Long Branch Creek Nutrient Source Evaluation and Assessment

Final Report

September 2012

Prepared for:

Pinellas County, Florida

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EXECUTIVE SUMMARY

General Description

The Long Branch Creek watershed is located in central Pinellas County and covers an area of approximately 1,808 acres. The drainage basin is located in a highly urbanized area of Pinellas County, with approximately 75% of the land use within the basin consisting of residential and commercial activities. Upstream segments of Long Branch Creek originate west of Belcher Road and extend in a general southwest-to-northeast direction with a total channel length of approximately 3.3 miles, ultimately discharging into Old Tampa Bay. An additional 2.6 miles of conveyance channels intersect with the main channel and introduce inflows generated in perimeter portions of the drainage basin. The vast majority of the creek consists of earthen open channels with underground stormsewers used to convey portions of the channel beneath roadways and other obstructions.

Pinellas County has experienced rapid growth over the past 20 years, and much of the basin has reached built-out conditions. A large portion of the drainage basin was developed prior to implementation of requirements for construction of stormwater management systems and discharges untreated runoff directly into the Creek. Western portions of the Long Branch Creek basin (comprising approximately one-third of the total basin area) are located within the City of Largo, while eastern portions of the drainage basin (which comprise the majority of the overall area) are located within unincorporated Pinellas County.

The vast majority of soils within the Long Branch Creek drainage basin consist of deep sandy soils which exhibit a high runoff potential in an undeveloped state and a low runoff potential in a developed state. Under the current developed conditions, much of the rainfall infiltrates into the groundwater which decreases the total runoff volume.

Historical Water Quality

Freshwater portions of the Long Branch Creek watershed (WBID 1627) are included on the FDEP-verified list as impaired for dissolved oxygen and total/fecal coliform bacteria. An EPA-proposed TMDL for total/fecal coliform bacteria was published by EPA in 2005 but has not been adopted by FDEP. Tidal portions of Long Branch Creek (identified as WBID 1627b) are also included on the verified-impaired list for dissolved oxygen and fecal coliform bacteria.

Historical water quality monitoring data have been collected by both Pinellas County and FDEP within the Long Branch Creek watershed. Seven separate sites have been monitored by Pinellas County as part of the ongoing ambient water quality monitoring program, with six of these sites located in the freshwater portion of the watershed and one site located in the tidal portion of the watershed. Water quality data in Long Branch Creek have been collected by FDEP at a total of six monitoring sites, beginning as early as 2002. However, the data collected by FDEP are extremely limited, with much of it collected during a single calendar year.

Historic measured concentrations of nitrogen species in Long Branch Creek have been low to moderate in value at the Pinellas County monitoring sites, with the majority of the total nitrogen comprised of organic nitrogen. Trend analyses suggest a statistically significant decrease in total nitrogen concentrations over time. Measured concentrations of phosphorus species in Long Branch Creek have been moderate to elevated in value at the Pinellas County monitoring sites, with a large portion of the total phosphorus contributed by dissolved SRP. No statistically significant trend is apparent in measured total phosphorus concentrations from 1995-2008.

Measured dissolved oxygen concentrations with Long Branch Creek have been highly variable, with concentrations in the freshwater portion of the basin ranging from 0.1-12.8 mg/l. Dissolved oxygen concentrations are frequently observed which are less than the minimum Class III criterion of 5 mg/l in the freshwater portion of the basin. Highly variable concentrations of total coliform, fecal coliform, and enterococcus bacteria have been highly variable at each of the monitoring sites, with frequent exceedances of the applicable Class III criteria for the measured bacteria groups. Microbiological contamination in Long Branch Creek appears to represent a significant ongoing water quality problem.

A USGS flow recording station is located near the center of the Long Branch Creek watershed, south of Roosevelt Blvd., with discharge data available from October 2003 to the present. Discharge rates in Long Branch Creek are typically less than 4-5 cfs, with higher discharge rates observed during significant rain events. Approximately half of the estimated annual discharges through Long Branch Creek are a result of direct stormwater runoff, with the remaining discharges resulting from baseflow which consists primarily of groundwater inputs.

Virtually all areas within the Long Branch Creek watershed currently utilize centralized sewer systems for wastewater disposal, although a small number of operational septic tank systems still exist within the Long Branch Creek watershed. Although reuse force mains run through the basin, irrigation with reclaimed water does not appear to occur within the Long Branch Creek watershed.

Field Monitoring Program

A field monitoring program was conducted by ERD from October 2010-January 2011 within Long Branch Creek to characterize the quantity and quality of discharges through the watershed area. Eighteen surface water sites were monitored on approximately a bi-weekly basis which included measurements of field parameters, discharge rate, and sample collection for laboratory analyses. Five separate monitoring events were conducted at each site. Each of the collected samples was analyzed in the ERD Laboratory for general parameters and nutrients, and aliquots of each collected sample was shipped to the Colorado Plateau Stable Isotope Laboratory for isotope analyses of oxygen and nitrogen. Twelve of the monitoring sites used by ERD were located along the main stem of Long Branch Creek, with six sites reflecting tributary inflows into the channel.

Monitoring Program Results

Rainfall during the field monitoring program was substantially less than normal during the initial three months covering the period from October-December 2010, with higher than normal rainfall observed during the final month of the monitoring program in January 2011. Measured discharge rates at each of the 18 monitoring sites were typically low in value during the initial four monitoring events, with substantially higher discharge rates measured during the final monitoring event on January 18, 2011 which occurred following a significant rain event within the watershed.

Measured concentrations of total nitrogen in Long Branch Creek were found to be substantially lower in value than total nitrogen concentrations measured by ERD in Roosevelt Creek and Klosterman Bayou, and appear to be similar in value to values measured along Joes Creek by ERD from July-September 2008. Measured total phosphorus concentrations in Long Branch Creek appear to be similar to values measured by ERD in Roosevelt Creek and Joes Creek, and substantially less than total phosphorus concentrations measured in Klosterman Bayou. Measured TSS concentrations in Long Branch Creek are lower in value than concentrations measured by ERD in Roosevelt Creek, Joes Creek, or Klosterman Bayou.

Under low flow conditions, moderate to elevated and highly variable concentrations of nitrogen species were observed in the northern and southern headwater segments. However, nitrogen concentrations along the main channel were typically lower in value and relatively consistent at each of the four main channel monitoring sites. Inputs into the main channel or upstream segments from the monitored tributary inflows do not appear to have significant impacts on water quality characteristics. A similar pattern is also apparent for measured phosphorus species, with low to moderate concentrations in the northern and southern segments with a high degree of variability in measured values. Within the main channel, phosphorus concentrations appear to be less variable, with a general trend of increasing phosphorus concentrations with increasing distance during most events.

Under high flow conditions (such as occurred on January 18, 2011), measured concentrations for virtually all parameters were elevated compared with concentrations measured under low flow conditions. Highly variable concentrations were observed for virtually all measured parameters in the northern and southern upstream segments, with more consistent values measured along the main channel. The majority of measured parameters appear to exhibit increases in upper portions of the main channel, followed by decreases in concentrations at the final monitoring sites. Total phosphorus concentrations in the segments and main channel appear to be much higher under high flow conditions than under low flow conditions. With the exception of Site 13 (which reflects an inflow to the main channel), tributary inflow concentrations of total phosphorus appear to be less than concentrations observed in the main channel.

Mass Loading Evaluation

Estimates of mass loadings discharging through the Long Branch Creek watershed were calculated for species of nitrogen, phosphorus, TSS, and fecal coliform bacteria for each of the monitoring sites included in the field monitoring programs. With the exception of the initial monitoring event on October 19, 2010, mass loadings of virtually all parameters were relatively low in value in both the northern and southern segments. No significant trend of either decreasing or increasing loadings is apparent in these segments for a majority of the monitored parameters. Mass loadings at the initial main channel monitoring site appear to be relatively similar during most events to loadings originating within the northern and southern segments. A slight increase or decrease in loading rates occur in mid-portions of the main channel, with a substantial increase in loadings occurring between the final main channel monitoring sites. In most cases, the monitored loadings from the tributary inflows into the main channel do not appear to be sufficient in magnitude to cause the observed increases in mass loadings, and there appear to be additional significant sources of nutrient additions between Sites 14 and 16 other than the monitored tributary inflows.

Under high flow conditions, mass loadings are greater in value in both northern and southern segments as well as the main channel. Mass loadings appear to increase in downstream portions of the northern and southern segments for most parameters. Mass loadings at the initial main channel monitoring site appear to be relatively similar to loadings discharging from the northern and southern segments. A significant increase in loadings occurs between Sites 11 an 12, followed by a decrease in loadings between Sites 12 and 14. However, a substantial increase in loadings appears to occur between Sites 14 and 16 which cannot be explained by the monitored tributary inflows.

Results of Source Identification Studies

The isotope analyses suggests the presence of manure or sewage in nitrogen sources in at least two of the monitored sites during each of the five sampling events. Monitoring sites with the most consistent isotopic signatures for the presence of manure or sewage included Site 15 (drainage canal along Whitney Road) which indicated the presence of manure or sewage during all five of the monitoring events, and Site 9 (discharge from southern segment into main channel) which indicated nitrogen originating from manure or sewage during four of the five monitoring events. The signature of manure or sewage appears to be inversely correlated with discharge, suggesting that the source of sewage inputs into Long Branch Creek is relatively consistent over time and is diluted during significant rain events within the watershed.

UV absorbances were also conducted on each of the collected samples to identify the presence of non-natural organic materials. The analyses suggest that the presence of non-natural organic materials occurs throughout the entire Long Branch Creek watershed, with the highest concentrations observed in the southern headwater segment, the inflow to the northern headwater segment at Site 4, and tributary inflow at Site 15 which reflects roadside drainage along Whitney Road. The Long Branch Creek watershed is serviced virtually entirely by a sanitary sewer collection system, and although reuse lines run through the watershed area, no application of reuse irrigation is known to occur. Therefore, it appears that pollutant sources within the Long Branch Creek enter primarily as diffuse sources, with groundwater inflows likely to be significant contributors.

SECTION 1

INTRODUCTION

1.1 Project Background

This document provides a summary of field and laboratory efforts conducted by Environmental Research & Design, Inc. (ERD) for the Pinellas County Department of Environmental Management (County), the Southwest Florida Water Management District (SWFWMD), and the City of Largo (City) as part of the Long Branch Creek nutrient source evaluation and assessment project. The purpose of this project is to identify, to the extent possible from the proposed field monitoring program, the general sources of elevated nutrient levels observed in the Long Branch Creek basin in Pinellas County, Florida. A general location map for the Long Branch Creek drainage basin is given on Figure 1-1.

The Long Branch Creek watershed is located in central Pinellas County and covers an area of approximately 1,808 acres. The drainage basin is located in a highly urbanized area of Pinellas County, with approximately 75% of the land use within the basin consisting of residential and commercial activities. Inflows to Long Branch Creek discharge in a southwest to northeast direction, ultimately entering Old Tampa Bay. The Creek consists primarily of open channels and ditches, with stormsewers used to convey the channel beneath roadways and other obstructions. There are no individual permitted wastewater or industrial facilities in the Long Branch Creek watershed, and urban stormwater runoff is considered to be the major contributor to nonpoint source pollution.

Historical water quality monitoring conducted in the Long Branch Creek basin has indicated elevated levels of both total nitrogen and total phosphorus, with a slight trend of decreasing concentrations with increasing distance along the main channel. Work efforts performed under this project are designed to assess the general sources of nutrients (such as runoff, groundwater inflow, tributary inflows, and interconnected waterbodies) which are causing elevated concentrations within the Long Branch Creek watershed.

The specific objectives of this project, as defined by Pinellas County, are to:

1. Design a monitoring program to determine the source of nutrients within the Long Branch Creek watershed

2. Interpret the collected data and other information to identify nutrient sources

3. Develop suggestions to alleviate the nutrient impairment

4. Prepare a Final Report which presents the study results and provides general recommendations for methods to improve water quality

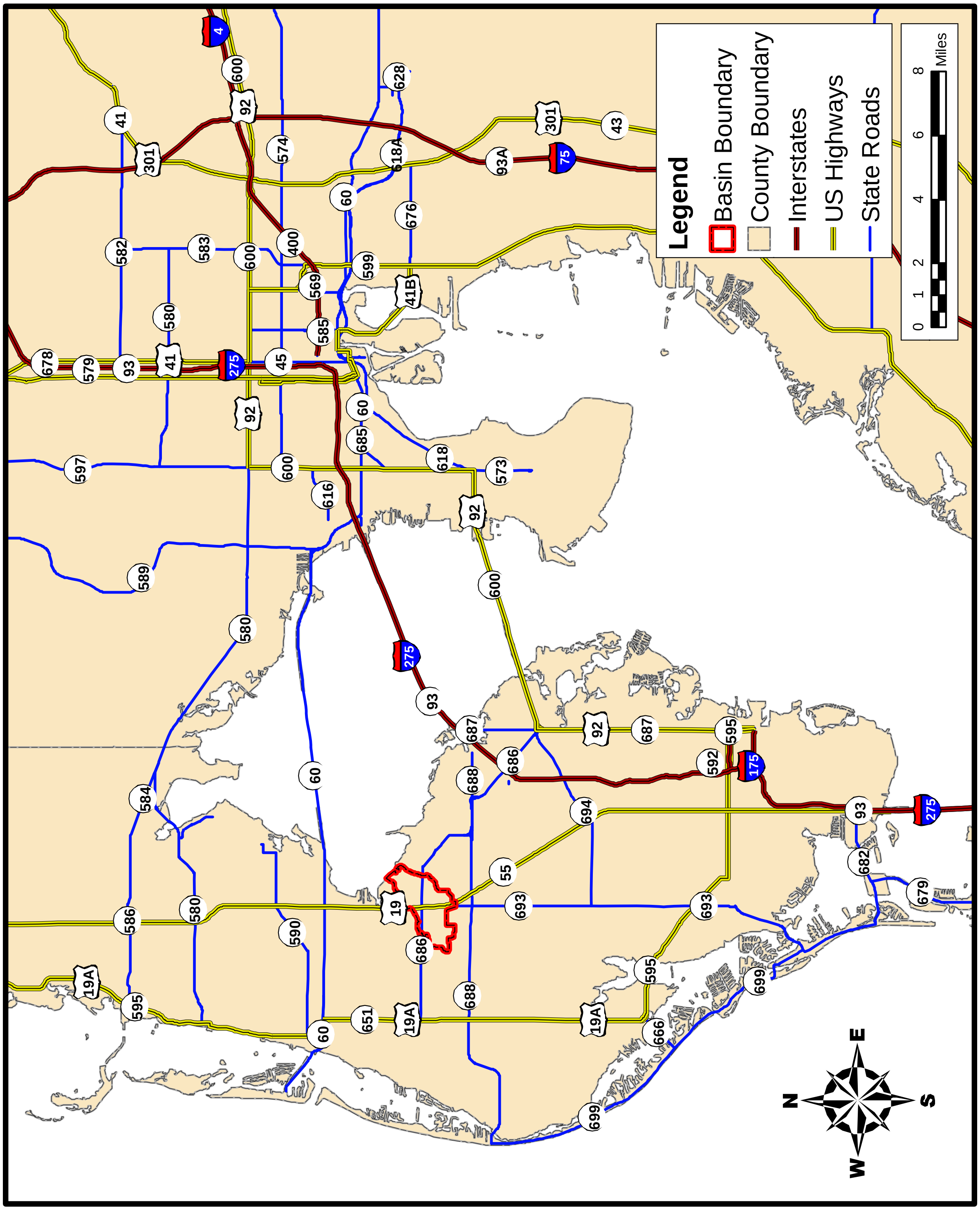


Figure 1-1. General Location Map for the Long Branch Creek Basin.

1.2 Work Efforts Conducted by ERD

Field monitoring was conducted by ERD from October 2010-January 2011 within the Long Branch Creek watershed to characterize discharges through the creek. Eighteen surface water sites were monitored on a biweekly basis, which included measurement of field parameters, discharge rates, and sample collection for laboratory analyses. Each of the collected samples was analyzed in the ERD Laboratory for general parameters and nutrients. In addition, aliquots of each collected sample were shipped to the Colorado Plateau Stable Isotope Laboratory for isotope analyses of nitrogen and oxygen to assist in identifying potential pollutant sources.

1.3 Report Organization

This report has been divided into six separate sections for presentation and analysis of the field and laboratory activities. Section 1 contains an introduction to the report and provides a summary of the work efforts performed by ERD. Section 2 contains a discussion of the characteristics of the Long Branch Creek watershed area. A description of field monitoring and laboratory analyses conducted for this project is given in Section 3. A discussion of the results of the field and laboratory activities is given in Section 4. Nutrient management recommendations are discussed in Section 5, a summary is given in Section 6, and a list of references is given in Section 7. Appendices are also attached which contain technical data and analyses used to support the information, conclusions, and recommendations contained within this report.

SECTION 2

CHARACTERISTICS OF THE LONG BRANCH CREEK WATERSHED

2.1 General Characteristics

The Long Branch Creek watershed is located in central Pinellas County and includes an area of approximately 1808 acres of intensely developed urban land. An overview of the Long Branch Creek drainage basin and significant drainage features, obtained from the Pinellas County GIS database, is given on Figure 2-1. The main channel of the creek originates west of Belcher Road and extends in a general southwest to northeast direction, with a total length of approximately 3.3 miles. An additional 2.6 miles of conveyance channels intersect with the main channel and introduce inflows generated in perimeter portions of the drainage basin. Underground stormsewers are also used to convey portions of the channel beneath roadways and other obstructions, although the vast majority of the creek consists of earthen open channels. The Long Branch Creek watershed is bisected in an east-west direction by Roosevelt Blvd., and in a north-south direction by U.S. 19.

Pinellas County has experienced rapid growth over the past 20 years, and much of the basin has reached built-out conditions. A large portion of the drainage basin was developed prior to implementation of requirements for construction of stormwater management systems, and discharges untreated runoff directly into the creek.

An overview of governmental jurisdictional boundaries in the vicinity of Long Branch Creek is given on Figure 2-2. Western portions of the Long Branch Creek basin, comprising approximately one-third of the total basin area, are located within the City of Largo. Eastern portions of the drainage basin, which comprise the majority of the overall basin area, are located within unincorporated Pinellas County.

2.2 Topography

A topographic map of the Long Branch Creek watershed is given on Figure 2-3 based upon a LIDAR digital elevation model (2007) with one foot elevation contours, provided by Pinellas County. The majority of areas within the watershed range in elevation from sea level to approximately 14-18 ft (NAVD 88). Localized areas within the watershed extend to elevations as high as 36-38 ft, although these areas are associated with elevated portions of U.S. 19 which runs in a north-south direction through the center of the watershed. Watershed areas west of U.S. 19 are relatively flat, with a higher degree of relief in areas east of U.S. 19, particularly in the tidal portions of the watershed. In general, topography within the watershed is relatively mild, with an average slope of approximately 4.6 ft/mile from southwestern to northeastern portions of the drainage basin.

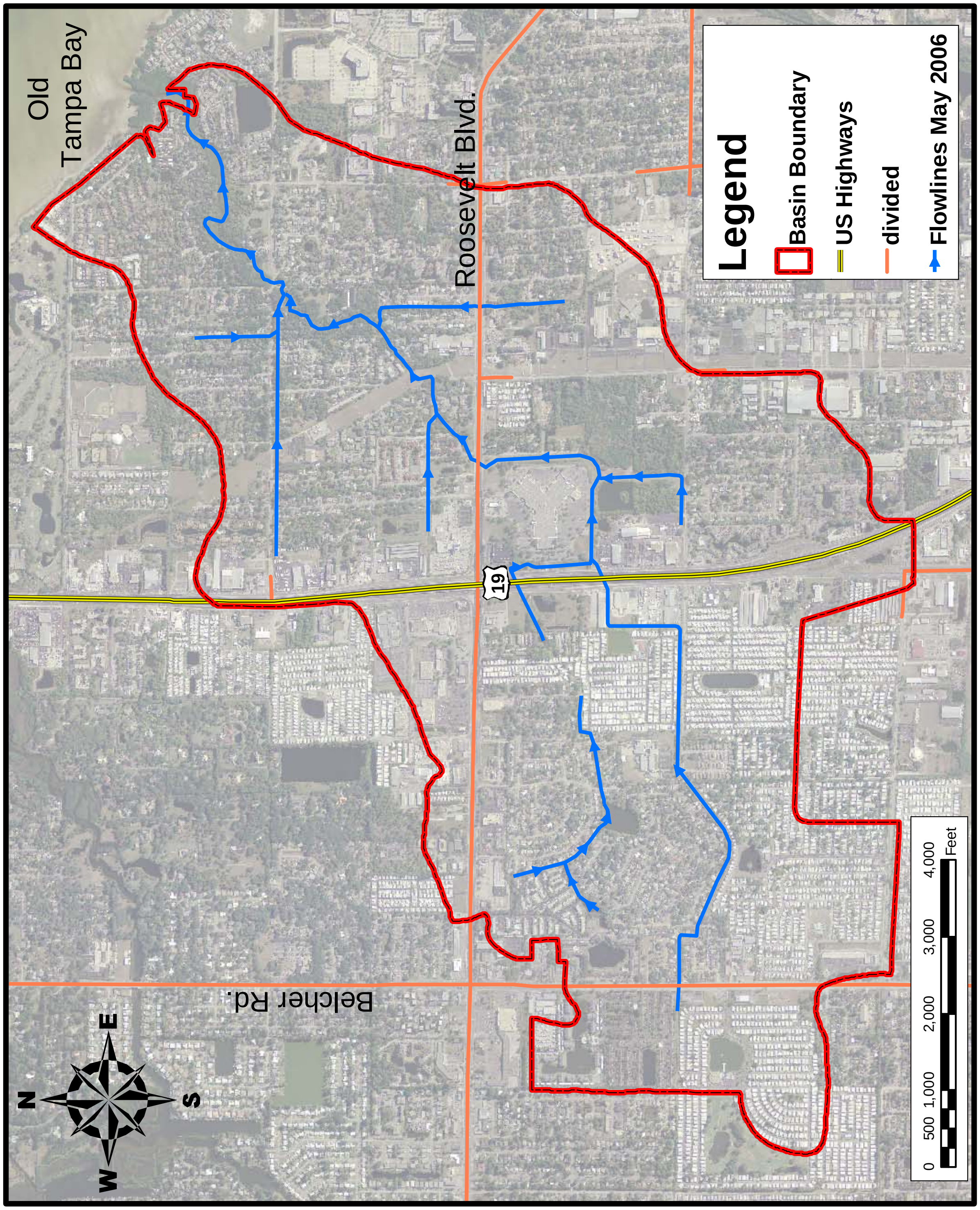


Figure 2-1. Overview of the Long Branch Creek Basin and Significant Drainage Features.

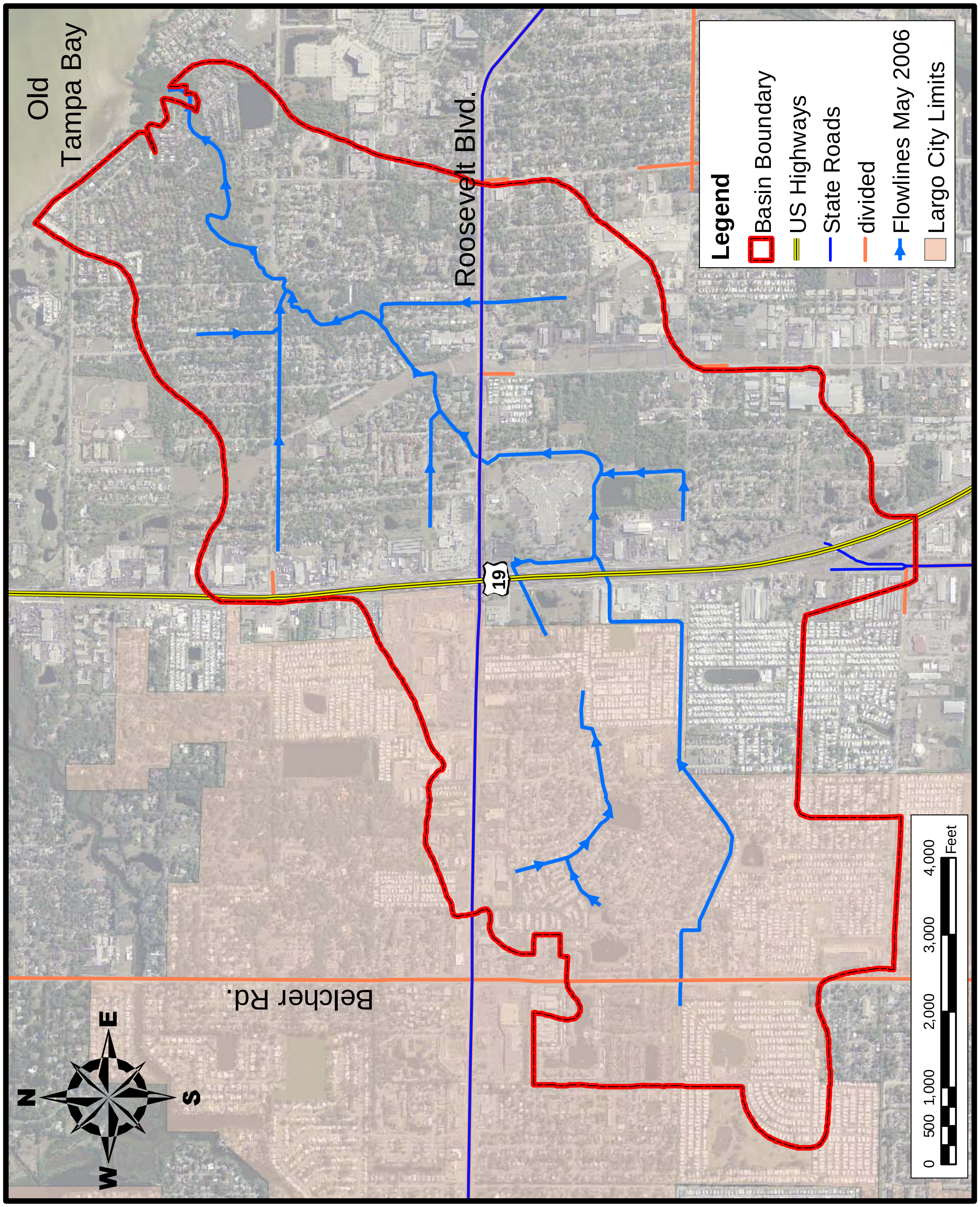


Figure 2-2. Governmental Jurisdictional Boundaries in the Vicinity of Long Branch Creek.

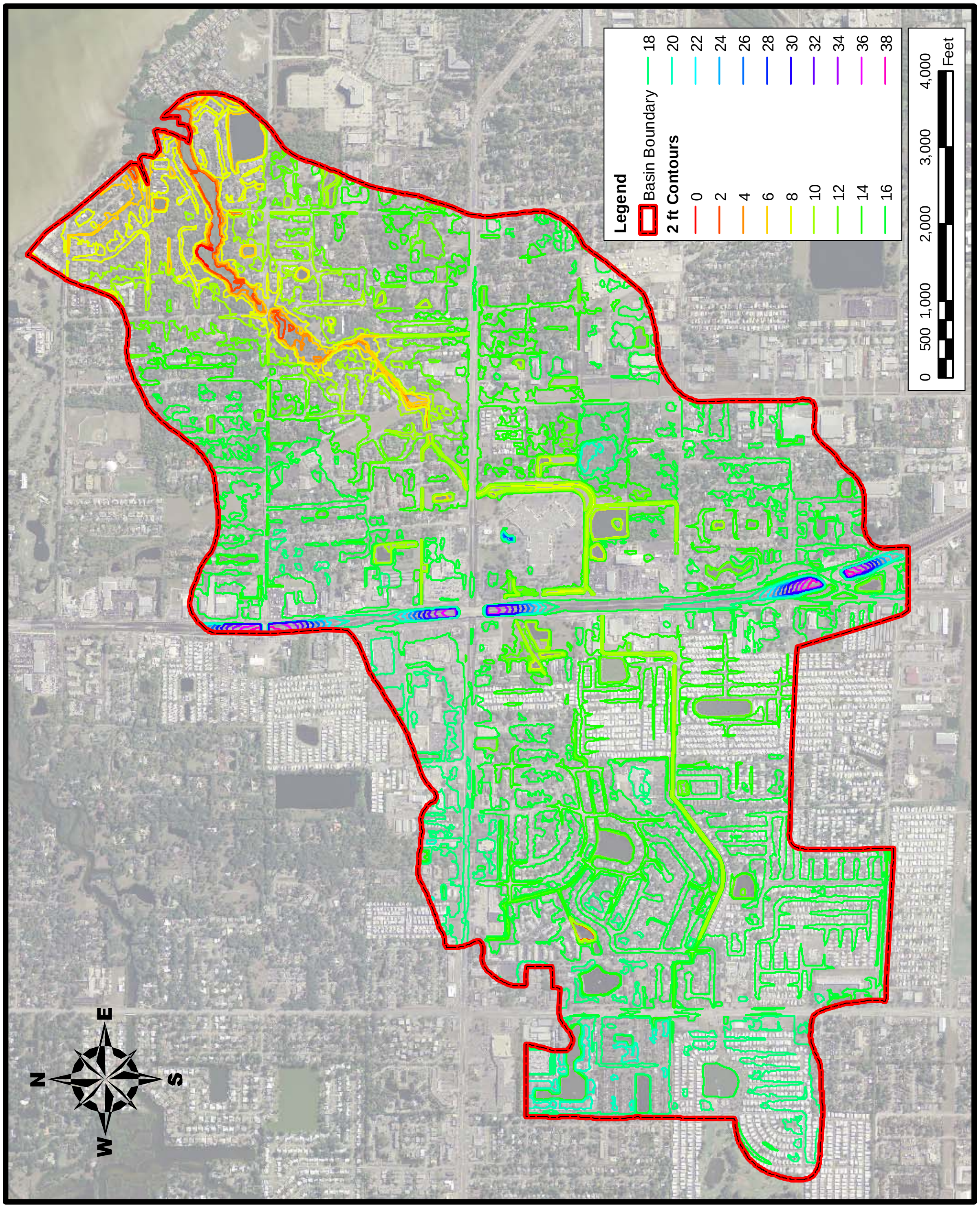


Figure 2-3. Topography in the Long Branch Creek Watershed.

2.3 Soil Characteristics

Information on soil characteristics within the Long Branch Creek watershed were obtained from the Pinellas County GIS database. Soil information was extracted in the form of hydrologic soil groups (HSG) which classify soil types with respect to infiltration rate and runoff potential. A summary of the characteristics of each of the hydrologic soil groups is given in Table 2-1.

TABLE 2-1

CHARACTERISTICS OF SCS HYDROLOGIC SOIL GROUP CLASSIFICATIONS

SOIL GROUP	DESCRIPTION	RUNOFF POTENTIAL	INFILTRATION RATE
A	Deep sandy soils	Very low	High
A/D	Deep sandy soils	Very high - undeveloped Very low - developed	High; restricted by groundwater table in undeveloped condition
B	Shallow sandy soils over low permeability layer	Low	Moderate
C/D	Sandy soil with high clay or organic content	Very High - undeveloped Medium to high - developed	Low
D	Clayey soils	Very high	Low to none
B/D	Shallow sandy soils in high groundwater table area	High – undeveloped Low – developed	Moderate; restricted by groundwater table in undeveloped condition

A graphical overview of hydrologic soil groups in the Long Branch Creek watershed is given in Figure 2-4, with a tabular summary provided in Table 2-2. The vast majority of soils within the drainage basin appear to be classified in HSG A/D which consists of deep sandy soils in a high groundwater table area, with a high runoff potential in an undeveloped state and a very low runoff potential in a developed state. Under undeveloped conditions, infiltration into these soils is limited by the high groundwater table, but as development occurs, the groundwater table is often lowered, allowing rainfall to enter the sandy soils, causing a decrease in runoff volume. Soils in HSG A/D occupy approximately 75% of the overall watershed area. Much of the remaining portion of the watershed is characterized by soils in HSG C/D which reflect sandy soil with a high clay or organic content. These soils have a relatively high runoff potential under both developed and undeveloped conditions and a relatively low infiltration rate. The vast majority of these soils appear to be located west of U.S. 19. Approximately 5% of the soils within the Long Branch Creek drainage basin have no associated soil grouping in the Pinellas County database and are listed as "undefined".

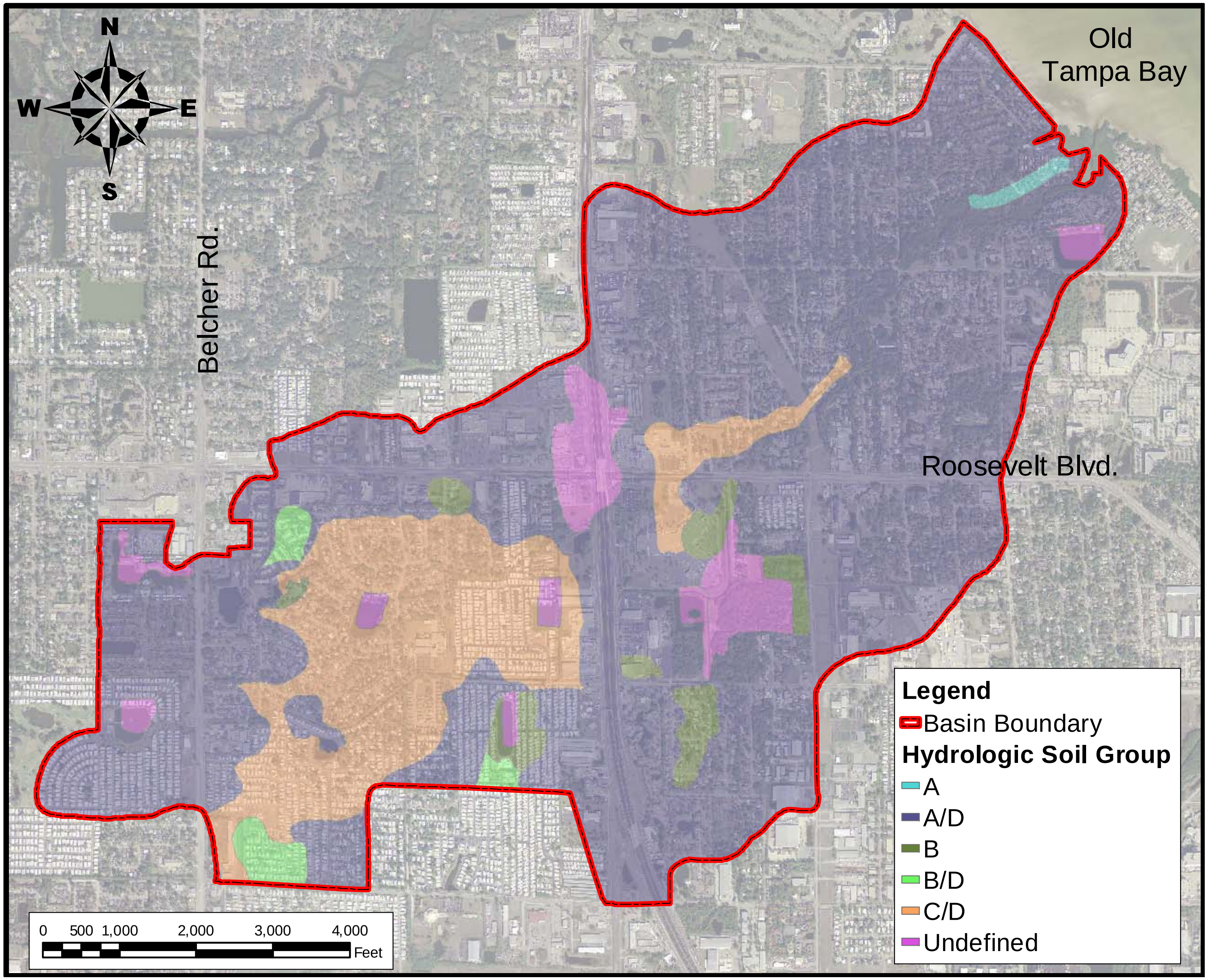


Figure 2-4. Hydrologic Soil Groups in the Long Branch Creek Watershed. (Source: Pinellas County)

TABLE 2-2

SUMMARY OF HYDROLOGIC SOIL GROUPS IN THE LONG BRANCH CREEK WATERSHED

HSG	AREA (acres)	PERCENT OF TOTAL (%)
A	6.3	0.3
A / D	1353	74.8
B	49.1	2.7
B/D	25.3	1.4
C/D	285	15.8
Undefined (Blank)	89.3	5.0
TOTAL:	**1808**	**100**

2.4 Land Use

Land use data were obtained from the SWFWMD GIS database, which reflects 2009 land coverage, in the form of Level III FLUCCS Codes. An overview of land use within the Long Branch Creek watershed is given on Figure 2-5 which reflects the land use categories provided in the SWFWMD database. A condensed summary of land use characteristics in the Long Branch Creek watershed is given on Table 2-3, with the Level III FLUCCS Code land uses summarized into common land use categories. Residential land uses, consisting of the combined categories of low-density, medium-density, and high-density residential areas, comprise 61.8% of the watershed area. Commercial activities occupy approximately 15.4% of the basin area. Overall, approximately 77.2% of the watershed area is covered by residential and commercial land use activities. The next most dominant land use is transportation, which comprises approximately 5.6% of the watershed area, followed by open land (4.6%). Each of the remaining land use categories each occupy approximately 4% or less of the overall watershed basin.

2.5 Hydrology

An overview of the primary drainage patterns in the Long Branch Creek watershed was given in Figure 2-1. In general, drainage patterns within the watershed are relatively complex and include a series of interconnected open ditches, surface waterbodies, and underground stormsewer systems.

An overview of delineated sub-basin areas in the Long Branch Creek watershed is given on Figure 2-6, based upon information obtained from the Pinellas County GIS database. Pinellas County has identified 12 separate sub-basin areas which discharge into Long Branch Creek.

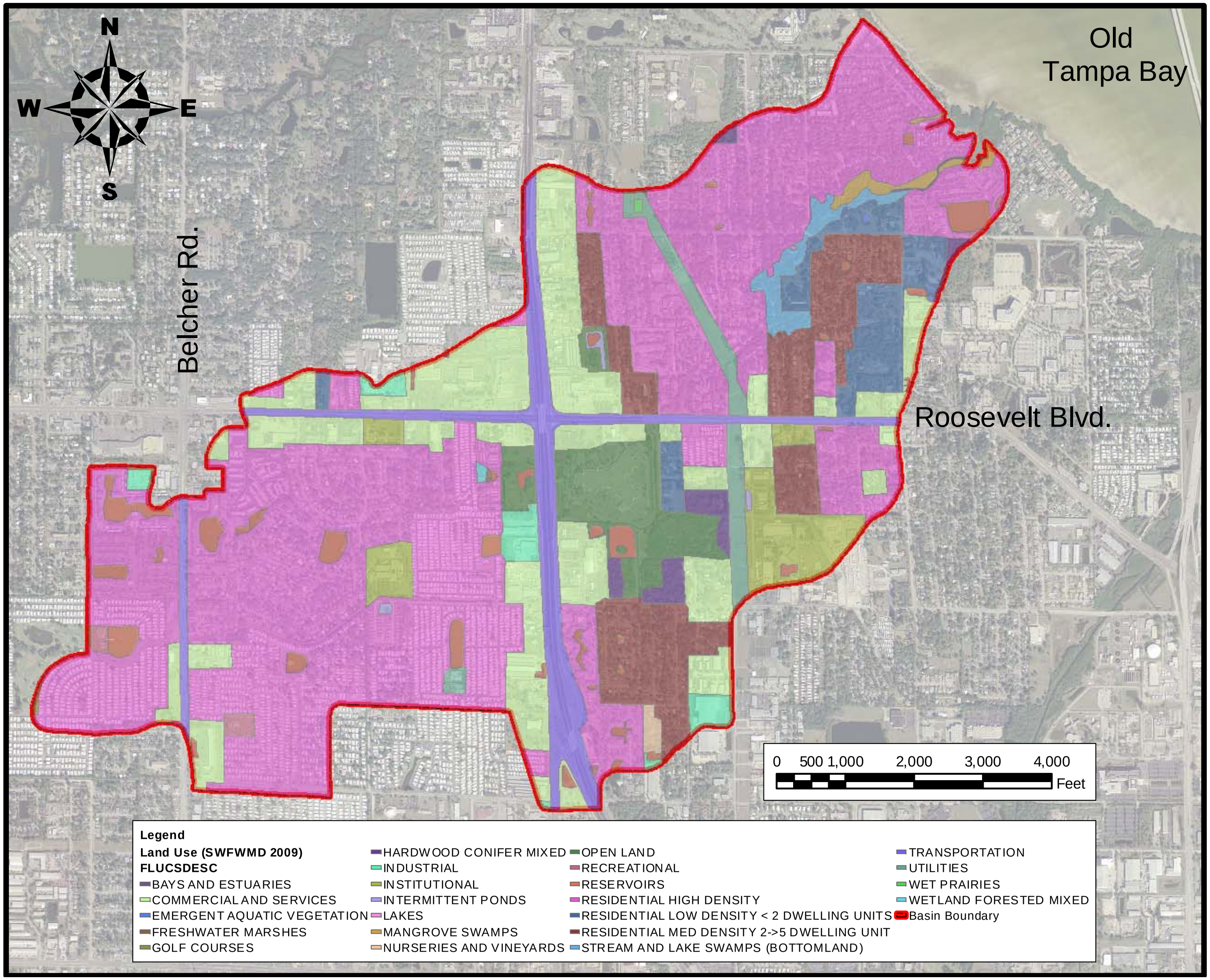


Figure 2-5. Overview of Land Use within the Long Branch Creek Watershed. (Source: SWFWMD 2009 Coverage).

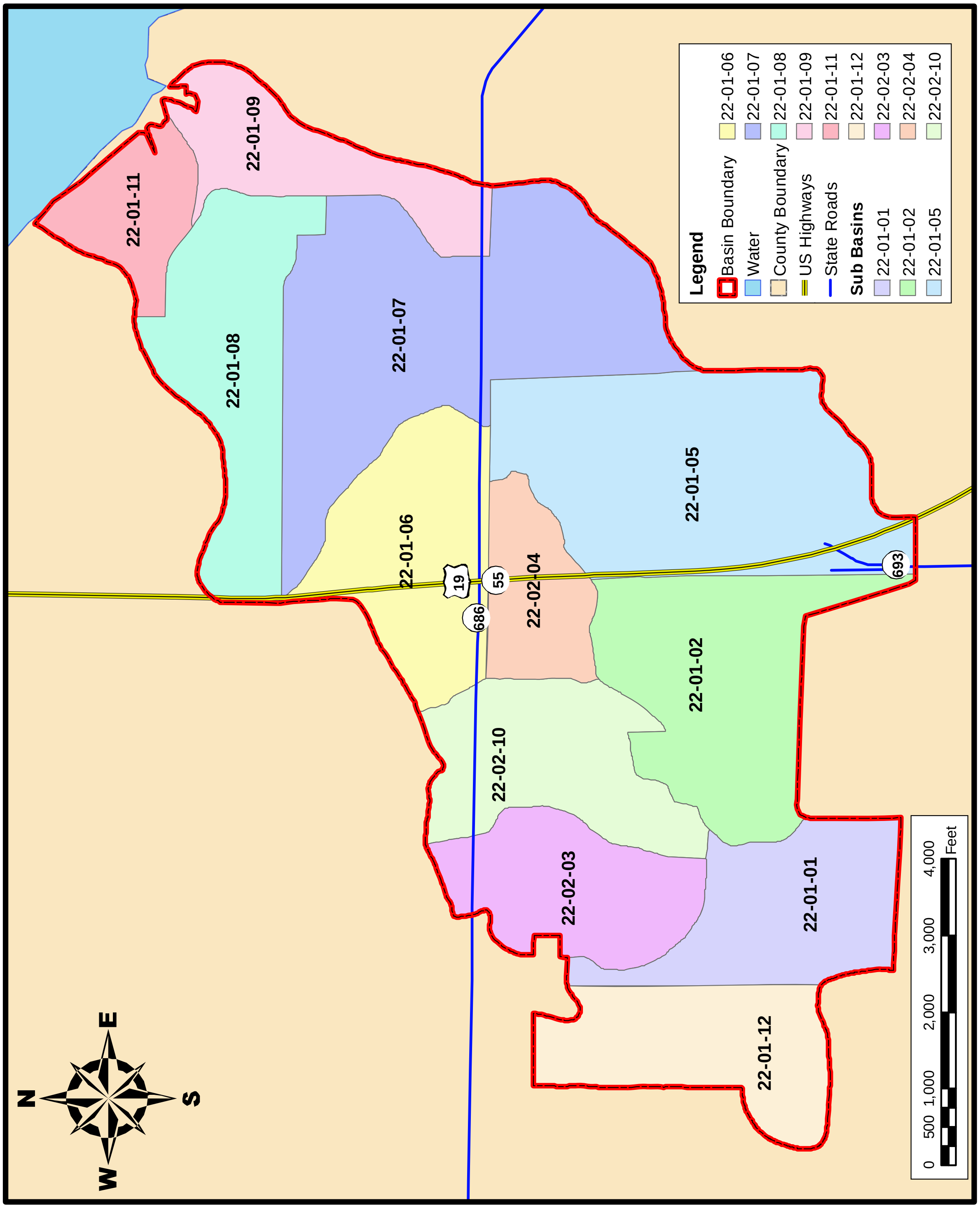


Figure 2-6. Delineated Sub-basin Areas in the Long Branch Creek Watershed.

TABLE 2-3

LAND USE CHARACTERISTICS (2009) IN THE LONG BRANCH CREEK WATERSHED

LAND USE CATEGORY	AREA (acres)	PERCENT OF TOTAL (%)
Low-Density Residential	68.3	3.8
Medium-Density Residential	151.5	8.4
High-Density Residential	896.0	49.6
Commercial	278.2	15.4
Industrial	23.8	1.3
Institutional	61.5	3.4
Transportation	101.9	5.6
Recreational	7.0	0.4
Open Land	82.4	4.6
Uplands/Forests	20.1	1.1
Open Water	47.6	2.6
Wetlands	31.4	1.7
Utilities	34.8	1.9
Agriculture	3.8	0.2
TOTALS:	**1808**	**100**

Long Branch Creek consists primarily of an open tributary throughout the majority of its length. Intercepting tributaries to the main channel also consist primarily of open channels. Small portions of the main channel and tributary inflows have been diverted into underground stormsewer systems to accommodate roadway passages. The main channel increases in both width and depth with increasing distance downstream, with upstream portions of Long Branch Creek characterized by open man-made ditches with widths of approximately 20-25 ft, changing to a more natural tree-covered channel with widths of approximately 40-50 ft in areas north of Roosevelt Blvd.

2.6 Impaired Waters Designation

Section 303 (D) of the Clean Water Act (CWA) requires states to submit lists of surface waterbodies that do not meet applicable water quality standards. These waterbodies are defined as “impaired waters” and Total Maximum Daily Loads (TMDLs) must be established for these waters on a prioritized schedule. FDEP has established a series of guidelines to identify impaired waters which may require the establishment of TMDLs. Waterbodies within the State of Florida have been divided into five separate groups for planning purposes, with the Tampa Bay Basin (which includes Long Branch Creek) located within the Coastal Old Tampa Bay planning unit in Group 1.

For TMDL purposes, FDEP has identified three separate WBIDs associated with Long Branch Creek. An overview of WBID boundaries in the Long Branch Creek watershed are indicated on Figure 2-7. The tidal portions of the Long Branch Creek watershed are identified as WBID 1627B, with freshwater portions of the watershed identified as WBID 1627. Swan Lake, referred to as the "headwaters" of Long Branch Creek by FDEP, is designated as WBID 1627A. As indicated on Figure 2-7, the Pinellas County watershed boundary and the WBID boundary agree relatively closely in the tidal portions of the watershed, but disagree substantially in freshwater portions of the watershed.

Freshwater portions of the Long Branch Creek watershed (WBID 1627) are included on the May 14, 2009 verified list as impaired for dissolved oxygen and total/fecal coliform bacteria. An EPA-proposed TMDL for total/fecal coliform bacteria was published by EPA in 2005 but has not been adopted by FDEP. A dissolved oxygen TMDL was proposed by EPA in June 2012. Tidal portions of Long Branch Creek, identified as WBID 1627B, are also included on the verified impaired list for dissolved oxygen and fecal coliform bacteria.

On January 26, 2010, the U.S. Environmental Protection Agency (EPA) published proposed "Water Quality Standards for the State of Florida's Lakes and Flowing Waters" (75 FR 4173). In this proposed rule, EPA classified Florida streams into regions for application of total phosphorus and total nitrogen criteria. Streams and canals within Pinellas County are classified within the Peninsula Region. Under the current version of this rule, the total nitrogen and total phosphorus water quality criteria for streams and canals in the Peninsula Region would be 1.54 mg/l and 0.12 mg/l, respectively. The objectives of the proposed rules are to maintain healthy biological conditions within the streams and canals as well as protect downstream receiving waterbodies. As discussed in Section 2.7, median concentrations of total phosphorus within Long Branch Creek exceed the proposed nutrient criteria by EPA at three of the seven Pinellas County monitoring sites. As a result, portions of Long Branch Creek may also be listed as impaired for nutrients under the proposed nutrient criteria rule, when adopted.

2.7 Water Quality Data

2.7.1 Data Availability

A review of available historical water quality data collected in the Long Branch Creek watershed was conducted using the US EPA STORET database as well as the Pinellas County Water Atlas data. Much of the historical data is duplicated within the two databases, although unique data were obtained from both the STORET and Water Atlas sources which were not contained within the other system. Locations of the identified water quality monitoring sites in the Long Branch Creek watershed are indicated on Figure 2-8, based upon geographic coordinates contained in the Pinellas County data, along with the site reference I.D. for each location. An expanded view of central portions of Long Branch creek which more clearly identifies locations of the historical water quality monitoring sites is given on Figure 2-9.

Historical water quality monitoring data has been collected by both Pinellas County and FDEP within the Long Branch Creek watershed. Seven separate sites have been monitored by Pinellas County as part of the ongoing ambient water quality monitoring program. Each of these sites is identified using the numbering system "22-xx" where the "22" identifies the Long Branch watershed, and the "-xx" refers to the monitoring site. Six of the Pinellas County monitoring sites appear to be located in the freshwater portion of the watershed, with one site (22-01) located in the tidal portion of the watershed.

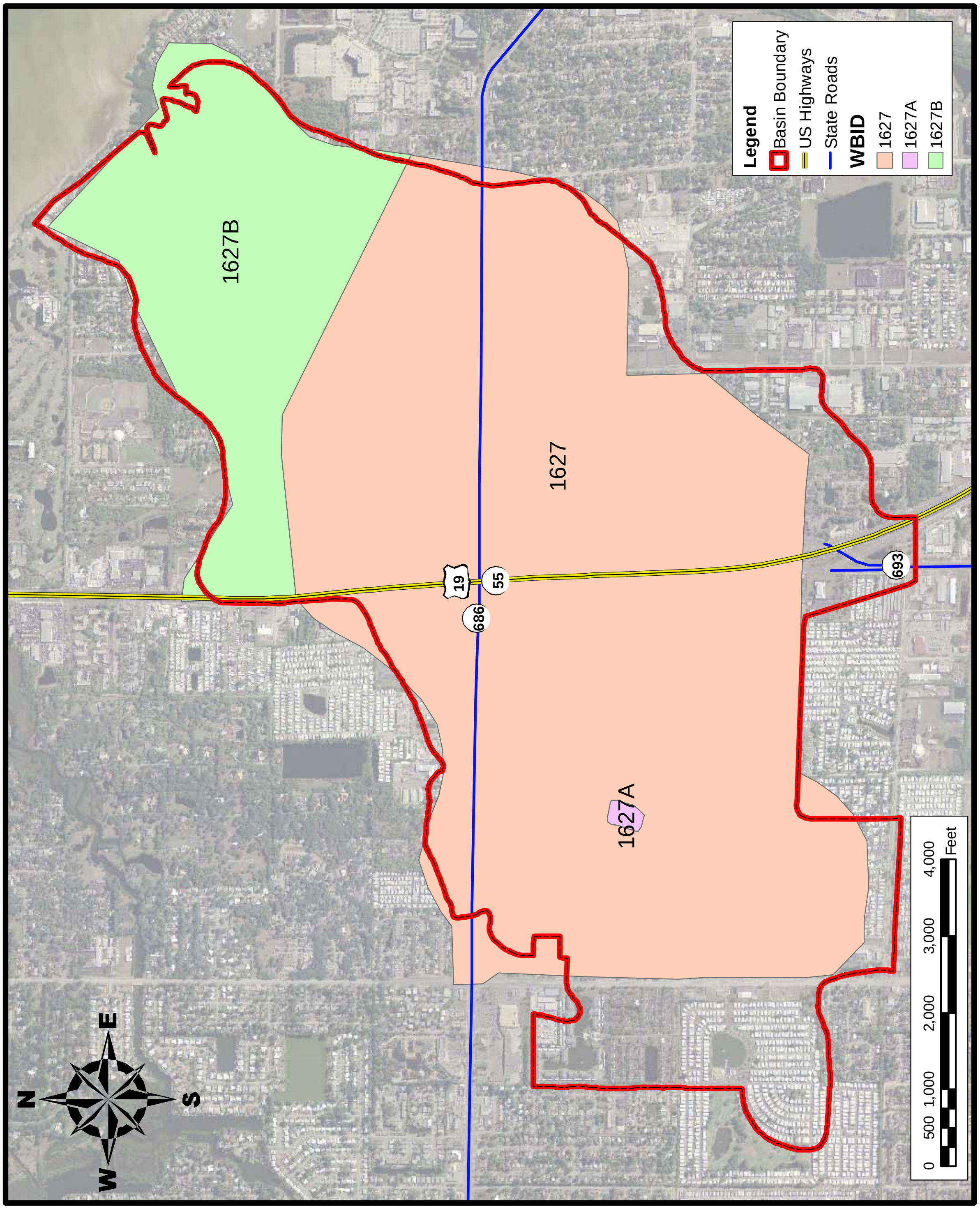


Figure 2-7. WBID Boundaries in the Long Branch Creek Watershed.

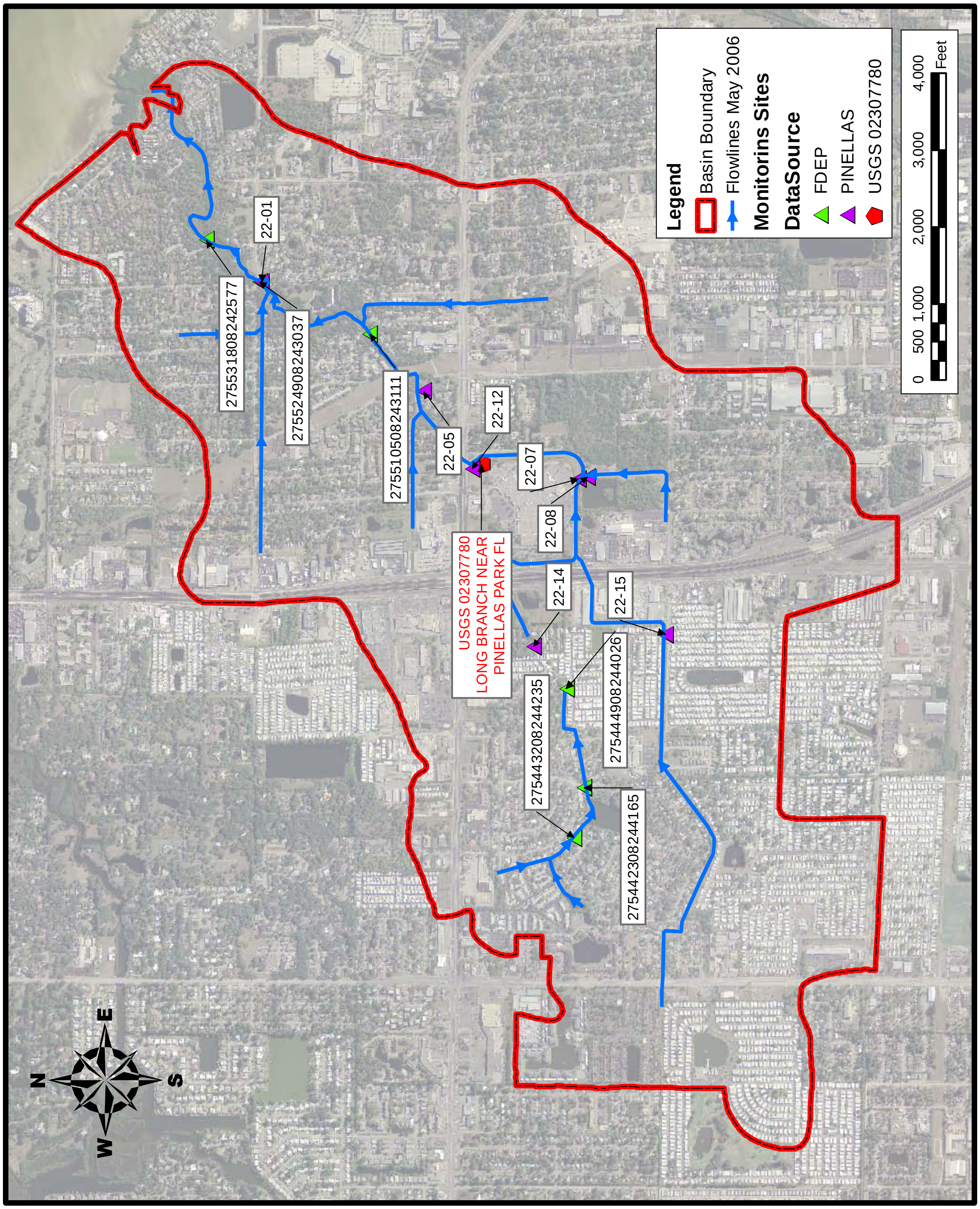


Figure 2-8. Location of Pinellas County, FDEP, and USGS Monitoring Sites in the Long Branch Creek Watershed.

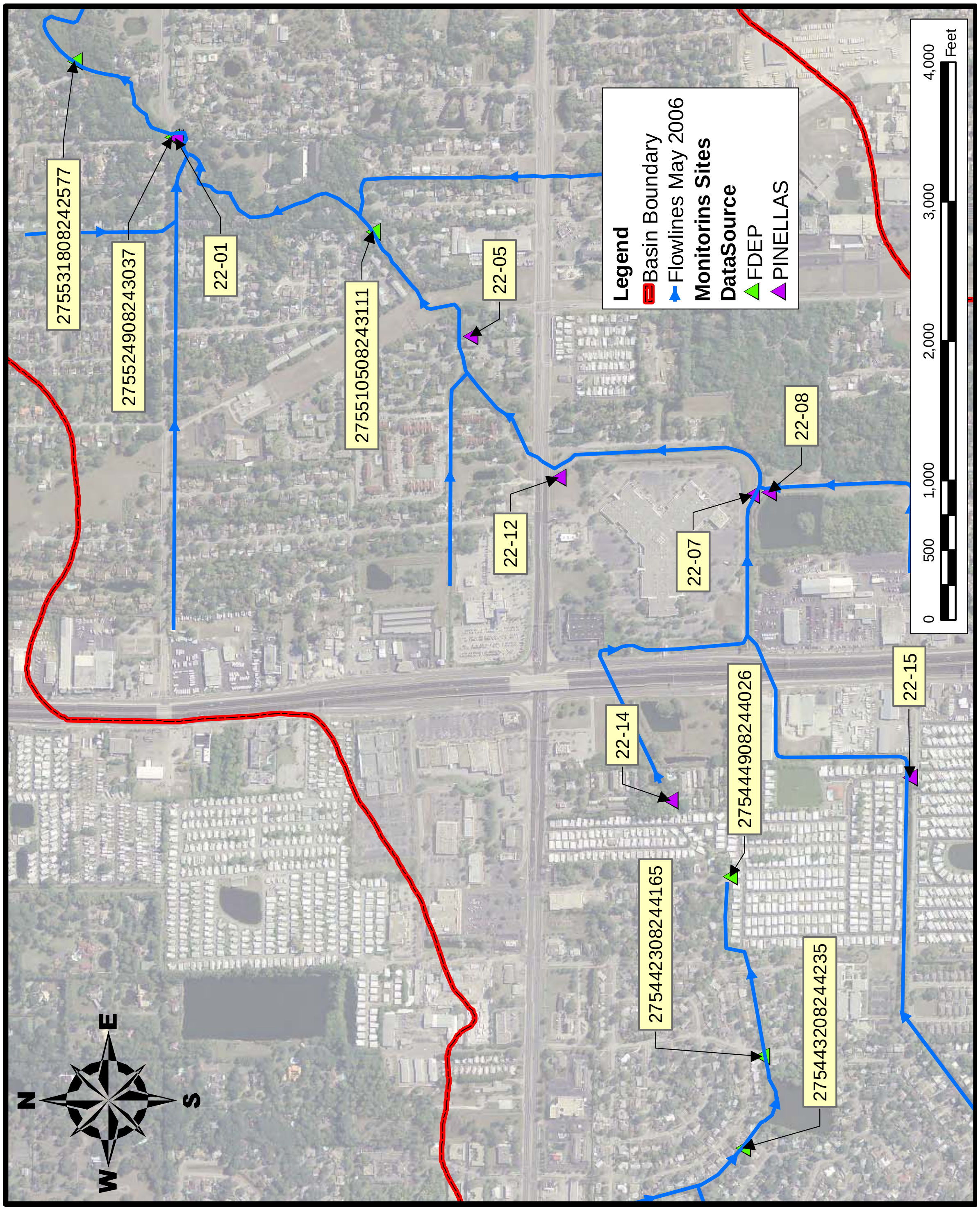


Figure 2-9. Expanded View of Pinellas County and FDEP Surface Water Monitoring Sites.

Surface water monitoring within the Long Branch Creek watershed has also been conducted by FDEP at a total of six separate monitoring sites, some of which coincide with the Pinellas County monitoring sites. Data at the FDEP monitoring sites are extremely limited, with virtually all of the water quality data collected during a single 12-month period. In addition to the Pinellas County and FDEP surface water monitoring sites, USGS also operates a gauging station near the center of the Long Branch Creek watershed, but no water quality data are available for this site. This station provides a continuous record of discharges to Long Branch Creek at the monitoring site located upstream from Roosevelt Blvd.

A summary of available Pinellas County and FDEP water quality data for Long Branch Creek is given in Table 2-4. Water quality data have been collected at a total of seven monitoring sites within the watershed, beginning as early as 1991. Monitoring Site 22-01, which is located in the tidal portion of the drainage basin, has available data from 1991-present, with a total of 88 quarterly monitoring events conducted at this site. Pinellas County monitoring Site 22-05, located in the freshwater portion of the basin north of Roosevelt Blvd., has available data from 1995-2008, with a total of 145 monthly monitoring events conducted at this site. Site 22-07 (located on the main channel in central portions of the Long Branch Creek watershed) has available data from 2003-2008, with a total of 37 bi-monthly events. Site 22-08 (located on a tributary to the main channel) also has available data from 2003-2008, with 48 bi-monthly events. Monitoring Site 22-12 (located in central portions of the drainage basin along the main channel) has available quarterly monitoring data extending from 2008-present. Pinellas County Sites 22-14 and 22-15 (located in the northern and southern headwater segments, respectively) also have available quarterly monitoring data from 2008-present. Data collected by Pinellas County at these sites include discharge, field parameters, and laboratory analyses, with discharge measurements conducted during each field monitoring event beginning in 2003. A compilation of historical Pinellas County water quality data in the Long Branch Creek watershed is given in Appendix A.1.

Water quality data in Long Branch Creek have been collected by FDEP at a total of six monitoring sites within the watershed, beginning as early as 2002. Locations of the monitoring sites are indicated on Figure 2-9. FDEP monitored three separate sites in the northern headwater segment, but had no monitoring sites in the southern headwater segment. None of the FDEP monitoring sites were located in mid-portions of the watershed. The final three monitoring sites were all located along the main channel, north and east of the powerline easement. One of the three sites was located in a predominantly freshwater portion of the main channel, with the final two monitoring sites located in predominantly marine portions of the main channel. In general, the number of sampling events conducted by FDEP is relatively limited at each of the six sites. One of the FDEP sites in the northern headwater segment has monthly data from April-December 2002. The remaining two sites have periodic data collected over the period from 2002-2006, with quarterly data collected at one site and annual data collected at the second site. The FDEP site located northeast of the powerline easement had a total of three samples collected from 2002-2006. The two marine monitoring sites had only monthly data collected from February-December 2006. Data collected by FDEP at these sites typically includes discharge measurements, field parameters, and laboratory analyses. A compilation of historical FDEP water quality data collected in the Long Branch Creek watershed is given in Appendix A.2.

TABLE 2-4

SUMMARY OF AVAILABLE PINELLAS COUNTY WATER QUALITY DATA FOR THE LONG BRANCH CREEK WATERSHED

AGENCY	STATION I.D.	COLLECTION DATES	MONITORING FREQUENCY	NUMBER OF EVENTS	TYPE OF DATA
Pinellas County	22-01	1/16/91-5/6/10	Quarterly	88	Field/Lab/Discharge[1]
	22-05	1/18/95-9/23/08	Monthly	145	Field/Lab/Discharge[1]
	22-07	1/22/03-6/25/08	Bi-monthly	37	Field/Lab/Discharge[1]
	22-08	1/22/03-9/23/08	Bi-monthly	48	Field/Lab/Discharge[1]
	22-12	10/28/08-5/6/10	Bi-monthly	11	Field/Lab/Discharge[1]
	22-14	10/28/08-5/6/10	Bi-monthly	11	Field/Lab/Discharge[1]
	22-15	10/28/08-5/6/10	Quarterly	6	Field/Lab/Discharge[1]
FDEP	275442308244165	4/23/02-12/4/02	Monthly	9	Field/Lab/Discharge
	275443208244235	4/23/02-7/11/06	Monthly during 2002; quarterly during 2006	12	Field/Lab/Discharge
	275444908244026	3/21/02-10/3/06	1 event in 2001; quarterly in 2006	4	Field/Lab/Discharge
	275510508243111	3/7/02-10/24/06	1 event in 2002; 2 events in 2006	3	Field/Lab/Discharge
	275524908243037	2/7/06-12/5/06	Monthly	10	Field/Lab/Discharge
	275531808242577	2/7/06-12/5/06	Monthly	11	Field/Lab/Discharge

1. Discharge data begin in 2003 at all sites

2.7.2 Pinellas County Data

A summary of simple descriptive statistics for historical water quality data collected at each of the Pinellas County monitoring sites in the Long Branch Creek watershed is given in Table 2-5. Monitoring sites are listed in order from upstream to downstream along Long Branch Creek. Summary statistics are provided for significant general parameters, nutrients, and microbiological parameters at the Pinellas County monitoring sites. Information is provided on minimum measured value, maximum measured value, median value, and the number of analyses conducted for each listed water quality parameter.

Measured conductivity values in Long Branch Creek have been highly variable between the Pinellas County monitoring sites. In general, low to moderate levels of conductivity have been observed in the northern and southern headwater streams, with typical conductivity values ranging from approximately 400-600 μmho/cm. Conductivity values in middle portions of Long Branch Creek (identified by monitoring Sites 22-05, 22-07, 22-08, and 22-12) have been substantially more variable, with typical values ranging from approximately 400-1500 μmho/cm. More elevated conductivity values, combined with a high degree of variability, have been observed at the tidal monitoring site (identified as Site 22-01). Trends in measured salinity values closely match the observed trends in conductivity.

TABLE 2-5

STATISTICAL SUMMARY OF HISTORICAL WATER QUALITY DATA COLLECTED IN LONG BRANCH CREEK BY PINELLAS COUNTY

STATION I.D.	STATISTIC	pH (s.u.)	TEMP. (°C)	COND. (μmho/cm)	SALINITY (ppt)	D.O. (mg/l)	NH_4 (μg/l)	NO_x (μg/l)	TKN (μg/l)	TN (μg/l)	SRP (μg/l)	TP (μg/l)	TSS (mg/l)	TURB. (NTU)	BOD_5 (mg/l)	CHL-a (μg/l)	CHL-b (μg/l)	CHL-c (μg/l)	TOTAL COLIFORM (cfu/100 ml)	FECAL COLIFORM (cfu/100 ml)	E. COLI (cfu/100 ml)
22-15	min	7.16	15.45	421	0.2	1.2	10	20	690	710	50	70	1.0	1.8	4.0	0.9	0.5	0.5	x	54	34
22-15	max	7.74	29.68	617	0.3	8.0	100	350	1,500	1,520	170	330	10.0	4.9	4.0	33.6	3.1	1.5	x	6,800	4,840
22-15	median	7.39	19.96	496	0.3	2.4	35	20	980	1,070	70	120	5.5	3.2	4.0	4.9	1.0	0.7	x	410	336
22-15	count	6	6	6	6	6	6	6	6	6	6	6	6	6	2	6	6	6	x	6	6
22-14	min	7.01	15.22	441	0.2	2.7	10	60	580	820	50	70	1.0	1.0	2.0	0.5	0.5	0.5	x	33	68
22-14	max	7.62	29.02	665	0.3	6.4	300	340	1,340	1,600	240	290	8.0	4.3	4.0	15.9	3.9	0.9	x	7,900	6,930
22-14	median	7.31	22.12	582	0.3	4.5	60	140	930	1,070	70	130	4.0	2.0	3.0	1.6	0.5	0.5	x	1,800	2,830
22-14	count	12	12	12	12	12	11	11	11	11	11	11	11	11	5	11	11	11	x	11	11
22-08	min	5.96	14.18	386	0.2	0.4	10	20	440	460	20	20	1.0	0.3	1.0	0.8	0.5	0.5	44	4	4
22-08	max	7.85	32.03	1,543	0.8	12.0	100	310	1,070	1,200	140	180	21.0	8.6	3.0	22.3	1.8	2.9	17,000	3,300	4,800
22-08	median	7.38	24.33	1,103	0.6	4.4	10	20	695	725	40	50	2.0	0.8	2.0	2.6	0.5	0.6	1,550	87	126
22-08	count	51	51	51	51	51	48	48	48	48	48	48	48	48	15	47	47	47	8	28	30
22-07	min	6.94	14.83	158	0.1	0.3	10	20	550	600	20	20	1.0	0.3	1.0	0.5	0.5	0.5	100	14	2
22-07	max	8.07	31.27	885	0.5	8.6	200	220	1,520	1,700	210	620	42.0	7.5	6.0	42.9	4.5	6.2	15,000	3,600	4,800
22-07	median	7.29	23.61	608	0.3	2.1	48	45	885	980	100	150	2.0	1.6	2.0	5.9	0.6	0.7	3,700	408	325
22-07	count	46	46	46	46	46	38	38	38	38	38	38	38	38	11	37	37	37	7	22	23
22-12	min	6.90	16.67	469	0.2	0.8	10	20	590	630	30	40	1.0	0.7	2.0	2.2	0.5	0.5	x	60	113
22-12	max	7.67	29.44	1,180	0.6	12.8	550	320	1,510	1,580	190	280	5.0	5.5	6.0	25.1	4.4	1.1	x	2,300	1,960
22-12	median	7.13	20.54	682	0.4	2.2	100	20	980	1,000	60	130	2.0	2.0	4.0	4.7	0.5	0.5	x	470	311
22-12	count	11	11	11	11	11	11	11	11	11	11	11	11	11	5	11	11	11	x	11	11
22-05	min	6.92	13.89	255	0.1	0.1	10	5	340	480	20	20	1.0	0.4	1.0	0.5	0.5	0.5	100	48	68
22-05	max	9.80	30.41	1,124	0.6	10.5	1,098	510	2,450	2,550	160	700	26.0	14.0	4.0	28.4	8.2	5.8	24,000	5,900	1,400
22-05	median	7.46	24.49	698	0.4	4.3	50	90	780	880	50	100	2.0	2.1	1.0	2.4	0.5	0.5	1,400	390	300
22-05	count	153	154	154	154	154	131	145	145	145	144	144	120	145	108	144	144	144	31	54	31
22-01	min	6.98	13.08	248	0.0	0.2	10	20	10	70	20	40	1.0	0.8	1.0	0.5	0.0	0.1	50	2	175
22-01	max	7.78	30.73	36,400	23.2	7.8	290	610	1,360	1,530	1,000	740	14.0	11.0	5.0	39.4	3.1	5.1	24,000	12,000	5,200
22-01	median	7.41	24.93	1,950	0.8	3.2	37	150	850	1,035	80	120	3.0	2.5	1.4	2.9	0.5	0.8	2,200	1,750	1,526
22-01	count	120	120	120	120	120	44	89	80	78	91	79	90	84	57	88	83	88	47	76	28

Measured dissolved oxygen concentrations within Long Branch Creek have also been highly variable, with measured oxygen concentrations in the freshwater portion of the basin ranging from approximately 0.1-12.8 mg/l. However, the median dissolved oxygen concentrations, ranging from 2.1-4.5 mg/l, are all less than the minimum Class III criterion outlined in Chapter 62-302 FAC of 5 mg/l. The median dissolved oxygen concentration of 3.2 mg/l for Site 22-01 in the tidal segment is also less than the applicable Class III criterion of 4 mg/l for marine systems.

In general, measured concentrations of nitrogen species in Long Branch Creek have been low to moderate in value at a majority of the monitoring sites. The dominant nitrogen species present appears to be organic nitrogen which comprises a large percentage of the overall total nitrogen observed. Median total nitrogen concentrations at the Pinellas County monitoring sites range from a low of 725 μg/l to a high of 1070 μg/l, reflecting relatively low to moderate total nitrogen concentrations. A decrease in total nitrogen concentrations appears to occur in central portions of the creek compared with values measured in the two headwater sites and at the tidal monitoring site.

A summary of median water quality characteristics at each of the Pinellas County monitoring sites, based upon the historical data sets, is given in Table 2-6. The monitoring sites are listed in the approximate order from upstream to downstream to facilitate evaluation of changes in water quality characteristics with distance along the main channel.

Measured concentrations of phosphorus species in Long Branch Creek have been moderate to elevated in value during the Pinellas County monitoring program. A large portion of the total phosphorus appears to be contributed by SRP, particularly in headwater and tidal portions of the creek. Median total phosphorus concentrations have ranged from 50-130 μg/l, reflecting moderate to elevated concentrations. Phosphorus concentrations along the main channel appear to remain fairly uniform, with no significant reduction in central portions of the channel, as was observed for total nitrogen.

Measured concentrations of TSS and turbidity in Long Branch Creek have been highly variable but typically low in value during most monitoring events. Median concentrations of TSS at the Pinellas County monitoring site range from approximately 2-5.5 mg/l, reflecting relatively low concentrations. Similarly, median turbidity values range from 0.8-3.2 NTU, also reflecting relatively low concentrations.

Measured concentrations of BOD appear to be moderate in value throughout much of the main channel. The most elevated levels of BOD appear to occur in the headwaters segment, with a mean BOD of 3.0 mg/l in the northern headwater segment and 4.0 mg/l in the southern headwater segment. An elevated median BOD value of 4.0 mg/l was also observed at Site 22-12 which is located along the main channel south of Roosevelt Blvd. Measured BOD concentrations in other portions of the main channel are typically lower in value, ranging from 1.0-2.0 mg/l.

TABLE 2-6

SUMMARY OF MEDIAN WATER QUALITY CHARACTERISTICS AT THE PINELLAS COUNTY MONITORING SITES

PARAMETER	UNITS	SITE LOCATION / IDENTIFICATION						
		Southern Headwater Segment	Northern Headwater Segment	Tributary Inflow	Main Channel			
		22-15	22-14	22-08	22-07	22-12	22-05	22-01
pH	s.u.	7.39	7.31	7.38	7.29	7.13	7.46	7.41
Temperature	^{o}C	19.96	22.12	24.33	23.61	20.54	24.49	24.93
Conductivity	µmho/cm	496	582	1103	608	682	698	1950
Salinity	ppt	0.3	0.3	0.6	0.3	0.4	0.4	0.8
D.O.	mg/l	2.4	4.5	4.4	2.1	2.2	4.3	3.2
NH_4	µg/l	35	60	10	48	100	50	37
NO_x	µg/l	20	140	20	45	20	90	150
TKN	µg/l	980	930	695	885	980	780	850
Total N	µg/l	1070	1070	725	980	1000	880	1035
SRP	µg/l	70	70	40	100	60	50	80
Total P	µg/l	120	130	50	150	130	100	120
TSS	mg/l	5.5	4.0	2.0	2.0	2.0	2.0	3.0
Turbidity	NTU	3.2	2.0	0.8	1.6	2.0	2.1	2.5
BOD_5	mg/l	4.0	3.0	2.0	2.0	4.0	1.0	1.4
Chlorophyll-a	µg/l	4.9	1.6	2.6	5.9	4.7	2.4	2.9
Chlorophyll-b	µg/l	1.0	0.5	0.5	0.6	0.5	0.5	0.5
Chlorophyll-c	µg/l	0.7	0.5	0.6	0.7	0.5	0.5	0.8
Total Coliform	cfu/100 ml	--	--	1550	3700	--	1400	2200
Fecal Coliform	cfu/100 ml	410	1800	87	408	470	390	1750
E. Coli	cfu/100 ml	336	2830	126	325	311	300	1526

As indicated on Table 2-6, median water quality characteristics at the Pinellas County monitoring sites in Long Branch Creek appear to be relatively similar in the southern headwater segment, northern headwater segment, and main channel monitoring sites. However, the water quality at the tributary inflow site (designated as 22-08) appears to be substantially different for a number of parameters. As indicated on Figure 2-9, this site reflects a tributary inflow to the main channel downstream from the point of confluence of the northern and southern headwaters segments. As indicated on Table 2-6, Pinellas County Site 22-08 is characterized by a median conductivity value which is approximately 40-50% greater than median values measured at the remaining Long Branch Creek monitoring sites with the exception of the site located in the marine segment. This site is also characterized by a total nitrogen concentration which is approximately 20-30% less than median nitrogen concentrations at the remaining sites. The median total phosphorus concentration of 50 µg/l at Site 22-08 is 50-70% lower than median phosphorus concentrations at the remaining main channel sites. This site is also characterized by a substantially lower median value for turbidity as well as substantially lower median concentrations for fecal coliform and E. coli bacteria. It appears that inflow from Site 22-08 may actually be diluting nutrient and bacteria concentrations within the main channel.

Measured concentrations of chlorophyll-a in the Long Branch Creek channel have also been highly variable, with individual values reflecting low to moderate concentrations during most events. Median concentrations of chlorophyll-a at the Pinellas County monitoring sites range from a low of 1.6 μg/l to a high of 5.9 μg/l. Chlorophyll within the channel appears to be contributed primarily by chlorophyll-a, with substantially lower concentrations of chlorophyll-b and chlorophyll-c.

Measured concentrations of total coliform, fecal coliform, and enterococcus bacteria in Long Branch Creek have been highly variable at each of the monitoring sites. Median concentrations of fecal coliform exceed the criterion of 400 cfu/100 ml outlined in Chapter 62-302 for Class III surface waters at each of the monitoring sites, with the exceptions of Site 22-08 (87 cfu/100 ml) which reflects an inflow to the main channel and Site 22-05 (390 cfu/100 ml) which is located on the main channel south of the power line easement. Substantially elevated levels of E. Coli bacteria have also been measured in Long Branch Creek, with median values at all sites, except Site 22-08, exceeding the US EPA guidance level of 126 cfu/100 ml. Microbiological contamination in Long Branch Creek appears to represent a relatively significant ongoing water quality problem.

Additional statistical evaluations and trend analyses were conducted for the historical water quality data collected at each of the seven Pinellas County surface water monitoring sites. However, data collected at many of the monitoring sites cover substantially different periods of record, with a high degree of variability in the number of events monitored at each site. As indicated in Table 2-4, monitoring Site 22-01 contains approximately 20 years of available data, with 13 years of available data for Site 22-05, five years for Sites 22-07 and 22-08, and two years of available data for Sites 22-12, 22-14, and 22-15. In addition, the period of record for several of the monitoring sites do not overlap which limits the usefulness of data comparisons between the sites.

A comparison of historical concentrations of pH, dissolved oxygen, BOD, and fecal coliform measured at Pinellas County monitoring sites is given on Figure 2-10 in the form of Tukey box plots, also often called "box and whisker plots". The bottom of the box portion of each plot represents the lower quartile, with 25% of the data points falling below this value. The upper line of the box represents the 75% upper quartile, with 25% of the data falling above this value. The horizontal line within the box represents the median value, with 50% of the data falling both above and below this value. The vertical lines, also known as "whiskers", represent the 5 and 95 percentiles for the data sets. Individual values which lie outside of the 5-95 percentile range are indicated as **red dots**. The monitoring sites are arranged in each of the box plots in approximate order from upstream to downstream portions of the creek to facilitate evaluation of changes in water quality characteristics within the creek.

