TOTAL MAXIMUM DAILY LOAD (TMDL)

For Nutrients and Dissolved Oxygen

In

Muddy Branch WBID 175

Apalachicola - Chipola Basin

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LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
FAC	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET
Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: Florida
County: Jackson
Major River Basin: Chipola River Basin (HUC 03130012)
WBID: 175
Segment Name and Type: Muddy Branch (fresh water)
Constituents: Nutrients and Dissolved Oxygen

2. TMDL Endpoints (i.e., Targets)

Class III Waters:
Total phosphorus concentration of 0.072 mg/l (interpretation of narrative standards)
Total nitrogen concentration of 0.81 mg/l (interpretation of narrative standards)
Dissolved Oxygen of not less than 5.0 mg/L

3. Allocations

Parameter	TMDL (kg/year)	LA (kg/year)	WLA[1]		MOS[3] (kg/year)	Percent Reduction
			Continuous (kg/year)	MS4		
Total Phosphorus	152	137	N/A[2]	N/A[2]	15	69%[4]
Total Nitrogen	1707	1536	N/A[2]	N/A[2]	171	26%[4]
Dissolved Oxygen	5410	4918	N/A[2]	N/A[2]	492	87%[5]

Notes:
1. WLA component is separated into load from continuous NPDES facilities (e.g., WWTPs) and load from MS4s. Currently, there are no continuous discharge facilities or MS4 areas in WBID 175.
2. N/A = not applicable
3. Represents a 10% Margin of Safety.
4. Percent reduction from current conditions to achieve the target concentration for that nutrient.
5. Percent increase from current conditions to achieve the target concentration for D.O.

5. Endangered Species (yes or blank): Yes

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

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

8. Major NPDES Discharges to surface waters addressed in EPA TMDLs: None

TOTAL MAXIMUM DAILY LOAD (TMDL) FOR NUTRIENTS AND DISSOLVED OXYGEN in WBID 175 MUDDY BRANCH, APALACHICOLA-CHIPOLA BASIN

1. 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 State of Florida Department of Environmental Protection (FDEP) has developed 303(d) lists since 1992. The process by which Florida implements section 303(d) requirements is set forth in the Florida Watershed Restoration Act (FWRA) of 1999 (s. 403.067, Florida Statutes). The FDEP list of impaired waters in each basin, referred to as the "Verified List", is also adopted pursuant to the FWRA (Subsection 403.067[4], Florida Statutes). However, the FWRA also states 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 (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The TMDL developed in this report is for an impaired water that is on the 1998 303(d) list but not the verified list. It is being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

FDEP developed a statewide, watershed-based approach to water resource management. Following this approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework DEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 2 basin includes waters in the Apalachicola River basin, Apalachicola Bay, Chipola River basin, Hillsborough River basin and Tampa Bay basin. Group 2 waters were first assessed in 2001 with plans to revisit water management issues in 2006. FDEP established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts. The Apalachicola–Chipola River basins are located in the Northwest Florida Water Management District (NWFWMD).

For the purpose of planning and management, the WMDs divided the district into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, cannel, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified numerous WBIDs in the Apalachicola – Chipola basin as potentially not supporting water quality standards (WQS). After assessing all readily available water quality data, EPA is responsible for determining whether TMDLs are needed for nutrients or dissolved oxygen (D.O.) in 5 WBIDs of the basin (WBIDs 1274 and 375A, 375B, and 375D were listed for possible coliform impairment and are addressed in a separate document). The geographic locations of these listed WBIDs are shown in Figure 1. It was determined that nutrient TMDLs are not needed at this time for three of the WBIDs (51B Chipola River; 272 Thompson Pond; 1286 Huckleberry Creek). Table 1 lists the two WBIDs for which TMDLs are needed for nutrients. This document will discuss the nutrient and D.O. TMDL for WBID 175 (Muddy Branch). The nutrient TMDL for WBID 60 (Lake Seminole) is discussed in a separate report.

Table 1. Nutrient and D.O. TMDLs Developed By EPA in Apalachicola-Chipola Basin

WBID	Name	Planning Unit	Parameter of Concern
60	Lake Seminole	Chattahoochee R./Lake Seminole	nutrients
175	Muddy Branch	Chipola River Basin	nutrients and dissolved oxygen

The waterbodies listed in Table 1 are Class III waters with the designated use of recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating.

To determine the status of surface water quality in the state, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR defines the threshold for determining if waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list. The TMDL developed in this report is for an impaired water on the 1998 303(d) list but not on FDEP's verified list.

The format of the remainder of this report is as follows: Chapter 3 is a general description of the impaired watershed; Chapter 4 describes the water quality standard and target criteria for the TMDL; and Chapter 5 describes the development of the TMDL.

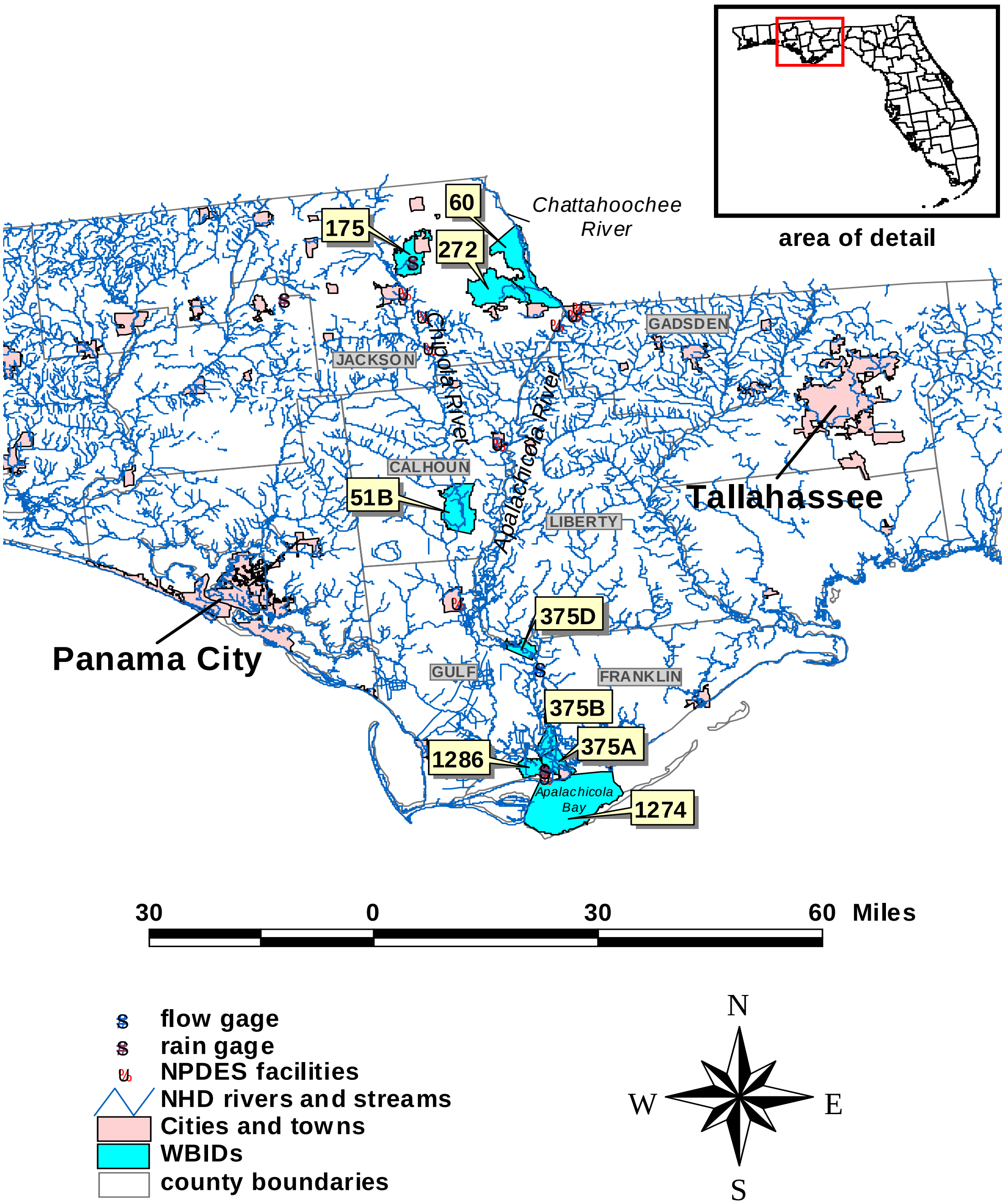

Figure 1. Location of 303(d) listed WBIDs in the Apalachicola-Chipola Basin

3. WATERSHED DESCRIPTION

The Apalachicola-Chipola basin is defined by USGS Hydrologic Unit Codes (HUC) 03130014 (Apalachicola Bay), 03130011 (Apalachicola River), 03130004 (Chattahoochee River), and 03130012 (Chipola River). The following description of the impaired watersheds is from the Basin Status Report (FDEP, 2002). This document should be consulted for additional details.

The Apalachicola-Chipola Basin encompasses more than 3,067 square miles of the state, including approximately 212 square miles of Apalachicola Bay waters. Only about 20 percent of the basin is within the state of Florida, in the panhandle region, with the remainder of the basin draining portions of Georgia and Alabama. The Apalachicola Bay estuary serves as the interface between the freshwater uplands and the Gulf of Mexico. The Apalachicola Bay estuary supports the largest oyster-harvesting industry in Florida, as well as extensive shrimping, crabbing, and commercial fishing. The federal government has classified the Bay as a National Estuarine Reserve.

The Upper Floridan aquifer underlies the Florida Panhandle. The geomorphology and hydrogeology of the Apalachicola-Chipola basin are typical of a karstic terrain. As the carbonate rocks beneath the land surface chemically weather and collapse, sinkholes commonly develop. In the region of Jackson County more than 2,800 mapable surface karstic features are present. Most of the surface runoff of rainfall in karst terrains seeps into the Upper Floridan aquifer.

Streams in the Apalachicola watershed have been modified by dredge-and-fill activities from past and present silvicultural practices. Planted pines have replaced native hardwoods along stream banks, the topography has been flattened, stream channels have filled from logging roads and clear-cutting, and deep ditches have lowered the basin’s water table. Additional impacts have been caused by the conversion of forestland to agriculture and municipal and industrial discharges and water withdrawals. The population density of the Apalachicola-Chipola Basin is relatively low. WBID 175 (Muddy Branch) is located within Jackson County, which saw a 13 percent increase in population between 1990 and 2000.

3.1 WBID 175 Muddy Branch

Muddy Branch is part of the Chipola River Planning Unit. It passes through Florida Caverns State Park before meeting up with the Chipola River northwest of the city of Marianna, Florida. Parts of Muddy Branch flow intermittently (personal communication: Richard Wieckowicz, FDEP), and the available flow data support that Muddy Branch frequently has little to no flow (ave. flow = 2.36 cfs).

Figure 2 is a flow duration curve for Muddy Branch. A flow duration curve displays the cumulative frequency distribution of daily flow data over the period of record. Flows toward the right side of the plot are exceeded in greater frequency and are indicative of low flow conditions. Flows on the left side of the plot represent high flows and occur less frequently. For example, the flow at the 60^{th} duration interval is equaled or exceeded 60 percent of the time. The flow duration curve for Muddy Branch (WBID 175) is based on the continuous flow record collected at USGS 02358784 (Muddy Branch near Marianna, FL). This gage was in operation from October 1998 through September 2003. Water quality samples were not collected during the time the gage was operational. Attempts were made to extend the record to the time of water quality sampling but it was not possible to find a comparable gage with the necessary flow record in the HUC. The flow duration curve indicates Muddy Branch is dry during long periods in several seasons. As a result, the flow duration curve approaches zero cfs at the 75th duration interval. The flow duration curve is plotted on a log scale to show variability in scale.

