Appendix A:

Modeling Report

South Prong Alafia River

WBID: 1653

Nutrients and Dissolved Oxygen

September 30, 2009

Region4 serving the southeast

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1. Watershed Description

South Prong Alafia River lies in the Tampa Bay area and is located in a phosphorus rich watershed that contains a number of phosphate mines.

WBID 1653 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 South Prong Alafia River.

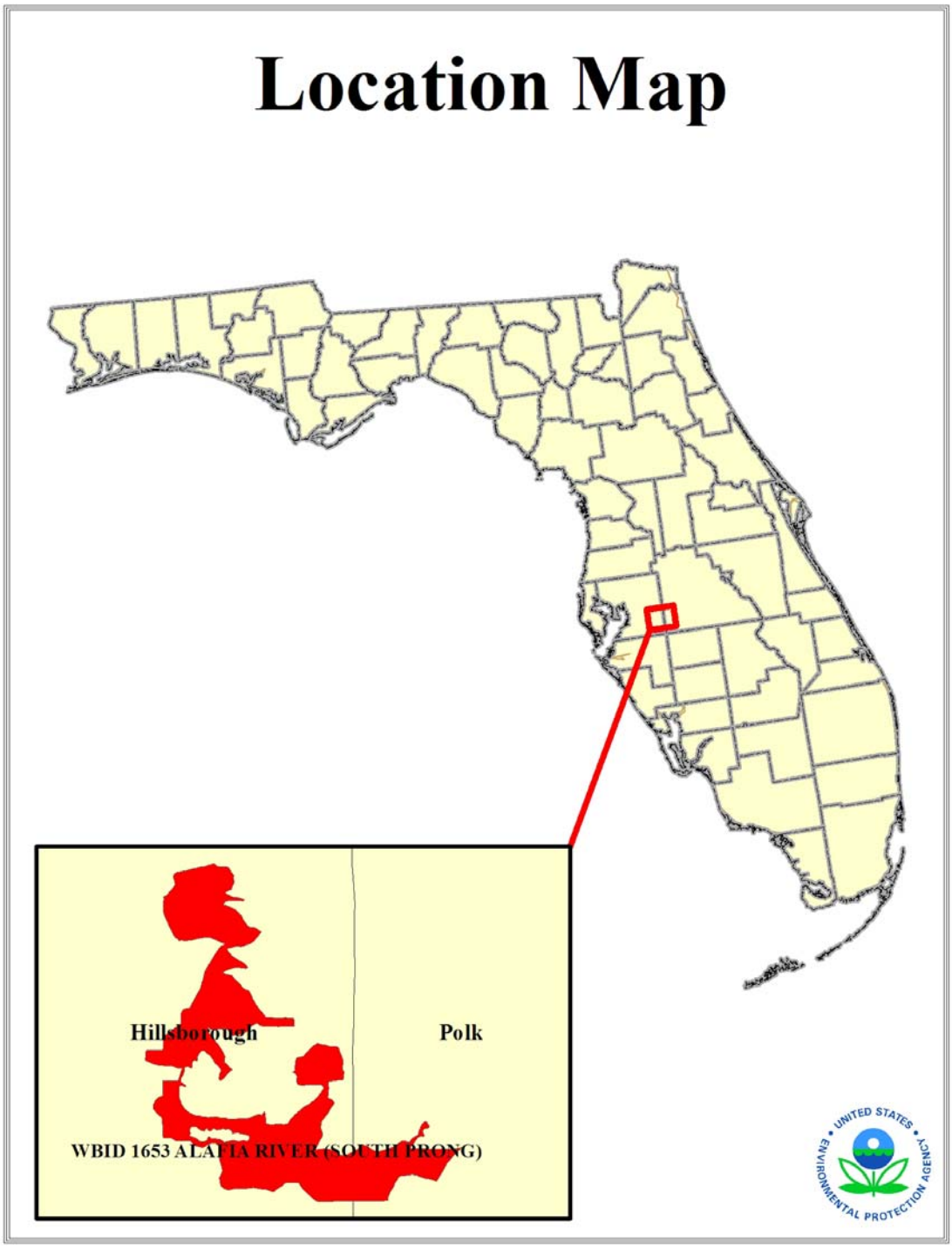

Figure 1 Location Map South Prong Alafia River

The landuse distribution for the South Prong Alafia River is presented in Table 1.