In general, measured pH values at the Pinellas County monitoring sites appear to be relatively uniform in value, with median concentrations ranging from approximately 7.3-7.5. Each of the sites appears to have little variability in measured pH values, with the exception of Site 22-05 which is located in central portions of the Long Branch Creek watershed, south of Roosevelt Blvd.

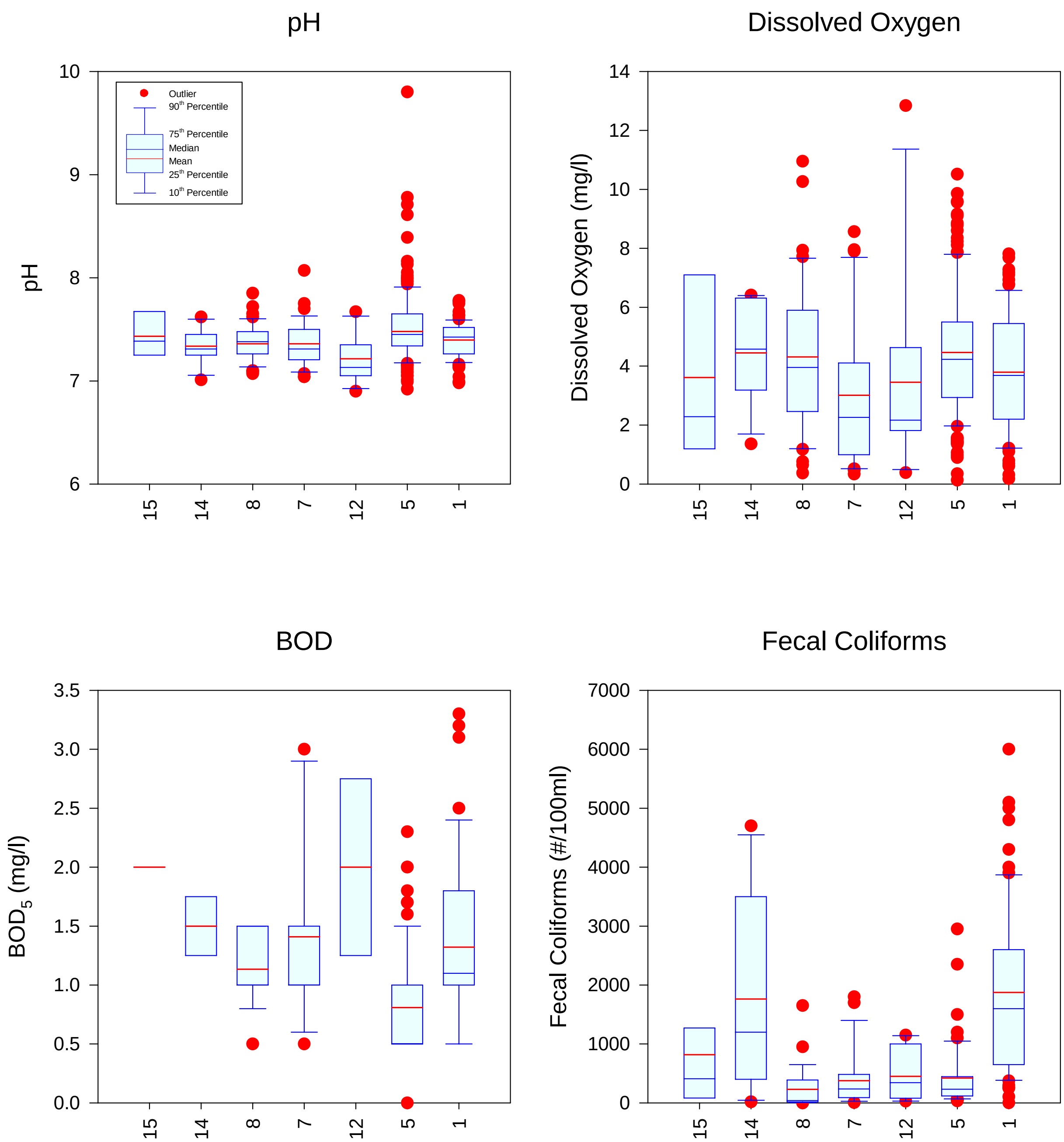


Figure 2-10. Statistical Comparison of Historical Concentrations of Fecal Coliform, Dissolved Oxygen, BOD, and pH Measured in Long Branch Creek by Pinellas County.

Measured dissolved oxygen concentrations in Long Branch Creek have been highly variable and generally low in value at the Pinellas County monitoring sites. Dissolved oxygen concentrations appear to be lower in central portions of the creek compared with the headwaters or tidal segments. Measured BOD concentrations also appear to be relatively low in value, with median concentrations ranging from 1.0-4.0 mg/l. The highest BOD concentrations occur at Site 22-12 which is located in central portions of the watershed. Fecal coliform bacteria appear to be most elevated in the northern headwater segment (Site 22-14) and at the tidal monitoring site (Site 22-01), with lower fecal coliform counts in central portions of the creek. The historical fecal coliform values reflect continuing exceedances of the Class III criterion.

A comparison of historical concentrations of nitrogen species measured at the Pinellas County monitoring sites in Long Branch Creek is given in Figure 2-11. In general, measured concentrations of ammonia in Long Branch Creek have been relatively low in value, with the majority of measured values less than approximately 0.2 mg/l. Measured ammonia concentrations at monitoring Sites 22-14 and 22-15 (reflecting the northern and southern headwater branches, respectively) appear to have higher ammonia concentrations than observed at the remaining sites.

Measured NO_x concentrations appear to be highly variable at each of the surface water monitoring sites. Somewhat elevated levels of NO_x appear to occur within the northern headwaters segment, with a median concentration of approximately 0.14 mg/l. NO_x concentrations in the southern headwaters segment appear to be substantially lower in value. Concentrations of NO_x appear to decrease somewhat in central portions of the Long Branch Creek before increasing at Site 22-05, located north of Roosevelt Blvd. Measured NO_x concentrations in the tidal segment exhibit the highest median concentration and greatest degree of variability of any of the monitoring sites.

Measured TKN concentrations within Long Branch Creek also appear to be highly variable between the monitoring sites. TKN concentrations in the northern and southern headwater segments appear to be higher in value than concentrations measured at the remaining sites with the exception of Site 22-12. Decreases in TKN concentrations appear to occur in portions of Long Branch Creek downstream from Site 22-12, with similar concentrations at the final two main channel sites.

In general, measured total nitrogen concentrations at the Pinellas County monitoring sites appear to exhibit a pattern similar to that observed for TKN which comprises the dominant nitrogen species in the channel. More elevated concentrations of total nitrogen were observed in the northern and southern headwater segments, followed by a decrease in concentration at Site 22-07, with a substantial increase at Site 22-12. Total nitrogen concentrations in the tidal segment exhibit a relatively high degree of variability, with a mean total nitrogen concentration of approximately 1 mg/l.

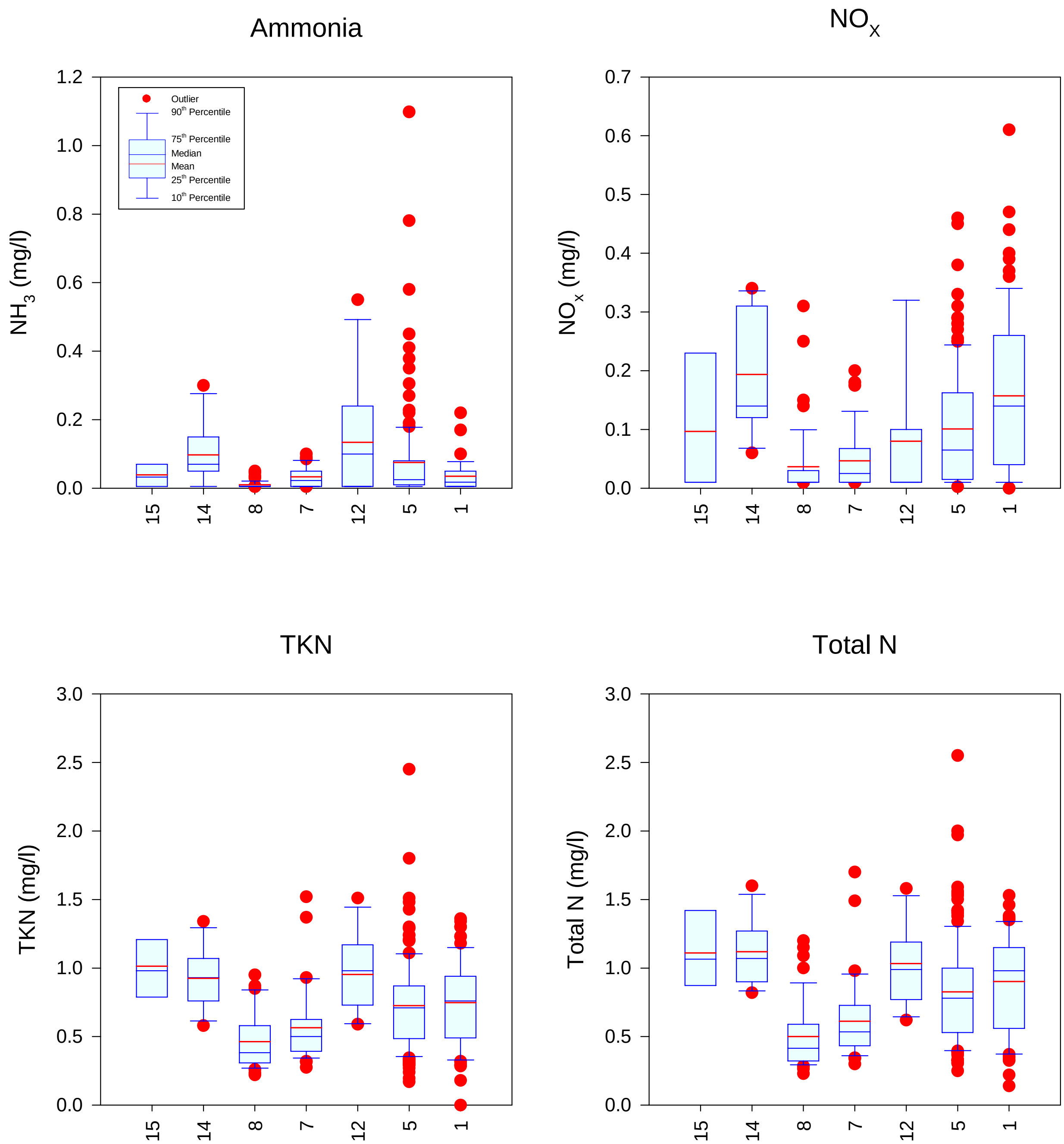


Figure 2-11. Statistical Comparison of Historical Concentrations of Nitrogen Species Measured in Long Branch Creek by Pinellas County.

A statistical comparison of historical concentrations of phosphorus species at the Pinellas County monitoring sites is given in Figure 2-12. Measured concentrations of soluble reactive phosphorus (SRP) appear to be highly variable between the surface water monitoring sites. Somewhat elevated concentrations of SRP appear to occur in the northern and southern headwater segments, followed by a slight decrease in concentrations at Site 22-07. Measured SRP concentrations at Sites 22-07, 22-12, and 22-05 (all located in central portions of the Long Branch Creek channel) appear to be relatively similar in value. A slight increase in total phosphorus concentrations, combined with a higher degree of variability in measured concentrations, appears to occur at the tidal monitoring station (Site 22-01).

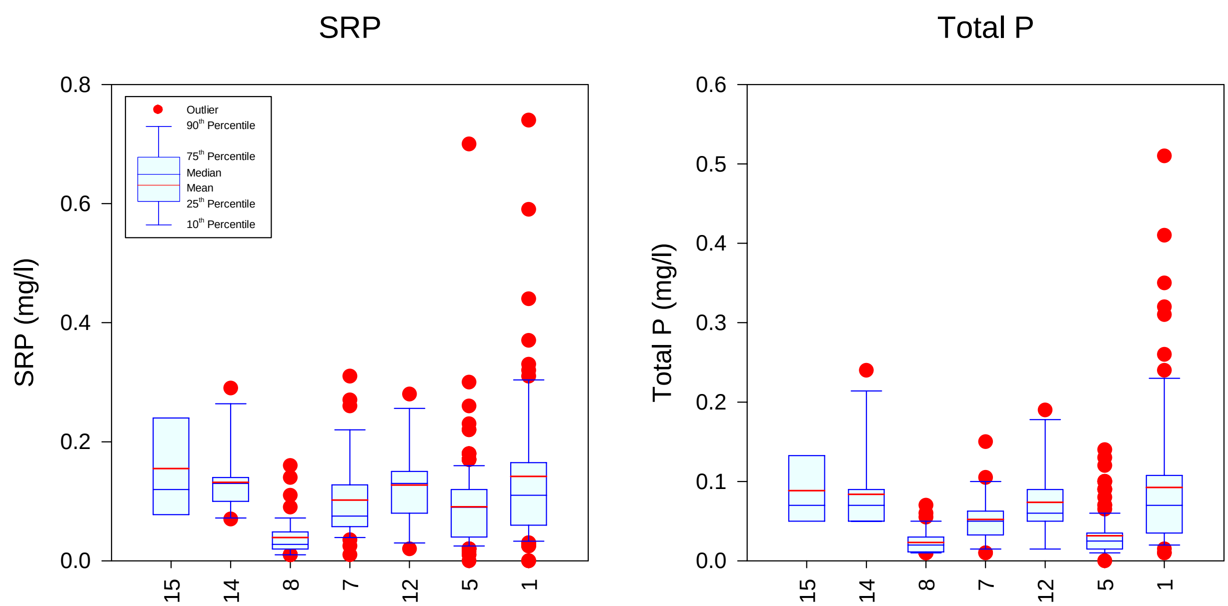


Figure 2-12. Statistical Comparison of Historical Concentrations of Phosphorus Species Measured in Long Branch Creek by Pinellas County.

Measured total phosphorus concentrations at the Pinellas County monitoring sites appear to follow a pattern similar to that observed for SRP. Somewhat elevated total phosphorus concentrations appear to occur in the northern and southern headwater segments, followed by decreases in concentrations at the central segment monitoring sites. Total phosphorus concentrations at the tidal segment monitoring site (Site 22-01) appear to both increase in value and variability compared with concentrations measured at the remaining sites. This decrease is likely related to periodic dilution of the creek water as the tides cycle into the creek.

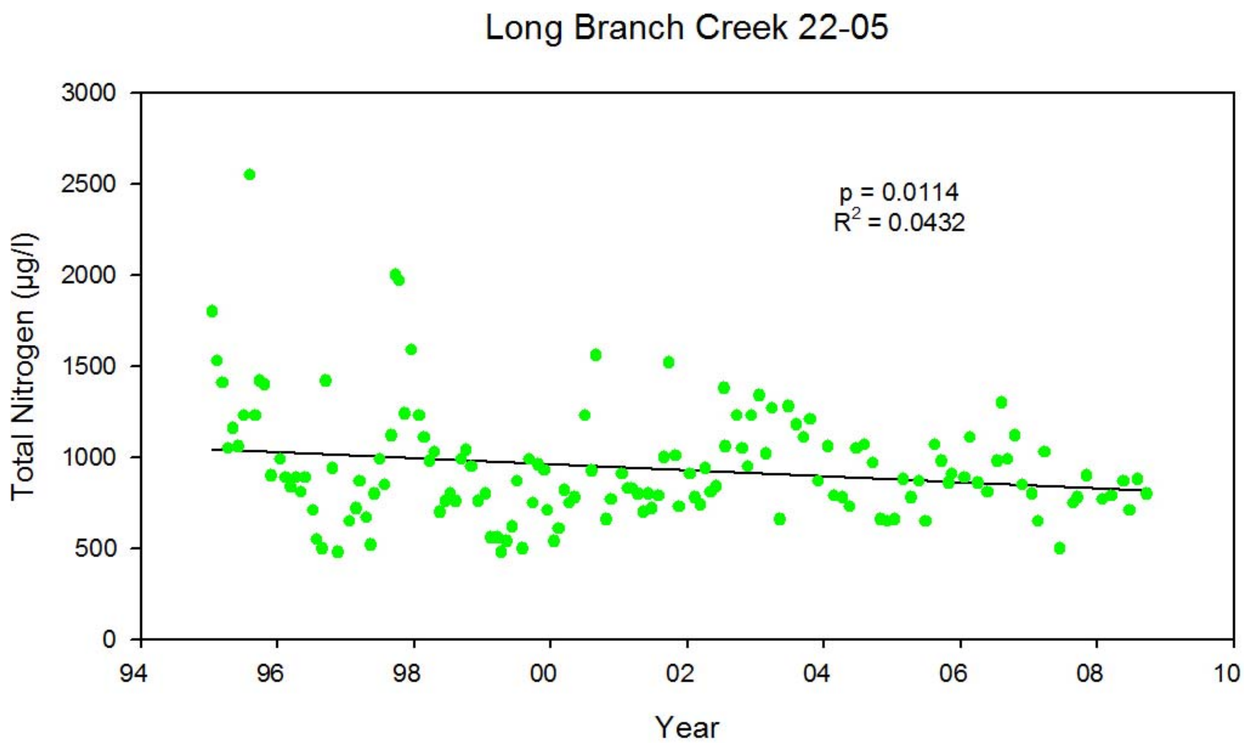
Trend analyses were also conducted on the historical water quality data collected in Long Branch Creek by Pinellas County. However, as indicated on Table 2-4, only Sites 22-01 and 22-05 have a sufficient period of available historical data to conduct meaningful water quality trend analyses. Site 22-05 is located near the center of the Long Branch Creek watershed and may provide a good indication of long-term trends in general water quality characteristics. Site 22-01 is located in the tidal portion of the sub-basin and is highly impacted by marine water which flows into and out of the creek during tidal cycles. As a result, water quality data collected at this site do not solely reflect the characteristics of Long Branch Creek but rather a combination of tidal inflow and Long Branch Creek outflow. Therefore, historical water quality trends are evaluated using Site 22-05 only.

A comparison of trends in historical total nitrogen concentrations at Pinellas County monitoring Site 22-05 is given on Figure 2-13. A "best fit" regression line is provided for each of the two plots to assist in identifying significant water quality trends. The calculated probability value (p-value) is also provided for each regression line which indicates the level of significance associated with each regression model. A model which is significant at a 95% confidence level would be associated with a p-value of 0.05. However, waterbodies exhibit normal seasonal and cyclic variations in water quality which can reduce the statistical significance of a regression model due to normal sources of variability which are unrelated to potential temporal trends. This normal variability may lead to elevated p-values which suggest that trends may not be significant when significant trends actually exist. Therefore, for evaluating water quality trends in surface waters, a p-value of 0.1 or less is generally considered to indicate a significant trend, with p-values greater than 0.1 indicating an insignificant trend. R-square (R^2) values are also provided for each regression line which provide another indicator of the strength of the relationship between concentrations and time.

A general trend of decreasing total nitrogen concentrations is apparent at monitoring Site 22-05 over the period from 1995-2008. Based upon the calculated p-value of 0.0114, this relationship is highly significant, although based upon the low R^2 value of 0.0432, time explains only approximately 4% of the variability in observed nitrogen concentrations. Based upon the trend line provided for Site 22-05, total nitrogen concentrations appear to have decreased from approximately 1000 μg/l during the mid-1990s to approximately 800 μg/l under existing conditions.

A graphical summary of trends in historical total phosphorus concentrations at Long Branch Creek monitoring Site 22-05 is also given on Figure 2-13. The calculated trend line suggests a decrease in total phosphorus concentrations over time, although the calculated p-value of 0.3665 indicates that the trend is not statistically significant. Based upon this analysis, phosphorus concentrations appear to have been relatively consistent over the past 20 years.

A graphical summary of trends in historical concentrations of dissolved oxygen at Pinellas County Site 22-05 from 1995-2008 is given on Figure 2-14. Measured dissolved oxygen concentrations at Site 22-05 have been highly variable over time, and the calculated p-value of 0.9202 indicates that there is no statistically significant trend of either increasing or decreasing dissolved oxygen concentrations within Long Branch Creek.



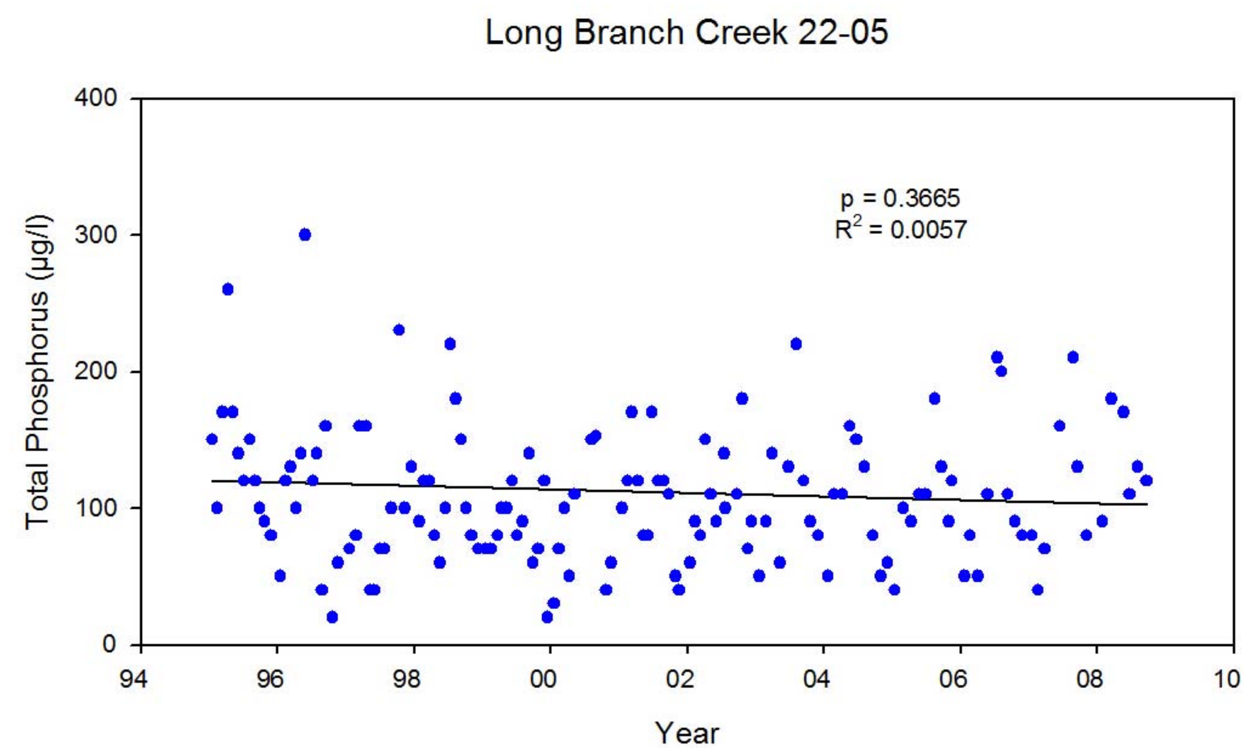


Figure 2-13. Trends in Historical Concentrations of Total Nitrogen and Total Phosphorus at Pinellas County Site 22-05 from 1995-2008.

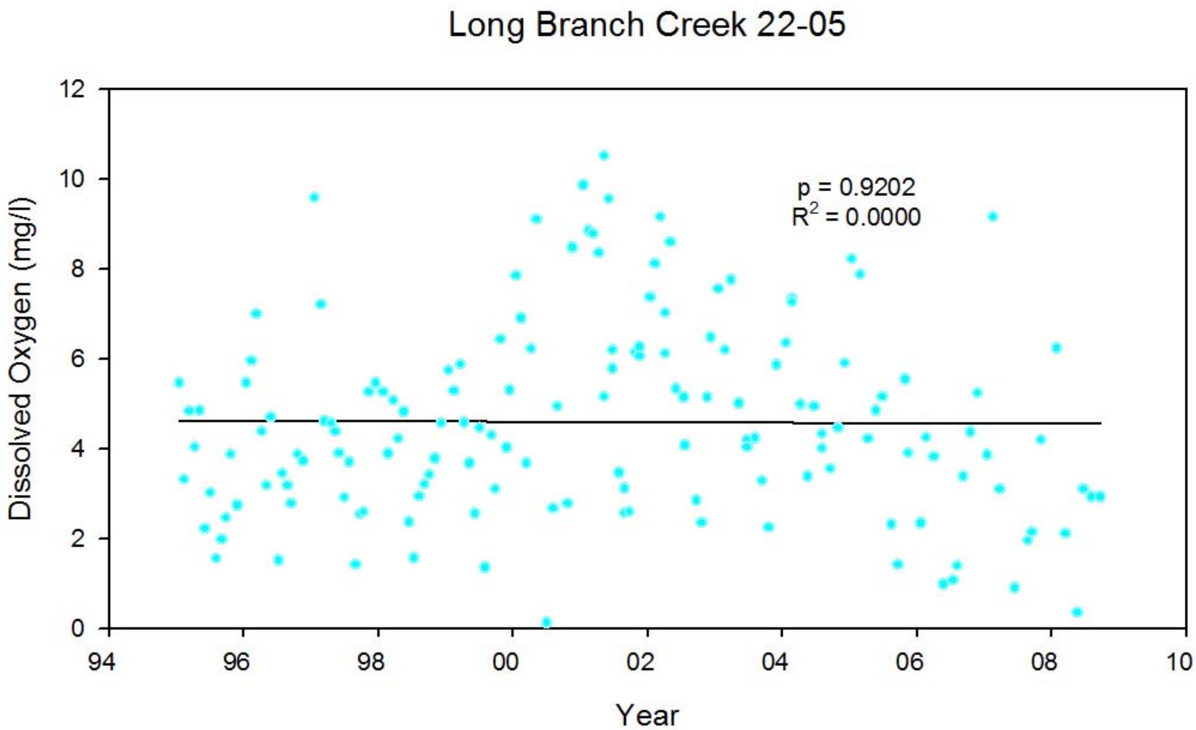


Figure 2-14. Trends in Historical Concentrations of Dissolved Oxygen at Pinellas County Site 22-05 from 1995-2008.

2.7.3 FDEP Data

A summary of simple descriptive statistics for historical water quality data collected at each of the FDEP monitoring sites in Long Branch Creek is given in Table 2-7. Sites are listed in an upstream to downstream order. Summary statistics are provided for significant general parameters, nutrients, and microbiological parameters at the FDEP monitoring sites. Information is provided on minimum measured value, maximum measured value, median value, and the number of analyses conducted for each listed water quality parameter.

As discussed previously, water quality data collected by FDEP in Long Branch Creek are extremely limited, with samples at one of the six sites collected only during 2002, samples at two sites collected only during 2006, and samples at the remaining sites collected sporadically from 2002-2006. As indicated on Figure 2-9, only one of the FDEP monitoring sites (Site 2755249008243037) is located in the general proximity of a Pinellas County monitoring site (Site 22-01).

TABLE 2-7

STATISTICAL SUMMARY OF HISTORICAL WATER QUALITY DATA COLLECTED IN LONG BRANCH CREEK BY FDEP

STATION I.D.	STATISTIC	pH (s.u.)	TEMP. (^oC)	COND. (μmho/cm)	SALINITY (ppt)	NH_4 (μg/l)	NO_x (μg/l)	TKN (μg/l)	TN (μg/l)	SRP (μg/l)	TP (μg/l)	TSS (mg/l)	TURB. (NTU)	BOD_5 (mg/l)	CHL-a (mg/m^3)	TOTAL COLIFORM (cfu/100 ml)	FECAL COLIFORM (cfu/100 ml)	COLOR (Pt-Co)
275443208244235	Min.	7.00	12.32	414	0.5	23	4	1,400	1,359	27	110	7.0	1.4	2.2	21.0	120	10	60
	Max	7.48	27.72	1,160	5.6	440	210	4,300	3,720	280	550	116.0	30.0	3.0	160.0	5,700	1,600	140
	Median	7.23	26.40	722	2.2	190	40	2,500	1,991	130	330	12.0	5.2	2.6	62.0	920	210	110
	Count	12	12	12	12	11	8	9	8	12	8	9	11	2	5	11	11	11
275442308244165	Min.	6.83	14.60	402	1.0	21	4	1,600	1,674	21	140	13.0	7.0	--	57.0	680	240	100
	Max	7.94	31.47	580	8.1	96	74	3,700	3,720	88	300	22.0	12.0	--	76.0	6,000	3,500	120
	Median	7.37	26.79	519	4.0	46	16	2,200	2,208	26	205	16.0	8.7	--	70.0	1,750	700	100
	Count	9	9	9	9	6	4	6	4	8	6	9	9	0	3	9	9	9
275444908244026	Min.	7.07	14.04	501	0.7	55	31	1,200	1,231	34	170	--	1.3	2.2	21.0	180	130	50
	Max	7.65	27.97	689	7.6	280	270	2,900	3,170	130	400	--	3.3	2.2	21.0	1,460	1,200	60
	Median	7.33	25.74	594	3.1	280	260	2,050	1,560	120	285	--	1.8	2.2	21.0	820	665	60
	Count	4	4	4	4	3	3	2	3	3	2	0	3	1	1	2	2	3
275510508243111	Min.	7.04	17.04	740	4.2	--	--	--	--	--	--	--	--	--	--	2,000	1,080	--
	Max	7.23	28.09	6,864	5.7	--	--	--	--	--	--	--	--	--	--	2,000	1,080	--
	Median	7.18	21.12	927	4.9	--	--	--	--	--	--	--	--	--	--	2,000	1,080	--
	Count	3	3	3	3	0	0	0	0	0	0	0	0	0	0	1	1	0
275524908243037	Min.	7.01	17.31	687	1.3	46	18	650	830	65	100	29.0	1.3	2.5	42.0	620	460	50
	Max	7.56	32.24	20,918	6.8	230	430	1,500	1,520	230	350	29.0	5.4	2.5	42.0	2,500	770	60
	Median	7.19	21.11	1,900	3.1	79	130	800	1,109	100	180	29.0	2.0	2.5	42.0	835	585	50
	Count	9	9	9	9	8	10	9	10	9	8	1	9	1	1	6	6	10
275531808242577	Min.	7.02	17.45	750	0.6	55	11	750	845	64	93	--	1.5	2.1	--	730	460	50
	Max	7.76	30.74	33,600	9.3	210	420	1,300	1,550	230	360	--	5.3	2.1	--	4,100	2,700	60
	Median	7.32	22.98	3,527	3.8	100	120	1,200	1,260	135	240	--	2.1	2.1	--	1,225	900	50
	Count	11	11	11	11	9	8	7	9	8	7	0	10	1	0	6	7	9

Although the FDEP data in Long Branch Creek are extremely limited, the data which are available suggest substantially higher concentrations for ammonia, TKN, total nitrogen, total phosphorus, TSS, and particularly chlorophyll-a in the samples collected by FDEP compared with historical long-term monitoring conducted by Pinellas County. For example, median concentrations of ammonia at the Pinellas County monitoring sites range from approximately 10-100 µg/l, while median concentrations at the FDEP monitoring sites range from 46-280 µg/l. A similar pattern is also apparent for TKN which exhibits median concentrations less than 1000 µg/l at each of the Pinellas County monitoring sites, while four of the five FDEP monitoring sites with available TKN data exhibit median concentrations substantially in excess of 1000 µg/l. Similar patterns are also apparent for concentrations of total nitrogen and total phosphorus. Median TSS concentrations by Pinellas County are generally less than 5 mg/l, while each of the three FDEP sites with available TSS data exhibit median concentrations in excess of 10 mg/l. The largest differences between the FDEP data and Pinellas County data occurs for chlorophyll-a. Median chlorophyll-a concentrations at the FDEP sites ranged from 21-70 mg/m^3, with median chlorophyll-a concentrations at the Pinellas County monitoring sites ranging from 1.6-5.9 mg/m^3.

A further analysis was conducted to evaluate relative water quality data for the Pinellas County and FDEP sites which are in relatively close proximity. These sites are located in downstream portions of Long Branch Creek near the intersection with Whitney Road. Unfortunately, the data at these sites only overlap for the period from February-September 2006, so the number of data points are relatively limited, with three monitoring events for Pinellas County Site 22-01 and eight monitoring events for FDEP site 275524908243037. A comparison of median values at these monitoring sites conducted by Pinellas County and FDEP is given in Table 2-8.

TABLE 2-8

COMPARISON OF MEDIAN VALUES FOR MONITORING CONDUCTED IN LONG BRANCH CREEK BY PINELLAS COUNTY AND FDEP FROM FEBRUARY-SEPTEMBER 2006

PARAMETER	UNITS	MEDIAN VALUE FROM 2/06-9/06	
		Pinellas County Site 22-01	FDEP Site 275524908243037
pH	s.u.	7.56	7.19
Conductivity	µmho/cm	1216	1063
Ammonia	µg/l	70	98
NO_x	µg/l	300	110
TKN	µg/l	820	900
Total Nitrogen	µg/l	1100	1118
SRP	µg/l	90	120
Total Phosphorus	µg/l	100	180
TSS	mg/l	1.0	29.0
Turbidity	NTU	1.4	2.0
BOD_5	mg/l	2.0	2.5
Chlorophyll-a	mg/m^3	1.0	42.0
Fecal Coliform	cfu/100 ml	860	585
Number of Samples	--	3	8

As indicated on Table 2-8, data collected by Pinellas County and FDEP appear to be relatively similar for conductivity, ammonia, TKN, total nitrogen, SRP, turbidity, BOD, and fecal coliform. However, relatively large differences in concentrations were observed between the two agencies for total phosphorus, TSS, and chlorophyll-a. For example, the median TSS concentration measured at this site by Pinellas County from February-September 2006 is 1 mg/l compared with a median value of 29.0 mg/l in the FDEP data set. An even larger difference is apparent for chlorophyll-a, with a median value of 1.0 mg/m^3 by Pinellas County and 42.0 mg/m^3 by FDEP.

2.8 Discharge Data

In addition to the water quality data summarized previously, a substantial amount of relatively recent discharge data are also available within the Long Branch Creek watershed. The USGS maintains a continuously recording flow monitoring station near the center of the Long Branch Creek watershed at the location indicated on Figure 2-8. Data for this site are available from October 2003-present. In addition, spot measurements of discharge rates have been conducted by Pinellas County since 2003 at each of the seven County monitoring stations during routine monitoring events. Details of the identified stream discharge data monitoring stations in Long Branch Creek are summarized on Table 2-9.

TABLE 2-9

DETAILS OF HYDROLOGIC MONITORING STATIONS IN LONG BRANCH CREEK

STATION I.D. NUMBER	AGENCY	MONITORING FREQUENCY	RANGE OF DATA	TYPE OF DATA
02307780	USGS	Continuous	10/1/03-Present	Continuous discharge
22-01	Pinellas County	Quarterly	1/22/03-Present	Spot measurements
22-05	Pinellas County	Monthly	1/22/03-Present	Spot measurements
22-07	Pinellas County	Bi-Monthly	1/22/03-Present	Spot measurements
22-08	Pinellas County	Bi-Monthly	1/22/03-Present	Spot measurements
22-12	Pinellas County	Bi-Monthly	10/28/08-Present	Spot measurements
22-14	Pinellas County	Bi-Monthly	10/28/08-Present	Spot measurements
22-15	Pinellas County	Quarterly	10/28/08-Present	Spot measurements

A graphical summary of spot discharge measurements in Long Branch Creek based upon the Pinellas County monitoring data is given on Figure 2-15. Two separate plots of the data area provided, with one plot indicating the full range of discharge measurements recorded in Long Branch Creek, and a second plot which provides an expanded view of discharge rates using a scale of 0-10 cfs.

In general, discharge measurements conducted during the Pinellas County field monitoring program were typically approximately 10 cfs or less during a majority of the monitoring dates. Isolated peak discharge rates in excess of 10 cfs, with several measurements approaching 20-25 cfs, were observed at monitoring Sites 22-01 (which reflects the most downstream monitoring site in the Long Branch Creek system), Site 22-05 (located north of Roosevelt Blvd.), and at Site 22-07. Consistently low discharge rates ranging from 0-1 cfs were recorded at Site 22-08 (which reflects a tributary inflow to the main channel downstream from Roosevelt Blvd.), and Sites 22-14 and 22-15 (reflecting the northern and southern headwaters segment, respectively). Recorded discharge measurements at the remaining sites appear to reflect a general pattern of increasing discharge with increasing distance along the main channel.

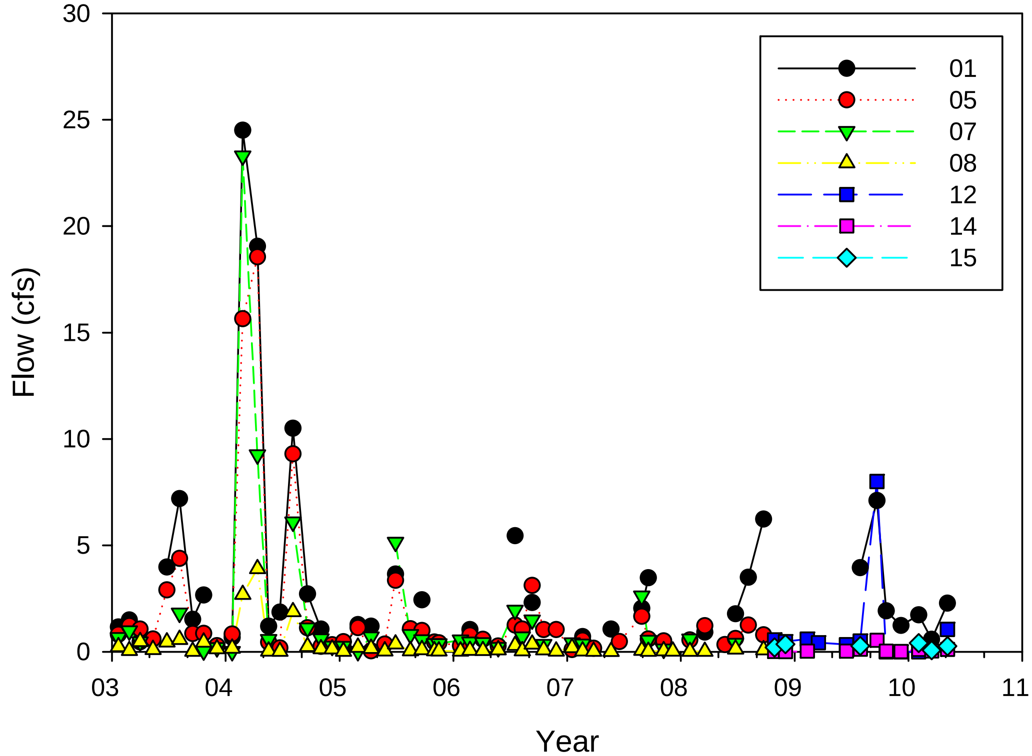
A tabular summary of mean annual discharge rates measured at the USGS monitoring site from October 2003-December 2010 is given on Table 2-10. Mean daily discharge rates are summarized for the period from 2004-2010. Mean values are not provided for 2003 and 2011 since the available data for these years represent only a portion of a full calendar year. Mean discharge rates measured at the USGS monitoring site have ranged from a low of 2.09 cfs during 2007 to a high of 4.17 cfs during 2004.

TABLE 2-10

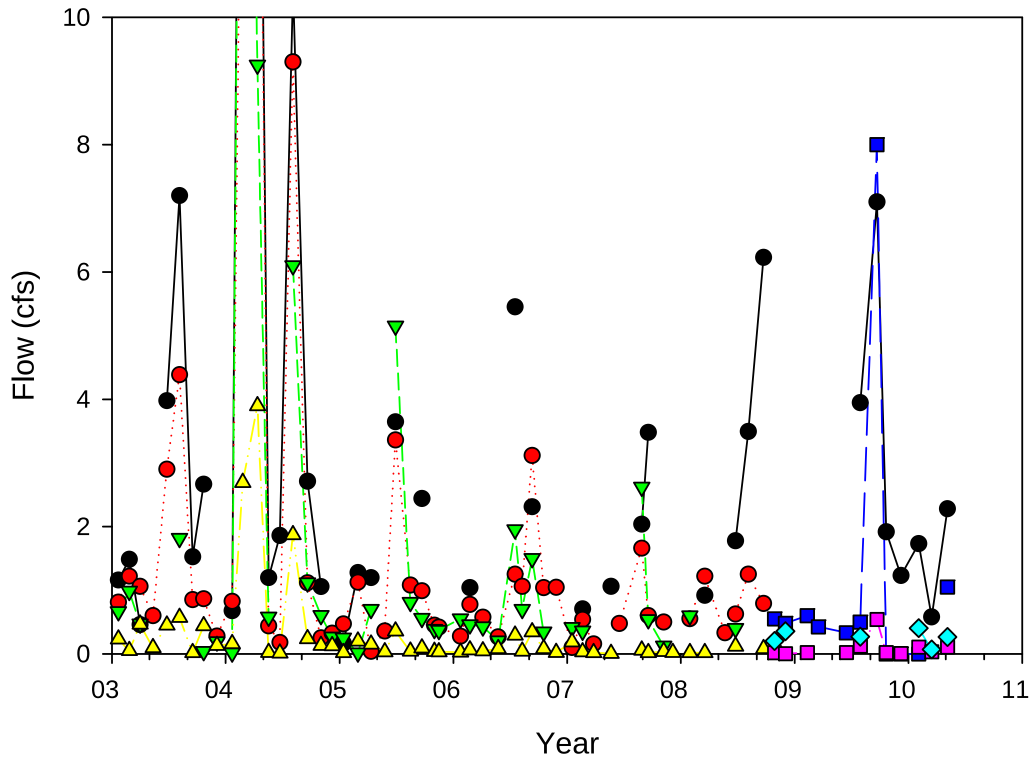
SUMMARY OF MEAN DISCHARGE RATES MEASURED AT USGS SITE 02307780 FROM OCTOBER 2003-DECEMBER 2010

YEAR	MEAN DAILY DISCHARGE (cfs)	ESTIMATED RUNOFF (cfs)	ESTIMATED BASEFLOW (cfs)
2004	4.17	2.35	1.82
2005	3.20	1.45	1.75
2006	2.99	1.58	1.40
2007	2.09	0.97	1.12
2008	2.15	0.78	1.37
2009	2.30	1.02	1.28
2010	3.35	1.67	1.68
MEAN VALUES:	**2.89**	**1.40**	**1.49**

A hydrograph separation program developed by Purdue University, referred to as WHAT (Web-Based Hydrograph Analysis Tool), was used to estimate the portion of the annual discharges which are attributed to direct runoff vs. inter-event baseflow conditions. The program reads in USGS data and separates the discharge into runoff and baseflow based upon a series of factors which have been developed for various geographical regions within the United States. The results of this analysis are provided in Table 2-10. The WHAT program estimates that the overall mean average discharge of approximately 2.89 cfs measured from 2004-2010, approximately 1.4 cfs (48%) is contributed by direct runoff during storm events, with 1.49 cfs (52%) contributed by baseflow which reflects drawdown of stormwater storage areas and groundwater seepage into the channel between storm events.



a. Full-Scale Plot



b. Expanded 0-10 cfs Plot

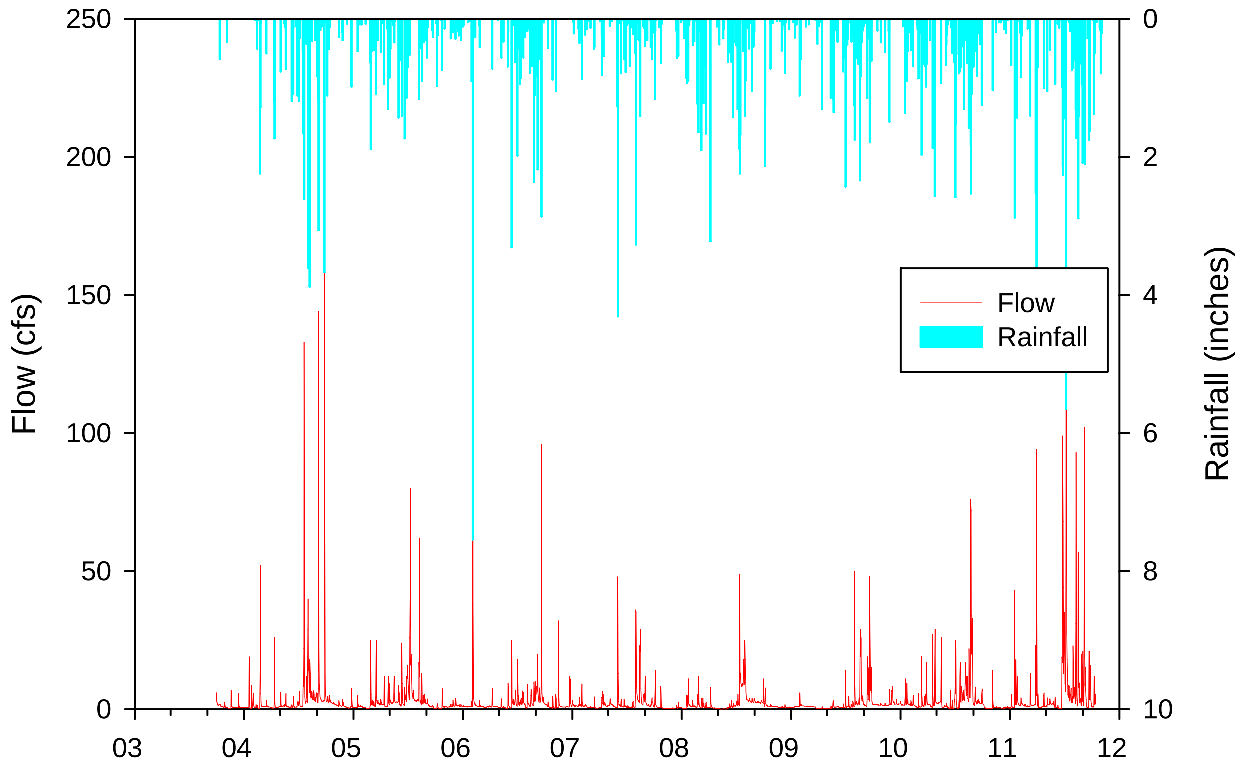
Figure 2-15. Recorded Discharge Measurements at Pinellas County Monitoring Sites.

A graphical summary of discharge measurements recorded at the USGS gauging station near the center of the Long Branch Creek water, approximately 160 ft upstream from Site 22-12, is given on Figure 2-16. Data are available at this site from October 2003-present. In general, the majority of measured discharge rates at this site have been less than approximately 5 cfs, with higher peaks observed during significant storm events. Rainfall events recorded at the SWFWMD meteorological site (22897) in Largo are also included for comparison purposes. In general, increases in discharge rates in Long Branch Creek are closely linked to rain events in the watershed.

2.9 Mass Loadings

Estimates of historical mass loadings of nitrogen, phosphorus, and fecal coliform bacteria discharging through Long Branch Creek were calculated based upon the historical surface water quality monitoring program conducted by Pinellas County. Sufficient monitoring data were available at four separate monitoring sites within Long Branch Creek to provide a minimum of 5-7 years of data for analysis. Mass loadings were calculated by multiplying the measured concentrations of total nitrogen, total phosphorus, and fecal coliform bacteria times the measured discharge rate during each field monitoring event. Mass loadings were calculated for Pinellas County monitoring Sites 22-01 (located in downstream portions of Long Branch Creek), Site 22-05 (located approximately mid-way in Long Branch Creek south of Roosevelt Blvd.), Site 22-07 (located approximately mid-way between US 19 and Roosevelt Blvd.), and Site 22-08 (tributary inflow near Site 22-07). It appears that monitoring was discontinued at Pinellas County Site 22-05 in September 2008 but was reinstated during October 2008 at a new site, designated as 22-12, in the same general area. Therefore, the data sets for 22-05 and 22-12 were combined to provide a complete data set over the period of analysis. Calculations for estimation of mass loadings are given in Appendix A.3.

A graphical summary of calculated historical mass loadings of total nitrogen in Long Branch Creek, based upon the Pinellas County monitoring data, is given in Figure 2-17. A full-scale plot of the mass loading data is provided in Figure 2-17a to illustrate the overall trend in the data over time. An expanded plot of low level loadings is given in Figure 2-17b to assist in evaluating loadings during typical flow conditions. In general, the highest annual loadings appear to occur at Site 22-01 which is the most downstream monitoring site in Long Branch Creek. Measured loadings at Site 22-05/22-12, located in middle portions of Long Branch Creek, appear to be somewhat lower in value. Nitrogen loadings at Site 22-07, located mid-way between US 19 and Roosevelt Blvd., appear to be slightly lower in value than observed at Site 22-05. Relatively low loadings appear to originate from the tributary inflow monitored at Site 22-08. In general, total nitrogen loadings appear to increase with increasing distance downstream during a majority of the monitoring events.



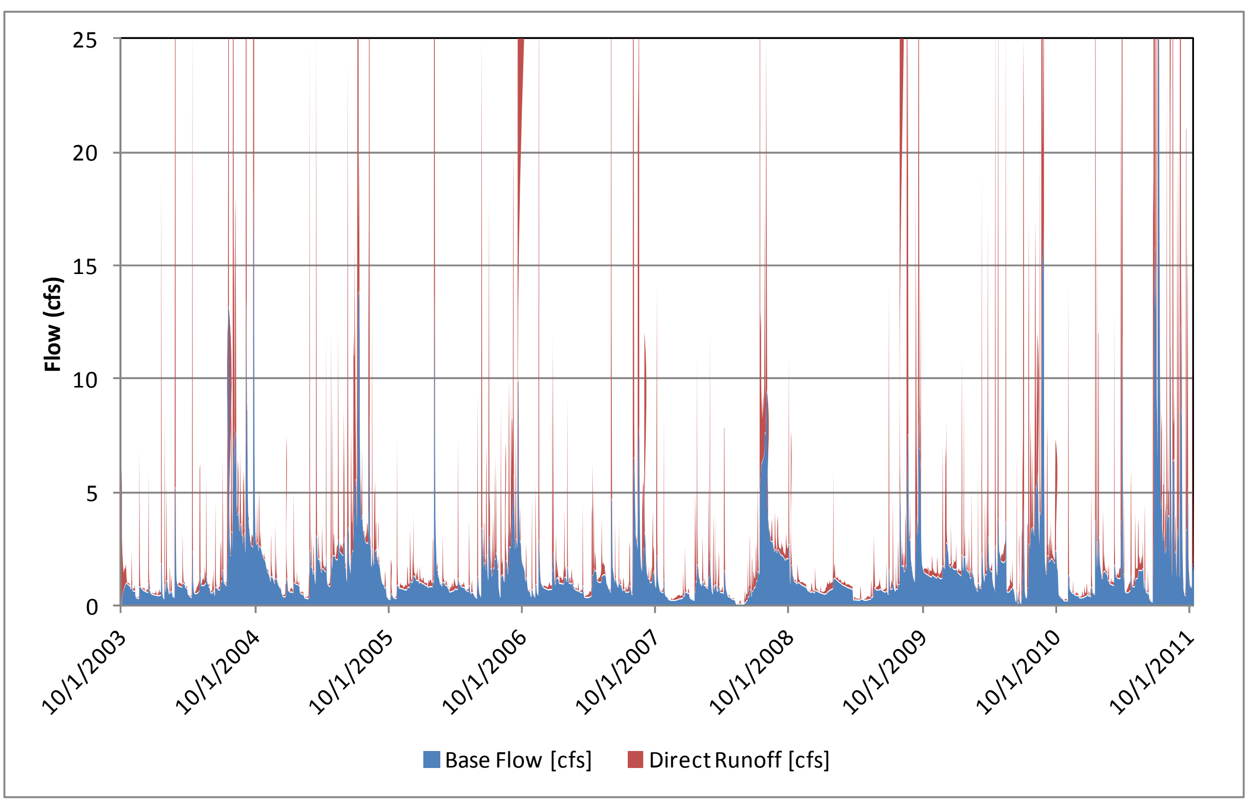
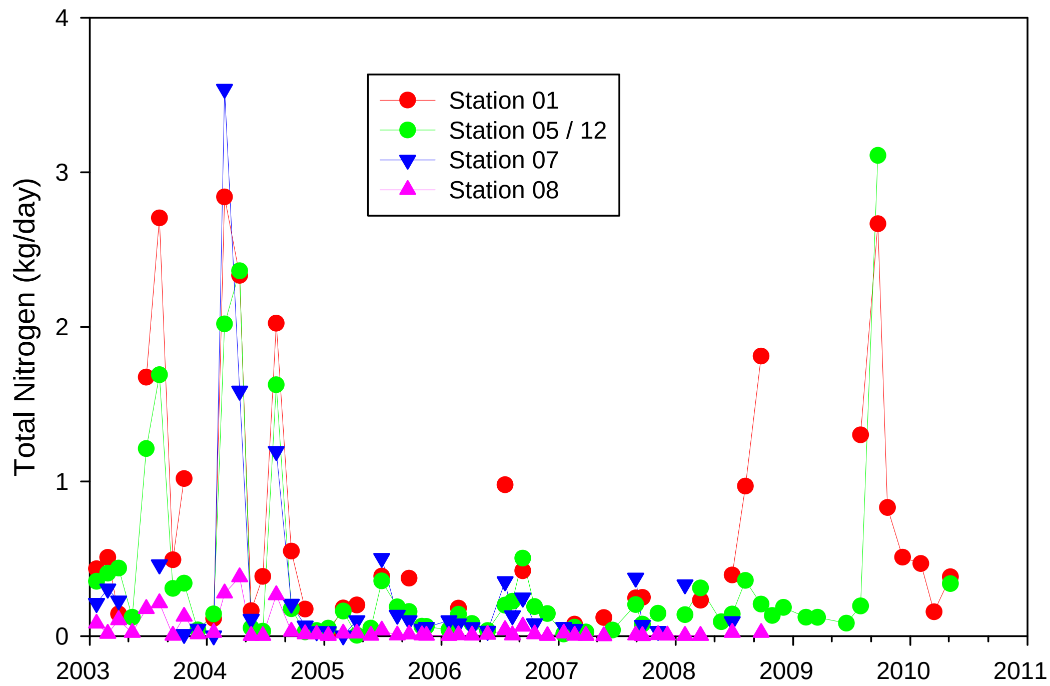
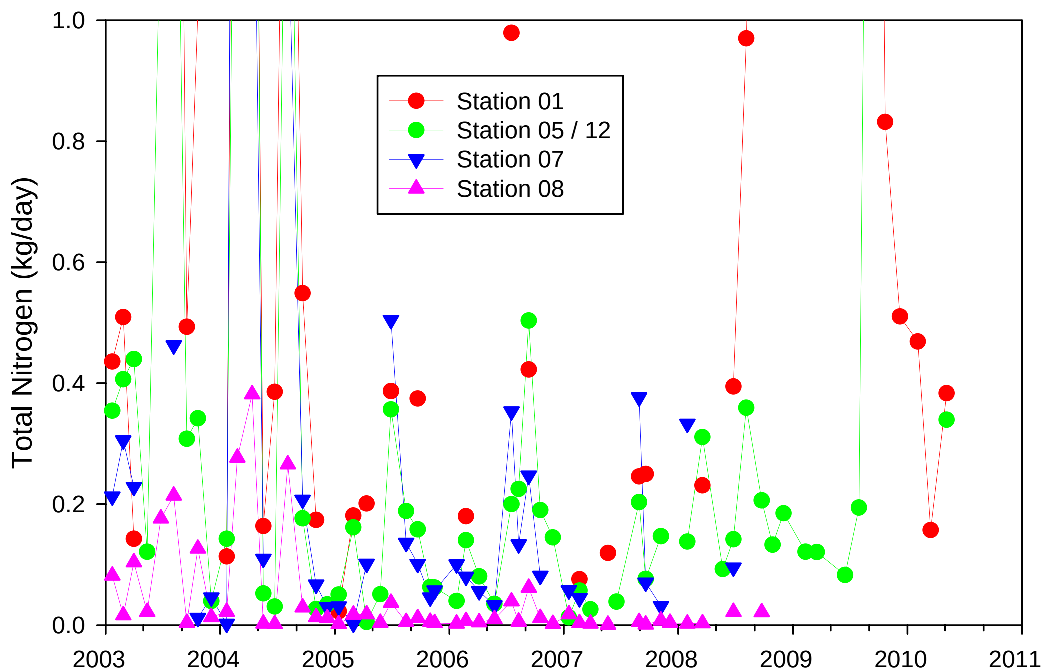


Figure 2-16. Recorded Discharge Measurements at USGS Site 02307780 from 2003-2010.



a. Full-scale plot



b. Expanded plot

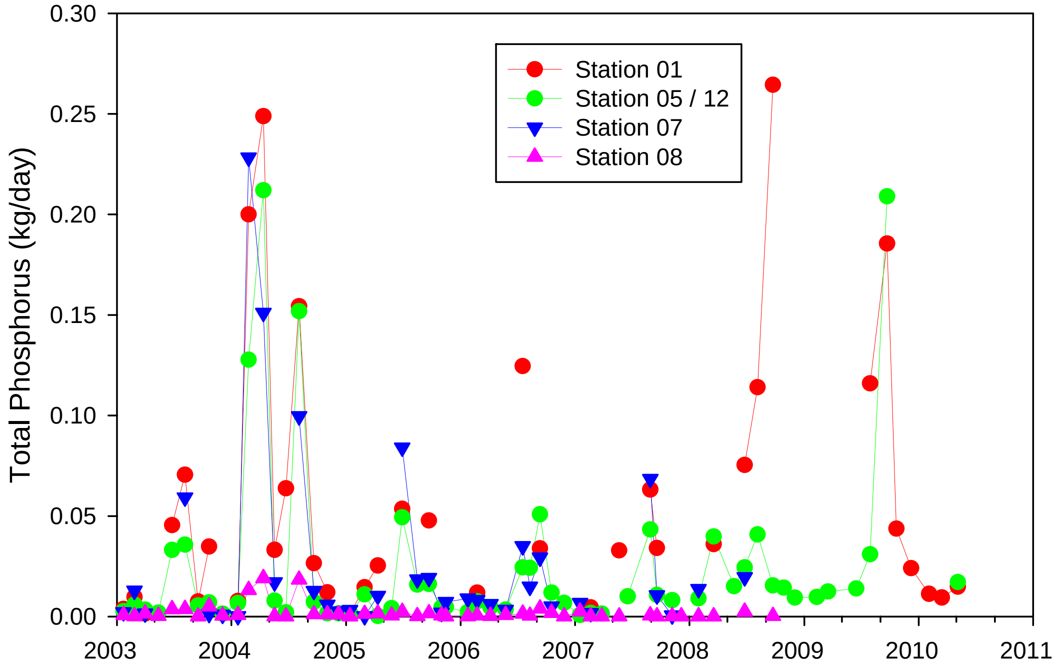
Figure 2-17. Calculated Historical Mass Loadings of Total Nitrogen in Long Branch Creek Based on the Pinellas County Monitoring Data.

A graphical summary of total phosphorus loadings discharging through Long Branch Creek from 2003-2010 is given in Figure 2-18 based upon the Pinellas County monitoring data. In general, total phosphorus loadings appear to be relatively low in value under typical conditions, with spikes in loadings associated with extreme rain events within the basin. The highest phosphorus loadings appear to be associated with Station 22-01 which is the most downstream monitoring site in Long Branch Creek. Phosphorus loadings monitored at Sites 22-05 and 22-12 appear to be substantially lower in value than observed at the downstream monitoring sites. In general, phosphorus loadings at Site 22-07, which is upstream from Site 22-05/12, appear to be lower in value than observed at Site 22-05/12 during most events, although loadings at this site exceed loadings at Site 22-05/12 during periods of extended rainfall or frequent multiple rain events. In general, inflows from the tributary monitored at Site 22-08 appear to be minimal. In general, phosphorus loadings appear to increase with increasing distance downstream although more elevated loadings have been observed at Site 22-07 during some storm event conditions.

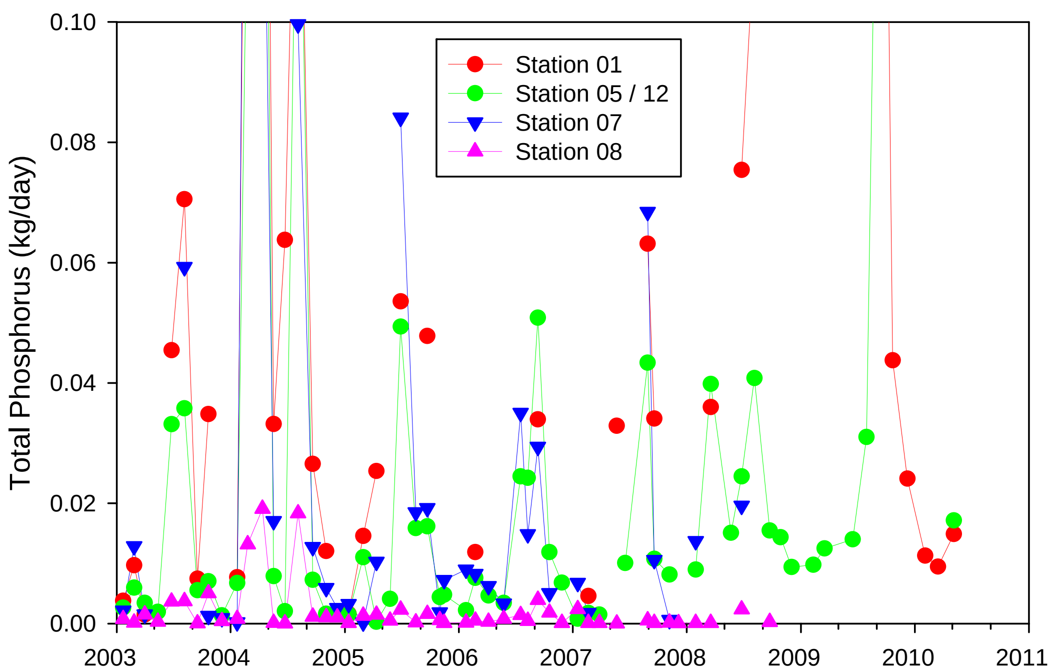
A graphical comparison of fecal coliform loadings in Long Branch Creek from 2005-2010 is given in Figure 2-19 based upon the Pinellas County historical monitoring data. In general, the highest fecal coliform loadings appear to occur at the downstream monitoring Site 22-01, although elevated values also occur at Site 22-05/12 which is located in mid-portions of the drainage basin. Fecal coliform loadings at Site 22-07 are generally low in value, with peaks in loadings occurring during significant storm events. Fecal coliform inputs from the tributary monitored at Site 22-08 are generally negligible.

A tabular summary of estimated annual mass loadings of total nitrogen, total phosphorus, and fecal coliform bacteria at the four Pinellas County monitoring sites is given in Table 2-11. Mass loadings were calculated by multiplying the mean daily loadings for a given year (summarized on Figures 2-17, 2-18, and 2-19) and multiplying the mean daily loading by 365 days/year. The monitoring sites are listed in approximate order along Long Branch Creek, with Site 22-08 reflecting a tributary inflow, Site 22-07 located adjacent to the tributary inflow, Site 22-05/12 located immediately south of Roosevelt Blvd., and Site 22-01 located at the downstream portion of Long Branch Creek. In general, nitrogen loadings appear to increase with increasing distance downstream during a majority of the monitoring events. However, decreases in nitrogen loadings between Site 22-07 and Site 22-05/12 were noted during three of the available years of data. This trend was also observed by ERD in the field monitoring program discussed in Section 4. Overall, approximately 252 kg/yr of total nitrogen discharged from Long Branch Creek into Old Tampa Bay.

Mass loadings of total phosphorus follow a pattern similar to that exhibited by total nitrogen. Inflows of phosphorus into the system from the tributary inflow reflected by Site 22-08 are relatively minimal compared with loadings discharging through the main channel. Phosphorus loadings appear to increase with increasing distance downstream during a majority of the monitoring events. However, decreases in phosphorus loadings appear to occur between Sites 22-07 and 22-05/12 during many of the evaluated years, similar to the trend exhibited by total nitrogen. It appears that significant uptake of nutrients occurs within the channel between these sites. Overall, Long Branch Creek contributes approximately 21.2 kg/yr of total phosphorus to Old Tampa Bay.

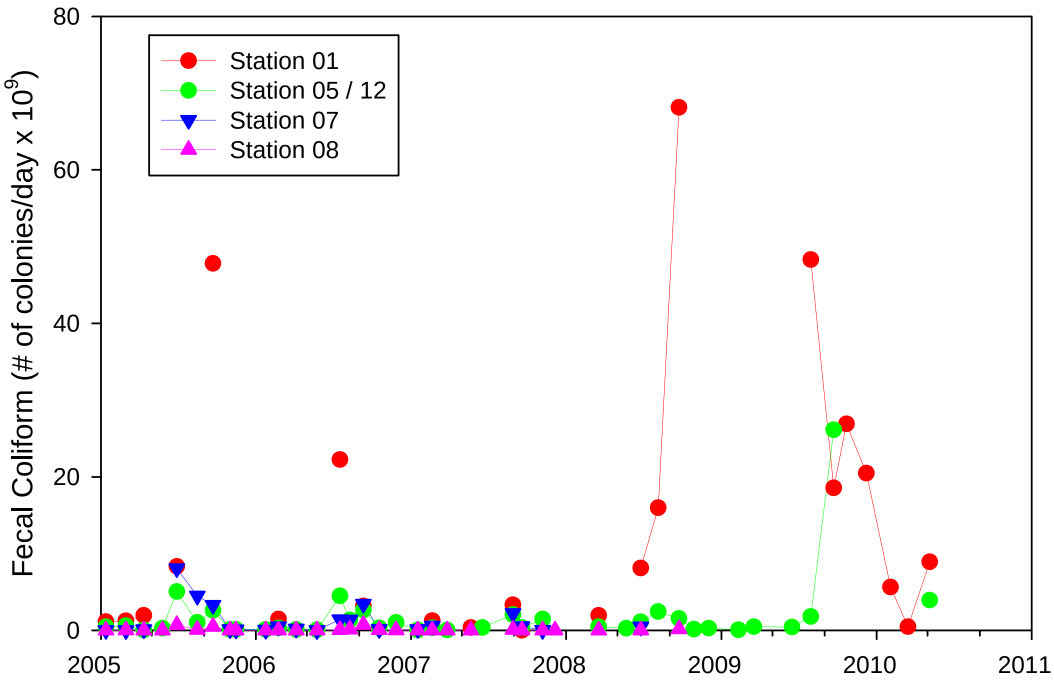


a. Full-scale plot

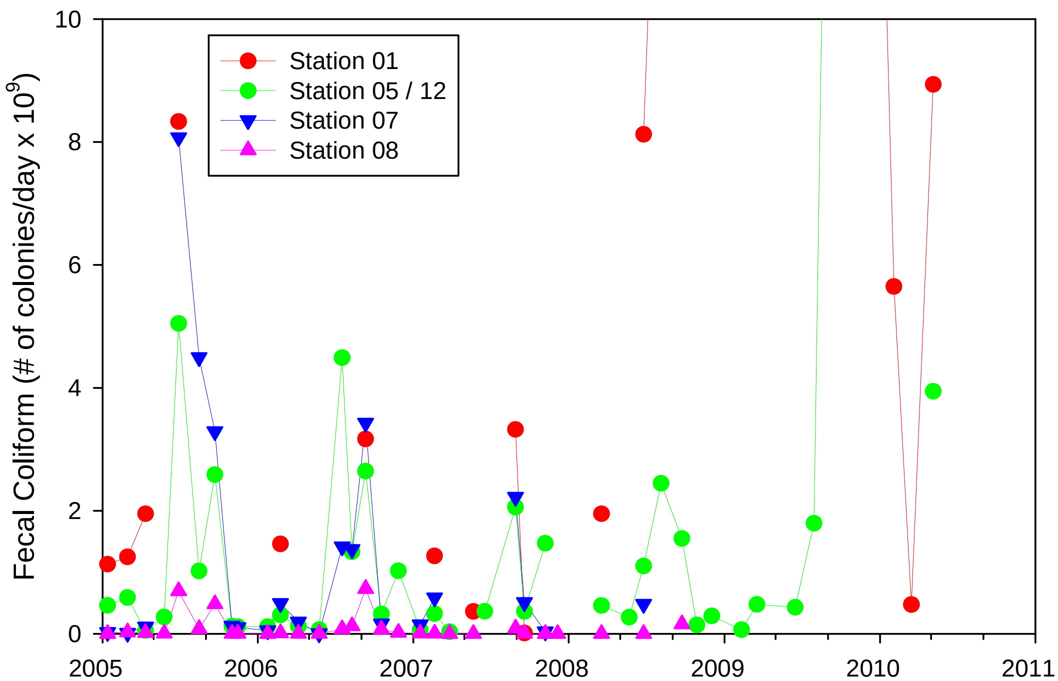


b. Expanded plot

Figure 2-18. Calculated Historical Mass Loadings of Total Phosphorus in Long Branch Creek Based on the Pinellas County Monitoring Data.



a. Full-scale plot



b. Expanded plot

Figure 2-19. Calculated Historical Mass Loadings of Fecal Coliform Bacteria in Long Branch Creek Based on the Pinellas County Monitoring Data.

TABLE 2-11

ESTIMATED ANNUAL MASS LOADINGS OF TOTAL NITROGEN, TOTAL PHOSPHORUS, AND FECAL COLIFORM BACTERIA IN LONG BRANCH CREEK BASED ON THE PINELLAS COUNTY HISTORICAL MONITORING DATA

YEAR	MASS TOTAL NITROGEN LOAD (kg/year)				MASS TOTAL PHOSPHORUS LOAD (kg/year)				MASS FECAL COLIFORM LOAD (# of colonies/year x 10^9)			
	Site 22-08	Site 22-07	Site 22-05 / 12	Site 22-01	Site 22-08	Site 22-07	Site 22-05 / 12	Site 22-01	Site 22-08	Site 22-07	Site 22-05 / 12	Site 22-01
2003	30.7	77.1	199.3	363.8	0.6	4.8	3.9	9.0	--	--	--	--
2004	40.8	308.2	263.1	392.7	2.2	23.7	21.1	34.2	--	--	--	--
2005	4.2	44.8	44.5	85.2	0.3	6.6	4.4	10.4	53.2	741	416	4,414
2006	5.9	49.6	63.3	192.4	0.4	5.1	5.5	20.7	42.1	325	422	3,270
2007	1.9	42.4	29.3	63.1	0.2	6.4	4.0	12.3	4.8	256	243	452
2008	4.5	78.4	71.7	311.6	0.3	6.1	7.7	44.8	19.1	176	327	8,618
2009	--	--	264.9	484.5	--	--	20.2	33.7	--	--	2,109	10,424
2010	--	--	123.9	122.8	--	--	6.3	4.3	--	--	1,439	1,832
Mean	**14.7**	**100.1**	**132.5**	**252.0**	**0.7**	**8.8**	**9.1**	**21.2**	**29.8**	**374**	**826**	**4,835**

Mass loadings of fecal coliform bacteria follow patterns similar to that exhibited by total nitrogen and total phosphorus. Relatively minimal fecal coliform loadings appear to originate from the tributary inflow at Site 22-08. In general, fecal coliform loadings appear to increase with increasing distance downstream, although decreases in fecal coliform loadings occur between Sites 22-07 and 22-05/12 during several of the evaluated annual periods.

2.10 Wastewater Disposal

Information on wastewater disposal in the Long Branch Creek watershed was provided to ERD by Pinellas County. Sanitary sewer collection lines within the Long Branch Creek watershed are currently provided by the City of Largo. Virtually all areas within the Long Branch Creek watershed currently utilize centralized sewer systems for wastewater disposal. However, a small number of operational septic tank systems still exist within the Long Branch Creek watershed. Locations of the remaining septic tank systems within the Long Branch Creek watershed are indicated on Figure 2-20.

2.11 Reclaimed Water

Information on areas within the Long Branch Creek watershed which receive reclaimed water for irrigation was provided to ERD by Pinellas County. Several reuse distribution lines operated by the City of Largo run through the Long Branch Creek watershed, but it appears that none of the reuse is actually applied within the basin. Locations of City of Largo reuse irrigation distribution lines in the vicinity of the Long Branch Creek watershed are given on Figure 2-21.

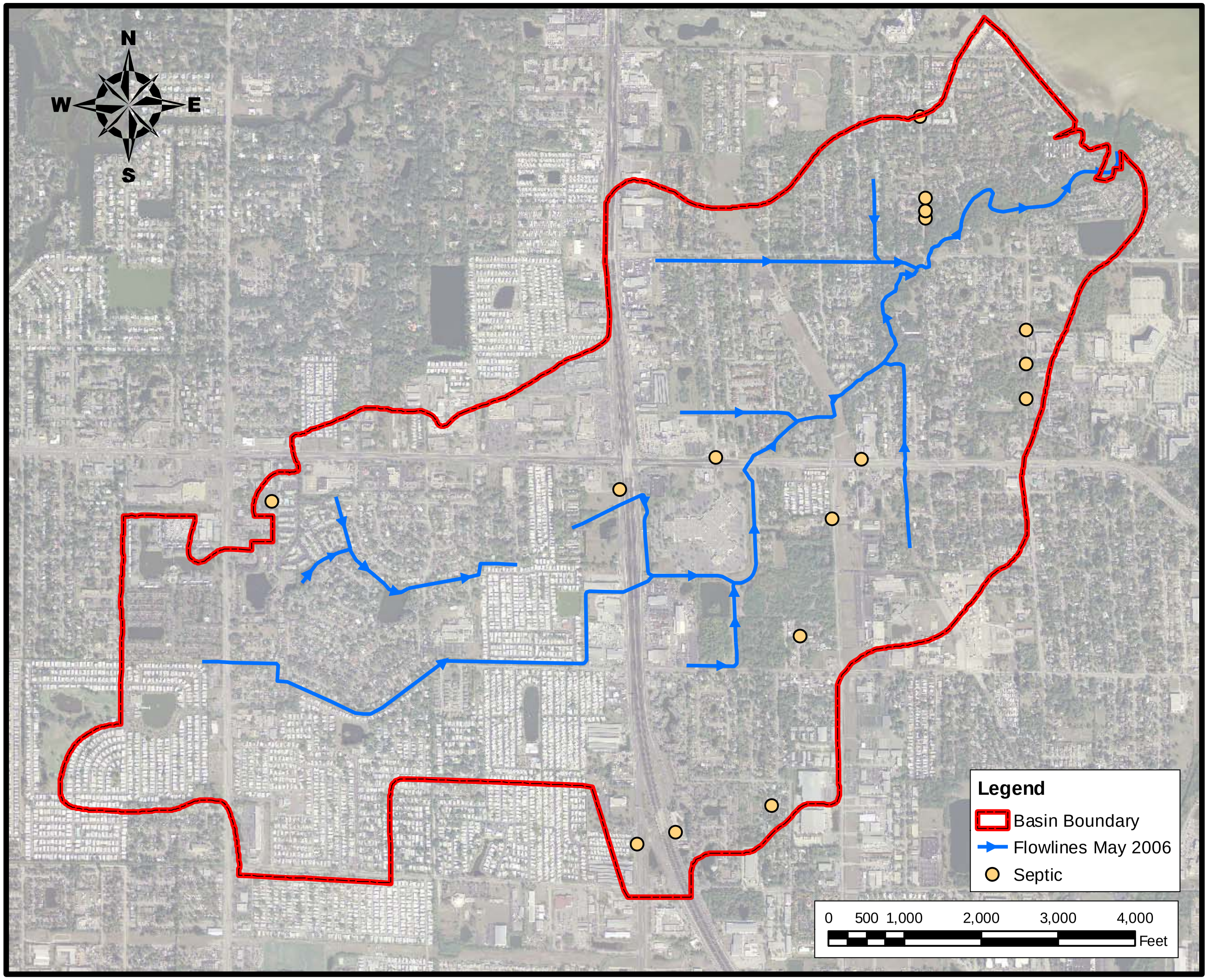


Figure 2-20. Locations of Existing Septic Tanks in the Long Branch Creek Watershed.
(Source: Pinellas County GIS)

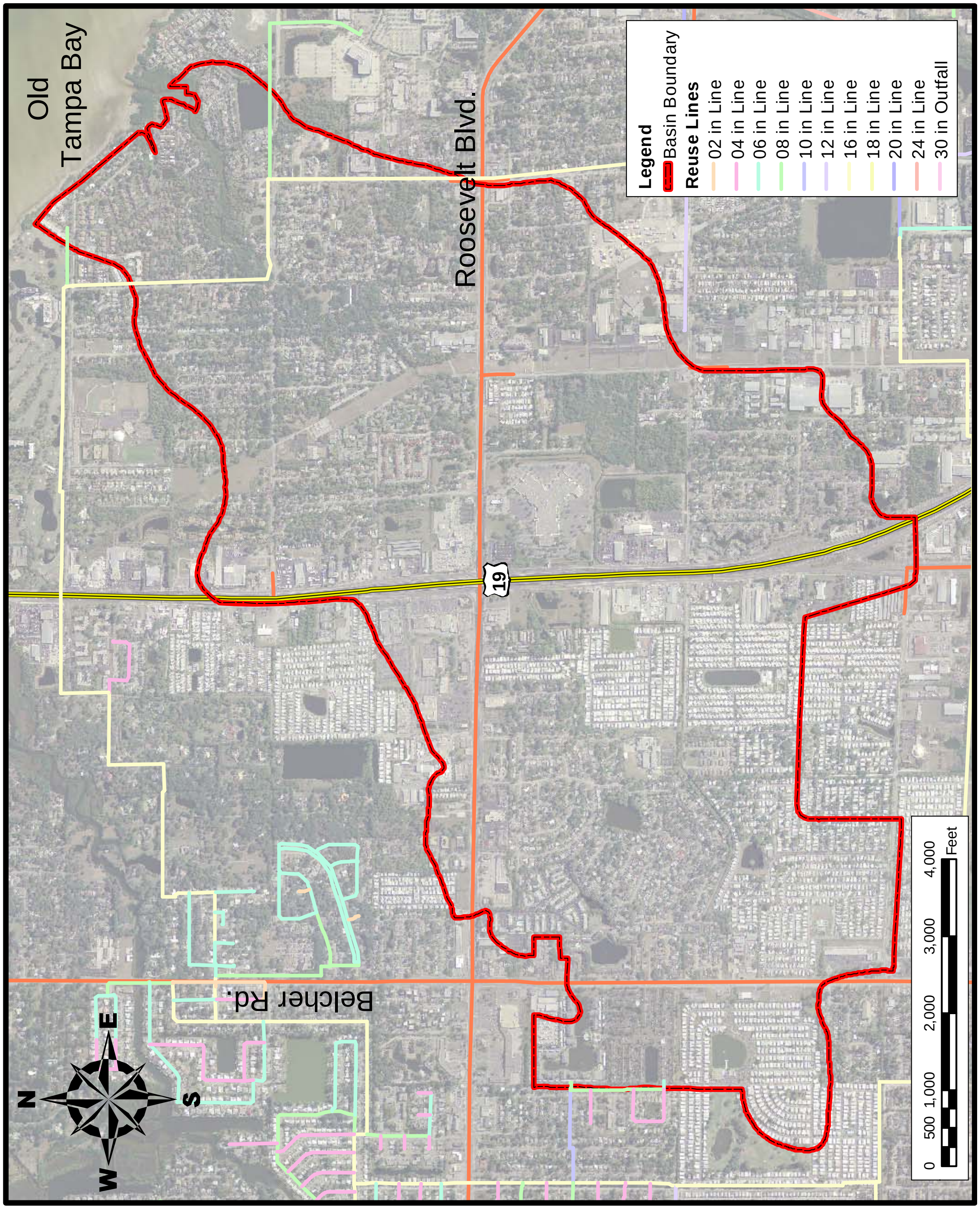


Figure 2-21. City of Largo Reuse Irrigation Distribution Lines in the Vicinity of the Long Branch Creek Watershed.

SECTION 3

FIELD AND LABORATORY ACTIVITIES

Field and laboratory analyses were conducted by ERD from October 2010-January 2011 within Long Branch Creek to characterize the quantity and quality of discharges through the watershed area. Eighteen surface water sites were monitored on approximately a biweekly basis, which included measurements of field parameters, discharge rate, and sample collection for laboratory analyses. Five separate monitoring events were conducted at each site. Each of the collected samples was analyzed in the ERD Laboratory for general parameters and nutrients. In addition, aliquots of each collected sample were shipped to the Colorado Plateau Stable Isotope Laboratory for isotope analyses of nitrogen and oxygen to assist in identifying potential pollutant sources.

3.1 Field Activities

A project kick-off meeting was conducted with representatives of ERD and Pinellas County on August 26, 2010 to discuss project details and review preliminary monitoring site locations. A description of field activities and laboratory analyses performed as part of this project is given in the following sections.