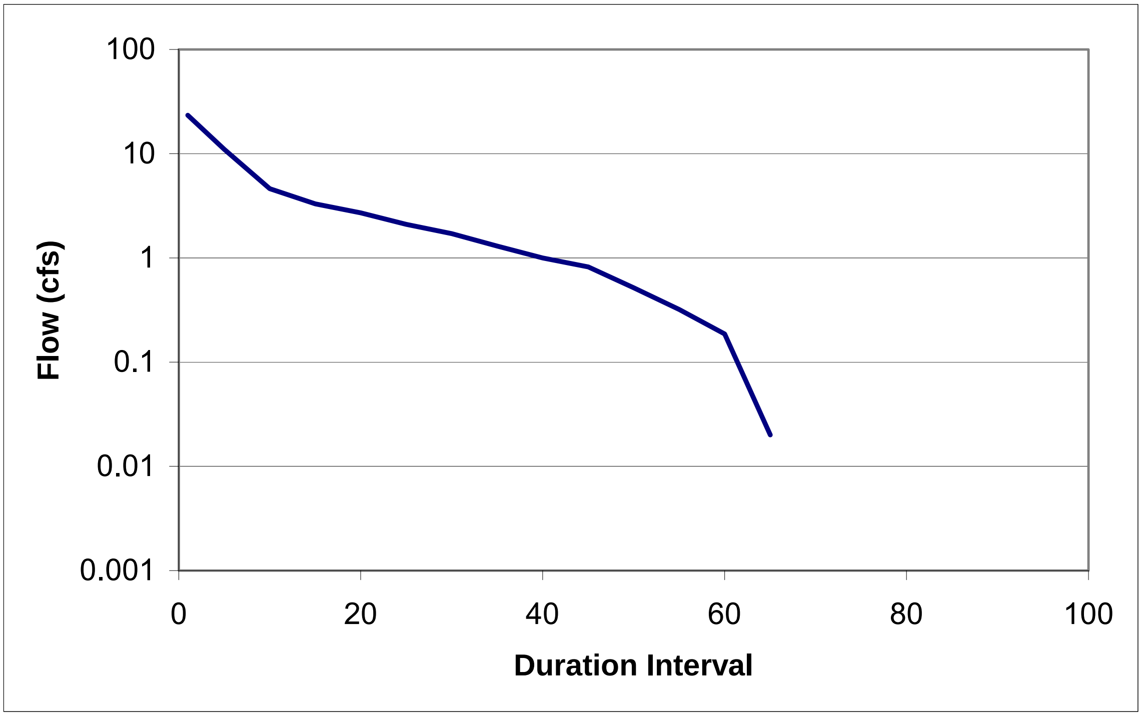

Figure 2. Flow Duration Curve for Muddy Branch (WBID 175).

In WBID 175, the predominant land uses are agriculture (51%) and forest (31%), transportation/utilities (7.3%), and residential (5.5%; see Table 2). Problems caused by agricultural runoff from dairy farms in the Muddy Branch watershed have been noted (FDEP, 2002). There is one active landfill within the WBID, but no hazardous waste sites or MS4 areas.

Table 2. Land Cover Distribution[1] (acres) in the WBID 175, Apalachicola-Chipola Basin.

WBID	Residential	Com, Ind, Public[2]	Agriculture	Rangeland[3]	Forest	Water	Wetlands	Transp & utilities	Barren & extractive	Total (acres)
175	721	244	6709	94	4094	25	176	957	88	13107

Notes:
1. Acreage represents the land use distribution in the WBID 175 and not the entire drainage area.
2. Public lands include urban and recreational areas.
3. Rangeland includes shrubland, grassland, and herbaceous land covers.
4. Data source for Apalachicola-Chipola Basin is land cover of 1995 from the NWFWMD.

4. WATER QUALITY STANDARD AND TARGET IDENTIFICATION

Waterbodies in WBID 175 are classified as Class III waters, with a designated use of 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 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. While the State of Florida does not have numeric criteria for nutrients, a narrative criterion exists as below. The specific criteria for the impaired WBIDs addressed in this TMDL 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 62.302.530 F.A.C.]

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

Biochemical Oxygen Demand
Biochemical Oxygen Demand (B.O.D.) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

Because the State of Florida does not have numeric criteria for nutrients, chlorophyll and dissolved oxygen levels are used to indicate whether nutrients are present in excessive amounts.

5. NUTRIENT/D.O. TMDL

WBID 175 (Muddy Branch) was listed on the 1998 303(d) list as potentially impaired for nutrients, D.O., and coliform bacteria. The bacteria TMDLs are addressed in a separate document. This section of the report details the development of the nutrient and dissolved oxygen TMDLs for WBID 175, Muddy Branch.

5.1 Water Quality Data Assessment and Deviation from Target

Table 3 provides a list of the monitoring stations in WBID 175. Each station is identified, and the time period of record for the individual stations is provided. Data collected at these monitoring stations within the impaired WBID are used in the TMDL analysis. Data collected during the Group 2 listing cycle (i.e., January 1996 through December 2003) and any data collected in 2004, if available, are considered in the data assessment. However, when no recent data are available for a particular parameter, data back to 1993 are considered. The most recent data for the WBID are from Muddy Branch itself, but there were data for another waterbody in the WBID (Spring Branch) collected between 1994-1997. Data from one of the stations in WBID 175, station 112WRD 305109085103700 (SU-L1), were not included in the analysis because this station is apparently a swine lagoon (Collins, 1996). Additionally, all of the data for it were collected more than a decade ago, in 1993, which is outside of the Group 2 listing cycle.

Table 3. Water Quality Stations in WBID 175.

Station	Station Name	First Date	Last Date
21FLBFA 31020021	Spring Branch cr167 below Sunland STP	8/7/94	5/4/97
21FLWQA 304858508513318 also 5520	Muddy Br. at Blue Hole Rd (Caverns State Park)	6/12/02	12/15/03
21FLWQA 304958708512313 also MC07 and 5510	Muddy Branch at SR 167	10/1/02	5/19/04
MC06	Muddy Br. inside Florida Caverns State Park	4/21/04	5/19/04

The biology of Muddy Branch was assessed on December 12, 2002 (FDEP, 2004). Biological assessments typically involve evaluating habitat quality, water chemistry and biological communities to determine if the waterbodies are meeting their designated use to support healthy aquatic life. The bioassessment found that the habitat of Muddy Branch was "suboptimal" and that dissolved oxygen concentrations were below the Class III water quality standard of 5.0 mg/L. The levels of ammonia, total Kjehldahl nitrogen, and total phosphorus were low, but nitrate-nitrite levels were elevated. The Stream Condition Index (SCI), which rates the health of benthic macroinvertebrate communities against reference conditions, was rated overall as "good" for Muddy Branch. However, there was not enough data to determine whether the WBID is or is not meeting its designated use to support a healthy and balanced aquatic life. FDEP concluded that further biological sampling should be completed on Muddy Branch.

While the State of Florida does not have numeric criteria for nutrients, a narrative criterion exists as described in the Water Quality Standards section of this report. Chlorophyll and dissolved oxygen are used to indicate whether nutrients are present in excessive amounts. For fresh waters the dissolved oxygen should not be less than 5.0 mg/l, excepting for occasional excursions. Table 4 summarizes the available water quality data, collected between 1996 to present, for waterbodies within WBID 175, including data from Muddy Branch and Spring Branch. The raw data summarized in Table 4 are also presented in Appendix A.

Chlorophyll is the green pigment in plants that allows them to create energy from light (chlorophyll-a is simply the active portion of the total chlorophyll). In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-a is simply a measure of the active portion of total chlorophyll. Only one of the eight Chlorophyll-a measurements, made on Muddy Branch at State Route 167 in May 2004 appears elevated. The Chlorophyll-a measurements for WBID 175 ranged from 0.45 to 28.0 μg/l, with a mean value of 5.92 μg/l and a median of 1.95 μg/l. Figure 3 illustrates chlorophyll measurements for stations in WBID 175.

Table 4. Water Quality Data for WBID 175 (Muddy Branch and Spring Branch)

Parameter	Obs	Max	Min	Mean	StDev	Median
Phosphorus Total as P§ (mg/l)	13	1.200	0.030	0.280	0.300	0.210
Dissolved Oxygen (mg/l)	18	8.20	0.26	3.20	2.28	2.67
Nitrogen Ammonia as N (mg/l)*§	13	1.20	0.01	0.23	0.34	0.14
Nitrate Nitrite (mg/l)*§	13	2.10	0.00	0.67	0.72	0.84
Phosphorus, Dissolved (mg/l)	4	0.16	0.06	0.10	0.05	0.09
Nitrogen Kjeldahl as N§ (mg/l)	12	2.20	0.29	0.77	0.66	0.68
Total Org. Carbon as C (mg/L)*	4	9.60	5.00	7.18	1.98	7.05
Chlorophyll A (µg/l)*	8	28.00	0.45	5.92	9.41	1.95
BOD, carbonaceous 5-day (mg/l)	9	2.30	1.00	1.51	0.46	1.30
Algal Growth Pot. (mg/l dry wt.)	4	16.7	2.0	6.6	6.8	3.8
Total Nitrogen (mg/l)						0.98

1. See Appendix A for a table of the raw data and any associated remark codes.
2. Total nitrogen was estimated as TKN + NO_3O_2 for each sample.
3. Some or all values contributing to these statistics were below the practical quantification or reporting limit; in those instances the value was left as the reported limit.
4. Obs= number of observations; Max= maximum value; Min= mininum value; Mean= average value; StDev= standard deviation; Median= median value.

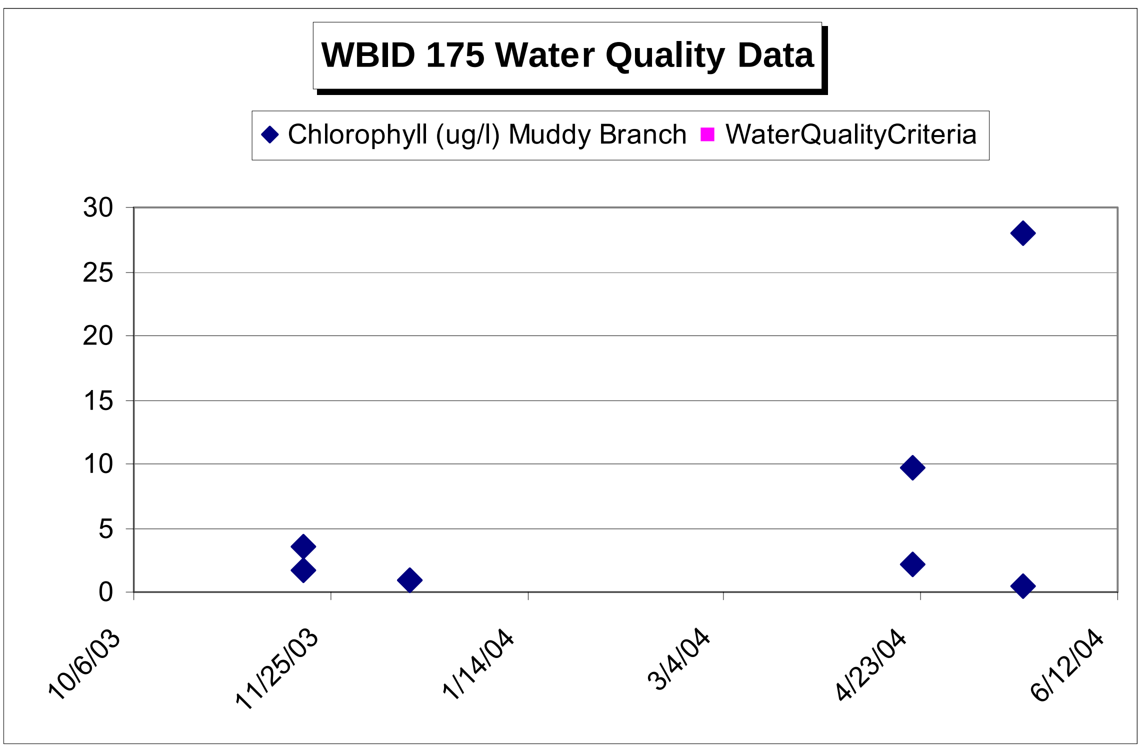

Figure 3. Chlorophyll Measurements for Muddy Branch (WBID 175)

Natural dissolved oxygen (D.O.) levels in a waterbody are a function of water temperature, the water depth and velocity, and the relative contributions of groundwater. (Because it is not in contact with air, groundwater naturally has lower concentrations of oxygen dissolved in it.) Oxygen can be introduced to streams by wind, diffusion, tributaries, and photosynthesis. D.O. levels naturally fluctuate over the course of a day. During the daylight, aquatic plants produce oxygen as a by-product of photosynthesis. At night, respiration may consume dissolved oxygen. Decomposition of organic matter, such as dead plants and animals, also uses up dissolved oxygen from the water.