Table 1 Landuse Distribution in South Prong Alafia River Watershed

Land Use Name	Area (ac)	Portion of Watershed (%)
AGRICULTURE	5,836	6%
BARREN LAND	283	0%
RANGELAND	29	0%
TRANSPORTATION, COMMUNICATION AND UTILITIES	3,789	4%
UPLAND FORESTS	35,109	34%
URBAN AND BUILT-UP	344	0%
WATER	5,785	6%
WETLANDS	51,176	50%
Totals	102,351	100%

2. TMDL Targets

The TMDL target to be evaluated in this modeling report is to meet the South Prong Alafia River dissolved oxygen standard of 5 mg/l and have nutrients at a level to be representative of a balanced system.

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 2001 through 2008. The watershed model provides daily runoff, nutrient and BOD loadings from the 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. South Prong Alafia River 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 South Prong Alafia River. 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. South Prong Alafia River Watershed Delineation and Landuse

The surrounding watershed that drains directly to the South Prong Alafia River is presented in Figure 2. This WBID was delineated into 15 LSPC sub basins to simulate the runoff and pollutant loads. Figure 2 illustrates the Florida Landuse Classification (Level-1) for the South Prong Alafia River surrounding watershed.

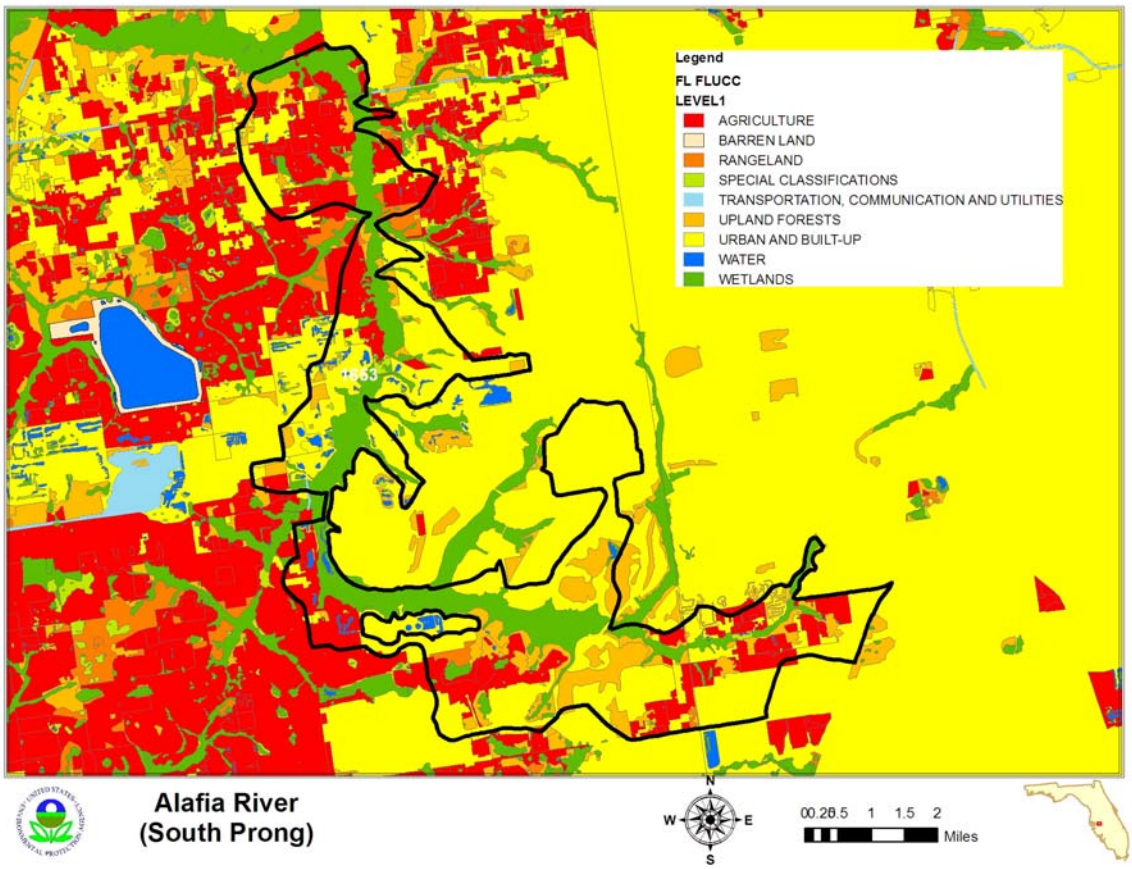

Figure 2 South Prong Alafia River Watershed Landuse Distribution

3.2. South Prong Alafia River 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.

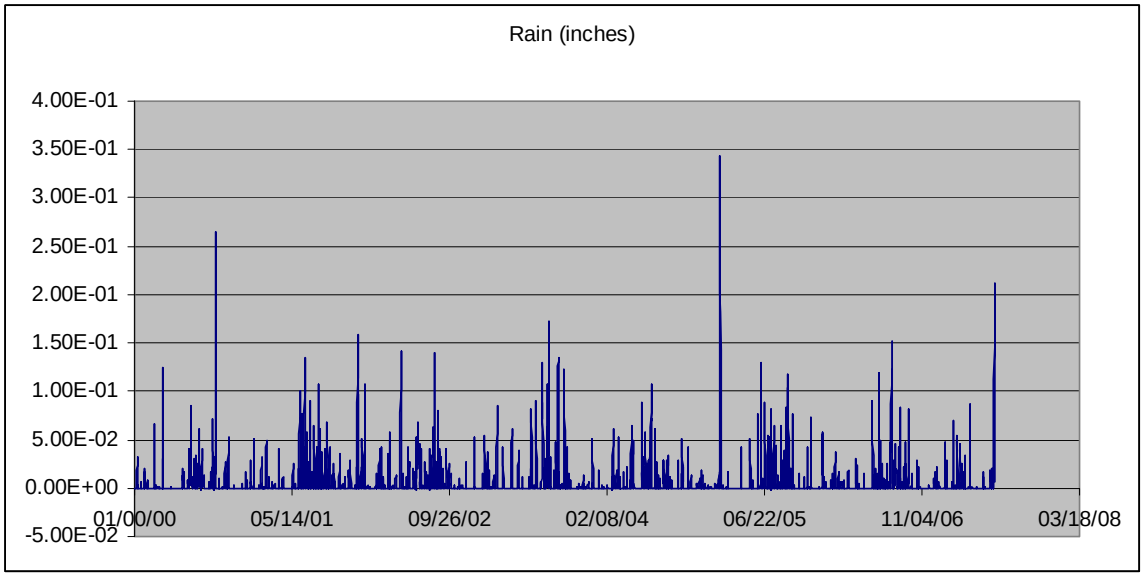