3.1.1 Monitoring Sites

An overview of surface water monitoring sites selected within the Long Branch Creek basin area is given on Figure 3-1. Selected monitoring sites were initially recommended by ERD and later verified during a site visit with Pinellas County personnel. The selected surface water monitoring sites include all significant inflows into Long Branch Creek. A total of 17 separate monitoring sites were initially selected within the Long Branch Creek basin to quantify nutrient loadings discharging through the system. Twelve of the proposed monitoring sites are located along the main stream of Long Branch Creek, including the northern and southern headwaters segments, to quantify changes in flow rates, nutrient concentrations, and mass loadings along the main path of the channel. Five of the initial sites reflect inputs into the main channel to assist in identifying potential sources of elevated nutrient loadings. An additional tributary site (Site 18) was later added by ERD during the third monitoring event when inflow was observed entering the main channel. A tabular summary of proposed monitoring sites for the Long Branch Creek basin study is given on Table 3-1. The selected monitoring sites are intended to provide an analysis of water quality characteristics, including changes in nutrient loadings, during migration through the study area.

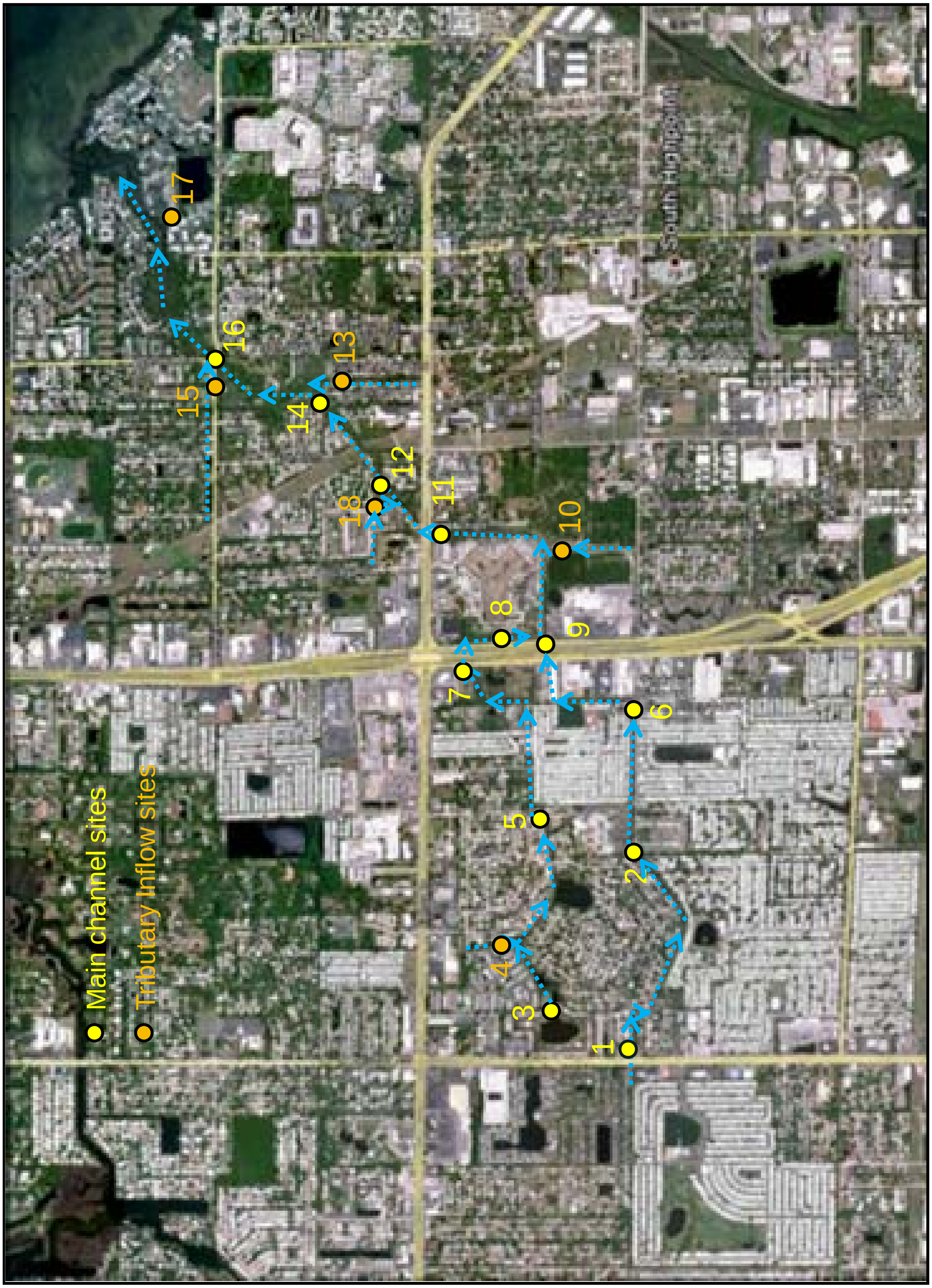


Figure 3-1. Locations of Surface Water Monitoring Sites in the Long Branch Creek Watershed.

TABLE 3-1

SUMMARY OF PROPOSED MONITORING SITES FOR THE LONG BRANCH CREEK BASIN STUDY AREA

SITE NO.	DESCRIPTION	PURPOSE
1	Inflow to South Main Channel from areas west of South Belcher Road	Primary inflow in upstream portion of south headwaters segment
2	South Main Channel at wooden bridge crossing	South headwaters segment site
3	Discharge from lake into North Main Channel	Primary inflow to north headwaters segment
4	Open ditch inflow to North Main Channel	Tributary inflow to north headwaters segment
5	North Main Channel at Hopedale Lane	North headwaters segment site
6	South Main Channel at 3rd Street	South headwaters segment site
7	North Main Channel at 65th Street North	North headwaters segment site
8	North Main Channel prior to confluence with South Main Channel	Final north headwaters segment site
9	South Main Channel prior to confluence with North Main Channel	South headwaters segment site prior to entering main channel
10	Tributary inflow to main channel	Tributary inflow to main channel
11	Main channel south of East Bay Drive	Main channel site
12	Main Channel at Briarwood Drive	Main channel site
13	Tributary inflow to main channel	Tributary inflow to main channel
14	Main channel upstream from Site 13 tributary inflow	Main channel site
15	Open ditch inflow along south side of Whitney Road	Tributary inflow to main channel
16	Main channel at Whitney Road	Main channel site
17	Discharge from pond into main channel	Pond discharge to main channel
18	Tributary inflow to main channel	Tributary inflow just upstream from Site 12

Locations of monitoring Sites 1-6 are indicated on Figure 3-2. In areas west of U.S. 19, Long Branch Creek consists of two separate channels which are referred to in this study as the south headwaters segment and north headwaters segment. These channels converge on the east side of U.S. 19 forming a single main channel for the remainder of Long Branch Creek. Monitoring sites designated as 1 and 2 are located in the south headwaters segment and are intended to evaluate discharge rates, nutrient concentrations, and mass loadings in the heavily urbanized headwater portions of the creek. Site 1 is intended to monitor inflow from areas west of Belcher Road, with Sites 2 and 6 located in downstream portions of the south headwaters segment.

A detailed location map for Site 1 is given on Figure 3-3. The monitoring site is located in extreme upstream portions of the southern headwaters segment on the east side of Belcher Road and provides information on inflow into the Long Branch Creek system from areas west of Belcher Road. Photographs of monitoring Site 1 are given on Figure 3-4. Monitoring at this site was conducted at the discharge from the two oval RCPs which discharge beneath Belcher Road. The stream in this area consists of a shallow earthen channel with dense aquatic vegetation.

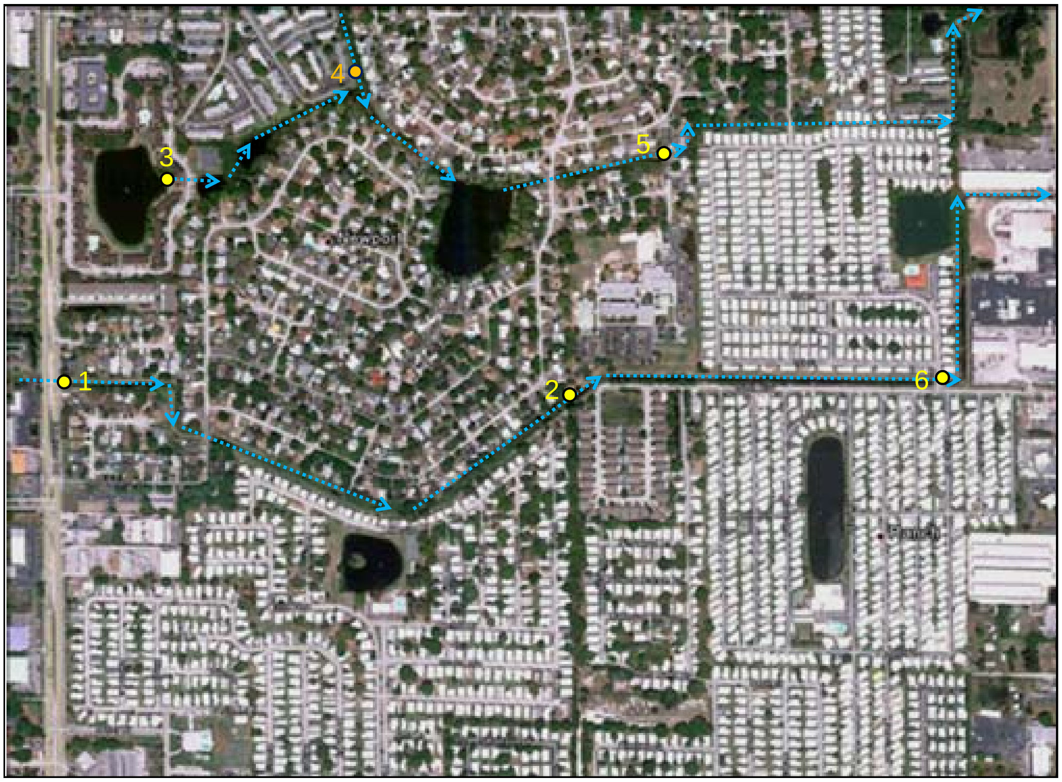


Figure 3-2. Locations of Monitoring Sites 1-6 in the Long Branch Creek Watershed.

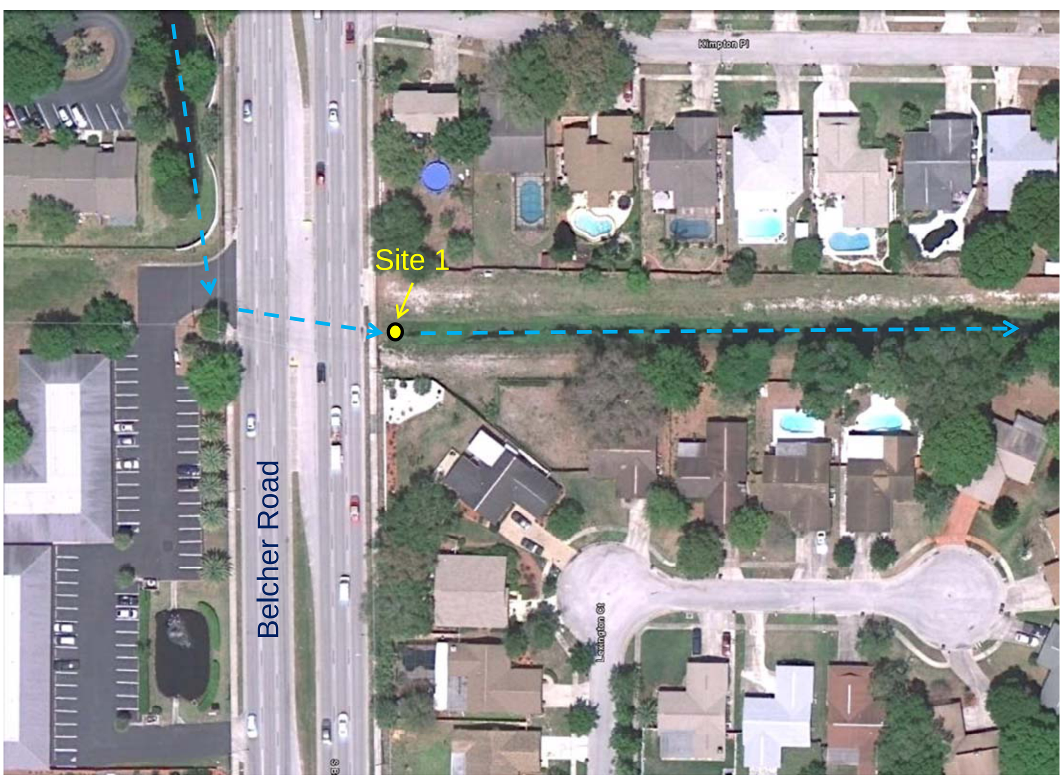


Figure 3-3. Detailed Location Map for Site 1.

a. Inflows from west side of Belcher Road


b. Channel flowing east toward Site 2

Figure 3-4. Photographs of Monitoring Site 1.

A detailed location map for monitoring Site 2 is given on Figure 3-5. Monitoring Site 2 is also located in the southern headwaters segment downstream from monitoring Site 1. Photographs of monitoring Site 2 are given on Figure 3-6. The channel at this location consists of a moderately deep canal with steep side slopes and dense vegetation. Field monitoring at this site was conducted at a location with minimal aquatic vegetation to minimize interference with discharge measurements and field monitoring. Site 2 is intended to reflect any changes in water quality characteristics which occur between Belcher Road and Site 2.

A detailed location map for Sites 3 and 4 is given on Figure 3-7. Each of these sites is located in the northern headwater segment to provide information on significant inputs to the northern headwaters. Site 3 reflects the discharge from Swan Lake which forms the headwaters of the northern channel segment. Photographs of Site 3 are given on Figure 3-8. Field monitoring at this site was conducted at the outfall structure for Swan Lake which forms the headwaters of the northern channel segment. The pond site was frequented by a wide variety of waterfowl which were present during each field monitoring event.

Monitoring Site 4 is located in a tributary stream which discharges into the northern channel segment downstream from Swan Lake. This channel introduces runoff generated from commercial and residential areas south of Roosevelt Blvd. The channel at this site has relatively steep banks and a relatively narrow width. A photograph of monitoring Site 4 is given on Figure 3-9.

A detailed location map for Site 5 is given on Figure 3-10. Site 5 is located in downstream portions of the northern channel, after inflows from Swan Lake, the tributary inflow reflected at Site 4, and inflow from a second lake located between Sites 4 and 5. Photographs of monitoring Site 5 are given on Figure 3-11. The monitoring site was located at the downstream side of the culvert crossing for Hopedale Lane. The channel at this location is relatively shallow and heavily choked with weeds, with generally a sluggish water movement.

Figure 3-5. Detailed Location Map for Site 2.

a. Channel downstream from foot bridge

b. Densely vegetated earthen channel

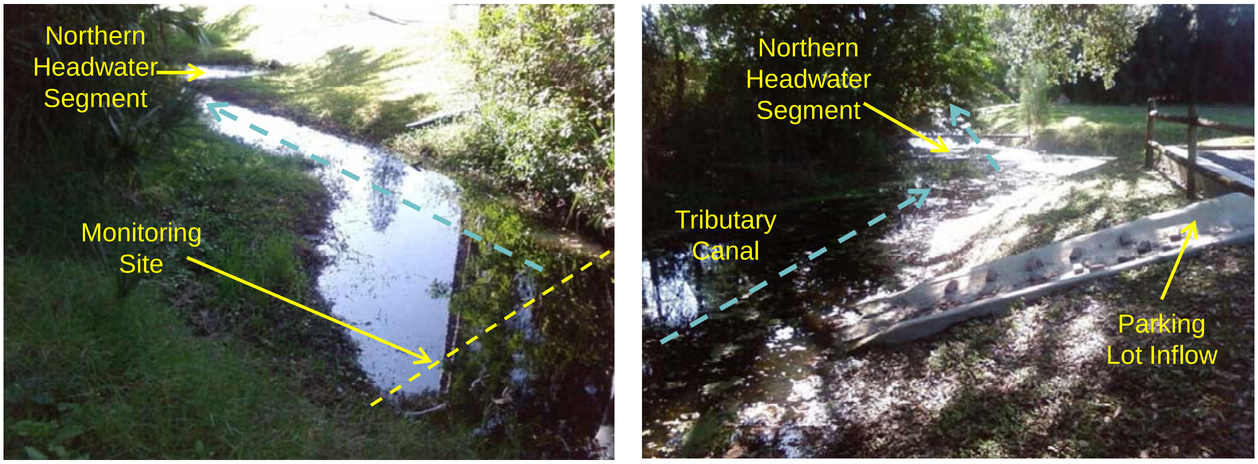
Figure 3-6. Photographs of Monitoring Site 2.

Figure 3-7. Detailed Location Map for Sites 3 and 4.

a. Monitoring site at lake outfall

b. Lake is home to many species of waterfowl

Figure 3-8. Photographs of Monitoring Site 3.



a. Tributary canal at monitoring site

b. Confluence of tributary canal and north headwater segment

Figure 3-9. Photographs of Monitoring Site 4.

Figure 3-10. Detailed Location Map for Site 5.

a. Monitoring site at culvert crossing

b. Channel is choked with weeds and debris

Figure 3-11. Photographs of Monitoring Site 5.

A detailed location map for Site 6 is given on Figure 3-12. Site 6 is located in the southern headwater segment, downstream from Site 2. Photographs of monitoring Site 6 are given on Figure 3-13. Site 6 is located on the downstream side of the double box culverts which transfer the southern channel beneath 3rd Street. The channel in this area is much wider and deeper than observed at the upstream monitoring sites. However, large portions of the channel are still choked with weeds and debris, similar to conditions observed in upstream areas.

Detailed location maps for Sites 7, 8, 9, and 10 are given on Figure 3-14. Sites 7, 8, and 9 are designed to monitor water quality characteristics of the final discharges from the northern (Sites 7 and 8) and southern (Site 9) segments which form the headwaters of the main channel. Photographs of Site 7 are given on Figure 3-15. This site reflects the final discharge from the northern channel segment west of US 19. The channel in this area is relatively narrow and shallow, with a dense tree canopy. The monitoring site was located inside a fenced FDOT parcel immediately upstream of the point of conveyance into the box culvert which discharges the channel beneath US 19. A photograph of blue water conditions observed at Site 7 on October 19, 2010 is also given on Figure 3-15. Investigation by Pinellas County indicated that this color was due to illegal use of an aquatic dye in an upstream tributary.

A photograph of monitoring Site 8 is given on Figure 3-16. This channel is located on the east side of US 19 and receives inflow from the northern headwaters segment west of US 19 along with a wetland depressional area located north of Site 8 which receives inflow from commercial areas adjacent to Roosevelt Blvd. The canal reflected by Site 8, which is the final monitoring site on the northern segment, discharges in a southerly direction and combines with the inflow from the southern headwaters segment at Site 9 to form the combined main channel. The channel at Site 8 is densely vegetated, with a narrow water width under most conditions.

Photographs of monitoring Site 9 are given on Figure 3-17. Site 9 reflects the final discharge from the southern headwater channel into the main channel at the point of conveyance beneath US 19. The channel at this site is relatively wide and choked with dense emergent vegetation.

Figure 3-12. Detailed Location Map for Site 6.

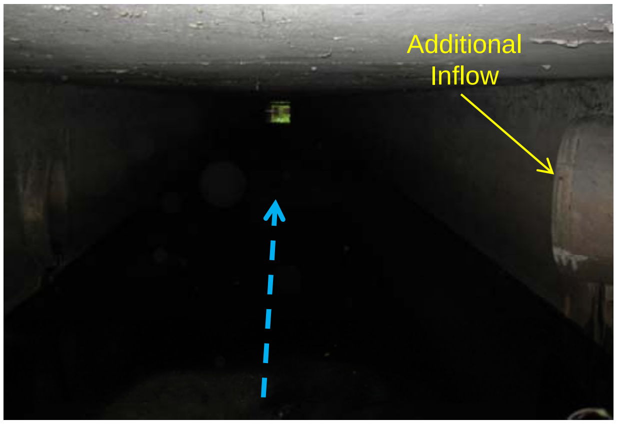
a. Box culverts beneath 3rd Street

b. Wide channel choked with weeds and debris

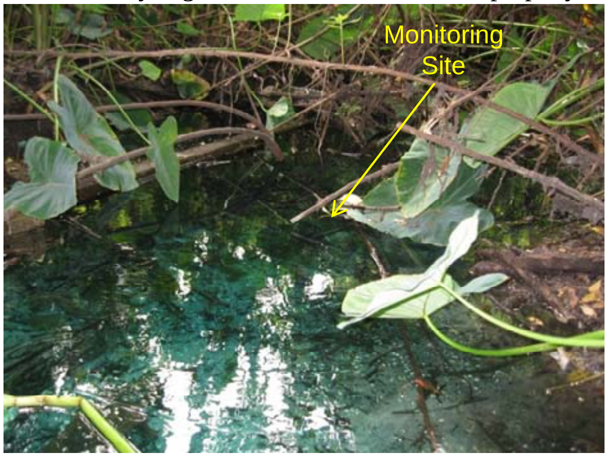
Figure 3-13. Photographs of Monitoring Site 6.

Figure 3-14. Detailed Location Map for Sites 7, 8, 9, and 10.

a. Densely vegetated channel inside FDOT property



b. Box culvert which conveys channel beneath US 19



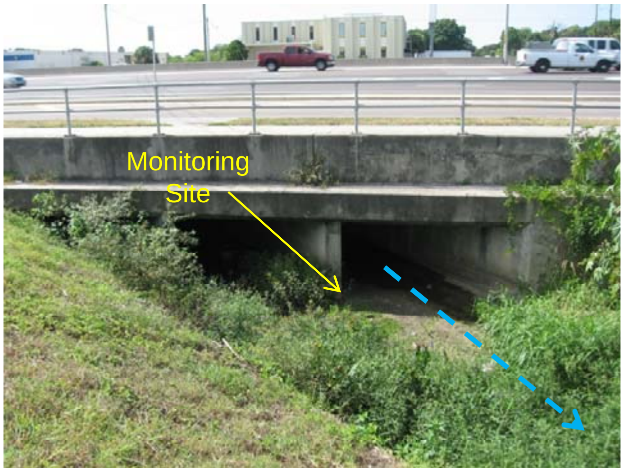
c. Blue water observed discharging through channel on 10/19/2010

Figure 3-15.

Photographs of Monitoring Site 7.

a. Densely vegetated channel

Figure 3-16. Photograph of Monitoring Site 8.



a. Inflow to main channel from west of US 19

b. Inflow channel upstream from convergence with main channel

Figure 3-17. Photographs of Monitoring Site 9.

Photographs of monitoring Site 10 are given on Figure 3-18. Site 10 reflects a tributary inflow into the main channel which flows from south to north and includes drainage from both developed and undeveloped areas in central southern portions of the watershed. The monitoring site was located at a 10-ft wide concrete weir structure located just upstream from the point of confluence of the tributary and the main channel. The tributary inflow channel monitored at Site 10 is relatively narrow, with a water depth of approximately 1-2 ft. Photographs of the tributary and point of confluence with the main channel are given on Figure 3-18.

a. Weir structure in tributary channel b. Convergence of tributary channel with main channel

Figure 3-18. Photographs of Monitoring Site 10.

Detailed location maps for Sites 11, 12, and 18 are given on Figure 3-19. Site 11 is located in the main channel on the south side of Roosevelt Blvd., with Site 12 located in the man channel on the north side of Roosevelt Blvd. Site 18 is located in a tributary inflow immediately upstream of Site 12. Photographs of monitoring Site 11 are given on Figure 3-20. This monitoring site is located upstream of the double box culvert which conveys the main channel beneath Roosevelt Blvd. The channel at this location is wide and shallow, with emergent vegetation along the sides of the channel. Also shown on Figure 3-20 is USGS gauging station 2307780, located just upstream from the field monitoring site.

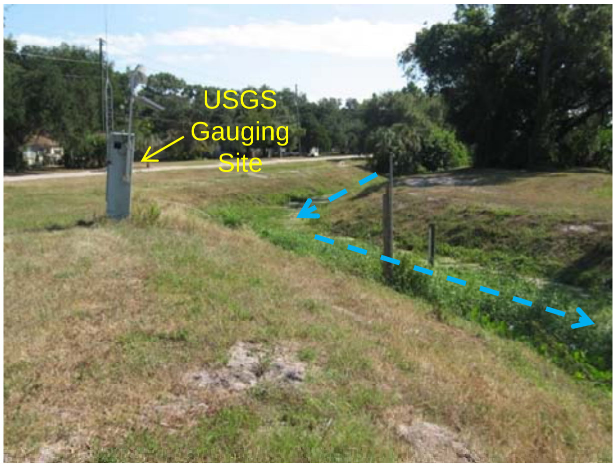
Photographs of monitoring Site 12 are given on Figure 3-21. This monitoring site is located along the main channel at the crossing with Briarwood Drive. The channel is conveyed beneath Briarwood Drive through seven 24-inch RCPs, with two additional smaller inflows also visible on Figure 3-21a. Downstream of the road crossing, the channel converges back into a smaller channel similar to channel widths in other portions in the main channel.

An overview of monitoring Site 18 is given on Figure 3-22. This site is located in a small side tributary which enters the main channel just upstream from Site 12. This tributary extends north and west of the main channel and is generally shallow and well defined with extensive aquatic vegetation.

A detailed location map for Sites 13 and 14 is given on Figure 3-23. Site 14 is located within the main channel downstream from Site 12, while Site 13 reflects a tributary inflow which joins the main channel downstream from Site 14. Photographs of monitoring Site 13 are given on Figure 3-24. The tributary inflow is characterized by steep side slopes with a relatively narrow bottom width. The bottom of the channel is strewn with a variety of rocks and other debris. Water velocity in the tributary was generally relatively swift, although the water depth was typically less than 1 ft. A photograph of Site 14 is given on Figure 3-25. The main channel in this area becomes relatively narrow, with dense vegetation cover. This site is located adjacent to a facility which includes a number of horse stables.

Figure 3-19. Detailed Location Map for Sites 11, 12, and 18.

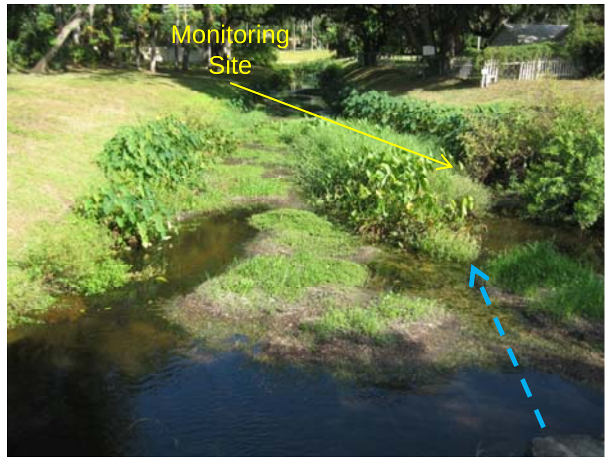
a. Box culverts beneath Roosevelt Blvd.



b. Channel upstream from Roosevelt Blvd.

Figure 3-20. Photographs of Monitoring Site 11.

a. Culverts beneath Briarwood Drive



b. Channel downstream from culverts

Figure 3-21. Photographs of Monitoring Site 12.

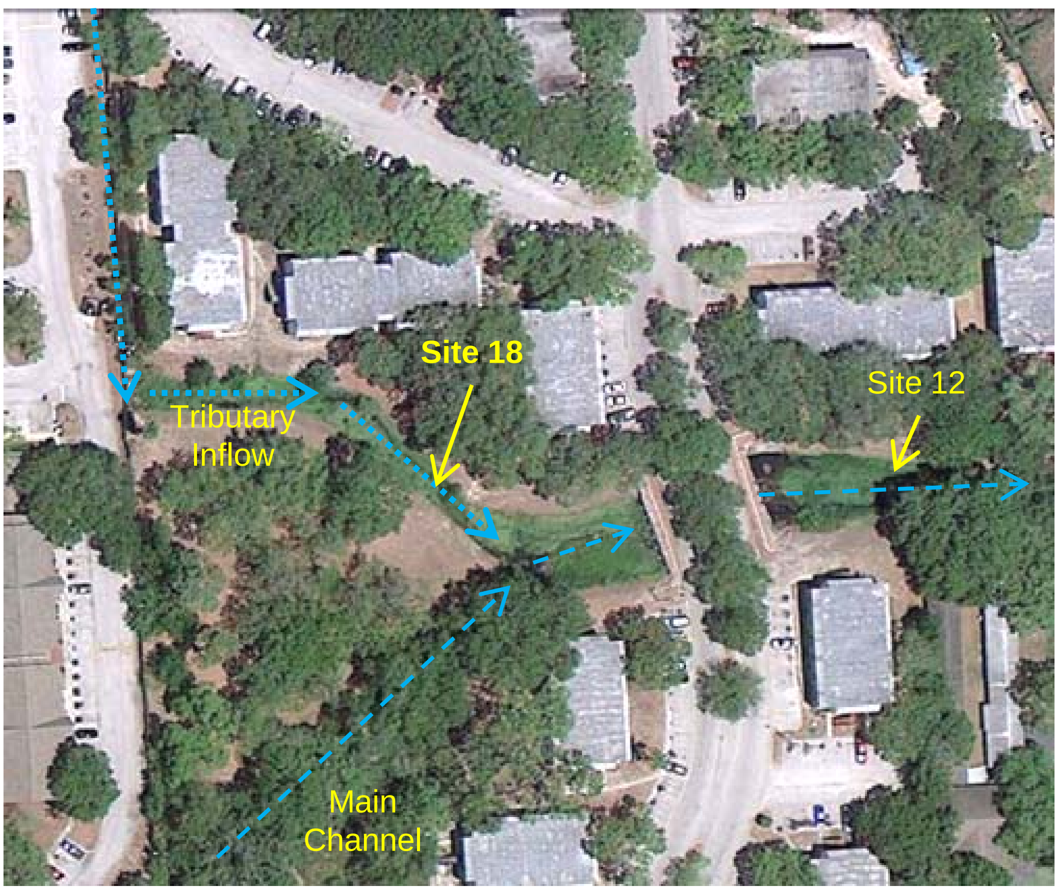


Figure 3-22. Overview of Monitoring Site 18.

Figure 3-23. Detailed Location Map for Sites 13 and 14.

a. Tributary channel upstream from main channel

b. Sample collection in channel

Figure 3-24. Photographs of Monitoring Site 13.

a. Main channel adjacent to horse stables

Figure 3-25.

Photograph of Monitoring Site 14.

Detailed location maps for Sites 15, 16, and 17 are given on Figure 3-26. Site 16 is located along the main channel and is the most downstream monitoring site included in this study. Sites 15 and 17 reflect inflows to the main channel. Photographs of monitoring Site 15 are given on Figure 3-27 This site receives inflow from a roadside ditch along Whitney Road which ultimately discharges into the main channel. The roadside channel is characterized by relatively steep sides with a narrow bottom width. Photographs of monitoring Site 16 are given on Figure 3-28. This monitoring site is located in the main channel at the box culvert crossing with Whitney Road. Monitoring was conducted on the upstream side of the box culvert. The inflow from the Whitney Road ditch is also visible on Figure 3-28b.

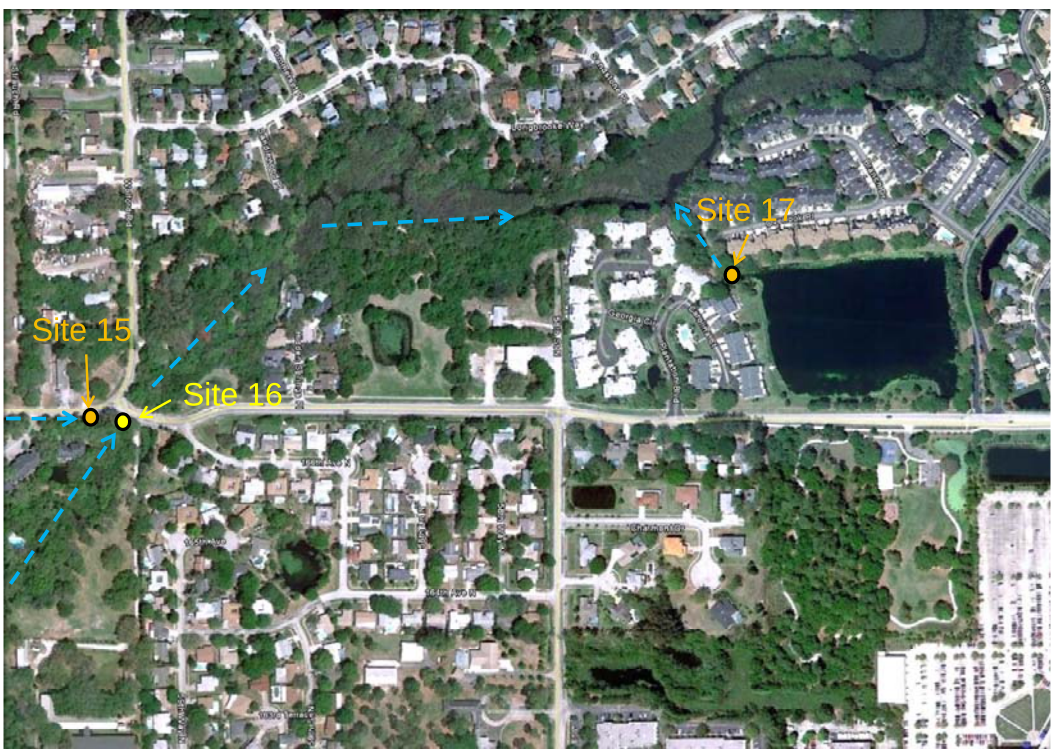


Figure 3-26. Detailed Location Map for Sites 15, 16, and 17.

a. Open ditch along Whitney Road

b. Tributary channel upstream from main channel

Figure 3-27. Photographs of Monitoring Site 15.

a. Main channel at Whitney Road

b. Box culvert beneath Whitney Road

Figure 3-28. Photographs of Monitoring Site 16.

Photographs of monitoring Site 17 are given on Figure 3-29. This site reflects discharges into the main channel from a large lake which appears to be either a borrow pit or stormwater management facility. Discharges into the creek are regulated by a lake outfall water control structure located just upstream of the point of inflow into the creek. However, no direct discharges were observed through the weir control structure during the field monitoring program. Water samples were collected on the upstream side of the water control structure during each field monitoring event to document the characteristics of discharges should they occur.

a. Outflow channel for stormwater treatment lake north of Whitney Road

b. Lake outfall water control structure

Figure 3-29. Photographs of Monitoring Site 17.

3.2 Field Monitoring

ERD field personnel conducted biweekly monitoring at each of the monitoring sites discussed in Section 3.1 for a period of approximately four months from October 2010-January 2011, with a total of five events attempted at each of the surface water monitoring sites. Surface water monitoring was not conducted if dry or stagnant water conditions were present. A total of five monitoring events was conducted at Sites 1-5, 7-14, and 16-17. A total of four monitoring events was conducted at Sites 6 and 15. Three monitoring events were conducted at Site 18 which is a supplemental site added by ERD during the third monitoring event when flow was observed entering the main channel. Typical field activities for surface water monitoring are discussed in the following sections.

3.2.1 Surface Water Monitoring

ERD field personnel visited each of the monitoring sites on approximately a biweekly basis and performed field measurements of discharge at each site, if applicable. The measurements reflect discharge conditions at the time of the monitoring event. Flow monitoring was conducted using the USGS velocity/cross-sectional area method with a Sontek acoustic Doppler flow meter. The spacing between individual velocity measurements was determined in the field such that not more than 10% of the total flow is represented by any one vertical cross-section. The depth at each cross-section was simultaneously measured using a graduated rod. A graduated tape was stretched across each channel so that reference locations can be determined for each simultaneous measurement of velocity and water depth.

If the water depth was less than 2.5 ft at a measurement point, the velocity was measured at 60% of the total water depth. If the water column depth exceeded 2.5 ft at a monitoring site, velocity measurements were performed at 20% and 80% of the total water depth, with the mean section velocity determined by taking the average of the two measurements. The velocity was then integrated over each of the cross-sectional areas to determine the total discharge through the section on each monitoring date.

During each monitoring visit, ERD field personnel performed field measurements of pH, temperature, dissolved oxygen, specific conductivity, turbidity, and ORP at approximately mid-depth in the water column at each monitoring site. A summary of analytical methods and detection limits for field measurements conducted during this project is given in Table 3-2.

Water samples were also collected at each site during each monitoring event. All samples were collected as a grab sample at mid-depth in the water column at each site. All field monitoring was conducted in accordance with DEP-SOP-001/01- Department of Environmental Protection Standard Operating Procedures for Field Activities.

All collected water samples were returned to the ERD Laboratory and analyzed for the following nutrients and selected general parameters:

- Alkalinity
- Ammonia
- NO_x
- Diss. Organic Nitrogen
- Particulate Nitrogen
- Total Nitrogen
- SRP
- Diss. Organic Phosphorus
- Particulate Phosphorus
- Total Phosphorus
- Turbidity
- Total Suspended Solids
- Color
- Fecal Coliform
- UV Absorbance

TABLE 3-2

ANALYTICAL METHODS AND DETECTION LIMITS FOR FIELD MEASUREMENTS ON SURFACE WATER

MEASUREMENT PARAMETER	METHOD	METHOD DETECTION LIMITS (MDLs)
pH	DEP-SOP-001/01, Sec. FT1100	NA
Temperature	DEP-SOP-001/01, Sec. FT1400	NA
Conductivity	DEP-SOP-001/01, Sec. FT1200	0.3 μmho/cm
Diss. Oxygen	DEP-SOP-001/01, Sec. FT1500	0.3 mg/l
Water Velocity and Discharge	DEP-SOP-001/01, Sec. FT1800	0.01 ft/sec

This monitoring program generated a total of 90 samples (18 sites x 5 events). Additional samples were also collected and analyzed, as appropriate, to meet applicable QA criteria.

In addition to the parameters listed above, aliquots of the collected samples were shipped to the Colorado Plateau Stable Isotope Laboratory at Northern Arizona University for ^{15}N and ^{18}O isotope analysis. A total of 90 samples were provided to the Stable Isotope Lab for analysis. Details of the stable isotope methodology are given in Section 3.3.

3.2.2 Sampling Equipment

All field sampling procedures and documentation followed procedures outlined in the document titled "Department of Environmental Protection Standard Operating Procedures for Field Activities," DEP-SOP-001/01, dated February 1, 2004. A listing of sampling equipment used for this project is given in Table 3-3.

TABLE 3-3

SAMPLING EQUIPMENT

EQUIPMENT DESCRIPTION		CONSTRUCTION MATERIALS	USE
Water Sampling Equipment	Geotech Submersible Geosquirt Purging/Sampling Pump	Plastic case, S.S. impeller, vinyl tubing	Purging for monitoring wells; Sample collection for general parameters and nutrients
	Nalgene Syringe Filter System - Surface Water	Acrylic/polyethylene	Filtration for Orthophosphorus
Filtration Equipment	Geotech 0.45 µ high-capacity disposable filter	Plastic casing glass fiber filter	Filtration for isotope samples
	Masterflex E/S Portable Sampler	Silicon tubing	Filtration for isotope samples
Field Measurement Equipment	Hydrolab H2O Water Quality Monitor	Teflon	Field parameters
	SonTek FlowTracker Hand-held ADV	Polyethylene, S.S.	Measure discharge at inflow and outflow to calibrate autosampler flow meters

3.3 Laboratory Analyses

3.3.1 Analytical Methods for Water Samples

Each of the collected surface water samples was returned to the ERD Laboratory and evaluated for general parameters, nutrients, BOD, fecal coliform, and selected heavy metals. A summary of laboratory methods and MDLs for analyses conducted on water samples collected during this project is given in Table 3-4. All laboratory analyses were conducted in the ERD Laboratory (NELAC Certification No. 1031026).

TABLE 3-4

ANALYTICAL METHODS AND DETECTION LIMITS FOR LABORATORY ANALYSES ON SURFACE WATER SAMPLES

PARAMETER	METHOD OF ANALYSIS	METHOD DETECTION LIMITS (MDLs)[1]
Alkalinity	SM-21[2], Sec. 2320 B	0.5 mg/l
Ammonia	SM-21, Sec. 4500-NH_3 G	0.005 mg/l
NO_x	SM-21, Sec. 4500-NO_3 F	0.005 mg/l
Total Nitrogen	SM-21, Sec. 4500-N C	0.01 mg/l
Ortho-P (SRP)	SM-21, Sec. 4500-P F	0.001 mg/l
Total Phosphorus	SM-21, Sec. 4500-P F and 4500-P B.5	0.001 mg/l
Turbidity	SM-21, Sec. 2130 B	0.3 NTU
Color	SM-21, Sec. 2120 C	1 Pt-Co Unit
TSS	SM-21, Sec. 2540 D	0.7 mg/l
Fecal Coliform	SM-21, Sec. 9222 D	1 cfu/100 ml
UV Absorbance	SM-21, Sec. 5910 B	N/A

1. MDLs are calculated based on the EPA method of determining detection limits
2. Standard Methods for the Examination of Water and Wastewater, 21st Ed., 2005.

3.3.2 Quality Control

Multiple QA/QC procedures were used by ERD during this project. A summary of QA/QC procedures is given in Table 3-5. The listed QA/QC procedures are designed to evaluate both the field and laboratory systems. Approximately 90 additional laboratory QA/QC samples were evaluated by ERD in addition to the 90 collected surface water samples. In addition, more than 30 field QA/QC samples were collected and analyzed to address potential field contamination. A complete listing of QA/QC samples evaluated as part of this project is given in Appendix F.

TABLE 3-5

QA/QC PROCEDURES USED BY ERD

QC ITEM	FREQUENCY
Continuous Calibration Verification Standards	Every 10 samples
Continuing Calibration Blanks	Every 10 samples
Lab Control Samples (Check Standards)	Every 20 samples and beginning/end of each run
Method Blank	Every 20 samples and beginning/end of each run
Duplicate Samples (Precision)	Every 10 samples
Spiked Samples (Accuracy)	Every 20 samples
Initial Calibration Verification (pH)	Every run
Field Equipment Blanks	Every 10 samples
Pre-Cleaned Equipment Blank	Every 10 samples

3.4 Isotope Analyses

3.4.1 Introduction

Isotopes are atoms of an element that differ in mass, due to differing numbers of neutrons in the atoms' nucleus. Some isotopes are unstable and are referred to as radioisotopes. Other isotopes have no known decay constants and are referred to as stable isotopes. Isotopes of the same element have the same numbers of protons and electrons, and so have similar chemical properties and similar chemical reactions. But, because of the difference in bond strength due to differing numbers of neutrons, different stable isotopes react at slightly different rates. In general, molecules containing heavier isotopes react more slowly. Differences in reaction rates give rise to "fractionation", such that isotopes are distributed unevenly in natural systems. Biological systems often exhibit strong fractionation effects, such that molecules containing the light isotope of an element react more quickly with a biological enzyme than do molecules containing the heavier isotope. Thus, molecules from different sources in the environment often exhibit isotopic "fingerprints" which can be useful in source partitioning studies.

There are two stable isotopes of nitrogen, ^{14}N and ^{15}N, where the superscripts describe the atomic mass of the isotope. ^{14}N contains seven protons and neutrons, whereas ^{15}N contains seven protons but eight neutrons. ^{14}N is the more abundant isotope of nitrogen since most nitrogen reservoirs in nature (e.g., the atmosphere) contain approximately 99.6% ^{14}N and only 0.4% ^{15}N. Fractionation processes cause very slight variations in this composition, differences that can be detected using isotope-ratio mass spectroscopy, routinely distinguishing samples that differ by as little as 0.0001 atom percent ^{15}N.

3.4.2 Theory of Measurement

Stable isotopes of carbon, nitrogen, sulfur, oxygen, and hydrogen, which are the most commonly used isotopes in ecological and environmental research, are measured by gas isotope-ratio mass spectroscopy. The sample is converted into a gas, such as N_2O, CO_2, N_2, SO_2, or H_2, and the gas molecules are ionized in the Ion Source (Figure 3-30) which strips an electron from each of them, causing each molecule to be positively charged. The charged molecules then enter a flight tube. The flight tube is bent, and a magnet is positioned over it such that the charged molecules separate according to their mass, with molecules containing the heavier isotope bending less than those containing the lighter isotope.

Faraday collectors are present at the end of the flight tube to measure the intensity of each beam of ions of a given mass after they have been separated by the magnet. For N_2O, three faraday collectors are set to collect ion beams of masses 44, 45, and 46. Several masses are collected simultaneously, so that the ratios of these masses can be determined very precisely.

In the flight tube, the magnet causes the ions to be deflected, with a radius of deflection that is proportional to the mass-to-charge ratio of the ion. Heavier ions are deflected less than lighter ions. For example, N_2O, mass 46 has the largest radius of deflection, mass 44 has the smallest, and mass 45 is intermediate. Charge also affects the radius of deflection but, for the most part, this is held constant because the ion source strips only one electron from most molecules.

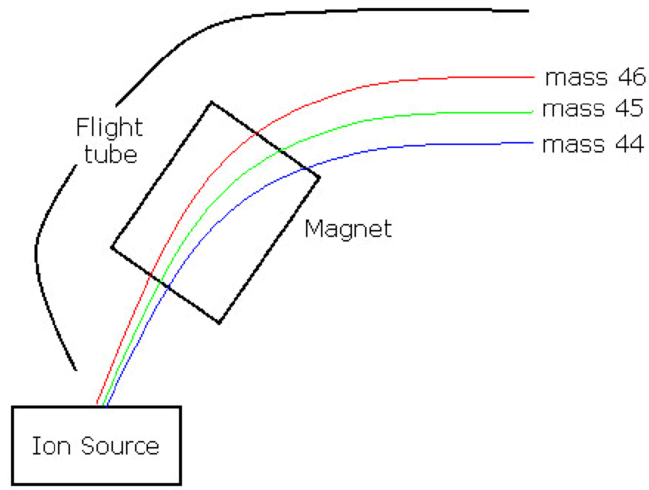


Figure 3-30. Separation of Isotopes by Gas Isotope-Ratio Mass Spectrometry.

Stable isotope abundances are expressed as the ratio of the two most abundant isotopes in the sample compared to the same ratio in an international standard, using the “delta” (δ) notation. Because the differences in ratios between the sample and standard are very small, they are expressed as parts per thousand or “per mil” (‰) deviation from the standard:

$$\delta X\ sample = \{(^{H}X / {}^{L}X\ sample) / (^{H}X / {}^{L}X\ standard) - 1\} \times 100$$

Where “^{H}X and ^{L}X” are the heavy and light stable isotopes of element X, “sample” refers to the environmental sample being analyzed, and “standard” refers to the international standard for element X. This equation defines the delta value of the standard as 0‰. For carbon, the international standard is Pee Dee Belemnite, a carbonate formation, with a generally accepted absolute ratio of $^{13}C/^{12}C$ equal to 0.0112372. Materials with ratios of $^{13}C/^{12}C$ greater than 0.0112372 have positive delta values, and those with ratios less than 0.0112372 have negative delta values.

Stable isotope techniques rely on natural differences in the ways that “heavy” and “light” isotopes are processed in the environment through chemical, biological, and physical transformations. These are referred to as “natural abundance isotope techniques”. Stable nitrogen isotopes of dissolved nutrients also provide specific information about the origin of nutrients. Pastureland, residential communities, and golf courses all produce nitrogen with unique isotopic signatures (Kendall, 1998). Land that is covered with a significant amount of cattle often produce nitrate with very heavy $\delta^{15}N$ values. This isotopic signature is due to the large amount of $^{14}NH_3$ released during ammonia volatilization of animal wastes which leaves the remaining material enriched in the heavier nitrogen isotope, ^{15}N.

Nitrogen derived from treated sewage undergoes similar biogeochemical processing through denitrification, which is the heterotrophic breakdown of organic matter. Denitrification produces N_2 with a high concentration of ^{14}N, leaving the remaining bulk waste material concentrated in ^{15}N. Consequently, nitrate that originates from pastureland and sewage have similar $\delta^{15}N$ values (12- 20‰). Contrastingly, nitrate derived from residential soils often has an intermediate nitrogen isotopic range (3-8‰). Possible contributions to the residential signal may include nitrogen derived from septic tanks, fertilizer application, or soil redistribution and relocation. Residential land development may also transport the ^{15}N-enriched organic matter that normally occurs in deeper soil layers to the surface.

The isotopic signature of nitrogen derived from golf courses is also unique. The fertilizer applied to golf courses is often derived from atmospheric nitrogen. This causes golf course runoff to contain nitrate with ^{15}N values similar to those of atmospheric N_2 (0-3‰). Golf course areas which irrigate with reclaimed water derived from sewage often exhibit a sewage signal (i.e., 12-20‰, as above). However, $\delta^{15}N$ can be used as a tracer only if large verifiable differences in $\delta^{15}N$ exist between the potential nitrogen sources.

One complication of source partitioning using stable isotopes of N and O in nitrate is that microbial transformations of nitrate can alter its isotopic signature, potentially obscuring the identity of the original source (Kellman et al, 1998).

Nitrification and denitrification are the major fractionating processes altering the isotopic composition of nitrate. Both processes preferentially utilize the lighter substrate, such that nitrification produces NO_3^- isotopically depleted compared to the NH_4^+ substrate, whereas denitrification preferentially utilizes isotopically depleted NO_3^-, leaving behind NO_3^- relatively enriched in $\delta^{15}N$ and $\delta^{18}O$. Predictable relationships among NO_3^- concentration, $\delta^{15}N$- NO_3^-, and $\delta^{18}O$- NO_3^- provide one means of detecting whether denitrification is influencing the isotopic composition of NO_3^-. For example, co-varying enrichment of $\delta^{15}N$ and $\delta^{18}O$ in nitrate provides evidence for denitrification, if the ratio of enrichments are between 1.3:1 and 2.1:1 (Aravena and Robertson, 1998; Fukada, et al., 2003). In a system where nitrate inputs are negligible, a negative relationship between $[NO_3^-]$ and $\delta^{15}N$-NO_3^- with a slope consistent with microbial fractionation during denitrification can also be used as a diagnostic for the importance of denitrification as a loss pathway, or in source identification, for the need to consider internal changes to $\delta^{15}N$ values observed in-situ to the expected $\delta^{15}N$ signature of the NO_3^- source. Analysis of $\delta^{15}N$-NH_4^+, and nitrification and denitrification rates at a given site can also constrain the influence of these processes on the observed isotopic signatures.

3.4.3 Analyses

All stable isotope analyses were conducted by the Colorado Plateau Stable Isotope Laboratory (CPSIL), based at Northern Arizona University (NAU). This laboratory was designed to serve students, researchers, and faculty at NAU who require stable isotope analyses for their research, although analyses are also conducted for researchers outside the university. All isotope analyses were overseen by Dr. Bruce Hungate, Professor and Director of CPSIL. Details concerning sample collection, preservation, and shipping were provided to ERD by CPSIL.

Surface waters collected in Long Branch Creek were analyzed for $\delta^{15}N-NO_3^-$ and $\delta^{18}O-NO_3^-$. The general question to be addressed was: "Are there changes in NO_3^-, $\delta^{15}N$, and $\delta^{18}O$ signatures within these systems that are consistent with internal microbial processing, and if so, is it possible to constrain the $\delta^{15}N$ and $\delta^{18}O$ signature of NO_3^- entering these systems?"

Samples were collected in the field and shipped to the Colorado Plateau Stable Isotope Laboratory at Northern Arizona University for preparation and analysis. Samples were measured for NO_3^- concentrations using automated colorimetry on a Lachat QuikChem 8000 to determine appropriate volumes for isotope analyses. The denitrifier method was used to measure the $\delta^{15}N$ and $\delta^{18}O$ composition of nitrate in each water sample (Sigman, et al., 2001; Casciotti et al., 2002; Révész and Casciotti, 2007). In this method, isotopes of both elements are measured simultaneously after the nitrate is converted to nitrous oxide (N_2O). Mass ratios of 45:44 and 46:44 distinguish $\delta^{15}N$ and $\delta^{18}O$ signatures, respectively. *Pseudomonas aurefaciens* lacks N_2O reductase, the enzyme that converts N_2O to N_2 during denitrification, so the reaction stops at N_2O, unlike normal denitrification which converts most of the NO_3^- to N_2.

Pseudomonas aurefaciens cultures were grown in tryptic soy broth, centrifuged to concentrate bacterial cells, and then concentrated suspensions of cells are added to sealed vials with headspace. The headspace vials were purged with helium gas to promote the anaerobic conditions suitable for denitrification, and the environmental samples containing NO_3^- were added to the vials and the volume of sample adjusted to obtain sufficient N_2O for analysis. Several drops of anti-foaming agent were added to each vial to reduce bubble formation during the reaction. The vials were allowed to incubate for 8 hours, during which time NO_3^- is converted completely to N_2O. After the 8-hour period, 0.1 ml of 10N NaOH was added to each vial to stop the reaction and to absorb CO_2 which can interfere with N_2O analysis. The samples were then placed on an autosampler tray interfaced with the mass spectrometer, and interspersed with standards with known $\delta^{15}N$ and $\delta^{18}O$ composition.

SECTION 4

RESULTS

Field monitoring, sample collection, and laboratory analyses were conducted by ERD from October 2010-January 2011 to evaluate the quantity and quality of discharges through Long Branch Creek. A discussion of the results of these efforts is given in the following sections.

4.1 Rainfall Records

A survey was conducted of available rainfall records in the vicinity of the Long Branch Creek watershed to evaluate the long-term rainfall characteristics as well as rainfall which occurred during and prior to the field monitoring program. The closest long-term rainfall recording station is a SWFWMD site (Site 22897) located at the City of Largo Public Works complex. This site is located approximately 3.3 miles west of the intersection of Roosevelt Blvd. and US 19 which is the approximate center of the Long Branch Creek watershed. Long-term rainfall characteristics are available at this site from 1997-2011. Rainfall records collected during this period are assumed to reflect "normal" rainfall characteristics in the vicinity of the Long Branch Creek watershed.

A comparison of measured and historical "normal" rainfall in the vicinity of the Long Branch Creek watershed is given in Table 4-1. Historical "normal" rainfall is provided on a monthly basis using rainfall data obtained from the SWFWMD rainfall recording site (Site 22897). Monthly rainfall recorded at SWFWMD Site 22897 is also provided over the period from February 2010-January 2011. A graphical comparison of "normal" and measured rainfall over the period from February 2010-January 2011 is given on Figure 4-1.

During the field monitoring program from October 2010-January 2011, a total of 8.08 inches of rainfall was recorded at the SWFWMD monitoring station. The "normal" rainfall during this period, based upon the SWFWMD Site 22897 data, is approximately 9.46 inches, indicating that, overall, rainfall during the field monitoring program was lower than normal. However, as indicated in Table 4-1, no measurable rainfall was recorded at SWFWMD Site 22897 during October 2010, with a rainfall deficit of 0.3 inches during November and 2.13 inches during December. Therefore, during the months of October, November, and December 2010, a rainfall deficit of 4.87 inches occurred. In contrast, substantially higher than normal rainfall was observed during January 2011, with a recorded rainfall of 6.32 inches compared with a "normal" rainfall of 2.83 inches, indicating a surplus of 3.4 inches during January. Substantial surpluses of rainfall were observed during July and August 2010, preceding the initiation of monitoring activities, with slightly lower than normal rainfall observed during September. In general, it appears that rainfall during three months of the field monitoring program (covering the period from October-December 2010) was substantially less than normal, with substantially higher than normal rainfall observed during the final month of the monitoring program in January 2011.

TABLE 4-1

COMPARISON OF MEASURED AND HISTORICAL RAINFALL IN THE VICINITY OF THE LONG BRANCH CREEK WATERSHED

MONTH	SWFWMD SITE 22897 (1977-2011)	MEASURED RAINFALL (2/10-1/11)	MONTH	SWFWMD SITE 22897 (1977-2011)	MEASURED RAINFALL (2/10-1/11)
February 2010	2.84	1.78	August 2010	7.28	12.51
March 2010	3.64	6.01	September 2010	6.26	4.41
April 2010	2.16	4.79	October 2010	2.44	0.00
May 2010	2.53	0.99	November 2010	1.60	1.30
June 2010	4.69	3.33	December 2010	2.59	0.46
July 2010	7.29	10.21	January 2011	2.83	6.32
			TOTAL:	**46.13**	**52.11**

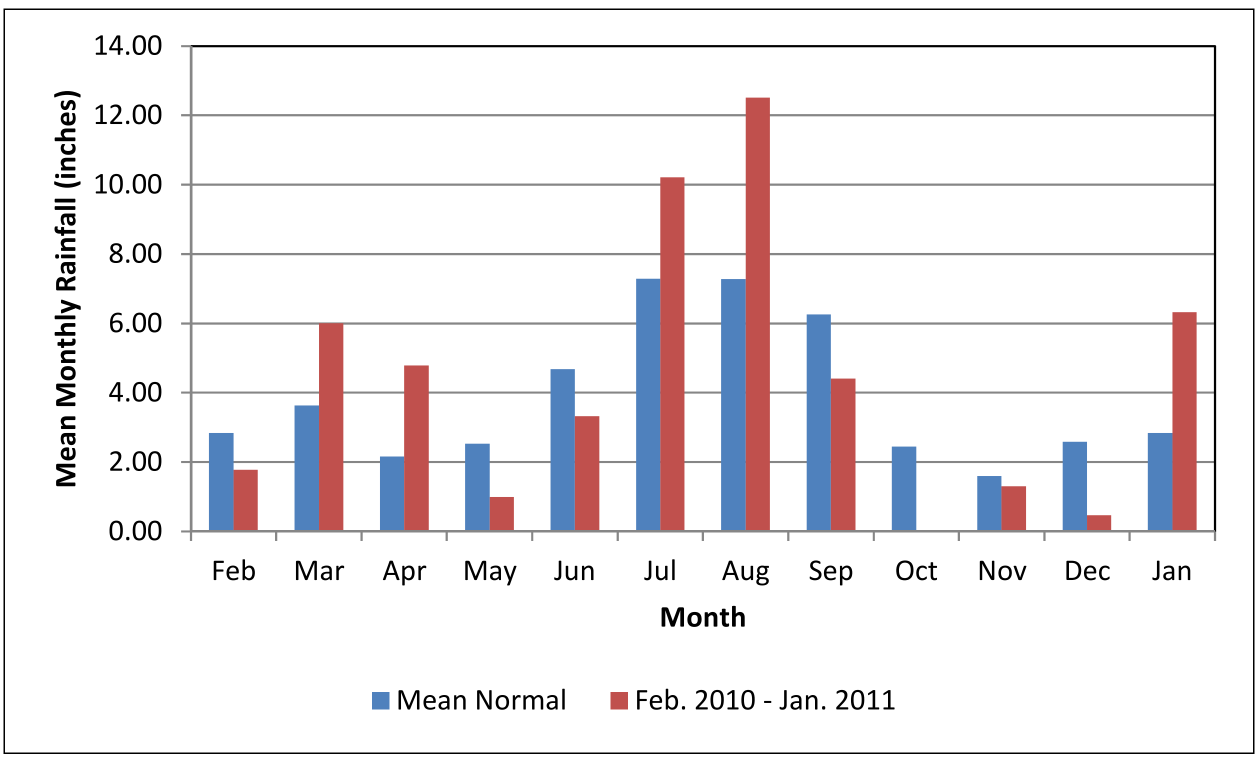


Figure 4-1. Comparison of Measured and Historical Mean Monthly Rainfall in the Vicinity of the Long Branch Creek Watershed.

4.2 Discharge Measurements

Field measurements of discharge rates were conducted at each of the 18 monitoring sites during each of the five monitoring events conducted from October 2010-January 2011. Techniques used for monitoring discharge rates are discussed in Section 3.2.1. A summary of measured discharge rates at the Long Branch Creek monitoring sites is given in Table 4-2. Site 18 is a supplemental site added by ERD during the November 16, 2010 monitoring event. Data were not collected at this site during the initial two monitoring events.

TABLE 4-2

SUMMARY OF FIELD MEASURED DISCHARGE RATES AT THE LONG BRANCH CREEK MONITORING SITES FROM OCTOBER 2010 - JANUARY 2011

SITE	MEASURED DISCHARGE BY DATE (cfs)					
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	Mean[1]
1	1.22	0.03	0.10	0.00	2.85	0.10
2	0.16	0.00	0.23	0.04	1.12	0.07
3	0.11	0.01	0.00	0.003	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	0.00
5	0.003	0.00	0.01	0.001	0.39	0.01
6	0.27	0.06	0.22	0.08	3.83	0.26
7	0.24	0.09	0.05	0.02	3.99	0.15
8	0.32	0.00	0.10	0.04	2.40	0.08
9	0.49	0.07	0.10	0.09	5.62	0.28
10	0.22	0.22	0.22	0.08	0.41	0.20
11	1.22	0.71	0.32	0.22	5.23	0.80
12	0.61	0.74	1.21	0.45	12.97	1.26
13	0.08	0.09	0.15	0.10	0.30	0.13
14	0.66	0.37	0.91	0.29	8.32	0.88
15	0.07	0.00	0.01	0.00	0.76	0.01
16	5.24	4.39	5.97	3.21	20.50	6.18
17	0.00	0.00	0.00	0.00	4.55	0.01
18	--	--	0.13	0.08	0.62	0.19

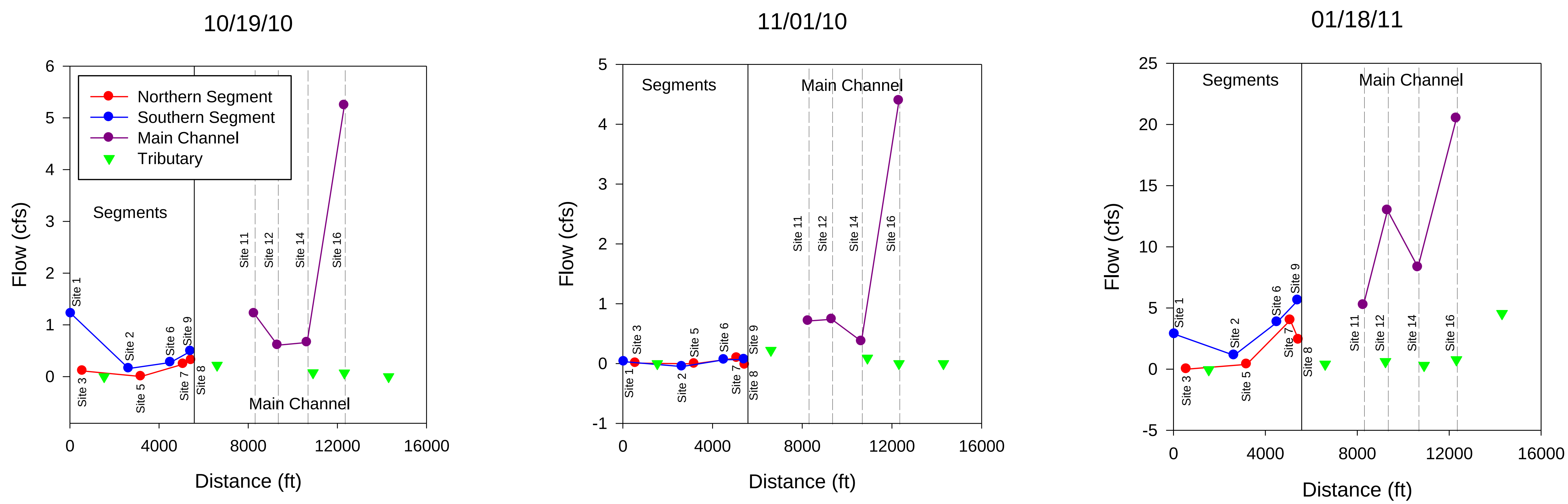
1. Reflects mean of log transformed values, also referred to as geometric mean

A graphical summary of measured discharge rates at the Long Branch Creek monitoring sites during the five monitoring events is given on Figure 4-2. In general, measured discharge rates in Long Branch Creek were typically low in value, with the vast majority of measured discharges less than approximately 1 cfs, even at the main channel monitoring sites. The only site which exhibited consistently more elevated discharge rates was Site 16 which is the most downstream site located in Long Branch Creek and is tidally influenced. Measured discharge rates within Long Branch Creek decreased steadily following the initial monitoring event on October 19, 2010 due to the deficits in rainfall observed during November and December 2010. The lowest observed discharge rates occurred on December 7, 2010 during the period of highest deficit rainfall conditions. The most elevated discharge rates occurred on January 18, 2011 following a significant rain event within the watershed immediately prior to the field monitoring event. Measured discharge rates during this event were many times greater than observed during previous monitoring events.

Measurements conducted on December 7, 2010 reflect the lowest discharge rates observed during the field monitoring program. Extremely low discharge rates were observed in both the northern and southern headwater segments, with all measured values equal to or less than 0.08 cfs. Discharge rates began to increase slowly in the main channel portion, with a discharge of 0.22 cfs at Site 11, 0.45 cfs at Site 12, 0.29 cfs at Site 14, and 3.21 cfs at Site 16. Tributary inflows into the main channel under low flow conditions were extremely low in value and do not appear to be significant contributors to the discharges observed in the main channel.

Measurements conducted on January 18, 2011 reflect the largest discharges observed during the field monitoring program, with monitoring conducted approximately 24 hours following a significant rain event of approximately 2.88 inches within the watershed. Discharge rates in the northern headwater segment were essentially zero at the discharge from Swan Lake, with a relatively minimal inflow at Site 4. However, a discharge of approximately 0.39 cfs was observed at Site 5 which increased to 3.99 cfs at Site 7. After passing beneath US 19, the flow decreased to 2.40 cfs, probably as a result of the substantial water attenuation and storage provided in the wetland system north of Site 8. Discharges from the west side of Belcher Road in the southern headwater segment were relatively high, with a measured discharge of 2.85 cfs. This value decreased to 1.12 cfs at Site 2 before increasing to 3.83 cfs at Site 6, with a final discharge of 5.62 cfs from the southern segment at Site 9.

Discharge rates along the main channel during the January 18, 2011 event were approximately 5.2 cfs at Site 11, increasing to 12.97 cfs at Site 12, before decreasing to 8.32 cfs at Site 14 and increasing again to 20.5 cfs at Site 16. Tributary inflows into the main channel were generally less than 0.75 cfs and were insufficient in magnitude to generate the observed increases in discharge within the channel. It is interesting to note that the measured discharge decreased between main channel Sites 12 and 14 during four of the five field monitoring dates.



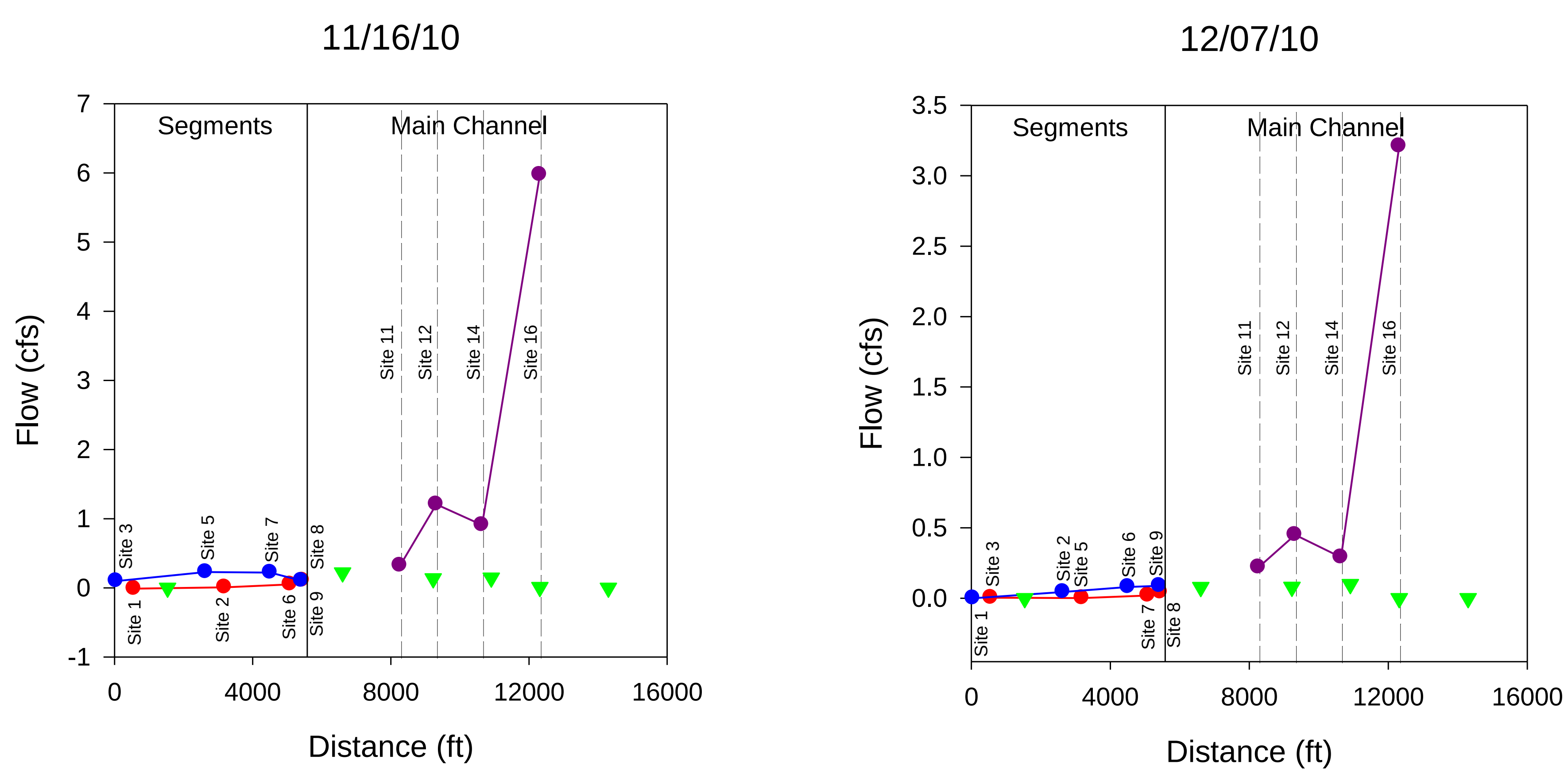


Figure 4-2.

Measured Discharge Rates in Long Branch Creek During the Five Field Monitoring Events.

A comparison of mean measured discharge rates at the Long Branch Creek monitoring sites from October 2010-January 2011 is given on Figure 4-3. The values summarized on this figure reflect the mean of the log-transformed values for the five monitoring dates. In general, upstream portions of the northern and southern headwater segments were characterized by extremely low mean discharge rates of approximately 0.1 cfs or less. Discharge rates in the northern and southern segments increase slightly in the vicinity of US 19, with a mean discharge of 0.15 cfs at Site 7 and 0.26 cfs at Site 6. Discharge rates begin to increase in main channel portions of Long Branch Creek, increasing to 0.80 cfs at Site 11, 1.26 cfs at Site 12, decreasing slightly to 0.88 cfs at Site 14, before increasing substantially to 6.18 cfs at Site 16. Tributary inflows to the main channel contribute relatively low discharge rates, ranging from 0.01 cfs at Site 15 to 0.20 cfs at Site 10. It appears that the observed increases in discharge along the main channel largely originate within the channel itself, possibly as a result of groundwater inflow, rather than as contributions from the adjacent tributary inflows.

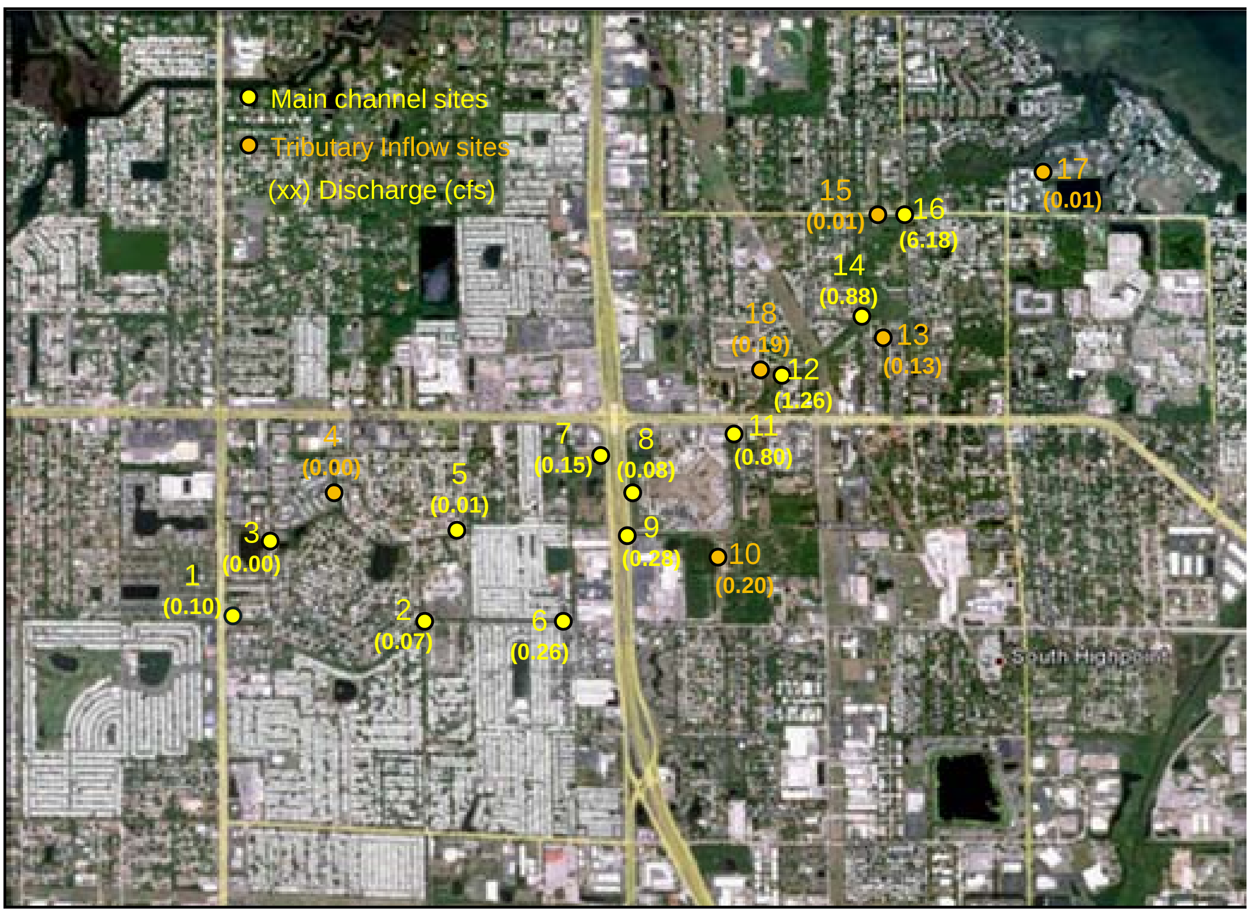


Figure 4-3. Mean Measured Discharge Rates at the Long Branch Creek Monitoring Sites from October 2010-January 2011.

4.3 Surface Water Characteristics

Field monitoring was conducted at 18 surface water sites in the Long Branch Creek watershed over the period from October 2010-January 2011, with a total of five events conducted at each of the 18 monitoring sites. A discussion of the characteristics of surface water samples collected in the Long Branch Creek watershed is given in the following sections.

4.3.1 Field Measurements

A complete listing of field measurements collected at each of the monitoring sites in the Long Branch Creek watershed from October 2010-January 2011 is given in Appendix B. Field measurements of temperature, pH, conductivity, dissolved oxygen, dissolved oxygen saturation, and oxidation-reduction potential (ORP) were collected at approximately mid-depth in the water column at each monitoring site.

4.3.1.1 Northern/Southern Segments and Main Channel

A summary of mean field measurements collected in the Long Branch Creek watershed from October 2010-January 2011 is given on Table 4-3. All mean values summarized in this table reflect log-normal mean values. Data in the table are highlighted to reflect sites located along the northern channel segment, southern channel segment, main channel, and tributary inflows.

In general, measured pH values in the northern segment, southern segment, main channel, and tributary inflows were approximately neutral to slightly alkaline in pH, with median pH values ranging from approximately 7.0-7.6 at each of the monitoring sites, with the exception of Site 3 (headwaters of the northern segment) which exhibited a somewhat higher mean pH value of 8.11.

Measured dissolved oxygen (DO) values at the segment and main channel monitoring sites were generally low to moderate in value, with log-normal mean dissolved oxygen concentrations ranging from 2.6-6.6 mg/l at a majority of the monitoring sites. More elevated dissolved oxygen concentrations were observed at Site 3. The elevated dissolved oxygen concentrations measured at this site are likely related to biological productivity within the upstream lake.

Dissolved oxygen saturation was typically low at a majority of the monitoring sites, ranging from approximately 30-74%, with more elevated dissolved oxygen saturation levels observed at Site 3 (headwaters of the northern segment). On average, measured ORP values ranged from 351-448 mV, reflecting oxidized conditions on average at each of the segment and main channel surface water monitoring sites.

TABLE 4-3

SUMMARY OF LOG-NORMAL MEAN FIELD MEASUREMENTS COLLECTED IN THE NORTHERN AND SOUTHERN SEGMENTS AND MAIN CHANNEL SITES OF LONG BRANCH CREEK FROM OCTOBER 2010 - JANUARY 2011

SITE	TEMPERATURE (°C)	pH (s.u.)	CONDUCTIVITY (μmho/cm)	DO (mg/l)	DO % SATURATION (%)	ORP (mV)
3	20.33	8.11	391	7.1	79	388
5	17.43	7.41	511	3.3	35	383
7	19.20	7.52	779	5.3	58	388
8	20.52	7.40	758	5.2	58	351
1	20.36	7.43	564	6.4	71	448
2	19.28	7.24	659	2.6	30	355
6	17.20	7.30	596	4.1	43	426
9	19.87	7.57	635	6.6	74	406
11	20.85	7.21	778	4.1	46	376
12	20.46	7.37	721	5.6	63	430
14	20.04	7.46	757	5.4	60	418
16	19.08	7.55	2489	4.9	53	393

Northern Headwater Segment (sites 3, 5, 7, 8)

Southern Headwater Segment (sites 1, 2, 6, 9)

Main Channel Sites (sites 11, 12, 14, 16)

A graphical comparison of measured concentrations of pH, dissolved oxygen, ORP, and conductivity at the Long Branch Creek segment and main channel monitoring sites is given on Figure 4-4 in the form of a box and whisker plot. In general, measured pH values were relatively similar at each of the segment and main channel monitoring sites, with the exception of Site 3 which reflects the headwaters of the northern segment. Dissolved oxygen concentrations were highly variable, with concentrations less than the applicable Class III criterion of 5 mg/l observed on at least one occasion at 8 of the 12 segment and main channel monitoring sites. Based on the measured ORP values, oxidized conditions were maintained throughout the segments and main channel at all times. The conductivity values were also relatively similar, with the exception of substantially elevated conductivity observed at Site 16 which reflects tidal influence.

4.3.1.2 <u>Tributary Inflows</u>

A summary of mean field measurements collected at the tributary monitoring sites is given in Table 4-4. In general, measured pH values in tributary inflows into the segments and main channel were approximately neutral to alkaline in pH, with log-normal mean pH values ranging from 7.03-8.48. The most elevated pH values were observed at Site 17 which reflects the discharge from the large lake which discharges into the main channel in the tidal portion of the system. Mean pH values at the remaining tributary inflows were relatively similar, ranging from 7.03-7.60.