The available D.O. data indicate that the dissolved oxygen concentration in Muddy Branch is typically below 5 mg/L. All but one D.O. measurement made on Muddy Branch was below 5.0 mg/l, while the limited D.O. data on Spring Branch were below 5 mg/L about half the time (Figure 4).

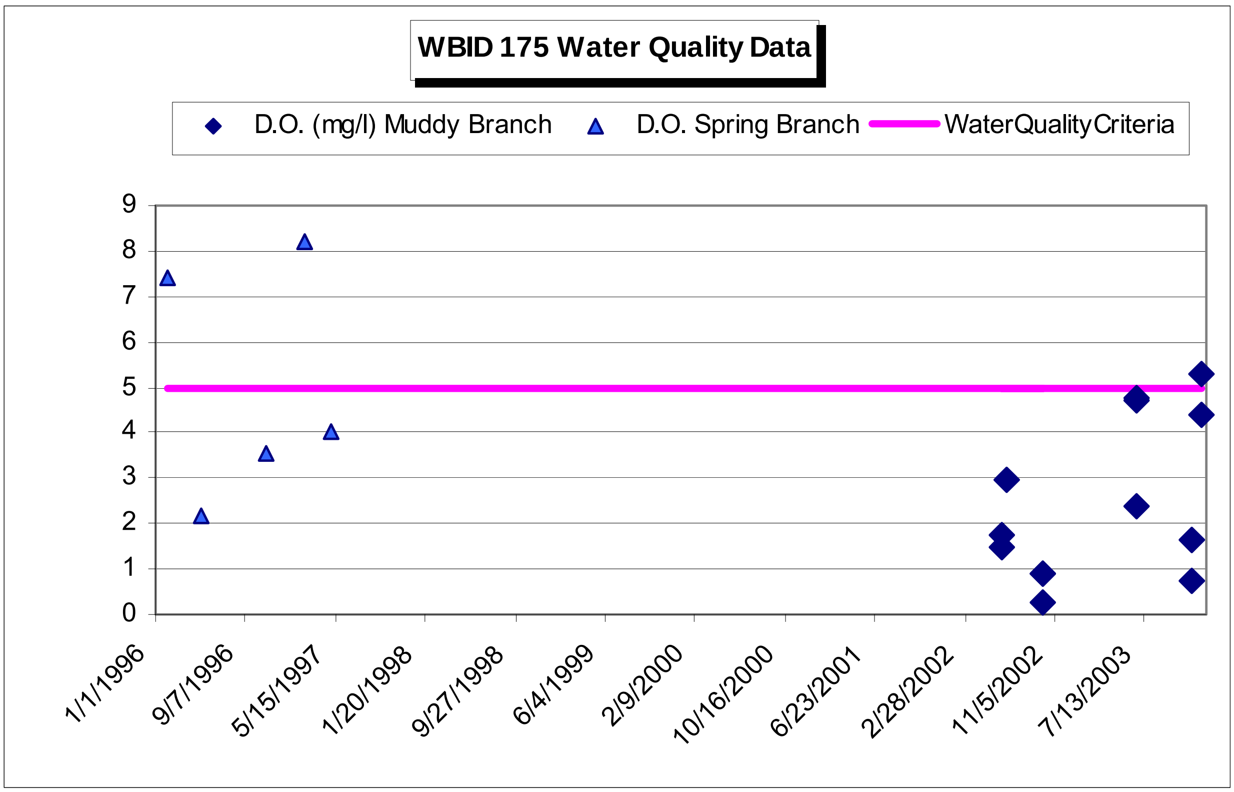

Figure 4. Dissolved Oxygen Measurements in Muddy Branch & Spring Branch, WBID 175

The levels of biochemical oxygen demand (BOD), a measure of the amount of oxygen used by bacteria as they stabilize organic matter, do not explain the consistently low D.O. BOD is not especially elevated in WBID 175, ranging from 1 to 2.3 mg/l, and averaging 1.5 mg/l (Table 4). In addition, BOD does not correlate well with D.O., as evidenced by a low correlation coefficient (R^2=0.37), and the relationship is the opposite of what would be expected if BOD were causing low D.O. (Figure 5). Increased BOD (i.e. increased oxygen demand) should lead to lower- not higher- concentrations of D.O.

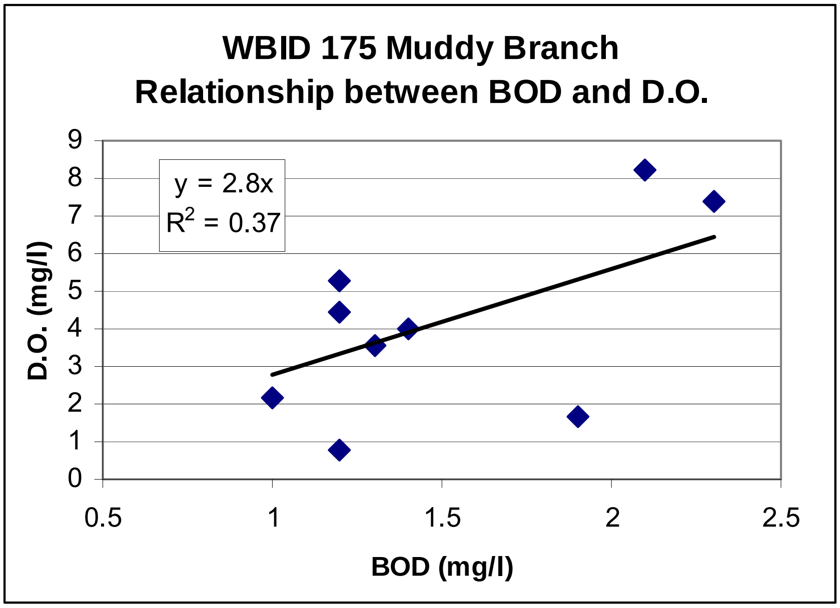

Figure 5. BOD versus D.O. in WBID 175 (Muddy Branch).

The saturation concentration of dissolved oxygen decreases with increasing temperature. Measured D.O. Muddy Branch is, on average, about one-third of the saturation concentration based on water temperature (Figure 6). That corresponds to 6.4 mg/l of oxygen that would need to be added to bring the D.O. of Muddy Branch up to saturation.

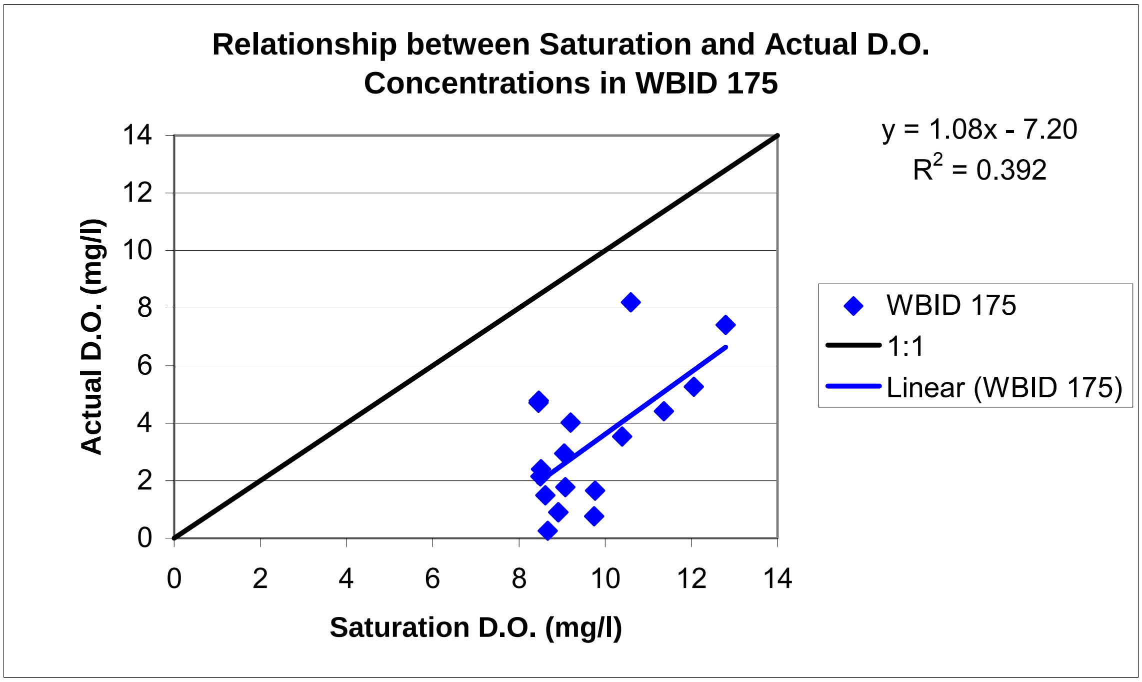

Figure 6. Measured versus Saturated Dissolved Oxygen in Muddy Branch

Algal Growth Potential (AGP) was determined for samples collected at two stations on Muddy Branch in April and May 2004. AGP tests measure the levels of biologically available nutrients by determining the maximum amount of algal growth nutrients in the water can support. This indicates the potential for algal blooms or nuisance aquatic weed growth, which can lead to eutrophication. Studies have shown that algal dry weight concentrations exceeding 6.1 mg/L are associated with highly productive waters (Miller et. al., 1974) and algal dry weight concentrations exceeding 10 mg/L are associated with eutrophic waters which are subject to nuisance algal blooms (EPA, 1975; and Raschke, et. al., 1987). One of the four samples had an AGP value associated with eutrophic water, but the other values were much lower. Nitrogen and phosphorus are the most common growth-limiting nutrients in surface waters. Assays to determine the limiting nutrient for Muddy Branch were also performed. The results indicate that phosphorus was most commonly the limiting nutrient in Muddy Branch (Table 5).

Table 5. Algal Growth Potential Test Results for Muddy Branch.

Station	Date	Time	Control MSC	C+N MSC	C+P MSC	LIMITING NUTRIENT
MC06	4/21/04	9:40 AM	2.0	1.7	28.2	Phosphorus
MC07	4/21/04	10:00 AM	3.5	14.6	3.4	Nitrogen
MC06	5/19/04	9:58 AM	4.0	2.1	22.8	Phosphorus
MC07	5/19/04	10:30 AM	16.7	16.0	20.7	Phosphorus

Notes: MSC = Maximum Standing Crop of *Selenastrum* - mg/L (dry wt),
C+ N = Control + Nitrogen
C+ P = Control + Phosphorus

As discussed above, only data collected in the Group 2 listing cycle, from 1996 to present, are included in the figures and the table of summary statistics. Additional tables and graphics showing the measured water quality data are provided in Appendix A. Based on this information, TMDLs for nutrients and D.O. are being established for WBID 175.

5.2 Source Assessment

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources. Nutrients enter surface waters from both point and nonpoint 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 stormwater systems (MS4 areas), certain industrial facilities, and construction sites over one acre, are storm-water driven sources that are considered “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 at a single location. These include nutrient runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. These sources generally, but not always, involve accumulation of nutrients on land surfaces and wash off as a result of storm events.

5.2.1 Point Sources

There are several point sources located in Apalachicola-Chipola drainage basin that possess NPDES permits for discharges of treated sanitary wastewater. However, most of these facilities discharge to percolation ponds, spray fields, or deep injection wells. A wasteload allocation (WLA) is given only to NPDES facilities discharging to surface waters and to permitted Municipal Separate Storm Sewer Systems (MS4s). It should be noted that wastewater facilities permits authorize a discharge only if the applicant provides reasonable assurance that the discharge will not cause or contribute to violations of the water quality criteria.

