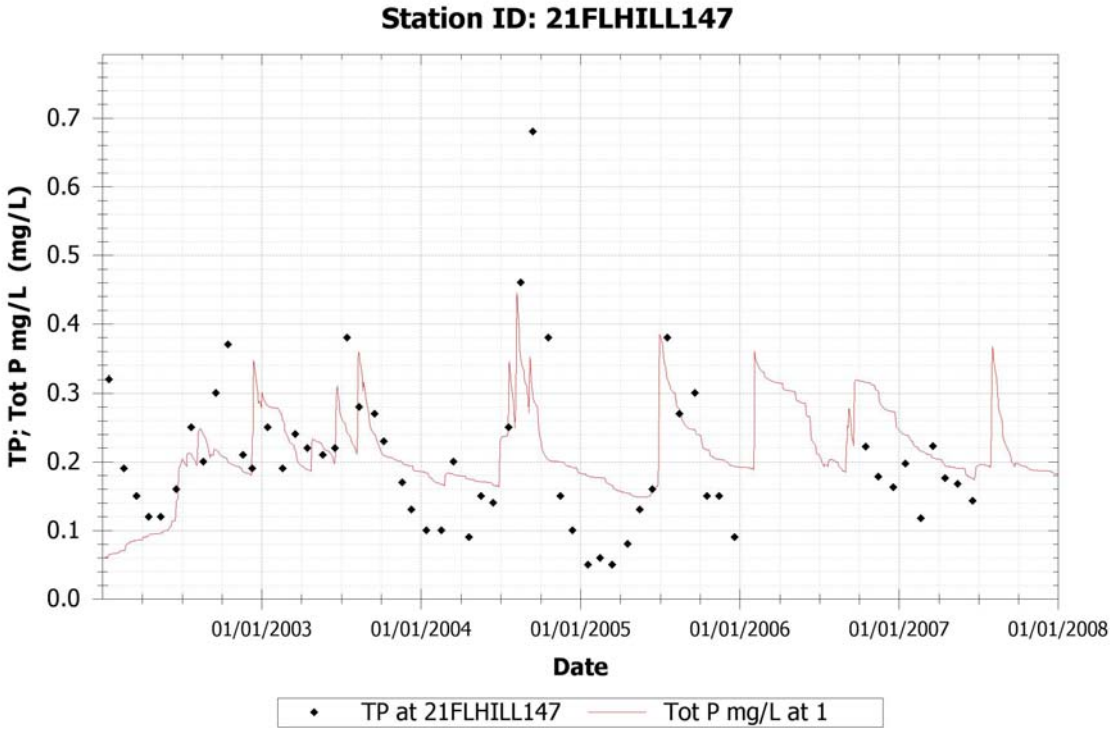

Figure 5 WASP Calibration for Total Phosphorus in Six Mile Creek (Tampa)

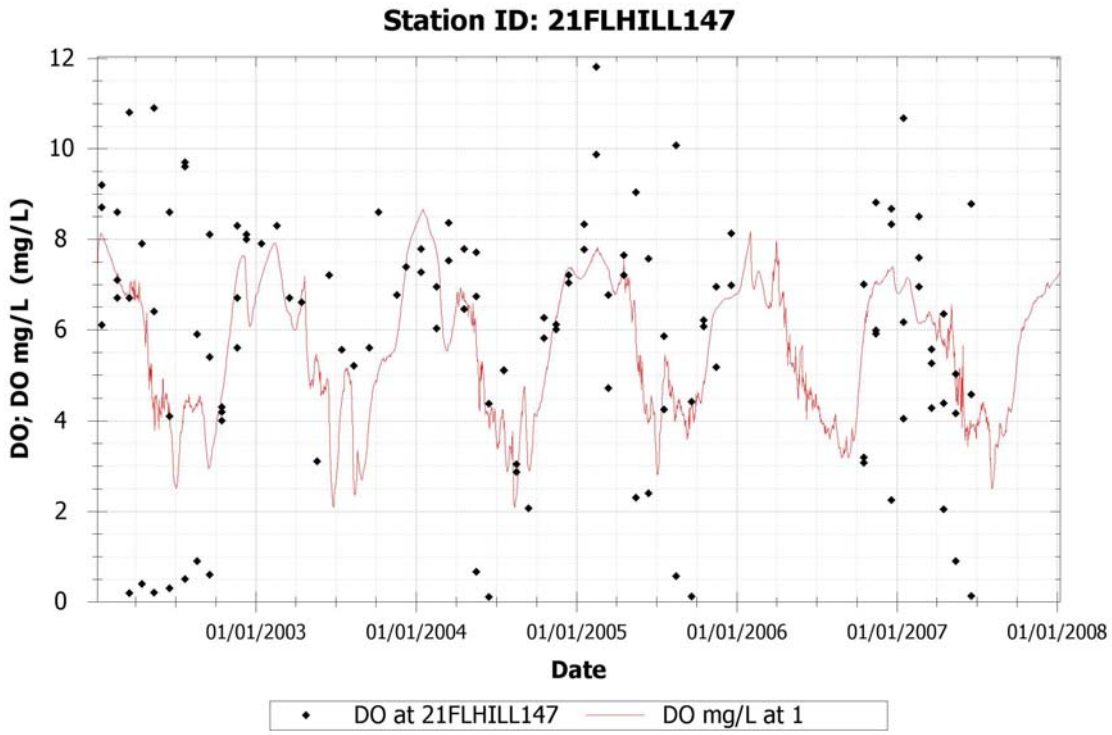

Figure 6 WASP Calibration for Dissolved Oxygen in Six Mile Creek (Tampa)