Figure 3 Rainfall for South Prong Alafia River and Watershed

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 South Prong Alafia River watershed using the watershed model and compared to the South Prong Alafia River USGS gage (USGS 02231600).

Flows in the South Prong Alafia River 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). TP levels of Barren Land and Special Classification landuse were increased to 10 mg/l to reflect the high TP loads from the mining areas. Baseflow concentrations were derived from the USJR HSPF report (CDM 2007) and review of the South Prong Alafia River data.

Table 3 Event Mean Concentration for Landuse Classifications

Landuse	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)	BOD (mg/l)
Agriculture	5.4	4	**10**
Barren Land	5.4	10	**10**
Rangeland	5	4	**10**
Special Classification	3.6	10	**10**
Transporation	3.6	1.2	**10**
Upland Forest	2.4	1.0	**5**
Urban Area	4.6	1.2	**10**
Water	2.4	1.0	**5**
Wetlands	**2.4**	**1.0**	**10**

BOD and nutrient watershed runoff were determined using EMCs for surface water runoff and interflow runoff and baseflow concentrations for groundwater flow. Note because of the intensive agriculture and presences of irrigation ditches, the BOD, total nitrogen and total phosphorus EMCs for disturbed land were increased by a factor of 2 to 3. These higher disturbed land EMCs provided a better representation of the instream data. Table 4 provides the annual average total nitrogen, total phosphorus and BOD loads for the period of record 2001 thru 2008.