There are no facilities currently discharging directly to surface water in WBID 175. According to the Basin Status Report, the Marianna Correctional Facility sewage treatment plant (FLA010128) occasionally discharged wastewater to Muddy Branch, but this facility is listed as currently discharging via land application. Waste from Florida Caverns State Park is transmitted to the City of Marianna wastewater treatment plant. The former Sunland Training Center wastewater treatment facility was supposed to have ceased discharging in 1989. In January 1999, F.D.E.P. received an anonymous complaint that raw sewage from the collection system of the City of Marianna was being bypassed through the unpermitted Sunland wastewater treatment facility and was subsequently discharged to Muddy Branch. After inspecting the facility, F.D.E.P. found evidence that the plant was indeed operational. Muddy Branch is adjacent to old sand filter beds (for effluent percolation) at Sunland. In January 1999, F.D.E.P. noted apparent eutrophication of Muddy Branch in the area of the Sunland wastewater facility. The surface of the water was covered with a thick mat of duckweed. During a further site inspection on February 8, 1999, F.D.E.P. followed up on information from an anonymous complainant and located a discharge pipe that ran from the Sunland chlorine contact chamber to the bank of Muddy Branch Creek. The complainant claimed that the city periodically discharged primary treated effluent to Muddy Branch. According to the city, the pipe was sealed with concrete and a discharge from it was not possible. By the time of a March 3, 1999 inspection, a section of the clay pipe had been removed, which prevented F.D.E.P. from conducting a dye test to see if discharge could have come from the pipe. An inspection on April 28, 1999 found other evidence of continual, frequent discharges. Specifically, F.D.E.P. discovered a depression at what would be the discharge point for the pipe, some apparently new or operational chains and piping, and trash and other solids on the trickling filter (which suggests recent wastewater application). F.D.E.P. entered into a Consent Order with the City of Marianna, applied a penalty of $550,000 and ordered proper abandonment of the Sunland Facility. Sunland was finally abandoned in 2001.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge nutrients to waterbodies in response to storm events. Currently, large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit. In March 2003, small MS4s serving urbanized areas will be required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. There are no Phase 1 or Phase 2 Municipal Separate Storm Sewer Systems (MS4s) in the Apalachicola-Chipola Basin.

5.2.2 Non-point Sources

Nonpoint sources that ultimately contribute to depletion of in-stream dissolved oxygen include sources of nutrients such as animal waste, waste-lagoon sludge, fertilizer application to agricultural fields, lawns, and golf courses, and malfunctioning onsite sewage treatment and disposal systems or septic tank systems.

In WBID 175, over half of the land area is used for agriculture (Table 2). Problems caused by agricultural runoff from dairy farms in the Muddy Branch watershed have been noted (FDEP, 2002).

5.2.2.1 Wildlife

Wildlife deposit bacteria deposit their feces onto land surfaces where it can be transported during storm events to nearby streams. The nutrient load from wildlife is assumed background, as the contribution from this source is small relative to the load from urban and agricultural areas. In addition, any strategy employed to control this source would probably have a negligible impact on obtaining water quality standards.

5.2.2.2 Agricultural Animals

Agricultural activities, including runoff from pastureland and cattle in streams, can impact water quality. A livestock inventory from the 2002 Census of Agriculture for the county encompassing the impaired WBID is listed in Table 6. Many agricultural activities are located in Jackson County. Cattle, including beef and dairy cows, is the predominate livestock. Collins (1996) studied the effects of swine farms in Jackson County on local groundwater quality.

The Florida Department of Agriculture and Consumer Services (FDACS), Office of Agricultural Water Policy developed a manual outlining best management practice for cow/calf operations

(FDACS, 1999). In this report the authors state "implementation of the practices described in this manual provides a good argument that you have made reasonable efforts to reduce pollutants from your ranch by the maximum practicable amount". The manual acknowledges "after implementation of these BMPs it may be necessary to add more stringent guidelines for site specific areas that continue to exceed water quality standards".

Table 6. Livestock Inventory for Jackson County (source: NASS, 2002)

Livestock (inventory)	Jackson
Cattle and calves	35,708
Beef Cows	17,878
Dairy Cows	2,387
Swine	1,532
Poultry (broilers sold)	(D)
Sheep	109
Goats	1,780
Horses and Ponies	1,387

Notes: (D) – data withheld to avoid disclosing data for individual farms

5.2.2.3 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrient (nitrogen and phosphorus), pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health (www.doh.state.fl.us/environment/statistics) publishes septic tanks data on a county basis. Table 7 summarizes the number of septic systems installed since the 1970 census and the total number of repair permits issued between 1996 and 2001. The data do not reflect septic tanks removed from service.

Table 7. County Estimates of Septic Tanks and Repair Permits (FDEP, 2002)

County	Number of Septic Tanks (2002)	Number of Repair Permits Issued (1996 – 2002)
Jackson	15,704	812

5.2.2.4 Urban Development

Nutrient loading from urban areas is attributable to multiple sources including storm water runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

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 outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

5.3 Analytical Approach

In order to develop a nutrient TMDL for Muddy Branch, the narrative criterion must first be translated to numeric targets. FDEP has interpreted the narrative criterion to develop total phosphorus (TP) and total nitrogen (TN) targets for Muddy Branch (Table 8). The approach is based on the nutrient concentrations of all streams in FDEP's database that are located in the same bioregion as Muddy Branch (Panhandle bioregion) and that scored well on the recalibrated Stream Condition Index (SCI≥45.5). The recalibrated Stream Condition Index (SCI) uses ten metrics of benthic macroinvertebrate community health to rate streams against reference conditions. Following EPA recommendations for developing nutrient targets in rivers and streams (EPA, 2000), the 75th percentiles of the reference TN and TP data were computed (Appendix B). Total Nitrogen was estimated by adding Nitrate-Nitrite and Total Kjeldahl Nitrogen. FDEP is in the process of developing a protocol for determining numeric nutrient criteria for rivers and streams. The methodology used to derive nutrient targets for Muddy Branch is the best available at this time but should be considered subject to refinement as the criteria development process continues.

Table 8. Targets for Muddy Branch TMDLs

Parameter	Target
Total Phosphorus	0.072 mg/l[1]
Total Nitrogen	0.81 mg/l[1]
Dissolved Oxygen	5.0 mg/l

Notes: Target is for the average and is the value before reserving a 10% margin of safety.

The approach for calculating TMDLs is usually dictated by the number of water quality samples and the availability of flow data. Since the dataset is somewhat limited, and a means for estimating flow at the time of each sampling is not available, a simple approach was determined to be the most technically defensible. The average flow from all available data (3.2 cfs) was used to convert the target concentrations for total phosphorus and total nitrogen to average annual loads.

TP or TN (kg/year) = [ave. flow in cfs] * [(target TP or TN concentration in mg/l)] * [C.F.]

where C.F. is a unit conversion factor equal to 2.45. Once the TMDL nutrient targets were defined, all available water quality data for WBID 175 were summarized and a median was calculated for TN and TP represent existing conditions. The median was used to represent the central tendency of the data instead of the mean because it is not as easily skewed by extreme values. These medians were compared to their respective targets and a percent reduction was computed.

The target for the dissolved oxygen TMDL is the standard of 5.0 mg/l (Table 8). The D.O. TMDL was determined by calculating the amount of oxygen that would need to be added to bring the median D.O. concentration up to 5.0 mg/l:

D.O. (kg/year) = [ave. flow in cfs] * [(5.0 mg/l)- (median D.O. concentration in mg/l)] * [C.F.]

where C.F. is a unit conversion factor equal to 2.45. The average flow from all available data is 2.36 cfs. The median D.O. from all of the available water quality data for WBID 175 is 2.7 mg/l, meaning that 2.3 mg/l would be needed to raise the average concentration to the target.

The available data do not support that D.O. is depressed due to elevated biochemical oxygen demand (BOD; see Table 4 and Figure 5). It is also unclear to what extent nutrients cause the low D.O. concentrations in Muddy Branch. As discussed above, the available data suggest that dissolved oxygen concentrations in Muddy Branch are consistently below the standard of 5 mg/l. Assuming that any anthropogenic influence on low dissolved oxygen is a function of nutrient enrichment, meeting the nutrient targets should ensure that nutrients do not cause or contribute to impairment. Given the typically low flows of Muddy Branch, and the warm climate of the region, the D.O. may not be able to meet the standard of 5 mg/l, even after eliminating excess nutrients derived from anthropogenic activities. The characteristics of Muddy Branch may warrant a site-specific D.O. standard. In the absence of a site-specific standard, the present D.O. standard of 5 mg/l must be met.

5.4 Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

The objective of a TMDL is to allocate loads among the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measure. The D.O. and nutrient TMDLs for Muddy Branch are expressed as the average annual loads in units of kilograms (kg) per year. TMDL components for WBID 175 are provided in Table 9 and are discussed further below.

Table 9. TMDL Components for WBID 175 (Muddy Branch).

Parameter	TMDL (kg/year)	LA (kg/year)	WLA[1]		MOS[3] (kg/year)	Percent Reduction
			Continuous (kg/year)	MS4		
Total Phosphorus	152	137	N/A[2]	N/A[2]	15	69%[4]
Total Nitrogen	1707	1536	N/A[2]	N/A[2]	171	26%[4]
Dissolved Oxygen	5410	4918	N/A[2]	N/A[2]	492	87%[5]

Notes:

1. WLA component is separated into load from continuous NPDES facilities (e.g., WWTPs) and load from MS4s. Currently, there are no continuous discharge facilities or MS4 areas in WBID 175.
2. N/A = not applicable
3. Represents a 10% Margin of Safety.
4. Percent reduction from current conditions to achieve the target concentration for that nutrient.
5. Percent increase from current conditions to achieve the target concentration for D.O.

5.4.1 Waste Load Allocations

Only facilities discharging directly into streams and MS4 areas are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTP) and MS4 areas as the former discharges during all weather conditions whereas the later discharges in response to storm events. There are no facilities currently discharging directly to surface water in WBID 175. There are also no MS4 areas in WBID 175.

5.4.2 Load Allocations

The nutrient load allocations are expressed as the annual average loads of total phosphorus and total nitrogen in WBID 175 to meet the target concentrations in Table 8, after reserving a 10% margin of safety from the TMDL value. The load allocation for dissolved oxygen is the average annual load of oxygen that would need to be added to raise the average dissolved oxygen concentration to 5.0 mg/l.

5.4.3 Margin of Safety

There are two methods for incorporating a MOS in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. An explicit MOS of 10% was used for both the nutrient and D.O. TMDLs. For D.O. the MOS was added to the TMDL (added because D.O. would need to be raised, not lowered, to meet standards), and for nutrients, the MOS was applied directly to the targets.

5.4.4 Critical Conditions and Seasonal Variation

The critical conditions can be defined as the environmental conditions requiring the largest reduction to meet standards. By achieving the reduction for critical conditions, water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year.

The critical condition for non-point source loadings are typically an extended dry period followed by a rainfall runoff event. During the dry weather period, pollutants build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. The expression of a nutrient impairment is more likely to occur during warmer months. However, because nutrients (especially phosphorus) can accumulate, nutrient loadings are usually considered over longer periods (e.g. annual instead of daily loads).

Critical conditions and seasonal variation were incorporated into the TMDL development by using all available water quality data associated with the WBID to express loads on an annual basis. These water quality data were collected in different years, during multiple seasons, at both high and low flows.

5.5 Recommendations

Determining the source of nutrients in waterbodies is the initial step to implementing a nutrient TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

In addition, the need for a site-specific dissolved oxygen criterion for Muddy Branch should be explored.

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APPENDIX A WATER QUALITY DATA

List of Tables

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Table A- 1. Guide to Water Quality Remark Codes (Rcode column in data tables)

Remark Code	Definition
A	Value reported is mean of two or more samples
B	Result based on colony counts outside the acceptable range
E	Extra sample taken in compositing process
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.
K	Off-scale low. Actual value not known, but known to be less than value shown
L	Off-scale high. Actual value not known, but known to be greater than value shown
Q	Sample held beyond normal holding time
T	Value reported is less than the criteria of detection
U	Material was analyzed for but not detected. Value stored is the limit of detection.
<	NAWQA – actual value is known to be less than the value shown

Table A- 2. Summary Statistics for Muddy Branch.[1]

parameter	obs	max	min	mean	stdev	median
CHLAC	8	28.00	0.45	5.92	9.41	1.95
BOD	4	1.90	1.20	1.38	0.35	1.20
DO	13	5.27	0.26	2.48	1.76	1.77
NH4	8	1.20	0.01	0.27	0.43	0.05
NO3O2	8	2.10	0.00	0.53	0.77	0.05
TKN	7	2.20	0.31	0.92	0.85	0.49
TP	8	1.200	0.030	0.296	0.380	0.205
ALK	4	139	76	108	26	108
COLOR	4	250	40	100	100	55
SD	4	3.7	0.5	2.8	1.6	3.6
pH	13	7.84	6.99	7.26	0.22	7.22
PORD	4	0.160	0.055	0.098	0.051	0.089
TSS	4	11.00	4.00	6.60	3.34	5.70
Turb	8	42.00	0.23	14.05	16.27	7.00
Temp	13	24.58	6.84	20.49	6.31	23.73
AGPT	4	16.7	2.0	6.6	6.8	3.8
TN*	N/A					0.54

Notes:

1 Statistics are for data collected on Muddy Branch only and does not include data collected on Spring Branch. For summary statistics for WBID 175, including Muddy and Spring Branches, see Table 4.