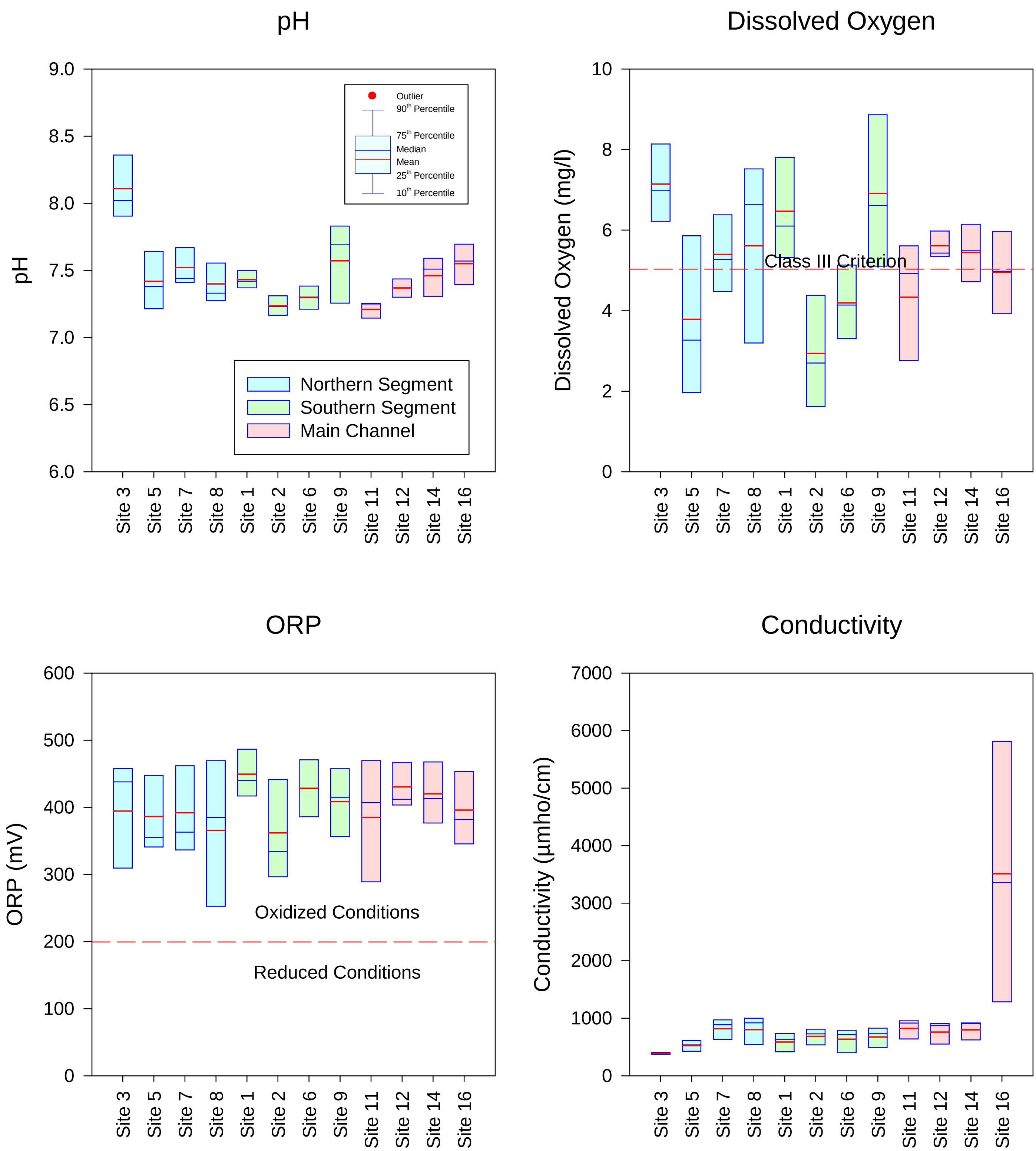


Figure 4-4. Comparison of Measured Concentrations of pH, Dissolved Oxygen, ORP, and Conductivity at the Long Branch Creek Northern/Southern Segments and Main Channel Monitoring Sites.

TABLE 4-4

SUMMARY OF LOG-NORMAL MEAN FIELD MEASUREMENTS COLLECTED IN TRIBUTARY INFLOWS TO LONG BRANCH CREEK FROM OCTOBER 2010 - JANUARY 2011

SITE	TEMPERATURE (^oC)	pH (s.u.)	CONDUCTIVITY (μmho/cm)	DO (mg/l)	DO % SATURATION (%)	ORP (mV)
4	18.66	7.03	811	3.4	37	366
10	20.45	7.34	1016	4.7	53	405
13	20.68	7.50	552	5.7	65	407
15	21.47	7.60	2485	5.9	67	371
17	23.30	8.48	690	9.3	109	382
18	19.41	7.47	581	7.8	85	449

Measured dissolved oxygen concentrations at the tributary monitoring sites were generally low to moderate in value, with mean dissolved oxygen concentrations ranging from 3.4-9.3 mg/l. The lowest dissolved oxygen concentrations of the tributary inflows were observed at Site 4 (which reflects a tributary inflow to the northern headwaters segment) and Site 10 (which reflects a tributary inflow to the main channel, south of Roosevelt Blvd.). Measured dissolved oxygen concentrations at these sites were consistently less than the Class III criterion of 5 mg/l. Dissolved oxygen concentrations measured at Site 13 (which reflects a tributary inflow to the main channel, downstream of Site 12) and Site 15 (which reflects the swale drainage along Whitney Road) were generally in excess of 5 mg/l during the field monitoring program. The most elevated dissolved oxygen concentrations were observed at Site 17 (which reflects the discharge from the large lake system) and Site 18 (which reflects a tributary inflow just upstream from Site 12). Mean dissolved oxygen saturation percentages were substantially less than 100% at each of the tributary inflows with the exception of Site 17. Measured ORP values at each of the tributary inflow sites reflected oxidized conditions, characterized by ORP measurements in excess of 200 mV, in spite of the low measured dissolved oxygen concentrations at some sites.

In general, measured conductivity values were less than approximately 1000 μmho/cm at each of the tributary inflow monitoring sites, with the exceptions of Sites 10 and 15. Substantially more elevated conductivity values were observed at each of these sites, with measured concentrations ranging from approximately 1000-5000 μmho/cm. The cause of the elevated conductivity values measured at these sites is not known.

A graphical comparison of measured concentrations of pH, dissolved oxygen, ORP, and conductivity at the tributary inflow monitoring sites is given on Figure 4-5 in the form of a box and whisker plot. Values of pH at the tributary inflow sites range from approximately 7-7.5, with the exception of Site 17 which exhibited an elevated pH value of approximately 8.5. Tributary monitoring Sites 4 and 10 exhibited periodic or frequent levels of dissolved oxygen which were less than the Class III criterion of 5 mg/l, with one dissolved oxygen measurement less than 5 mg/l observed at Site 15. No violations of the dissolved oxygen criterion were observed at monitoring Sites 13, 17, and 18. Based upon the calculated ORP values, oxidized conditions were maintained at each of the tributary inflow monitoring sites throughout the field monitoring program. In general, measured conductivity values were relatively similar between the inflow monitoring sites, with the exception of Site 15 which reflects roadside drainage along Whitney Road, and exhibited a wide variability in conductivity values.

4.3.2 Chemical Characteristics

A complete listing of the results of laboratory analyses conducted on surface water samples collected from the Long Branch Creek watershed during the field monitoring program is given in Appendix C. Water quality data are provided for each of the 18 monitoring sites and monitoring dates. Each of the collected surface water samples was analyzed in the ERD Laboratory for general parameters, nutrients, and fecal coliform bacteria. A discussion of the chemical characteristics of water samples collected at each of the monitoring sites during the field monitoring program is given in the following sections.

4.3.2.1 Northern/Southern Segments and Main Channel

A comparison of mean chemical characteristics of surface water samples collected from the northern/southern segments and the main channel of Long Branch Creek from October 2010-January 2011 is given on Table 4-5. The mean values summarized in this table reflect the mean of the log-transformed data sets since the data exhibit a log-normal distribution.

Surface water samples collected from the northern/southern segments and main channel portions of Long Branch Creek were found to be well buffered, with log-normal mean alkalinity values ranging from 134-213 mg/l. In general, measured alkalinity values in the northern and southern segments appear to be lower than values measured along the main channel. Measured turbidity values were low to moderate in value, with log-normal mean concentrations ranging from 1.5-9.0 NTU. In contrast to the trend observed for alkalinity, measured turbidity concentrations appear to be greatest in the northern and southern headwaters segments and lower at the main channel monitoring sites. A similar pattern is also exhibited by TSS, with log-normal mean concentrations ranging from 1.9-11.5 mg/l. Mean TSS concentrations at the northern and southern headwater segments appear to be approximately 2-3 times greater than concentrations measured at the main channel monitoring sites. Measured color concentrations at the monitoring sites were moderate in value, with mean values ranging from 30-67 Pt-Co units. Color concentrations in the southern headwater segment appear to be somewhat higher than observed in the northern segment or main channel.

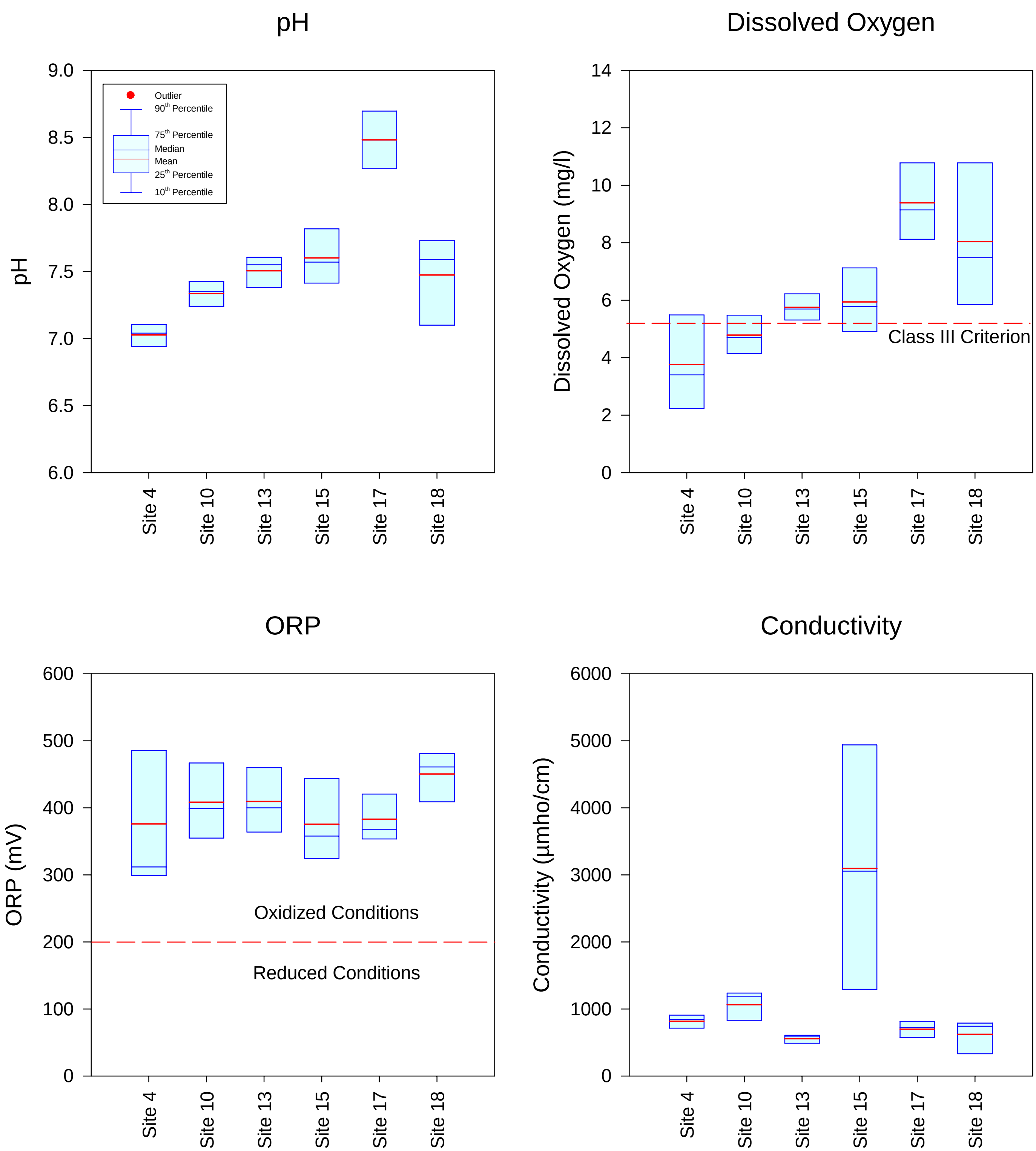


Figure 4-5. Comparison of Measured Concentrations of pH, Dissolved Oxygen, ORP, and Conductivity at the Long Branch Creek Tributary Inflow Monitoring Sites.

TABLE 4-5

SUMMARY OF LOG-NORMAL MEAN CHARACTERISTICS OF SURFACE WATER SAMPLES COLLECTED FROM THE NORTHERN / SOUTHERN SEGMENTS AND MAIN CHANNEL IN LONG BRANCH CREEK FROM OCTOBER 2010 - JANUARY 2011

SITE	ALK. (mg/l)	NH_3 (µg/l)	NO_x (µg/l)	DISS. ORG. N (µg/l)	PART. N (µg/l)	TOTAL N (µg/l)	SRP (µg/l)	DISS. ORG. P (µg/l)	PART. P (µg/l)	TOTAL P (µg/l)	TURB. (NTU)	TSS (mg/l)	Fecal Coliform (cfu/100 ml)	Color (Pt-Co)
3	134	63	6	454	682	1,341	2	3	41	51	5.4	10.0	889	34
5	157	501	39	614	321	1,798	116	43	59	240	3.1	6.6	431	51
7	189	272	170	375	210	1,192	66	16	23	113	5.5	11.5	3,683	30
8	205	170	175	426	182	1,216	76	25	45	157	3.9	6.4	3,102	30
1	149	149	228	228	374	1,342	22	13	28	76	9.0	6.5	425	41
2	194	208	45	857	156	1,408	54	22	51	157	3.4	6.2	672	67
6	201	82	18	476	116	1,003	41	20	50	119	1.7	4.2	688	64
9	197	45	59	611	107	961	52	15	32	107	1.6	2.2	535	57
11	213	108	44	613	147	972	21	15	25	73	1.5	2.7	273	49
12	211	26	105	499	46	737	22	10	35	83	2.0	3.4	1,153	46
14	211	49	137	510	56	903	26	15	9	58	1.8	1.9	1,154	49
16	189	86	138	388	48	775	51	10	20	88	1.5	1.9	3,072	47

Northern Headwater Segment

Southern Headwater Segment

Main Channel Sites

Measured concentrations of nitrogen species exhibited a relatively wide degree of variability between the listed monitoring sites. Dissolved organic nitrogen appears to be the dominant nitrogen species at northern headwater segments Sites 5, 7, and 8; southern headwater segments Sites 2, 6, and 9; and main channel Sites 11, 12, 14, and 16. At each of these sites, dissolved organic nitrogen comprises approximately 35-50% of the total nitrogen measured at each site. Particulate nitrogen appears to be the dominant nitrogen source at northern headwater segment Site 3 and southern headwater segment Site 1. Ammonia or NO_x do not appear to be the dominant nitrogen species at any of the northern headwater, southern headwater, or main channel sites. The dominance of ammonia and NO_x as an inorganic nitrogen source appears to be split relatively evenly between the 12 monitoring sites, with ammonia reflecting the dominant inorganic species at 6 of the 12 sites and NO_x reflecting the dominant inorganic nitrogen species at the remaining 6 sites. Measured concentrations of total nitrogen in the northern and southern headwater segments are generally equal to or less than total nitrogen concentrations commonly observed in urban drainage systems. Total nitrogen concentrations measured along the main channel appear to be relatively low in value.

In general, measured ammonia concentrations at the northern/southern segments and main channel monitoring sites were low to elevated in value, with low to moderate concentrations observed for NO_x. The most elevated ammonia concentrations were observed at Sites 5, 7, and 8 (all located in the northern headwater segment), and Sites 1 and 2 (located in the southern headwaters segment). The most elevated levels of NO_x were observed at Sites 7 and 8 (located in the northern headwaters segment) and at Site 1 (located in the southern headwaters segment). Overall, total nitrogen concentrations ranged from moderate to elevated, with substantially higher total nitrogen concentrations observed in the northern and southern headwater segments as compared with the main channel monitoring sites. The most elevated total nitrogen concentrations were observed at northern headwaters segment Site 5.

Measured concentrations of phosphorus species ranged from moderate to elevated at the Long Branch Creek monitoring sites. Measured SRP (soluble reactive phosphorus) concentrations in the southern headwater segment and at the main channel sites appear to be consistent with concentrations commonly observed in urban drainage systems. Somewhat more elevated SRP concentrations were observed in the northern headwater segment, particularly at Site 5 (mid-portion of the northern headwater segment), Site 7 (northern headwater segment west of US 19), and Site 8 (northern headwater segment east of US 19). Dissolved organic phosphorus concentrations appear to be relatively low in value at each of the monitoring sites, with the exception of Site 5, located in mid-portions of the northern headwater segment. Particulate phosphorus concentrations also appear to be moderate in value, with the most elevated concentration also observed at Site 5.

Overall, measured total phosphorus concentrations were found to be moderate to elevated, with elevated concentrations observed in both the northern and southern headwater segments, and moderate concentrations observed along the main channel sites. The highest total phosphorus mean concentration of 240 μg/l was measured at Site 5 in the northern headwater segment, with the lowest mean total phosphorus concentration of 51 μg/l measured in the discharge from Swan Lake.

Fecal coliform counts at the monitoring sites were highly variable, with substantially elevated fecal coliform counts observed at Sites 7 and 8 in the northern headwater segment, and at Sites 12, 14, and 16 located along the main channel. With the exception of Site 11, the log-normal mean concentrations for fecal coliform bacteria exceed the Class III criterion of 400 cfu/100 ml for Class III surface waters at all of the monitoring sites. Fecal coliform contamination appears to be an ongoing issue in Long Branch Creek.

A graphical comparison of measured concentrations of alkalinity, TSS, turbidity, and fecal coliform bacteria in the northern/southern segments and main channel sites is given on Figure 4-6 in the form of a box and whisker plot. Measured alkalinity values appear to be lower in the northern and southern segments, with more elevated values measured at the main channel sites. Measured TSS concentrations appear to be greatest in the northern channel segment, with slightly lower values observed in the southern channel segment, and substantially lower values observed at the main channel monitoring sites. Measured turbidity values appear to be generally low in value, with the exception of Site 1 which reflects inflow into the southern headwater segment from areas west of Belcher Road.

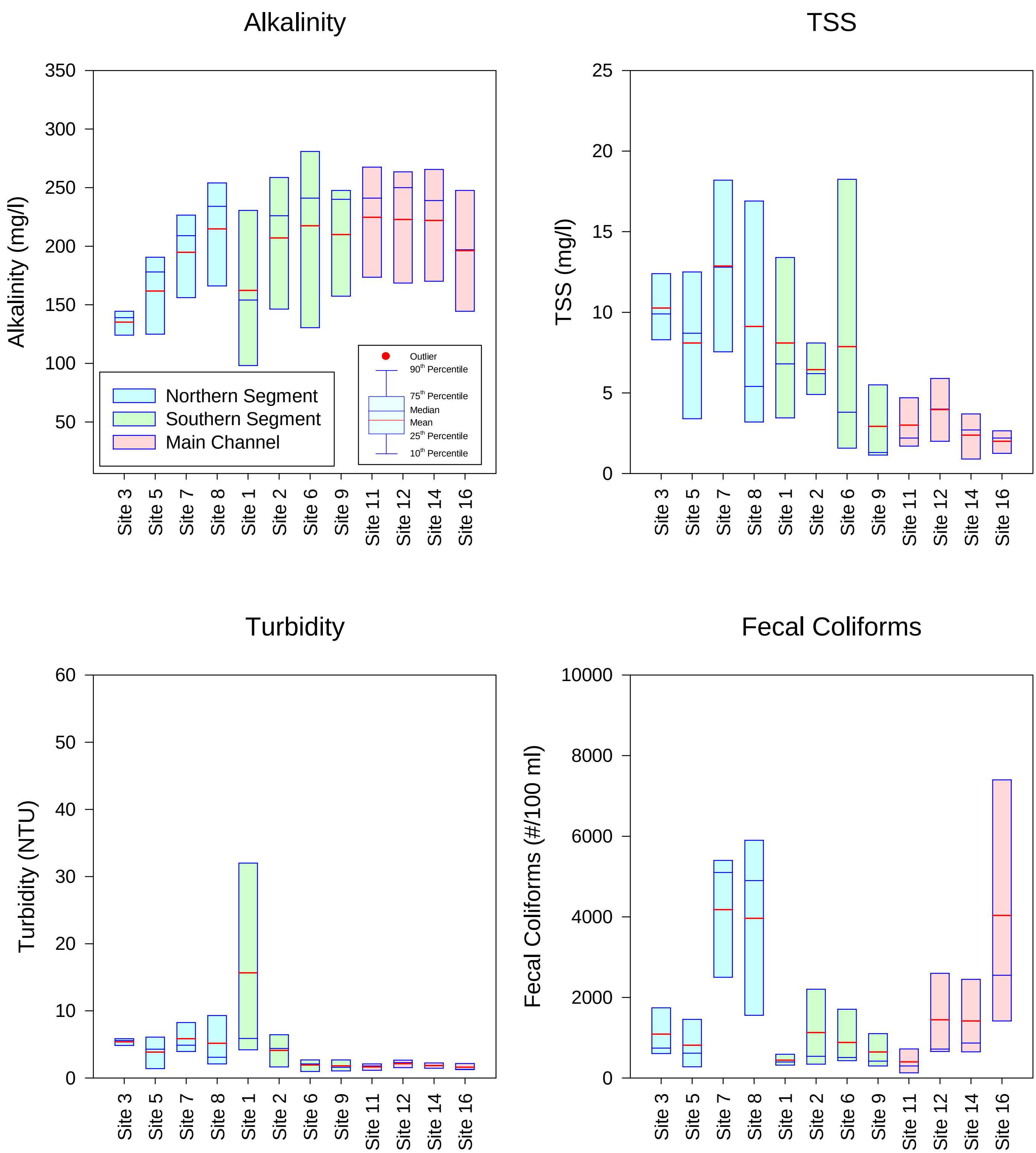


Figure 4-6. Comparison of Measured Concentrations of Alkalinity, TSS, Turbidity, and Fecal Coliform in the Long Branch Creek Northern/Southern Segments and Main Channel Sites.

Fecal coliform counts appear to be elevated at virtually all of the monitoring sites, with the most elevated concentrations observed at northern headwater segment Sites 7 and 8, and at the main channel Site 16. Fecal coliform concentrations appear to increase substantially in the northern headwater segment between Site 5 (located approximately mid-way in the northern headwater segment) and Sites 7 and 8 (which are located downstream of Site 5). Fecal inputs from Site 4, discussed in Section 4.3.2.2 (log-normal mean = 812 cfu/100 ml), may be a contributing factor to the elevated log-normal mean of 431 cfu/100 ml measured at Site 5. Between Site 5 and Site 7, the northern segment passes through areas which are primarily residential in character, including a combination of single-family residential homes and a dense mobile home park community. However, monitoring Site 6 (which is located in the southern segment on the southern end of the mobile home park) does not indicate the same level of fecal coliform contamination as observed at Sites 7 and 8, suggesting that the mobile home park may not be the source of the elevated fecal coliform counts observed. A significant increase in fecal coliform counts appears to occur between Sites 14 and 16 along the main channel. Significant inputs between Sites 14 and 16 include the tributary inflow referred to as Site 13, as well as runoff from the horse stables just upstream from monitoring Site 14. Fecal inputs from Site 13 (log-normal mean = 3923 cfu/100 ml) appear to be a contributing source for the observed increases between Sites 14 and 16.

A graphical comparison of measured concentrations of nitrogen species at the northern/ southern segments and main channel monitoring sites is given on Figure 4-7. Low to moderate levels of ammonia were observed at each of the northern segment, southern segment, and main channel monitoring sites, with the exception of Site 5 which exhibited substantially elevated levels of ammonia during the initial two monitoring events which increased the mean value at this site to 501 μg/l. Site 5 is located in the northern headwater segment and reflects the combined inputs from Swan Lake and the tributary inflow at Site 4, along with the additional unnamed waterbody west of Site 5. The source of the elevated ammonia concentrations does not appear to be Swan Lake since relatively low concentrations of ammonia were observed in the discharge from the lake. Site 4 also does not appear to be a significant contributor of ammonia to Site 5 due to the low log-normal mean value of 90 μg/l at this site (Section 4.3.2.2).

Low to moderate concentrations of NO_x were also observed at a majority of the monitoring sites, with the exceptions of northern segment Sites 7 and 8 (which reflect the west and east sides of US 19, respectively), and southern segment Site 1 (which reflects inflow from areas west of Belcher Road). The increase in NO_x concentrations observed at these sites suggests a significant loading of NO_x into the channel in these areas.

Measured concentrations of particulate nitrogen were found to be moderate to elevated in value at the monitoring sites. Relatively moderate levels of particulate phosphorus were observed at virtually all of the main channel monitoring sites, along with Site 7 in the northern headwater segment, and Sites 2 and 9 in the southern headwater segment. However, more elevated levels of particulate nitrogen were observed at Sites 3 and 8 in the northern headwaters segment, and at Sites 1 and 6 in the southern headwater segment. The elevated particulate nitrogen observed at Site 3 may reflect algal biomass since this site is the discharge from Swan Lake. However, potential sources of the additional particulate nitrogen loadings are not obvious.

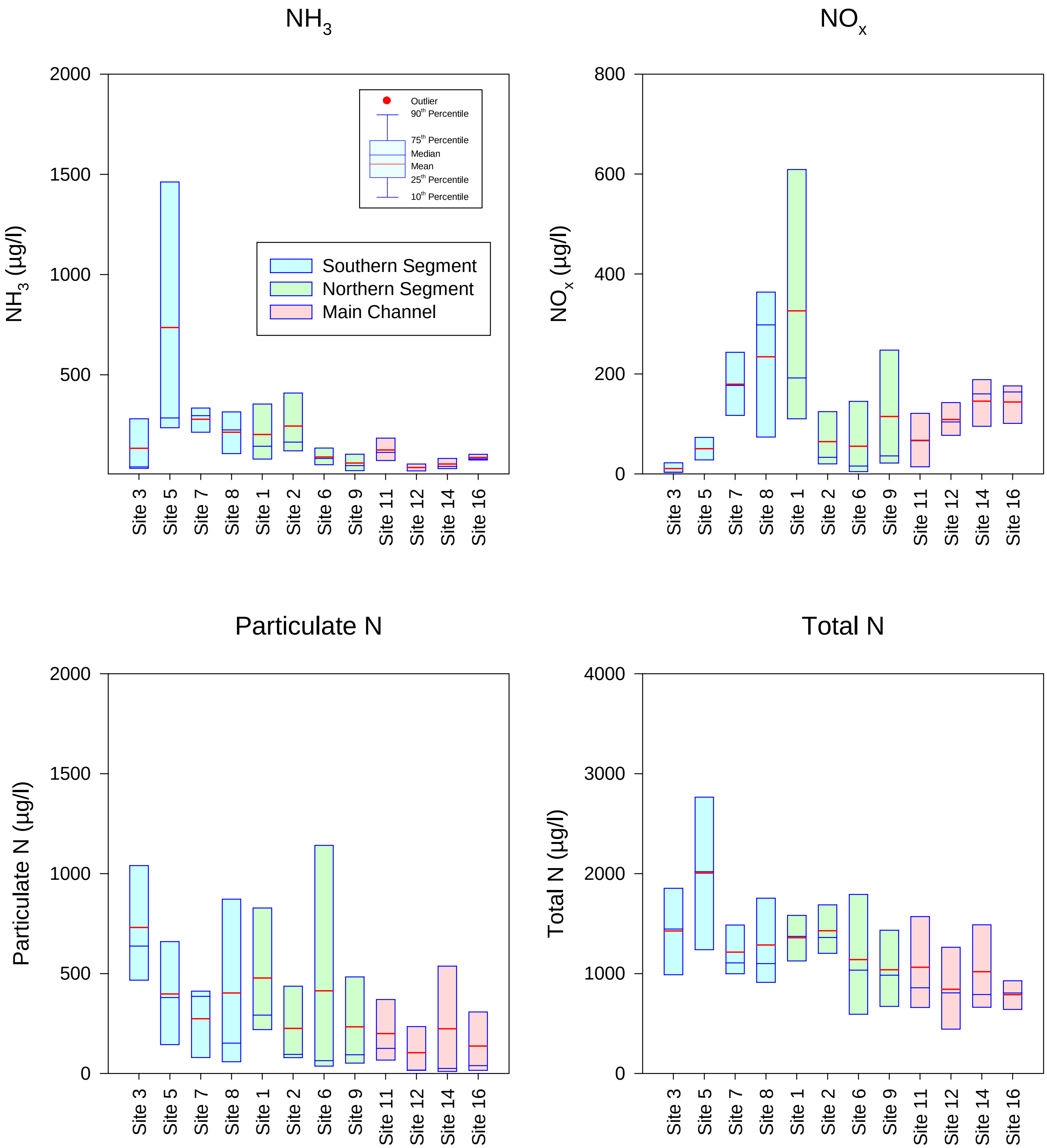


Figure 4-7. Comparison of Measured Concentrations of Nitrogen Species in the Long Branch Creek Northern/Southern Segments and Main Channel Sites.

Overall, measured total nitrogen concentrations were moderate to elevated at the Long Branch Creek monitoring sites. Moderate levels of total nitrogen were observed at each of the main channel monitoring sites and at Sites 6 and 9 in the southern headwater segment. More elevated total nitrogen concentrations were observed at Sites 3, 7, and 8 in the northern headwater segment, and at Sites 1 and 2 in the southern headwater segment. The most elevated levels of total nitrogen were observed at Site 5 in the northern headwater segment. This site was also characterized by the most elevated concentrations of ammonia, with moderate levels of NO_x and particulate nitrogen.

A graphical comparison of measured concentrations of phosphorus species in the northern and southern headwater segments and main channel monitoring sites is given on Figure 4-8. Relatively low levels of SRP were observed at the main channel monitoring sites, although an increase in SRP appears to occur between Sites 14 and 16. Somewhat more elevated concentrations of SRP were observed at the northern headwater monitoring sites and at Sites 2, 6, and 9 in the southern headwater segment. The somewhat elevated concentrations of SRP entering the main channel at Sites 8 and 9 appear to be quickly assimilated by the time the flow reaches Roosevelt Blvd.

Moderate to elevated concentrations of dissolved organic phosphorus were observed at each of the monitoring sites. Moderate levels of dissolved organic phosphorus were observed within the main channel and at northern headwater segment Sites 3, 7, and 8 and at southern headwater segment Sites 1, 6, and 9. Substantially more elevated concentrations of dissolved organic phosphorus were observed at Site 5 in the northern headwater segment and at Site 2 in the southern headwater segment. Site 5 is also characterized by substantially elevated levels of nitrogen species as well.

Low to somewhat elevated levels of particulate phosphorus were observed at the Long Branch Creek monitoring sites. Somewhat elevated concentrations of particulate phosphorus were observed at the northern headwater segment monitoring Sites 3, 5, and 8, and at the southern headwater segment Sites 1 and 2. Relatively moderate levels of particulate phosphorus were observed at each of the main channel monitoring sites.

Overall, measured phosphorus concentrations at the main channel monitoring sites are typical of phosphorus concentrations commonly observed in urban drainage systems. However, substantially more elevated phosphorus concentrations were observed at Sites 5 and 8 in the northern headwater segment, and at Sites 2, 6, and 9 in the southern headwater segment. The main channel appears to be assimilating total phosphorus rapidly since the measured concentrations at Site 11 in the main channel are substantially lower than the input concentrations from the northern headwater segment at Site 8 and the southern headwater segment at Site 9. An apparent increase in total phosphorus also occurs in the main channel between Sites 14 and 16.

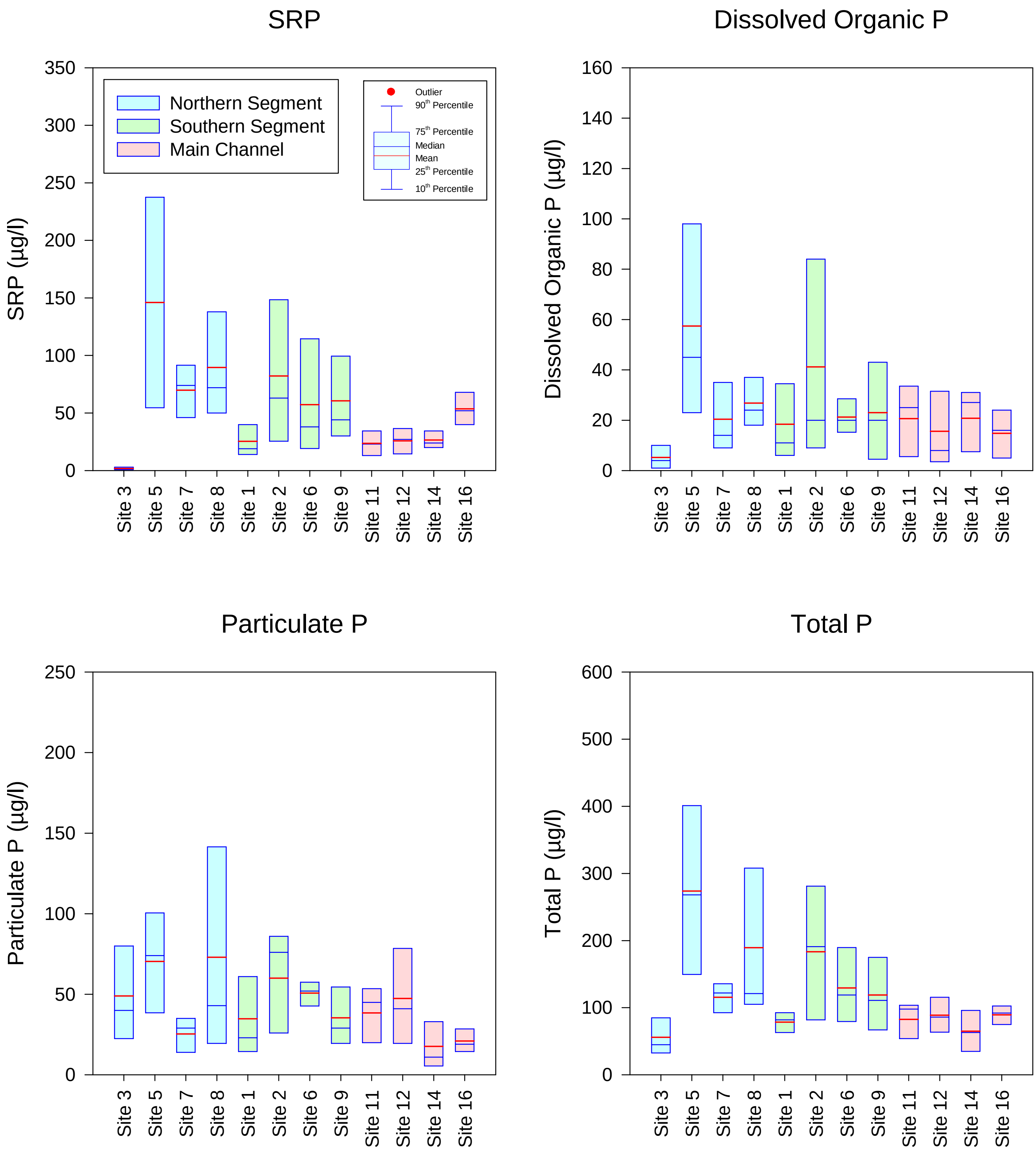


Figure 4-8. Comparison of Measured Concentrations of Phosphorus Species in the Long Branch Creek Northern/Southern Segments and Main Channel Sites.

4.3.2.2 Tributary Inflows

A comparison of log-normal mean chemical characteristics of surface water samples collected from tributary inflows to Long Branch Creek from October 2010-January 2011 is given on Table 4-6. The mean values summarized in this table reflect the mean of the log-transformed data set.

TABLE 4-6

SUMMARY OF LOG-NORMAL MEAN CHARACTERISTICS OF SURFACE WATER SAMPLES COLLECTED IN TRIBUTARY INFLOWS TO LONG BRANCH CREEK FROM OCTOBER 2010 - JANUARY 2011

SITE	ALK. (mg/l)	NH_3 (µg/l)	NO_x (µg/l)	DISS. ORG. N (µg/l)	PART. N (µg/l)	TOTAL N (µg/l)	SRP (µg/l)	DISS. ORG. P (µg/l)	PART. P (µg/l)	TOTAL P (µg/l)	TURB. (NTU)	TSS (mg/l)	Fecal Coliform (cfu/100 ml)	Color (Pt-Co)
4	232	90	37	521	174	988	71	28	78	189	2.8	3.5	812	56
10	200	37	10	355	226	735	29	7	7	47	0.7	1.2	267	52
13	201	106	224	365	42	806	51	17	59	141	3.1	4.3	3,923	53
15	154	105	169	367	80	813	21	12	12	56	1.7	2.3	3,625	43
17-Pond	148	56	8	663	319	1,082	3	13	12	35	4.6	6.5	142	25
18	180	40	31	494	108	696	24	5	18	55	1.4	2.5	883	46

Tributary inflows into the main channel were found to be well buffered, with log-normal mean alkalinity values ranging from 148-232 mg/l, which is similar to values measured at the segments and main channel sites. Measured turbidity values were generally low at the tributary inflows, with the exception of Site 17 which reflects the discharge from the large stormwater lake in the tidal portion of the basin. The elevated turbidity levels measured at this site may be indicative of algal biomass discharging through the overflow weir. A similar pattern is also exhibited by TSS, with mean concentrations ranging from 1.2-6.5 mg/l. In general, measured TSS concentrations in the tributary inflows are lower than TSS concentrations observed in the northern and southern segments and upstream portions of the main channel. The highest mean TSS concentration was also observed at Site 17, presumably due to algal biomass discharging from the pond. Measured color concentrations in the tributary inflows are similar to values measured in the headwater segments and main channel.

Mean concentrations of nitrogen species exhibited a relatively wide degree of variability between the monitored tributary inflow sites. Similar to the trend observed for the segment and main channel sites, dissolved organic nitrogen appears to be the dominant nitrogen species at each of the tributary inflow sites, comprising approximately 40-60% of the total nitrogen measured at each site. Measured particulate nitrogen was highly variable at each of the tributary inflow sites, with mean concentrations ranging from 42-319 µg/l, reflecting moderate to low concentrations.

A relatively low degree of variability was observed between measured concentrations of ammonia at the tributary inflow sites, with relatively low values observed at each site. In contrast, a high degree of variability was observed in measured NO_x concentrations, with mean values ranging from 8-224 µg/l between the tributary monitoring sites. Low levels of NO_x were observed at tributary inflow Sites 4, 10, 17, and 18, with substantially elevated concentrations observed at Sites 13 and 15. Sites 13 and 15, both of which are located north of Roosevelt Blvd., also produced the highest mean concentrations for ammonia. Overall, total nitrogen concentrations ranged from relatively low to moderate at the tributary inflow sites, with mean concentrations ranging from 696-1082 µg/l. The most elevated levels of total nitrogen were observed at Site 17 (1082 µg/l) which reflects an inflow from the large stormwater treatment lake, and Site 4 (988 µg/l) which reflects an inflow to the northern headwater segment. Nitrogen concentrations at the remaining tributary inflow sites were relatively low in value and lower in concentration than a majority of the segment and main channel sites. As a result, tributary inflows do not appear to be a significant contributor to elevated nitrogen concentrations in Long Branch Creek.

Measured concentrations of phosphorus species at the tributary inflow sites ranged from moderate to elevated, with mean concentrations ranging from 35-189 µg/l. Measured SRP concentrations in the tributary inflows ranged from 3-71 µg/l, reflecting low to elevated SRP concentrations. The most elevated SRP concentrations were observed at Site 4 (71 µg/l) and Site 13 (51 µg/l). Site 13 also contained the most elevated concentrations of inorganic nitrogen species, suggesting that inflows from this site may be a significant contributor of inorganic nutrient species. Dissolved organic phosphorus was low to moderate at the tributary inflow sites, ranging from 5-28 µg/l. The most elevated dissolved organic phosphorus concentration was observed at Site 4 which also exhibited elevated concentrations of SRP.

Measured particulate phosphorus concentrations were also highly variable, with mean values ranging from 7-78 µg/l. The most elevated levels of particulate phosphorus were observed at Site 4 which also exhibited elevated levels of dissolved organic phosphorus and SRP. Overall, measured total phosphorus concentrations were found to be moderate to elevated, with elevated values observed in the tributary inflows at Site 4 (189 µg/l) and Site 13 (141 µg/l). Measured phosphorus concentrations at the remaining tributary inflow sites are all lower than values measured in the headwater segments or main channel sites. Based upon the information summarized in Table 4-6, it appears that Site 4 may be a significant contributor of loadings of total phosphorus and total nitrogen, with Site 13 contributing significant loadings of total phosphorus and inorganic nitrogen.

Fecal coliform counts at the tributary inflow sites were highly variable, with substantially elevated fecal coliform counts observed at Sites 13 and 15, and low fecal coliform counts observed in the discharges from the stormwater management pond at Site 17. The mean fecal coliform counts measured at Sites 13 and 15 are equal to or greater than fecal coliform counts measured at any of the headwater segments or main channel sites.

A graphical comparison of measured concentrations of alkalinity, TSS, turbidity, and fecal coliform bacteria in the tributary inflows is given on Figure 4-9. Measured alkalinity values at each of the tributary inflow sites reflect well buffered conditions at the inflow sites. Measured TSS concentrations were highly variable at the inflow monitoring sites, with low TSS concentrations measured at Sites 4, 10, 15, and 18, and substantially more elevated values measured at Sites 13 and 17.

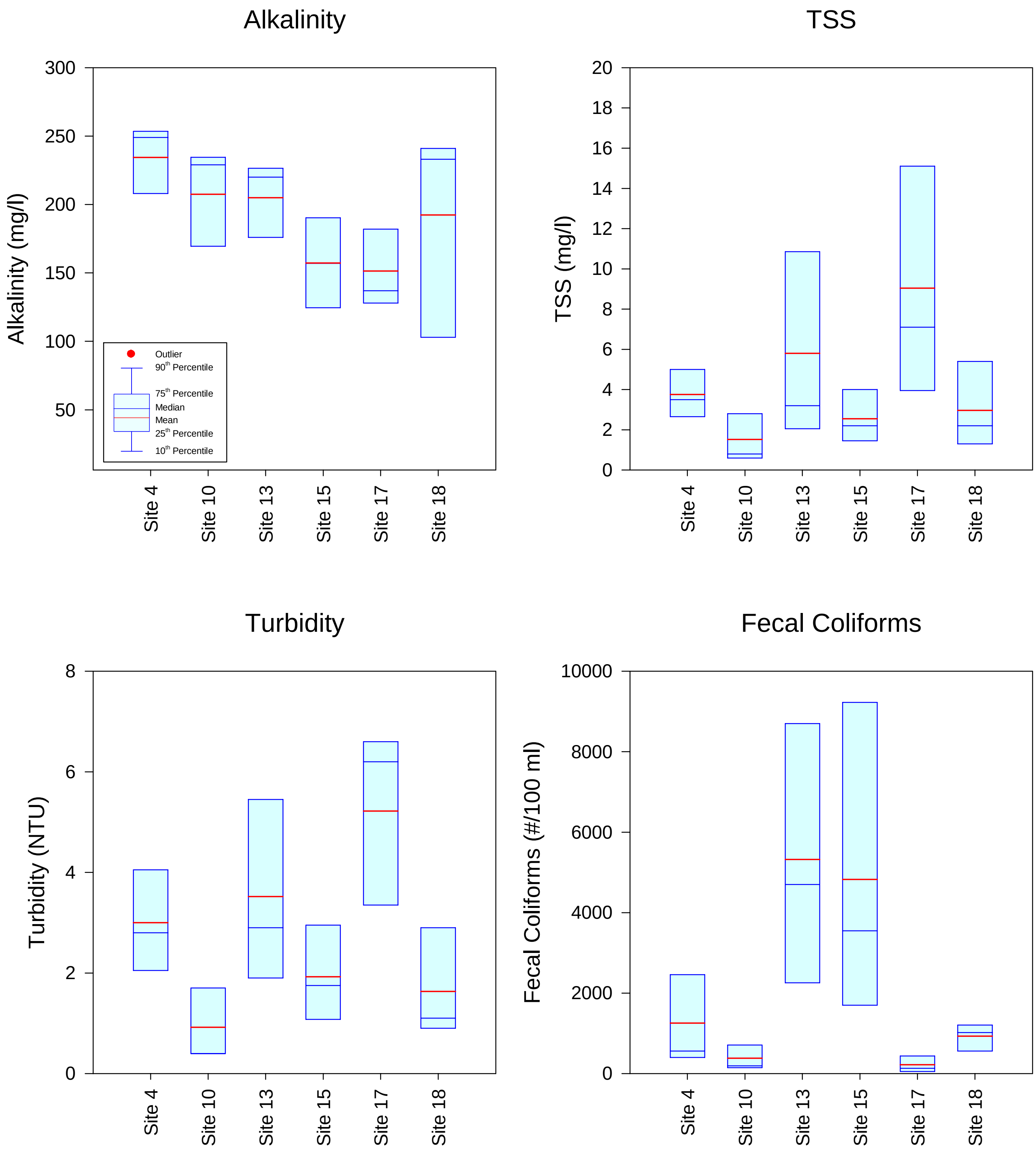


Figure 4-9. Comparison of Measured Concentrations of Alkalinity, TSS, Turbidity, and Fecal Coliform in the Long Branch Creek Tributary Inflows.

Fecal coliform counts measured at the tributary inflow sites were highly variable, with low coliform counts measured at Sites 10 and 17, reflecting mean concentrations less than the applicable Class III criterion. These are the only two sites in the entire monitoring program which met, on an average basis, the Class III fecal coliform criterion. Somewhat more elevated fecal coliform counts were observed at Sites 4 and 18, with multiple exceedances of the Class III fecal coliform criterion at each site. Substantially elevated fecal coliform counts were observed at Sites 13 and 15, with exceedances of the Class III criterion observed during every monitoring event at these sites and values in excess of 10,000 cfu/100 ml at each site during the 11/1/10 monitoring event. These sites are clearly impacted by fecal coliform contamination which does not appear to occur at the remaining tributary inflow sites.

A graphical comparison of measured nitrogen species at the tributary inflow sites is given on Figure 4-10. Low to moderate levels of ammonia were observed at each of the tributary inflow monitoring sites, with the possible exceptions of Sites 13 and 15 which exhibited somewhat more elevated concentrations. Low concentrations of NO_x were observed at monitoring Sites 10, 17, and 18, with more elevated and more variable concentrations observed at Sites 4, 13, and 15. In general, particulate nitrogen concentrations ranged from low to moderate in value at the tributary inflow sites, with low mean concentrations observed at Sites 13, 15, and 18 and more elevated values observed at the remaining sites. However, overall, total nitrogen concentrations were relatively similar between the tributary inflow sites, with the possible exception of Sites 4 and 17 which appear to exhibit slightly higher mean concentrations.

A graphical comparison of measured concentrations of phosphorus species at the tributary inflow sites is given on Figure 4-11. Relatively low levels of SRP were observed at monitoring Sites 10, 13, 15, 17, and 18, with substantially elevated SRP values measured at Site 4. Measured dissolved organic phosphorus concentrations appear to follow the pattern of other phosphorus species, with the highest concentrations observed at Site 4 and elevated concentrations at Site 13. Particulate phosphorus was found to be low in value at monitoring Sites 10, 15, 17, and 18, with more elevated and highly variable concentrations observed at Sites 4 and 13. A similar pattern is also apparent for total phosphorus, with relatively low total phosphorus concentrations measured at Sites 10, 15, 17, and 18, and higher concentrations, combined with a higher degree of variability, observed at Sites 4 and 13.

4.3.2.3 Comparison with Other Urban Drainage Systems

A tabular comparison of water quality characteristics in Long Branch Creek with water quality in other Pinellas County creeks and waterways monitored by ERD is given in Table 4-7. Water quality comparisons are provided for significant field and laboratory parameters. Water quality characteristics monitored in Long Branch Creek from October 2010-January 2011 are compared with water quality characteristics measured by ERD in Roosevelt Creek, Joes Creek, and Klosterman Bayou. Monitoring conducted by ERD in the Roosevelt Creek basin occurred from August-October 2009 and included both main channel and tributary monitoring sites, with separate mean values provided for samples collected along the main channel and tributary inflows. Monitoring conducted by ERD in Joes Creek was performed from July-September 2008, with all of the monitoring sites reflecting main channel locations. Monitoring in the Klosterman Bayou watershed was also conducted from July-September 2008, with monitoring sites that included both main channel and a tributary inflow. Mean values summarized in Table 4-7 reflect log-normal or geometric means.

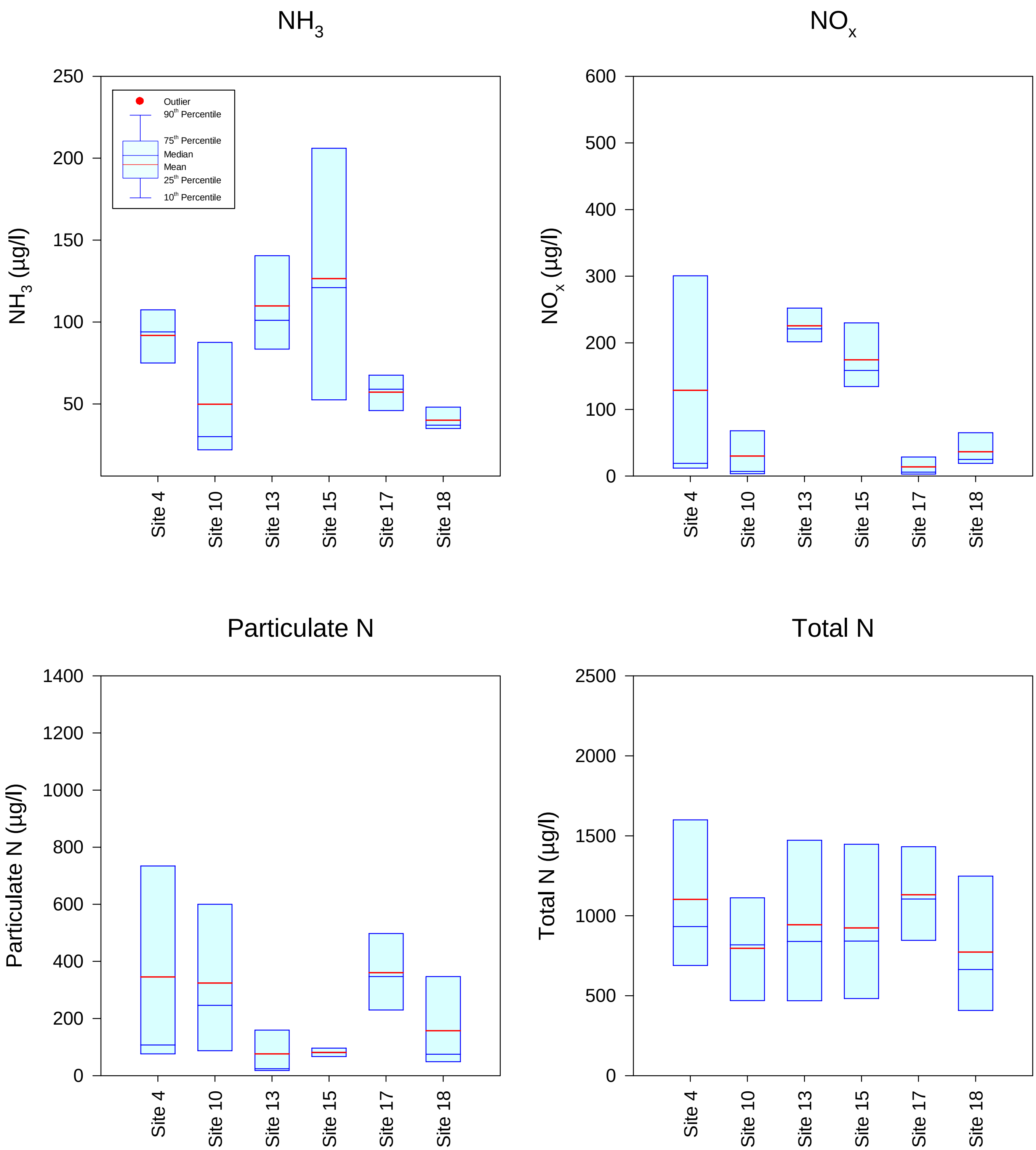


Figure 4-10. Comparison of Measured Concentrations of Nitrogen Species in the Long Branch Creek Tributary Inflows.

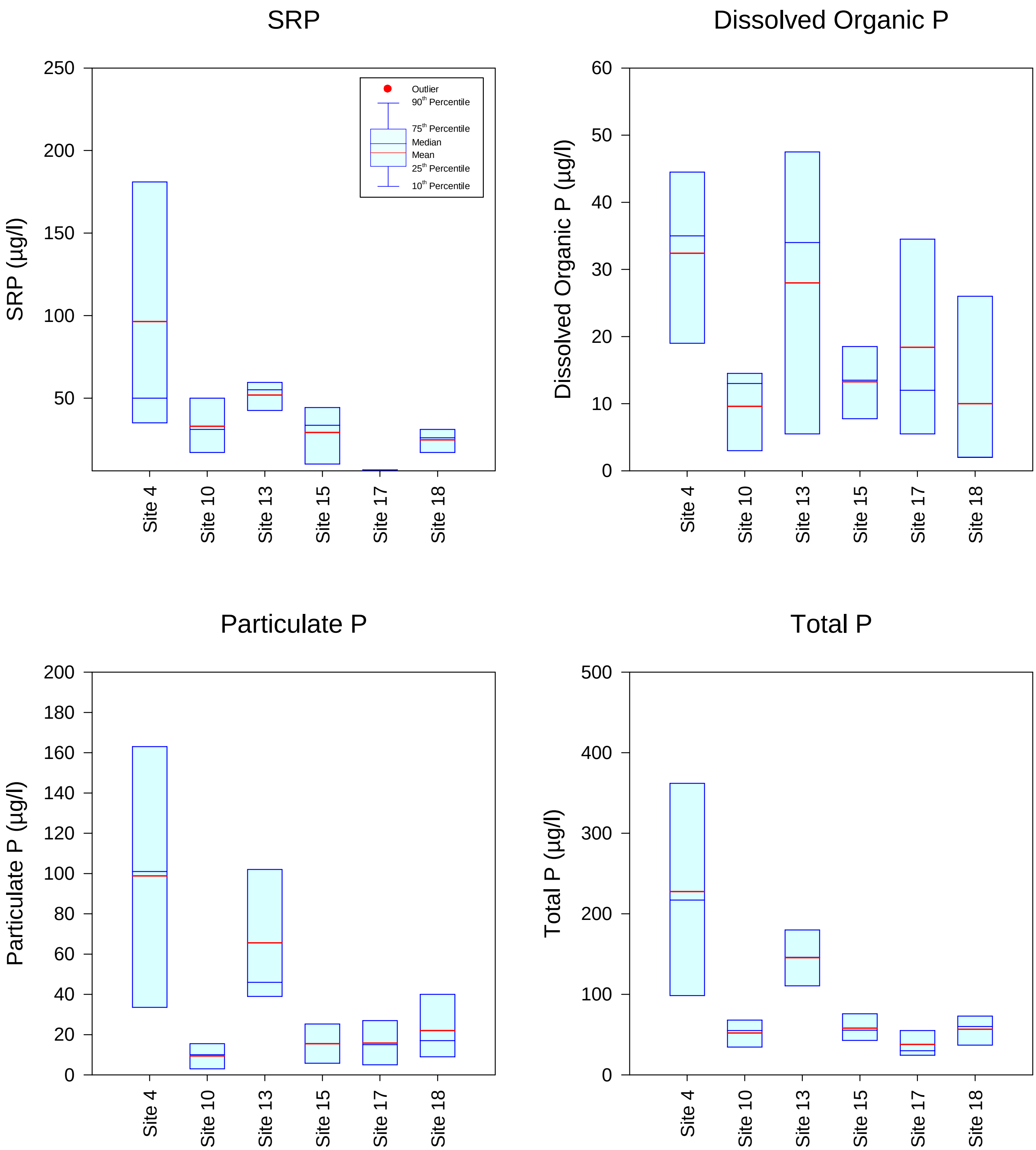


Figure 4-11. Comparison of Measured Concentrations of Phosphorus Species in the Long Branch Creek Tributary Inflows.

TABLE 4-7

COMPARISON OF WATER QUALITY CHARACTERISTICS IN LONG BRANCH CREEK WITH WATER QUALITY IN OTHER PINELLAS COUNTY CREEKS

PARAMETER	UNITS	ROOSEVELT CREEK (Aug.-Oct. 2009)		JOES CREEK (July-Sept. 2008)	KLOSTERMAN BAYOU (July-Sept. 2008)		LONG BRANCH CREEK (Oct. 2010-Jan. 2011)	
		Main Channel	Tributary		Main Channel	Tributary	Main Channel	Tributaries
pH	s.u.	7.27	7.27	7.30	7.13	7.23	7.40	7.56
Conductivity	µmho/cm	696	992	312	1020	1172	766	1056
Diss. Oxygen	mg/l	2.3	3.2	4.9	3.7	5.1	5.0	5.8
Ammonia	µg/l	474	143	58	251	138	59	66
NO_x	µg/l	66	47	16	103	95	97	38
Total N	µg/l	1837	1223	805	1872	1577	841	843
SRP	µg/l	12	26	4	648	283	28	23
Total P	µg/l	89	105	62	762	369	75	71
TSS	mg/l	5.6	3.9	9.1	5.9	5.9	2.4	2.9
Number of Sites		7	9	6	4	1	12	6
Number of Samples		34	40	36	24	6	60	27

As seen in Table 4-7, measured pH values in each of the watersheds was approximately neutral and relatively similar in value. Measured conductivity values in Roosevelt Creek and Long Branch Creek appear to be relatively similar in both main channel and tributary sites, with a slightly more elevated conductivity measured in the Klosterman Bayou watershed. A substantially lower conductivity was measured in the Joes Creek watershed. The Long Branch Creek watershed appears to exhibit dissolved oxygen concentrations which are similar to or greater than values measured in tributary or main channel monitoring sites in the other waterways.

Relatively low concentrations of ammonia were observed in Long Branch Creek, particularly in comparison with mean values measured in Roosevelt Creek and Klosterman Bayou. However, concentrations of NO_x appear to be relatively similar between Roosevelt Creek and Long Branch Creek, with somewhat more elevated concentrations measured in Klosterman Bayou and substantially lower concentrations measured in Joes Creek. Overall, total nitrogen concentrations measured in Long Branch Creek along the main channel, as well as the tributary sites, is substantially less than measured by ERD in Roosevelt Creek and Klosterman Bayou, and similar in value to total nitrogen concentrations measured in Joes Creek. Relatively low levels of SRP were observed in Long Branch Creek which are similar to values measured in Roosevelt Creek and an order of magnitude lower than SRP concentrations measured in Klosterman Bayou. Measured concentrations of total phosphorus in Long Branch Creek are also relatively similar to values measured in Roosevelt Creek and Joes Creek, but substantially lower than concentrations measured in Klosterman Bayou. Measured TSS concentrations in Long Branch Creek appear to be lower in value than measurements conducted in any of the other watersheds.

4.4 Impacts of Tributary Inflows on Main Channel Characteristics

The potential impacts on tributary inflows on main channel characteristics were evaluated using two separate techniques. First, plots of measured concentrations at the monitoring sites were generated to compare chemical characteristics in various portions of Long Branch Creek. The results of this evaluation is discussed in this section. The second method of evaluating impacts from tributary inflows involves an examination of mass loadings at various locations along Long Branch Creek. This analysis is discussed in a subsequent section.

4.4.1 Mean Flow Conditions

Graphical summaries of field measured concentrations for general parameters, nitrogen, phosphorus, and fecal coliform bacteria were generated for overall mean conditions, along with extreme low and high flow conditions within the creek to evaluate tributary impacts under a wide range of hydrologic conditions. Comparisons of mean concentrations of alkalinity, color, TSS, and fecal coliform bacteria at the Long Branch Creek monitoring sites is given on Figure 4-12. The monitoring sites are referenced in terms of distance from Belcher Road which is used as a baseline location. Distances associated with the northern and southern segments reflect perpendicular distances from Belcher Road to each monitoring location, while monitoring sites associated with the main channel are referenced in terms of actual distance along the main channel. For purposes of this analysis, it is assumed that Site 11 reflects the initial main channel monitoring site, with subsequent downstream main channel sites consisting of Sites 12, 14, and 16. Concentrations associated with tributary inflows are also included using the same distance protocol described for the segments and main channel sites.

Alkalinity values appear to increase steadily during migration through both the northern and southern segments. The tributary inflow into the northern segment monitored at Site 4 contains a somewhat elevated mean alkalinity value of approximately 232 mg/l and may have an impact on alkalinity values in the northern segment. However, alkalinity concentrations continue to increase following the introduction of the Site 4 tributary which suggests that other factors, such as groundwater inflow, may also be involved. Alkalinity values in the middle portions of the main channel appear to be relatively consistent before decreasing substantially at Site 16. Tributary inflows into the main channel at Sites 10, 13, 15, and 17 are characterized by alkalinity values lower than concentrations observed along the main channel and may be partially responsible for the decrease in alkalinity at the final monitoring site.

Mean color concentrations increased between the initial two sites in both the northern and southern segments before decreasing prior to forming the main channel. The most elevated color concentrations appear to occur in the southern segment, with substantially lower values observed in the northern segment. Color concentrations along the main channel appear to fall mid-way between concentrations observed in the northern and southern segments, with relatively similar color concentrations observed for the tributary inflows. Tributary inflows do not appear to have a significant impact on color concentrations in Long Branch Creek.

Mean TSS concentrations in the northern and southern segments appear to be somewhat elevated, particularly at the northern segment sites. The tributary inflow at Site 4 does not appear to be a significant contributor of TSS. In general, TSS concentrations along the main channel appear to be relatively low in value, with TSS concentrations monitored at Sites 10, 18, and 15 exhibiting concentrations similar to the main channel. More elevated TSS concentrations were observed at inflow Sites 13 and 17.

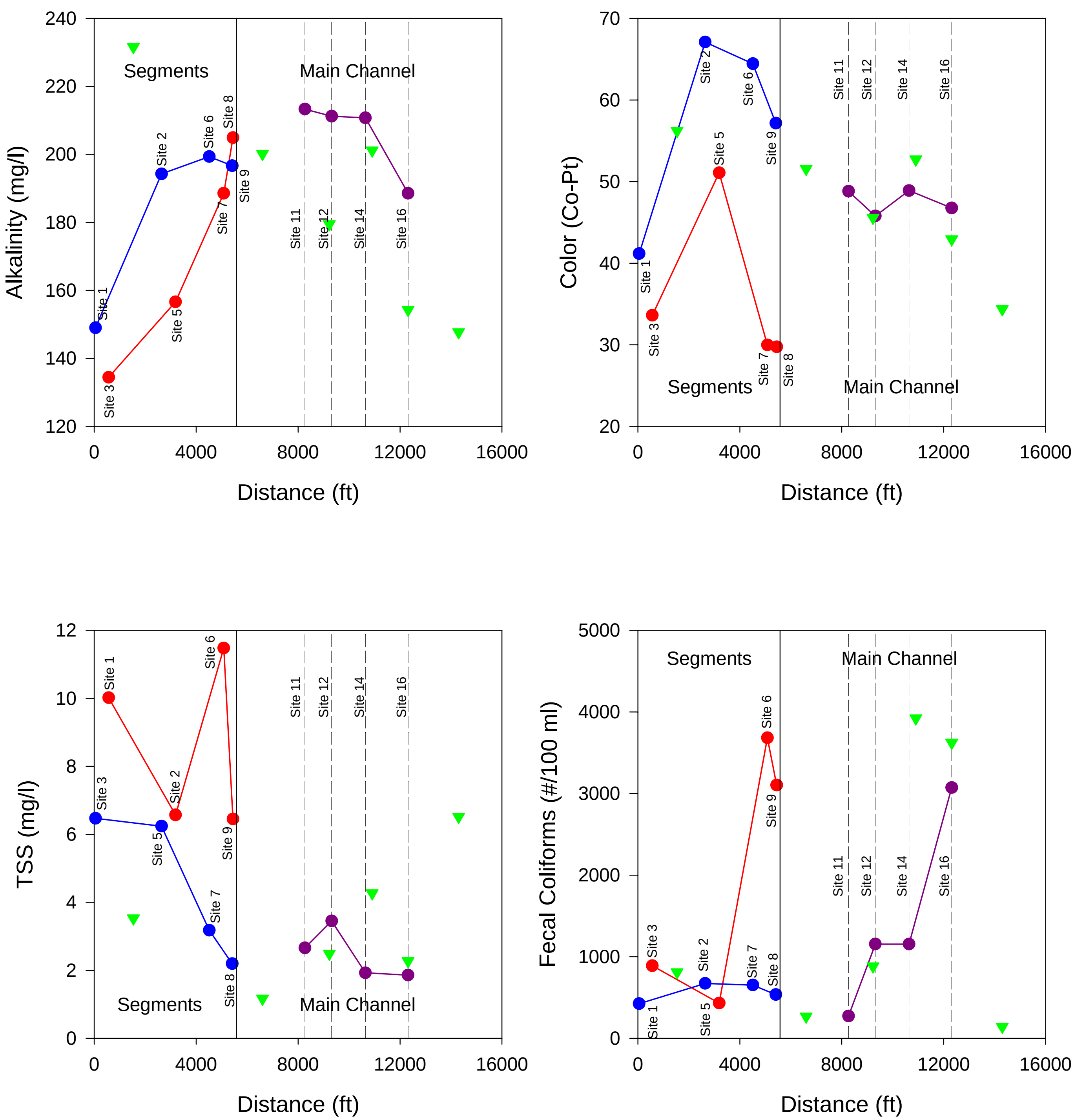


Figure 4-12. Comparisons of Mean Concentrations of Alkalinity, Color, TSS, and Fecal Coliform Bacteria at the Long Branch Creek Monitoring Sites.

Fecal coliform bacteria appear to be relatively low in value in upstream portions of both the northern and southern segments. This trend of relatively low concentrations continues throughout the southern segment, although substantial increases in mean fecal coliform concentrations were observed in the northern segment. On an average basis, the main channel begins with a relatively low fecal coliform count and increases steadily through the remainder of the main channel. The most pronounced increase in fecal coliform occurs between Sites 15 and 16. Inflows into the main channel between these sites include the tributary inflow Site 13 and runoff from the horse stables on the west side of the main channel.

A graphical summary of mean concentrations of nitrogen species measured in the northern and southern segments, main channel, and tributary inflows is given in Figure 4-13. The mean values summarized in these plots reflect the log-normal mean concentrations summarized in Table 4-5.

A substantial increase in ammonia concentrations appears to occur between Sites 3 and 5 in the northern headwater segment. The tributary inflow at Site 4 enters the northern segment between these sites, but Site 4 is characterized by a low ammonia concentration and does not appear to be the source of the observed increase in concentrations. After peaking at Site 5, ammonia concentrations in the northern segment decrease substantially at Sites 7 and 8. An increase in ammonia concentrations also occurs in the southern segment between monitoring Sites 1 and 2, although the increase is relatively minimal. A substantial reduction in ammonia concentrations occurs at downstream Sites 6 and 9. The northern and southern segment channels appear to be assimilating ammonia rapidly in the densely vegetated open channels. In general, mean ammonia concentrations along the main channel appear to be relatively low in value, with ammonia concentrations in tributary inflows similar to values observed within the main channel.

In general, concentration patterns for NO_x appear to be opposite to those observed for ammonia. The northern segment begins with an extremely low NO_x concentration at the outfall from Swan Lake, with steady increases in concentrations at the downstream monitoring sites, reaching approximately 175 μg/l at Site 8 which reflects the terminal end of the northern segment. An opposite pattern appears to occur for NO_x concentrations in the southern segment which are initially elevated at Belcher Road followed by a steady decrease in concentration, with a mean concentration of 59 μg/l at the terminal end of the southern segment. NO_x concentrations in the main channel begin at 44 μg/l at Site 11 and increase steadily to a concentration of 138 μg/l at the final monitoring site in the main channel. Tributary inflows at Sites 10, 18, and 17 are characterized by extremely low levels of NO_x which are lower in value than concentrations in the main channel. Tributary inflows designated as Sites 13 and 15 are slightly greater than concentrations along the main channel.

Measured concentrations of particulate nitrogen follow similar patterns in both the northern and southern segments. Particulate nitrogen concentrations are relatively elevated in upstream portions of both the northern and southern segments, decreasing steadily with increasing distance downstream. The tributary inflow to the northern segment at Site 4 is also characterized by a low particulate nitrogen concentration. The data suggests that particulate nitrogen may be assimilated within the vegetated portions of the northern and southern segments. Particulate nitrogen concentrations in the main channel are relatively low, and appear to decrease with increasing distance downstream. Tributary inflows at Sites 10 and 17 have particulate nitrogen concentrations slightly higher than those observed in the main channel, with the remaining tributary inflows characterized by concentrations similar to the main channel.

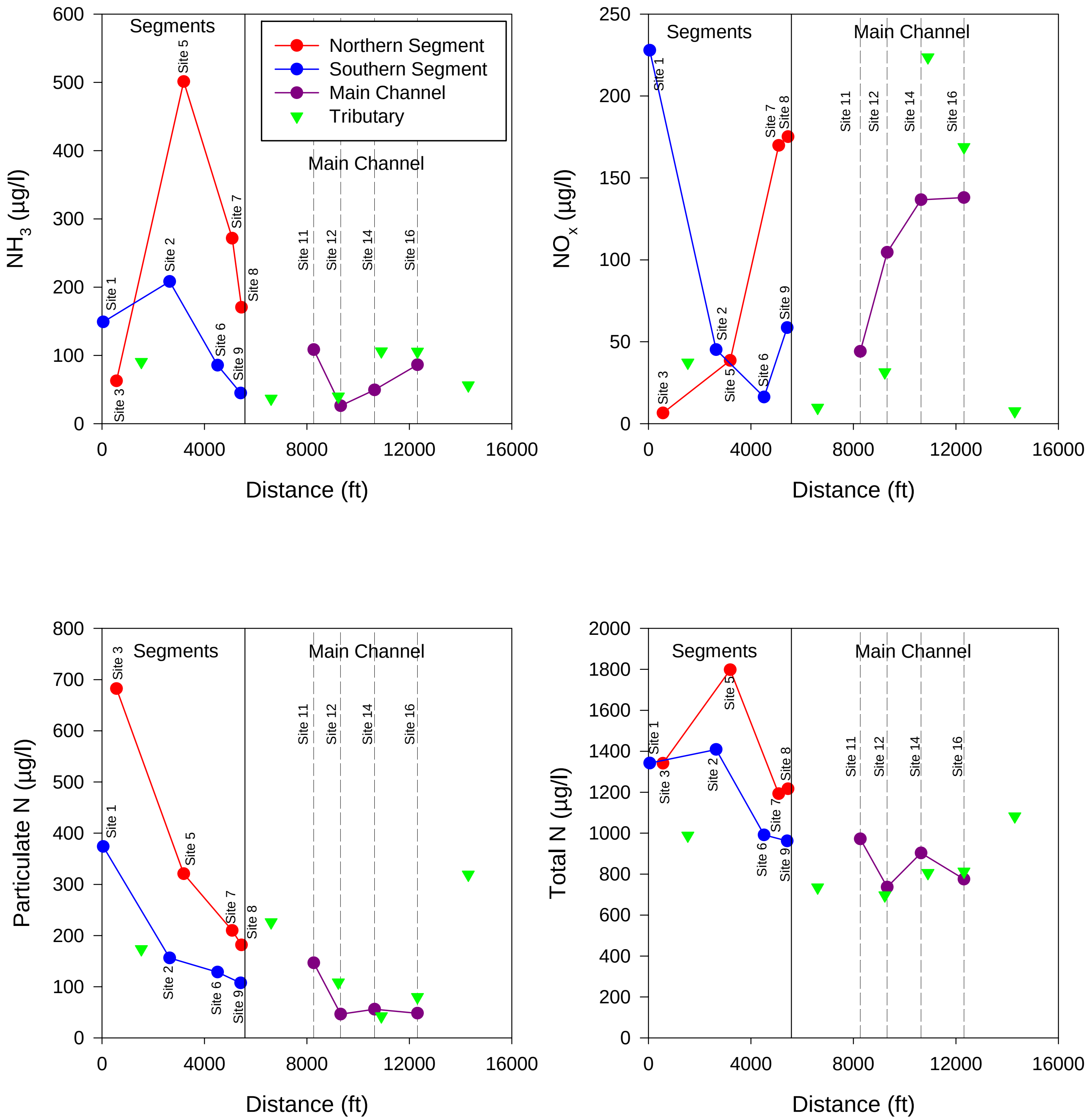


Figure 4-13. Comparisons of Mean Concentrations of Nitrogen Species at the Long Branch Creek Monitoring Sites.

Overall, both the northern and southern segments originate with moderately elevated total nitrogen concentrations of approximately 1340 µg/l. A slight increase in total nitrogen appears to occur between the first and second monitoring sites, followed by a sharp decrease in concentration in both the northern and southern segments, reaching concentrations of approximately 1200 and 960 µg/l. Mean total nitrogen concentrations in the channel are typically less than 1000 µg/l, suggesting assimilation of total nitrogen within the main channel. Tributary inflows to the main channel appear to have total nitrogen concentrations similar to concentrations in the main channel.

A graphical comparison of log-normal mean concentrations of phosphorus species measured at the Long Branch Creek monitoring sites is given on Figure 4-14. Measured SRP concentrations originate at relatively low concentrations in the extreme upstream portions of the northern and southern segments. However, SRP concentrations increase substantially in middle portions of the northern and southern segments, reaching a mean value of 116 µg/l in the northern segment and 54 µg/l in the southern segment. SRP concentrations in both the northern and southern segments decrease in downstream portions of the segments, reaching values ranging from 52-76 µg/l at the point of confluence with the main channel. Tributary inflow to the northern segment at Site 4 was characterized by a mean SRP concentration of 71 µg/l which is insufficient to generate the observed substantial increase in SRP in mid-portions of the northern segment. SRP concentrations in the main channel originate at a relatively low SRP concentration of 21 µg/l, with steady increases with increasing distance downstream, reaching a mean value of 51 µg/l at the final main channel monitoring site. SRP concentrations in tributary inflows at Sites 10, 13, 17, and 18 are all approximately equal to or less than concentrations observed in the main channel and do not appear to have a significant impact on SRP concentrations within the main channel. A more elevated SRP concentration of 51 µg/l was observed in the inflow at Site 13 which may be partially responsible for the increase in SRP concentrations observed between main channel Sites 14 and 16.

A similar pattern also appears to occur for mean concentrations of dissolved organic phosphorus, with low dissolved organic phosphorus concentrations in upstream portions of the northern and southern segments, followed by peaks in concentrations observed in mid-portions of the segments. Dissolved organic phosphorus concentrations decrease prior to combining to form the main channel, with concentrations ranging from 15-25 µg/l. Dissolved organic phosphorus concentrations in the main channel are typically low in value, ranging from 10-15 µg/l. Tributary inflows of dissolved organic phosphorus into the main channel appear to be equal to or less than concentrations observed within the main channel.

In general, particulate phosphorus concentrations in the northern and southern segments appear to exhibit a pattern similar to those observed for SRP and dissolved organic phosphorus, with relatively low concentrations in upstream portions of the northern and southern segments followed by increases in mid-portions of the sediments. Particulate phosphorus concentrations in the tributary inflow to the northern segment at Site 4 are substantially higher than observed in the northern segment and may be partially responsible for the increase in concentrations observed in mid-portions of the segment. Particulate phosphorus concentrations in the main channel are typically low in value, with an observed general trend of decreasing concentrations with increasing distance. Measured tributary inflow concentrations of particulate phosphorus appear to be equal to or less than concentrations observed in the main channel. The only exception to this appears to be particulate phosphorus concentrations at Site 13 which may be partially responsible for the observed increase in particulate phosphorus between main channel Sites 14 and 16.

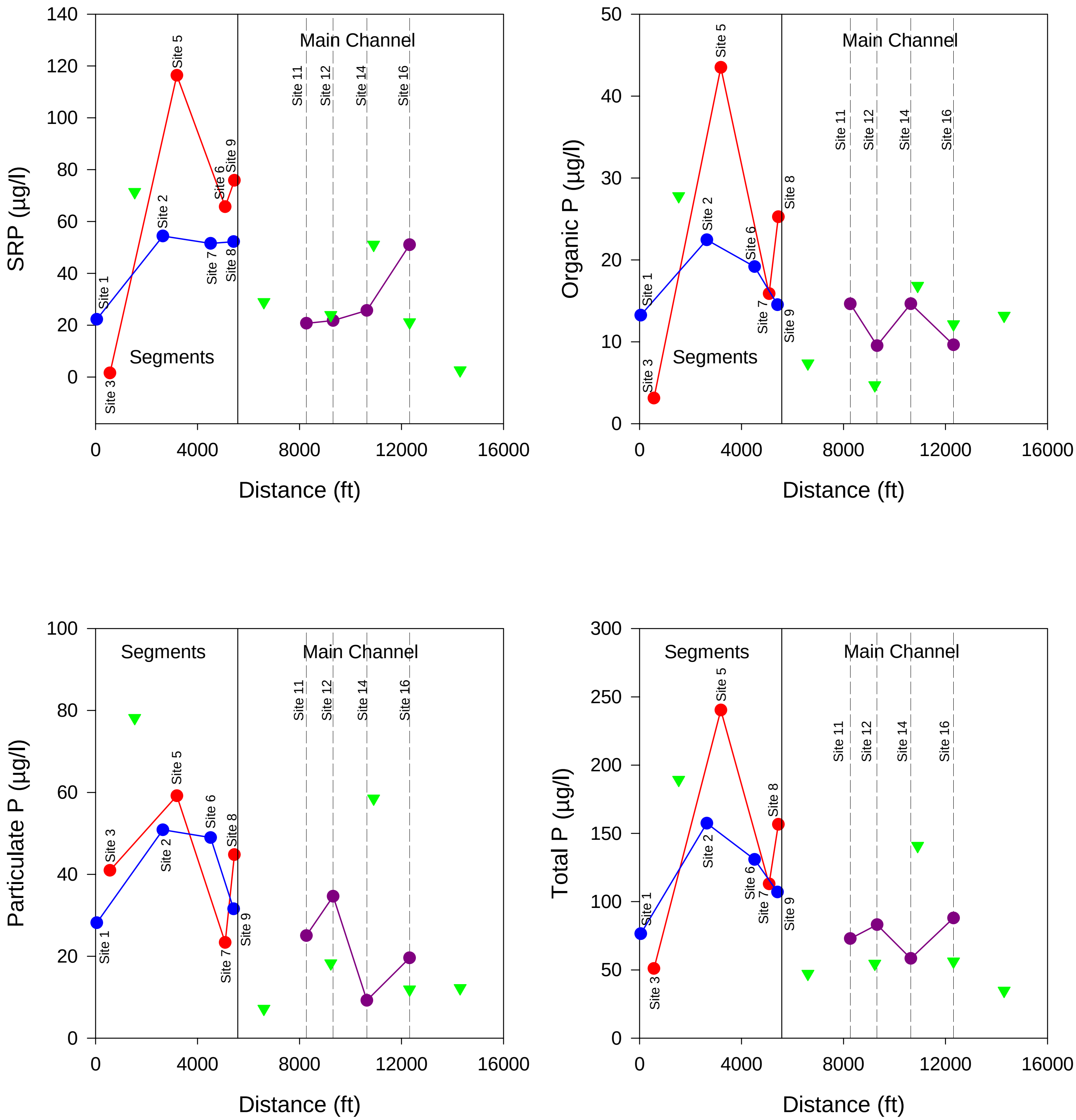


Figure 4-14. Comparisons of Mean Concentrations of Phosphorus Species at the Long Branch Creek Monitoring Sites.

Overall, total phosphorus concentrations observe a pattern similar to that previously discussed for other phosphorus species. Total phosphorus concentrations in upstream portions of the northern and southern segments range from 51-76 μg/l, increasing to 157 and 240 μg/l in mid-portions of the northern and southern segments, with concentrations of 107 and 157 μg/l finally discharging into the main channel. Total phosphorus concentrations in the main channel are lower in value than observed in the northern and southern segments, ranging from 58-88 μg/l. With the exception of tributary inflow at Site 13, tributary inflows into the main channel are characterized by total phosphorus concentrations equal to or less than concentrations in the main channel and do not appear to be a significant contributor of overall loadings. A somewhat more elevated total phosphorus concentration was observed at tributary Site 13 which may be partially responsible for the observed increase in total phosphorus between Sites 14 and 16 on the main channel.

4.4.2 Low Flow Conditions

A graphical comparison of measured concentrations of alkalinity, color, TSS, and fecal coliform bacteria at the Long Branch Creek monitoring sites under low flow conditions on December 7, 2010 is given on Figure 4-15. During this monitoring event, inflows from tributaries were minimal, and changes in chemical characteristics primarily reflect changes which occur as a result of inputs into the northern and southern segments and main channel other than tributary inflows.

The observed patterns for alkalinity in the northern and southern segments and main channel are similar to those summarized in Figure 4-12 for overall mean conditions, with the exception that measured alkalinity values appear to be slightly higher under low flow conditions. Alkalinity concentrations continue to increase with increasing distance in both the northern and southern segments, with relatively consistent concentrations observed along the main channel. With the exception of Site 4, which reflects a tributary inflow into the northern segment, alkalinity concentrations in tributary inflows appear to be lower than concentrations observed along the main channel.

The trend exhibited by color during low flow conditions also appears to be similar to the overall mean characteristics, with more elevated color concentrations observed in the southern segment and peaks in color in mid-portions of both the northern and southern segments. Color concentrations in the main channel appear to be relatively consistent, with tributary inflow values approximately equal to or less than values measured in the main channel.

Somewhat elevated concentrations of TSS were observed in upstream portions of the northern segment, followed by decreases in mid-portions of the segment. Final TSS concentrations in the northern and southern segments are relatively low in value at the point of confluence with the main channel. Low concentrations were also observed in the main channel under low flow conditions. Tributary inflows at Sites 18, 13, and 15 reflect elevated values compared with main channel characteristics.