Table 4 South Prong Alafia River & Nutrient Loads (2001-2008)

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
South Prong Alafia River Watershed	339,279	509,780	677,920

3.3. South Prong Alafia River Water Quality Model

The South Prong Alafia River 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 32 segment WASP water quality model was setup to include the 15 South Prong Alafia River sub basins and two lower end segments connecting South Prong Alafia River 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. 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)	0.5
Sediment Oxygen Demand (g/m2/day)	2.0 for stream segments
Phytoplankton Maximum Growth Rate Constant @20 °C (per day)	2
Phytoplankton Carbon to Chlorophyll Ratio	80
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 South Prong Alafia River WASP model predictions were compared to South Prong Alafia River water quality data stations on WASP Segments 3 and 6.

Table 6 provides the annual average calibration summary of the comparison between the WASP South Prong Alafia River segment and the South Prong Alafia River Station for total nitrogen, total phosphorus and dissolved oxygen. Figure 4 to Figure 9 illustrates the comparisons of model results and data at the same location.

Table 6 Model Calibration Summary

South Prong Alafia River Segment 3	**2001–2008 Data Average**	**2001-2008 Model Average**
Total Nitrogen (mg/l)	1.1	1.1
Total Phosphorus (mg/l)	1.3	1.0
DO (mg/l)	2.4	3.0
Segment 6	**2001–2005 Data Average**	**2001-2008 Model Average**
Total Nitrogen (mg/l)	1.1	1.1
Total Phosphorus (mg/l)	0.8	0.84

DO (mg/l)	6.9	6.4
USGS Gage 02301300		
Flow (cms)	3.1	3.5

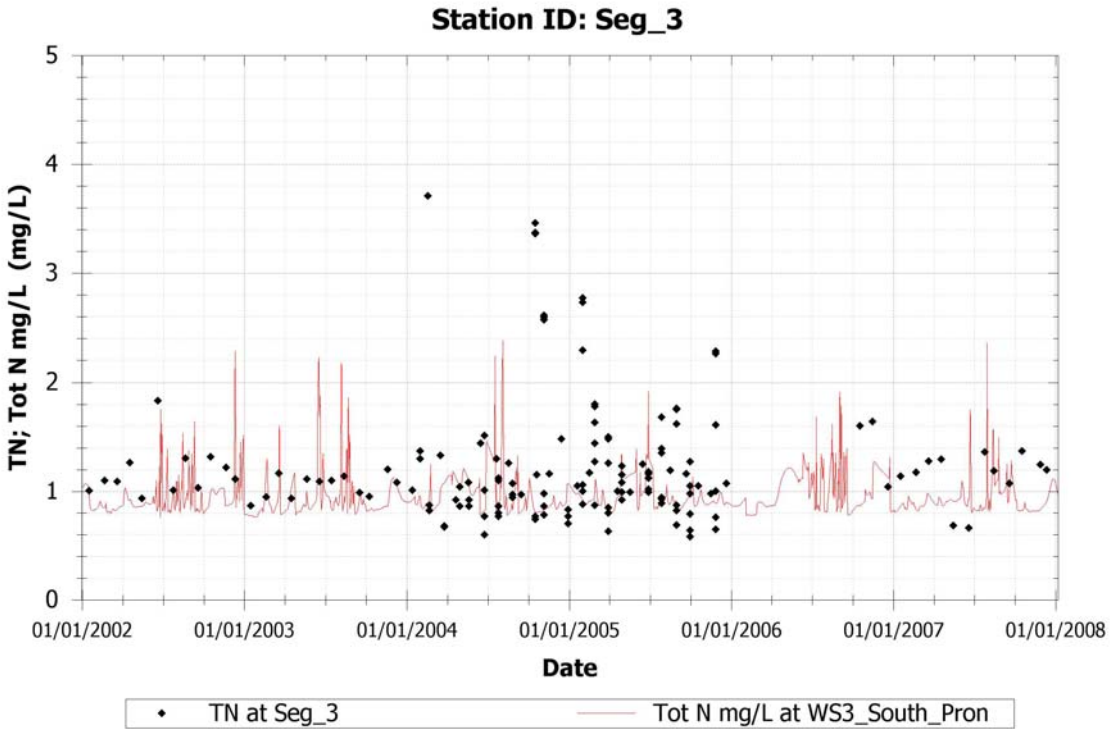

Figure 4 WASP Calibration for Total Nitrogen in Segment 3 of South Prong Alafia River