*TN is estimated from median TKN + median NO_3O_2.

Table A- 3. Water Quality Data for WBID 175 (Muddy Branch Basin), 1996-present.

Data Source	Waterbody	station	parameter code	Date	time	depth	result	rcode
EPA	Muddy Branch	MC06	AGPT	04/21/04	9:40		2.00	
EPA	Muddy Branch	MC07	AGPT	04/21/04	10:00		3.50	
EPA	Muddy Branch	MC06	AGPT	05/19/04	9:58		4.00	
EPA	Muddy Branch	MC07	AGPT	05/19/04	10:30		16.70	
IWR v.16	Spring Branch	21FLBFA 31020021	AIRC	05/05/96	1150	1.00	29	
IWR v.16	Spring Branch	21FLBFA 31020021	AIRC	11/03/96	1205	1.00	16	
IWR v.16	Spring Branch	21FLBFA 31020021	AIRC	02/16/97	1200	0.50	17	
IWR v.16	Spring Branch	21FLBFA 31020021	AIRC	05/04/97	1102	1.00	26.1	
FDEP	Muddy Branch	5520	ALK	11/18/03	1049	0.5	139	
FDEP	Muddy Branch	5510	ALK	11/18/03	1019	0.5	107	A
FDEP	Muddy Branch	5520	ALK	12/15/03	1050	0.5	109	
FDEP	Muddy Branch	5510	ALK	12/15/03	945	0.5	76	A
IWR v.16	Spring Branch	21FLBFA 31020021	BOD	02/04/96	1100	1.00	2.3	Q
IWR v.16	Spring Branch	21FLBFA 31020021	BOD	05/05/96	1150	1.00	1	Q
IWR v.16	Spring Branch	21FLBFA 31020021	BOD	11/03/96	1205	1.00	1.3	Q
IWR v.16	Spring Branch	21FLBFA 31020021	BOD	02/16/97	1200	0.50	2.1	Q
IWR v.16	Spring Branch	21FLBFA 31020021	BOD	05/04/97	1102	1.00	1.4	Q
FDEP	Muddy Branch	5520	BOD	11/18/03	1049	0.5	1.2	
FDEP	Muddy Branch	5510	BOD	11/18/03	1019	0.5	1.9	
FDEP	Muddy Branch	5520	BOD	12/15/03	1050	0.5	1.2	
FDEP	Muddy Branch	5510	BOD	12/15/03	945	0.5	1.2	
FDEP	Muddy Branch	5520	BOTTM	06/12/02	1140	0.5	1	
FDEP	Muddy Branch	5510	BOTTM	06/12/02	839	0.5	0.5	
FDEP	Muddy Branch	5520	BOTTM	06/25/02	1120	0.5	1	
FDEP	Muddy Branch	5520	BOTTM	07/23/02	900	0	0	
FDEP	Muddy Branch	5520	BOTTM	10/01/02	748	0.5	3.7	
FDEP	Muddy Branch	5510	BOTTM	10/01/02	845	0.5	0.871	
FDEP	Muddy Branch	5520	BOTTM	06/18/03	1135	0.5	3.65	
FDEP	Muddy Branch	5520	BOTTM	06/18/03	1135	3	3.65	
FDEP	Muddy Branch	5510	BOTTM	06/18/03	1115	0.5	0.5	
FDEP	Muddy Branch	5520	BOTTM	11/18/03	1049	0.5	2.7	
FDEP	Muddy Branch	5510	BOTTM	11/18/03	1019	0.5	2	
FDEP	Muddy Branch	5520	BOTTM	12/15/03	1050	0.5	3.5	
FDEP	Muddy Branch	5510	BOTTM	12/15/03	945	0.5	1	
FDEP	Muddy Branch	5520	CHLAC	11/18/03	1049	0.5	1.7	U
FDEP	Muddy Branch	5510	CHLAC	11/18/03	1019	0.5	3.6	AI
FDEP	Muddy Branch	5520	CHLAC	12/15/03	1050	0.5	0.85	U
FDEP	Muddy Branch	5510	CHLAC	12/15/03	945	0.5	0.85	U
EPA	Muddy Branch	MC06	CHLAC-F	04/21/04	9:40		9.70	
EPA	Muddy Branch	MC07	CHLAC-F	04/21/04	10:00		2.20	
EPA	Muddy Branch	MC06	CHLAC-F	05/19/04	9:58		0.45	
EPA	Muddy Branch	MC07	CHLAC-F	05/19/04	10:30		28.00	
IWR v.16	Spring Branch	21FLBFA 31020021	CHLOR	02/04/96	1100	1.00	3.8	

IWR v.16	Spring Branch	21FLBFA 31020021	CHLOR	11/03/96	1205	1.00	14	
IWR v.16	Spring Branch	21FLBFA 31020021	CHLOR	02/16/97	1200	0.50	6.6	
IWR v.16	Spring Branch	21FLBFA 31020021	CHLOR	05/04/97	1102	1.00	4.7	
IWR v.16	Spring Branch	21FLBFA 31020021	CLOUD	02/04/96	1100	1.00	20	
IWR v.16	Spring Branch	21FLBFA 31020021	CLOUD	05/05/96	1150	1.00	30	
IWR v.16	Spring Branch	21FLBFA 31020021	CLOUD	11/03/96	1205	1.00	0	
IWR v.16	Spring Branch	21FLBFA 31020021	CLOUD	02/16/97	1200	0.50	0	
IWR v.16	Spring Branch	21FLBFA 31020021	CLOUD	05/04/97	1102	1.00	0	
IWR v.16	Spring Branch	21FLBFA 31020021	COLOR	02/04/96	1100	1.00	100	
IWR v.16	Spring Branch	21FLBFA 31020021	COLOR	05/05/96	1150	1.00	40	
IWR v.16	Spring Branch	21FLBFA 31020021	COLOR	11/03/96	1205	1.00	30	
IWR v.16	Spring Branch	21FLBFA 31020021	COLOR	02/16/97	1200	0.50	40	
IWR v.16	Spring Branch	21FLBFA 31020021	COLOR	05/04/97	1102	1.00	45	
FDEP	Muddy Branch	5520	COLOR	11/18/03	1049	0.5	50	
FDEP	Muddy Branch	5510	COLOR	11/18/03	1019	0.5	250	
FDEP	Muddy Branch	5520	COLOR	12/15/03	1050	0.5	40	
FDEP	Muddy Branch	5510	COLOR	12/15/03	945	0.5	60	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	02/04/96	1100	1.00	72	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	05/05/96	1150	1.00	200	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	05/05/96	1150	1.00	241	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	11/03/96	1205	1.00	250	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	11/03/96	1205	1.00	335	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	02/16/97	1200	0.50	238	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	05/04/97	1102	1.00	163	
IWR v.16	Spring Branch	21FLBFA 31020021	COND	05/04/97	1102	1.00	209	
FDEP	Muddy Branch	5520	COND	06/12/02	1140	0.5	207	
FDEP	Muddy Branch	5510	COND	06/12/02	839	0.5	118	
FDEP	Muddy Branch	5520	COND	06/25/02	1120	0.5	195	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	COND	10/01/02	0	0.50	271	
FDEP	Muddy Branch	5520	COND	10/01/02	748	0.5	248	
FDEP	Muddy Branch	5510	COND	10/01/02	845	0.5	271	
FDEP	Muddy Branch	5520	COND	06/18/03	1135	0.5	236	
FDEP	Muddy Branch	5520	COND	06/18/03	1135	3	237	
FDEP	Muddy Branch	5510	COND	06/18/03	1115	0.5	245	
FDEP	Muddy Branch	5520	COND	11/18/03	1049	0.5	273	
FDEP	Muddy Branch	5510	COND	11/18/03	1019	0.5	217	
FDEP	Muddy Branch	5520	COND	12/15/03	1050	0.5	217	
FDEP	Muddy Branch	5510	COND	12/15/03	945	0.5	175	
FDEP	Muddy Branch	5520	DISS	11/18/03	1049	0.5	175	
FDEP	Muddy Branch	5510	DISS	11/18/03	1019	0.5	146	A
FDEP	Muddy Branch	5520	DISS	12/15/03	1050	0.5	138	
FDEP	Muddy Branch	5510	DISS	12/15/03	945	0.5	110	
IWR v.16	Spring Branch	21FLBFA 31020021	DO	02/04/96	1100	1.00	7.41	
IWR v.16	Spring Branch	21FLBFA 31020021	DO	05/05/96	1150	1.00	2.15	
IWR v.16	Spring Branch	21FLBFA 31020021	DO	11/03/96	1205	1.00	3.53	
IWR v.16	Spring Branch	21FLBFA 31020021	DO	02/16/97	1200	0.50	8.2	

IWR v.16	Spring Branch	21FLBFA 31020021	DO	05/04/97	1102	1.00	4.02	
FDEP	Muddy Branch	5520	DO	06/12/02	1140	0.5	1.49	
FDEP	Muddy Branch	5510	DO	06/12/02	839	0.5	1.77	
FDEP	Muddy Branch	5520	DO	06/25/02	1120	0.5	2.94	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	DO	10/01/02	0	0.50	0.9	
FDEP	Muddy Branch	5520	DO	10/01/02	748	0.5	0.26	
FDEP	Muddy Branch	5510	DO	10/01/02	845	0.5	0.9	
FDEP	Muddy Branch	5520	DO	06/18/03	1135	0.5	4.78	
FDEP	Muddy Branch	5520	DO	06/18/03	1135	3	4.71	
FDEP	Muddy Branch	5510	DO	06/18/03	1115	0.5	2.4	
FDEP	Muddy Branch	5520	DO	11/18/03	1049	0.5	0.76	
FDEP	Muddy Branch	5510	DO	11/18/03	1019	0.5	1.66	
FDEP	Muddy Branch	5520	DO	12/15/03	1050	0.5	5.27	
FDEP	Muddy Branch	5510	DO	12/15/03	945	0.5	4.42	
IWR v.16	Spring Branch	21FLBFA 31020021	DOSAT	02/04/96	1100	1.00	57.9	$
IWR v.16	Spring Branch	21FLBFA 31020021	DOSAT	05/05/96	1150	1.00	25.3	$
IWR v.16	Spring Branch	21FLBFA 31020021	DOSAT	11/03/96	1205	1.00	33.9	$
IWR v.16	Spring Branch	21FLBFA 31020021	DOSAT	02/16/97	1200	0.50	77.4	$
IWR v.16	Spring Branch	21FLBFA 31020021	DOSAT	05/04/97	1102	1.00	43.7	$
FDEP	Muddy Branch	5520	DOSAT	06/12/02	1140	0.5	17.3	
FDEP	Muddy Branch	5510	DOSAT	06/12/02	839	0.5	19.5	
FDEP	Muddy Branch	5520	DOSAT	06/25/02	1120	0.5	32.5	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	DOSAT	10/01/02	0	0.50	10.1	
FDEP	Muddy Branch	5520	DOSAT	10/01/02	748	0.5	3	
FDEP	Muddy Branch	5510	DOSAT	10/01/02	845	0.5	10.1	
FDEP	Muddy Branch	5520	DOSAT	06/18/03	1135	0.5	56.5	
FDEP	Muddy Branch	5520	DOSAT	06/18/03	1135	3	55.7	
FDEP	Muddy Branch	5510	DOSAT	06/18/03	1115	0.5	28.2	
FDEP	Muddy Branch	5520	DOSAT	11/18/03	1049	0.5	7.8	
FDEP	Muddy Branch	5510	DOSAT	11/18/03	1019	0.5	17	
FDEP	Muddy Branch	5520	DOSAT	12/15/03	1050	0.5	43.7	
FDEP	Muddy Branch	5510	DOSAT	12/15/03	945	0.5	38.9	
IWR v.16	Spring Branch	21FLBFA 31020021	FCOLI	02/04/96	1100	1.00	1	Z
IWR v.16	Spring Branch	21FLBFA 31020021	FCOLI	05/05/96	1150	1.00	30	Q
IWR v.16	Spring Branch	21FLBFA 31020021	FCOLI	11/03/96	1205	1.00	20	Q
IWR v.16	Spring Branch	21FLBFA 31020021	FCOLI	02/16/97	1200	0.50	400	Q
IWR v.16	Spring Branch	21FLBFA 31020021	FCOLI	05/04/97	1102	1.00	1400	Q
FDEP	Muddy Branch	5510	FLOW	06/12/02	839	0.5	0	
FDEP	Muddy Branch	5520	FLOW	06/25/02	1120	0.5	0	
FDEP	Muddy Branch	5520	FLOW	07/23/02	900	0	0	
FDEP	Muddy Branch	5520	FLOW	10/01/02	748	0.5	0.208	
IWR v.16	Spring Branch	21FLBFA 31020021	NH4	02/04/96	1100	1.00	0.022	
IWR v.16	Spring Branch	21FLBFA 31020021	NH4	05/05/96	1150	1.00	0.35	
IWR v.16	Spring Branch	21FLBFA 31020021	NH4	11/03/96	1205	1.00	0.036	
IWR v.16	Spring Branch	21FLBFA 31020021	NH4	02/16/97	1200	0.50	0.1	
IWR v.16	Spring Branch	21FLBFA 31020021	NH4	05/04/97	1102	1.00	0.28	