The observed pattern for fecal coliform bacteria under low flow conditions is similar to the pattern observed under overall mean conditions. Relatively low fecal coliform counts were observed in the southern segment, with substantially elevated concentrations observed in downstream portions of the northern segment. Fecal coliform counts in the main channel originate at low values and increase steadily with increasing distance downstream. Fecal coliform counts in tributary inflows at Sites 18 and 15 appear to be greater than concentrations observed in the main channel.

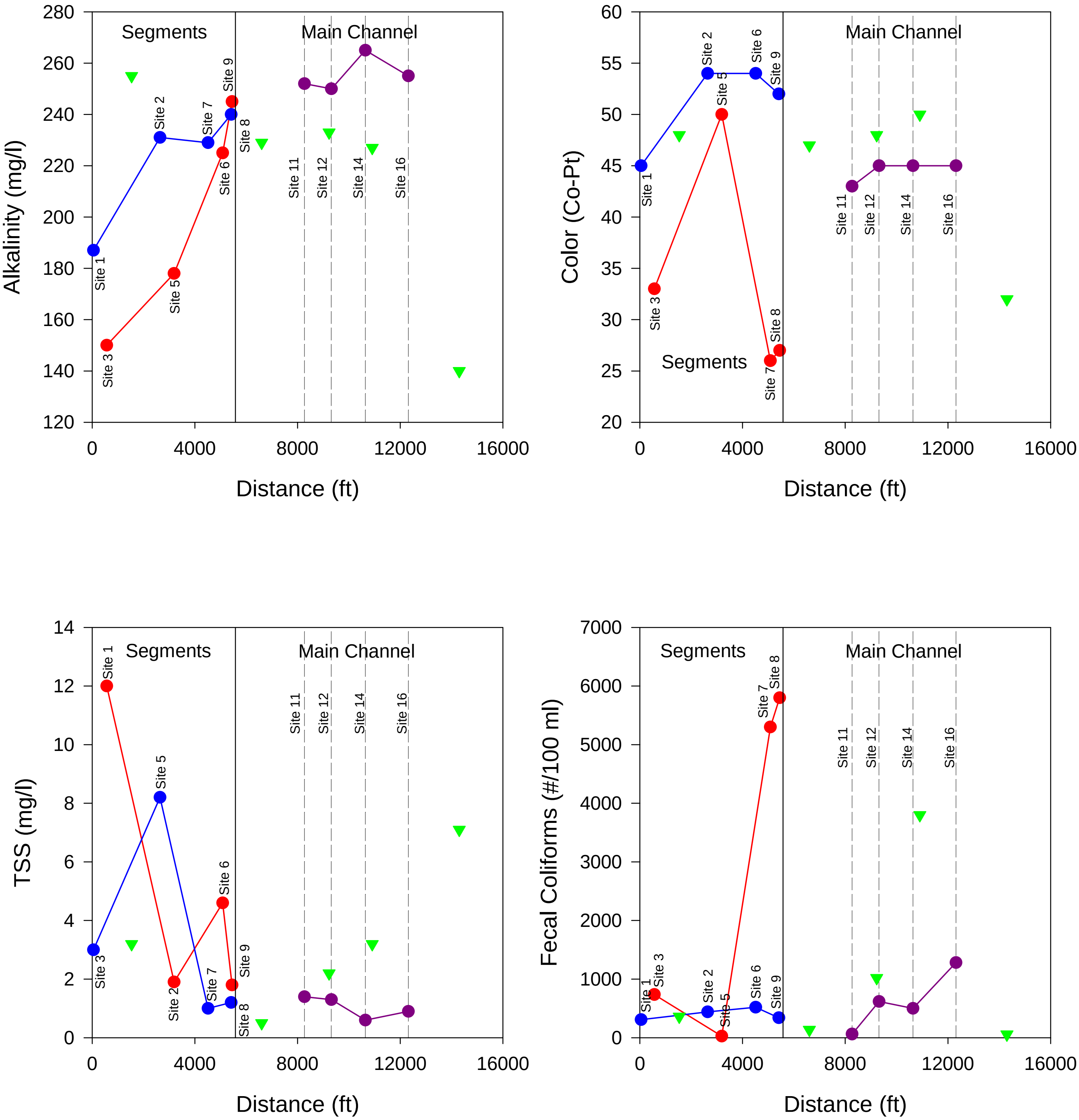


Figure 4-15. Comparison of Measured Concentrations of Alkalinity, Color, TSS, and Fecal Coliform Bacteria at the Long Branch Creek Monitoring Sites Under Low Flow Conditions (December 7, 2010).

A graphical comparison of measured concentrations of nitrogen species at the Long Branch Creek monitoring sites under low flow conditions on December 7, 2010 is given on Figure 4-16. In general, the patterns observed for concentrations of nitrogen species under low flow conditions is similar to the patterns observed under overall mean conditions. Increases in ammonia concentrations were observed in mid-portions of both the northern and southern segments, with somewhat elevated concentrations observed in the northern segment. The tributary inflow into the northern segment at Site 4 is characterized by concentrations less than those observed in the northern segment. Main channel ammonia concentrations appear to be relatively low in value, with no significant impacts from tributary inflows with the exception of slightly higher ammonia concentrations observed at the tributary inflow at Site 15.

The general pattern for NO_x concentrations under low flow conditions is very similar to the pattern observed under overall mean conditions, with the exception of more elevated NO_x concentrations. NO_x concentrations along the main channel appear to be relatively consistent in value, with tributary inflow concentrations generally lower than those observed in the main channel with the exception of Site 15.

Concentration patterns for particulate nitrogen under low flow conditions are also similar to characteristics under overall mean conditions. Particulate nitrogen concentrations decreased steadily with increasing distance in both the northern and southern segments. A trend of decreasing concentration with increasing distance is also apparent in the main channel. Tributary inflows of particulate nitrogen to both the segments and main channel appear to be equal to or less than values measured in main portions of the system.

Overall, total nitrogen concentrations under low flow conditions appear to be lower than observed under overall mean conditions, particularly in the northern and southern segments. Measured total nitrogen concentrations along the main channel appear to be relatively consistent in value, with tributary inflow concentrations generally less than those observed along the main channel.

A graphical comparison of measured concentrations of phosphorus species at the Long Branch Creek monitoring site under low flow conditions on December 7, 2010 is given on Figure 4-17. In general, the observed patterns for phosphorus species under low flow conditions are very similar to the patterns exhibited by phosphorus species under overall mean conditions, with the exception that phosphorus concentrations are typically lower in value for all measured species during low flow conditions. Measured SRP concentrations in the main channel increase with increasing distance downstream under low flow conditions, similar to the conditions observed under overall mean conditions. Dissolved organic phosphorus concentrations in the main channel under low flow conditions are extremely low in value, with a trend of decreasing concentration with increasing distance downstream. Substantially more elevated organic phosphorus concentrations were observed at monitoring Sites 15 and 17. Measured particulate phosphorus concentrations under low flow conditions were low in value, with more elevated concentrations observed in the northern and southern segments, and substantially lower concentrations observed in the main channel. In general, tributary inflow concentrations were equal to or less than those observed along the segment and main channel portions of the creek, with the exception of tributary inflow Site 15 which was characterized by a somewhat elevated value.

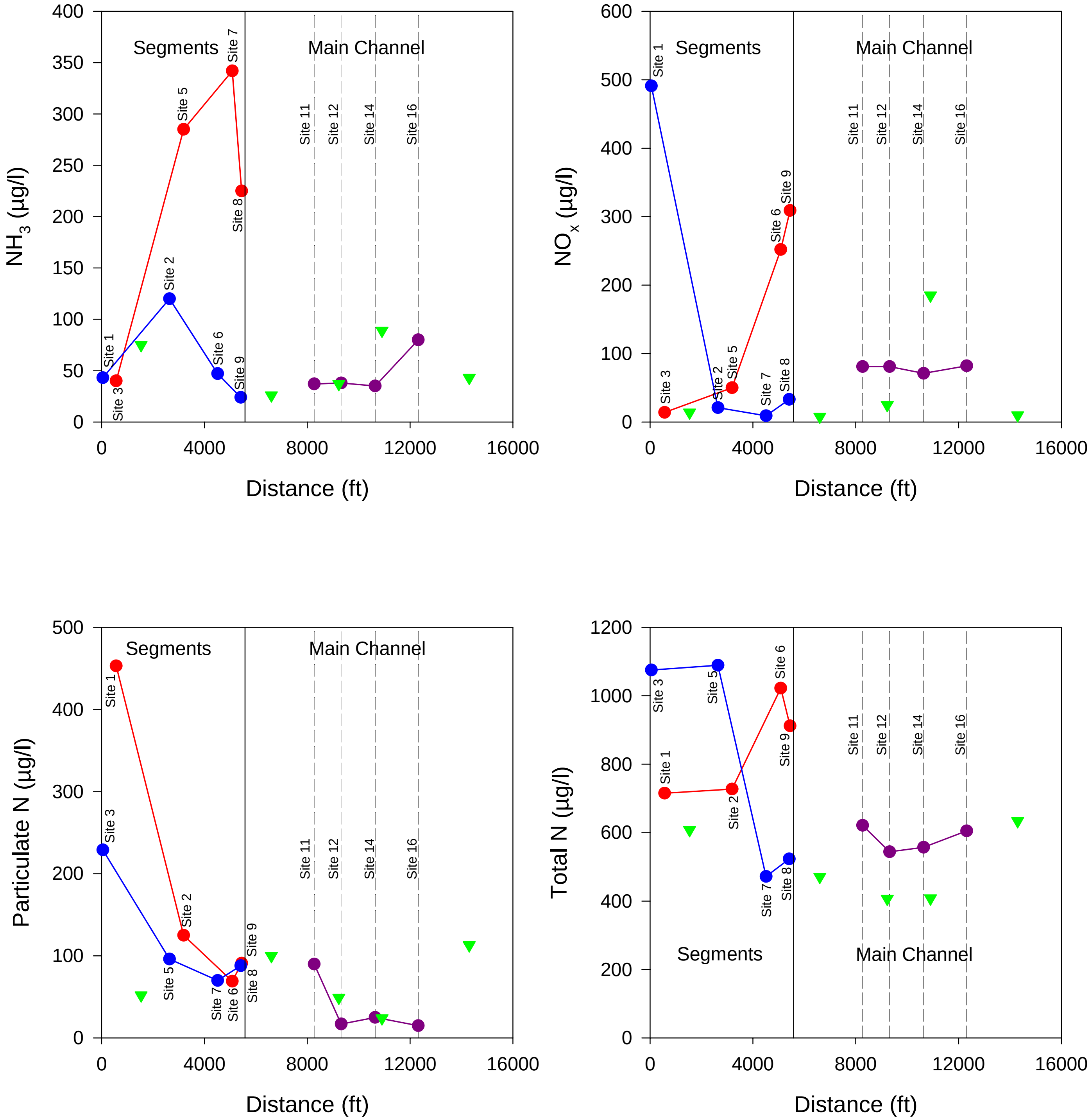


Figure 4-16. Comparison of Measured Concentrations of Nitrogen Species at the Long Branch Creek Monitoring Sites Under Low Flow Conditions (December 7, 2010).

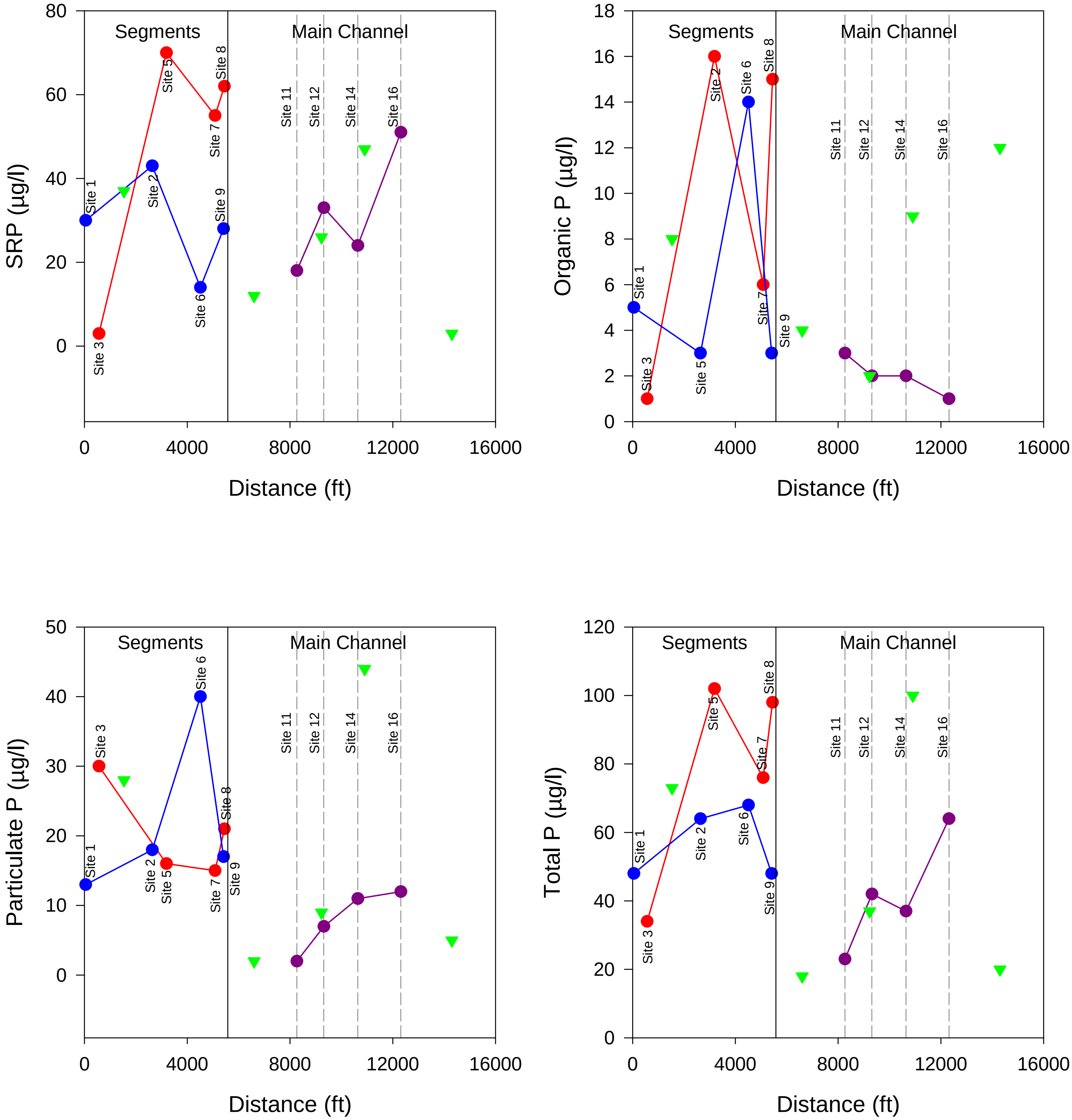


Figure 4-17. Comparison of Measured Concentrations of Phosphorus Species at the Long Branch Creek Monitoring Sites Under Low Flow Conditions (December 7, 2010).

Overall, concentration patterns for total phosphorus under low flow conditions are very similar to those observed under overall mean conditions, with the exception of lower concentration values. Total phosphorus concentrations in the northern and southern segments appear to increase with increasing distance downstream. Total phosphorus concentrations in the main channel begin at a relatively low value but increase steadily with increasing distance downstream. With the exception of the tributary inflow at Site 15, tributary inflow concentrations of total phosphorus were equal to or less than concentrations observed in the main channel.

4.4.3 High Flow Conditions

A graphical comparison of measured concentrations of alkalinity, color, TSS, and fecal coliform bacteria at the Long Branch Creek monitoring sites during high flow conditions on January 18, 2011 is given on Figure 4-18. Monitoring was conducted the day following a 2.88-inch rain event in the watershed area. Discharges through the system on this date were the highest observed during the entire field monitoring program.

Under high flow conditions, measured alkalinity concentrations in both the northern and southern segments and main channel were substantially lower in value than observed during the other monitoring events. Measured concentrations in the tributary inflows were also lower in value under high flow conditions, although several of the tributary inflow sites were characterized by alkalinity values greater than observed along the segments or main channel.

Measured color concentrations in the northern and southern segments and main channel sites were also lower in value during high flow conditions, although the same general trend of changes in concentrations were similar to those observed under overall mean conditions. Mean color concentrations within the main channel under high flow conditions range from about 33-36 Pt-CO units, with concentrations ranging from 46-50 Pt-Co units under overall mean conditions. In general, measured concentrations of TSS in the southern segment and main channel under high flow conditions were similar to overall mean characteristics, although somewhat higher TSS concentrations were measured in the northern segment under high flow conditions.

Measured fecal coliform counts were highly variable under virtually all flow conditions. A substantial peak in fecal coliform counts was observed in mid-portions of the southern segment under high flow conditions which was not present under mean or low flow conditions. Elevated concentrations of fecal coliform were observed throughout the southern segment during high flow conditions as opposed to low flow conditions where the elevated concentrations were limited to downstream portions of the northern segment. Elevated concentrations of fecal coliform were observed throughout the main channel under high flow conditions, although tributary inflows were generally characterized by lower fecal coliform counts than observed in the main channel. The only exception to this appears to be Site 15 which was characterized by substantially higher elevated fecal coliform counts.

A comparison of measured concentrations of nitrogen species at the Long Branch Creek monitoring site during high flow conditions on January 18, 2011 is given on Figure 4-19. Changes in nitrogen species appear to be very different within Long Branch Creek under high flow conditions as compared with low flow or overall mean conditions. Under high flow

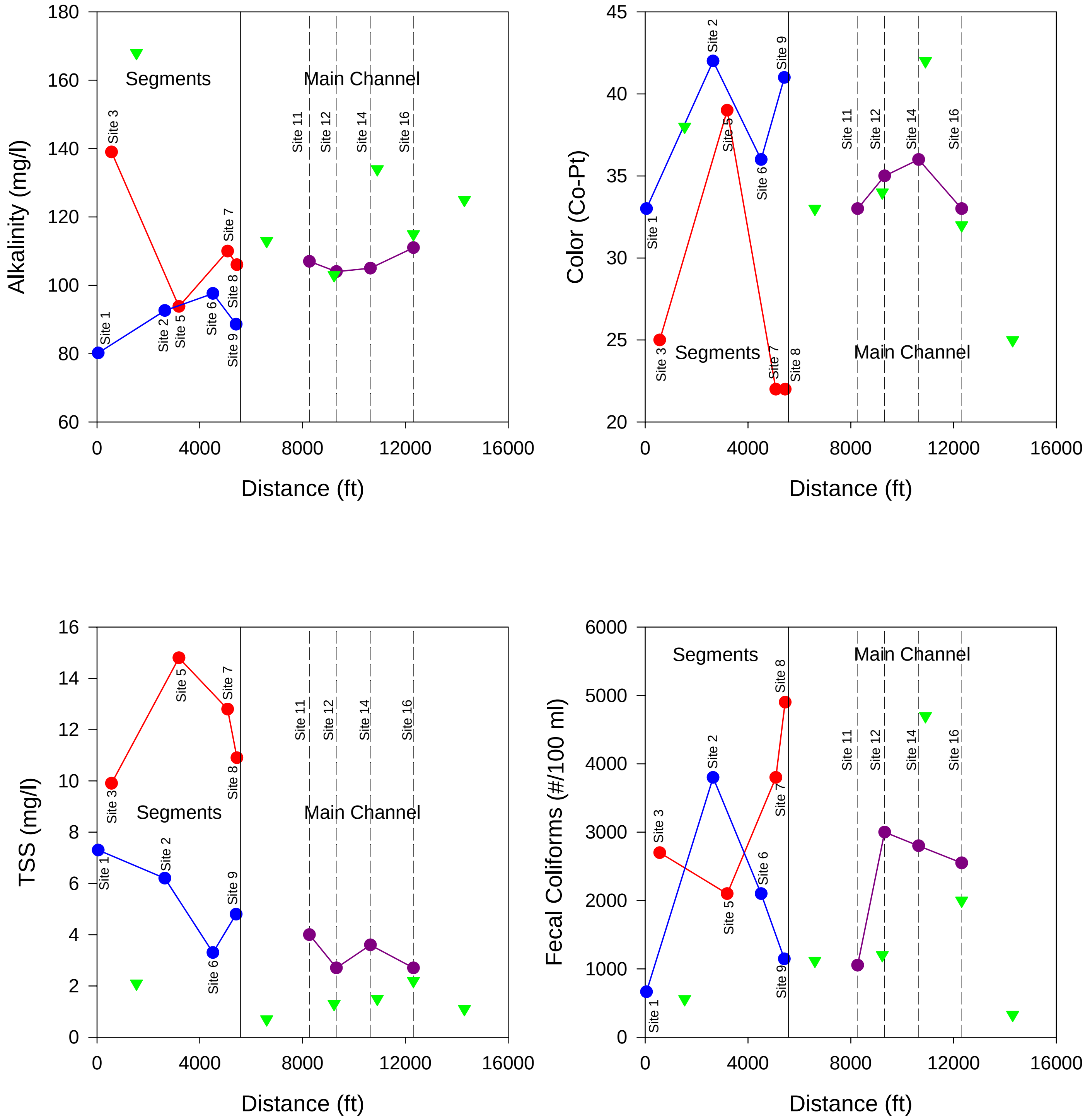


Figure 4-18. Comparison of Measured Concentrations of Alkalinity, Color, TSS, and Fecal Coliform Bacteria at the Long Branch Creek Monitoring Sites Under High Flow Conditions (January 18, 2011).

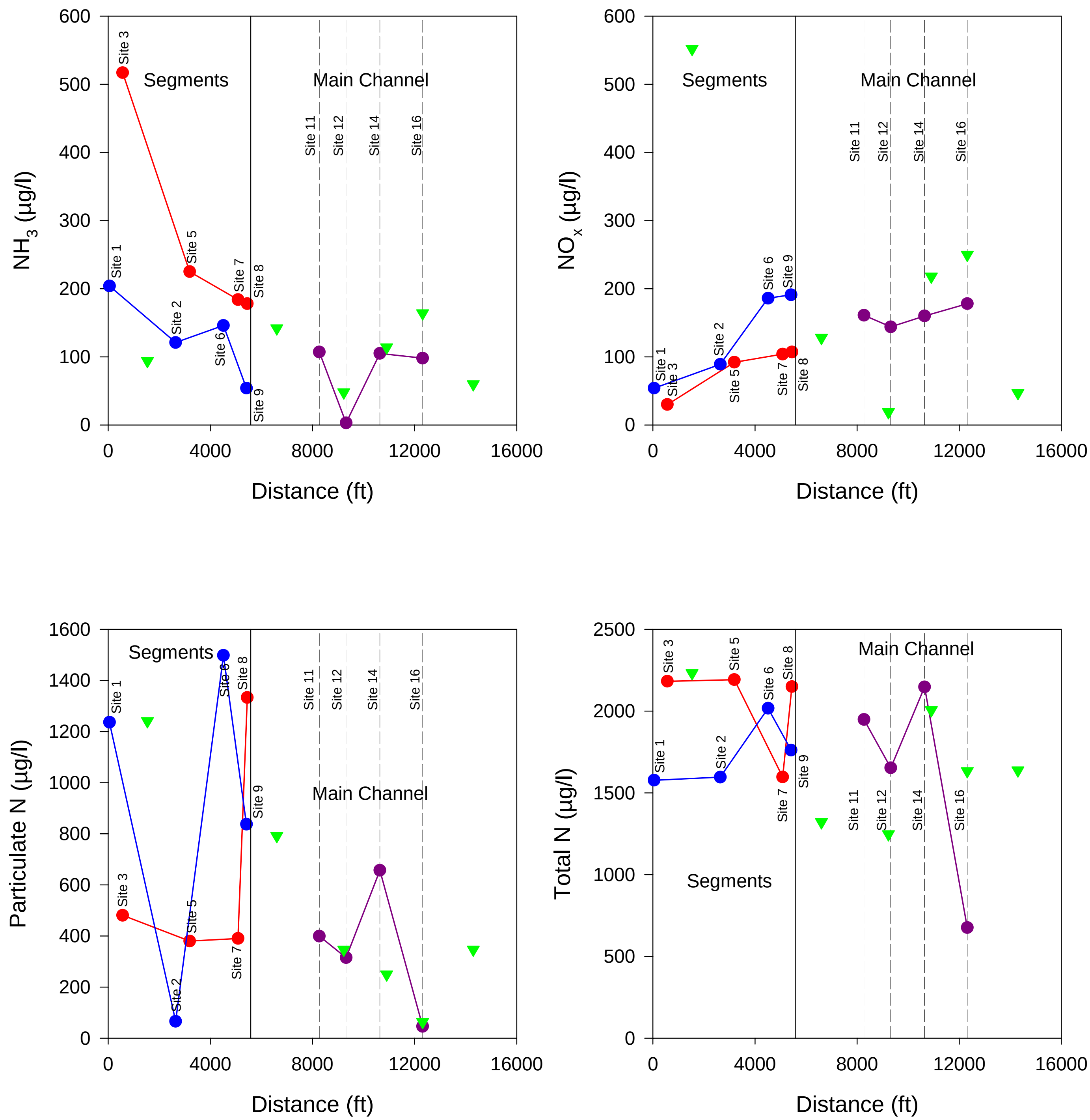


Figure 4-19. Comparison of Measured Concentrations of Nitrogen Species at the Long Branch Creek Monitoring Sites Under High Flow Conditions (January 18, 2011).

conditions, ammonia concentrations reached peak values at the initial upstream portions of both the northern and southern segments, followed by decreases in concentrations with increasing distance downstream. Measured concentrations of ammonia in the main channel are typically low in value. Tributary inflows appear to have concentrations approximately equal to or less than ammonia concentrations measured in the segments and main channel.

Under high flow conditions, NO_x concentrations were found to be initially low in value in the headwaters of both the northern and southern segments, followed by a steady increase with increasing distance downstream. A slight trend of increasing concentration was observed in the main channel, although the measured concentrations were moderate in value. Tributary inflow concentrations of NO_x were roughly similar to or less than concentrations measured in the main channel, with the exception of the inflow to the northern segment at Site 4 which was characterized by a substantially elevated NO_x concentrations, primarily during high flow conditions.

Particulate nitrogen concentrations under high flow conditions were highly variable in both the northern and southern segments, with increases and decreases in concentrations observed between the various monitoring locations. Particulate nitrogen concentrations in the main channel were higher under high flow conditions than observed under mean or low flow conditions. An extremely low particulate nitrogen concentration was observed at Site 16 which may be influenced by tidal movement at that site. In general, particulate nitrogen concentrations at the tributary inflow sites appear to be similar to or less than concentrations in the segments or main channel with the exception of the Site 10 inflow which was characterized by concentrations twice that observed at the downstream main channel monitoring site.

Overall, total nitrogen concentrations appear to be substantially higher during high flow conditions than observed under overall mean or low flow conditions. Total nitrogen concentrations in the segments and main channel range from approximately 1600-2200 µg/l at a majority of the sites, with the exception of the final main channel monitoring site which was characterized by an extremely low total nitrogen concentration. Inflow concentrations of total nitrogen from the tributaries appear to be equal to or less than concentrations measured in the segments or main channel.

A comparison of measured concentrations of phosphorus species at the Long Branch Creek monitoring site during high flow conditions on January 18, 2011 is given on Figure 4-20. The observed trends in phosphorus concentrations under high flow conditions appear to be similar to the general characteristics observed under overall mean discharge conditions. Increases in SRP concentrations were observed in both the northern and southern segments with increasing distance downstream, with relatively uniform SRP concentrations observed in the main channel. With the exception of Site 4, which reflects an inflow into the northern headwater segment, measured SRP concentrations at tributary inflows were less than or equal to concentrations in the main channel.

In general, dissolved organic phosphorus concentrations appear to be slightly greater during high flow conditions than observed under overall mean conditions, but very elevated compared to low flow conditions. Increases in concentrations of dissolved organic phosphorus concentrations occur in both the northern and southern segments with increasing distance. However, relatively moderate concentrations were observed within the main channel. With the exception of Site 4 (which reflects a tributary inflow to the northern segment) and Site 13 (which reflects a tributary inflow to the main channel), tributary inflows were characterized by concentrations equal to or less than concentrations in the segments or main channel.

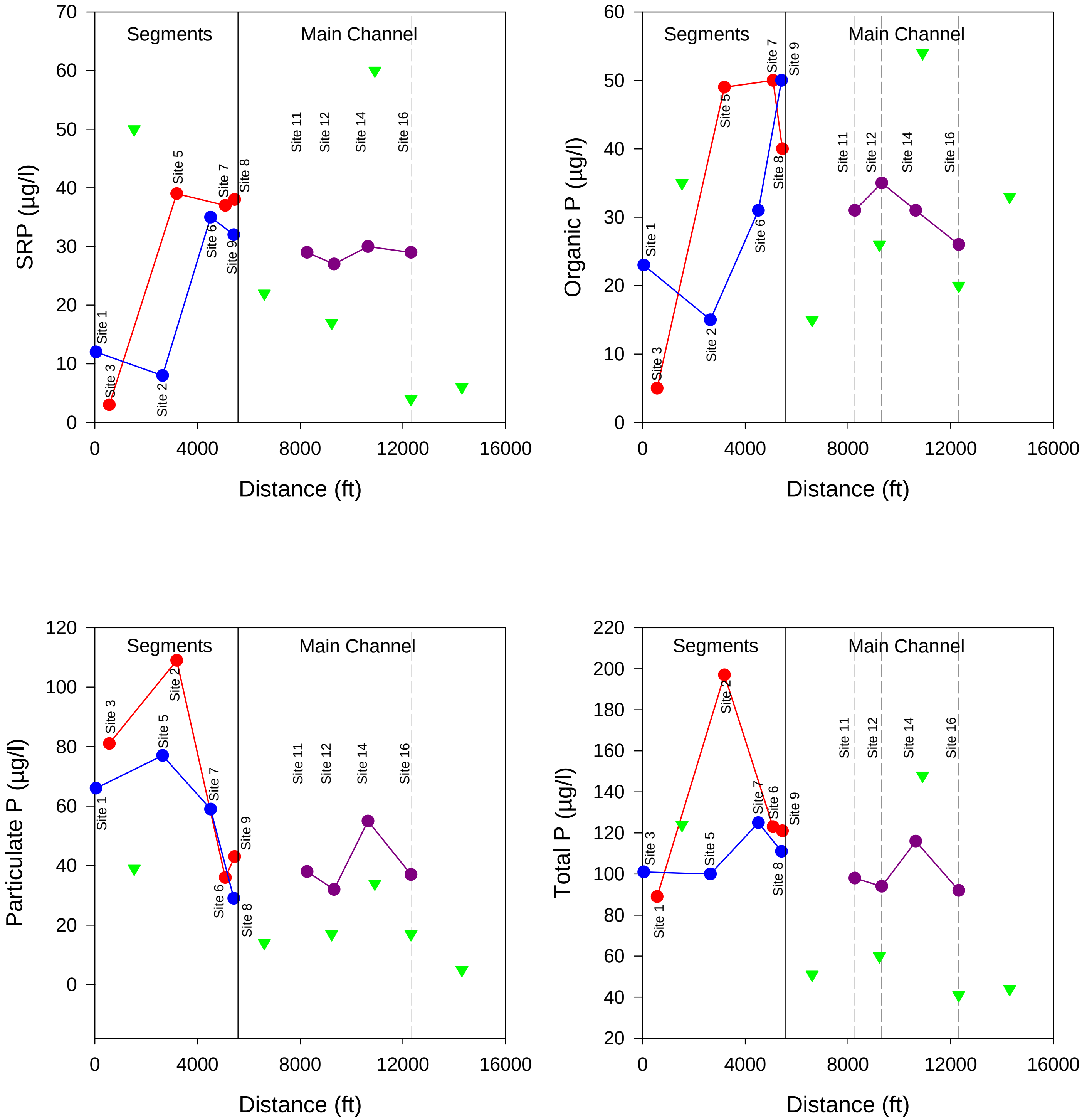


Figure 4-20. Comparison of Measured Concentrations of Phosphorus Species at the Long Branch Creek Monitoring Sites Under High Flow Conditions (January 18, 2011).

Measured particulate phosphorus concentrations in the northern and southern segments increase in mid-portions of the segments prior to decreasing at the point of confluence into the main channel. Overall, main channel concentrations were relatively uniform although higher in value than observed under overall mean conditions. Tributary inflow concentrations of particulate phosphorus were found to be lower than concentrations measured in the segments and main channel.

Overall, total phosphorus concentrations in the segments and main channel appear to be much higher under high flow conditions than under low flow conditions. With the exception of Site 13 (which reflects an inflow to the main channel), tributary inflow concentrations of total phosphorus appear to be less than concentrations observed in the main channel.

4.4.4 Summary

A discussion of water quality characteristics in Long Branch Creek under low flow and high flow conditions, along with mean overall conditions, was provided in the previous sections to assist in identifying the significance of stormwater runoff as a source of loadings to Long Branch Creek. Measured concentrations of alkalinity appeared to be substantially higher within Long Branch Creek during low flow conditions than observed under high flow conditions, suggesting the significance of a high alkalinity groundwater source under low flow conditions. The lower alkalinity values observed under high flow conditions suggest that stormwater runoff may be diluting the alkalinity contributed from the groundwater inflows. Color concentrations also appeared to be higher in both the segments and main channel sites under low flow conditions than during high flow conditions. This pattern suggests that contributions from high color sources (such as wetlands) are more significant under low flow conditions and become diluted under high flow conditions.

In contrast, measured concentrations of TSS appear to be higher in value at many of the sites during high flow conditions as compared with low flow conditions. This suggests that stormwater runoff may be a significant contributor of TSS loadings, although the differences in concentrations in TSS between low and high flow conditions are relatively minimal. With the exceptions of Sites 7 and 8 located in the northern headwater segment, fecal coliform counts appear to be lower in value under low flow conditions and substantially higher in value during high flow conditions, suggesting that stormwater may contribute significant fecal coliform loadings. However, fecal coliform counts during low flow conditions exceeded the applicable Class III criteria within the segment and main channel sites during most events.

The significance of runoff as a contributor of ammonia is inconclusive since both elevated and low concentrations were observed at various sites under both low and high flow conditions. A similar pattern is apparent for NO_x, although main channel concentrations for NO_x appear to be somewhat greater during high flow conditions. Concentrations of particulate phosphorus appear to be higher in value throughout most of Long Branch Creek during high flow conditions, along with total nitrogen. Therefore, it appears that concentrations and loadings of particulate nitrogen and total nitrogen are substantially enhanced under high flow conditions compared with low flow conditions.

No distinct pattern in concentrations of SRP is apparent between low flow and high flow conditions, with both high and low concentrations observed in the segments and main channel sites during both conditions. However, measured concentrations of organic phosphorus, particulate phosphorus, and total phosphorus appear to be substantially greater during high flow conditions than under low flow conditions, suggesting that stormwater runoff may be a significant contributor to phosphorus loadings within Long Branch Creek.

4.5 Mass Loadings

Estimates of mass loadings discharging through the Long Branch Creek watershed were calculated for species of nitrogen, phosphorus, TSS, and fecal coliform bacteria for each of the monitoring sites included in the field monitoring program. Loading estimates were generated by multiplying the measured discharge rates for each monitoring site and event times the measured concentrations for species of nitrogen, phosphorus, TSS, and fecal coliform bacteria on each site and event date. Calculations for loading rate estimates are provided in Appendix D.

A summary of calculated mass loadings of species of nitrogen, phosphorus, TSS, and fecal coliform bacteria for each monitoring event is given in Table 4-8. The overall mean loadings are used to evaluate changes in mass loadings during migration through Long Branch Creek as well as estimate the significance of individual tributary inflows on overall mass loadings. The mean mass loadings are used to evaluate watershed loadings since previous analyses in this section have indicated that water quality patterns are relatively similar under low flow, high flow, and mean flow conditions, with variability primarily resulting from the magnitude of the individual loadings. Mass loadings combine the measured discharge rates and chemical characteristics to evaluate overall impacts from potential inflow sources.

4.5.1 Ammonia

A graphical comparison of mass loadings of ammonia in Long Branch Creek during each of the five monitoring events is given in Figure 4-21. An elevated mass loading rate for ammonia was observed at Site 1 during the October 19, 2010 monitoring event due to a combination of a relatively high discharge rate (1.22 cfs) and an elevated ammonia concentration (504 μg/l). However, mass loadings of ammonia decrease substantially at the remaining northern and southern segment sites, each of which was characterized by low discharge rates and relatively low concentrations. The tributary inflow at Site 4 did not appear to contribute significant loadings to the northern segment.

A substantial increase in mass loadings was observed along the main channel at Site 11, due primarily to an increase in discharge rates, followed by significant decreases in loadings at Sites 12 and 14 due to a combination of lower discharge rates and lower concentrations. A significant increase in ammonia loadings appears to occur between Sites 14 and 16 due primarily to an increase in discharge rates since the ammonia concentrations at these sites were relatively low. Tributary inflows into the main channel did not appear to be significant contributors of ammonia during this event.

TABLE 4-8

CALCULATED MASS LOADINGS OF MEASURED PARAMETERS IN LONG BRANCH CREEK DURING THE FIELD MONITORING PROGRAM FROM OCTOBER 2010 - JANUARY 2011

SITE	AMMONIA LOADINGS						NO_x LOADINGS						PARTICULATE N LOADINGS					
	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
3	0.008	0.001	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.319	0.016	0.002	0.003	0.001	0.068
5	0.008	0.004	0.004	0.001	0.213	0.046	0.000	0.000	0.000	0.000	0.087	0.018	0.005	0.000	0.011	0.000	0.360	0.075
7	0.193	0.067	0.030	0.017	1.797	0.421	0.077	0.053	0.022	0.012	1.016	0.236	0.257	0.088	0.011	0.003	3.809	0.834
8	0.251	0.001	0.009	0.023	1.046	0.266	0.231	0.001	0.010	0.032	0.629	0.181	0.020	0.000	0.105	0.009	7.835	1.594
1	1.504	0.009	0.034	0.000	1.424	0.594	2.169	0.013	0.046	0.001	0.377	0.521	0.871	0.016	0.101	0.001	8.629	1.924
2	0.063	0.001	0.261	0.013	0.332	0.134	0.007	0.000	0.018	0.002	0.245	0.055	0.234	0.000	0.145	0.010	0.181	0.114
6	0.044	0.015	0.054	0.009	1.368	0.298	0.087	0.036	0.095	0.049	0.975	0.248	0.039	0.005	0.103	0.014	14.038	2.840
9	0.023	0.008	0.039	0.005	0.742	0.163	0.012	0.006	0.076	0.007	2.624	0.545	0.019	0.021	0.024	0.019	11.500	2.316
11	0.600	0.289	0.089	0.020	1.370	0.473	0.048	0.021	0.052	0.044	2.061	0.445	0.131	0.219	0.267	0.048	5.108	1.155
12	0.058	0.128	0.112	0.042	0.095	0.087	0.155	0.132	0.416	0.089	4.570	1.072	0.025	0.027	0.455	0.019	9.997	2.105
14	0.048	0.055	0.095	0.025	2.137	0.472	0.192	0.188	0.378	0.050	3.257	0.813	0.674	0.005	0.036	0.018	13.374	2.821
16	0.910	1.171	1.139	0.628	4.914	1.753	1.539	1.869	2.395	0.644	8.926	3.075	0.500	6.113	0.248	0.118	2.307	1.857
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.003	0.001
10	0.010	0.018	0.016	0.005	0.141	0.038	0.002	0.002	0.004	0.002	0.127	0.027	0.133	0.221	0.040	0.019	0.787	0.240
13	0.019	0.037	0.028	0.022	0.085	0.038	0.041	0.062	0.080	0.045	0.162	0.078	0.003	0.015	0.006	0.006	0.185	0.043
15	0.008	0.000	0.004	--	0.306	0.080	0.030	0.000	0.003	--	0.466	0.125	0.015	0.000	0.002	--	0.119	0.034
17	0.000	0.000	0.000	0.000	0.668	0.134	0.000	0.000	0.000	0.000	0.523	0.105	0.001	0.001	0.001	0.000	3.862	0.773
18	--	--	0.011	0.007	0.073	0.030	--	--	0.021	0.005	0.029	0.018	--	--	0.025	0.010	0.525	0.187

Northern Headwater Segment | Southern Headwater Segment | Main Channel Sites | Tributary Inflows

TABLE 4-8 -- CONTINUED

CALCULATED MASS LOADINGS OF MEASURED PARAMETERS IN LONG BRANCH CREEK DURING THE FIELD MONITORING PROGRAM FROM OCTOBER 2010 - JANUARY 2011

SITE	TOTAL N LOADINGS						SRP LOADINGS						PARTICULATE P LOADINGS					
	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (cfu x 10^8/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
3	0.393	0.026	0.003	0.005	0.005	0.087	0.000	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.004
5	0.015	0.008	0.030	0.002	2.075	0.426	0.001	0.001	0.002	0.000	0.037	0.008	0.000	0.000	0.002	0.000	0.103	0.021
7	0.576	0.311	0.135	0.050	15.598	3.334	0.044	0.017	0.013	0.003	0.361	0.088	0.020	0.003	0.004	0.001	0.352	0.076
8	0.853	0.003	0.232	0.095	12.637	2.764	0.056	0.000	0.019	0.006	0.223	0.061	0.036	0.001	0.005	0.002	0.253	0.059
1	4.736	0.107	0.284	0.003	11.009	3.228	0.057	0.001	0.012	0.000	0.084	0.031	0.167	0.001	0.006	0.000	0.461	0.127
2	0.520	0.003	0.990	0.119	4.385	1.204	0.024	0.000	0.076	0.005	0.022	0.025	0.036	0.000	0.019	0.002	0.212	0.054
6	0.639	0.171	0.509	0.092	18.902	4.062	0.027	0.021	0.070	0.003	0.328	0.090	0.036	0.008	0.024	0.008	0.553	0.126
9	0.985	0.162	0.277	0.112	24.194	5.146	0.053	0.017	0.024	0.006	0.440	0.108	0.026	0.007	0.016	0.004	0.398	0.090
11	2.089	1.492	0.936	0.334	24.949	5.960	0.024	0.040	0.031	0.010	0.371	0.095	0.155	0.078	0.043	0.001	0.486	0.153
12	0.511	1.457	2.568	0.599	52.460	11.519	0.034	0.011	0.118	0.036	0.857	0.211	0.158	0.092	0.121	0.008	1.016	0.279
14	1.277	0.697	1.839	0.395	43.725	9.587	0.034	0.017	0.087	0.017	0.611	0.153	0.018	0.001	0.022	0.008	1.120	0.234
16	10.321	11.056	12.065	4.751	33.899	14.418	0.667	0.849	0.833	0.400	1.454	0.841	0.244	0.183	0.292	0.094	1.855	0.534
4	0.002	0.002	0.002	0.001	0.005	0.003	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.253	0.488	0.442	0.090	1.313	0.517	0.017	0.029	0.025	0.002	0.022	0.019	0.005	0.002	0.009	0.000	0.014	0.006
13	0.099	0.208	0.300	0.100	1.487	0.439	0.007	0.012	0.021	0.011	0.044	0.019	0.015	0.027	0.016	0.011	0.025	0.019
15	0.066	0.002	0.016	--	3.047	0.783	0.005	0.000	0.001	0.000	0.007	0.003	0.002	0.000	0.001	0.000	0.032	0.007
17	0.003	0.003	0.003	0.002	18.230	3.648	0.000	0.000	0.000	0.000	0.067	0.013	0.000	0.000	0.000	0.000	0.056	0.011
18	--	--	0.218	0.080	1.889	0.729	0.000	0.000	0.010	0.005	0.026	0.008	0.000	0.000	0.013	0.002	0.026	0.008

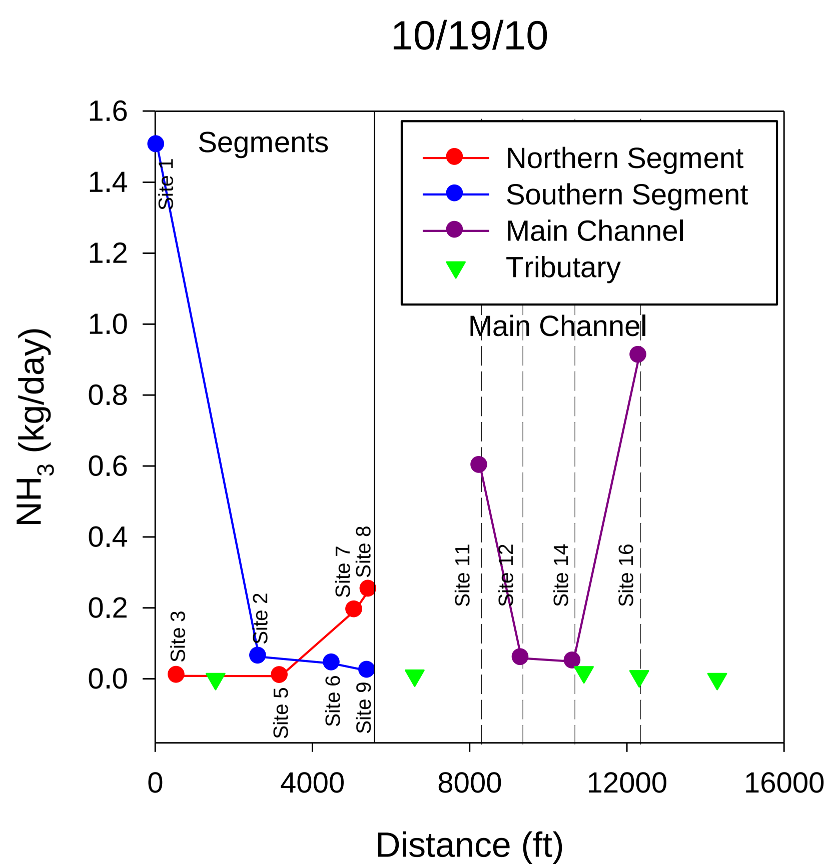
Northern Headwater Segment | Southern Headwater Segment | Main Channel Sites | Tributary Inflows

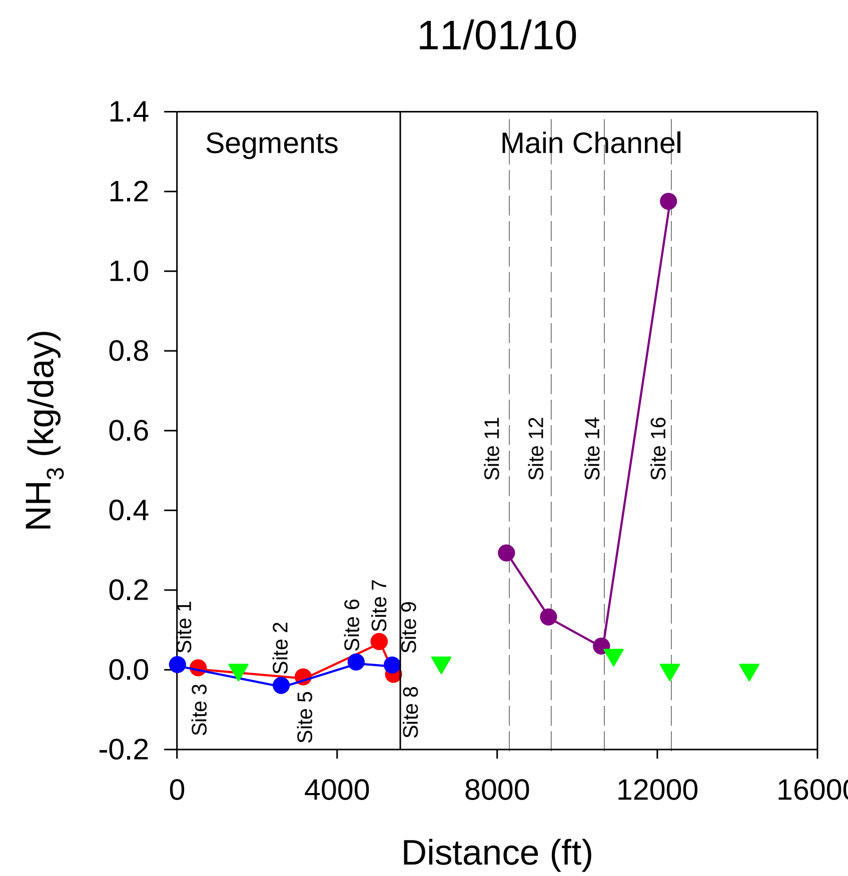
TABLE 4-8 -- CONTINUED

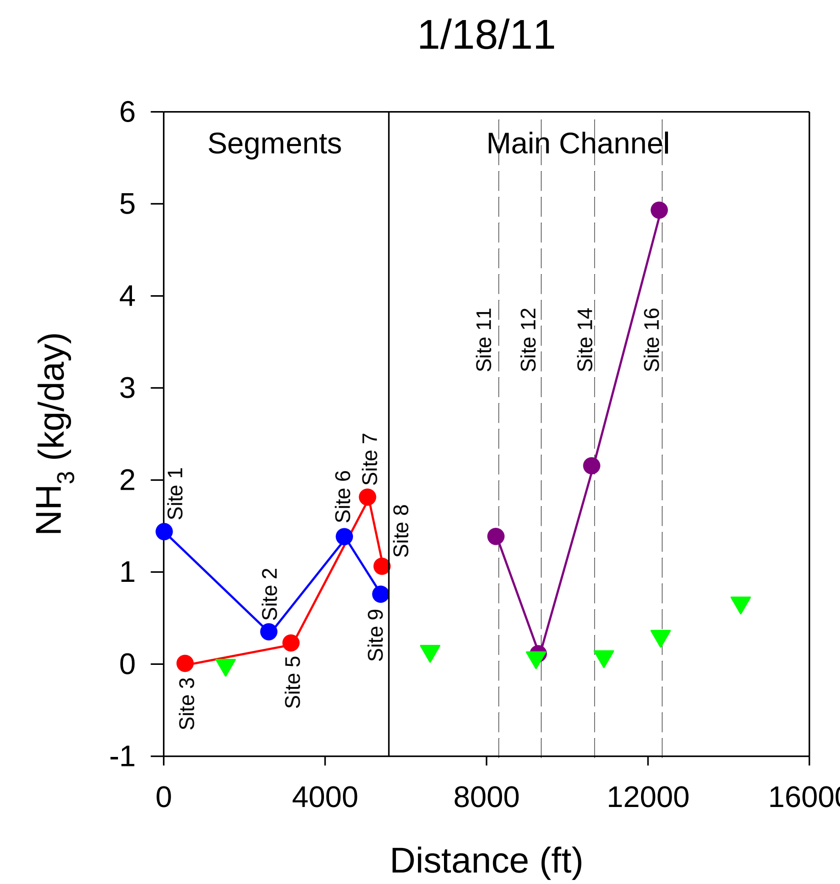
CALCULATED MASS LOADINGS OF MEASURED PARAMETERS IN LONG BRANCH CREEK DURING THE FIELD MONITORING PROGRAM FROM OCTOBER 2010 - JANUARY 2011

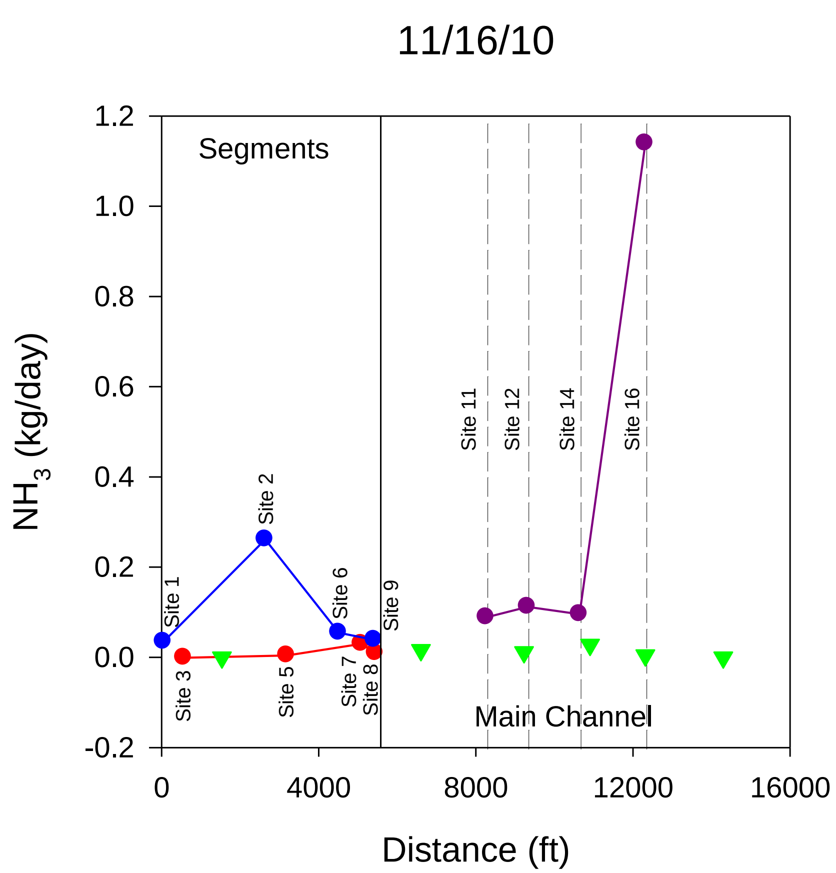
SITE	TOTAL P LOADINGS						TSS LOADINGS						FECAL COLIFORM LOADINGS					
	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (kg/day)					Mean Loading	Loading by Collection Date (cfu x 10^8/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11		10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
3	0.022	0.001	0.000	0.000	0.000	0.005	2.70	0.22	0.02	0.09	0.02	0.61	20	1	0	1	1	4
5	0.002	0.001	0.005	0.000	0.186	0.039	0.06	0.01	0.17	0.00	14.01	2.85	0	0	1	0	199	40
7	0.072	0.025	0.018	0.004	1.201	0.264	12.55	3.45	1.28	0.23	125.02	28.50	71	125	62	26	3,712	799
8	0.119	0.001	0.029	0.010	0.711	0.174	4.19	0.06	1.17	0.19	64.07	13.94	187	1	18	60	2,880	629
1	0.245	0.006	0.020	0.000	0.705	0.195	58.19	0.53	0.94	0.01	50.96	22.13	152	3	8	0	464	125
2	0.103	0.001	0.106	0.007	0.275	0.098	3.06	0.01	3.23	0.90	17.04	4.85	23	0	30	5	1,044	220
6	0.076	0.032	0.102	0.013	1.171	0.279	2.88	3.51	0.54	0.20	30.93	7.61	33	6	29	10	1,968	409
9	0.103	0.031	0.041	0.010	1.525	0.342	7.44	0.18	0.33	0.26	65.95	14.83	30	7	27	7	1,573	329
11	0.254	0.181	0.081	0.012	1.254	0.356	16.11	3.83	1.57	0.75	51.20	14.69	116	34	24	3	1,349	305
12	0.204	0.154	0.254	0.046	2.983	0.728	8.92	7.23	17.12	1.43	85.69	24.08	104	398	212	68	9,521	2,060
14	0.102	0.030	0.169	0.026	2.361	0.538	6.14	2.45	2.67	0.43	73.28	16.99	140	191	178	35	5,700	1,249
16	1.192	1.203	1.256	0.503	4.613	1.754	28.21	27.93	23.37	7.07	135.39	44.39	1,982	7,091	11,977	1,007	12,787	6,969
4	0.001	0.001	0.001	0.000	0.000	0.001	0.01	0.01	0.02	0.01	0.01	0.01	0	1	0	0	0	0
10	0.030	0.038	0.036	0.003	0.051	0.031	1.51	1.51	0.43	0.10	0.70	0.85	16	8	10	3	111	30
13	0.023	0.047	0.052	0.024	0.110	0.051	0.49	2.86	3.14	0.78	1.11	1.68	13	228	254	93	348	187
15	0.008	0.000	0.002	0.000	0.076	0.017	0.39	0.00	0.09	--	4.10	1.15	28	3	10	--	373	103
17	0.000	0.000	0.000	0.000	0.490	0.098	0.04	0.03	0.02	0.02	12.24	2.47	0	0	0	0	367	73
18	0.000	0.000	0.024	0.007	0.091	0.024	--	--	1.77	0.43	1.97	1.39	--	--	18	20	182	74

Northern Headwater Segment | Southern Headwater Segment | Main Channel Sites | Tributary Inflows









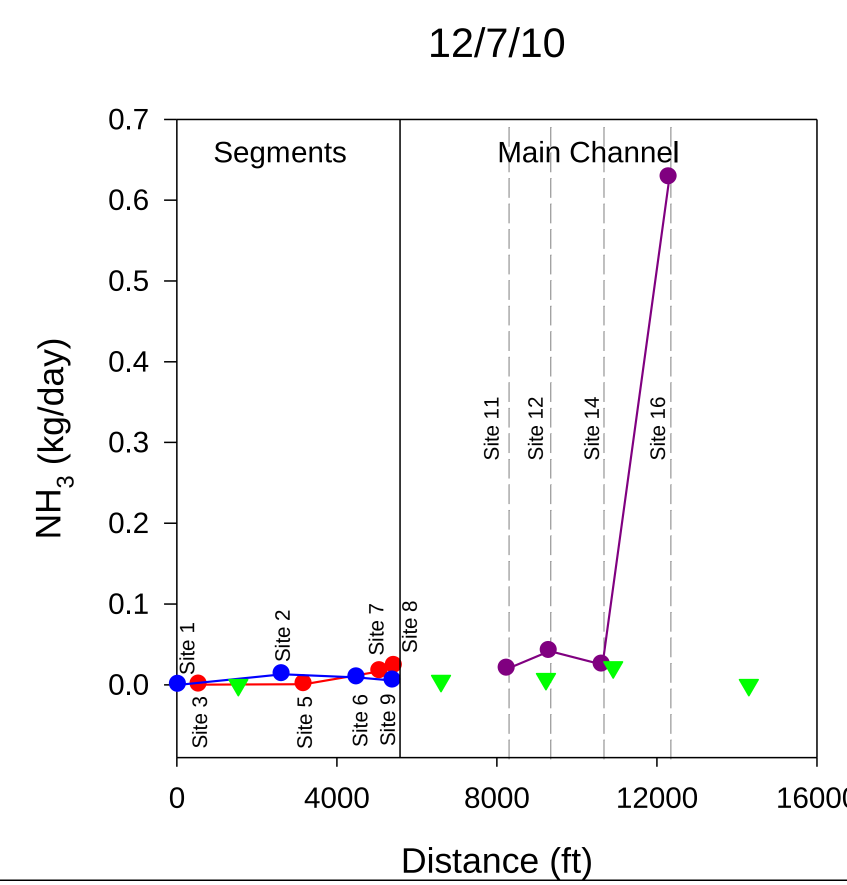


Figure 4-21.

Comparison of Mass Loadings of Ammonia in Long Branch Creek During the Field Monitoring Program.

A somewhat similar pattern was also observed for ammonia during the January 18, 2011 monitoring event which occurred after a significant rain event within the watershed. Although the general patterns for loadings of ammonia appear to be relatively similar, the magnitude of the loadings is substantially enhanced, particularly along the main channel sites. In contrast, relatively low loadings of ammonia were observed during the November 1, November 16, and December 7, 2010 monitoring events, followed by either slight increases or decreases in loadings between Sites 11 and 12, with a substantial increase in loadings between Sites 14 and 16. Tributary inflows did not appear to be significant contributors of ammonia loadings to either the segments or main channel.

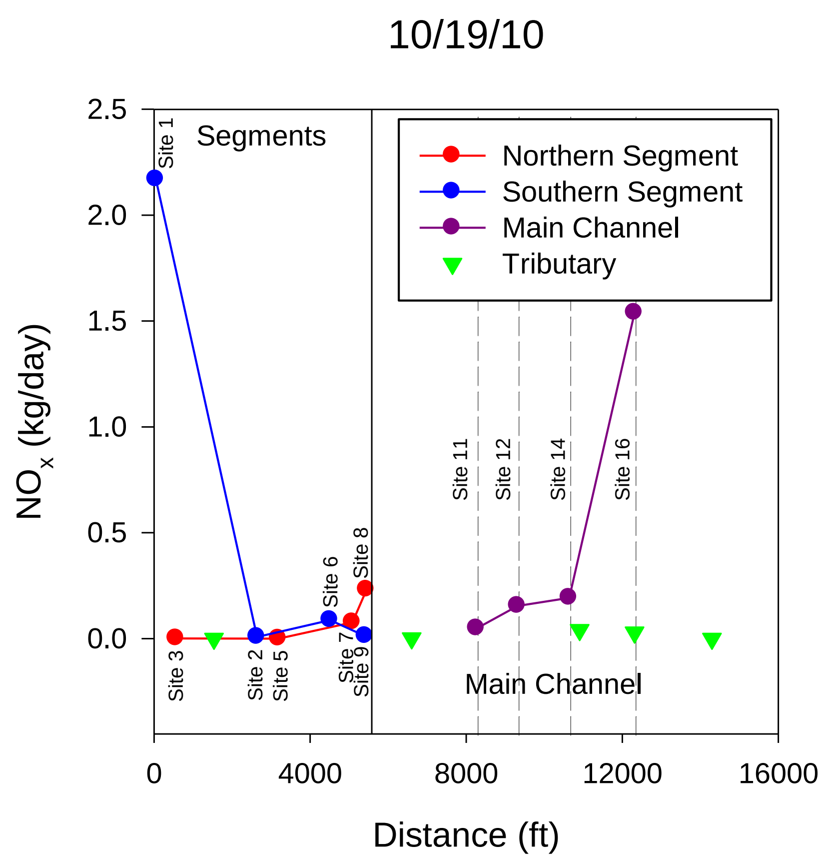
4.5.2 NO_x

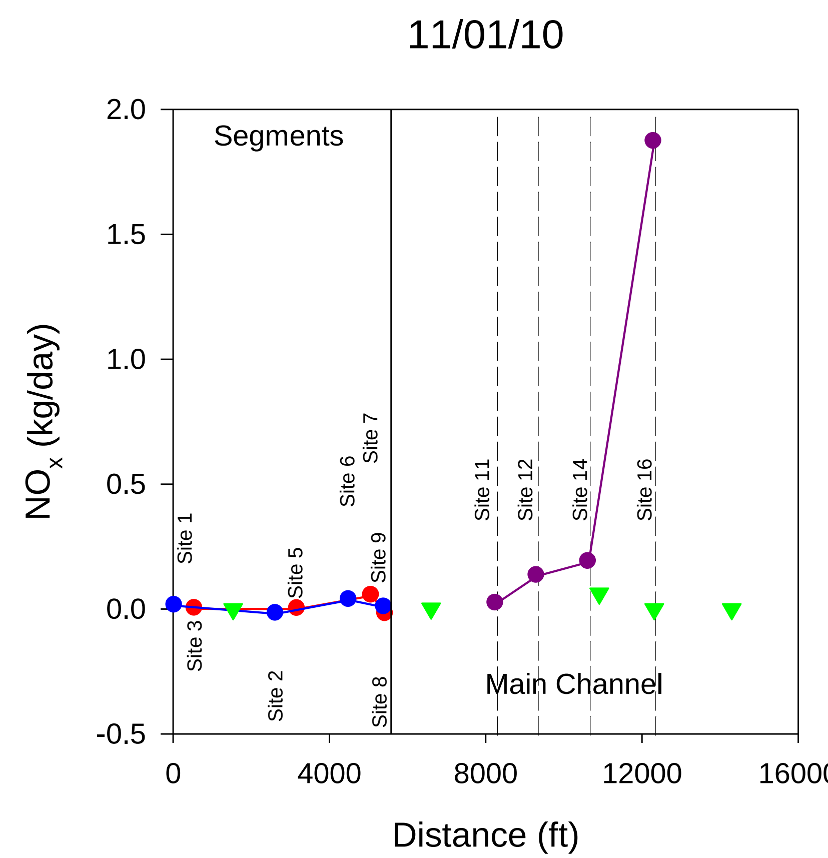
A graphical comparison of mass loadings of NO_x in Long Branch Creek during each of the five monitoring events is given on Figure 4-22. A substantially elevated loading of NO_x was observed at Site 1 during the October 19, 2010 monitoring event, with lower loading rates for the remaining northern and southern segment sites, similar to the pattern exhibited by ammonia for the same date. A slight increase in mass loadings of NO_x was observed at the initial main channel monitoring sites (Sites 11, 12, and 14), followed by a significant increase in loading at Site 16, caused primarily by the observed increase in discharge.

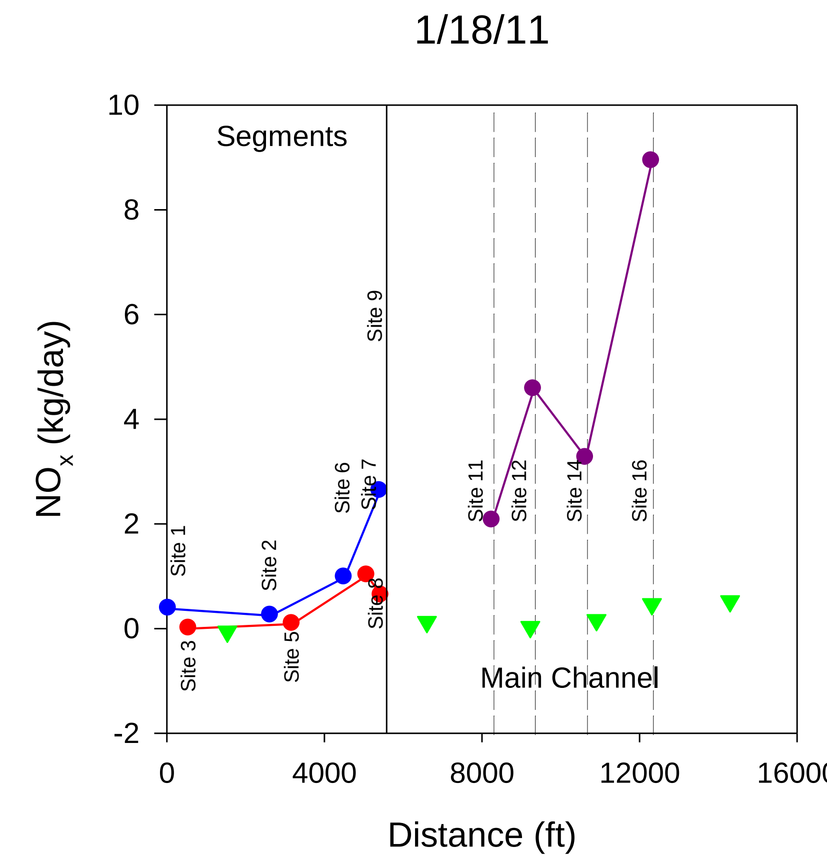
Extremely low loading rates for NO_x were observed during the November 1, November 16, and December 7, 2010 monitoring events. Mass loadings of NO_x were relatively low in value along the northern and southern segments, with slight increases observed in downstream portions of both segments. Mass loading rates for NO_x typically increased within the main channel with increasing distance downstream with the exception of the December 7, 2010 monitoring event. Mass loadings of NO_x from tributary inflows do not appear to be a significant source of loadings to either the segments or main channel sites during these events.

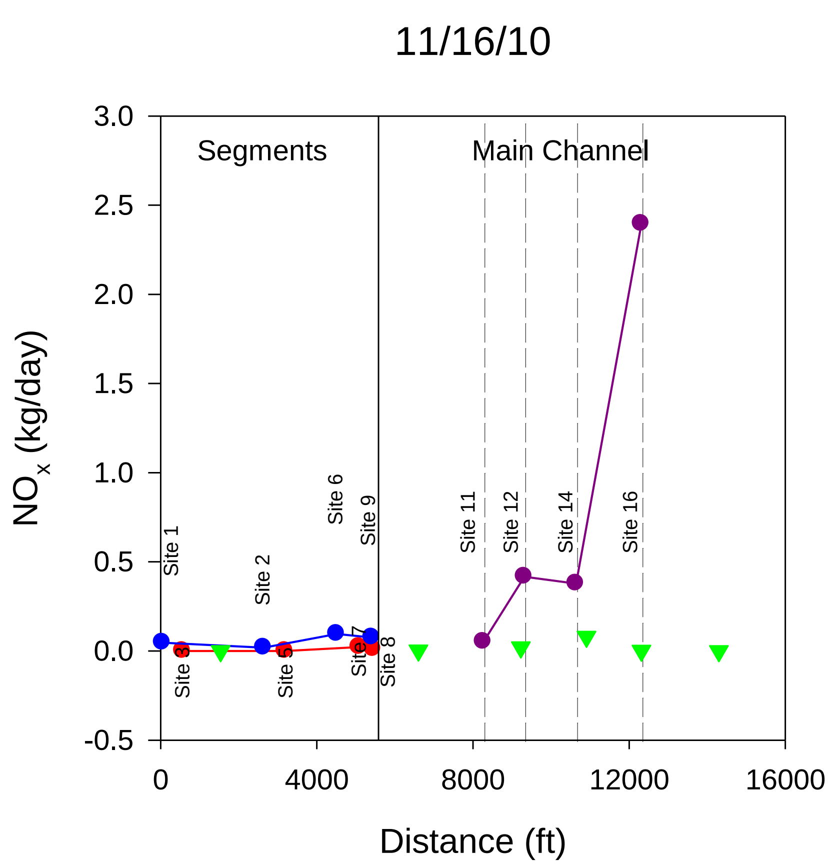
During the high flow conditions event conducted on January 17, 2011, more elevated mass loading rates were generally observed within the northern and southern segments, with a general trend of increasing loadings with increasing distance downstream, although a decrease in loadings was observed between Sites 7 and 8.

Mass loadings of NO_x within the main channel during three of the five monitoring events, including both low and high flow conditions, increased substantially between Sites 11 and 12, with a notable decrease between Sites 12 and 14, followed by a substantial increase between Sites 14 and 16. Mass loadings of NO_x from the tributary inflows do not appear to be a significant source of loadings to the main channel under most conditions, with the possible exception of mass loadings of NO_x entering the main channel from Site 13 on December 7, 2010, although the overall loading rates were generally low throughout the entire channel.









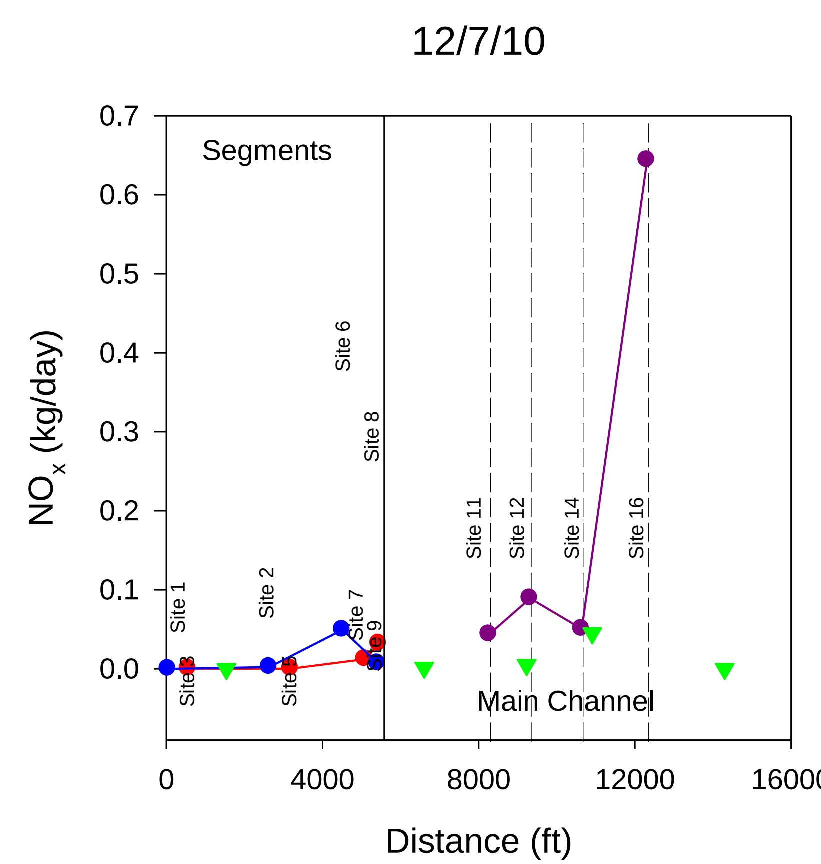


Figure 4-22.

Comparison of Mass Loadings of NO_x in Long Branch Creek During the Field Monitoring Program.

4.5.3 Particulate Nitrogen

A graphical comparison of mass loadings of particulate nitrogen in Long Branch Creek during each of the five field monitoring events is given on Figure 4-23. During the initial monitoring event on October 19, 2010, a significant loading of particulate nitrogen appears to have originated from Site 1 due primarily to the elevated discharge observed at this site. A much lower particulate nitrogen loading was observed at the headwaters of the northern segment at Site 3. Decreases in mass loadings were observed at downstream sites along the entire southern segment. However, a substantial increase in loading occurred in the northern segment between Sites 5 and 7 before decreasing at Site 8. A decrease in particulate nitrogen loading was observed between Sites 11 and 12, followed by an increase in loading at Site 14, and a slight decrease in loading between Sites 14 and 16. During this event, tributary inflows into the segments and main channel did not appear to contribute significant loadings of particulate nitrogen, with the exception of the inflow from tributary Site 10 which was similar to the loading rate observed at Site 11.

During the low flow conditions observed on the November 1, November 16, and December 7, 2010 monitoring events, relatively low loading rates for particulate nitrogen were observed in both the northern and southern segments. A substantial decrease in particulate nitrogen loading was observed between Sites 7 and 8 on November 1, 2010, with increases in loadings between Sites 7 and 8 observed on the two remaining dates. Substantial increases in loadings of particulate nitrogen were observed between Sites 14 and 16 on November 1, November 16, and December 7, 2010. However, under high flow conditions observed on January 18, 2011, particulate nitrogen loadings decreased substantially at Site 16 compared with the remaining main channel sites. Inputs of particulate nitrogen from the tributaries do not appear to be significant contributors of loadings during most events, with the exceptions of inflows from tributary Sites 10 and 13 on November 1, 2010.

4.5.4 Total Nitrogen

A graphical comparison of mass loadings of total nitrogen in Long Branch Creek during each of the five field monitoring events is given on Figure 4-24. In general, the patterns of mass loadings for total nitrogen are similar to the mass loadings for particulate nitrogen during most events. An elevated total nitrogen loading was observed at Site 1 during the October 19, 2010 monitoring event due primarily to the elevated discharge at this site. Total nitrogen loadings at the remaining segment and tributary inflow sites appear to be relatively similar in value for the November 1, November 16, and December 7, 2010 events. Substantial increases in mass loadings of total nitrogen are observed between Sites 14 and 16 for these events. Mass loadings from tributary inflows do not appear to be a significant contributor to total nitrogen loadings during these events.

During the high flow conditions observed on January 18, 2011, total nitrogen loadings were substantially higher than observed under low flow conditions. Nitrogen loadings decreased from Site 1 to Site 2 in the southern segment before increasing at Sites 6 and 9. In the northern segment, total nitrogen loadings increased between Sites 3, 5, and 7, with a slight decrease at Site 8. Under high flow conditions, a substantial increase in total nitrogen occurred between Sites 11 and 12, followed by steady decreases at Sites 14 and 16. Tributary inflows to the main channel do not appear to be significant contributors of nitrogen loadings under most conditions. Total nitrogen loadings in the northern and southern segments appear to be similar to loadings along the main channel during a majority of the monitoring events.