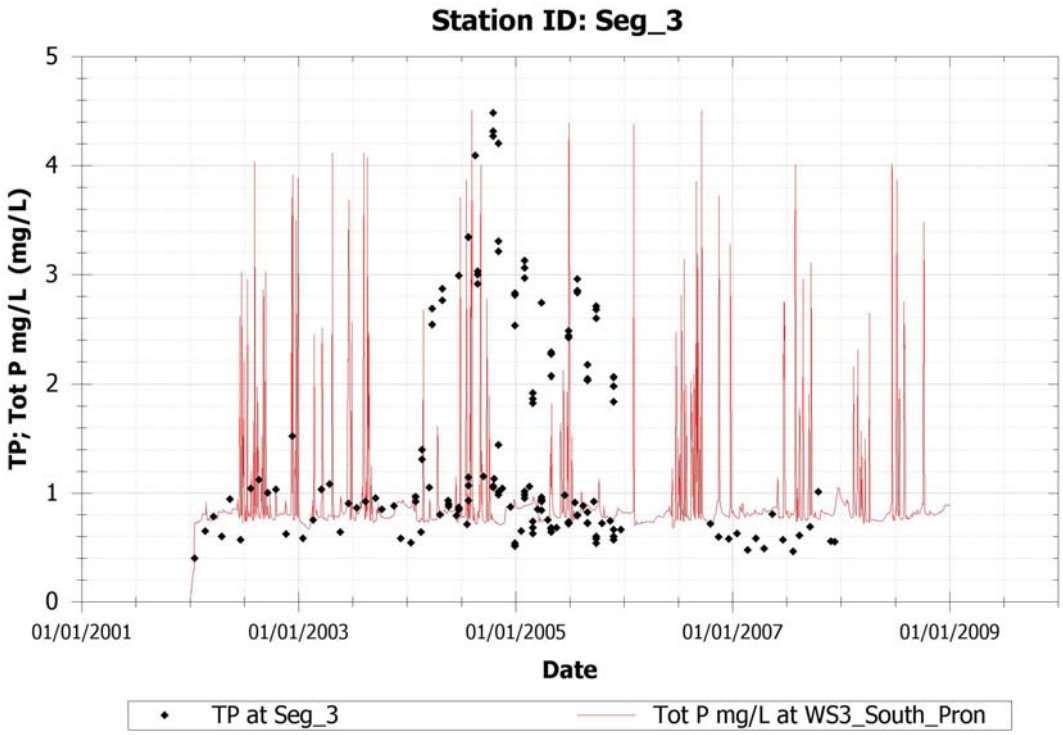

Figure 5 WASP Calibration for Total Phosphorus in Segment 3 of South Prong Alafia River