FDEP	Muddy Branch	5510	NH4	11/18/03	1019	0.5	0.63	
FDEP	Muddy Branch	5520	NH4	11/18/03	1049	0.5	0.012	
FDEP	Muddy Branch	5510	NH4	12/15/03	945	0.5	0.042	A
FDEP	Muddy Branch	5520	NH4	12/15/03	1050	0.5	0.01	U
EPA	Muddy Branch	MC06	NH4	04/21/04	9:40		0.05	UJ
EPA	Muddy Branch	MC07	NH4	04/21/04	10:10		0.16	J
EPA	Muddy Branch	MC06	NH4	05/19/04	9:58		0.05	U
EPA	Muddy Branch	MC07	NH4	05/19/04	10:30		1.2	
IWR v.16	Spring Branch	21FLBFA 31020021	NO3O2	02/04/96	1100	1.00	0.22	
IWR v.16	Spring Branch	21FLBFA 31020021	NO3O2	05/05/96	1150	1.00	1.3	
IWR v.16	Spring Branch	21FLBFA 31020021	NO3O2	11/03/96	1205	1.00	0.44	
IWR v.16	Spring Branch	21FLBFA 31020021	NO3O2	02/16/97	1200	0.50	1.8	
IWR v.16	Spring Branch	21FLBFA 31020021	NO3O2	05/04/97	1102	1.00	0.81	
FDEP	Muddy Branch	5510	NO3O2	11/18/03	1019	0.5	0.024	
FDEP	Muddy Branch	5520	NO3O2	11/18/03	1049	0.5	0.87	
FDEP	Muddy Branch	5510	NO3O2	12/15/03	945	0.5	0.005	I
FDEP	Muddy Branch	5520	NO3O2	12/15/03	1050	0.5	0.004	U
EPA	Muddy Branch	MC06	NO3O2	04/21/04	9:40		2.100	J
EPA	Muddy Branch	MC07	NO3O2	04/21/04	10:10		0.050	UJ
EPA	Muddy Branch	MC06	NO3O2	05/19/04	9:58		1.100	
EPA	Muddy Branch	MC07	NO3O2	05/19/04	10:30		0.050	U
IWR v.16	Spring Branch	21FLBFA 31020021	PH	02/04/96	1100	1.00	6.21	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	05/05/96	1150	1.00	7.08	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	05/05/96	1150	1.00	6.68	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	11/03/96	1205	1.00	6.8	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	11/03/96	1205	1.00	7.2	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	02/16/97	1200	0.50	7.35	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	02/16/97	1200	0.50	6.67	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	05/04/97	1102	1.00	6.78	
IWR v.16	Spring Branch	21FLBFA 31020021	PH	05/04/97	1102	1.00	7.13	
FDEP	Muddy Branch	5520	PH	06/12/02	1140	0.5	7.48	
FDEP	Muddy Branch	5510	PH	06/12/02	839	0.5	7.39	
FDEP	Muddy Branch	5520	PH	06/25/02	1120	0.5	7.84	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	PH	10/01/02	0	0.50	7.22	
FDEP	Muddy Branch	5520	PH	10/01/02	748	0.5	7.01	
FDEP	Muddy Branch	5510	PH	10/01/02	845	0.5	7.22	
FDEP	Muddy Branch	5520	PH	06/18/03	1135	0.5	7.28	
FDEP	Muddy Branch	5520	PH	06/18/03	1135	3	7.28	
FDEP	Muddy Branch	5510	PH	06/18/03	1115	0.5	7.18	
FDEP	Muddy Branch	5520	PH	11/18/03	1049	0.5	7.25	
FDEP	Muddy Branch	5510	PH	11/18/03	1019	0.5	7.08	
FDEP	Muddy Branch	5520	PH	12/15/03	1050	0.5	7.15	
FDEP	Muddy Branch	5510	PH	12/15/03	945	0.5	6.99	
FDEP	Muddy Branch	5520	PHEOA	11/18/03	1049	0.5	1.7	U
FDEP	Muddy Branch	5510	PHEOA	11/18/03	1019	0.5	0	AJ
FDEP	Muddy Branch	5520	PHEOA	12/15/03	1050	0.5	0.85	U

FDEP	Muddy Branch	5510	PHEOA	12/15/03	945	0.5	0.85	U
FDEP	Muddy Branch	5520	PORD	11/18/03	1049	0.5	0.055	
FDEP	Muddy Branch	5510	PORD	11/18/03	1019	0.5	0.16	
FDEP	Muddy Branch	5520	PORD	12/15/03	1050	0.5	0.058	
FDEP	Muddy Branch	5510	PORD	12/15/03	945	0.5	0.12	
FDEP	Muddy Branch	5520	SALIN	06/12/02	1140	0.5	0.1	
FDEP	Muddy Branch	5510	SALIN	06/12/02	839	0.5	0.05	
FDEP	Muddy Branch	5520	SALIN	06/25/02	1120	0.5	0.09	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	SALIN	10/01/02	0	0.50	0.13	
FDEP	Muddy Branch	5520	SALIN	10/01/02	748	0.5	0.12	
FDEP	Muddy Branch	5510	SALIN	10/01/02	845	0.5	0.13	
FDEP	Muddy Branch	5520	SALIN	06/18/03	1135	0.5	0.11	
FDEP	Muddy Branch	5520	SALIN	06/18/03	1135	3	0.11	
FDEP	Muddy Branch	5510	SALIN	06/18/03	1115	0.5	0.12	
FDEP	Muddy Branch	5520	SALIN	11/18/03	1049	0.5	0.13	
FDEP	Muddy Branch	5510	SALIN	11/18/03	1019	0.5	0.1	
FDEP	Muddy Branch	5520	SALIN	12/15/03	1050	0.5	0.1	
FDEP	Muddy Branch	5510	SALIN	12/15/03	945	0.5	0.08	
FDEP	Muddy Branch	5520	SD	10/01/02	748	0.5	3.5	
FDEP	Muddy Branch	5520	SD	06/18/03	1135	0.5	3.65	
FDEP	Muddy Branch	5520	SD	06/18/03	1135	3	3.65	
FDEP	Muddy Branch	5510	SD	06/18/03	1115	0.5	0.5	>
FDEP	Muddy Branch	5520	SD	12/15/03	1050	0.5		TB
FDEP	Muddy Branch	5510	SD	12/15/03	945	0.5		TB
IWR v.16	Spring Branch	21FLBFA 31020021	SO4	02/04/96	1100	1.00	2.3	
IWR v.16	Spring Branch	21FLBFA 31020021	SO4	11/03/96	1205	1.00	1.7	
IWR v.16	Spring Branch	21FLBFA 31020021	SO4	02/16/97	1200	0.50	3.3	
IWR v.16	Spring Branch	21FLBFA 31020021	SO4	05/04/97	1102	1.00	1.8	
FDEP	Muddy Branch	5520	SO4	11/18/03	1049	0.5	0.34	I
FDEP	Muddy Branch	5510	SO4	11/18/03	1019	0.5	0.38	I
FDEP	Muddy Branch	5520	SO4	12/15/03	1050	0.5	0.93	
FDEP	Muddy Branch	5510	SO4	12/15/03	945	0.5	1	
IWR v.16	Spring Branch	21FLBFA 31020021	TCOLI	02/04/96	1100	1.00	1	Z
IWR v.16	Spring Branch	21FLBFA 31020021	TCOLI	05/05/96	1150	1.00	400	Q
IWR v.16	Spring Branch	21FLBFA 31020021	TCOLI	11/03/96	1205	1.00	320	Q
IWR v.16	Spring Branch	21FLBFA 31020021	TCOLI	02/16/97	1200	0.50	1500	Q
IWR v.16	Spring Branch	21FLBFA 31020021	TCOLI	05/04/97	1102	1.00	5	Z
IWR v.16	Spring Branch	21FLBFA 31020021	TEMP	02/04/96	1100	1.00	5.39	
IWR v.16	Spring Branch	21FLBFA 31020021	TEMP	05/05/96	1150	1.00	24.2	
IWR v.16	Spring Branch	21FLBFA 31020021	TEMP	11/03/96	1205	1.00	14.1	
IWR v.16	Spring Branch	21FLBFA 31020021	TEMP	02/16/97	1200	0.50	12.65	
IWR v.16	Spring Branch	21FLBFA 31020021	TEMP	05/04/97	1102	1.00	19.61	
FDEP	Muddy Branch	5520	TEMP	06/12/02	1140	0.5	24.49	
FDEP	Muddy Branch	5510	TEMP	06/12/02	839	0.5	24.42	
FDEP	Muddy Branch	5520	TEMP	06/25/02	1120	0.5	24.58	
IWR v.16	Muddy Branch	21FLWQA 304958708512313	TEMP	10/01/02	0	0.50	24.31	

FDEP	Muddy Branch	5520	TEMP	10/01/02	748	0.5	23.59	
FDEP	Muddy Branch	5510	TEMP	10/01/02	845	0.5	24.31	
FDEP	Muddy Branch	5520	TEMP	06/18/03	1135	0.5	23.73	
FDEP	Muddy Branch	5520	TEMP	06/18/03	1135	3	23.72	
FDEP	Muddy Branch	5510	TEMP	06/18/03	1115	0.5	24.06	
FDEP	Muddy Branch	5520	TEMP	11/18/03	1049	0.5	16.55	
FDEP	Muddy Branch	5510	TEMP	11/18/03	1019	0.5	17.38	
FDEP	Muddy Branch	5520	TEMP	12/15/03	1050	0.5	6.84	
FDEP	Muddy Branch	5510	TEMP	12/15/03	945	0.5	8.41	
IWR v.16	Spring Branch	21FLBFA 31020021	TKN	02/04/96	1100	1.00	0.46	
IWR v.16	Spring Branch	21FLBFA 31020021	TKN	05/05/96	1150	1.00	0.74	
IWR v.16	Spring Branch	21FLBFA 31020021	TKN	11/03/96	1205	1.00	0.29	
IWR v.16	Spring Branch	21FLBFA 31020021	TKN	02/16/97	1200	0.50	0.68	
IWR v.16	Spring Branch	21FLBFA 31020021	TKN	05/04/97	1102	1.00	0.63	
FDEP	Muddy Branch	5510	TKN	11/18/03	1019	0.5	2.2	
FDEP	Muddy Branch	5510	TKN	12/15/03	945	0.5	0.45	
FDEP	Muddy Branch	5520	TKN	12/15/03	1050	0.5	0.49	
EPA	Muddy Branch	MC06	TKN	04/21/04	9:40		0.320	J
EPA	Muddy Branch	MC07	TKN	04/21/04	10:10		0.580	J
EPA	Muddy Branch	MC07	TKN	05/19/04	10:30		2.100	
EPA	Muddy Branch	MC06	TKN	05/19/04	9:58		0.310	
FDEP	Muddy Branch	5520	TOC	11/18/03	1049	0.5	7.8	
FDEP	Muddy Branch	5510	TOC	11/18/03	1019	0.5	9.6	
FDEP	Muddy Branch	5520	TOC	12/15/03	1050	0.5	6.3	
FDEP	Muddy Branch	5510	TOC	12/15/03	945	0.5	5	I
IWR v.16	Spring Branch	21FLBFA 31020021	TP	02/04/96	1100	1.00	0.29	
IWR v.16	Spring Branch	21FLBFA 31020021	TP	05/05/96	1150	1.00	0.37	A
IWR v.16	Spring Branch	21FLBFA 31020021	TP	11/03/96	1205	1.00	0.15	
IWR v.16	Spring Branch	21FLBFA 31020021	TP	02/16/97	1200	0.50	0.21	
IWR v.16	Spring Branch	21FLBFA 31020021	TP	05/04/97	1102	1.00	0.22	
FDEP	Muddy Branch	5510	TP	11/18/03	1019	0.5	1.2	
FDEP	Muddy Branch	5520	TP	11/18/03	1049	0.5	0.2	
FDEP	Muddy Branch	5510	TP	12/15/03	945	0.5	0.21	
FDEP	Muddy Branch	5520	TP	12/15/03	1050	0.5	0.1	
EPA	Muddy Branch	MC06	TP	04/21/04	9:40		0.059	J
EPA	Muddy Branch	MC07	TP	04/21/04	10:10		0.210	J
EPA	Muddy Branch	MC06	TP	05/19/04	9:58		0.030	
EPA	Muddy Branch	MC07	TP	05/19/04	10:30		0.360	
IWR v.16	Spring Branch	21FLBFA 31020021	TSS	02/04/96	1100	1.00	5	U
IWR v.16	Spring Branch	21FLBFA 31020021	TSS	05/05/96	1150	1.00	5	U
IWR v.16	Spring Branch	21FLBFA 31020021	TSS	11/03/96	1205	1.00	29	
IWR v.16	Spring Branch	21FLBFA 31020021	TSS	02/16/97	1200	0.50	5	U
IWR v.16	Spring Branch	21FLBFA 31020021	TSS	05/04/97	1102	1.00	5	U
FDEP	Muddy Branch	5520	TSS	11/18/03	1049	0.5	7.4	
FDEP	Muddy Branch	5510	TSS	11/18/03	1019	0.5	11	I
FDEP	Muddy Branch	5520	TSS	12/15/03	1050	0.5	4	U