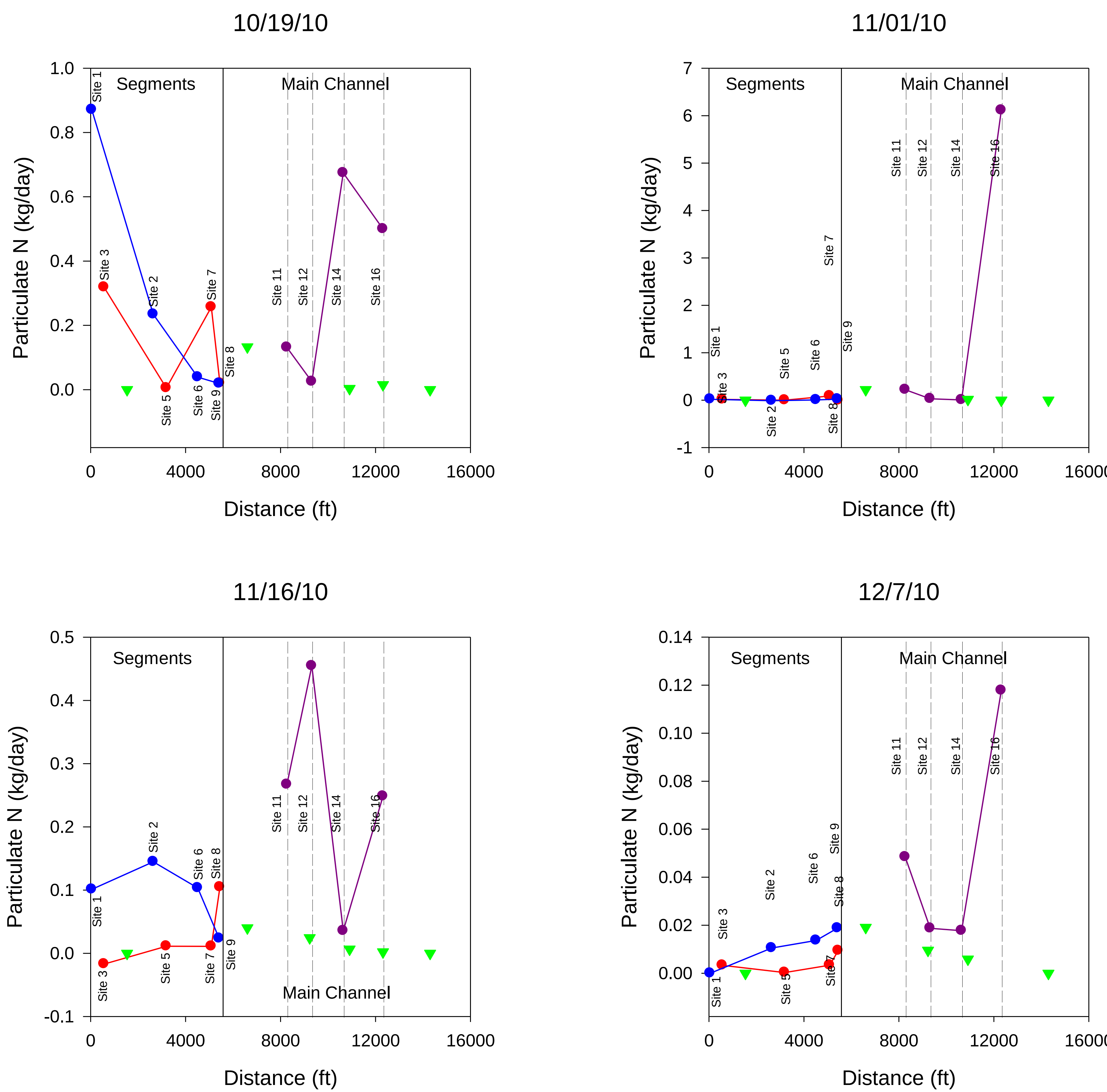
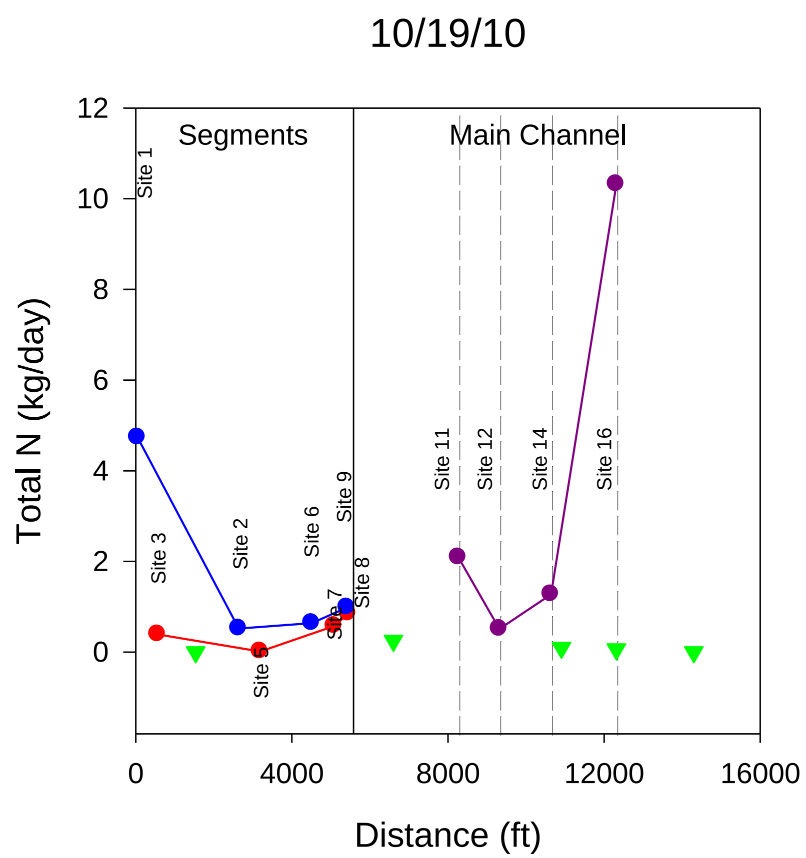
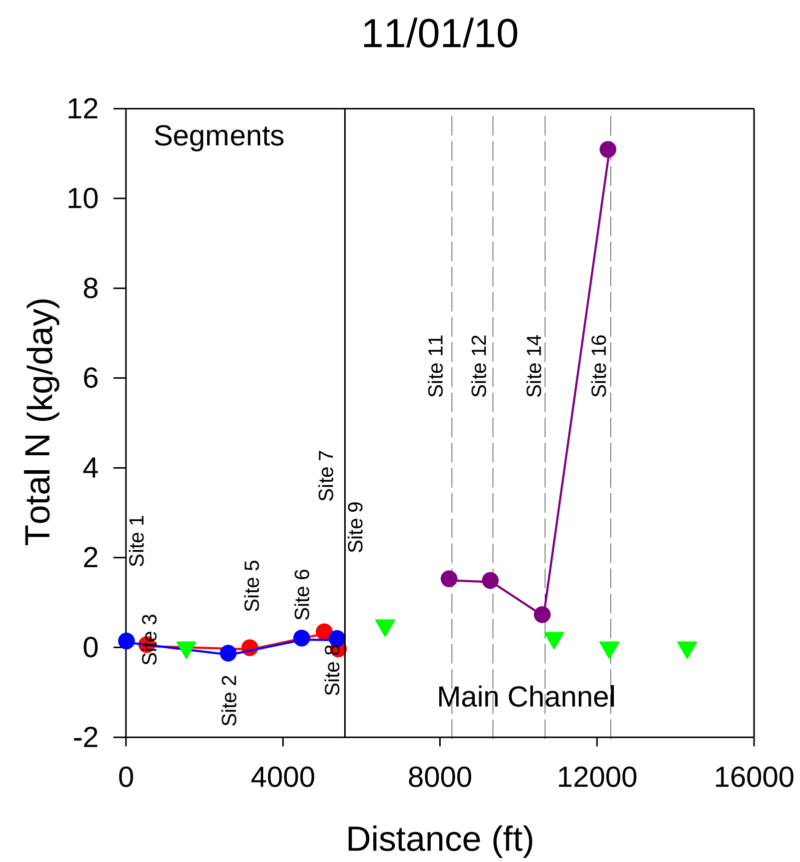
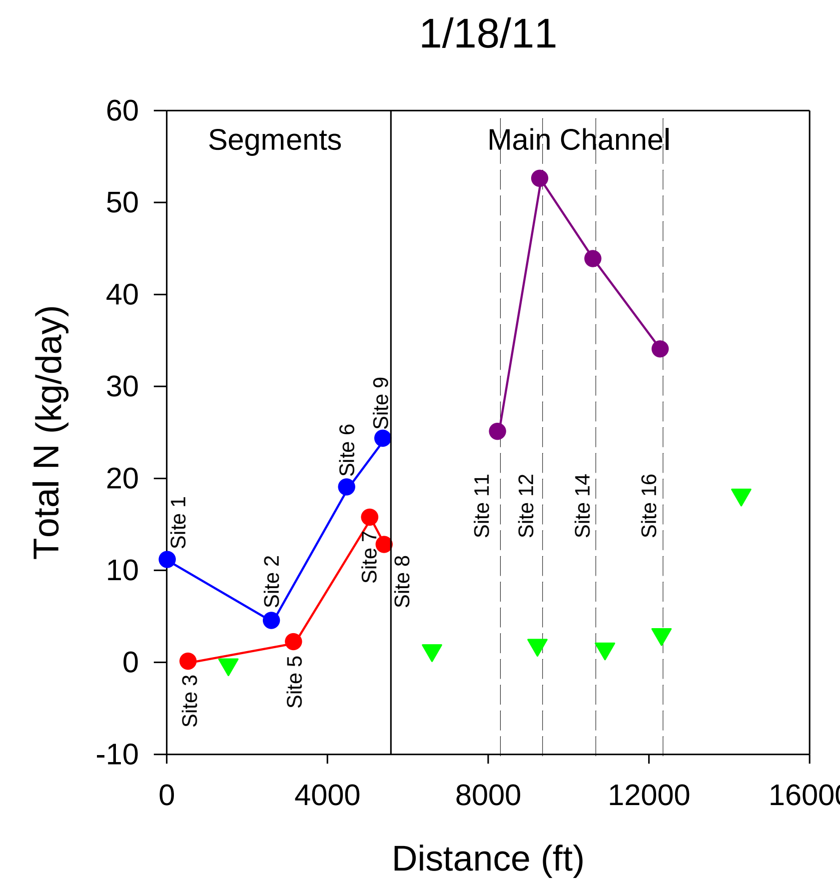


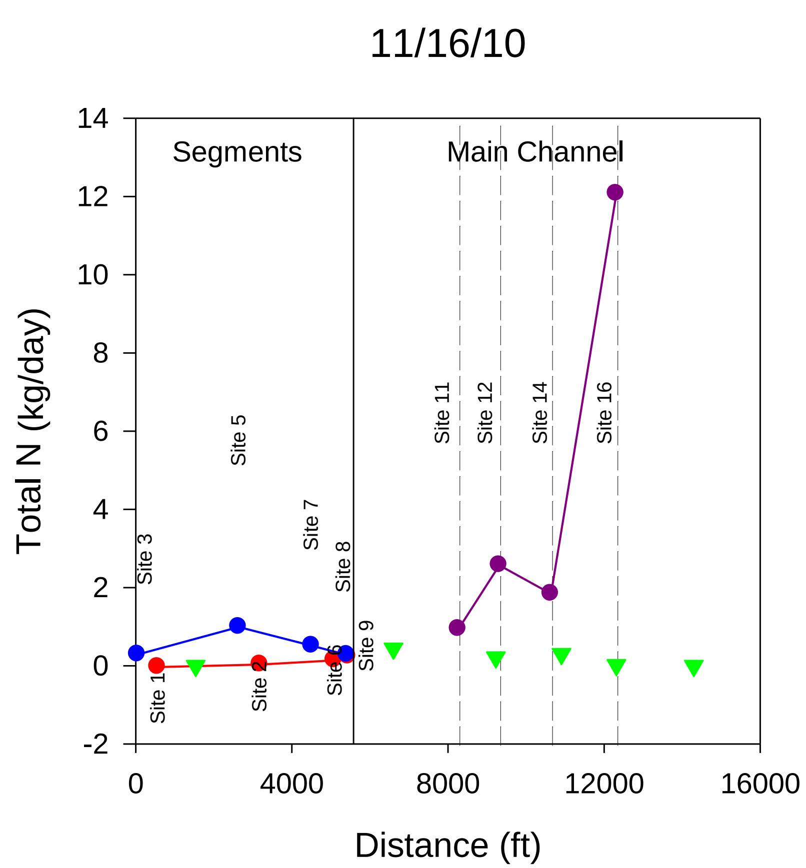
Figure 4-23.

Comparison of Mass Loadings of Particulate Nitrogen in Long Branch Creek During the Field Monitoring Program.









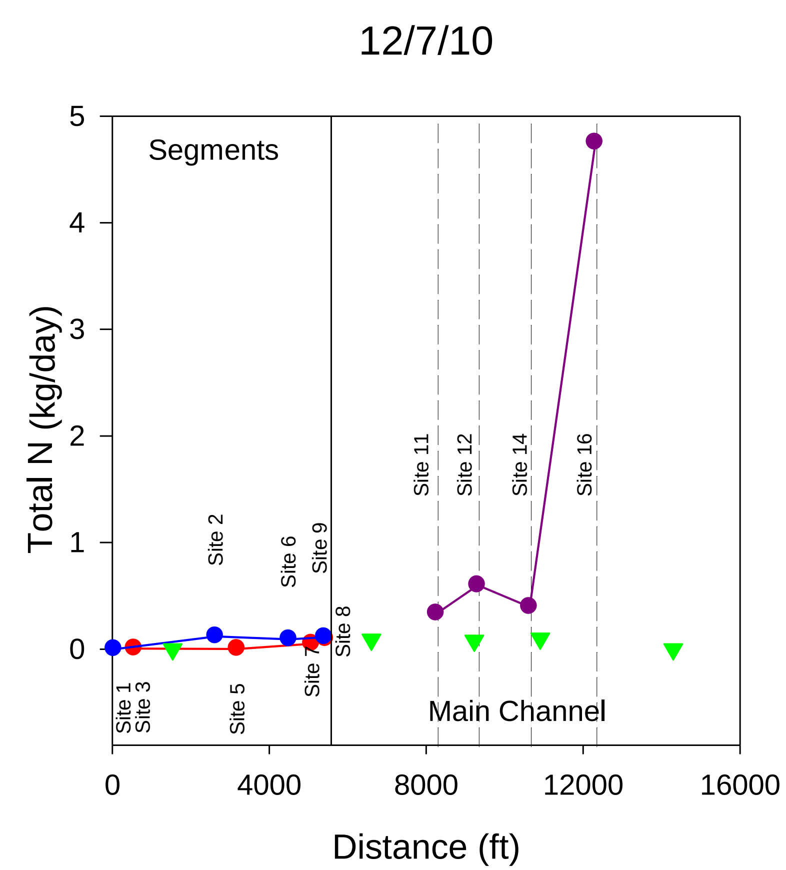


Figure 4-24.

Comparison of Mass Loadings of Total Nitrogen in Long Branch Creek During the Field Monitoring Program.

4.5.5 Soluble Reactive Phosphorus (SRP)

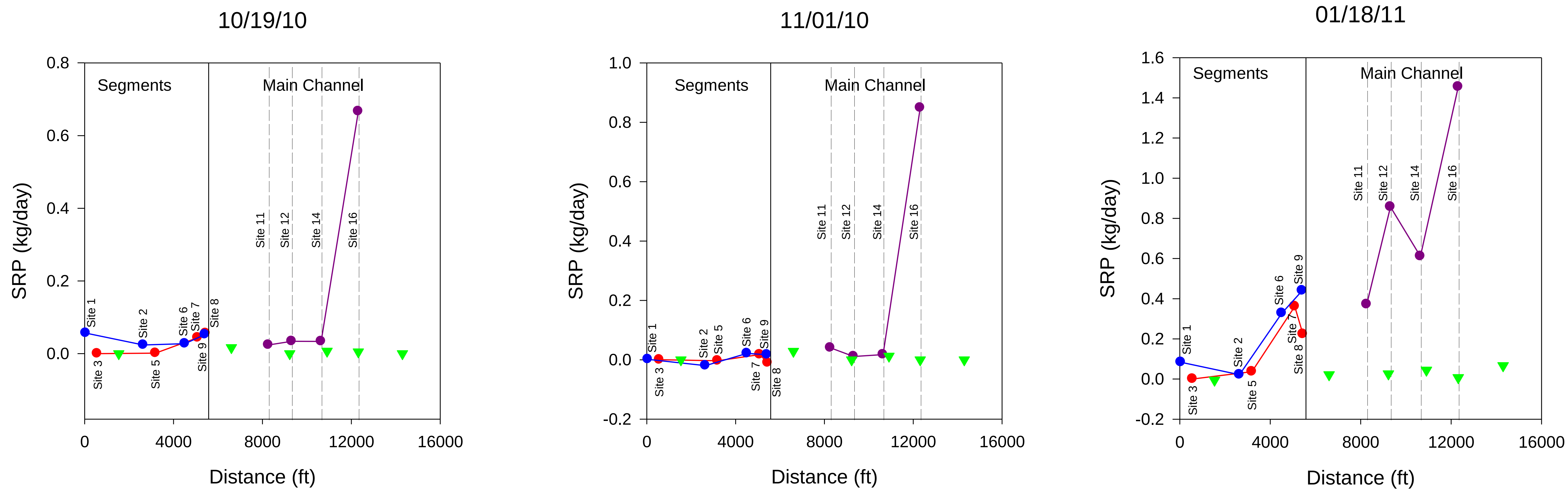
A graphical comparison of mass loadings of SRP in Long Branch Creek during each of the five field monitoring events is given on Figure 4-25. In general, mass loadings of SRP in the segments were low in value, with no significant trend of increasing or decreasing values during the October 19, November 1, November 16, and December 7, 2010 events. Mass loadings of SRP either increased slightly or remained relatively constant between Sites 11 and 14, followed by a substantial increase in loading at Site 16. Tributary inflows to the main channel do not appear to be significant contributors of SRP loadings, although tributary inflow to the northern segment from Site 4 is similar to mass loadings occurring within the main channel.

During the high flow conditions observed on January 18, 2011, increases in SRP loadings were observed from middle to final portions of the northern and southern segments, with increasing mass loadings generally observed along the main channel, with the exception of the decrease in loadings observed between Sites 12 and 14. Mass loadings of SRP contributed by tributary inflows do not appear to be significant along the main channel, although loadings of SRP into the northern segment from the tributary inflow at Site 4 appear to be similar to values measured along the main channel of the segment.

4.5.6 Particulate Phosphorus

A graphical comparison of mass loadings of particulate phosphorus in Long Branch Creek during the five field monitoring events is given on Figure 4-26. A somewhat elevated influx of particulate phosphorus was observed at Site 1 during the initial monitoring event on October 19, 2010 due primarily to the elevated discharge rate measured at this site. During the November 1, November 16, and December 7, 2010 events, mass loadings of particulate phosphorus were relatively consistent in both the northern and southern segments. A similar pattern was observed along the main channel monitoring sites for these events, with a slight increase in particulate phosphorus loading between Sites 11 and 12, followed by a decrease at Site 14 during three of the four events, with a substantial increase in loading observed at Site 16. Tributary inflows of particulate phosphorus do not appear to contribute significant mass loadings along the main channel, although the tributary inflow at Site 4 is generally similar to loadings measured along the northern segment.

Under high flow conditions, mass loadings of particulate phosphorus were generally enhanced, with an increasing trend generally observed along the northern segment and a relatively steady trend observed in the southern segment. However, in the main channel, mass loadings of particulate phosphorus increased steadily with increasing distance along the main channel. Mass loadings of particulate phosphorus from tributary inflows do not appear to be a significant source of loadings to the main channel, although the tributary inflow at Site 4 generates a particulate phosphorus loading similar to loadings observed along the northern and southern channel segments.



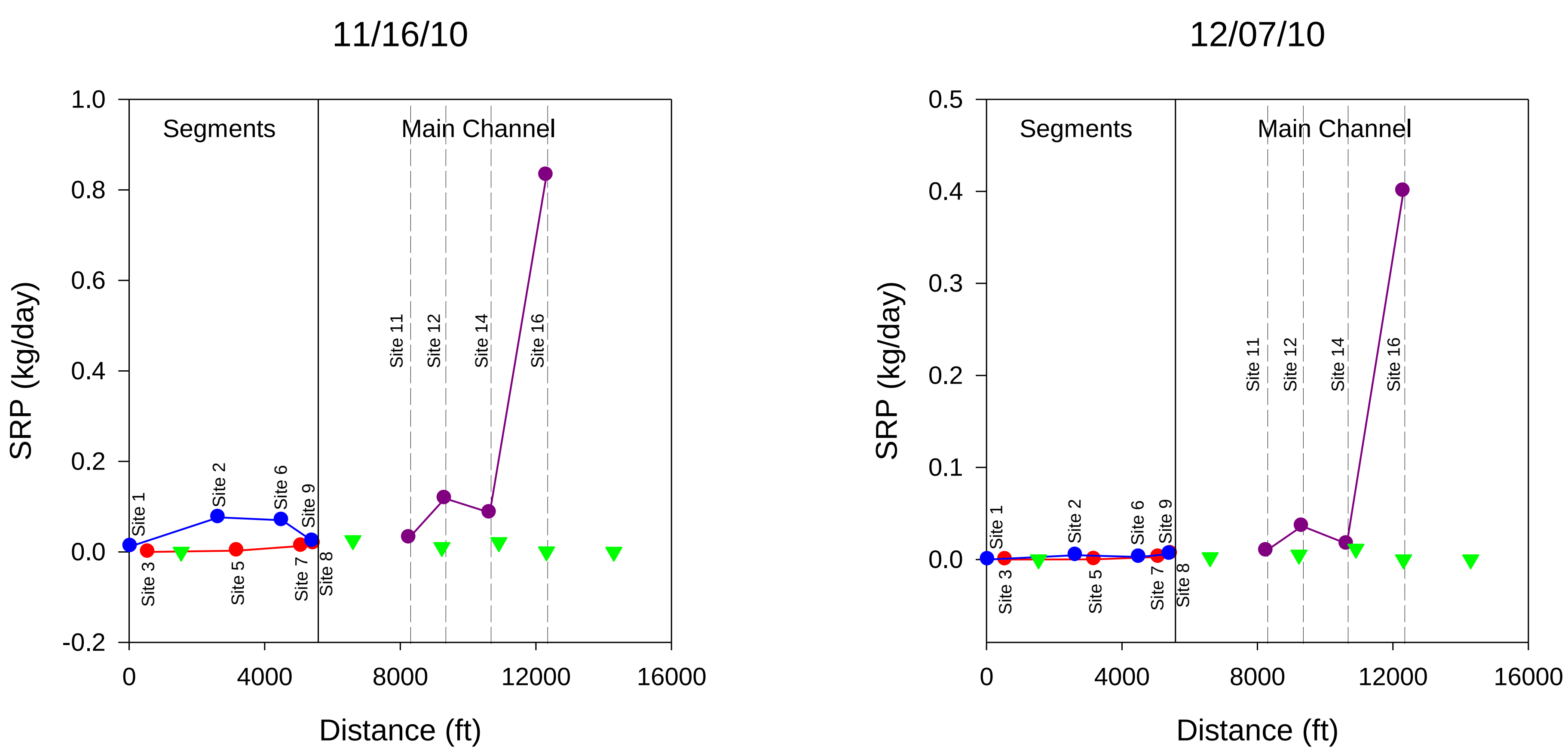
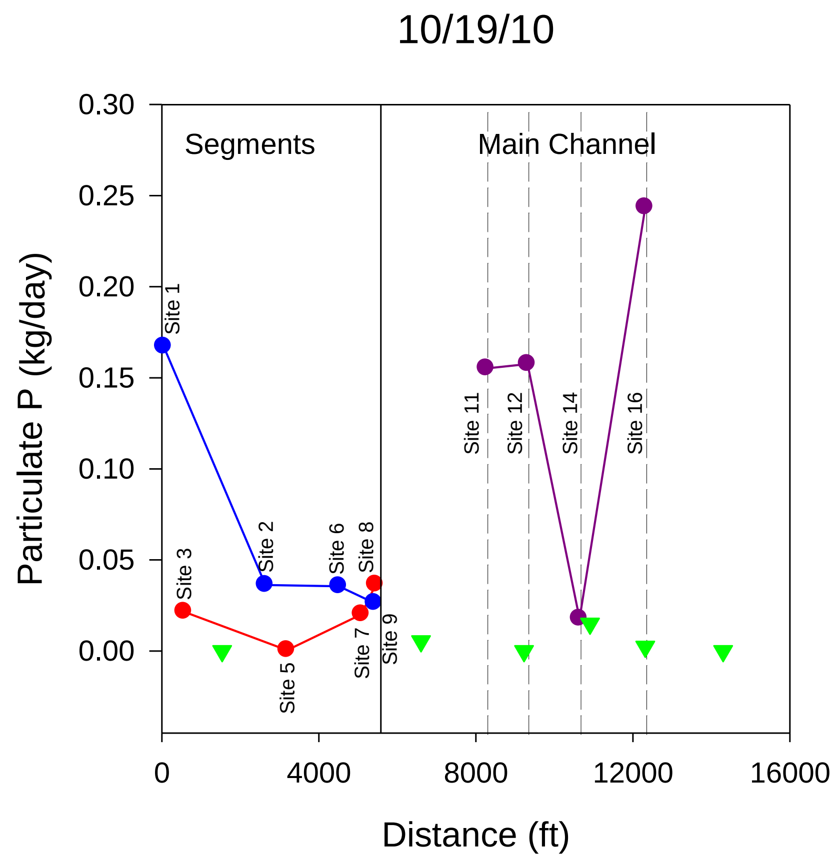
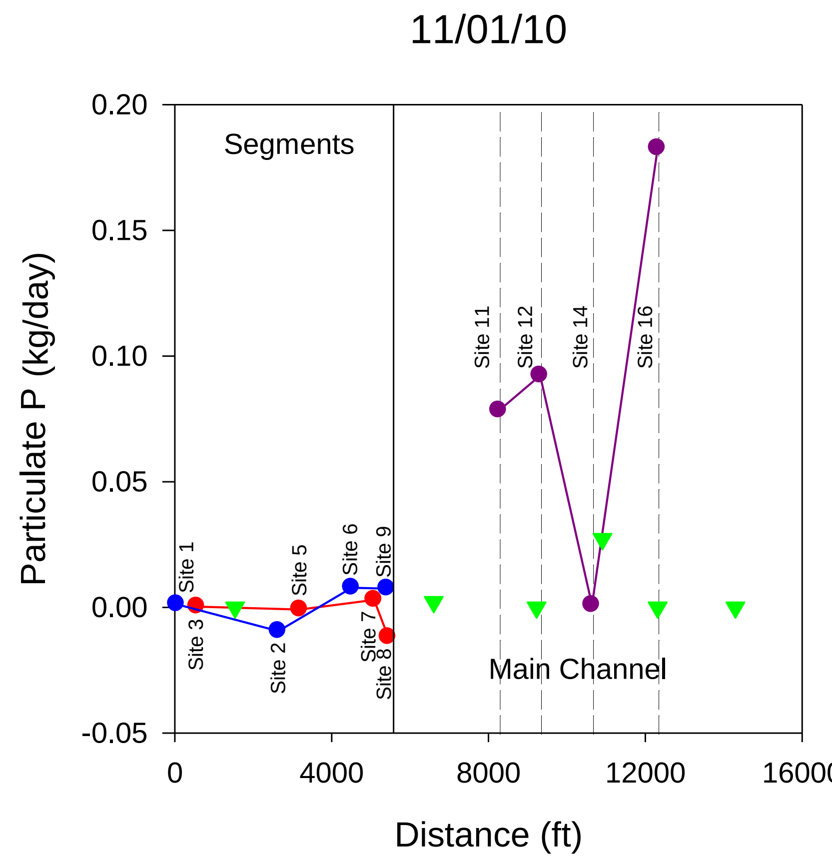
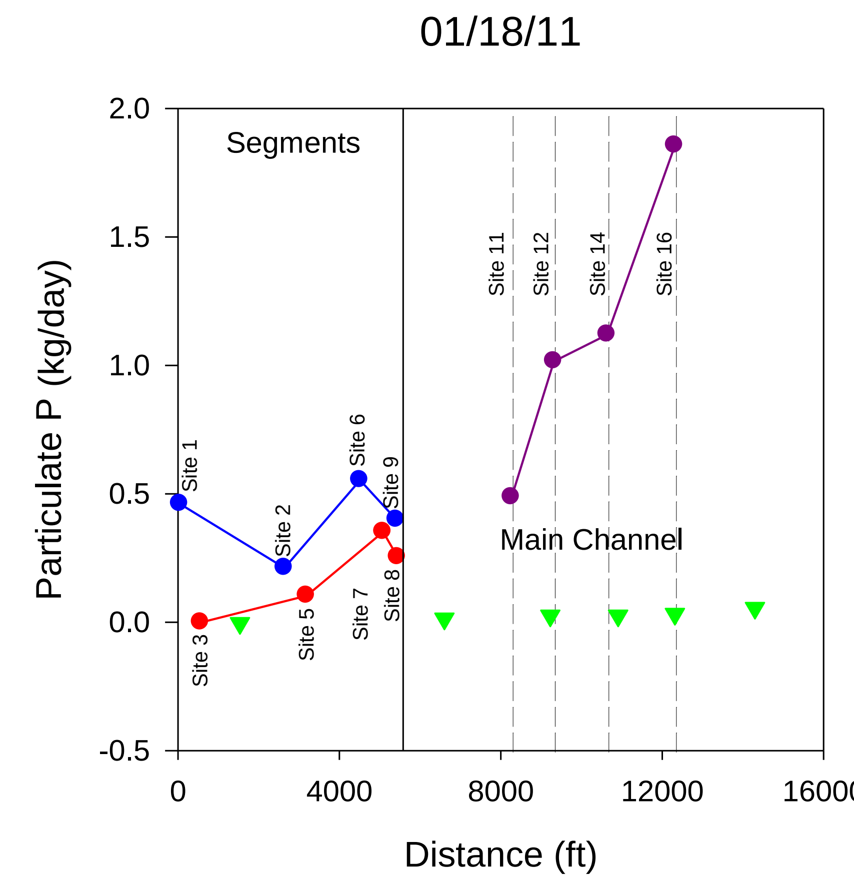


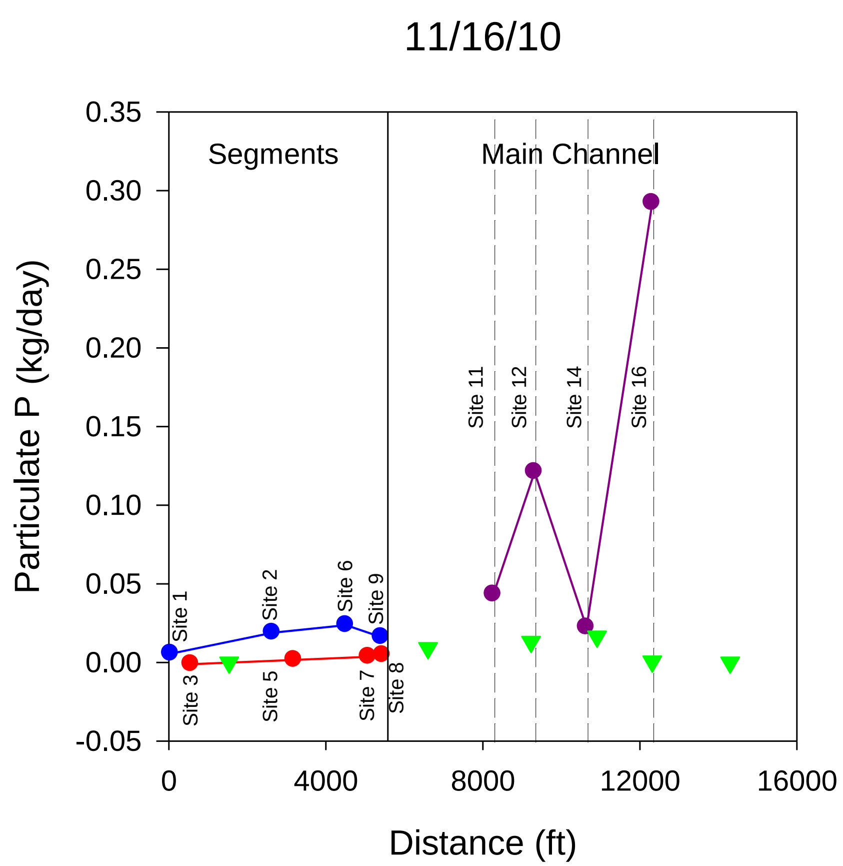
Figure 4-25.

Comparison of Mass Loadings of SRP in Long Branch Creek During the Field Monitoring Program.









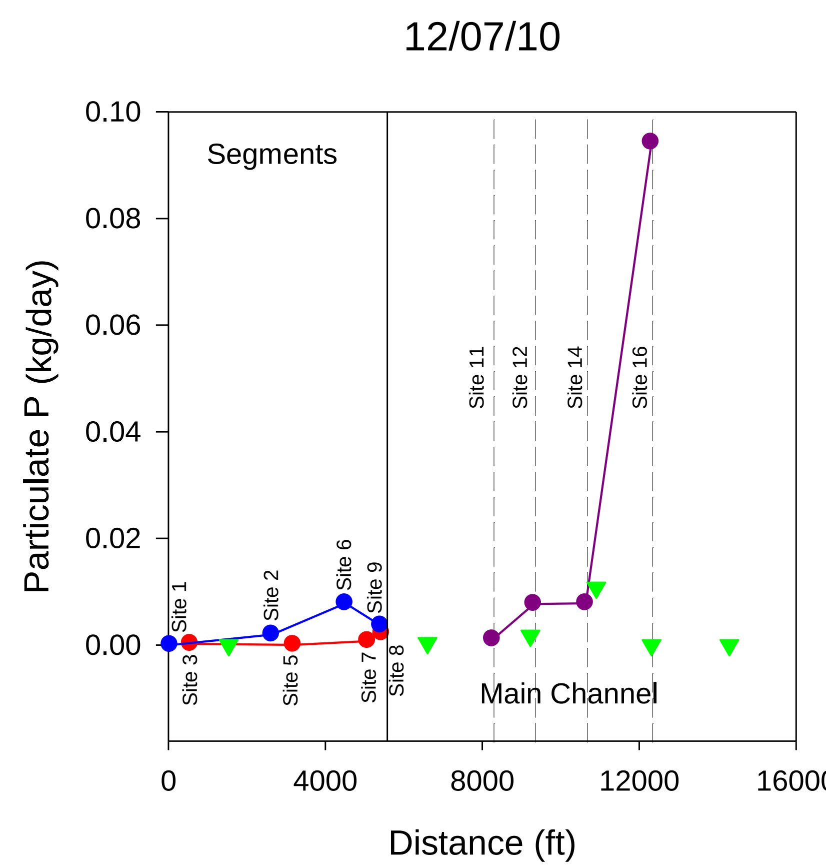


Figure 4-26.

Comparison of Mass Loadings of Particulate Phosphorus in Long Branch Creek During the Field Monitoring Program.

4.5.7 Total Phosphorus

A graphical comparison of mass loadings of total phosphorus in Long Branch Creek during each of the five monitoring events is given on Figure 4-27. In general, the trends exhibited by total phosphorus are very similar to the trends observed for particulate phosphorus during each of the five monitoring events. Relatively low and consistent loadings of total phosphorus were observed in the northern and southern segments during a majority of the monitoring events, followed by slight increases or decreases in upstream portions of the main channel, with a substantial increase in downstream portions of the main channel.

Under the high flow conditions observed on January 18, 2011, phosphorus loading rates were generally higher with slight increases in mass loadings between the beginning and ends of the northern and southern segments. Total phosphorus loadings increased between Sites 11 and 12 before decreasing at Site 14 and finally increasing again at Site 16.

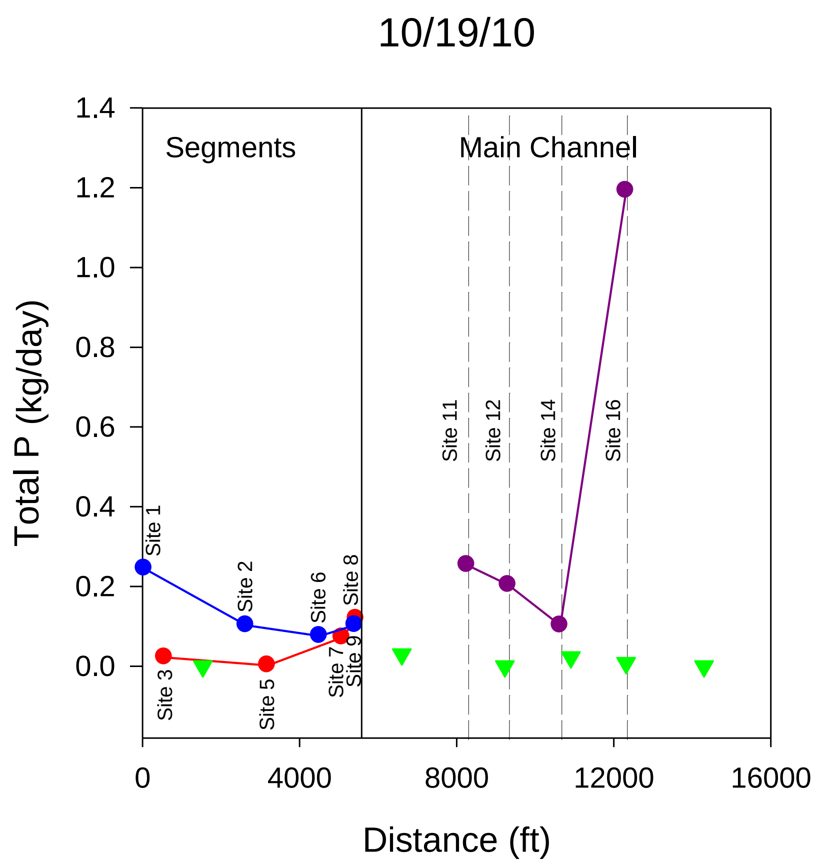
4.5.8 Suspended Solids (TSS)

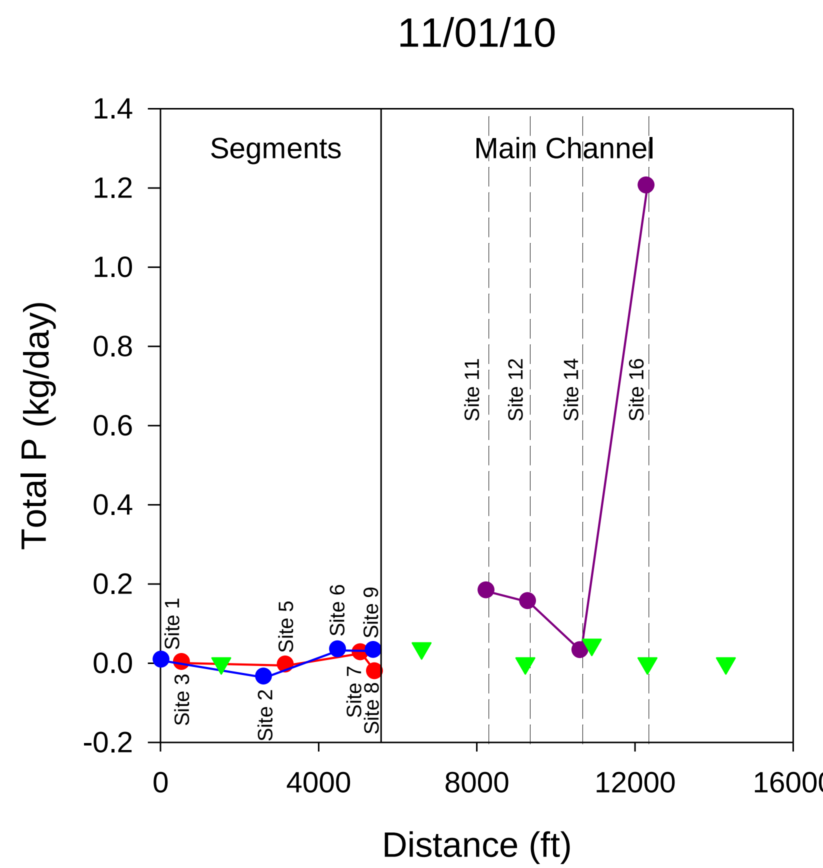
A graphical comparison of mass loadings of TSS in Long Branch Creek during the five field monitoring events is given on Figure 4-28. During the initial monitoring event on October 19, 2010, a substantially elevated TSS loading was observed at Site 1 due primarily to the elevated discharge rate at this site. Other than this site, mass loadings of TSS remained relatively consistent in the northern and southern segments during the October 19, November 1, November 16, and December 7, 2010 monitoring events. In the main channel, slight increases or decreases in TSS loadings occur between Site 11 and 14, with a substantial increase in loadings between Sites 14 and 16.

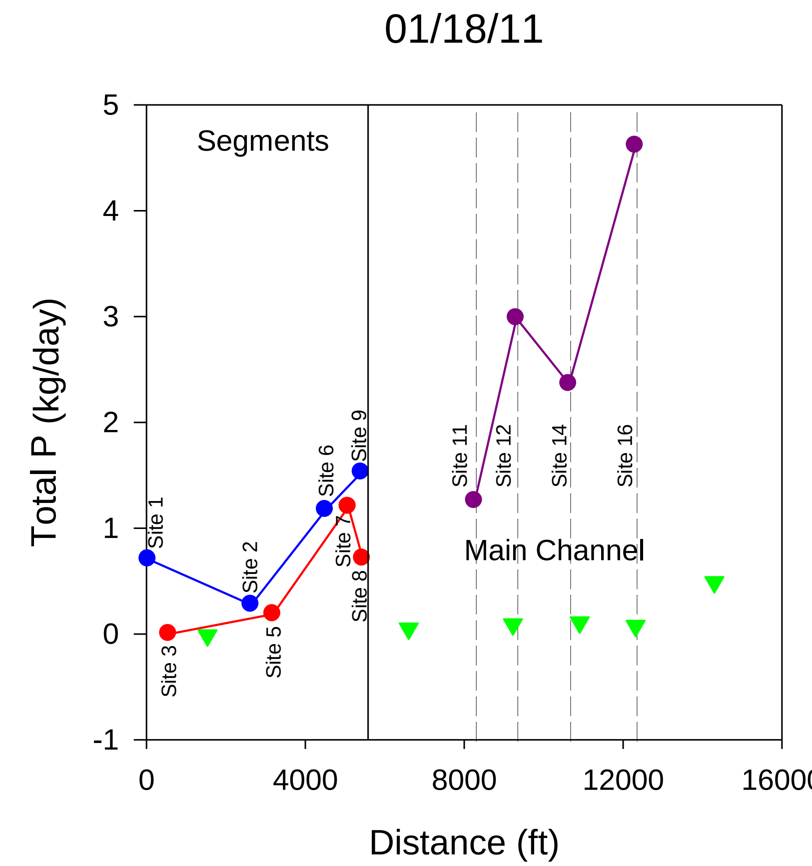
Under the high flow conditions observed on January 18, 2011, TSS loadings increased steadily along the northern segment, although a decrease in loading appears to occur between Sites 7 and 8. In the southern segment, TSS loadings decrease between Sites 1 and 2 before increasing again at Sites 6 and 9. The observed pattern of TSS loadings along the main channel during high flow conditions is similar to the trend observed under low flow conditions, with an increase in loadings between Sites 11 and 12, followed by a decrease at Site 14, with an additional increase at Site 16.

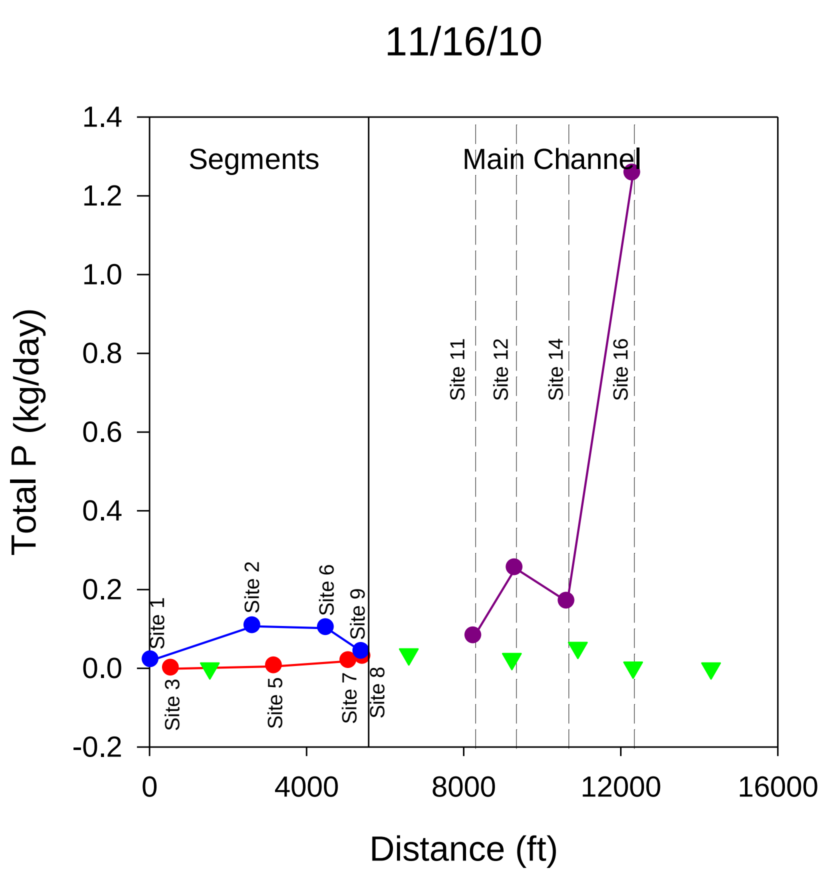
4.5.9 Fecal Coliform

A graphical comparison of mass loadings of fecal coliform bacteria in Long Branch Creek during each of the five field monitoring events is given on Figure 4-29. Under moderate and low flow conditions (which occurred during the October 19, November 1, November 16, and December 7, 2010 monitoring events), loadings of fecal coliform bacteria were generally low in value within the northern and southern segments, with the exception of a more elevated loading rate observed at Site 1 during the October 19, 2010 monitoring event due in most part to an elevated discharge rate at this site during the initial event. Fecal coliform inputs from the tributary inflow at Site 4 appear to be similar to loadings measured along the northern segment. Upon entering the main channel, fecal coliform loadings at the initial monitoring site (Site 11)









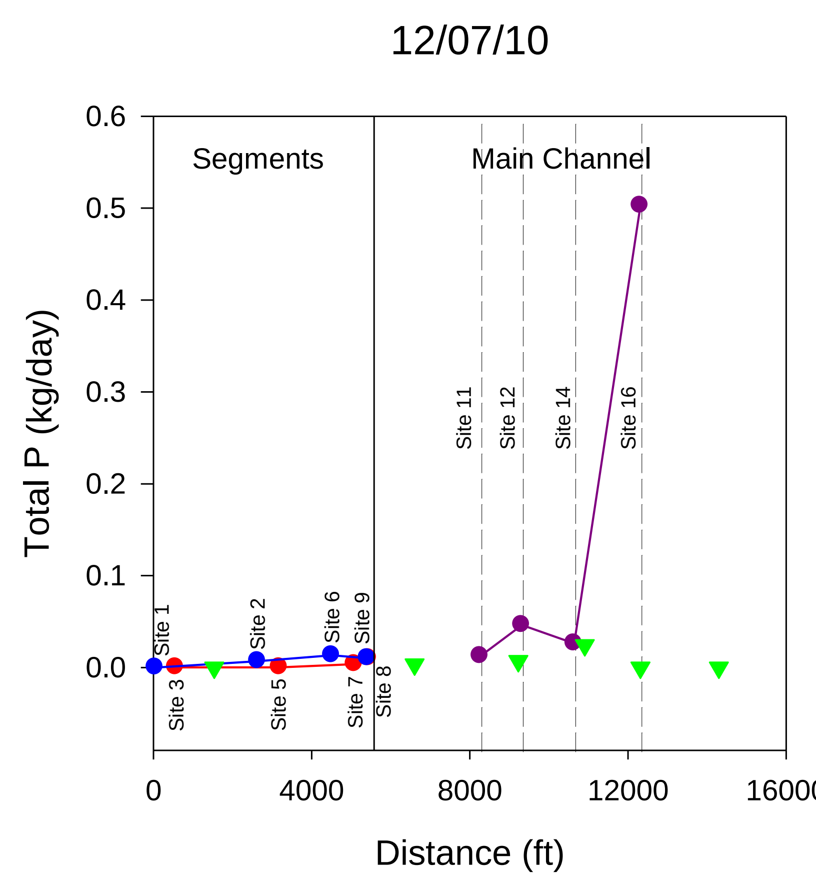


Figure 4-27.

Comparison of Mass Loadings of Total Phosphorus in Long Branch Creek During the Field Monitoring Program.

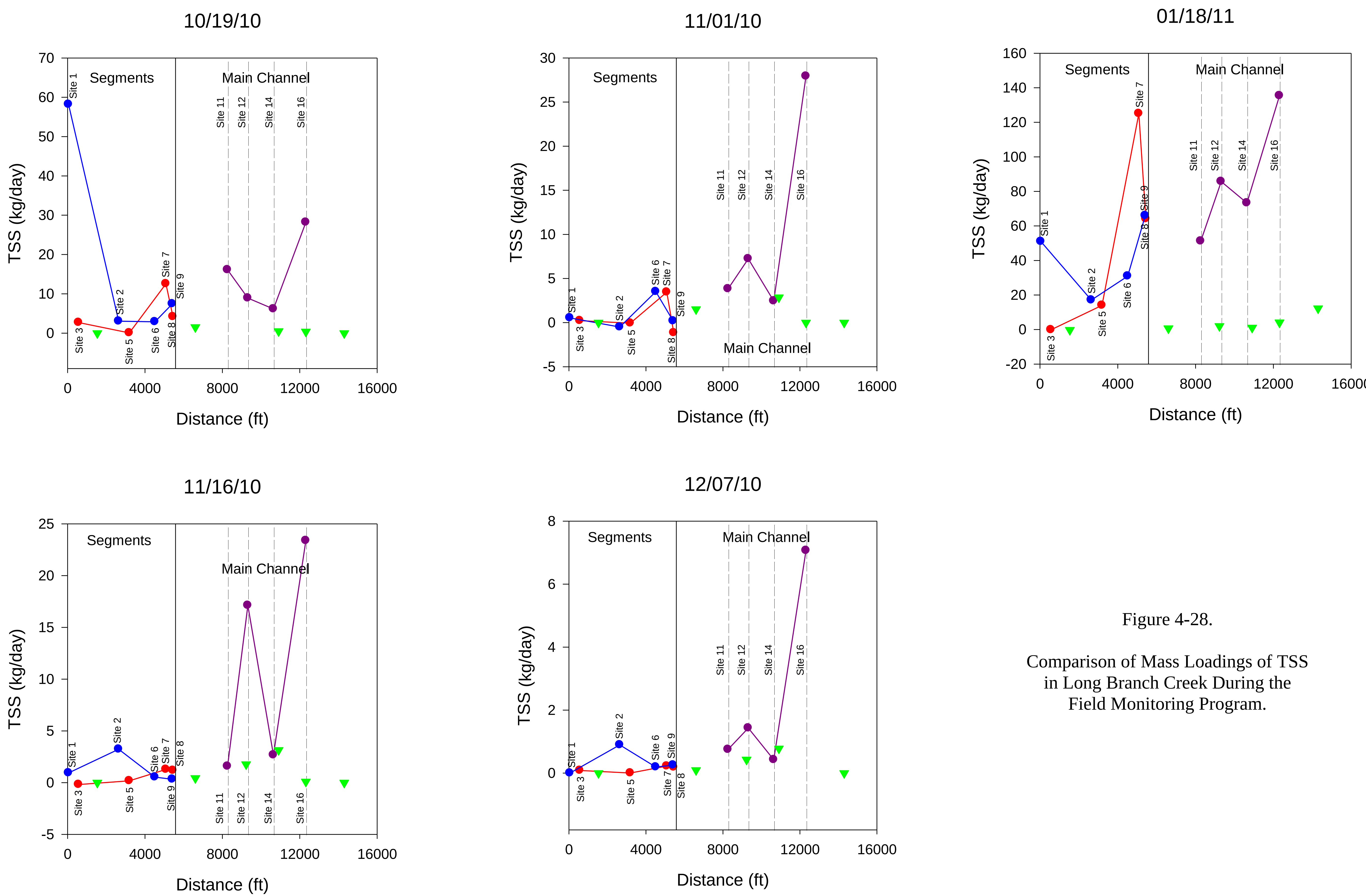


Figure 4-28.

Comparison of Mass Loadings of TSS in Long Branch Creek During the Field Monitoring Program.

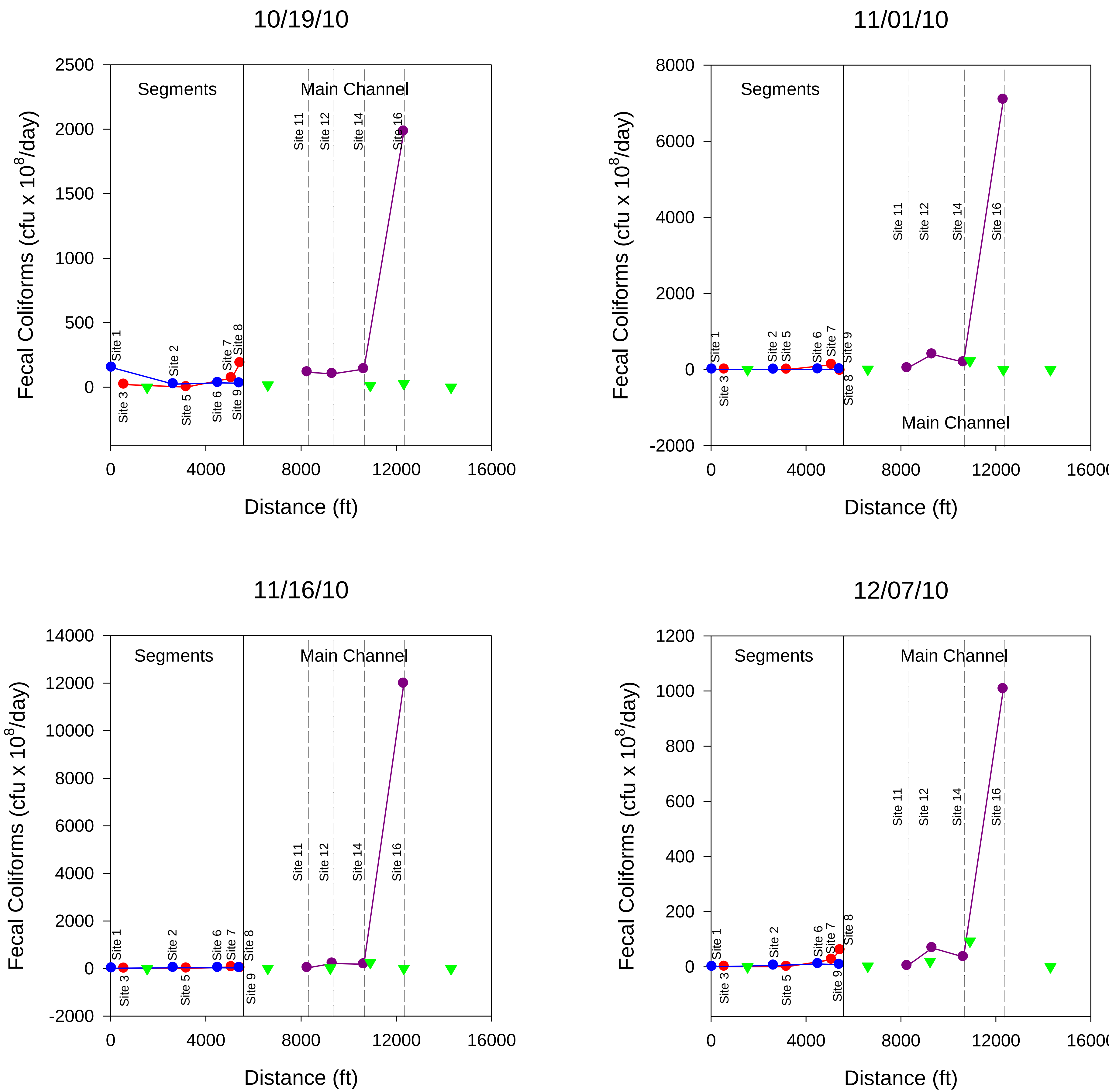


Figure 4-29.

Comparison of Mass Loadings of Fecal Coliform Bacteria in Long Branch Creek During the Field Monitoring Program.

appear to be similar to inflows from the northern and southern segments. Little change in fecal coliform loading appears to occur between Sites 11 and 14. However, as observed with species of nitrogen and phosphorus, a substantial increase in mass loadings of fecal coliform bacteria occurs between Sites 14 and 16. The observed increase in mass loadings in this portion of Long Branch Creek cannot be explained by the calculated loadings from the monitored tributary inflows, suggesting that an additional significant source of fecal coliform bacteria is present between Sites 14 and 16.

Under high flow conditions on January 18, 2011, fecal coliform loading rates were generally higher in value, with a general trend of increasing loading with increasing distance along the northern and southern segments, although a slight decrease appears to occur at the final monitoring sites for each segment. Fecal coliform loadings from the tributary inflow at Site 4 appear to be similar to values measured within the northern segment. Fecal coliform loadings at the initial main channel monitoring site (Site 11) are similar to the values measured in the upstream segments. A substantial increase in fecal coliform occurs between Sites 11 and 12, followed by a decrease between Sites 12 and 14, with a substantial increase between Sites 14 and 16. Under high flow conditions, inputs of fecal coliform bacteria appear to originate between Sites 11 and 12 as well as between Sites 14 and 16. The increase in fecal coliform between Sites 11 and 12 is much less pronounced or absent during moderate to low flow conditions. Fecal coliform loadings from tributary inflows are insufficient to generate the significant additional mass loadings of fecal coliform observed under high flow conditions.

4.5.10 Summary

In summary, most of the evaluated parameters appear to exhibit similar patterns with respect to generated loadings during the October, November, and December 2010 monitoring events which reflect moderate to low flow conditions. With the exception of the initial monitoring event on October 19, 2010, mass loadings of virtually all parameters were relatively low in value in both the northern and southern segments. No significant trend of either decreasing or increasing loadings is apparent in these segments for a majority of the monitored parameters. Loadings originating from the tributary inflow at Site 4 appear to be similar to loadings measured along the northern segment. Mass loadings within the main channel at the initial monitoring site (Site 11) appear to be relatively similar during many events to loadings originating within the northern and southern segments. A slight increase or decrease in loading rates appears to occur in mid-portions of the main channel between monitoring Sites 11, 12, and 14 during most events. However, during virtually all events, a substantial increase in loadings occurs between Sites 14 and 16. In most cases, the monitored loadings from the tributary inflows into the main channel do not appear to be sufficient in magnitude to cause the observed increases in mass loadings between Sites 14 and 16. There appears to be an additional significant source of nutrient addition between Sites 14 and 16 other than the monitored tributary inflows.

A slightly different pattern appears to occur under high flow conditions. In general, mass loadings are greater in value in both the northern and southern segments as well as the main channel during high flow conditions. A pattern of increases in mass loadings in downstream portions of the northern and southern segments was observed for most parameters compared with upstream portions of the northern and southern segments. Mass loadings from the tributary inflow at Site 4 appear to be similar to loading rates observed along the northern segment. Similar to the trends observed under moderate and low flow conditions, mass loadings at the initial main channel monitoring site appear to be relatively similar to loadings discharged from the northern and southern segments for most parameters. A significant increase in loadings appears to occur between Sites 11 and 12 for most parameters during most of the monitoring events. Many parameters then exhibit a decrease in loadings between Sites 12 and 14. However, as observed under moderate and low flow conditions, a substantial increase in loadings appears to occur between Sites 14 and 16 which cannot be explained by the monitored tributary inflows.

4.6 Source Identification

Two supplemental lines of analyses were conducted to assist in evaluating sources for the elevated nutrients and fecal coliform bacteria observed throughout Long Branch Creek. The first method utilizes stable isotope analyses to distinguish sources of NO_x present in the collected surface water samples. The second technique involves analysis of ultraviolet light absorption which can show qualitative differences in the composition of dissolved organic carbon from different sources. A discussion of the results of each of these source identification techniques is given in the following sections.

4.6.1 Isotope Analyses

As discussed in Section 3.4, analyses were conducted for stable isotopes of nitrogen and oxygen on tributary and main channel samples collected from Long Branch Creek during the field monitoring program. Sample analyses were conducted by the Colorado Plateau Stable Isotope Laboratory of Northern Arizona University. At the completion of the analyses, a summary report was prepared by Dr. Bruce Hungate which described the work efforts and results of the isotope analyses. A complete version of this report is given in Appendix E, and a summary of the results is given below.

The isotope methodology involves analysis of NO_x as well as stable isotopes of NO_x. A discussion of NO_x concentrations in tributary inflow and main channel samples has been previously provided based upon analyses conducted by ERD. However, a discussion of the NO_x analyses conducted by the Colorado Plateau Stable Isotope Laboratory are included below, as necessary, along with a discussion of isotope determinations.

4.6.1.1 Analysis of δ^{15}N and δ^{18}O of Nitrate + Nitrite (NO_x)

All but one of the 86 samples received had sufficient NO_2^- + NO_3^- (hereafter, NO_x) for isotope analysis, although 18 were at or below the detection limits for the method utilized to determine NO_x concentrations (0.02 mg NO_x-N L^{-1}). In 17 of these cases, the mass spectrometry method nevertheless obtained sufficient N_2O for isotopic determination.

$[NO_x]$ concentrations averaged 0.15 mg N L^{-1}, with a standard deviation of 0.16. $\delta^{15}N-NO_x$ averaged 3.52‰ with a standard deviation of 5.05‰, and $\delta^{18}O-NO_x$ averaged 3.99‰ with a standard deviation of 10.03‰.

The spatial configuration of the sampling scheme used in the Long Branch Creek system enabled testing for correspondence between putative sources of nitrate and nitrate found in the main channel. For example, if inlet Sites 10 and 13 are significant sources to the main channel, there should be correspondence between variation at these sites and at downstream sampling Sites 14 and 16 in the main channel. Similarly, if inlet Sites 3 and 4 have a strong influence, their signatures should be reflected in downstream main channel Sites 5, 7, and 8. In general, there was evidence for such temporal-spatial covariation in the study system. For example, the decline in $\delta^{15}N$ values at inlet Sites 10 and 15 from November 16-December 7, 2010 was also observed in main channel Sites 14 and 16. In general, inlet sites with high $[NO_x]$ concentrations (13, 15) tended to show higher temporal covariation with downstream main channel sites.

4.6.1.2 Evidence for *in situ* Denitrification

Two lines of evidence could support *in situ* denitrification as a major pathway of NO_x removal, and thus as a confounding signal for interpreting isotopes in source partitioning. One sign of denitrification is a negative slope for the relationship between $[NO_3^-]$ and $\delta^{15}N-NO_x$, reflecting preferential removal of $^{14}N-NO_x$ through denitrification. A second sign of *in situ* denitrification is co-varying enrichment of $\delta^{15}N$ and $\delta^{18}O$ in nitrate, if the ratios of enrichments are between 1.3 and 2.1 to 1 (Aravena and Robertson 1998; Fukada, et al. 2003). However, there was no evidence for any such relationships in the Long Branch Creek system, including for any given sampling date across sites, within individual sites sampled over time, and across the entire dataset. Therefore, denitrification does not appear to have a major influence on patterns of $\delta^{15}N$ and $\delta^{18}O$ in nitrate in Long Branch Creek.

4.6.1.3 Source Partitioning

$\delta^{15}N$ and $\delta^{18}O$ values of NO_x (with an average value just below 4‰ for both) were consistent with NO_x derived from nitrification or native soil organic matter, synthetic fertilizers, and sewage sources of nitrogen. Although synthetic fertilizers in the form of nitrate have constrained figures for $\delta^{18}O$, ammonium-based fertilizer sources will carry the same $\delta^{18}O$ signature as nitrogen derived from native organic matter, because these sources are nitrified under similar conditions.

The positive anomaly for the last sample date, and the fact that this occurred at virtually all sites, suggests nitrogen input through precipitation, which typically carries a more positive $\delta^{18}O$ signature in NO_x compared to other sources. The $\delta^{18}O$ anomaly immediately followed a 2.88 inch precipitation event that occurred in the region on January 17, 2011. This precipitation event was fairly large, and occurred after several weeks of little rain. This finding is consistent with other estimates from the region that identify atmospheric deposition as an important source of inorganic nitrogen input to watersheds. For example, bulk atmospheric deposition has been estimated to contribute 32% of nitrogen loading to the Tampa Bay watershed (Poor, 2002).

As summarized in Figure 7 of the stable isotope report provided in Appendix E, samples with $\delta^{15}N\text{-}NO_x$ values greater than +3 and $\delta^{18}O\text{-}NO_x$ values ranging from approximately -10 to +12 are within the 90% confidence interval for nitrogen concentrations associated with manure or sewage. A summary of Long Branch Creek samples within the 90% confidence interval for the presence of manure or sewage is given in Table 4-9. Samples with isotopic signatures which fall within the range of values listed previously are indicated by an "X" in Table 4-9 Virtually all of the field monitoring sites, with the exception of Site 7 located in the northern headwater segment, indicated nitrogen sources originating from manure or sewage during at least one of the five monitoring dates. Monitoring sites with the most consistent isotopic nitrogen signatures for the presence of manure or sewage included Site 15 (drainage canal along Whitney Road) which indicated the presence of manure or sewage during all five of the monitoring events, and Site 9 (discharge from southern segment into main channel) which indicated nitrogen originating from manure or sewage during four of the five monitoring events. Nitrogen sources originating from manure or sewage were detected during three of the five monitoring events at Site 3 (discharge from Swan Lake), Sites 12, 14, and 16 (main channel sites), and Site 17 (discharge from downstream stormwater lake).

TABLE 4-9

SUMMARY OF LONG BRANCH CREEK SAMPLES INDICATING MANURE OR SEWAGE AS NITROGEN SOURCES

SITE	$\delta^{15}N\text{-}NO_x$ (%)				
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11
3		X	X	X	
5			X		
7					
8		X	X		
1				X	
2	X				
6		X			
9	X	X	X	X	
11			X		
12	X	X	X		
14	X	X	X		
16	X	X	X		
4			X	X	X
10			X	X	
13	X		X	X	
15	X	X	X	X	X
17	X	X	X		
18			X	X	

Northern Headwater Segment (sites 3, 5, 7, 8) — Main Channel Sites (sites 11, 12, 14, 16)

Southern Headwater Segment (sites 1, 2, 6, 9) — Tributary Inflows (sites 4, 10, 13, 15, 17, 18)

As indicated on Table 4-9, the number of sites exhibiting a signature of manure or sewage may actually be inversely correlated with discharge since the largest number of “hits” appears to occur during the low flow conditions which occurred on November 1, November 16, and December 7, 2010, and the lowest number of “hits” appears to occur during the high flow conditions observed on January 18, 2011. This pattern suggests that the source of sewage inputs into Long Branch Creek is relatively consistent over time and is actually diluted during significant rain events in the watershed. The source of fecal coliform loadings does not appear to be related to runoff conditions but is more of a steady input into the system.

4.6.2 UV Absorbance

The UV absorption technique is based upon the concept that the ultraviolet light absorption of a filtered water sample will vary depending upon the composition and source of dissolved organic carbon sources within the sample. This technique has been used in multiple investigations to identify the presence of wastewater or reclaimed water contamination in watersheds. This technique was used successfully by Kaehler and Belitz (2003) to identify reclaimed water fractions in groundwater monitoring wells in Riverside County, California. The technique relies upon the fact that the absorption properties of synthetic organic compounds are different from those of natural organic materials. The magnitude of the absorbance is related to the molecular structure of the specific functional groups within the organic molecules as well as the concentration of those molecules. Absorbance is typically measured at a wavelength of 254 nm which maximizes absorption of aromatic rings that form the building blocks of many organic compounds. According to Kaehler and Belitz, UV absorbances in excess of 0.01 indicate the presence of organic compounds that originate from sources other than decomposition of natural organic matter.

A tabular summary of measured UV absorbances for each of the Long Branch Creek samples collected from October 2010-January 2011 is given on Table 4-10. The vast majority of the measured UV absorbances exceed 0.01, indicating the presence of non-natural organic materials within the samples. The most elevated UV absorbances were observed at Sites 2 and 6 in the southern headwater segment, at Site 4 in the northern headwater segment, and at Site 15 (ditch along Whitney Road). The lowest absorbance values were observed at Site 7 (located in downstream portions of the northern headwater segment) and at Site 17 (which reflects discharge from the stormwater lake in the extreme downstream portion of the watershed). It appears that contamination with non-natural organic compounds occurs throughout the entire Long Branch Creek watershed.

Mean absorbance values are provided at the bottom of Table 4-10 for each of the five monitoring dates. The mean UV absorbance values appear to increase as discharge rates within the creek decrease, suggesting that the sources of the organic compounds are not necessarily associated with stormwater runoff. However, substantial increases in absorbance were observed from Site 7 to Site 8 (both of which are located along the northern segment) during low and high flow conditions. The lowest levels of UV absorbances in the watershed were obtained during the final monitoring event when discharges to the system were heavily impacted by precipitation. UV absorbance values appear to be relatively consistent within the main channel portion of Long Branch Creek and highly variable in the northern segment, southern segment, and tributary inflows. Tributary inflow Sites 13, 17, and 18 appear to have absorbance values equal to or less than values measured in the main channel, with absorbances measured at Sites 4, 10, and 15 exceeding values measured in the main channel.

TABLE 4-10

MEASURED UV ABSORBANCES (@ 254 nm) FOR THE LONG BRANCH CREEK SAMPLES COLLECTED FROM OCTOBER 2010 - JANUARY 2011

SITE	UV-A (@ 254 nm) COLLECTION DATE					MEAN VALUE
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
3	0.031	0.032	0.044	0.049	0.050	0.041
5	0.052	0.078	0.073	0.076	0.030	0.062
7	0.001	0.000	0.013	0.000	0.050	0.013
8	0.026	0.017	0.098	0.001	0.040	0.036
1	0.031	0.069	0.025	0.083	0.000	0.042
2	0.113	0.184	0.142	0.132	0.030	0.120
6	0.093	0.157	0.124	0.106	0.025	0.101
9	0.060	0.136	0.050	0.079	0.020	0.069
11	0.050	0.074	0.078	0.066	0.030	0.060
12	0.045	0.071	0.071	0.058	0.030	0.055
14	0.047	0.073	0.073	0.062	0.030	0.057
16	0.033	0.063	0.027	0.062	0.030	0.043
4	0.096	0.127	0.119	0.108	0.070	0.104
10	0.061	0.091	0.089	0.071	0.040	0.070
13	0.047	0.053	0.083	0.071	0.030	0.057
15	0.117	0.142	0.123	--	0.030	0.103
17	0.000	0.036	0.000	0.002	0.020	0.012
18	--	--	0.069	0.076	0.040	0.062
Average	**0.053**	**0.083**	**0.072**	**0.065**	**0.033**	**0.061**

Northern Headwater Segment (sites 3, 5, 7, 8) · Southern Headwater Segment (sites 1, 2, 6, 9) · Main Channel Sites (sites 11, 12, 14, 16) · Tributary Inflows (sites 4, 10, 13, 15, 17, 18)

4.7 Summary

Field monitoring, sample collection, and laboratory analyses were conducted by ERD from October 2010-January 2011 to evaluate the characteristics of discharges through Long Branch Creek, located in Central Pinellas County. Rainfall during the field monitoring program was substantially less than normal, although a significant rain event of approximately 2.88 inches occurred within the watershed prior to the final monitoring event.

Discharge rates through the northern and southern segments, as well as the main channel, generally increased with increasing distance downstream during each of the field monitoring events. However, the observed increases in discharge rates substantially exceeded the additional inflows contributed by the monitored tributaries, suggesting significant additional inputs into the segments and main channel other than the monitored tributary inflow sites.

In general, surface water samples collected in the segments and main channel monitoring sites were approximately neutral in pH. Low levels of dissolved oxygen, less than the applicable Class III criterion of 5 mg/l, were measured at virtually all sites during the field monitoring program, with several sites exhibiting dissolved oxygen concentrations less than the Class III criterion during each of the five monitoring events.

Contrary to the trends observed by ERD in the Roosevelt Creek basin, nutrient concentrations in Long Branch Creek appear to decrease with increasing distance downstream, with substantially lower concentrations of total nitrogen and total phosphorus measured in the main channel than in the northern and southern headwater segments. The only exceptions to this generality occur in mid-portions of the main channel where substantial increases in both total nitrogen and total phosphorus were observed. Tributary inflows into the main channel were generally insufficient to create the observed additional increases in nutrient concentrations in central portions of the main channel. The data suggest that additional inputs other than the monitored tributaries are impacting nutrient concentrations in the headwater segments and main channel sites.

In general, tributary inflows appear to have a minimal impact on water quality characteristics within the main channel or upstream segments, with only a few exceptions. Elevated total phosphorus concentrations were observed in the tributary inflow at Site 4 (which discharges into the northern headwater segment) and at tributary inflow Site 13 (which discharges into central portions of the main channel). Substantially elevated fecal coliform counts were also observed at tributary inflow Sites 4, 13, and 15 (which reflects the roadside swale along Whitney Road). However, in spite of the elevated concentrations measured in these tributary inflows, the mass loadings contributed by these sources do not fully explain the observed increases in mass loadings within the main channel.

Mass loadings of species of nitrogen and phosphorus generally increase with increasing distance downstream in the northern and southern headwater segments as well as the main channel. Mass loadings originating from tributary inflows appear to be relatively minimal compared with mass loadings discharging through the overall system. Sections of the main channel appear to provide significant assimilation of nutrients, presumably due to vegetative uptake of nutrients within the channel.

Stable isotope analyses were conducted on each of the surface water samples collected during the field monitoring program. Evidence of NO_x associated with manure or sewage was observed consistently during the field monitoring program, particularly at Site 15 which reflects the roadside swale along Whitney Road. The inputs do not appear to be associated with runoff since no positive correlation was found between the presence of manure and sewage indicators and discharge rates through the channel. In fact, the correlation between discharge and sewage or manure indicators appears to be negative, suggesting that sewage impacts may be an on-going process which is actually diluted by runoff inflows.

UV absorbances were also conducted on each of the collected samples to identify the presence of non-natural organic materials. The analyses suggest that the presence of non-natural organic materials occurs throughout the entire Long Branch Creek watershed, with the highest concentrations observed in the southern headwater segment, the inflow to the northern headwater segment at Site 4, and tributary inflow at Site 15 which reflects roadside drainage along Whitney Road. The Long Branch Creek watershed is serviced virtually entirely by a sanitary sewer collection system, and although reuse lines run through the watershed area, no application of reuse irrigation is known to occur. Therefore, it appears that pollutant sources within the Long Branch Creek enter primarily as diffuse sources, with groundwater inflows likely to be significant contributors.

SECTION 5

NUTRIENT MANAGEMENT RECOMMENDATIONS

As discussed in Section 4, increases in mass loadings of nitrogen, phosphorus, and fecal coliform bacteria were observed during migration through Long Branch Creek, although localized areas of significant uptake were also present. Substantial increases in mass loadings of total phosphorus, total nitrogen, and fecal coliform bacteria occur between main channel monitoring Sites 14 and 16 in spite of a relatively minimal inflow from the tributary at Site 13. It is apparent that a significant additional influx of nutrients and fecal coliform bacteria occurs into the main channel between Sites 14 and 16 other than the monitored tributary at Site 13. Although overall mass loadings were minimal, elevated concentrations of total phosphorus were observed in the inflow from the Site 4 and Site 13 tributary inflows. Extremely elevated levels of fecal coliform bacteria were observed in the Site 13 and Site 15 tributary inflows.

Conceptual management and/or treatment options were developed for selected areas within Long Branch Creek. Based upon the field monitoring program conducted by ERD, elevated concentrations of total phosphorus were observed in discharges from tributary inflow Sites 4 and 13, and elevated fecal coliform counts were observed in discharges from tributary inflows at Sites 13 and 15. Therefore, conceptual treatment/management options are discussed for tributary inflow Sites 4, 13, and 15. In addition, a substantial increase in measured loadings appears to occur for virtually all parameters between main channel Sites 14 and 16 in downstream portions of the Long Branch Creek system. A discussion of potential sources and management options for the additional nutrient and fecal coliform loadings between Sites 14 and 16 is presented. Guidelines for general watershed maintenance are also discussed.

5.1 <u>Significance of Groundwater Inflows</u>

As discussed in Section 2, volumetric discharge measurements increased steadily with increasing distance downstream in both the northern and southern segments and main channel portions of Long Branch Creek with a few exceptions. Decreases in discharge rates were observed between the western and eastern sides of US 19, presumably due to attenuation and storage of water in a wetland system on the east side of US 19. Volumetric discharges also decrease between Sites 12 and 14 in the main channel, with the most likely explanation involving evapotranspiration of water in this heavily vegetated portion of the main channel. Otherwise, steady increases in volumetric discharge occur with increasing distance downstream.

The most likely explanation for the observed increases in discharge rates in the segments and main channel is influx of groundwater seepage from areas adjacent to the canal since the monitored tributary inflows are clearly insufficient to generate the additional monitored discharges. Most portions of the segments and main channel have been cut well below the level of the existing land surface, and the resulting water levels within the canal are substantially lower than the anticipated groundwater table elevations within the watershed based upon soil types and proximity to Tampa Bay.

As discussed in Section 2.3, approximately 75% of the basin area is covered with A/D soils which are characterized as sandy soils with a high infiltration rate and low runoff generation rate under developed conditions. It appears that large portions of the precipitation within the drainage basin are entering the watershed soils and migrating into channels or conveyances which ultimately lead to Long Branch Creek or directly into the creek itself. It appears that the observed increases in discharge rates with increasing distance downstream are a result of groundwater seeping into the segments and main channel from the adjacent watershed areas.

As discussed in Section 4.6, evidence of manure or sewage as significant sources of nitrogen species in Long Branch Creek was observed at many of the monitoring sites, particularly along the main channel and tributary inflows. The significance of manure and sewer as nitrogen sources appear to increase under low flow conditions, providing evidence that the sources of these inputs are primarily groundwater related rather than resulting from stormwater runoff. The results of the UV absorbance measurements indicate that non-natural organic molecules are present throughout virtually all parts of the basin, particularly at tributary Sites 4 and 15 as well as the southern segment Sites 2 and 6. These data suggest that contamination with sewage and other non-natural organic compounds occurs throughout much of the Long Branch Creek watershed. However, the conclusion that NO_x concentrations within the watershed are consistent with manure, sewage, or wastewater inputs cannot be easily explained since all areas within the watershed are currently served by a central sewer system, and although reuse force mains are present within the basin, there does not appear to be any application of reuse water for irrigation within the watershed area.

The prevalence of manure and wastewater signatures, combined with the indications of man-made synthetic compounds within the basin, suggests that wastewater sources of some type may be impacting groundwater within the basin which ultimately reaches Long Branch Creek. It is very interesting that a wastewater signature is prevalent throughout the basin when known wastewater sources are extremely limited. The prevalence of the wastewater signature throughout much of the basin is disturbing since this implies that the potential wastewater sources are not limited in location but are spread throughout the entire watershed area. The data suggest that groundwater with a wastewater signature may be seeping or upwelling throughout much of the basin area. However, evaluation of this potential phenomenon is well beyond the scope of services for this project. Further evaluation of potential linkage between the observed groundwater inflows and the wastewater signature appears warranted.

5.2 BMP Considerations

A variety of BMPs are currently used in urban areas for management of stormwater runoff. Selection of appropriate BMPs is a function of several factors, including target pollutants, watershed size, land availability, construction costs, and routine maintenance. A list of potential urban BMPs was developed for this project, and each potential BMP was evaluated with respect to appropriateness for use in the Long Branch watershed. Each BMP was evaluated for its ability to remove the watershed target pollutant which include nutrients, fecal coliform, and suspended solids, along with land requirements and potential maintenance activities. BMPs evaluated as part of this study include the following:

1. Wet Detention
2. Pervious Pavement
3. Bio-retention
4. Stormwater Harvesting
5. Filter/Buffer Strips
6. Bio-swales
7. Inlet Filters
8. Sediment Traps
9. Education and Outreach

A general discussion of each of these BMPs is provided in the following sections, along with a discussion of its appropriateness for use within the Long Branch watershed.

5.2.1 Wet Detention Systems

Wet detention systems are currently a very popular stormwater management technique throughout the State of Florida, particularly in areas with high groundwater tables. A wet detention pond is simply a modified detention facility which is designed to include a permanent pool of water. These permanently wet ponds are designed to slowly release collected runoff through an outlet structure. A schematic diagram of a wet detention system is given in Figure 5-1.

Pollutant removal processes in wet detention systems occur through a variety of mechanisms, including physical processes such as sedimentation, chemical processes such as precipitation and adsorption, and biological uptake from algae, bacteria, and rooted vegetation. In essence, these systems operate similar to a natural lake system.

Upon entering a wet detention facility, stormwater inputs mix with existing water contained in the permanent pool. Physical, chemical, and biological processes begin to rapidly remove pollutant inputs from the water column. Water which leaves through the orifice in the outfall structure is a combination of the mixture of stormwater and the water contained within the permanent pool. In general, the concentration of constituents in the permanent pool are typically much less than input concentrations in stormwater runoff, resulting in discharges from the facility which are substantially lower in concentration than found in raw stormwater. As a result, good removal efficiencies are achieved within a wet detention facility for most stormwater constituents. Although the littoral zone provides a small amount of enhanced biological uptake, previous research has indicated that a vast majority of removal processes occurring in wet detention facilities occur within the permanent pool volume rather than in the littoral zone vegetation for the treatment volume (Harper, 1985; Harper 1988; Harper and Herr, 1993).

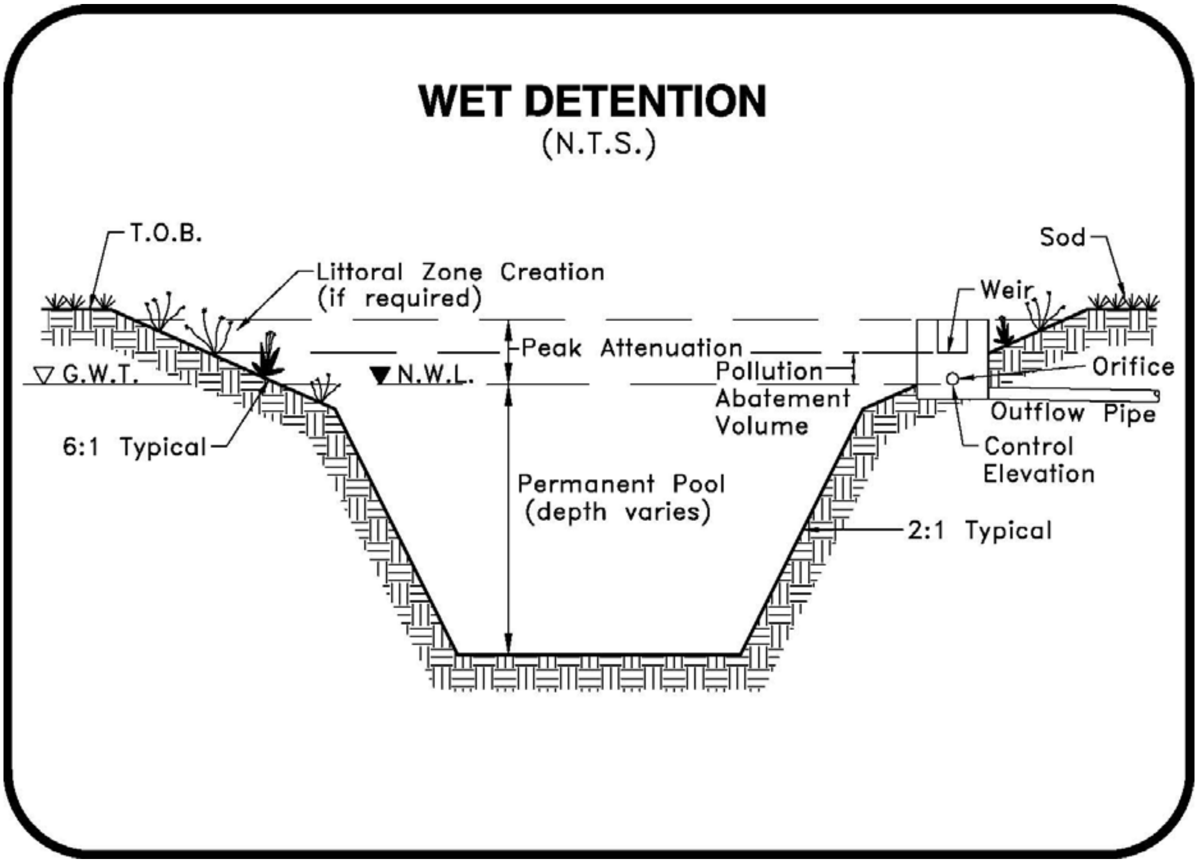


Figure 5-1. Schematic of a Wet Detention System.

Wet detention systems offer several advantages over some other stormwater management systems. First, wet detention systems provide relatively good removal of stormwater constituents since physical, chemical, and biological mechanisms are all available for pollutant attenuation. Other stormwater management facilities provide only one or two of these basic removal methods for stormwater. A second advantage of wet detention systems is that the systems are not complex and can be relatively easily maintained. Wet detention systems do not have underdrain systems which can become clogged and need periodic maintenance. Wet detention systems can be viewed as amenities in development projects.

Of the stormwater facilities investigated during this evaluation, probably the most amount of research within the State of Florida has been conducted on wet detention systems. Research on wet detention ponds clearly indicates that the most significant factor impacting the performance efficiency of a wet detention pond is the residence time within the system, specifically the volume of the permanent pool in comparison to the volume of runoff entering the pond. The most typical design detention time for wet detention ponds in the State of Florida is approximately 14 days. Ponds constructed with a minimum 14-day residence time typically achieve removal efficiencies ranging from approximately 20-40% for total nitrogen, 60-65% for total phosphorus, BOD, and copper, with removal efficiencies for orthophosphorus, TSS, lead, and zinc approaching or exceeding 75-85%. Few studies have been conducted to document the performance efficiency of wet detention ponds for removal of microbiological contaminants, but the limited number of studies which are available indicate removal efficiencies ranging from 60-90%.