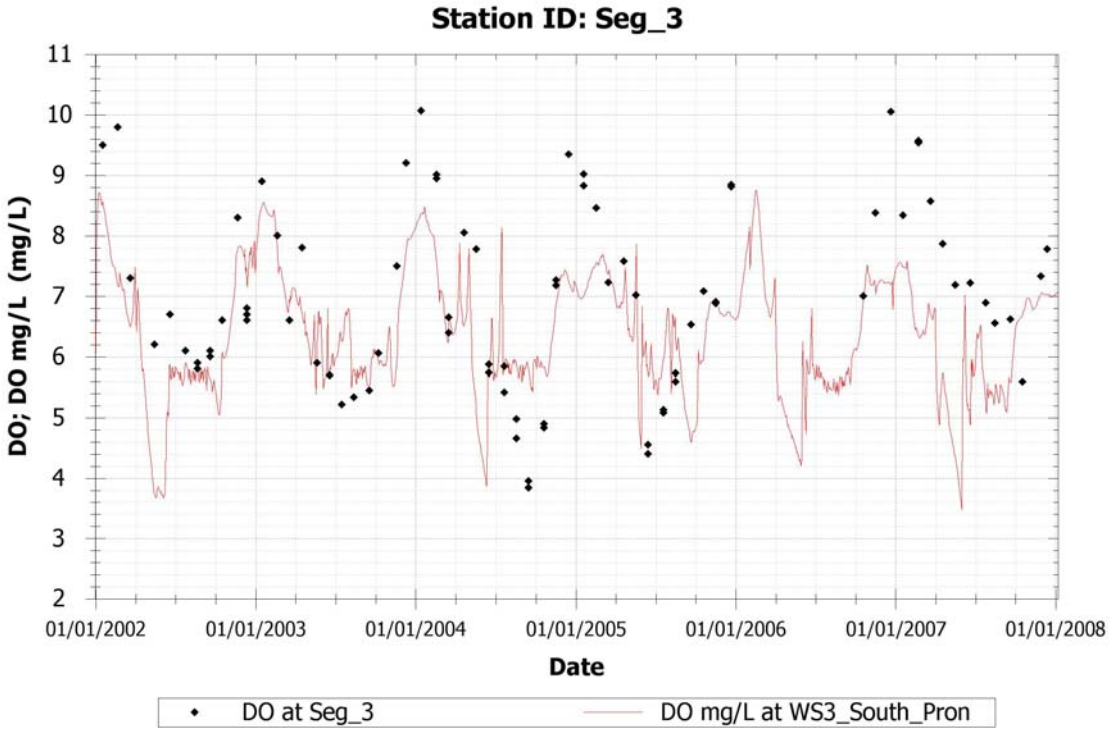

Figure 6 WASP Calibration for Dissolved Oxygen in Segment 3 of South Prong Alafia River