FDEP	Muddy Branch	5510	TSS	12/15/03	945	0.5	4	I
IWR v.16	Spring Branch	21FLBFA 31020021	TURB	02/04/96	1100	1.00	27	
IWR v.16	Spring Branch	21FLBFA 31020021	TURB	05/05/96	1150	1.00	6	
IWR v.16	Spring Branch	21FLBFA 31020021	TURB	11/03/96	1205	1.00	9	
IWR v.16	Spring Branch	21FLBFA 31020021	TURB	02/16/97	1200	0.50	7	
IWR v.16	Spring Branch	21FLBFA 31020021	TURB	05/04/97	1102	1.00	11	
FDEP	Muddy Branch	5520	TURB	11/18/03	1049	0.5	0.23	
FDEP	Muddy Branch	5510	TURB	11/18/03	1019	0.5	38	
FDEP	Muddy Branch	5520	TURB	11/18/03	1049	0.5	8	
FDEP	Muddy Branch	5510	TURB	11/18/03	1019	0.5	42	
FDEP	Muddy Branch	5520	TURB	12/15/03	1050	0.5	3.8	
FDEP	Muddy Branch	5510	TURB	12/15/03	945	0.5	5.4	
FDEP	Muddy Branch	5520	TURB	12/15/03	1050	0.5	6	
FDEP	Muddy Branch	5510	TURB	12/15/03	945	0.5	9	
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	02/04/96	1100	1.00	5.6E-07	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	02/04/96	1100	1.00	4.6E-07	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	05/05/96	1150	1.00	9.0E-04	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	05/05/96	1150	1.00	1.1E-03	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	11/03/96	1205	1.00	7.0E-05	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	11/03/96	1205	1.00	5.8E-05	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	02/16/97	1200	0.50	1.3E-04	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	02/16/97	1200	0.50	1.1E-04	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	05/04/97	1102	1.00	7.9E-04	$
IWR v.16	Spring Branch	21FLBFA 31020021	UNNH4	05/04/97	1102	1.00	6.5E-04	$
IWR v.16	Spring Branch	21FLBFA 31020021	WINDD	02/04/96	1100	1.00	360	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDD	05/05/96	1150	1.00	135	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDD	11/03/96	1205	1.00	45	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDD	02/16/97	1200	0.50	285	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDD	05/04/97	1102	1.00	270	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDV	02/04/96	1100	1.00	15	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDV	05/05/96	1150	1.00	5	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDV	11/03/96	1205	1.00	10	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDV	02/16/97	1200	0.50	5	
IWR v.16	Spring Branch	21FLBFA 31020021	WINDV	05/04/97	1102	1.00	14	

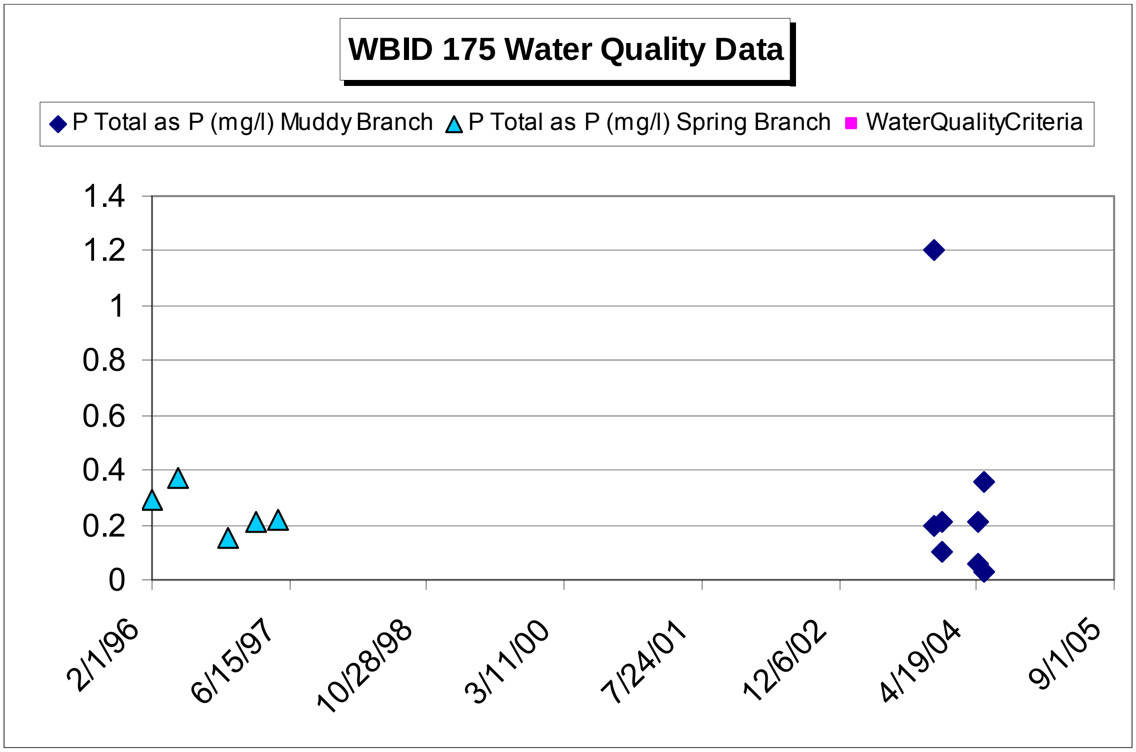

Figure A- 1. Total Phosphorus as P in WBID 175 (Muddy B ranch).

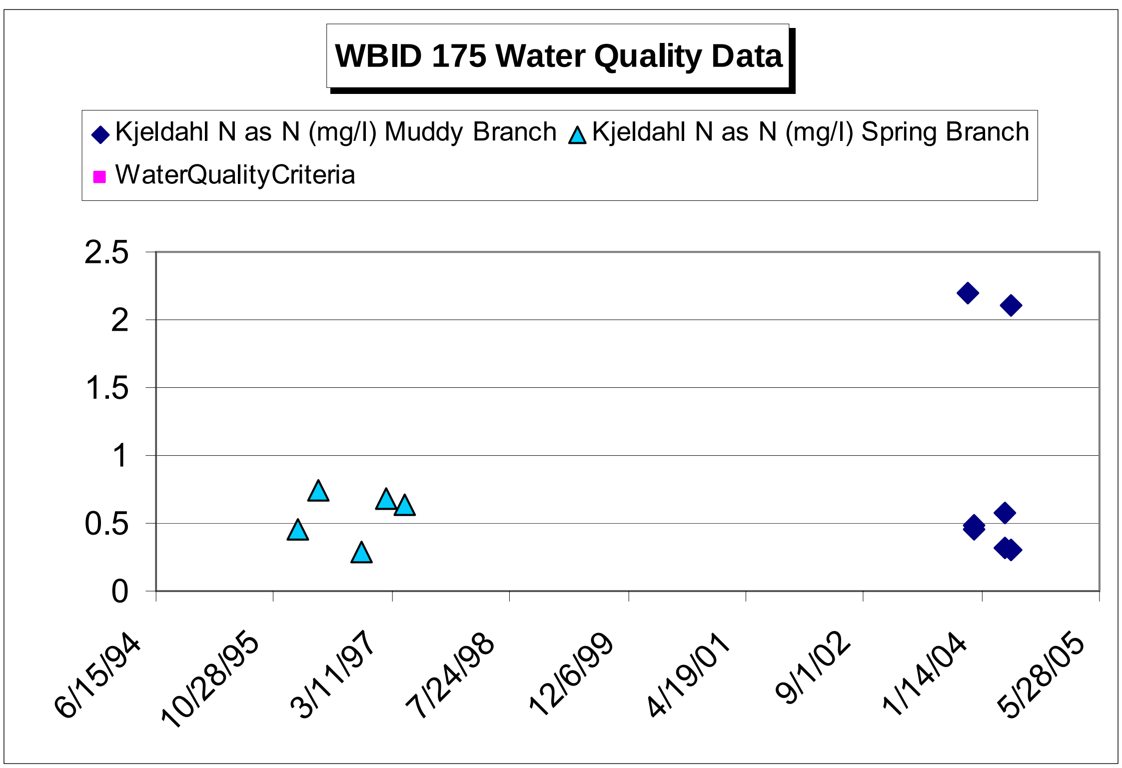

Figure A- 2. Total Kjeldahl Nitrogen as N in WBID 175 (Muddy Branch).

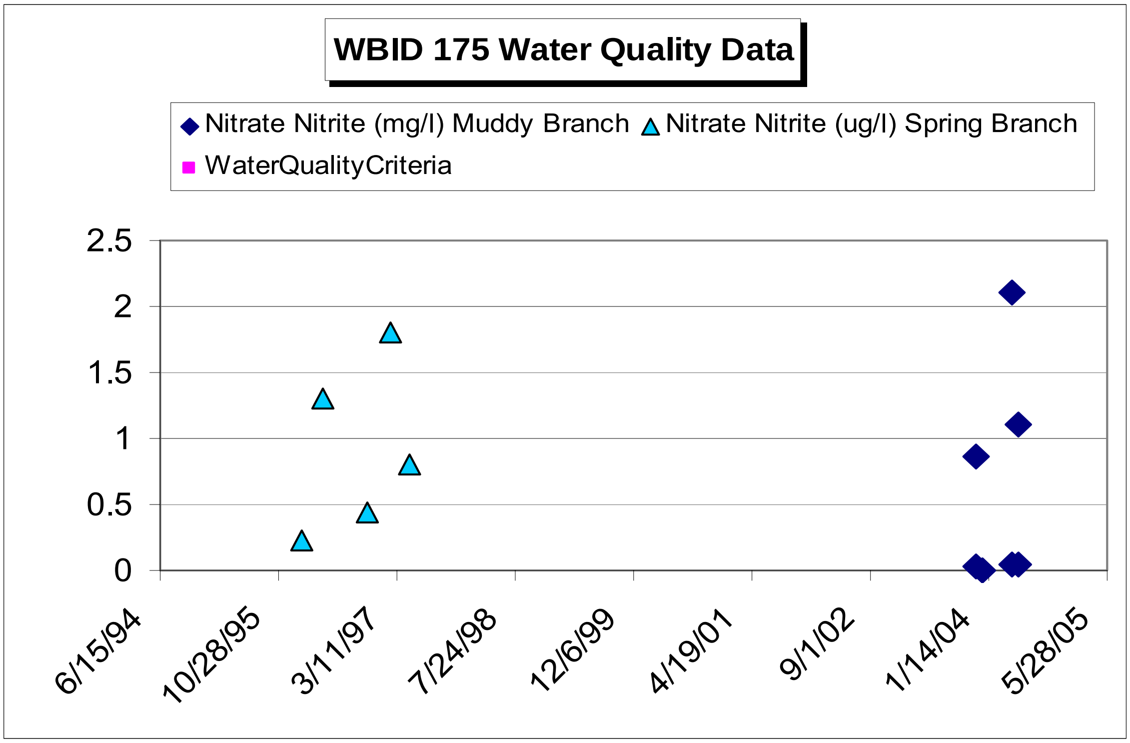

Figure A- 3. Nitrate Nitrite in WBID 175 (Muddy Branch).