In summary, wet detention ponds provide good to excellent removal efficiencies for each of the target pollutants generated in the Long Branch watershed and should be given significant consideration when selecting retrofit BMPs. Perhaps the most significant drawback to use of a wet detention pond is the area required for construction of the pond. Therefore, wet detention treatment in urban areas is most attractive when it can be incorporated into an existing pond or water feature.

5.2.2 Pervious Pavement

Pervious pavement systems are basically a retention-type BMP which collects and stores stormwater runoff while gradually infiltrating the runoff into the shallow groundwater table. Pervious pavement systems include products such as pervious concrete, pervious aggregate/ binder products, pervious paver systems, and modular paver systems. Newer innovations in pervious pavement include pervious asphalt and pervious pavements which use crushed and recycled glass, although many of these products are still under research and design. Since pervious pavement systems are basically retention systems, they can be used for many impervious applications to reduce the volume of generated runoff.

Due to the structural limitations inherent in pervious pavement systems, pervious pavement is most appropriate for impervious applications such as sidewalks, driveways, and parking areas, primarily in the area of the parking stalls. The use of pervious pavement is not recommended in areas of frequent turning movements, such as public roadways, drive-through lanes, gas pump areas, or driveway entrances. Pervious pavement is also not recommended in areas with poorly draining soils or soils which contain shallow confining units, clay, hardpan, or organic muck. The use of pervious pavement should also be limited in areas where hazardous materials are used to prevent the potential for spills that could potentially seep into the underlying groundwater. Certain pervious pavement systems have a potential for tripping hazards when the areas are used by pedestrians.

Since pervious pavement is an infiltration practice, it provides excellent removal efficiencies for the target pollutants in the Long Branch watershed, including nutrients, bacteria, and TSS. The performance efficiency of pervious pavement systems is a direct function of the amount of the annual runoff volume that can be infiltrated into the ground. Currently, the cost of pervious pavement is approximately 2-4 times greater than the cost of traditional impervious coverings.

Pervious pavements are rarely used as retrofit options due to the high costs involved and are more commonly used in new construction to reduce the area requirements for stormwater treatment systems. The use of pervious pavement can substantially reduce the size of additional stormwater management or flood attenuation storage that may be required. Other than being incorporated into new construction in the Long Branch Creek watershed, pervious pavement appears to have little benefit as a retrofit BMP option for this area. The use of pervious pavement would only address pollutant loadings on the individual parcel where the pervious pavement was installed which would have little impact on overall pollutant loads discharging through Long Branch Creek.

5.2.3 Bio-retention

Bio-retention areas, also referred to as rain gardens, are landscaped depressional areas used to store and infiltrate runoff into groundwater. Although the term “bio-retention” is relatively new in the stormwater BMP field, this process is simply a smaller version of the standard dry retention design used in Florida for several decades with the exception that the grass used to line the bottom of the pond is replaced with more decorative vegetation. Bio-retention systems are more suited to small drainage basins rather than the larger drainage basin areas which commonly discharge to a standard dry retention pond.

Typical photographs of bio-retention systems used in a residential and commercial setting are given on Figure 5-2. These systems are used to collect and store runoff from a relatively small area and infiltrate the runoff into the groundwater between storm events. The planted vegetation aids in uptake and adsorption of nutrients during migration through the upper layers of the soil. Since bio-retention systems are simply dry retention ponds with planted vegetation, the removal efficiency of a bio-retention pond is a direct function of the percentage of the annual runoff volume which is infiltrated into the ground.

a. Bio-retention on a residential setting

b. Bio-retention on a commercial setting

Figure 5-2. Photographs of Bio-retention Systems.

Bio-retention systems are generally utilized on small sites in a highly urbanized setting. The majority of bio-retention systems which have been constructed have been used in residential and commercial areas where the bio-retention system can be fitted into vacant spots in landscaping or in parking areas.

Since bio-retention is an infiltration technique, it would provide excellent removal efficiencies for the pollutants of concern in the Long Branch Creek watershed. However, since bio-retention systems are generally constructed to treat relatively small areas, significant reductions in overall pollutant loadings within the Long Branch watershed would require construction of a multitude of individual bio-retention areas to create a significant reduction in pollutant loadings.

An interesting modification of a standard bio-retention system is illustrated on Figure 5-3. This modification may enhance the effectiveness of a bio-retention system depending upon the concentration of pollutants and the type of soil filter media mixture used. However, this modification still is limited to relatively small size areas and is generally not suitable as a large-scale retrofit option for the Long Branch Creek watershed.

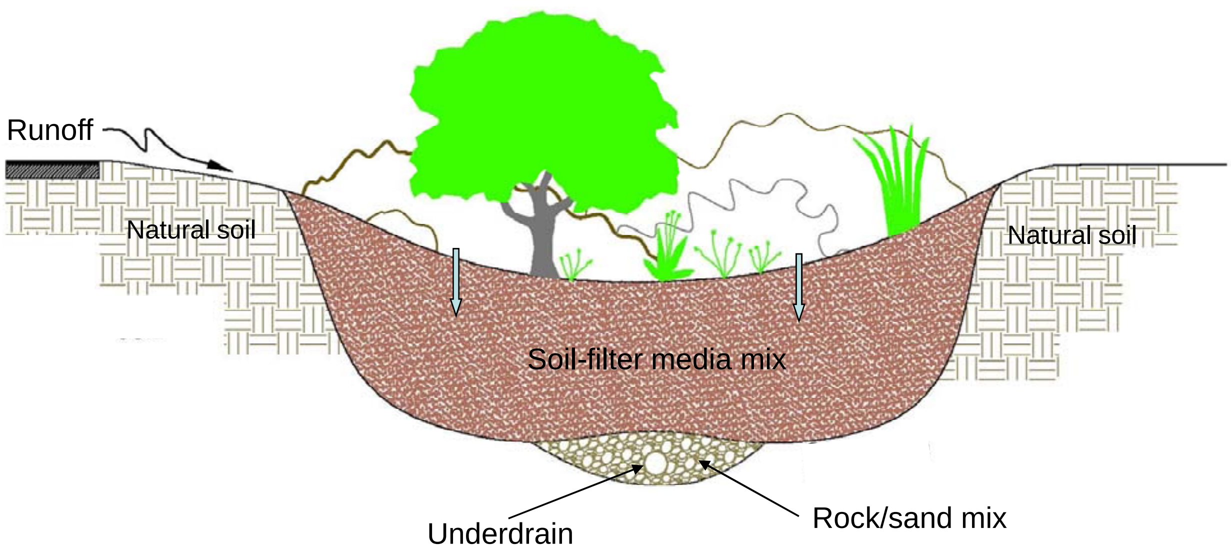


Figure 5-3. Modified Bio-retention System.

5.2.4 Stormwater Harvesting

Stormwater harvesting involves beneficial reuse of treated stormwater runoff to reduce the stormwater volume and mass of pollutants discharged to receiving waterbodies. Stormwater harvesting generally consists of collection of runoff in a wet detention pond and using the stored water within the pond as a source of irrigation. The amount of water removed from the pond for irrigation purposes is directly related to the pollutant load reduction which occurs to off-site receiving waterbodies. Stormwater harvesting is an excellent water conservation technique which can significantly reduce the demand for potable water supply used for irrigation.

In general, irrigation of urban areas with treated stormwater runoff is far superior from a pollutant loading standpoint than irrigation with reclaimed wastewater. Irrigation with stormwater runoff will reduce loadings to downstream waterbodies within the watershed because a portion of the generated runoff volume will be retained in the urban areas and will not discharge downstream. In contrast, irrigation with reuse water introduces additional new water volumes into the watershed, often with significantly elevated levels of both total nitrogen and total phosphorus in comparison to treated stormwater runoff. Multiple studies have indicated that the use of secondarily treated wastewater for irrigation in urban watersheds substantially increases loadings to downstream waterbodies.

Multiple waterbodies currently exist along the path of Long Branch Creek. Any of these existing waterbodies could be used as a source of irrigation for the urban areas which would reduce both the volume and mass loading of stormwater generated pollutants discharging to Old Tampa Bay. The volume of irrigation water extracted from Long Branch Creek could be adapted on a seasonal basis to maintain just the minimum flows required within the creek to maintain the desired ecological functions, with the remaining water volume distributed over the urban areas for irrigation. However, this process would require installation of an expensive distribution system throughout much of the urban area to distribute the stormwater reuse to areas of potential use. Reuse of stormwater for irrigation would provide excellent removal and retention of nutrients within the watershed. Microbiological contamination could be filtered out from the stormwater reuse by installation of horizontal wells in the selected waterbodies used for irrigation. Although stormwater reuse is probably one of the best technical solutions for the observed water quality problems within Long Branch Creek, the high cost of this option eliminates it from further consideration.

5.2.5 Filter/Buffer Strips

The term “buffer strip” refers to natural areas adjacent to receiving waterbodies that are designed to treat runoff and remove pollutants through filtration and infiltration. Buffer strips differ from filter strips primarily by the location of the activity, with filter strips generally referring to vegetated sections of land designed to treat runoff and remove pollutants in areas other than the banks of the receiving waterbody. Both filter and buffer strips are best suited for treating small amounts of runoff from roads and highways, roof downspouts, small parking lots, and pervious surfaces. They can also be used to serve as a buffer between incompatible land uses as well as provide groundwater recharge in areas with pervious soils.

Filter/buffer strips rely on the use of vegetation to slow runoff velocities and filter out sediments from urban stormwater runoff. The contact time with the vegetation is generally minimal and does not allow for significant uptake of dissolved pollutants. For the pollutants of concern in the Long Branch Creek watershed, filter/buffer strips would be most applicable to removal of TSS and particulate forms of nutrients but would provide little removal of dissolved nutrients or biological constituents. To maximize effectiveness, sheet flow must be maintained across the entire filter/buffer strip. If short-circuits develop within the filter/buffer strip, it can reduce water quality benefits as well as create additional erosion-related discharges.

Filter strips are primarily used in areas of low to moderate density where sufficient land is available. Therefore, filter/buffer strips are not generally applicable in many highly developed areas. Filter/buffer strips can be used in both upland portions of the watershed as well as areas immediately adjacent to Long Branch Creek. Given the configuration of Long Branch Creek, there are few areas where buffer strips could be implemented immediately adjacent to the creek. Much of the upland portion of the Long Branch Creek watershed is built-out with relatively dense urban development which offers little opportunity for construction of filter/buffer strips as a retrofit BMP. This activity appears to be more appropriate for new construction or redevelopment within the watershed rather than as a retrofit BMP. The relatively small amount of water quality improvement generated by filter strips does not appear to be worth the significant cost of retrofitting much of the Long Branch Creek watershed with this option.

5.2.6 Bio-swales

A bio-swale is simply a shallow depressional area which is used to collect and convey stormwater runoff. Bio-swales are also referred to as "grassed swales" which are common throughout the State of Florida. Swales use the combination of vegetation and infiltration into the soil to reduce the volume of stormwater runoff while improving the water quality characteristics. Bio-swales are currently used extensively throughout the State of Florida to convey stormwater runoff along roadways and in residential communities. Stormwater treatment occurs primarily as a result of infiltration of runoff into the ground and adsorption of pollutants onto the surface of the plant material within the swale. Grassed swales are well suited to treat both highway and residential road runoff because of their linear nature and because swales both treat and convey stormwater runoff. Swales used for roadway drainage are usually found in more rural sections, although several of the major roadways in the Long Branch Creek watershed currently use swales to convey stormwater runoff.

It appears unlikely that removal of existing drainage systems within the Long Branch Creek watershed and replacement with grassed swales would generate a pollutant load reduction that would be justified by the extensive construction costs. However, enhancement of the existing swale systems is possible by installation of check-dams to convert the existing swales into a series of linear retention ponds that slow down the runoff, provide opportunities for additional settling of particulate matter, and enhance infiltration into groundwater. This type of retrofit is extremely inexpensive and can provide a relatively significant pollutant load reduction. Hydrologic modeling would need to be conducted to ensure that the installed check-dams do not create flood-related issues. Pollutant removal efficiencies achieved using swale drainage systems are a function of both the annual runoff volume which can be infiltrated, as well as settling of particulate matter and, to a more limited extent, adsorption of dissolved pollutants within the swale vegetation.

5.2.7 Inlet Filters

Inlet filters consist of strainer-type baskets which are placed inside grate and curb inlets to collect leaves, vegetation debris, and trash to prevent the material from discharging into the stormwater management system. A wide variety of grate and curb inlets are now available from a wide range of manufacturing companies. However, each of these perform the same basic function of collecting and separating leaves and larger debris from the runoff stream. The majority of the grate and inlet baskets are constructed with approximately 0.5-inch openings to allow water to pass through the basket while retaining the leaves and other debris.

Inlet baskets are a relatively inexpensive method of removing large debris from stormwater runoff. The initial installation costs for these systems are generally low, but require monthly maintenance to remove and dispose of the collected material. This type of BMP is appropriate for highly urbanized areas which primarily use a curb and gutter system with underground stormsewers.

ERD generally recommends that curb and inlet baskets be installed to the maximum extent possible in any urbanized watershed. However, much of the drainage within the Long Branch Creek watershed discharges by overland flow or vegetated conveyance channels, and the opportunity of installation of curb and grate inlets in the Long Branch Creek watershed is somewhat reduced compared with other urbanized areas. Opportunities for installation of curb and grate inlets should be evaluated and units installed where appropriate. However, a maintenance activity must be in place for the routine cleaning and disposal of the collected material.

5.2.8 Sediment Traps

Sediment traps include a wide variety of retrofit units manufactured by companies such as CDS, Stormceptor, Sun Tree Technologies, and similar companies. Although the units vary somewhat between manufacturers, they all perform the same basic function of collection of sediment and large debris from stormwater which prevents the material from discharging to downstream waterbodies. Removal mechanisms fall into three basic categories, including units which attempt to remove solids using a centrifugal force created by circulation of the stormwater within the unit, baffle box type units which rely upon physical settling of larger particles, and units which use screen mesh to remove larger vegetation and debris.

ERD has conducted several previous research projects on the performance efficiency of sediment trap type devices. This research has indicated that sediment traps primarily remove particles in excess of 100 microns in size which includes medium to large sand, gravel, and vegetation debris. Particle sizes removed by these units generally have low nutrient content which substantially reduces the nutrient removal efficiencies for these systems. Sediment traps have no affinity for removal of microbiological parameters and in some cases, increases in bacteria counts have been observed between the inlet and outlet for these systems. Installation costs for sediment traps are relatively high, particularly for the CDS-type units, which results in a very elevated nutrient mass removal cost. As a result, sediment traps appear to be most appropriate in areas where sediment removal is the primary concern. Installation of sediment traps is not recommended for removal of the target pollutants in the Long Branch Creek watershed.

5.2.9 Education and Outreach

Since stormwater runoff is generated on land surfaces which are heavily impacted by human activities, public behaviors and activities can have a large impact on the characteristics of stormwater runoff generated in urban areas. Common individual behaviors which have the potential to impact stormwater runoff pollution include littering, storage and disposal of trash and recyclables, disposal of pet wastes, application of fertilizers and lawn chemicals, washing cars, vehicle maintenance activities, and other household behaviors. Many people are simply unaware of the link between their activities and stormwater pollution.

Education and outreach programs attempt to effect behavioral modifications in the general public through information and education about the significance of individual activities. ERD consistently recommends education and outreach as a method of reducing watershed loadings in urban areas. This activity is discussed in more detail in a subsequent section.

5.3 Tributary Site 4 Inflow

An overview of drainage patterns in the vicinity of tributary inflow monitoring Site 4 is given on Figure 5-4. The tributary at Site 4 reflects an inflow into the northern headwater segment downstream from the discharge from Swann Lake. The tributary monitored at Site 4 consists of an earthen drainage channel (see Figure 3-9) which extends in a general north-south direction, passing through an area of single-family homes, and high-density apartment/condo buildings. Upstream portions of the tributary consist of multiple professional office buildings with large parking areas, several fast food restaurants, and an industrial facility. Each of these areas discharges untreated stormwater runoff directly into the tributary monitored at Site 4. Wastewater mains, approximately 6-8 inches in diameter, cross the tributary stream at multiple locations.

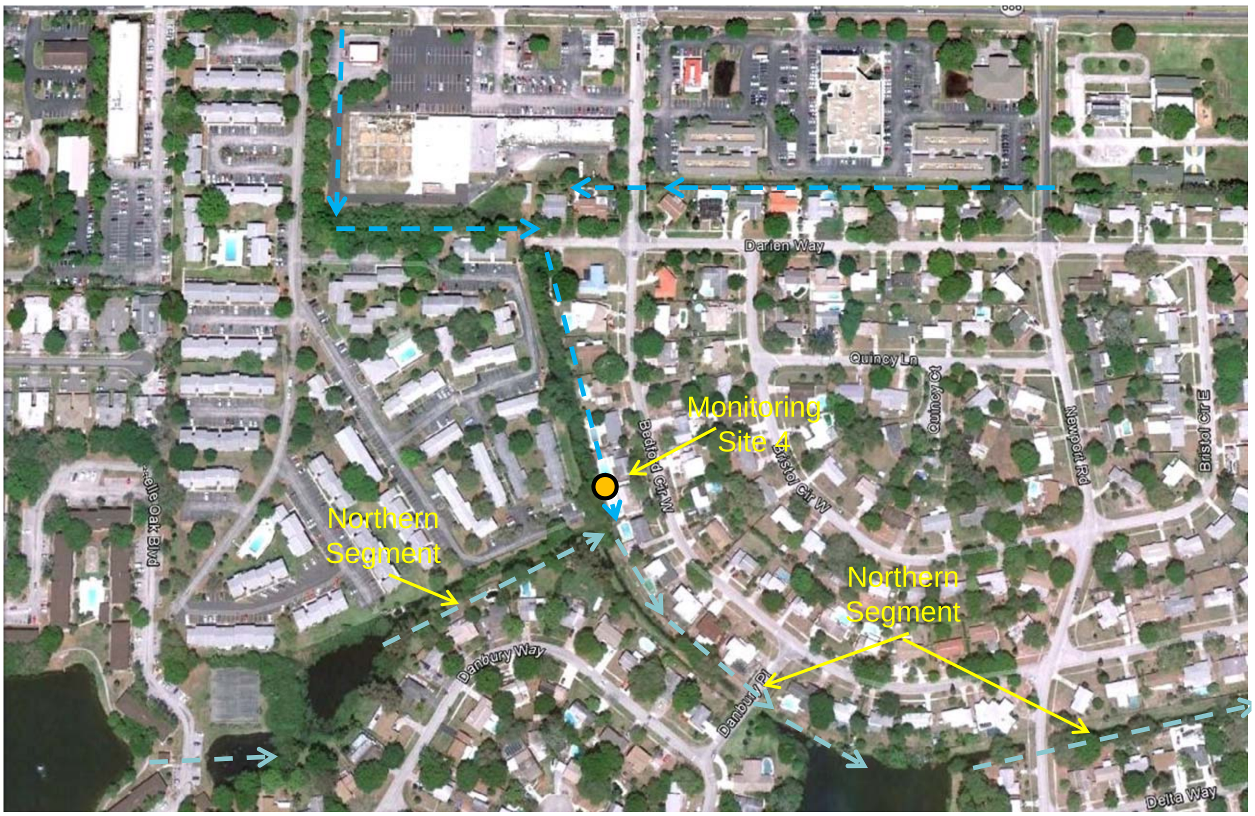


Figure 5-4. Overview of Drainage Patterns in the Vicinity of Tributary Inflow Monitoring Site 4.

The specific sources of the elevated observed concentrations of total phosphorus and fecal coliform bacteria could not be identified from the field monitoring conducted as part of this study. Therefore, further evaluation of this tributary watershed is recommended to assist in identifying the sources of the elevated nutrients and fecal coliform bacteria. The existing earthen channel between Darien Way and the confluence with the main channel currently contains a large amount of debris and relatively deep accumulations of organic muck which may be contributing to the observed elevated concentrations of phosphorus, particularly under low flow conditions. A more detailed evaluation of this tributary and potential pollutant impacts is recommended.

5.4 Main Channel East of US 19

An overview of drainage patterns in the vicinity of the main channel east of US 19 is given on Figure 5-5. Inflows from the northern headwater segment (monitored at Site 8) combine with inflows from the southern headwater segment (monitored at Site 9) to form the main channel. An additional tributary inflow to the main channel occurs from Site 10, as indicated on Figure 5-5. As discussed in Section 4.3.2.1, inflow into the main channel from Site 8 was found to have elevated concentrations of total nitrogen, total phosphorus, and fecal coliform bacteria, while inflows from Site 9 were characterized by moderately elevated levels of total nitrogen, total phosphorus, and fecal coliform bacteria. Since these two inflows form the headwaters of the main channel, reductions in nutrient and fecal coliform concentrations at these sites would likely carry downstream and improve water quality characteristics throughout the main channel.

Figure 5-5. Overview of Drainage Patterns in the Vicinity of Monitoring Sites 8, 9, and 10.

A large borrow pit pond currently exists south of the main channel and west of tributary inflow monitoring Site 10. The depth of this pond is not known at this time, but it appears that the pond could perform a function as a regional wet detention pond. Construction activities are currently ongoing in the parcel located immediately south of the pond, and it is likely that the constructed development will utilize the borrow pit pond as a stormwater management facility. However, the size of the pond appears to be substantially larger than would be required to provide treatment for a development in the southern portions of the parcel.

One potential opportunity for treatment of the combined inflows from Sites 8 and 9 would be to divert the water into the existing borrow pit pond for treatment. A conceptual schematic for a regional treatment pond for upstream portions of Long Branch Creek is given in Figure 5-6. A simple diversion weir could be constructed along the channel to divert the headwaters of Long Branch Creek into a regional treatment pond constructed from the existing borrow pit. If feasible, the tributary inflow monitored at Site 10 could also be diverted into the pond for treatment. Although the hydraulics of diverting the water from the main channel and the Site 10 tributary flow into the pond would need to be further evaluated, the location of the treatment pond appears ideal to achieve the proposed treatment system. The diversion weirs could be sized to discharge low to moderate flow conditions into the treatment pond, with high flows passing over the diversion weirs and into downstream portions of the main channel. This treatment concept is consistent with the fact that the most elevated levels of nutrients and bacteria were observed in Long Branch Creek under low flow conditions, with lower concentrations observed during periods of heavy rainfall. The existing borrow pit pond appears to be more than adequate in size to provide treatment for both the main channel and Site 10 tributary inflow.

Figure 5-6. Conceptual Schematic for Regional Treatment Pond for Upstream Portions of Long Branch Creek.

The proposed treatment pond would provide opportunity for nutrient uptake and assimilation of fecal coliform bacteria before discharging back into the main channel. An aeration system could also be installed in the pond to enhance circulation, nutrient uptake, BOD degradation, and improve dissolved oxygen concentrations. As a result, discharges from the treatment pond would have lower concentrations of nutrients and fecal coliform bacteria, along with higher concentrations of dissolved oxygen than occur within the main channel under existing conditions. This concept is particularly attractive since it does not require purchase of any land, although an easement would likely be required over the treatment pond area to allow maintenance activities by the County.

Another potential option for the proposed regional treatment pond is to use the stored water within the pond as a source of irrigation for nearby commercial properties. A large retail parcel is located north of the pond, with currently undeveloped land located east of the pond. Water from the pond could easily supply the irrigation needs for each of these properties and potentially others which would remove nutrients from the current discharges through the channel and reduce the current nutrient loadings to Old Tampa Bay. Use of the pond for irrigation would substantially enhance the overall effectiveness of the wet detention system.

5.5 Main Channel Between Sites 14 and 16

As discussed in Section 4, substantial increases in concentrations of total nitrogen, total phosphorus, and fecal coliform bacteria occur within the main channel between monitoring Sites 14 and 16. These increases in concentrations, combined with increases in discharge rates, result in 3-fold increase in mass loadings of total phosphorus, a 50% increase in mass loadings of total nitrogen, a 3-fold increase in loadings of TSS, and a 5-fold increase in fecal coliform bacteria loadings between Sites 14 and 16 along the main channel.

An overview of drainage patterns in the vicinity of main channel Sites 14 and 16 is given on Figure 5-7. The only significant inflows into Long Branch Creek between Sites 14 and 16 is the tributary inflow at Site 13. However, based upon the field monitoring conducted by ERD, mass loadings of nitrogen and phosphorus introduced into the main channel from this tributary inflow are minimal in comparison with the overall mass loadings. Inflows into the main channel from this site were characterized by substantially elevated concentrations of both total phosphorus and fecal coliform bacteria, but the overall mass loadings of these parameters were relatively low. However, additional monitoring or research is recommended to identify the sources of the elevated phosphorus and fecal coliform counts observed in this tributary.

One of the most significant features along Long Branch Creek between Sites 14 and 16 is the horse stables and riding area which are located along virtually the entire eastern portion of the creek between the two monitoring sites. Existing drainage patterns in the area result in surface runoff discharging from east to west and ultimately entering the main channel from this parcel. Runoff from residential areas also enters the main channel from areas west of the channel, although there is nothing about the physical characteristics of this neighborhood which would suggest elevated loadings of either total phosphorus or fecal coliform bacteria. All homes within the parcel are currently serviced by a central sanitary sewer system, and discharges of fecal coliform bacteria from this area do not appear likely. Therefore, the horse stables and riding area appear to be the most logical source of the elevated nutrients and fecal coliform bacteria observed between monitoring Sites 14 and 16.

Figure 5-7. Overview of Drainage Patterns in the Vicinity of Main Channel Sites 14 and 16.

Assuming that the horse farm parcel is the source of the elevated nutrients and fecal coliform bacteria entering Long Branch Creek, then the observed loadings can be reduced either by enhanced on-site management practices or constructing a treatment system to either treat or prevent runoff from the property from entering Long Branch Creek. Improvements in management activities are always desirable, and should be a first step in evaluating and reducing on-site loadings. However, BMP management practices for equestrian activities are not foolproof and do not always prevent introduction of contaminants through on-site runoff. Therefore, in addition to enhanced management practices, a berm and swale system is proposed to retain on-site runoff within the horse farm parcel.

A schematic of a proposed berm and swale system for the horse stable parcel is given on Figure 5-8. A shallow berm could be constructed around the perimeter portions of the property indicated on Figure 5-8 to intercept runoff, which travels in an east-west direction, prior to entering Long Branch Creek. The berm system would contain the water and allow it to infiltrate through the soil rather than discharging directly into the creek. The soil infiltration process will be very effective in removing both phosphorus and fecal coliform bacteria. The proposed berm and swale system is a relatively inexpensive method of reducing on-site loadings from this parcel into Long Branch Creek.

Figure 5-8. Proposed Berm and Swale System for Horse Stable Parcel.

5.6 Tributary Inflow Site 15

As discussed in Section 4, substantially elevated levels of fecal coliform bacteria were observed in discharges from tributary inflow Site 15. Measured concentrations of nitrogen and phosphorus discharging from this tributary were moderate in value, with the main water quality problem appearing to be elevated fecal coliform bacteria. An overview of drainage patterns in the vicinity of monitoring Sites 15 and 16 is given on Figure 5-9. As indicated on Figure 3-27b, the inflow from the Whitney Road ditch enters the box culvert which passes Long Branch Creek beneath Whitney Road. The ditch alongside Whitney Road consists of a relatively deep earthen channel which runs the entire length of Whitney Road and directs roadway runoff, along with adjacent watershed runoff, to the point of inflow into the main channel. Evidence of fecal coliform bacteria was observed at this site even under low flow conditions, suggesting a non-runoff related inflow of bacteria into the drainage system.

Figure 5-9. Overview of Drainage Patterns in the Vicinity of Monitoring Sites 15 and 16.

As discussed previously, the most appropriate method of reducing fecal coliform bacteria at this site would be to evaluate and identify the sources of the fecal coliform bacteria within the watershed. If the specific sources cannot be identified, it may be appropriate to construct a treatment system to attenuate some of the fecal coliform bacteria prior to entering Long Branch Creek.

Several parcels are currently available in the vicinity of the Site 15 tributary inflow into Long Branch Creek. A summary of available parcels is given on Figure 5-10. A vacant pie-shaped parcel is located immediately north of the drainage canal and appears to be a potential location for a small wet detention or infiltration type treatment process. A second parcel owned by Pinellas County is located east of Long Branch Creek and north of Whitney Road. This parcel is currently the site of a small stormwater treatment pond which could be substantially enhanced to perhaps provide treatment for the Whitney Road drainage system as well.

A conceptual schematic of a proposed treatment system for the Whitney Road drainage swale is given on Figure 5-11. The existing channel piping could be extended initially into a small treatment pond associated with the development on the south side of Whitney Road. After migrating through this treatment area, the discharge from Whitney Road would then be directed into an enlarged and reconfigured pond on the north side of the roadway in the parcel currently owned by Pinellas County. This additional detention time and opportunity for biological uptake and degradation of the fecal coliform bacteria has the potential to reduce fecal coliform loadings to Long Branch Creek.

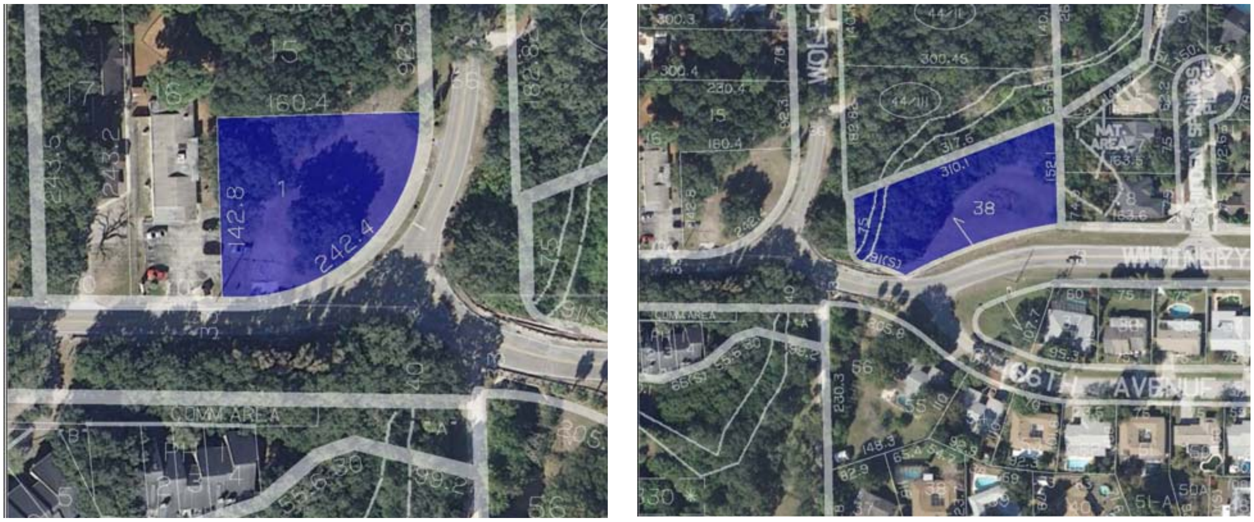


Figure 5-10. Available Parcels in the Vicinity of the Whitney Road Drainage Swale.

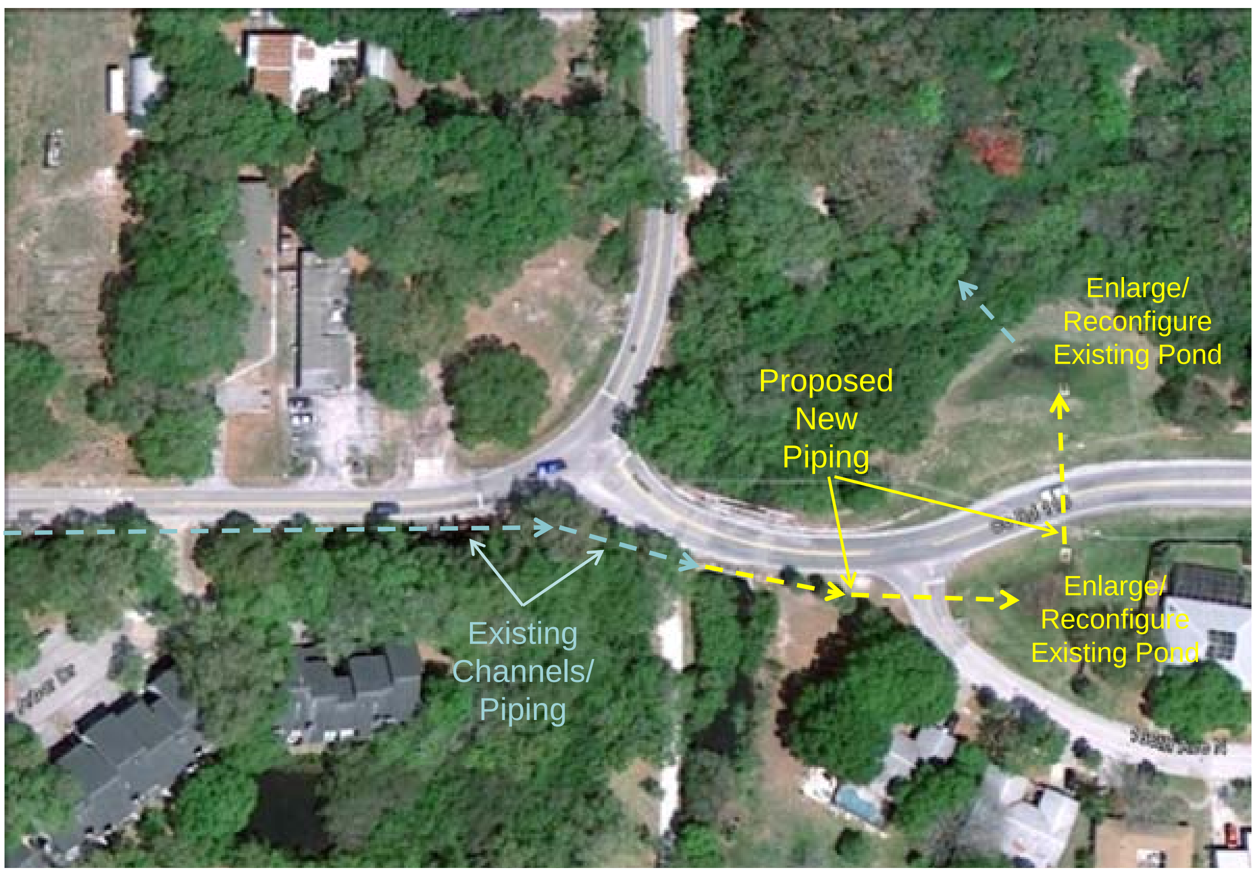


Figure 5-11. Conceptual Schematic of Proposed Treatment System for Whitney Road Drainage Swale.

An alternative conceptual treatment system for the Whitney Road drainage swale is indicated on Figure 5-12. Discharges from the roadside swale could be directed into a newly constructed detention pond to provide either wet detention or dry detention treatment prior to introduction back into Long Branch Creek. This option would require purchase of land whereas the option illustrated on Figure 5-11 would utilize land already in possession of Pinellas County. Either of the two treatment options would provide benefits to water quality in Long Branch Creek.

Figure 5-12. Alternative Conceptual Treatment System for the Whitney Road Drainage Swale.

A less expensive and potentially more effective BMP option for the Whitney Road drainage system would be to construct a series of berms or check-dams in the existing roadside drainage system along Whitney Road. A photograph of the drainage system is given on Figure 5-13. Under current conditions, stormwater runoff is collected and conveyed through a deep open channel located on the south side of Whitney Road. This channel extends for much of the length of Whitney Road which discharges into Long Branch Creek. The drainage system is both wide and deep, particularly in downstream portions of the channel. These areas seem like excellent opportunities for construction of check-dams or berms to retain portions of the stormwater volume within the channel, as well as increase residence time for the drainage which will allow settling of particulate matter and die-off and predation of the microbiological contaminants. If adequate right-of-way is available, the channel could be easily expanded in some areas to provide a larger area and volume of stored water. Any proposed modifications to the drainage system would need to be evaluated using hydrologic modeling to ensure that flooding conditions would not be produced. However, if this option is feasible, it would be a relatively inexpensive and effective method of treating stormwater runoff along Whitney Road prior to discharge into Long Branch Creek.

Figure 5-13. Roadside Drainage System Along Whitney Road.

Based upon the field monitoring conducted by ERD, a constant baseflow was present within the channel during much of the field monitoring program. This baseflow exhibited elevated levels of nutrients and fecal coliform bacteria which would also receive treatment with the proposed drainage system modifications. If adequate storage can be provided, and if the proposed water storage areas do not negatively impact the hydraulics of the system, this option would likely be more effective than the proposed pond treatment systems discussed previously.

5.7 General Watershed Maintenance

General observations of areas within the Long Branch Creek watershed, conducted by ERD personnel during this project, suggest that many portions of the drainage basin are relatively "dirty" as indicated by excessive amounts of dust, soils, vegetation debris, and litter on both roadway and parking surfaces. These "dirty" areas are particularly prevalent in the middle industrial portions of the basin. Virtually all of these areas are currently developed, and opportunities for nutrient reductions through structural projects are relatively limited. However, non-structural source control programs have been shown to be effective in reducing pollutant accumulations within watersheds and have a valid potential for improving the characteristics of stormwater runoff in the Long Branch Creek watershed.

Source reduction programs have the potential to provide effective reductions in stormwater concentrations, particularly for nutrients and suspended solids. Source reduction techniques, such as street sweeping and public education, are capable of reducing loadings of pollutants entering receiving waterbodies by reducing pollutant accumulation within the watershed. If properly conducted, source reduction programs can be almost as effective as changes in stormwater regulations for reducing pollutant loadings to lakes. The two most common source reduction techniques are street sweeping and public education which are discussed in the following sections.

5.7.1 Street Sweeping

Street sweeping is an effective best management practice (BMP) for reducing total suspended solids and associated pollutant wash-off from urban streets. Street sweeping is well suited to an urban environment where little land is available for installation of structural controls. Street sweeping can be extremely effective in commercial business districts, industrial sites, and intensely developed areas in close proximity to receiving waters.

Street sweeping involves the use of machines which basically pick-up contaminants from the street surface and deposit them in a self-contained bin or hopper. Mechanical sweepers are the most commonly used sweeping devices and consist of a series of brooms which rotate at high speeds, forcing debris from the street and gutter into a collection hopper. Water is often sprayed on the surface for dust control during the sweeping process. The effectiveness of mechanical sweepers is a function of a number of factors, including: (1) particle size distribution of accumulated surface contaminants; (2) sweeping frequency; (3) number of passes during each sweeping event; (4) equipment speed; and (5) pavement conditions. Unfortunately, mechanical sweepers perform relatively poorly for collection of particle sizes which are commonly associated with total phosphorus loadings in stormwater runoff. During the 1980s, the U.S. EPA concluded that street sweeping using mechanical sweepers had no significant impact on runoff characteristics.

Over the past decade, improvements have been made to street sweeping devices which substantially enhance the performance efficiency. Vacuum-type sweepers, which literally vacuum the roadway surface, have become increasingly more popular, particularly for parking lots and residential roadways. The overall efficiency of vacuum-type sweepers is generally higher than that of mechanical cleaners, especially for particles larger than 3 mm. Estimated efficiencies of mechanical and vacuum-assisted sweepers are summarized in Table 5-1 based upon information provided by the Federal Highway Administration. Mechanical sweepers can provide approximately 40% removal of phosphorus in roadway dust and debris, while vacuum-assisted sweepers can provide removals up to 74%. Recent studies in Hamilton County, Ohio indicated a significant reduction in runoff concentrations of nutrients after implementation of a vacuum sweeper program in residential areas.

The efficiency of street sweepers is highly dependent upon the sweeping interval. To achieve a 30% annual removal of street dirt, the sweeping interval should be less than two times the average interval between storms. Since the average interval between storms in the St. Petersburg area is approximately three days, a sweeping frequency of once every six days is necessary to achieve a 30% removal of street dirt. To achieve a 50% annual removal, sweeping must occur at least once between storm events. In the Long Branch Creek area, a 50% removal would require street sweeping to occur approximately once every three days.

TABLE 5-1

EFFICIENCIES OF MECHANICAL (BROOM) AND VACUUM-ASSISTED SWEEPERS

CONSTITUENT	MECHANICAL SWEEPER EFFICIENCY (%)	VACUUM-ASSISTED SWEEPER EFFICIENCY (%)
Total Solids	55	93
Total Phosphorus	40	74
Total Nitrogen	42	77
COD	31	63
BOD	43	77
Lead	35	76

SOURCE: Federal Highway Administration (FHWA) – Report No. WI-11-01 – "Pollutant Loadings to Stormwater Runoff from Highways: The Impact of a Freeway Sweeping Program".

Street sweeping activities can be particularly effective during periods of high leaf fall by removing solid leaf material and the associated nutrient loadings from roadside areas where they can easily become transported by stormwater flow. Previous research by ERD has indicated that leaves release large quantities of both nitrogen and phosphorus into surface water within 24-48 hours after becoming saturated in an aquatic environment. Loadings to waterbodies from leaf fall are often the most significant loadings to receiving waters during the fall and winter months. Street sweeping operations are typically performed on a monthly basis, with increased frequency during periods of high leaf fall.

Capital costs for street sweepers range from approximately $70,000-150,000, with the lower end of the range associated with mechanical street sweepers and the higher end of the range associated with vacuum-type sweepers. The useful life span is typically 4-8 years, with an operating cost of approximately $70/hour.

One potential drawback for the use of street sweepers in the Long Branch Creek Sub-basin H area is the lack of curbs throughout much of the area. Many of the existing industrial and commercial areas have roadways which slope directly into roadside drainage systems without a standard curb and gutter system. The use of mechanical sweepers requires a curb and gutter system for proper operation. Therefore, street sweeping within much of Sub-basin H would need to be conducted using vacuum-assisted sweepers rather than mechanical broom sweepers. Although this would substantially enhance the efficiency of the sweeping process, vacuum-assisted sweepers are relatively rare in public works departments and may not be available to the governmental entities with jurisdiction within Long Branch Creek.

5.7.2 Public Education

Public education is one of the most important nonpoint source controls which can be used in a watershed. Many residents appear to be unaware of the direct link between watershed activities and the water quality in adjacent waterbodies. The more a resident or business owner understands the relationship between nonpoint source loadings and receiving water quality, the more that person may be willing to implement source controls.

Several national studies have indicated that it is an extremely worthwhile and cost-effective activity to periodically remind property owners of the potential for water quality degradation which can occur due to misapplication of fertilizers and pesticides. Periodic information pamphlets can be distributed by hand or enclosed with water and sewer bills which will reach virtually all residents within the watershed. These educational brochures should emphasize the fact that taxpayer funds are currently being utilized to treat nonpoint source water pollution, and the homeowners have the opportunity to reduce this tax burden by modifying their daily activities. A comprehensive public education program should concentrate, at a minimum, on the following topics:

1. Relationship between land use, stormwater runoff, and pollutants
2. Functions of stormwater treatment systems
3. How to reduce stormwater runoff volume
4. Impacts of water fowl and pets on runoff characteristics and surface water quality
5. County stormwater program goals and regulations
6. Responsible use of fertilizer, pesticides and herbicides
7. Elimination of illicit connections to the stormwater system
8. Controlling erosion and turbidity
9. Proper operation and maintenance of stormwater systems

The public education program can be implemented in a variety of ways, including homeowner and business seminars, newsletters, performing special projects with local schools (elementary, middle and high schools), Earth Day celebrations, brochures, and special signage at stormwater treatment construction sites. Many people do not realize that stormsewers eventually drain to area waterbodies. Many cities and counties in Florida have implemented a signage program which places a small engraved plaque on each stormsewer inlet indicating "Do Not Dump, Drains to Waterbody". ERD recommends that an aggressive public education program be implemented in the Long Branch Creek watershed which incorporates all of the elements discussed previously. This program should be targeted to all land use categories including industrial, commercial, and residential areas.

Anticipated load reductions for implementation of public education programs are difficult to predict and depend highly upon the degree of implementation by the homeowners within the basin. The impacts of public education programs also depend, to a large extent, on the degree to which water quality within the Long Branch Creek basin is currently being impacted by uneducated and uninformed activities by current homeowners. Several regional and national studies are currently being performed which will attempt to document the pollutant removal effectiveness of public education programs.

SECTION 6

RECOMMENDATIONS

Based upon the recommendations and results discussed in the previous sections, the following recommendations are made to improve water quality characteristics in Long Branch Creek:

1. The sources of elevated nutrients and fecal coliform bacteria originating from the tributary monitored at Site 4 should be further evaluated, particularly in view of the results of the isotope analyses indicating the presence of manure or sewage as a nitrogen source during three of the five monitoring events, and the elevated UV absorbance values suggesting the presence of non-natural organic compounds during each monitoring event.

2. The feasibility of constructing a regional wet detention pond in upstream portions of the main channel to provide treatment for inflows from Sites 8, 9, and 10 should be further evaluated. If feasible, this system has the potential to reduce upstream concentrations of nutrients and fecal coliform bacteria, while increasing dissolved oxygen concentrations, in the headwaters of the main channel.

3. The sources of increases in nutrient and fecal coliform loadings between Sites 14 and 16 along the main channel should be further investigated. If these investigations indicate that the horse stables and riding area are the primary source for these additional loadings, then construction of a berm and swale system is recommended to retain the nutrients and fecal coliform loadings on-site.

4. The sources of the elevated fecal coliform loadings observed in the Whitney Road drainage system should be further evaluated to identify potential illicit inputs. If the sources cannot be identified and mitigated, further consideration should be given to the proposed treatment options discussed previously, particularly the series of berms proposed along the roadside drainage system which, if feasible, would be both inexpensive and effective.

5. Although not a significant contributor of overall mass loadings, tributary inflow Site 13 was shown to contain elevated levels of both total phosphorus and fecal coliform bacteria. Further studies are recommended to identify potential sources for these inputs given the well defined nature of the tributary inflow.

6. Street sweeping should be initiated in the residential, industrial, and commercial portions of the Long Branch Creek watershed to reduce accumulations of dirt, dust, vegetation, and debris within these areas which can contribute to nutrient loadings to the tributaries and main channel.

7. A public education program should be initiated and targeted to residents and property owners within the Long Branch Creek watershed to provide educational links between personal activities and surface water pollution.

SECTION 7

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APPENDICES

APPENDIX A

HISTORICAL WATER QUALITY DATA FOR LONG BRANCH CREEK

A.1 Historical Water Quality Data Collected by Pinellas County
A.2 Historical Water Quality Data Collected by FDEP
A.3 Calculated Historical Mass Loadings of Total Nitrogen and Total Phosphorus Based on Pinellas County Monitoring Data

A.1 Historical Water Quality Data Collected by Pinellas County

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
1991	22-01	1/16/91	7.52	18.95	1,690	0.4	5.8															
1991	22-01	2/27/91	7.36	16.02	5,490	2.6	5.9													1,170		
1991	22-01	3/20/91	7.46	18.83	1,449	0.2	4.3														5,900	
1991	22-01	4/17/91	7.20	24.51	15,400	8.4	1.1		20			260								50	1,300	
1991	22-01	5/15/91	7.34	26.51	30,400	18.5	0.7		20			240		3.0	3.5					400	420	
1991	22-01	6/12/91	7.48	26.41	11,370	6.2	2.4		120			120		2.0	5.0					3,400	1,200	
1991	22-01	7/10/91	7.75	28.54	22,100	13.6	1.2		120			80		3.0		1.3	2.9	1.1	1.5	1,000	750	
1991	22-01	8/7/91	7.32	27.37	389	0.0	4.8															
1991	22-01	8/7/91	7.27	27.37	389	0.0	4.7		280			40		4.0		3.3	13.5	1.2	2.1		3,000	
1991	22-01	9/4/91	7.34	27.33	805	0.0	2.5		340			40		1.0	4.5	1.2	1.7	3.1	3.8	1,200	3,300	
1991	22-01	9/25/91	6.99	27.90	4,590	2.0	2.5		310			110		3.0	6.5	1.9	3.5	0.8	1.6	1,700	2,600	
1991	22-01	10/23/91	7.33	24.57	7,020	3.5	3.0		330			100		4.0	5.4	1.0	2.9	0.2	1.0	4,400	2,100	
1991	22-01	11/20/91	7.48	23.23	11,890	6.5	4.4		140			70		6.0	9.6	1.8	6.6	0.2	1.6	2,800	1,400	
1991	22-01	12/18/91	7.77	14.60	4,370	0.0	5.7		160			70		4.0		1.0	2.6		0.3	4,200	4,000	
1992	22-01	2/5/92	7.52	18.50	1,860	0.5	6.2		220	820	1,040	40	110	6.0	7.1	1.9	4.9		0.7	5,900	2,000	
1992	22-01	3/4/92	7.48	20.62	1,890	0.5	5.3		120	910	1,030	70	70	2.0	6.1	1.6	6.2	0.7	1.1	1,900	550	
1992	22-01	4/1/92	7.41	19.74	5,630	2.7	5.0			920		90	180	3.0	6.8	1.2	10.7	1.0	1.2	1,800	1,100	
1992	22-01	4/29/92	7.64	19.13	1,145	0.0	6.9		100	880	980	70	180	4.0	5.3	1.0	1.6		0.1	1,400	1,100	
1992	22-01	5/27/92	7.43	27.58	35,800	22.6	3.5		20	740	760	320	330	2.0	5.9	2.4	33.6		2.6	400	440	
1992	22-01	6/24/92	7.12	28.66	36,400	23.2	0.4															
1992	22-01	6/24/92	7.13	27.70	22,900	13.2	0.2		20	850	870	110	160	3.0	5.3	3.1	6.6	0.1	0.7		5,000	
1992	22-01	7/22/92	7.37	27.48	1,720	0.4	1.9		160	680	840	100	160	3.0	2.7	1.4	11.2	0.1	1.0	5,600	7,300	
1992	22-01	8/19/92	7.34	28.00	7,150	3.6	2.3		60	780	840	230		1.0	2.7	1.0	2.8	0.1	0.5	6,300	3,900	
1992	22-01	9/9/92	7.43	27.75	632	0.0	3.7		140			80		11.0	5.8	1.0	4.0	0.3	0.6	1,500	2,200	
1992	22-01	10/21/92	7.67	22.06	4,980	2.3	4.8		230	1,230	1,460	110	140	3.0	3.6	1.0	2.1	0.2	0.2	1,200	2,600	
1992	22-01	11/23/92	7.58	24.23	5,540	2.6	4.4		40	1,300	1,340	140	220	13.0	4.8	2.2	39.4		5.1	2,200	5,000	
1992	22-01	12/16/92	7.58	19.00	6,940	3.4	5.0			1,030		90	110	2.0	3.4	1.0	2.5	0.2	0.5	2,100	2,600	
1993	22-01	1/20/93	7.58	18.80	11,900	0.0	6.3		400	750	1,150	50	110	2.0	2.9	1.0	6.0	0.9	0.4	2,000	1,200	
1993	22-01	2/24/93	7.48	16.98	669	0.0	6.8		340	760	1,100	40	100	6.0	1.9	1.0	5.7	0.8	1.4	1,200	560	
1993	22-01	3/17/93	7.57	18.02	731	0.0	6.4		230	740	970	40	80	2.0	2.5	1.0	5.3	0.5	0.2	1,600	520	
1993	22-01	4/14/93	7.31	21.52	14,900	8.5	3.1		40	1,230	1,270	80	300	5.0	4.7	1.2	11.3	0.0	1.4	2,100	700	
1993	22-01	5/12/93	7.24	24.36	21,800	12.9	2.5		30	1,180	1,210	210	310	2.0	3.5	1.1	4.0	0.7	1.7	900	950	
1993	22-01	6/9/93	7.20	28.64	27,500	16.8	0.3		20	1,360	1,380	410	590	4.0	4.1	1.9	13.7	0.0	1.8	600	1,100	
1993	22-01	7/7/93	7.42	28.43	2,000	0.5	2.1		220	920	1,140	160	270	2.0	4.2	1.3	2.9	2.0	2.1		3,800	
1993	22-01	8/11/93	7.52	30.21	29,500	18.2	0.2															
1993	22-01	8/11/93	7.45	28.05	1,690	0.3	2.4		140	1,010	1,150	70	170	5.0	3.2	2.4	11.7	2.3	1.1	2,100	3,200	
1993	22-01	9/1/93	7.45	27.29	624	0.0	5.5		260	1,120	1,380	70	150	6.0	2.5	1.1	11.1	2.7	2.9	2,200	2,200	
1993	22-01	9/29/93	7.25	25.00	981	0.0	4.3		610	920	1,530	70	110	2.0	5.0	1.4	1.6	0.5	0.5	3,000	2,500	
1993	22-01	10/27/93	7.29	22.92	1,153	0.1	4.6		370	740	1,110	120	130	3.0	3.5	1.3	2.4	0.5	0.5	2,900	2,100	
1993	22-01	12/8/93	7.45	17.12	13,130	7.3	6.1		20	1,200	1,220	70	170	5.0		2.1	21.3	0.5	3.0		4,800	
1993	22-01	12/28/93	7.40	13.13	3,550	1.4	7.7		270	870	1,140	40	120	2.0	2.0	1.3	6.4	0.5	2.2	3,500	2,700	
1994	22-01	1/26/94	7.78	17.12	1,970	0.5	6.2		310	940	1,250	40	80	1.0	2.9	1.0	2.9	0.5	0.5	3,600	2,100	
1994	22-01	2/23/94	7.39	22.22	7,550	3.8	5.2		200	1,100	1,300	40	160	3.0	4.3	1.0	3.8	0.5	0.6		1,600	
1994	22-01	3/23/94	7.38	24.36	23,500	14.1	3.0		60	990	1,050	170	290	7.0	4.3	2.2	15.3	0.5	1.7	2,300	2,000	
1994	22-01	4/20/94	7.26	24.72	25,000	15.2	1.3		20	1,130	1,150	350	440	6.0	5.3	1.2	6.2	0.5	1.4		3,100	
1994	22-01	5/25/94	7.15	23.22	25,000	15.2	1.5		20	1,030	1,050	230	320	8.0	3.2	1.7	8.2	0.5	1.6		2,600	
1994	22-01	6/15/94	7.15	29.20	33,600	20.9	0.8		20	1,340	1,360	510	740	9.0	5.8	3.2	30.6	1.0	4.3	1,100	500	
1994	22-01	7/13/94	7.39	27.27	15,900	9.0	1.3		60	1,300	1,360	310	370	4.0	4.0	1.6	28.4	0.5	4.5	900	1,600	
1994	22-01	7/13/94	7.30	28.28	30,500	19.0	0.8															
1994	22-01	8/10/94	7.24	27.82	1,446	0.8	3.2		160	970	1,130	50	240	1.0	2.3	1.0	2.3	0.5	0.5	4,100	1,500	

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
1994	22-01	8/31/94	7.58	27.90	857	0.0	5.5		260	900	1,160	60	110	1.0	2.2	1.0	1.2	0.5	0.5	3,600	2,800	
1994	22-01	8/31/94	7.45	30.10	25,900	15.7	2.1															
1994	22-01	9/28/94	7.44	24.87	430	0.2	3.2		290	690	980	80	90	9.0	1.6	1.0	5.9	0.9	0.9	2,700	1,900	
1994	22-01	9/28/94	7.34	24.88	431	0.2	3.2															
1994	22-01	11/1/94	7.44	24.43	716	0.0	4.8		360	980	1,340	60	120	2.0	1.7	1.0	3.3	0.5	0.5	2,700	3,100	
1994	22-01	12/14/94	7.49	17.95	759	0.4	6.2		340	890	1,230	40	130	1.0		1.0	3.7	0.5	1.3	3,800	2,100	
2003	22-01	1/22/03	7.40	17.35	1,901	1.0	6.8	30	440	710	1,150	20	50	2.0	1.5		1.6	0.5	0.8			
2003	22-01	2/26/03	7.48	19.71	757	0.4	5.5	60	220	830	1,050	40	90	2.0	2.0		1.8	0.5	0.5			
2003	22-01	4/1/03	7.60	18.97	744	0.4	7.8	20	250	700	950	20	50	1.0	1.3		1.3	0.9	1.3			
2003	22-01	5/13/03	7.51	26.06	1,268	0.7	3.6	40	180	580	760	20	100	2.0	1.6		1.5	0.6	1.2			
2003	22-01	6/26/03	7.03	26.81	433	0.2	3.2															
2003	22-01	6/26/03	6.98	26.84	433	0.2	3.0	170	260	1,030	1,290	70	150	1.0	0.9		1.6	0.6	0.9			
2003	22-01	9/17/03	7.24	27.34	676	0.4	3.7	30	270	720	990	30	90	1.0	1.0		0.7	1.0	1.2			
2003	22-01	10/22/03	7.51	22.68	3,552	1.9	2.8															
2003	22-01	10/22/03	7.49	22.52	3,397	1.8	2.3	50	300	870	1,170	80	130	2.0	1.8		2.1	0.6	0.6			
2004	22-01	1/22/04	7.44	13.73	1,929	1.0	6.6	90	270	760	1,030	70	50	1.0	1.7		0.8	0.5	0.6			
2004	22-01	2/25/04	7.63	19.32	248	0.1	7.3															
2004	22-01	2/25/04	7.59	19.33	249	0.1	7.2	20	140	570	710	50	120	11.0	6.1		22.1	1.2	2.3			
2004	22-01	4/12/04	7.40	21.38	275	0.1	5.0															
2004	22-01	4/12/04	7.36	21.38	274	0.1	5.0	40	120	630	750	80	120	8.0	4.3		12.6	2.0	1.6			
2004	22-01	5/18/04	7.40	24.94	3,169	1.7	1.9															
2004	22-01	5/18/04	7.39	24.92	3,066	1.7	1.7	20	20	820	840	170	120	4.0	2.0		3.2	0.5	0.7			
2004	22-01	6/23/04	7.23	28.37	25,210	15.3	1.6															
2004	22-01	6/23/04	7.27	28.22	15,650	9.1	2.5	10	100	1,170	1,270	210	330	4.0	3.5		24.0	0.5	4.4			
2004	22-01	8/4/04	7.22	27.51	423	0.2	4.2															
2004	22-01	8/4/04	7.21	27.51	420	0.2	4.0	150	210	970	1,180	90	180	14.0	11.0		5.1	1.4	0.7			
2004	22-01	9/20/04	7.45	25.26	736	0.4	6.1	20	320	920	1,240	60	120	1.0	2.1		0.7	0.5	0.6			
2004	22-01	11/2/04	7.43	26.04	3,313	1.8	3.8	10	150	860	1,010	70	100	1.0	1.9		1.2	0.5	0.5			
2005	22-01	1/13/05	7.56	22.14	4,397	2.4	6.5	55	80	770	850	60	100	2.0	1.8		1.0	0.5	0.5	24,000	4,200	2,000
2005	22-01	3/1/05	7.56	19.17	770	0.4	7.1	10	90	780	870	70	110	3.0	1.3	2.0	7.2	1.0	0.8	4,600	600	410
2005	22-01	4/12/05	7.21	21.24	8,045	4.5	1.9	40	30	1,000	1,030	130	160	5.0	2.1		3.0	0.5	0.8	2,200	1,000	4,400
2005	22-01	6/29/05	7.22	27.68	392	0.2	2.2															
2005	22-01	6/29/05	7.23	27.69	391	0.2	2.1	30	60	590	650	90	110	1.0	1.2		3.2	0.5	0.5	5,600	1,400	500
2005	22-01	9/22/05	7.16	27.18	3,877	2.1	1.2	70	40	900	940	120	140	1.0	1.0		1.6	0.5	0.6	23,000	12,000	5,200
2005	22-01	11/15/05	7.41	22.97	3,396	1.8	3.5	120	100	850	950	170	160	2.0	1.7		0.9	0.5	0.5		1,100	740
2006	22-01	2/23/06	7.56	21.47	1,216	0.6	4.5	30	320	740	1,060	70	60	1.0	1.4	2.0	1.0	0.6	0.9		860	1,300
2006	22-01	7/18/06	7.60	30.68	31,320	19.5	0.2															
2006	22-01	7/18/06	7.43	27.76	1,478	0.8	1.9	70	90	1,010	1,100	140	180	1.0	1.2		0.8	1.0	1.3		2,500	1,642
2006	22-01	9/11/06	7.56	27.31	765	0.4	2.9	70	300	820	1,120	90	100	1.0	1.7		1.1	0.5	0.5		840	489
2007	22-01	1/17/07	7.28	19.51	18,810	11.1	2.4	40	190	650	840	70	90	1.0	1.6		0.6	0.5	0.5		2,300	3,106
2007	22-01	2/20/07	7.59	13.08	967	0.5	7.4	10	80	580	660	40	70	1.0	1.3	2.0	0.7	0.5	0.5		1,100	1,317
2007	22-01	5/22/07	7.13	23.56	31,590	19.7	0.6	70	20	670	690	190	210	7.0	2.0	2.0	2.1	0.5	0.5		210	580
2007	22-01	5/22/07	7.10	23.59	35,460	22.4	0.3															
2007	22-01	8/29/07	7.38	28.76	735	0.4	2.2	130	100	640	740	190	210	1.0	0.8	2.0	2.3	0.5	0.5		1,000	175
2007	22-01	9/19/07	7.54	26.21	2,288	1.2	2.3	10	80	360	440	60	60	2.0	0.8		0.8	0.5	0.5		2	3,683
2007	22-01	9/19/07	7.47	26.35	3,567	1.9	1.7															
2008	22-01	1/30/08	7.07	17.71	32,260	20.1	3.9															
2008	22-01	3/18/08	7.51	20.73	1,032	0.5	4.1	20	120	650	770	120	140	1.0	1.7	2.0	1.4	0.5	0.9		1,300	2,420
2008	22-01	6/25/08	7.18	27.16	603	0.3	2.0	50	60	620	680	130	140	1.0	1.3	2.0	2.3	0.5	0.9		1,400	816
2008	22-01	8/5/08	7.20	26.98	896	0.5	2.2	40	160	690	850	100	110	2.0	1.5		1.0	0.5	0.5		1,400	1,410

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
2008	22-01	8/5/08	7.07	27.04	3,360	1.8	2.0															
2008	22-01	9/23/08	7.31	26.82	5,473	3.0	2.5	40	90	800	890	130	140	1.0	2.4	2.0	13.3	0.5	1.9		6,700	1,730
2008	22-01	9/23/08	7.49	28.90	34,630	21.8	0.5															
2009	22-01	7/30/09	7.22	29.29	3,913	2.1	1.8	60	150	860	1,010	90	180	6.0	2.7		2.0	0.5	0.5		7,500	2,600
2009	22-01	9/22/09	7.18	27.92	503	0.3	3.2	100	250	900	1,150	80	130	3.0	2.4	5.0	8.0	0.5	0.5		1,600	384
2009	22-01	9/22/09	7.16	27.92	504	0.3	2.8															
2009	22-01	10/22/09	7.32	23.94	4,798	2.6	2.4	10	470	860	1,330	70	100	3.0	2.9		2.4	0.5	0.5		4,300	3,470
2009	22-01	12/8/09	7.52	20.26	604	0.3	4.2	10	390	880	1,270	60	80	3.0	1.5	2.0	2.3	0.5	0.5		5,100	4,840
2009	22-01	12/8/09	7.50	20.26	608	0.3	4.1															
2010	22-01	2/3/10	7.51	16.48	736	0.4	7.3	10	340	490	830	40	70	1.0	1.3		16.2	0.5	1.4		1,000	1,300
2010	22-01	3/16/10	7.63	17.09	781	0.4	5.3	10	240	590	830	50	60	5.0	1.5	4.0	1.2	0.8	1.2		500	1,100
2010	22-01	5/6/10	7.44	26.47	962	0.5	2.4	10	30	500	530	40	60	6.0	3.7		2.9	0.5	0.5		1,200	2,070
2010	22-01	5/6/10	7.41	26.41	1,245	0.7	2.3															
2010	22-01	6/21/10	7.20	28.56	3,387	1.8	1.0	10	20	360	380	90	190	2.0	2.2	2.0	3.8	0.5	0.5		10,000	2,070
2010	22-01	6/21/10	7.59	30.73	31,290	19.5	0.2															
2010	22-01	8/16/10	7.36	29.32	950	0.5	3.4	290	60	10	70	1,000	40	3.2			0.5	0.6	3.5	3,600		
2010	22-01	8/16/10	7.33	29.37	1,564	0.8	2.7															
2010	22-01	9/2/10	7.31	27.19	679	0.4	2.9	10	340	340	680	50	80	5.0	2.3	4.0	0.5	0.5	0.5		1,100	422
2010	22-01	10/11/10	7.53	23.43	4,629	2.5	2.9															
2011	22-01	1/26/11	7.53	17.17	294	0.1	5.5	34	200	560	760	58	94	4.3	6.3		3.0	1.6	2.7		1,000	4,840
	22-01	**min**	**6.98**	**13.08**	**248**	**0.0**	**0.2**	**10**	**20**	**10**	**70**	**20**	**40**	**1.0**	**0.8**	**1.0**	**0.5**	**0.0**	**0.1**	**50**	**2**	**175**
	22-01	**max**	**7.78**	**30.73**	**36,400**	**23.2**	**7.8**	**290**	**610**	**1,360**	**1,530**	**1,000**	**740**	**14.0**	**11.0**	**5.0**	**39.4**	**3.1**	**5.1**	**24,000**	**12,000**	**5,200**
	22-01	**median**	**7.41**	**24.93**	**1,950**	**0.8**	**3.2**	**37**	**150**	**850**	**1,035**	**80**	**120**	**3.0**	**2.5**	**1.4**	**2.9**	**0.5**	**0.8**	**2,200**	**1,750**	**1,526**
	22-01	**count**	**120**	**120**	**120**	**120**	**120**	**44**	**89**	**80**	**78**	**91**	**79**	**90**	**84**	**57**	**88**	**83**	**88**	**47**	**76**	**28**

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (μmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (μg/l)	NOx (μg/l)	TKN (μg/l)	Total N (μg/l)	SRP (μg/l)	Total P (μg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (μg/l)	Chyl-b (μg/l)	Chyl-c (μg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
1995	22-05	1/18/95	7.35	16.93	627	0.4	5.5		510	1,290	1,800	40	150	5.0	3.9	1.3	5.8	0.5	1.1	4,300	300	
1995	22-05	2/15/95	7.40	19.06	600	0.4	3.3		330	1,200	1,530	40	100	1.0	2.5	1.5	6.6	0.7	0.9	800	260	
1995	22-05	3/15/95	7.70	20.34	719	0.4	4.8		170	1,240	1,410	40	170	5.0	5.8	1.7	4.2	0.5	0.5	2,100	880	
1995	22-05	4/12/95	7.45	22.97	285	0.1	4.0		170	880	1,050	40	260	11.0	6.3	2.2	16.8	2.5	1.5	2,900	4,700	
1995	22-05	5/10/95	8.61	26.82	754	0.4	4.9		60	1,100	1,160	70	170	25.0	6.9	1.8	16.9	2.6	1.9	1,200	200	
1995	22-05	6/7/95	7.58	26.82	544	0.3	2.2		120	940	1,060	90	140	1.0	2.9	1.3	7.2	0.5	0.5	750	500	
1995	22-05	7/5/95	7.70	28.86	663	0.3	3.0		250	980	1,230	60	120	2.0	3.4	1.3	1.9	0.5	0.5	1,200	280	
1995	22-05	8/9/95	7.49	27.87	653	0.3	1.6		100	2,450	2,550	40	150	2.0	4.1	1.2	2.0	0.5	1.0	1,700	1,200	
1995	22-05	9/6/95	7.68	26.52	372	0.2	2.0		180	1,050	1,230	50	120	2.0	2.5	1.4	6.2	0.7	1.1	4,100	5,900	
1995	22-05	9/27/95	8.16	26.91	776	0.4	2.5		120	1,300	1,420	60	100	1.0	2.0	1.4	0.9	0.6	1.1	1,000	400	
1995	22-05	10/25/95	7.58	25.03	609	0.3	3.9		290	1,110	1,400	40	90	1.0	2.4	1.0	1.1	0.5	0.6	100	340	
1995	22-05	11/29/95	7.89	21.54	616	0.3	2.7		140	760	900	60	80	1.0	2.1	1.5	1.3	0.5	0.5		3,000	
1996	22-05	1/17/96	8.13	17.20	641	0.3	5.5		250	740	990	50	50	1.0	2.2	1.0	1.5	0.5	1.5	1,400	150	
1996	22-05	2/14/96	8.39	14.06	709	0.4	6.0		140	750	890	40	120	1.0	3.8	1.2	4.3	0.5	1.8	900	100	
1996	22-05	3/13/96		16.07	655	0.3	7.0	80	280	560	840	20	130		2.9	2.3	2.0	1.8	4.2	450	70	
1996	22-05	4/10/96	7.58	17.47	634	0.3	4.4	60	190	700	890	60	100		4.6	1.3	1.0	0.5	0.5	1,200	140	
1996	22-05	5/8/96	7.64	25.37	666	0.3	3.2	50	120	690	810	80	140		4.6	1.7	1.6	0.5	0.8	750	130	
1996	22-05	5/29/96	7.05	29.07	529	0.3	4.7	30	60	830	890	100	300		4.8	2.6	10.5	1.8	0.5	2,600	860	
1996	22-05	7/10/96	7.44	26.61	610	0.3	1.5	110	150	560	710	60	120		2.5	1.6	26.4	8.2	1.4	1,800	880	
1996	22-05	7/31/96	7.38	28.53	741	0.4	3.5	50	50	500	550	50	140		2.4	1.0	3.1	0.7	0.5	2,800	720	
1996	22-05	8/27/96	7.40	27.17	464	0.2	3.2	80	110	390	500	50	40		2.0	2.2	2.6	0.5	0.5	1,800	2,000	
1996	22-05	9/18/96	7.48	28.73	708	0.4	2.8	220	130	1,290	1,420	130	160		3.0	1.2	1.9	0.5	0.5	1,200	48	
1996	22-05	10/23/96	7.77	23.20	730	0.4	3.9	60	120	820	940	20	20		4.8	1.0	1.7	0.5	0.5	1,400	160	
1996	22-05	11/20/96	7.31	21.18	800	0.4	3.7	30	140	340	480	30	60		3.6	1.0	1.1	0.5	0.5	1,000	360	
1997	22-05	1/22/97	7.41	16.28	834	0.4	9.6	20	30	620	650	20	70		2.9	1.0	1.1	0.5	0.5			
1997	22-05	2/26/97	7.60	23.19	728	0.4	7.2	20	20	700	720	40	80		2.9	2.0	6.6	1.5	1.1			
1997	22-05	3/19/97	7.50	23.70	768	0.4	4.6	49	20	850	870	60	160		3.6	2.0	1.2	0.5	0.8			
1997	22-05	4/23/97	7.36	24.64	799	0.4	4.6	24	20	650	670	50	160		3.1	1.0	1.9	0.5	0.5			
1997	22-05	5/14/97	7.52	24.33	633	0.3	4.4	85	80	440	520	30	40		1.6	1.0	4.9	0.7	0.5			
1997	22-05	6/4/97	7.63	26.22	659	0.3	3.9	24	20	780	800	30	40		2.5	1.0	0.7	0.5	0.6			
1997	22-05	7/2/97	7.47	26.84	414	0.2	2.9	305	30	960	990	30	70		2.9	2.0	2.4	0.9	0.8			
1997	22-05	7/30/97	7.38	29.15	451	0.2	3.7	24	70	780	850	40	70		1.5	1.0	3.2	0.5	0.5			
1997	22-05	9/3/97	7.23	27.83	532	0.3	1.4	49	30	1,090	1,120	50	100		2.2	2.0	3.9	0.9	0.5			
1997	22-05	9/24/97	7.29	27.55	721	0.4	2.5	134	200	1,800	2,000	50	700		8.4	4.0	11.7	3.7	1.4			
1997	22-05	10/15/97	7.22	24.89	735	0.4	2.6	781	460	1,510	1,970	40	230		5.5	4.0	5.1	1.5	0.7			
1997	22-05	11/12/97	7.31	22.40	647	0.3	5.3	378	280	960	1,240	50	100		4.4	1.0	2.7	0.5	0.5			
1997	22-05	12/17/97	7.13	17.36	559	0.3	5.5	1,098	380	1,210	1,590	40	130		2.8	1.0	1.2	0.5	0.6			
1998	22-05	1/28/98	7.15	15.64	527	0.3	5.3	450	240	990	1,230	40	90		1.8	2.0	1.7	0.5	0.5			
1998	22-05	2/25/98	7.08	16.38	582	0.3	3.9	580	210	900	1,110	40	120		5.7	2.0	3.0	0.5	0.6			
1998	22-05	3/25/98	7.09	19.34	572	0.3	5.1	350	210	770	980	60	120	1.0	2.7	1.0	1.8	0.5	0.5			
1998	22-05	4/21/98	7.67	23.35	744	0.4	4.2	90	220	810	1,030	30	80	2.0	3.9	2.0	5.3	0.6	0.5			
1998	22-05	5/20/98	7.59	26.51	838	0.4	4.8	20	30	670	700	40	60	1.0	3.0	1.0	2.3	0.5	0.5			
1998	22-05	6/17/98	7.48	29.72	739	0.4	2.4	50	70	690	760	70	100	12.0	3.4	2.0	5.4	0.8	0.5			
1998	22-05	7/15/98	7.43	27.80	493	0.2	1.6	70	40	760	800	50	220	3.0	2.5	1.0	11.2	1.2	0.7			
1998	22-05	8/12/98	7.45	29.17	536	0.3	3.0	100	120	640	760	80	180	2.0	3.8	1.0	1.0	0.5	0.5			
1998	22-05	9/9/98	7.18	27.90	500	0.3	3.2	120	210	780	990	60	150	8.0	14.0	1.0	4.7	1.0	0.5			
1998	22-05	10/7/98	7.78	27.81	667	0.3	3.4	130	180	860	1,040	20	100	6.0	5.4	1.0	0.5	0.5	0.5			
1998	22-05	11/4/98	7.56	24.30	933	0.5	3.8	60	240	710	950	40	80	5.0	4.4	3.0	1.6	0.5	0.5			
1998	22-05	12/9/98	8.71	21.54	980	0.5	4.6	40	160	600	760	30	70	1.0	2.3	1.0	1.1	0.5	0.5			
1999	22-05	1/20/99	7.82	21.33	732	0.4	5.7	70	170	630	800	20	70	2.0	2.2	1.0	1.1	0.5	0.5			
1999	22-05	2/18/99	7.65	20.11	854	0.4	5.3	40	90	470	560	20	70	1.0	2.8	1.0	0.5	0.5	0.5			
1999	22-05	3/23/99	7.65	20.24	751	0.4	5.9	50	20	540	560	40	80	6.0	2.6	2.0	1.1	0.5	0.5			
1999	22-05	4/14/99	8.78	23.47	877	0.5	4.6	40	20	460	480	70	100	1.0	2.3	1.0	0.8	0.5	0.5			
1999	22-05	5/12/99	7.76	26.10	752	0.3	3.7	20	20	520	540	70	100	3.0	1.7	1.0	1.3	0.5	0.5			

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (^oC)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
1999	22-05	6/9/99	7.38	25.85	939	0.5	2.6	20	50	570	620	50	120	1.0	1.7	1.0	1.4	0.5	0.5			
1999	22-05	7/7/99	7.61	28.73	497	0.3	4.5	70	160	710	870	70	80	2.0	1.4	1.0	4.1	0.8	0.5			
1999	22-05	8/4/99	7.41	28.69	547	0.3	1.4	50	50	450	500	60	90	3.0	1.2	1.0	1.8	0.5	0.5			
1999	22-05	9/8/99	7.97	27.04	322	0.2	4.3	270	200	790	990	20	140	8.0	5.8	2.0	18.4	3.8	1.0			
1999	22-05	9/29/99	7.89	27.38	445	0.2	3.1	90	140	610	750	50	60	4.0	1.5	2.0	6.4	0.5	1.4			
1999	22-05	10/27/99	7.62	22.14	814	0.4	6.4	70	240	720	960	20	70	3.0	2.3	1.0	2.1	0.5	0.5			
1999	22-05	11/30/99	7.60	18.19	887	0.5	4.0	20	70	860	930	20	120	26.0	10.0	1.0	17.5	0.7	1.9			
1999	22-05	12/14/99	7.61	21.46	904	0.5	5.3	40	80	630	710	20	20	2.0	1.7	1.0	0.9	0.6	1.0			
2000	22-05	1/19/00	7.59	18.76	935	0.5	7.9	40	20	520	540	30	30	1.0	1.6	1.0	1.5	0.5	0.5			
2000	22-05	2/16/00	7.62	19.63	648	0.3	6.9	40	20	590	610	20	70	1.0	1.2	1.0	0.8	0.5	0.5			
2000	22-05	3/15/00	7.50	21.08	970	0.5	3.7	40	20	800	820	30	100	4.0	2.0	2.0	1.0	0.5	0.5			
2000	22-05	4/11/00	7.69	20.25	922	0.5	6.2	20	20	730	750	50	50	1.0	1.8	1.0	0.6	0.5	0.5			
2000	22-05	5/10/00	7.99	29.00	1,086	0.6	9.1	60	30	750	780	60	110	2.0	2.2	1.0	2.0	0.5	0.5			
2000	22-05	7/5/00	7.05	29.48	455	0.2	0.1	20	30	1,200	1,230			4.0	2.3	1.0	5.0	5.0	5.0			
2000	22-05	8/8/00	7.37	29.59	674	0.4	2.7	170	5	920	925	20	150	8.0	2.3	1.5	4.4	0.9	1.0			
2000	22-05	8/30/00	7.48	29.12	709	0.4	4.9	228	131	1,428	1,559	90	153	5.0	3.6		3.0	0.5	0.5			
2000	22-05	10/25/00	7.29	21.88	965	0.5	2.8	10	20	640	660	20	40	4.0	1.6	1.0	1.7	0.5	0.5			
2000	22-05	11/21/00	7.74	17.30	380	0.2	8.5	10	110	660	770	30	60	1.0	1.5	1.0	1.2	0.5	0.5			
2001	22-05	1/17/01	7.73	19.16	783	0.4	9.9	50	110	800	910	20	100	4.0	3.1	1.0	3.3	0.5	0.7			
2001	22-05	2/15/01	7.71	22.64	818	0.4	8.9	50	40	790	830	60	120	1.0	3.7	1.0	2.6	0.7	0.5			
2001	22-05	3/12/01	7.94	23.73	869	0.5	8.8	30	50	780	830	20	170	1.0	3.8	2.0	2.9	0.5	0.5			
2001	22-05	4/11/01	7.78	25.12	681	0.4	8.4	20	40	760	800	20	120	2.0	2.6	1.0	2.7	0.5	0.5			
2001	22-05	5/10/01	7.39	24.34	1,010	0.5	5.2															
2001	22-05	5/10/01	8.05	25.54	1,016	0.5	10.5	30	20	680	700	20	80	5.0	3.9	1.0	2.3	0.5	0.6			
2001	22-05	6/6/01	7.96	30.41	940	0.5	9.6	10	20	780	800	40	80	2.0	1.6	1.0	4.1	0.9	1.1			
2001	22-05	6/26/01	7.65	27.80	512	0.3	5.8															
2001	22-05	6/26/01	7.50	28.20	514	0.3	6.2	10	20	700	720	20	170	1.0	0.8	1.0	2.9	0.5	0.5			
2001	22-05	8/1/01	7.35	26.86	643	0.3	3.5	10	50	740	790	90	120	1.0	0.4	1.0	1.3	0.5	0.5			
2001	22-05	8/29/01	7.60	27.05	498	0.3	3.1															
2001	22-05	8/29/01	7.48	27.06	436	0.2	2.6	10	40	960	1,000	70	120	2.0	2.4	3.0	6.7	0.5	0.5			
2001	22-05	9/24/01	7.25	26.53	674	0.4	2.6	410	40	1,480	1,520	30	110	2.0	1.8	1.0	3.7	0.7	0.8			
2001	22-05	10/31/01	7.22	21.17	756	0.4	6.2	40	240	770	1,010	20	50	1.0	1.1	1.0	1.7	0.5	1.7			
2001	22-05	11/19/01	7.44	21.47	896	0.5	6.1															
2001	22-05	11/19/01	7.41	21.54	897	0.5	6.3	10	130	600	730	20	40	2.0	1.7	1.0	1.4	0.5	0.6			
2002	22-05	1/16/02	7.73	16.34	542	0.3	7.4	10	140	770	910	30	60	2.0	1.4	1.0	6.8	0.5	0.8			
2002	22-05	2/13/02	7.73	17.31	815	0.4	8.1	10	70	710	780	20	90	1.0	1.1		1.3	0.5	0.5			
2002	22-05	3/13/02	7.62	23.34	830	0.4	9.2	10	30	710	740	40	80	1.0	1.7	1.0	1.4	0.5	0.5			
2002	22-05	4/9/02	7.85	22.34	453	0.2	7.0															
2002	22-05	4/9/02	7.77	22.42	815	0.4	6.1	10	40	900	940	50	150	6.0	3.9	1.0	9.1	0.5	1.2			
2002	22-05	5/8/02	8.02	28.55	1,030	0.5	8.6	10	40	770	810	30	110	6.0	0.9	1.0	3.1	0.5	1.0			
2002	22-05	6/5/02	8.00	27.21	941	0.5	5.3	10	40	800	840	60	90	2.0	1.5	1.0	11.5	0.5	1.7			
2002	22-05	7/17/02	7.78	30.07	695	0.4	5.1	120	140	1,240	1,380	70	140	4.0	2.1	1.0	3.0	0.8	0.9			
2002	22-05	7/23/02	7.70	27.10	725	0.4	4.1	50	120	940	1,060	30	100	3.0	2.1	1.0	2.9	1.1	1.4			
2002	22-05	9/24/02	7.41	27.98	645	0.3	2.9	160	230	1,000	1,230	20	110	3.0	1.6	1.0	1.6	0.5	0.5			
2002	22-05	10/23/02	7.25	25.49	701	0.4	2.4	120	120	930	1,050	80	180	4.0	2.1	1.0	4.1	0.8	1.9			
2002	22-05	11/19/02	7.36	17.35	629	0.3	5.1	50	290	660	950	20	70	1.0	0.8	1.0	3.2	0.7	1.0			
2002	22-05	12/11/02	7.33	19.57	430	0.2	6.5	150	310	920	1,230	40	90	3.0	2.4	2.0	14.4	0.8	2.3			
2003	22-05	1/22/03	7.30	18.05	816	0.4	7.6	70	450	890	1,340	20	50	4.0	1.4		7.1	0.5	1.7			
2003	22-05	2/26/03	7.43	19.98	713	0.4	6.2	90	190	830	1,020	30	90	3.0	2.2		4.5	0.5	0.8			
2003	22-05	4/1/03	9.80	18.79	719	0.4	7.8	10	210	1,060	1,270	20	140	14.0	1.8		22.6	3.8	5.8			
2003	22-05	5/13/03	7.42	26.75	685	0.4	5.0	10	80	580	660	20	60	2.0	0.8		1.5	0.7	1.2			
2003	22-05	6/26/03	6.92	27.52	437	0.2	4.2															
2003	22-05	6/26/03	6.92	27.57	435	0.2	4.0	190	270	1,010	1,280	70	130	2.0	0.8		3.6	0.8	1.0			