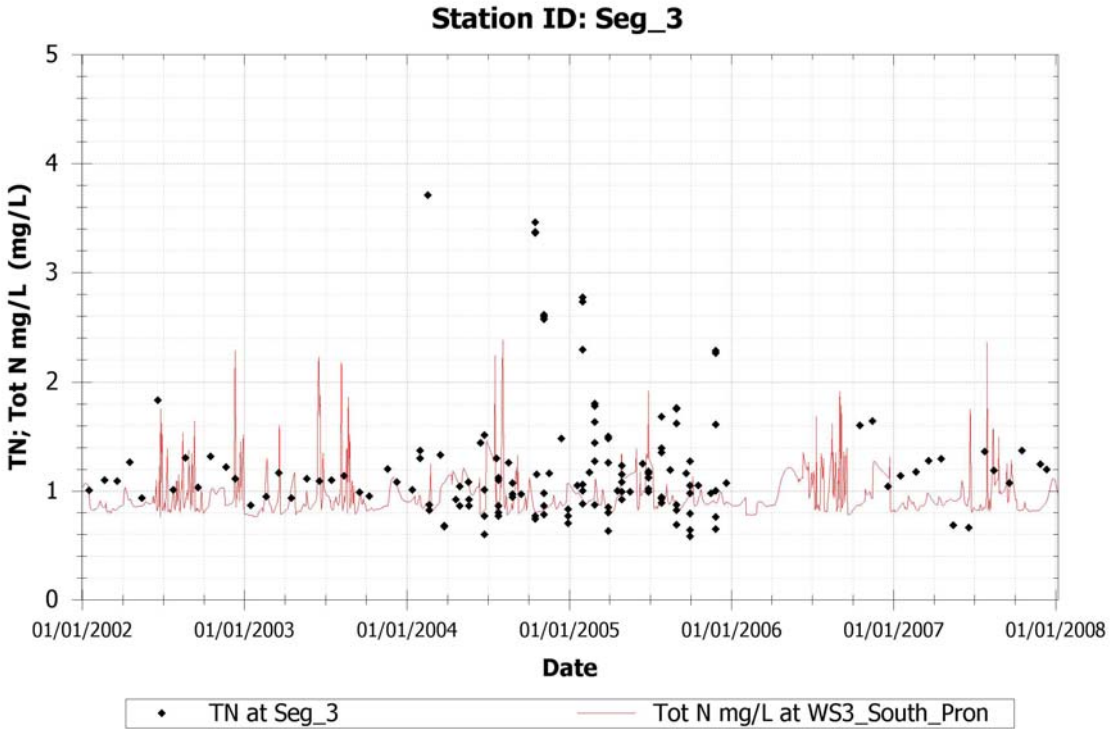

Figure 7 WASP Calibration for Total Nitrogen in Segment 6

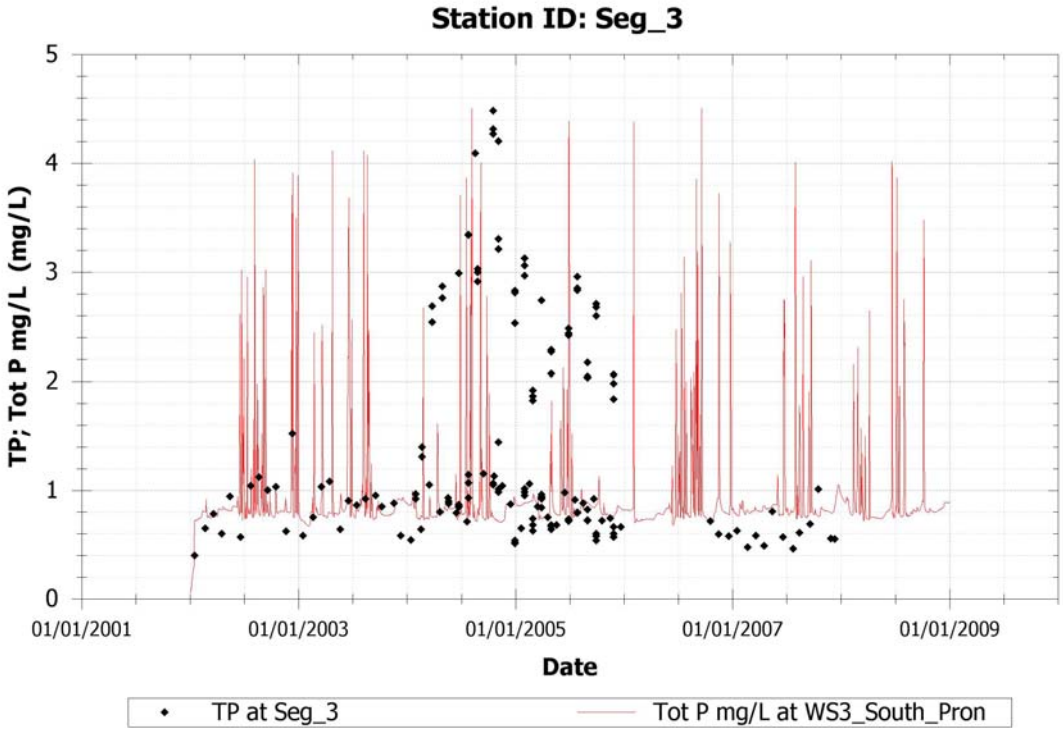

Figure 8 WASP Calibration for Total Phosphorus in Segment 6

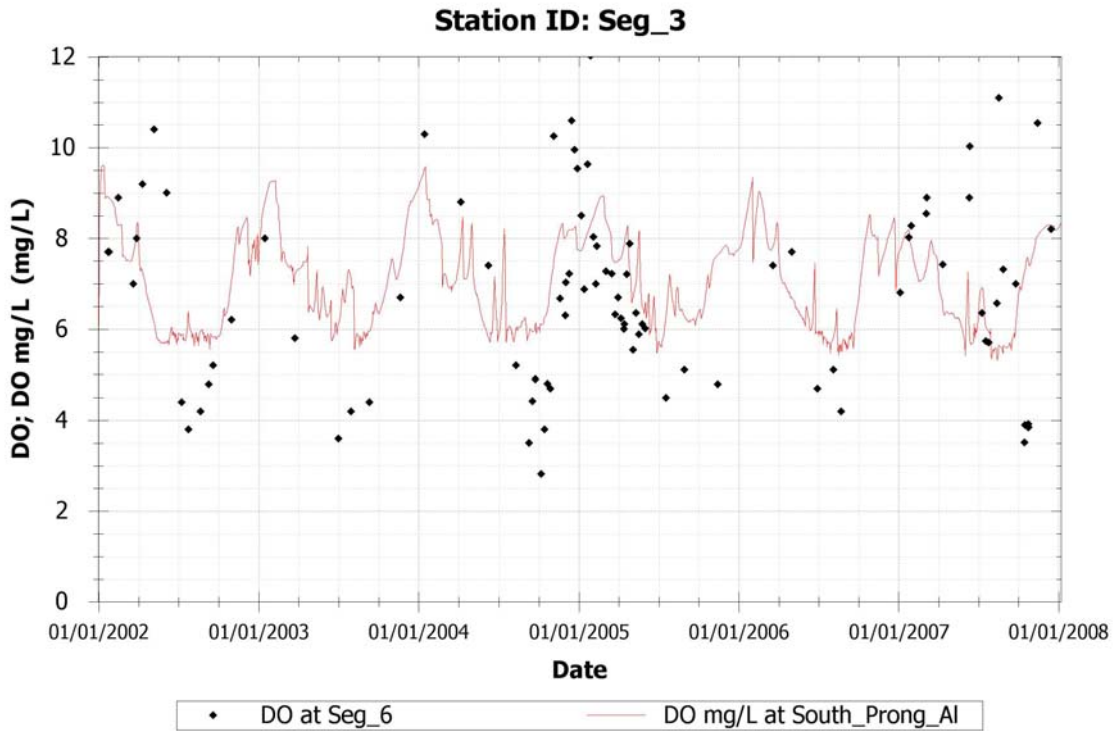

Figure 9 WASP Calibration for Dissolved Oxygen in Segment 6

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

Table 7 Existing Condition Annual Average Model Predictions

South Prong Alafia River @ 21FLSJWMJGS	2001-2008 Model Prediction Annual Average
BOD (mg/l)	1.4
Total Nitrogen (mg/l)	0.94
Total Phosphorus (mg/l)	1.0
DO avg (mg/l)	6.1
DO min (mg/l)	3.2

4. Modeling Scenarios

Two modeling scenarios were 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 South Prong Alafia River chlorophyll a and dissolved oxygen levels would be if all impacted upstream lands were converted back to upland forest and wetlands. The second analysis examined the impacts

of the fifty percent reduction scenario which provides the BOD, total nitrogen and total phosphorus reductions needed to meet the TMDL targets.

4.1. South Prong Alafia River Watershed Natural Condition Analysis

South Prong Alafia River sub basins 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 the natural conditions. Table 9 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)
South Prong Alafia River Watershed	298,483	144,902	609,955