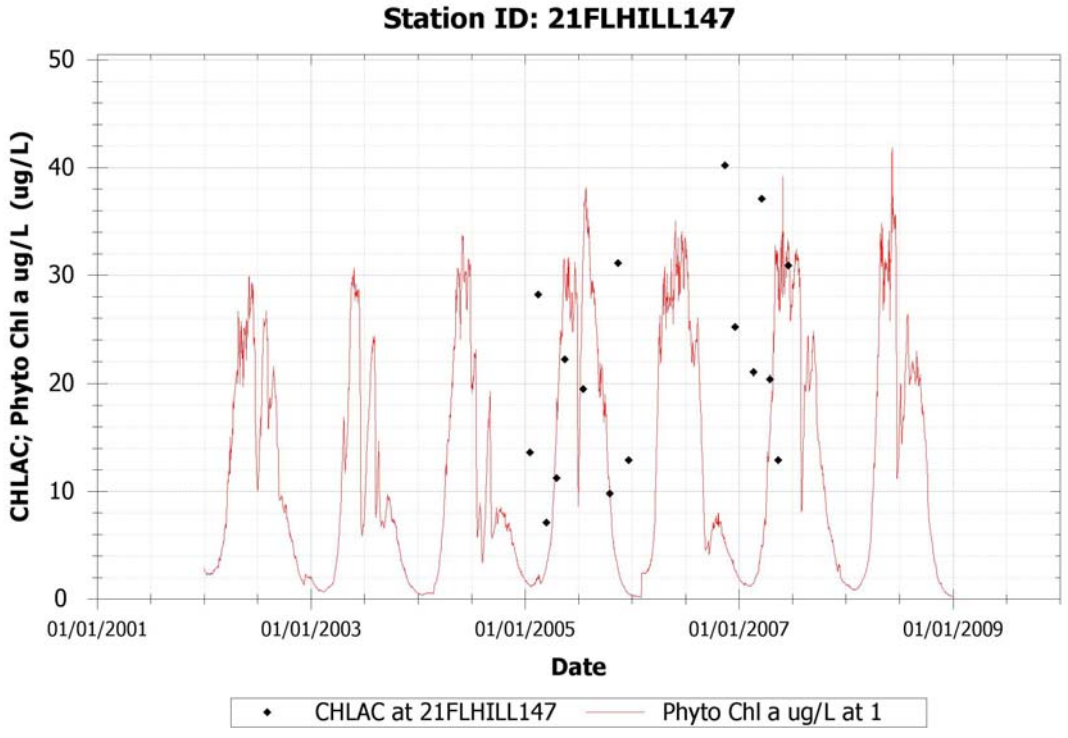

Figure 7 WASP Calibration for Chla in Six Mile Creek (Tampa)

Table 7 presents the annual average predictions for BOD, total nitrogen, total phosphorus and dissolved oxygen.

Table 7 Existing Condition Annual Average Model Predictions

Six Mile Creek (Tampa) @ 21FLHILL147	2002-2008 Model Prediction Annual Average
BOD (mg/l)	3.6
Total Nitrogen (mg/l)	.96
Total Phosphorus (mg/l)	0.095
DO avg (mg/l)	5.6
DO min (mg/l)	2.0

4. Modeling Scenarios

One modeling scenarios was completed to evaluate potential nutrient reduction options. Model years 2002 thru 2008 were used, 2001 was used as model ramp up period. An initial natural condition analysis was completed to predict what Six Mile Creek (Tampa) chlorophyll a and dissolved oxygen levels would be if all impacted upstream lands were converted back to upland forest and wetlands.

4.1. Six Mile Creek (Tampa) Watershed Natural Condition Analysis

Six Mile Creek (Tampa) sub basins and upstream USJR landuses were changed from impacted lands to upland forest and wetlands landuses. LSPC was then used to simulate the natural condition nutrient loads (Table 8) were inputted in to WASP model. Other than the nutrient load reductions the SOD rate was reduced to reflect the reduced loadings. Table 8 provides the annual average model predictions for total nitrogen, total phosphorus, chlorophyll a, dissolved oxygen.

Table 8 Natural Condition Annual Average Nutrient Loads

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Six Mile Creek (Tampa) Watershed	20,074	2,694	157,703

Table 9 presents the predicted annual average concentrations under natural conditions. Without the impacts of anthropogenic sources the dissolved oxygen concentration in the Six Mile Creek (Tampa) still would not achieve the dissolved oxygen standard of 5 mg/l.

Table 9 Natural Condition Annual Average Model Predictions

Six Mile Creek (Tampa)	2002-2008 Model Prediction Annual Average
BOD (mg/l)	2.3
Total Nitrogen (mg/l)	0.52
Total Phosphorus (mg/l)	0.05
DO avg (mg/l)	7.7
DO minimum (mg/l)	4.6

4.2. TMDL Reduction

The TMDL load reduction was set to the natural conditions scenario (Table 10). Because the waterbodies can not meet the dissolved oxygen standard under natural conditions, there is no assimilative capacity for oxygen demanding materials. The percent reduction that is prescribed by the TMDL is calculated by reducing the existing loadings to natural conditions.

Table 10 Natural Condition Annual Average Nutrient Loads

Six Mile Creek (Tampa) Watershed	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Existing Loads	55,893	12,148	319,068
Natural Loads	20,074	2,694	157,703
Percent Reduction	64%	78%	51%