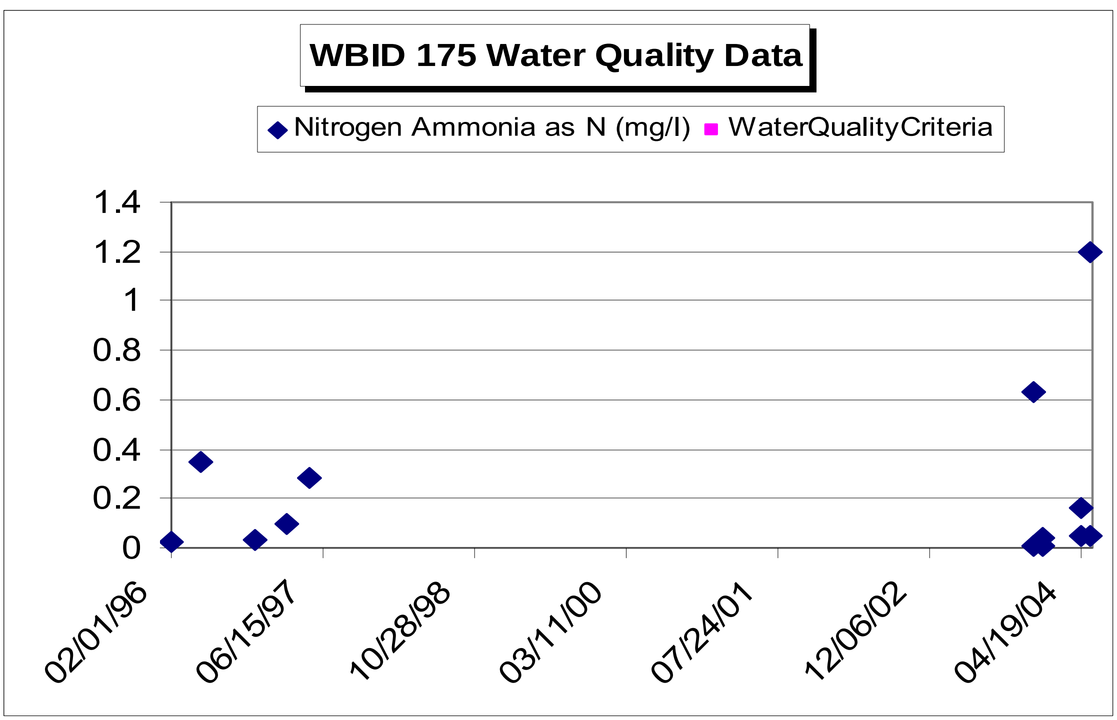

Figure A- 4. Nitrogen Ammonia as N in WBID 175 (Muddy Branch).

APPENDIX B CALCULATION OF NUTRIENT TARGETS

Table B- 1. Water Quality for Panhandle Reference Streams based on SCI

STORET	Bioregion	Month	Season	Year	SC hydro	SC Hab	Temp	pH	Cond	DO	Turb	TKN	NH3	NO_3NO_2	TN[1]	TP	SCI6 100	WBID	Subeco-region	Waterbody
33040014	Panhandle W	7	S	1998	5	82.50	23.6	5.5	31	7.2	8	0.29	0.02	0.07	0.36	0.047	96.3	28	65f	Big Horse Cr.
32030023	Panhandle W	2	W	1997	1	91.72	15.6	4.8	24	8.6		0.22	0.012	0.02	0.24	0.009	87.9	553	65g	Ecofina Cr.
31010050	Panhandle W	7	S	1996	2	87.59	23.2	7.5	21	7.2	9.9	0.35	0.025	0.08	0.43	0.21	84.8	504	65h	Crooked Cr.
33010065	Panhandle W	7	S	1995	2	91.03	23.5	5.6	58	6.5		0.33	0.032	0.5	0.83	0.012	82.2	542	65f	Unnamed Cr.
22050077	Panhandle E	2	W	1996	2	100.00	20	7.5	322	6.2	1.1	0.32	0.013	0.03	0.35	0.11	81.4	3402	75a	Ecofina R.
31020074	Panhandle W	7	S	1996	3	85.00	26.8	5.2	25	1.8	2.7	0.76	0.078	0.069	0.829	0.032	79.9	279	65g	Little Dry Cr.
32020063	Panhandle W	1	W	1999	4	91.30	16.4	4.0	35	8.7	2	0.29	0.012	0.01	0.3	0	78.6	907	75a	Ltl Crooked Cr.
31020070	Panhandle W	7	S	1996	7	84.29	23.2	5.8	22	6.8	2.3	0.16	0	0.036	0.196	0.012	75.8	970	75a	Cypress Cr.
33010054	Panhandle W	2	W	2001	5	94.40	15.6	4.5	36	8.9	1	0.21	0.01	0.13	0.34	0.015	75.6	149	65f	McDavid Cr.
32020002	Panhandle W	4	W	1993	2	72.00	13.8	6.1	40	9		0.46	0.06		0.46	0.06	74.9	54	65g	Wrights Cr.
32010024	Panhandle W	7	S	1998	5	75.00	23.3	7.7	189	7.1	3	0.12	0.017	0.1	0.22	0.019	74.5	43	65g	Limestone Cr.
32030023	Panhandle W	7	S	1998	5	76.30	25.7	6.1		7.5	2	0.17	0.01	0.02	0.19	0.01	74.2	553	65g	Ecofina Cr.
32020066	Panhandle W	4	W	1993	2	76.00	12	6.2	40	9.8		0.55	0.05		0.55	0	73.9	54	65g	Wrights Cr.
32030024	Panhandle W	7	S	2001	1	74.38	21.7	6.5	56	8	2	0	0.041		0	0	72.8	1041	75a	S. Fork Bear Cr.
31010076	Panhandle W	10	S	1998	5	69.38	21	6.9	60	8.7		0.26	0	0.68	0.94	0.11	71.7	376	65h	Mosquito Cr.
31020071	Panhandle W	7	S	1996	7	84.29	21.9	6.1	38	6.7	1.5	0.21	0	1.4	1.61	0	70.5	1021A	75a	Crooked Cr.
31010051	Panhandle W	2	W	1996	2	84.80	6.7	6.5	20	10.7	2.6	0.16	0.051	0.13	0.29	0.017	69.9	728	65h	Sweetwater Cr.
33040015	Panhandle W	5	S	2000	1	44.38	19.9	6.8	54	7.7		0.11	0	0.41	0.52	0.015	69.7	101	65f	Pine Log Cr.
31020073	Panhandle W	7	S	1996	3	84.29	22.6	6.0	19	8.2	2.7	0.11	0	0.12	0.23	0	68.2	1021A	75a	Pitts Mill Cr.
33010068	Panhandle W	2	W	1996	8	44.10	12.6	6.5	61	10.5	4	0.51	0.39	0.35	0.86	0.005	66.9	489	65f	Coffee Cr.
33040064	Panhandle W	7	S	1998	1	84.38	25.5	5.0	2	5.1	1.9	0.19	0.016	0.02	0.21		66.9	161	65f	Jack's Br.
31010144	Panhandle W	5	S	2000	5	78.75	24.8	7.0	58	7		0.52	0.091	0.1	0.62	0.052	65.0	376	65h	Mosquito Cr.
32030024	Panhandle W	2	W	1999	8	81.90	16.1	4.5	31	8.9	5	0.35	0.01	0.01	0.36	0.015	63.9	1041	75a	S. Fork Bear Cr.
22020012	Panhandle W	11	W	1996	5	73.79	10.1	6.6	32	10.9	7.3	0.29	0.032	0.48	0.77	0.047	63.3	1297D	65h	Willacoochee Cr.
31010125	Panhandle W	10	S	1998	5	75.63	20.4	6.8	60	8.4		0.38	0.091	0.66	1.04	0.094	62.5	375H	65g	Mosquito Cr.
32010021	Panhandle W	8	S	1997	6	81.40	23.9	5.9	29	6.7		0.49		0.08	0.57	0.018	62.3	351	65f	Alaqua Cr.
22020016	Panhandle W	11	W	1996	5	75.17	10.5	5.1	62	9.9	11	0.79	0.22	2.7	3.49	0.095	61.0	424	65h	Little R.
33010068	Panhandle W	7	S	1995	2	71.72	24.3	5.7	52	7.5		0.52	0.29	0.21	0.73	0.011	59.4	489	65f	Coffee Cr.
22020077	Panhandle W	5	S	1995	4	92.41	18.3	7.6	1020	8.2		0.14	0	0.069	0.209	0.43	59.1	1297E	75a	Three Pole Cr.
22030062	Panhandle E	2	W	1997	1	97.20	18.3	7.6	290	5.4	0.7	0.071	0.014	0.52	0.591	0.023	57.3	1028	75a	McBride Slough
22030010	Panhandle E	5	S	2000	2	96.90	20.7	7.6	285	5.4	0.3	0.078	0	0.18	0.258	0.028	55.0	793B	75a	St. Marks R.
22040038	Panhandle E	12	W	1995	5	82.07	8.1	7.6	30	10.5		0.39	0.05	0.31	0.7	0.072	54.7	3337	65h	Unnamed Cr.
22020070	Panhandle W	8	S	1999	3	79.38	24.3	5.4	40	2.1		0.69	0.028	0	0.69	0.36	53.6	1049	65f	Big Cypress Br.

STORET	Bioregion	Month	Season	Year	SC hydro	SC Hab	Temp	pH	Cond	DO	Turb	TKN	NH3	NO_3NO_2	TN[1]	TP	SCI6 100	WBID	Subeco-region	Waterbody
31010145	Panhandle W	5	S	2000	5	76.25	24	7.6	153	7.5		0.83	0.082	0.52	1.35	0.53	52.3	376	65h	Mosquito Cr.
22020062	Panhandle W	9	S	1998	2	86.25	23.1	3.7	8	7.1	1.2	0.37	0	0	0.37	0.016	52.0	811	65f	Oklawaha Cr.
22020001	Panhandle W	11	W	1996	5	80.69	10.3	6.1	110	9.9	9.9	2.1	1.2	8.5	10.6	0.033	51.0	424	65h	Attapulgus Cr.
22020049	Panhandle W	3	W	1993	2	81.00	16	4.6	20	9	31	0.28	0	0.04	0.32	0.024	49.9	684	65h	Mule Cr.
31020040	Panhandle W	2	W	1998	5	80.70	9.7	4.1		10.4							49.4	569	65g	Ten Mile Cr.
33010112	Panhandle W	2	W	1999	6	55.00	13.5	5.0	54	9.94	3	0	0	0.17	0.17	0.015	47.7	489	65f	Perdido Bay
22020046	Panhandle W	11	W	1996	5	55.86	11.6	6.6	39	10.7	7.4	0.36	0.047	0.34	0.7	0.083	47.3	1303	65h	Quincy Cr.
31020037	Panhandle W	7	S	1996	7	87.86	27.8	7.6	199	6.5	0.31	0.23	0.039	1.5	1.73	0.017	46.9	180	65g	Spring Cr.
22020092	Panhandle W	11	W	1996	5	88.28	9.8	6.0	30	10.4	6.6	0.3	0.029	0.76	1.06	0	45.9	410	65h	Willacoochee Cr.
22020010	Panhandle W	11	W	1995	5	91.72	16.3	7.0	55	8.8		0.37	0.064	0.34	0.71	0.096	45.5	1303	65h	Quincy Cr.
														75^{th} percentile:	**0.81**	**0.072**				

NOTES:

1. Total nitrogen was estimated by adding nitrate-nitrite (NO_3NO_2) and total Kjeldahl nitrogen (TKN).