Table 9 presents the predicted annual average concentrations under natural conditions. Without the impacts of anthropogenic sources the dissolved oxygen concentration in the South Prong Alafia River is above the dissolved oxygen standard of 5 mg/l.

Table 9 Natural Condition Annual Average Model Predictions

South Prong Alafia River	2001-2008 Model Prediction Annual Average
BOD (mg/l)	1.2
Total Nitrogen (mg/l)	0.7
Total Phosphorus (mg/l)	0.54
DO avg (mg/l)	7.8
DO minimum (mg/l)	5.8

4.2. Fifty Percent Reduction of Total Phosphorous Reduction Scenario

The total phosphorous load was reduced by 50 percent, total nitrogen and BOD were already close to natural conditions so additional reductions were not taken The stream SOD was reduced to reflect the total phosphorus reductions. Table 10 provides the PLRG annual loads and Table 11 the resultant predictions for total nitrogen, total phosphorus and dissolved oxygen.

Table 10 50 Percent Reduction Annual Average Nutrient Loads

Subbasin	Total Nitrogen Load (kg/yr)	Total Phosphorus Load (kg/yr)	BOD Load (kg/yr)
Total of Crabgrass and South Prong Alafia River Watershed	339,279	254,890	677,920

Table 11 50 Percent Reduction Annual Average Nutrient Concentrations

South Prong Alafia River	2001-2008 Model Prediction Annual Average
BOD (mg/l)	1.2
Total Nitrogen (mg/l)	0.9
Total Phosphorus (mg/l)	0.6
DO avg (mg/l)	6.1
DO minimum (mg/l)	5.0

4.3. TMDL Reduction

The TMDL load reduction was set 50% reduction of the annual TP load scenario.