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
2003	22-05	8/6/03	6.99	29.59	478	0.2	4.2	150	240	940	1,180	50	220	4.0	1.1		0.8	0.5	0.6			
2003	22-05	9/17/03	7.01	27.14	677	0.4	3.3	180	180	930	1,110	40	120	1.0	3.1		1.7	0.9	1.2			
2003	22-05	10/22/03	7.36	23.08	764	0.4	2.3	80	290	920	1,210	50	90	2.0	0.6		1.2	0.5	0.6			
2003	22-05	12/4/03	7.47	18.49	822	0.4	5.9	10	330	540	870	30	80	3.0	1.8		1.6	0.8	1.0			
2004	22-05	1/22/04	7.45	13.89	550	0.3	6.4	100	250	810	1,060	50	50	1.0	2.0		4.2	0.6	1.0			
2004	22-05	2/25/04	7.66	20.09	271	0.1	7.4	20	150	640	790	50	110	8.0	5.7		28.4	0.5	2.3			
2004	22-05	2/25/04	7.64	20.10	271	0.1	7.3															
2004	22-05	4/12/04	7.54	21.53	256	0.1	5.0															
2004	22-05	4/12/04	7.41	21.51	255	0.1	5.0	60	120	660	780	70	110	7.0	4.5		15.5	2.5	2.4			
2004	22-05	5/18/04	7.45	25.23	692	0.4	3.4	10	20	710	730	110	160	2.0	1.3		1.5	0.5	0.5			
2004	22-05	6/23/04	7.53	29.20	793	0.4	4.9	50	50	1,000	1,050	70	150	1.0	2.1		4.3	0.6	0.5			
2004	22-05	8/4/04	7.20	28.19	383	0.2	4.3															
2004	22-05	8/4/04	7.19	28.20	379	0.2	4.0	150	180	890	1,070	100	130	8.0	6.2		5.2	1.4	0.7			
2004	22-05	9/20/04	7.24	25.52	694	0.4	3.6	120	160	810	970	40	80	2.0	1.3		1.5	0.6	0.7			
2004	22-05	11/2/04	7.34	25.36	866	0.5	4.5	10	50	610	660	40	50	2.0	1.0		1.3	0.7	0.7			
2004	22-05	12/8/04	7.48	22.38	938	0.5	5.9	10	50	600	650	30	60	2.0	1.1		1.0	0.5	0.5			
2005	22-05	1/13/05	7.57	21.36	1,004	0.5	8.2	28	30	630	660	20	40	2.0	1.2		1.5	0.5	0.5	24,000	600	230
2005	22-05	3/1/05	7.59	20.25	621	0.3	7.9	10	80	800	880	60	100	4.0	1.7	2.0	11.6	1.4	1.0	1,400	320	270
2005	22-05	4/12/05	7.55	22.05	930	0.5	4.2	10	20	760	780	50	90	2.0	2.0		1.1	0.5	0.5	2,400	780	910
2005	22-05	5/26/05	7.51	25.09	892	0.5	4.9	10	20	850	870	70	110	2.0	1.9	2.0	2.1	0.5	0.5	550	460	300
2005	22-05	6/29/05	7.46	28.49	392	0.2	5.2	20	60	590	650	90	110	1.0	1.2		4.8	0.6	0.5	1,500	920	320
2005	22-05	8/16/05	7.24	29.30	669	0.3	2.3	190	50	1,020	1,070	90	180	2.0	1.9	2.0	2.6	0.5	0.5	1,800	580	1,200
2005	22-05	9/22/05	7.11	26.77	616	0.3	1.4	140	20	960	980	100	130	1.0	0.7		2.9	0.5	0.5	3,700	1,600	1,300
2005	22-05	11/1/05	7.30	21.26	850	0.4	5.5	60	130	730	860	60	90	2.0	0.7	1.0	1.3	0.5	0.6		170	250
2005	22-05	11/15/05	7.36	23.32	1,003	0.5	3.9	20	70	840	910	70	120	8.0	1.0		2.2	0.5	0.5		170	310
2006	22-05	1/24/06	7.38	21.06	1,124	0.6	2.3	20	90	800	890	50	50	1.0	1.1		1.0	1.0	1.0		260	280
2006	22-05	2/23/06	7.45	21.53	798	0.4	4.3	130	190	920	1,110	60	80	2.0	2.1	2.0	6.0	1.3	1.2		240	380
2006	22-05	4/6/06	7.43	19.60	1,025	0.5	3.8	30	20	840	860	50	50	4.0	3.0		1.1	0.5	0.6		130	1,400
2006	22-05	5/25/06	7.36	24.22	1,011	0.5	1.0	10	20	790	810	80	110	5.0	0.9	3.0	5.8	0.5	0.9		150	260
2006	22-05	7/18/06	7.17	28.60	646	0.3	1.1	80	20	960	980	120	210	1.0	1.3		2.6	1.0	1.3		2,200	428
2006	22-05	8/10/06	7.32	28.68	642	0.3	1.4	320	20	1,280	1,300	140	200	1.0	1.3	2.0					770	1,302
2006	22-05	9/11/06	7.30	28.27	587	0.3	3.4	120	150	840	990	100	110	1.0	1.2		2.6	0.5	0.5		520	166
2006	22-05	10/18/06	7.23	25.84	839	0.4	4.4	40	270	850	1,120	70	90	1.0	1.8	3.0	1.8	0.5	0.8		190	224
2006	22-05	11/27/06	7.38	20.05	796	0.4	5.2	30	180	670	850	40	80	1.0	1.5		1.7	0.5	0.5		600	1,034
2007	22-05	1/17/07	7.44	19.04	894	0.5	3.9	20	110	690	800	50	80	4.0	1.4		1.4	0.5	0.5		380	922
2007	22-05	2/20/07	7.61	15.00	813	0.4	9.2	10	70	580	650	20	40	1.0	0.7	2.0	1.1	0.5	0.5		370	403
2007	22-05	3/27/07	7.48	22.17	992	0.5	3.1	10	20	1,010	1,030	60	70	1.0	1.5		1.5	0.5	0.5		130	176
2007	22-05	6/18/07	7.24	27.67	625	0.3	0.9	10	20	480	500	130	160	1.0	0.9		4.0	0.5	0.5		470	275
2007	22-05	8/29/07	7.44	29.51	512	0.3	2.0	190	20	730	750	160	210	2.0	1.9	2.0	7.6	0.9	0.5		760	68
2007	22-05	9/19/07	7.43	26.51	703	0.4	2.2	130	70	710	780	110	130	2.0	3.2		1.6	0.5	0.5		370	150
2007	22-05	11/7/07	7.45	18.82	859	0.5	4.2	10	110	790	900	50	80	2.0	1.3	2.0	2.3	0.5	0.5		900	461
2008	22-05	1/30/08	7.39	17.32	783	0.4	6.2	10	110	660	770	50	90	2.0	1.7		2.5	0.5	0.6	880		200
2008	22-05	3/18/08	7.42	20.25	674	0.4	2.1	10	20	770	790	100	180	3.0	1.9	2.0	2.3	0.5	0.5		230	271
2008	22-05	5/22/08	7.30	26.21	744	0.4	0.4	60	20	850	870	140	170	1.0	0.9		2.8	0.5	0.5		250	570
2008	22-05	6/25/08	7.16	27.86	466	0.2	3.1	80	30	680	710	120	110	2.0	1.2	2.0	3.2	0.5	0.5		540	204
2008	22-05	8/5/08	7.15	27.91	620	0.3	2.9	100	80	800	880	100	130	5.0	2.3		2.4	0.5	0.5		600	220
2008	22-05	9/23/08	7.34	26.62	756	0.4	2.9	20	90	710	800	60	120	2.0	1.5	2.0	2.5	0.5	0.5		1,200	498
	22-05	**min**	**6.92**	**13.89**	**255**	**0.1**	**0.1**	**10**	**5**	**340**	**480**	**20**	**20**	**1.0**	**0.4**	**1.0**	**0.5**	**0.5**	**0.5**	**100**	**48**	**68**
	22-05	**max**	**9.80**	**30.41**	**1,124**	**0.6**	**10.5**	**1,098**	**510**	**2,450**	**2,550**	**160**	**700**	**26.0**	**14.0**	**4.0**	**28.4**	**8.2**	**5.8**	**24,000**	**5,900**	**1,400**
	22-05	**median**	**7.46**	**24.49**	**698**	**0.4**	**4.3**	**50**	**90**	**780**	**880**	**50**	**100**	**2.0**	**2.1**	**1.0**	**2.4**	**0.5**	**0.5**	**1,400**	**390**	**300**
	22-05	**count**	**153**	**154**	**154**	**154**	**154**	**131**	**145**	**145**	**145**	**144**	**144**	**120**	**145**	**108**	**144**	**144**	**144**	**31**	**54**	**31**

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
2003	22-07	1/22/03	7.52	18.09	722	0.4	8.6	30	200	780	980	20	70	2.0	1.5		4.1	0.5	1.1			
2003	22-07	2/26/03	7.19	20.84	618	0.3	1.0	80	60	920	980	80	140	3.0	2.2		5.9	0.7	0.9			
2003	22-07	4/1/03	8.07	16.19	613	0.3	7.9	20	120	1,370	1,490	20	260	42.0	1.5		19.7	3.7	6.2			
2003	22-07	5/13/03	7.35	26.58	577	0.3	2.7	10	20	600	620	100	130	4.0	1.6		10.8	0.6	2.3			
2003	22-07	6/26/03	7.14	28.51	369	0.2	3.6															
2003	22-07	6/26/03	7.16	28.63	377	0.2	3.7	70	160	900	1,060	90	170	2.0	1.1		8.1	1.5	1.6			
2003	22-07	8/6/03	7.16	28.90	317	0.2	2.1															
2003	22-07	8/6/03	7.04	28.96	413	0.2	1.1	50	40	760	800	100	160	2.0	1.5		1.4	0.5	0.5			
2003	22-07	10/22/03	7.35	22.80	716	0.4	0.7															
2003	22-07	10/22/03	7.35	22.57	705	0.4	0.3	50	20	930	950	100	170	7.0	3.0		7.3	2.1	1.0			
2004	22-07	1/22/04	7.53	14.83	633	0.3	6.9	100	220	790	1,010	90	100	6.0	3.8		9.8	1.2	2.3			
2004	22-07	2/25/04	7.75	20.53	255	0.1	7.6	20	160	770	930	60	130	12.0	7.5		42.9	0.9	3.2			
2004	22-07	2/25/04	7.46	20.53	255	0.1	1.3															
2004	22-07	4/12/04	6.94	21.27	404	0.2	0.9															
2004	22-07	4/12/04	7.50	21.08	158	0.1	5.2	80	130	920	1,050	100	180	10.0	5.4		18.5	3.6	1.9			
2004	22-07	5/18/04	7.26	24.15	602	0.3	1.4	10	20	1,140	1,160	180	320	15.0	2.0		13.7	1.9	1.6			
2004	22-07	8/4/04	7.21	28.87	385	0.2	3.6															
2004	22-07	8/4/04	7.21	28.89	385	0.2	3.7	160	200	1,000	1,200	100	150	8.0	4.5		13.9	2.6	1.9			
2004	22-07	9/20/04	7.28	25.53	628	0.3	2.0	20	80	1,060	1,140	70	150	36.0	4.2		6.3	3.4	3.9			
2004	22-07	11/2/04	7.31	25.11	885	0.5	3.3	10	40	640	680	60	90	1.0	0.9		1.1	0.5	0.5			
2004	22-07	12/8/04	7.30	21.59	826	0.4	1.6	10	60	630	690	60	80	2.0	1.0		2.4	0.5	0.5			
2005	22-07	1/13/05	7.34	20.54	817	0.4	3.3	45	60	700	760	80	130	1.0	1.6		1.7	0.5	0.5	7,300	60	380
2005	22-07	3/1/05	7.70	19.92	491	0.3	8.0	10	20	1,090	1,110	80	150	7.0	2.8	3.0	25.6	2.6	2.5	1,300	500	210
2005	22-07	4/12/05	7.45	22.37	777	0.4	2.5	10	20	870	890	90	100	6.0	1.1		2.3	0.7	0.8	950	100	260
2005	22-07	6/29/05	7.21	28.28	316	0.2	1.2															
2005	22-07	6/29/05	7.28	28.31	309	0.2	2.3	20	50	550	600	100	130	2.0	1.6		8.7	0.8	0.5	3,700	960	1,200
2005	22-07	8/16/05	7.17	29.71	546	0.3	0.5	170	20	1,010	1,030	140	230	1.0	2.2	2.0	3.8	0.5	0.5	15,000	3,400	4,800
2005	22-07	9/22/05	7.09	26.61	579	0.3	0.5	140	20	1,090	1,110	210	220	2.0	1.6		8.0	0.5	0.7	14,000	3,600	3,900
2005	22-07	11/1/05	7.12	20.63	647	0.3	1.0	20	20	710	730	30	20	1.0	0.3	1.0	1.0	0.5	0.6		200	680
2005	22-07	11/15/05	7.20	23.06	804	0.4	0.5	90	20	930	950	120	170	1.0	1.6		1.8	0.5	0.5		170	1,600
2006	22-07	1/24/06	7.34	21.20	836	0.4	1.0	80	30	1,090	1,120	100	190	9.0	2.5		22.0	4.5	1.0		60	610
2006	22-07	2/23/06	7.55	23.02	658	0.3	3.9	110	110	960	1,070	110	110	2.0	1.6	3.0	3.0	0.8	1.0		660	990
2006	22-07	4/6/06	7.61	22.11	797	0.4	7.0	20	20	790	810	90	540	2.0	2.3		0.5	0.5	0.5		280	210
2006	22-07	5/25/06	7.41	27.42	797	0.4	4.1	60	20	960	980	100	140	4.0	1.1	5.0	9.1	0.5	2.2		14	8
2006	22-07	7/18/06	7.09	29.01	543	0.3	1.4															
2006	22-07	7/18/06	7.07	29.07	521	0.3	1.0	100	20	1,090	1,110	110	200	3.0	1.2		6.1	1.6	1.6		445	276
2006	22-07	8/10/06	7.22	30.66	495	0.3	1.8	180	20	1,150	1,170	130	210	7.0	2.6	3.0					1,200	215
2006	22-07	9/11/06	7.27	29.06	500	0.3	1.5	70	140	870	1,010	120	130	1.0	1.1		3.2	0.5	0.5		1,400	333
2006	22-07	10/18/06	7.18	25.68	698	0.4	1.3	10	100	1,350	1,450	90	620	1.0	2.2	6.0	2.1	0.5	0.5		290	325
2007	22-07	1/17/07	7.28	19.04	725	0.4	1.0	10	80	770	850	100	110	2.0	1.3		1.4	0.5	0.5		220	775
2007	22-07	2/20/07	7.57	15.18	653	0.3	8.2	10	60	700	760	30	50	1.0	0.6	2.0	1.9	0.5	0.5		1,000	2
2007	22-07	8/29/07	7.50	31.27	442	0.2	2.3	200	20	860	880	160	190	2.0	2.6	2.0	13.4	1.8	0.6		520	343
2007	22-07	9/19/07	7.43	26.67	644	0.3	2.0	150	20	780	800	120	120	1.0	0.7		7.2	0.6	0.5		580	228
2007	22-07	11/7/07	7.41	19.54	780	0.4	3.5	10	90	690	780	30	70	1.0	0.7	2.0	4.7	0.5	0.5		180	201
2008	22-07	1/30/08	7.30	17.70	646	0.3	3.5	10	180	1,520	1,700	70	210	18.0	6.7		4.4	0.6	0.7	100		200
2008	22-07	6/25/08	7.04	27.54	442	0.2	0.8	50	20	720	740	150	150	1.0	1.3	2.0	4.6	0.5	0.5		370	231
	22-07	**min**	**6.94**	**14.83**	**158**	**0.1**	**0.3**	**10**	**20**	**550**	**600**	**20**	**20**	**1.0**	**0.3**	**1.0**	**0.5**	**0.5**	**0.5**	**100**	**14**	**2**
	22-07	**max**	**8.07**	**31.27**	**885**	**0.5**	**8.6**	**200**	**220**	**1,520**	**1,700**	**210**	**620**	**42.0**	**7.5**	**6.0**	**42.9**	**4.5**	**6.2**	**15,000**	**3,600**	**4,800**
	22-07	**median**	**7.29**	**23.61**	**608**	**0.3**	**2.1**	**48**	**45**	**885**	**980**	**100**	**150**	**2.0**	**1.6**	**2.0**	**5.9**	**0.6**	**0.7**	**3,700**	**408**	**325**
	22-07	**count**	**46**	**46**	**46**	**46**	**46**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**38**	**11**	**37**	**37**	**37**	**7**	**22**	**23**

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
2003	22-08	1/22/03	7.57	19.58	929	0.5	11.0	10	140	950	1,090	20	30	3.0	0.8		14.4	0.5	2.6			
2003	22-08	2/26/03	7.52	21.01	921	0.5	7.1	40	150	850	1,000	20	80	3.0	1.8		2.9	0.5	0.9			
2003	22-08	4/1/03	5.96	15.32	919	0.5	7.7	10	50	660	710	20	30	2.0	0.5		2.0	0.5	1.0			
2003	22-08	5/13/03	7.33	26.76	865	0.5	2.5	10	20	700	720	20	160	8.0	8.6		3.7	0.7	1.2			
2003	22-08	6/26/03	7.30	29.56	562	0.3	7.2															
2003	22-08	6/26/03	7.34	29.76	564	0.3	7.9	40	250	950	1,200	50	110	3.0	0.9		5.9	1.2	1.8			
2003	22-08	8/6/03	7.09	28.33	557	0.3	3.3	20	310	840	1,150	40	80	6.0	0.9		3.1	0.5	0.6			
2003	22-08	9/17/03	7.10	25.82	766	0.4	2.4	10	30	750	780	20	40	1.0	0.4		2.4	1.0	1.4			
2003	22-08	10/22/03	7.34	23.01	868	0.5	1.2	10	20	870	890	70	140	3.0	1.7		1.5	0.7	0.5			
2003	22-08	12/4/03	7.42	17.95	1,077	0.6	4.9															
2003	22-08	12/4/03	7.36	17.89	1,076	0.6	2.1	10	60	560	620	20	40	1.0	1.0		4.4	0.5	0.5			
2004	22-08	1/22/04	7.39	14.18	1,064	0.6	5.3	10	190	660	850	30	20	1.0	0.9		1.1	0.9	1.4			
2004	22-08	2/25/04	7.50	20.54	394	0.2	6.6	10	110	520	630	30	60	3.0	2.8		8.8	0.5	1.0			
2004	22-08	4/12/04	7.37	22.56	566	0.3	4.6	20	50	550	600	30	50	4.0	2.9		7.1	1.1	1.2			
2004	22-08	5/18/04	7.52	25.19	872	0.5	3.1	10	20	810	830	40	60	4.0	1.3		2.5	0.5	0.5			
2004	22-08	6/23/04	7.65	30.53	1,233	0.7	5.4	10	20	980	1,000	20	70	3.0	1.1		5.2	0.5	0.5			
2004	22-08	8/4/04	7.34	28.38	387	0.2	5.8															
2004	22-08	8/4/04	7.34	28.39	386	0.2	5.8	38	150	720	870	60	80	2.0	3.9		4.5	1.8	1.3			
2004	22-08	9/20/04	7.21	24.73	830	0.4	2.7	10	20	740	760	30	70	2.0	0.4		1.5	0.9	1.4			
2004	22-08	11/2/04	7.22	24.65	1,103	0.6	0.8	10	20	600	620	50	50	1.0	0.3		1.1	0.6	0.8			
2004	22-08	12/8/04	7.26	21.59	1,217	0.6	1.2	10	20	540	560	50	50	1.0	0.3		1.0	0.5	0.5			
2005	22-08	1/13/05	7.25	20.31	1,319	0.7	2.3	25	20	630	650	40	50	4.0	0.3		2.0	0.5	0.5	6,900	20	10
2005	22-08	3/1/05	7.85	22.43	1,120	0.6	10.3	10	60	470	530	40	50	1.0	0.5	2.0	2.6	0.5	0.6	750	80	240
2005	22-08	4/12/05	7.48	23.01	1,280	0.7	4.5	10	20	710	730	60	40	1.0	0.3		2.1	0.5	0.5	200	60	96
2005	22-08	5/26/05	7.37	24.93	1,294	0.7	3.8	10	20	750	770	100	120	2.0	0.7	2.0	1.9	0.5	0.5	900	110	1,500
2005	22-08	6/29/05	7.46	28.73	829	0.4	6.2	30	90	550	640	40	60	2.0	1.6		6.0	0.6	0.5	2,200	1,200	380
2005	22-08	8/16/05	7.25	29.23	1,112	0.6	1.5	20	40	760	800	30	40	1.0	0.5	1.0	2.2	0.5	0.5	9,200	1,200	4,800
2005	22-08	9/22/05	7.18	26.76	1,054	0.6	3.0	20	20	770	790	110	140	2.0	1.6		5.6	0.5	0.8	17,000	3,300	3,500
2005	22-08	11/1/05	7.45	21.70	1,332	0.7	7.2	100	50	880	930	100	130	2.0	0.9	3.0	4.0	0.5	0.7		57	72
2005	22-08	11/15/05	7.39	25.08	1,431	0.8	5.7	10	20	690	710	20	30	3.0	0.3		1.5	0.5	0.5		60	410
2006	22-08	1/24/06	7.47	21.72	1,543	0.8	6.1	10	20	640	660	40	20	1.0	0.3		2.4	1.0	1.0		40	400
2006	22-08	2/23/06	7.60	22.65	1,116	0.6	7.7	10	20	690	710	50	40	1.0	0.7	2.0	2.4	0.7	1.2		110	690
2006	22-08	4/6/06	7.42	20.02	1,418	0.8	5.1	10	20	610	630	40	20	4.0	0.6		3.4	0.5	1.0		34	530
2006	22-08	5/25/06	7.38	25.38	1,457	0.8	3.6	10	20	750	770	60	140	1.0	0.4	2.0	3.2	0.5	0.9		29	40
2006	22-08	7/18/06	7.14	29.22	1,167	0.6	2.0	20	20	810	830	30	50	1.0	0.5		2.8	0.9	1.3		160	140
2006	22-08	8/10/06	7.34	29.91	1,049	0.6	3.2	10	20	850	870	70	110	1.0	1.3	3.0					1,900	96
2006	22-08	9/11/06	7.27	31.01	934	0.5	4.0	90	170	930	1,100	70	90	2.0	1.4		2.8	0.5	0.5		1,300	53
2006	22-08	10/18/06	7.24	26.92	1,174	0.6	3.5	10	20	890	910	140	180	2.0	1.6	3.0	2.3	0.5	0.6		540	1,159
2006	22-08	11/27/06	7.41	20.26	1,162	0.6	5.1	10	60	560	620	30	20	1.0	0.7		2.6	0.5	0.5		570	498
2007	22-08	1/17/07	7.38	18.51	1,275	0.7	3.6	10	20	570	590	80	80	2.0	0.4		5.3	0.5	0.8		20	86
2007	22-08	2/20/07	7.72	16.42	1,230	0.7	12.0	10	20	670	690	20	20	2.0	0.8	2.0	22.3	0.5	2.9		94	4
2007	22-08	3/27/07	7.40	21.60	1,366	0.7	2.5	10	20	1,070	1,090	40	20	1.0	0.5		1.4	0.5	0.5		43	84
2007	22-08	5/22/07	7.44	24.33	1,450	0.8	4.0	60	20	860	880	20	70	21.0	2.4	3.0	10.7	0.6	2.0		29	649
2007	22-08	8/29/07	7.62	32.03	535	0.3	6.7	70	30	540	570	60	90	1.0	1.2	2.0	7.0	0.6	0.5		980	100
2007	22-08	9/19/07	7.48	26.16	1,113	0.6	4.4	10	20	440	460	40	50	4.0	1.5		1.5	0.5	0.5		200	111
2007	22-08	11/7/07	7.46	19.22	1,152	0.6	4.9	10	20	670	690	30	30	1.0	0.5	2.0	1.1	0.5	0.5		13	68
2007	22-08	12/6/07	7.59	17.02	1,385	0.7	4.0	10	20	590	610	20	20	1.0	0.5		0.8	0.5	0.5		4	30
2008	22-08	1/30/08	7.38	18.46	1,233	0.7	5.9	10	30	530	560	40	40	1.0	0.6		1.6	0.5	0.8	44		200
2008	22-08	3/18/08	7.33	20.05	1,108	0.6	2.5	10	20	600	620	40	50	1.0	0.7	2.0	1.3	0.5	0.5		8	51
2008	22-08	6/25/08	7.07	27.01	972	0.5	0.4	10	20	550	570	60	60	1.0	0.7	2.0	1.7	0.5	0.5			38
2008	22-08	9/23/08	7.37	28.27	628	0.3	1.3	10	20	810	830	20	70	1.0	2.4	3.0	10.9	0.5	0.5		1,200	2,410
	22-08	**min**	**5.96**	**14.18**	**386**	**0.2**	**0.4**	**10**	**20**	**440**	**460**	**20**	**20**	**1.0**	**0.3**	**1.0**	**0.8**	**0.5**	**0.5**	**44**	**4**	**4**
	22-08	**max**	**7.85**	**32.03**	**1,543**	**0.8**	**12.0**	**100**	**310**	**1,070**	**1,200**	**140**	**180**	**21.0**	**8.6**	**3.0**	**22.3**	**1.8**	**2.9**	**17,000**	**3,300**	**4,800**
	22-08	**median**	**7.38**	**24.33**	**1,103**	**0.6**	**4.4**	**10**	**20**	**695**	**725**	**40**	**50**	**2.0**	**0.8**	**2.0**	**2.6**	**0.5**	**0.6**	**1,550**	**87**	**126**
	22-08	**count**	**51**	**51**	**51**	**51**	**51**	**48**	**48**	**48**	**48**	**48**	**48**	**48**	**48**	**15**	**47**	**47**	**47**	**8**	**28**	**30**

Historical Water Quality Data Collected in Longbranch Creek by Pinellas County

Year	Station ID	Sample Date	pH (s.u.)	Temp. (^{o}C)	Conductivity (µmho/cm)	Salinity (ppt)	D.O. (mg/l)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	Chyl-b (µg/l)	Chyl-c (µg/l)	T Coliform (# / 100 ml)	F Coliform (# / 100 ml)	Enterococcus (# / 100 ml)
2008	22-12	10/28/08	6.90	17.81	607	0.3	0.9	140	20	730	750	80	130	1.0	0.7		2.4	0.5	0.6		160	288
2008	22-12	12/2/08	7.33	17.69	682	0.4	3.2	20	20	1,170	1,190	60	120	5.0	3.7	6.0	25.1	4.4	0.7		370	651
2009	22-12	2/10/09	7.46	16.67	836	0.4	5.5	10	20	610	630	50	80	2.0	1.3		4.2	0.5	0.5		67	113
2009	22-12	3/18/09	7.07	20.49	1,180	0.6	1.8	10	20	860	880	90	130	2.0	1.3	3.0	2.2	0.5	0.5		690	242
2009	22-12	6/16/09	7.11	29.16	997	0.5	2.0	10	20	760	780	130	160	2.0	1.3	4.0	4.7	0.5	0.5		800	403
2009	22-12	7/30/09	7.26	29.44	582	0.3	1.8	240	20	1,180	1,200	190	280	2.0	2.0		5.5	0.5	0.5		1,100	334
2009	22-12	9/22/09	7.03	28.24	469	0.2	2.2	260	100	1,090	1,190	80	140	4.0	2.7	5.0	10.9	0.7	0.5		2,000	311
2009	22-12	10/22/09	7.13	24.28	982	0.5	2.7	550	70	1,510	1,580	30	120	4.0	5.5		2.9	0.5	0.5		470	1,230
2009	22-12	12/8/09	7.35	20.54	556	0.3	4.6	100	320	1,000	1,320	50	70	2.0	1.5	2.0	6.2	0.5	0.5		400	151
2010	22-12	2/3/10	7.67	18.35	606	0.3	12.8	10	320	590	910	30	40	1.0	2.0		4.1	0.5	0.7		60	258
2010	22-12	5/6/10	7.05	26.09	702	0.4	0.8	150	20	980	1,000	50	150	3.0	2.5		11.9	0.5	1.1		2,300	1,960
	22-12	**min**	**6.90**	**16.67**	**469**	**0.2**	**0.8**	**10**	**20**	**590**	**630**	**30**	**40**	**1.0**	**0.7**	**2.0**	**2.2**	**0.5**	**0.5**	**x**	**60**	**113**
	22-12	**max**	**7.67**	**29.44**	**1,180**	**0.6**	**12.8**	**550**	**320**	**1,510**	**1,580**	**190**	**280**	**5.0**	**5.5**	**6.0**	**25.1**	**4.4**	**1.1**	**x**	**2,300**	**1,960**
	22-12	**median**	**7.13**	**20.54**	**682**	**0.4**	**2.2**	**100**	**20**	**980**	**1,000**	**60**	**130**	**2.0**	**2.0**	**4.0**	**4.7**	**0.5**	**0.5**	**x**	**470**	**311**
	22-12	**count**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**5**	**11**	**11**	**11**	**x**	**11**	**11**
2008	22-14	10/28/08	7.27	18.00	514	0.3	4.3	50	340	930	1,270	70	110	4.0	2.3		10.3	1.2	0.6		2,400	1,300
2008	22-14	12/2/08	7.23	16.71	509	0.3	5.2	10	60	760	820	50	70	2.0	1.1	4.0	5.9	0.5	0.5		400	1,840
2009	22-14	2/10/09	7.45	15.22	530	0.3	6.3	70	220	1,070	1,290	60	100	4.0	3.1		11.5	0.7	0.6		1,300	2,830
2009	22-14	6/16/09	7.34	26.97	637	0.3	3.5	60	140	800	940	110	160	6.0	3.8	3.0	0.9	0.5	0.5		3,000	3,680
2009	22-14	7/30/09	7.51	29.02	441	0.2	3.0	60	120	1,110	1,230	90	140	3.0	1.7		5.9	0.7	0.5		1,200	68
2009	22-14	9/22/09	7.01	27.37	572	0.3	3.2	60	310	950	1,260	70	100	4.0	2.0	3.0	0.5	0.5	0.5		4,700	2,830
2009	22-14	10/22/09	7.31	23.51	665	0.3	4.6	180	100	970	1,070	70	130	4.0	3.4		1.6	0.5	0.5		7,900	3,270
2009	22-14	10/22/09	7.28	23.52	664	0.3	4.4															
2009	22-14	12/8/09	7.25	20.73	539	0.3	4.7	150	120	910	1,030	60	80	2.0	1.5	2.0	0.5	0.5	0.5		3,500	6,930
2010	22-14	2/3/10	7.62	17.11	592	0.3	6.3	10	320	580	900	50	130	6.0	1.0		1.0	0.5	0.5		330	127
2010	22-14	3/16/10	7.42	16.97	632	0.3	6.4	110	140	750	890	50	140	1.0	1.2	3.0	0.5	0.6	0.9		1,800	5,650
2010	22-14	5/6/10	7.30	25.69	609	0.3	2.7	300	260	1,340	1,600	240	290	8.0	4.3		15.9	3.9	0.5		33	195
	22-14	**min**	**7.01**	**15.22**	**441**	**0.2**	**2.7**	**10**	**60**	**580**	**820**	**50**	**70**	**1.0**	**1.0**	**2.0**	**0.5**	**0.5**	**0.5**	**x**	**33**	**68**
	22-14	**max**	**7.62**	**29.02**	**665**	**0.3**	**6.4**	**300**	**340**	**1,340**	**1,600**	**240**	**290**	**8.0**	**4.3**	**4.0**	**15.9**	**3.9**	**0.9**	**x**	**7,900**	**6,930**
	22-14	**median**	**7.31**	**22.12**	**582**	**0.3**	**4.5**	**60**	**140**	**930**	**1,070**	**70**	**130**	**4.0**	**2.0**	**3.0**	**1.6**	**0.5**	**0.5**	**x**	**1,800**	**2,830**
	22-14	**count**	**12**	**12**	**12**	**12**	**12**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**11**	**5**	**11**	**11**	**11**	**x**	**11**	**11**
2008	22-15	10/28/08	7.16	15.45	465	0.2	2.0	60	20	1,110	1,130	80	120	3.0	1.8		19.5	3.1	0.9		54	2,600
2008	22-15	12/2/08	7.37	16.68	527	0.3	2.6	10	20	690	710	60	70	1.0	2.0	4.0	0.9	0.5	0.5		6,800	4,840
2009	22-15	7/30/09	7.40	29.68	452	0.2	1.2	100	20	1,500	1,520	170	330	7.0	4.6		33.6	1.5	1.3		540	34
2010	22-15	2/3/10	7.65	21.01	421	0.2	8.0	60	350	1,040	1,390	50	120	10.0	4.9		4.0	0.5	0.5		200	120
2010	22-15	3/16/10	7.74	18.91	579	0.3	6.8	10	190	820	1,010	50	80	6.0	1.9	4.0	2.6	1.2	1.5		280	110
2010	22-15	5/6/10	7.28	26.68	617	0.3	2.2	10	20	920	940	120	210	5.0	4.3		5.7	0.7	0.5		560	551
	22-15	**min**	**7.16**	**15.45**	**421**	**0.2**	**1.2**	**10**	**20**	**690**	**710**	**50**	**70**	**1.0**	**1.8**	**4.0**	**0.9**	**0.5**	**0.5**	**x**	**54**	**34**
	22-15	**max**	**7.74**	**29.68**	**617**	**0.3**	**8.0**	**100**	**350**	**1,500**	**1,520**	**170**	**330**	**10.0**	**4.9**	**4.0**	**33.6**	**3.1**	**1.5**	**x**	**6,800**	**4,840**
	22-15	**median**	**7.39**	**19.96**	**496**	**0.3**	**2.4**	**35**	**20**	**980**	**1,070**	**70**	**120**	**5.5**	**3.2**	**4.0**	**4.9**	**1.0**	**0.7**	**x**	**410**	**336**
	22-15	**count**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**2**	**6**	**6**	**6**	**x**	**6**	**6**

A.2 Historical Water Quality Data Collected by FDEP

Historical Water Quality Data Collected in Longbranch Creek by FDEP

Station ID	Sample Date	pH (s.u.)	Temp. (^oC)	Conductivity (µmho/cm)	Salinity (ppt)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	T Coli. (#/100 ml)	F Coli. (#/100 ml)	Color (Pt-Co)
	4/23/02	7.06	25.59	534	1.0	21	4	2,700	2,704	26	270	19.0	10.1		70.0	4,300	3,500	100
	5/7/02	7.33	27.74	580	3.1	93	20	3,700	3,720	27	300	22.0	12.0		76.0	6,000	1,600	120
	6/4/02	7.37	26.79	436	1.9	96		2,800			290	20.0	8.3			680	400	120
	7/23/02	7.61	31.47	518	6.0			1,700		21	140	16.0	10.1		57.0	710	700	120
275442308244165	8/20/02	6.83	28.57	402	3.7		74	1,600	1,674	21	140	14.0	7.0			5,800	1,200	100
	9/25/02	7.37	28.52	535	4.6	63				88		14.0	7.5			2,900	370	120
	10/21/02	7.46	25.10	519	4.0	25				74		13.0	7.5			1,040	470	100
	11/20/02	7.94	17.59	500	8.1	29				23		13.0	8.7			1,750	720	100
	12/4/02	7.43	14.60	576	5.5		11	1,700	1,711	26	140	22.0	10.7			1,750	240	100
Minimum Value:		**6.83**	**14.60**	**402**	**1.0**	**21**	**4**	**1,600**	**1,674**	**21**	**140**	**13.0**	**7.0**		**57.0**	**680**	**240**	**100**
Maximum Value:		**7.94**	**31.47**	**580**	**8.1**	**96**	**74**	**3,700**	**3,720**	**88**	**300**	**22.0**	**12.0**		**76.0**	**6,000**	**3,500**	**120**
Median Value:		**7.37**	**26.79**	**519**	**4.0**	**46**	**16**	**2,200**	**2,208**	**26**	**205**	**16.0**	**8.7**		**70.0**	**1,750**	**700**	**100**
Count:		**9**	**9**	**9**	**9**	**6**	**4**	**6**	**4**	**8**	**6**	**9**	**9**	**0**	**3**	**9**	**9**	**9**
	4/23/02	7.08	27.02	855	2.5	58	4	2,000	2,004	170	320	12.0	3.2		41.0	490	150	110
	5/7/02	7.48	27.18	828	5.6	93	20	3,700	3,720	27	300	116.0	30.0		130.0	120	75	120
	6/4/02	7.00	27.39	714	0.5	440		4,300		54	550	33.0	11.0			1,600	10	120
	7/23/02	7.16	26.34	834	1.6			3,900		220	550	37.0	18.0		160.0	590	200	140
	8/20/02	7.21	27.72	414	3.1	110	77	1,900	1,977	64	200	12.0	7.0		62.0	4,300	1,200	100
275443208244235	9/25/02	7.14	26.50	714	1.7	310		1,900		230		8.0	13.9			5,700	1,600	120
	10/21/02	7.33	23.00	714	1.3	270	14			280		10.0	4.7		21.0	920	330	110
	11/20/02	7.26	16.17	640	2.8	190	59		1,359	110		7.0	3.4			2,350	680	80
	12/4/02	7.32	14.38	800	5.6	23	16	1,400	1,416	50	110	11.0	5.2			1,220	210	70
	2/13/06	7.46	12.32	720	4.7	240	210	3,400	3,610	130	430		3.6			310	140	60
	5/8/06	7.24	25.05	1,160	1.9	90		2,500	2,510	130	340			3.0		840	710	
	7/11/06	7.15	26.45	723	0.7	190	210		1,410	260			1.4	2.2				60
Minimum Value:		**7.00**	**12.32**	**414**	**0.5**	**23**	**4**	**1,400**	**1,359**	**27**	**110**	**7.0**	**1.4**	**2.2**	**21.0**	**120**	**10**	**60**
Maximum Value:		**7.48**	**27.72**	**1,160**	**5.6**	**440**	**210**	**4,300**	**3,720**	**280**	**550**	**116.0**	**30.0**	**3.0**	**160.0**	**5,700**	**1,600**	**140**
Median Value:		**7.23**	**26.40**	**722**	**2.2**	**190**	**40**	**2,500**	**1,991**	**130**	**330**	**12.0**	**5.2**	**2.6**	**62.0**	**920**	**210**	**110**
Count:		**12**	**12**	**12**	**12**	**11**	**8**	**9**	**8**	**12**	**8**	**9**	**11**	**2**	**5**	**11**	**11**	**11**
	3/21/02	7.52	25.72	689	5.6													
275444908244026	2/13/06	7.65	14.04	572	7.6	55	270	2,900	3,170	34	400		3.3		21.0	180	130	50
	7/11/06	7.13	27.97	501	0.7	280	31	1,200	1,231	120	170		1.3					60
	10/2/06	7.07	25.76	615	0.7				1,560	130						1,460	1,200	60
Minimum Value:		**7.07**	**14.04**	**501**	**0.7**	**55**	**31**	**1,200**	**1,231**	**34**	**170**		**1.3**		**21.0**	**180**	**130**	**50**
Maximum Value:		**7.65**	**27.97**	**689**	**7.6**	**280**	**270**	**2,900**	**3,170**	**130**	**400**		**3.3**		**21.0**	**1,460**	**1,200**	**60**
Median Value:		**7.33**	**25.74**	**594**	**3.1**	**168**	**151**	**2,050**	**1,560**	**120**	**285**		**2.3**		**21.0**	**820**	**665**	**60**
Count:		**4**	**4**	**4**	**4**	**2**	**2**	**2**	**3**	**3**	**2**	**0**	**2**	**0**	**1**	**2**	**2**	**3**
	3/7/02	7.04	17.04	740	5.7													
275510508243111	7/25/06	7.23	28.09	927	4.2													
	10/24/06	7.18	21.12	6,864	4.9											2,000	1,080	
Minimum Value:		**7.04**	**17.04**	**740**	**4.2**											**2,000**	**1,080**	
Maximum Value:		**7.23**	**28.09**	**6,864**	**5.7**											**2,000**	**1,080**	
Median Value:		**7.18**	**21.12**	**927**	**4.9**											**2,000**	**1,080**	
Count:		**3**	**3**	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**

Historical Water Quality Data Collected in Longbranch Creek by FDEP

Station ID	Sample Date	pH (s.u.)	Temp. (°C)	Conductivity (µmho/cm)	Salinity (ppt)	Ammonia (µg/l)	NOx (µg/l)	TKN (µg/l)	Total N (µg/l)	SRP (µg/l)	Total P (µg/l)	TSS (mg/l)	Turbidity (NTU)	BOD_5 (mg/l)	Chyl-a (µg/l)	T Coli. (#/100 ml)	F Coli. (#/100 ml)	Color (Pt-Co)
	2/7/06	7.46	17.31	687	6.8	230	320	1,100	1,420	65	100		1.8			850	460	50
	2/20/06	7.01	18.32	837	4.9		430	800	1,230		100		2.0			820	770	50
	4/11/06	7.56	21.11	1,024	3.3	60	73	790	863	140	220	29.0	3.1			620	540	50
	4/24/06	7.17	25.53	10,620	1.6	120	18	1,100	1,118	230	310		5.4			940	710	50
	5/23/06	7.18	24.99	20,918	1.3	46	20	1,500	1,520	220	350		5.0	2.5	42.0	710	630	60
275524908243037	7/11/06	7.19	27.02	1,063	2.4	98	100	1,000	1,100	100	190		1.3					50
	7/25/06						110	740	850	84	170		1.4					60
	8/14/06	7.22	32.24	3,050	1.5	190	150		1,350	180			4.3			2,500	520	60
	10/24/06					60	290	710	1,000	87	120		1.9					50
	11/13/06	7.13	20.10	1,900	3.1	51	180	650	830	66								50
	12/5/06	7.41	19.08	6,333	5.6													
Minimum Value:		**7.01**	**17.31**	**687**	**1.3**	**46**	**18**	**650**	**830**	**65**	**100**	**29.0**	**1.3**	**2.5**	**42.0**	**620**	**460**	**50**
Maximum Value:		**7.56**	**32.24**	**20,918**	**6.8**	**230**	**430**	**1,500**	**1,520**	**230**	**350**	**29.0**	**5.4**	**2.5**	**42.0**	**2,500**	**770**	**60**
Median Value:		**7.19**	**21.11**	**1,900**	**3.1**	**79**	**130**	**800**	**1,109**	**100**	**180**	**29.0**	**2.0**	**2.5**	**42.0**	**835**	**585**	**50**
Count:		**9**	**9**	**9**	**9**	**8**	**10**	**9**	**10**	**9**	**8**	**1**	**9**	**1**	**1**	**6**	**6**	**10**
	2/7/06	7.44	17.45	750	6.3	210	350	1,200	1,550	76	97		1.8			1,120	560	50
	2/20/06	7.14	18.24	1,075	5.4	69	420	840	1,260	64	93		2.1			1,330	1,260	50
	4/11/06	7.57	22.98	3,010	3.8	100	51	1,300	1,351	160	360		2.0			730	620	50
	4/24/06	7.02	27.21	26,920	1.3	100	11	1,100	1,111	230	310		5.1			810	460	50
	5/23/06	7.18	25.81	33,600	1.5	55			1,010	220			5.3	2.1				50
275531808242577	7/11/06	7.08	27.68	33,455	0.6	210	120	1,200	1,320		240		1.5					50
	7/25/06	7.32	28.17	1,326	3.6	110	95	750	845	68	210		2.1					50
	8/14/06	7.76	30.74	8,872	2.8	180	120	1,200	1,320	170	250		4.0				900	60
	10/24/06	7.40	20.30	3,527	9.3	100	270		1,150	110			2.0			3,800	2,700	50
	11/14/06	7.20	20.26	5,500	3.9								2.4			4,100	2,600	
	12/5/06	7.51	17.85	1,777	6.8													
Minimum Value:		**7.02**	**17.45**	**750**	**0.6**	**55**	**11**	**750**	**845**	**64**	**93**		**1.5**	**2.1**		**730**	**460**	**50**
Maximum Value:		**7.76**	**30.74**	**33,600**	**9.3**	**210**	**420**	**1,300**	**1,550**	**230**	**360**		**5.3**	**2.1**		**4,100**	**2,700**	**60**
Median Value:		**7.32**	**22.98**	**3,527**	**3.8**	**100**	**120**	**1,200**	**1,260**	**135**	**240**		**2.1**	**2.1**		**1,225**	**900**	**50**
Count:		**11**	**11**	**11**	**11**	**9**	**8**	**7**	**9**	**8**	**7**	**0**	**10**	**1**	**0**	**6**	**7**	**9**

A.3 Calculated Historical Mass Loadings of Total Nitrogen and Total Phosphorus Based on Pinellas County Monitoring Data

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l) Total N	Measured Conc. (mg/l) Total P	Mass Loading (kg/day) Total N	Mass Loading (kg/day) Total P
01	1/16/91					
	2/27/91					
	3/20/91					
	4/17/91			0.26		
	5/15/91			0.24		
	6/12/91			0.12		
	7/10/91			0.08		
	8/7/91			0.02		
	9/4/91			0.02		
	9/25/91			0.11		
	10/23/91			0.10		
	11/20/91			0.07		
	12/18/91			0.07		
	2/5/92		1.04	0.02		
	3/4/92		1.03	0.07		
	4/1/92		0.92	0.09		
	4/29/92		0.98	0.07		
	5/27/92		0.75	0.32		
	6/24/92		0.86	0.11		
	7/22/92		0.84	0.10		
	8/19/92		0.84	0.23		
	9/9/92		0.14	0.08		
	10/21/92		1.46	0.11		
	11/23/92		1.34	0.14		
	12/16/92		1.03	0.09		
	1/20/93		1.15	0.05		
	2/24/93		1.10	0.02		
	3/17/93		0.97	0.02		
	4/14/93		1.27	0.08		
	5/12/93		1.21	0.21		
	6/9/93		1.37	0.41		
	7/7/93		1.14	0.16		
	8/11/93		1.15	0.07		
	9/1/93		1.38	0.07		
	9/29/93		1.53	0.07		
	10/27/93		1.11	0.12		
	12/8/93		0.61	0.07		
	12/28/93		1.14	0.04		

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l) Total N	Measured Conc. (mg/l) Total P	Mass Loading (kg/day) Total N	Mass Loading (kg/day) Total P
01	1/26/94		1.25	0.02		
	2/23/94		1.30	0.02		
	3/23/94		1.02	0.17		
	4/20/94		1.14	0.35		
	5/25/94		1.04	0.23		
	6/15/94		1.35	0.51		
	7/13/94		1.36	0.31		
	8/10/94		1.13	0.05		
	8/31/94		1.16	0.06		
	9/28/94		0.98	0.08		
	11/1/94		1.34	0.06		
	12/14/94		1.23	0.04		
	1/22/03	1.16	1.15	0.01	0.44	0.004
	2/26/03	1.49	1.05	0.02	0.51	0.010
	4/1/03	0.46	0.95	0.01	0.14	0.002
	6/26/03	3.98	1.29	0.04	1.67	0.045
	8/6/03	7.20	1.15	0.03	2.70	0.071
	9/17/03	1.53	0.99	0.02	0.49	0.007
	10/22/03	2.67	1.17	0.04	1.02	0.035
	1/22/04	0.68	0.52	0.04	0.11	0.008
	2/25/04	24.50	0.36	0.03	2.84	0.200
	4/12/04	19.05	0.38	0.04	2.33	0.249
	5/18/04	1.20	0.42	0.09	0.16	0.033
	6/23/04	1.86	0.64	0.11	0.39	0.064
	8/4/04	10.50	0.59	0.05	2.02	0.154
	9/20/04	2.71	0.62	0.03	0.55	0.027
	11/2/04	1.06	0.51	0.04	0.17	0.012
	1/13/05	0.17	0.43	0.03	0.02	0.002
	3/1/05	1.28	0.44	0.04	0.18	0.015
	4/12/05	1.20	0.52	0.07	0.20	0.025
	6/29/05	3.65	0.33	0.05	0.39	0.054
	9/22/05	2.44	0.47	0.06	0.37	0.048
	2/23/06	1.04	0.53	0.04	0.18	0.012
	7/18/06	5.45	0.55	0.07	0.98	0.125
	9/11/06	2.31	0.56	0.05	0.42	0.034
	2/20/07	0.71	0.33	0.02	0.08	0.005
	5/22/07	1.06	0.35	0.10	0.12	0.033
	8/29/07	2.04	0.37	0.10	0.25	0.063

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
01	9/19/07	3.48	0.22	0.03	0.25	0.034
	3/18/08	0.92	0.77	0.12	0.23	0.036
	6/25/08	1.78	0.68	0.13	0.39	0.075
	8/5/08	3.49	0.85	0.10	0.97	0.114
	9/23/08	6.23	0.89	0.13	1.81	0.264
	7/30/09	3.95	1.01	0.09	1.30	0.116
	9/22/09	7.10	1.15	0.08	2.67	0.186
	10/22/09	1.92	1.33	0.07	0.83	0.044
	12/8/09	1.23	1.27	0.06	0.51	0.024
	2/3/10	1.73	0.83	0.02	0.47	0.011
	3/16/10	0.58	0.83	0.05	0.16	0.009
	5/6/10	2.28	0.52	0.02	0.38	0.015
Geometric Mean:		**2.10**	**0.81**	**0.06**	**0.44**	**0.030**
05	1/18/95		1.55	0.02		
	2/15/95		1.53	0.02		
	3/15/95		1.41	0.02		
	4/12/95		1.05	0.04		
	5/10/95		1.16	0.07		
	6/7/95		1.06	0.09		
	7/5/95		0.74	0.06		
	8/9/95		2.55	0.02		
	9/6/95		1.23	0.05		
	9/27/95		1.42	0.06		
	10/25/95		1.40	0.02		
	11/29/95		0.90	0.06		
	1/17/96		0.99	0.05		
	2/14/96		0.89	0.02		
	3/13/96		0.84	0.01		
	4/10/96		0.89	0.06		
	5/8/96		0.81	0.04		
	5/29/96		0.86	0.10		
	7/10/96		0.71	0.03		
	7/31/96		0.53	0.03		
	8/27/96		0.31	0.03		
	9/18/96		1.42	0.13		
	10/23/96		0.94	0.01		
	11/20/96		0.31	0.02		

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
05	1/22/97		0.64	0.01		
	2/26/97		0.71	0.02		
	3/19/97		0.86	0.03		
	4/23/97		0.66	0.03		
	5/14/97		0.48	0.02		
	6/4/97		0.79	0.02		
	7/2/97		0.98	0.02		
	7/30/97		0.82	0.02		
	9/3/97		1.11	0.03		
	9/24/97		2.00	0.03		
	10/15/97		1.97	0.02		
	11/12/97		1.24	0.03		
	12/17/97		1.59	0.02		
	1/28/98		1.23	0.02		
	2/25/98		1.11	0.02		
	3/25/98		0.98	0.03		
	4/21/98		1.03	0.02		
	5/20/98		0.69	0.02		
	6/17/98		0.73	0.04		
	7/15/98		0.78	0.03		
	8/12/98		0.76	0.04		
	9/9/98		0.99	0.03		
	10/7/98		1.04	0.01		
	11/4/98		0.95	0.02		
	12/9/98		0.76	0.02		
	1/20/99		0.80	0.01		
	2/18/99		0.56	0.01		
	3/23/99		0.55	0.02		
	4/14/99		0.47	0.04		
	5/12/99		0.53	0.04		
	6/9/99		0.60	0.03		
	7/7/99		0.87	0.04		
	8/4/99		0.48	0.03		
	9/8/99		0.99	0.01		
	9/29/99		0.75	0.03		
	10/27/99		0.96	0.01		
	11/30/99		0.90	0.01		
	12/14/99		0.67	0.01		

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
05	1/19/00		0.53	0.02		
	2/16/00		0.60	0.01		
	3/15/00		0.81	0.02		
	4/11/00		0.74	0.03		
	5/10/00		0.77	0.03		
	7/5/00		1.22			
	8/8/00		0.92	0.01		
	8/30/00		1.56	0.09		
	10/25/00		0.65	0.01		
	11/21/00		0.77	0.02		
	1/17/01		0.91	0.01		
	2/15/01		0.81	0.03		
	3/12/01		0.81	0.01		
	4/11/01		0.78	0.01		
	5/10/01		0.69	0.01		
	6/6/01		0.79	0.02		
	6/26/01		0.71	0.01		
	8/1/01		0.77	0.09		
	8/29/01		0.98	0.04		
	9/24/01		1.50	0.02		
	10/31/01		1.01	0.01		
	11/19/01		0.73	0.01		
	1/16/02		0.91	0.02		
	2/13/02		0.75	0.01		
	3/13/02		0.73	0.02		
	4/9/02		0.92	0.03		
	5/8/02		0.79	0.02		
	6/5/02		0.82	0.03		
	7/17/02		1.38	0.04		
	7/23/02		1.06	0.02		
	9/24/02		1.23	0.01		
	10/23/02		1.05	0.04		
	11/19/02		0.95	0.01		
	12/11/02		1.23	0.02		
	1/22/03	0.81	1.34	0.01	0.35	0.003
	2/26/03	1.22	1.02	0.02	0.41	0.006
	4/1/03	1.06	1.27	0.01	0.44	0.003
	5/13/03	0.60	0.62	0.01	0.12	0.002

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
05	6/26/03	2.90	1.28	0.04	1.21	0.033
	8/6/03	4.39	1.18	0.03	1.69	0.036
	9/17/03	0.85	1.11	0.02	0.31	0.006
	10/22/03	0.87	1.21	0.03	0.34	0.007
	12/4/03	0.28	0.44	0.02	0.04	0.001
	1/22/04	0.83	0.53	0.03	0.14	0.007
	2/25/04	15.65	0.40	0.03	2.02	0.128
	4/12/04	18.55	0.39	0.04	2.36	0.212
	5/18/04	0.44	0.37	0.06	0.05	0.008
	6/23/04	0.18	0.53	0.04	0.03	0.002
	8/4/04	9.30	0.54	0.05	1.62	0.152
	9/20/04	1.12	0.49	0.02	0.18	0.007
	11/2/04	0.25	0.33	0.02	0.03	0.002
	12/8/04	0.33	0.33	0.02	0.03	0.002
	1/13/05	0.47	0.33	0.01	0.05	0.002
	3/1/05	1.13	0.44	0.03	0.16	0.011
	4/12/05	0.04	0.39	0.03	0.01	0.000
	5/26/05	0.36	0.44	0.04	0.05	0.004
	6/29/05	3.36	0.33	0.05	0.36	0.049
	8/16/05	1.08	0.54	0.05	0.19	0.016
	9/22/05	0.99	0.49	0.05	0.16	0.016
	11/1/05	0.45	0.43	0.03	0.06	0.004
	11/15/05	0.42	0.46	0.04	0.06	0.005
	1/24/06	0.28	0.45	0.03	0.04	0.002
	2/23/06	0.78	0.56	0.03	0.14	0.008
	4/6/06	0.58	0.43	0.03	0.08	0.005
	5/25/06	0.27	0.41	0.04	0.04	0.003
	7/18/06	1.25	0.49	0.06	0.20	0.024
	8/10/06	1.06	0.65	0.07	0.23	0.024
	9/11/06	3.12	0.50	0.05	0.50	0.051
	10/18/06	1.04	0.56	0.04	0.19	0.012
	11/27/06	1.05	0.43	0.02	0.15	0.007
	1/17/07	0.10	0.40	0.03	0.01	0.001
	2/20/07	0.54	0.33	0.01	0.06	0.002
	3/27/07	0.16	0.52	0.03	0.03	0.002
	6/18/07	0.48	0.25	0.07	0.04	0.010
	8/29/07	1.66	0.38	0.08	0.20	0.043
	9/19/07	0.60	0.39	0.06	0.08	0.011

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
05	11/7/07	0.50	0.90	0.05	0.15	0.008
	1/30/08	0.55	0.77	0.05	0.14	0.009
	3/18/08	1.22	0.78	0.10	0.31	0.040
	5/22/08	0.33	0.86	0.14	0.09	0.015
	6/25/08	0.63	0.70	0.12	0.14	0.024
	8/5/08	1.25	0.88	0.10	0.36	0.041
	9/23/08	0.79	0.80	0.06	0.21	0.015
Geometric Mean:		**0.78**	**0.75**	**0.02**	**0.14**	**0.008**
07	1/22/03	0.67	0.98	0.01	0.21	0.002
	2/26/03	0.99	0.95	0.04	0.31	0.013
	4/1/03	0.47	1.49	0.01	0.23	0.002
	8/6/03	1.82	0.78	0.10	0.46	0.059
	10/22/03	0.04	0.94	0.10	0.01	0.001
	12/4/03	0.19	0.74	0.02	0.05	0.001
	1/22/04	0.02	0.51	0.05	0.00	0.000
	2/25/04	23.30	0.47	0.03	3.54	0.228
	4/12/04	9.25	0.53	0.05	1.59	0.151
	5/18/04	0.58	0.58	0.09	0.11	0.017
	8/4/04	6.10	0.60	0.05	1.20	0.100
	9/20/04	1.12	0.57	0.04	0.21	0.013
	11/2/04	0.61	0.34	0.03	0.07	0.006
	12/8/04	0.27	0.35	0.03	0.03	0.003
	1/13/05	0.25	0.38	0.04	0.03	0.003
	3/1/05	0.02	0.56	0.04	0.00	0.000
	4/12/05	0.70	0.45	0.05	0.10	0.010
	6/29/05	5.15	0.30	0.05	0.50	0.084
	8/16/05	0.81	0.52	0.07	0.14	0.019
	9/22/05	0.56	0.56	0.11	0.10	0.019
	11/1/05	0.39	0.37	0.02	0.05	0.002
	11/15/05	0.37	0.48	0.06	0.06	0.007
	1/24/06	0.55	0.56	0.05	0.10	0.009
	2/23/06	0.46	0.54	0.06	0.08	0.008
	4/6/06	0.43	0.41	0.05	0.06	0.006
	5/25/06	0.21	0.49	0.05	0.03	0.003
	7/18/06	1.95	0.56	0.06	0.35	0.035
	8/10/06	0.70	0.59	0.07	0.13	0.015
	9/11/06	1.50	0.51	0.06	0.25	0.029

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l) Total N	Measured Conc. (mg/l) Total P	Mass Loading (kg/day) Total N	Mass Loading (kg/day) Total P
07	10/18/06	0.35	0.73	0.05	0.08	0.005
	1/17/07	0.42	0.43	0.05	0.06	0.007
	2/20/07	0.36	0.38	0.02	0.04	0.002
	8/29/07	2.62	0.44	0.08	0.38	0.068
	9/19/07	0.54	0.40	0.06	0.07	0.011
	11/7/07	0.13	0.78	0.02	0.03	0.001
	1/30/08	0.60	1.70	0.07	0.33	0.014
	6/25/08	0.40	0.73	0.15	0.10	0.020
Geometric Mean:		**0.57**	**0.56**	**0.04**	**0.10**	**0.008**
08	1/22/03	0.23	1.09	0.01	0.08	0.001
	2/26/03	0.05	1.00	0.01	0.02	0.000
	4/1/03	0.47	0.69	0.01	0.10	0.002
	5/13/03	0.10	0.71	0.01	0.02	0.000
	6/26/03	0.45	1.20	0.03	0.18	0.004
	8/6/03	0.57	1.15	0.02	0.21	0.004
	9/17/03	0.02	0.77	0.01	0.00	0.000
	10/22/03	0.44	0.88	0.04	0.13	0.005
	12/4/03	0.13	0.31	0.01	0.01	0.000
	1/22/04	0.16	0.43	0.02	0.02	0.001
	2/25/04	2.69	0.32	0.02	0.28	0.013
	4/12/04	3.90	0.30	0.02	0.38	0.019
	5/18/04	0.02	0.42	0.02	0.00	0.000
	6/23/04	0.01	0.50	0.01	0.00	0.000
	8/4/04	1.87	0.44	0.03	0.27	0.018
	9/20/04	0.24	0.38	0.02	0.03	0.001
	11/2/04	0.13	0.31	0.03	0.01	0.001
	12/8/04	0.13	0.28	0.03	0.01	0.001
	1/13/05	0.02	0.33	0.02	0.00	0.000
	3/1/05	0.20	0.27	0.02	0.02	0.001
	4/12/05	0.15	0.37	0.03	0.02	0.001
	5/26/05	0.03	0.39	0.05	0.00	0.000
	6/29/05	0.36	0.32	0.02	0.04	0.002
	8/16/05	0.04	0.40	0.02	0.01	0.000
	9/22/05	0.09	0.40	0.06	0.01	0.002
	11/1/05	0.04	0.49	0.05	0.01	0.001
	11/15/05	0.03	0.36	0.01	0.00	0.000
	1/24/06	0.03	0.33	0.02	0.00	0.000

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l) Total N	Measured Conc. (mg/l) Total P	Mass Loading (kg/day) Total N	Mass Loading (kg/day) Total P
08	2/23/06	0.06	0.36	0.03	0.01	0.000
	4/6/06	0.05	0.32	0.02	0.00	0.000
	5/25/06	0.08	0.39	0.03	0.01	0.001
	7/18/06	0.29	0.42	0.02	0.04	0.001
	8/10/06	0.04	0.44	0.04	0.01	0.000
	9/11/06	0.35	0.55	0.04	0.06	0.004
	10/18/06	0.08	0.46	0.07	0.01	0.002
	11/27/06	0.02	0.31	0.02	0.00	0.000
	1/17/07	0.19	0.30	0.04	0.02	0.002
	2/20/07	0.03	0.35	0.01	0.00	0.000
	3/27/07	0.02	0.55	0.02	0.00	0.000
	5/22/07	0.01	0.44	0.01	0.00	0.000
	8/29/07	0.06	0.29	0.03	0.01	0.001
	9/19/07	0.02	0.23	0.02	0.00	0.000
	11/7/07	0.04	0.68	0.02	0.01	0.000
	12/6/07	0.02	0.60	0.01	0.00	0.000
	1/30/08	0.02	0.55	0.02	0.00	0.000
	3/18/08	0.02	0.61	0.02	0.00	0.000
	6/25/08	0.12	0.56	0.06	0.02	0.002
	9/23/08	0.08	0.82	0.01	0.02	0.000
Geometric Mean:		**0.08**	**0.46**	**0.02**	**0.01**	**0.001**
12	10/28/08	0.55	0.74	0.08	0.13	0.014
	12/2/08	0.48	1.18	0.06	0.18	0.009
	2/10/09	0.60	0.62	0.05	0.12	0.010
	3/18/09	0.43	0.87	0.09	0.12	0.012
	6/16/09	0.33	0.77	0.13	0.08	0.014
	7/30/09	0.50	1.19	0.19	0.19	0.031
	9/22/09	8.00	1.19	0.08	3.11	0.209
	10/22/09		1.58	0.02		
	12/8/09		1.32	0.05		
	2/3/10		0.91	0.02		
	5/6/10	1.05	0.99	0.05	0.34	0.017
Geometric Mean:		**0.74**	**1.00**	**0.06**	**0.22**	**0.020**

Historical Calculated Mass Loadings of Total N and Total P in Long Branch Creek Based on the Pinellas County Data

Site	Date	Flow (cfs)	Measured Conc. (mg/l)		Mass Loading (kg/day)	
			Total N	Total P	Total N	Total P
14	10/28/08	0.02	1.27	0.07	0.01	0.000
	12/2/08	0.00	0.82	0.05	0.00	0.000
	2/10/09	0.02	1.29	0.06	0.01	0.000
	6/16/09	0.02	0.94	0.11	0.01	0.001
	7/30/09	0.12	1.23	0.09	0.05	0.004
	9/22/09	0.54	1.26	0.07	0.22	0.012
	10/22/09	0.02	1.07	0.07	0.01	0.000
	12/8/09	0.01	1.03	0.06	0.00	0.000
	2/3/10	0.11	0.90	0.05	0.03	0.002
	3/16/10	0.03	0.89	0.05	0.01	0.000
	5/6/10	0.11	1.60	0.24	0.05	0.008
Geometric Mean:		**0.03**	**1.10**	**0.07**	**0.01**	**0.001**
15	10/28/08	0.20	1.12	0.08	0.07	0.005
	12/2/08	0.36	0.70	0.06	0.08	0.007
	7/30/09	0.27	1.51	0.17	0.13	0.015
	2/3/10	0.41	1.39	0.05	0.18	0.007
	3/16/10	0.07	1.01	0.05	0.02	0.001
	5/6/10	0.27	0.93	0.12	0.08	0.010
Geometric Mean:		**0.23**	**1.08**	**0.08**	**0.08**	**0.006**

APPENDIX B

FIELD MEASUREMENTS COLLECTED IN THE LONG BRANCH CREEK WATERSHED FROM OCTOBER 2010 - JANUARY 2011

Field Measurements Collected in Long Branch Creek from October 2010- January 2011

Site	Date	Time	Depth (m)	Temp (° C)	pH (s.u.)	Conductivity (µmho/cm)	DO (mg/l)	% Sat (%)	ORP (mV)
Site 1	10/19/10	10:55	1.07	27.36	7.46	775	6.1	77	433
Site 1	11/1/10	8:15	1.14	23.76	7.42	633	5.7	67	401
Site 1	11/16/10	8:43	0.25	21.84	7.39	488	7.3	84	440
Site 1	12/7/10	10:07	0.49	15.22	7.35	695	5.0	50	498
Site 1	1/18/11	10:13	0.07	16.21	7.54	344	8.3	84	475
Minimum Value:			**0.07**	**15.22**	**7.35**	**344**	**5.0**	**50**	**401**
Maximum Value:			**1.14**	**27.36**	**7.54**	**775**	**8.3**	**84**	**498**
Log Normal Mean Value:			**0.40**	**20.36**	**7.43**	**564**	**6.4**	**71**	**448**
Site 2	10/19/10	11:50	1.44	23.39	7.32	835	2.7	32	334
Site 2	11/1/10	8:57	1.33	21.82	7.30	784	1.3	15	274
Site 2	11/16/10	10:08	0.29	19.85	7.11	714	1.9	21	319
Site 2	12/7/10	10:15	0.45	15.87	7.22	729	3.4	42	412
Site 2	1/18/11	11:15	0.15	16.59	7.23	364	5.4	55	471
Minimum Value:			**0.15**	**15.87**	**7.11**	**364**	**1.3**	**15**	**274**
Maximum Value:			**1.44**	**23.39**	**7.32**	**835**	**5.4**	**55**	**471**
Log Normal Mean Value:			**0.52**	**19.28**	**7.24**	**659**	**2.6**	**30**	**355**
Site 3	10/19/10	11:25	0.56	25.81	8.41	407	7.9	97	325
Site 3	11/1/10	9:29	0.45	24.86	8.31	402	6.0	73	294
Site 3	11/16/10	9:12	0.34	20.87	7.89	397	7.0	78	438
Site 3	12/7/10	10:28	0.61	16.06	8.02	383	6.4	65	462
Site 3	1/18/11	10:39	0.21	16.13	7.92	366	8.4	85	454
Minimum Value:			**0.21**	**16.06**	**7.89**	**366**	**6.0**	**65**	**294**
Maximum Value:			**0.61**	**25.81**	**8.41**	**407**	**8.4**	**97**	**462**
Log Normal Mean Value:			**0.41**	**20.33**	**8.11**	**391**	**7.1**	**79**	**388**
Site 4	10/19/10	12:35	0.88	24.89	7.12	884	7.1	86	308
Site 4	11/1/10	8:38	2.30	21.42	7.00	931	2.1	24	312
Site 4	11/16/10	9:37	0.38	19.08	6.88	841	2.4	26	290
Site 4	12/7/10	10:45	0.35	12.45	7.09	752	3.4	32	491
Site 4	1/18/11	10:51	0.11	17.88	7.04	676	3.9	41	480
Minimum Value:			**0.11**	**12.45**	**6.88**	**676**	**2.1**	**23.8**	**290**
Maximum Value:			**2.30**	**24.89**	**7.12**	**931**	**7.1**	**86.0**	**491**
Log Normal Mean Value:			**0.49**	**18.66**	**7.03**	**811**	**3.4**	**36.8**	**366**
Site 5	10/19/10	12:15	0.94	22.04	7.42	591	4.0	46	355
Site 5	11/1/10	9:51	0.71	22.23	7.38	636	1.7	20	338
Site 5	11/16/10	10:28	0.36	18.54	7.11	537	2.2	24	344
Site 5	12/7/10	11:14	0.32	10.55	7.32	517	3.3	29	444
Site 5	1/18/11	11:28	0.20	16.80	7.86	333	7.7	80	451
Minimum Value:			**0.20**	**10.55**	**7.11**	**333**	**1.7**	**20**	**338**
Maximum Value:			**0.94**	**22.23**	**7.86**	**636**	**7.7**	**80**	**451**
Log Normal Mean Value:			**0.43**	**17.43**	**7.41**	**511**	**3.3**	**35**	**383**

Field Measurements Collected in Long Branch Creek from October 2010- January 2011

Site	Date	Time	Depth (m)	Temp (° C)	pH (s.u.)	Conductivity (µmho/cm)	DO (mg/l)	% Sat (%)	ORP (mV)
Site 6	10/19/10	13:00	0.89	24.66	7.36	798	3.8	46	398
Site 6	11/1/10	10:22	0.81	22.25	7.35	725	2.1	21	345
Site 6	11/16/10	11:21	0.71	20.45	7.20	761	3.1	35	382
Site 6	12/7/10	11:35	0.48	10.11	7.39	669	4.5	40	458
Site 6	1/18/11	11:50	0.36	17.18	7.24	311	5.4	56	475
Minimum Value:			**0.36**	**10.11**	**7.20**	**333**	**2.1**	**21**	**345**
Maximum Value:			**0.89**	**24.66**	**7.39**	**636**	**5.4**	**56**	**475**
Log Normal Mean Value:			**0.62**	**18.11**	**7.31**	**620**	**3.6**	**38**	**409**
Site 7	10/19/10	13:35	0.65	26.42	7.71	870	4.7	58	346
Site 7	11/1/10	10:31	0.57	21.71	7.63	989	5.3	60	327
Site 7	11/16/10	11:02	0.53	20.71	7.42	887	4.3	48	363
Site 7	12/7/10	12:36	0.56	12.34	7.44	955	5.9	56	460
Site 7	1/18/11	12:56	0.24	17.80	7.40	394	6.9	72	464
Minimum Value:			**0.24**	**12.34**	**7.40**	**394**	**4.3**	**48**	**327**
Maximum Value:			**0.65**	**26.42**	**7.71**	**989**	**6.9**	**72**	**464**
Log Normal Mean Value:			**0.48**	**19.20**	**7.52**	**779**	**5.3**	**58**	**388**
Site 8	10/19/10	14:20	0.79	27.97	7.33	921	3.7	47	288
Site 8	11/1/10	11:46	0.62	25.03	7.22	1,029	2.7	33	217
Site 8	11/16/10	12:00	0.45	22.06	7.75	698	8.3	95	385
Site 8	12/7/10	12:21	0.32	12.95	7.33	971	6.6	63	473
Site 8	1/18/11	12:38	0.29	18.21	7.36	389	6.7	71	466
Minimum Value:			**0.29**	**12.95**	**7.22**	**389**	**2.7**	**33**	**217**
Maximum Value:			**0.79**	**27.97**	**7.75**	**1,029**	**8.3**	**95**	**473**
Log Normal Mean Value:			**0.46**	**20.52**	**7.40**	**758**	**5.2**	**58**	**351**
Site 9	10/19/10	13:55	0.81	27.01	7.69	731	9.2	115	377
Site 9	11/1/10	11:24	0.69	24.83	7.76	734	6.6	80	336
Site 9	11/16/10	12:27	0.48	24.02	7.19	922	4.1	48	415
Site 9	12/7/10	12:01	0.80	10.70	7.90	681	8.5	77	445
Site 9	1/18/11	12:20	0.67	17.98	7.32	307	6.2	65	470
Minimum Value:			**0.48**	**10.70**	**7.19**	**307**	**4.1**	**48**	**336**
Maximum Value:			**0.81**	**27.01**	**7.90**	**922**	**9.2**	**115**	**470**
Log Normal Mean Value:			**0.68**	**19.87**	**7.57**	**635**	**6.6**	**74**	**406**
Site 10	10/19/10	14:40	0.94	25.92	7.47	1,145	5.8	71	387
Site 10	11/1/10	12:37	0.75	24.41	7.35	1,191	3.7	45	323
Site 10	11/16/10	13:02	0.45	23.63	7.29	1,237	4.6	54	399
Site 10	12/7/10	12:55	0.39	12.66	7.38	1,237	5.2	49	463
Site 10	1/18/11	13:14	0.28	18.88	7.19	518	4.7	51	471
Minimum Value:			**0.28**	**12.66**	**7.19**	**518**	**3.7**	**45**	**323**
Maximum Value:			**0.94**	**25.92**	**7.47**	**1,237**	**5.8**	**71**	**471**
Log Normal Mean Value:			**0.51**	**20.45**	**7.34**	**1,016**	**4.7**	**53**	**405**

Field Measurements Collected in Long Branch Creek from
October 2010- January 2011

Site	Date	Time	Depth (m)	Temp (° C)	pH (s.u.)	Conductivity (µmho/cm)	DO (mg/l)	% Sat (%)	ORP (mV)
Site 11	10/19/10	14:05	1.25	25.71	7.26	906	3.2	39	301
Site 11	11/1/10	12:11	1.15	23.81	7.15	939	2.3	28	277
Site 11	11/16/10	13:16	0.37	22.78	7.14	915	4.9	57	407
Site 11	12/7/10	13:12	0.52	14.88	7.25	973	5.5	54	469
Site 11	1/18/11	13:36	0.34	18.99	7.25	377	5.8	63	470
Minimum Value:			**0.34**	**14.88**	**7.14**	**377**	**2.3**	**28**	**277**
Maximum Value:			**1.25**	**25.71**	**7.26**	**973**	**5.8**	**63**	**470**
Log Normal Mean Value:			**0.62**	**20.85**	**7.21**	**778**	**4.1**	**46**	**376**
Site 12	10/19/10	15:50	1.03	24.38	7.45	875	5.4	65	412
Site 12	11/1/10	13:17	0.77	24.48	7.37	928	5.3	63	399
Site 12	11/16/10	14:31	0.54	22.51	7.33	888	5.6	65	408
Site 12	12/7/10	13:59	0.43	13.04	7.42	742	5.4	52	460
Site 12	1/18/11	14:51	0.51	20.46	7.27	363	6.3	70	474
Minimum Value:			**0.43**	**13.04**	**7.27**	**363**	**5.3**	**52**	**399**
Maximum Value:			**1.03**	**24.48**	**7.45**	**928**	**6.3**	**70**	**474**
Log Normal Mean Value:			**0.62**	**20.46**	**7.37**	**721**	**5.6**	**63**	**430**
Site 13	10/19/10	16:20	0.94	25.09	7.63	595	5.5	67	389
Site 13	11/1/10	13:30	0.74	25.44	7.58	609	5.1	63	339
Site 13	11/16/10	13:41	0.50	23.41	7.52	604	5.7	67	400
Site 13	12/7/10	13:33	0.34	12.67	7.55	562	6.6	62	464
Site 13	1/18/11	13:57	0.20	19.97	7.24	416	5.9	65	456
Minimum Value:			**0.20**	**12.67**	**7.24**	**416**	**5.1**	**62**	**339**
Maximum Value:			**0.94**	**25.44**	**7.63**	**609**	**6.6**	**67**	**464**
Log Normal Mean Value:			**0.47**	**20.68**	**7.50**	**552**	**5.7**	**65**	**407**
Site 14	10/19/10	15:30	1.77	24.83	7.66	876	5.5	66	399
Site 14	11/1/10	13:51	1.64	24.81	7.52	927	4.5	55	354
Site 14	11/16/10	14:00	0.54	22.11	7.33	907	4.9	56	413
Site 14	12/7/10	13:44	0.56	11.90	7.51	911	6.0	56	458
Site 14	1/18/11	14:23	0.53	19.95	7.28	371	6.3	69	477
Minimum Value:			**0.53**	**11.90**	**7.28**	**371**	**4.5**	**55**	**354**
Maximum Value:			**1.77**	**24.83**	**7.66**	**927**	**6.3**	**69**	**477**
Log Normal Mean Value:			**0.86**	**20.04**	**7.46**	**757**	**5.4**	**60**	**418**
Site 15	10/19/10	17:05	2.33	22.52	7.85	3,157	6.3	73	369
Site 15	11/1/10	14:32	2.13	23.09	7.72	2,953	4.8	57	347
Site 15	11/16/10	15:17	0.78	21.43	7.42	5,532	5.3	61	317
Site 15	1/18/11	15:41	0.32	19.06	7.41	740	7.4	80	469
Minimum Value:			**0.32**	**19.06**	**7.41**	**740**	**4.8**	**57**	**317**
Maximum Value:			**2.33**	**23.09**	**7.85**	**5,532**	**7.4**	**80**	**469**
Log Normal Mean Value:			**1.05**	**21.47**	**7.60**	**2,485**	**5.9**	**67**	**371**

Field Measurements Collected in Long Branch Creek from October 2010- January 2011

Site	Date	Time	Depth (m)	Temp (° C)	pH (s.u.)	Conductivity (µmho/cm)	DO (mg/l)	% Sat (%)	ORP (mV)
Site 16	10/19/10	17:15	0.68	23.10	7.73	5,489	4.1	48	382
Site 16	11/1/10	14:10	0.51	23.82	7.66	3,360	3.8	45	362
Site 16	11/16/10	15:22	0.42	20.96	7.50	6,131	5.0	57	329
Site 16	12/7/10	14:28	0.49	12.13	7.57	2,183	5.7	53	451
Site 16	1/18/11	15:43	0.25	18.09	7.29	387	6.3	67	456
Minimum Value:			**0.25**	**12.13**	**7.29**	**387**	**3.8**	**45**	**329**
Maximum Value:			**0.68**	**23.82**	**7.73**	**6,131**	**6.3**	**67**	**456**
Log Normal Mean Value:			**0.45**	**19.08**	**7.55**	**2,489**	**4.9**	**53**	**393**
Site 17-Pond	10/19/10	17:50	0.79	28.30	8.74	770	11.7	150	368
Site 17-Pond	11/1/10	14:55	0.61	28.77	8.65	723	9.1	119	339
Site 17-Pond	11/16/10	15:50	0.21	23.85	8.48	853	9.9	117	368
Site 17-Pond	12/7/10	14:53	0.31	17.22	8.43	612	7.1	74	416
Site 17-Pond	1/18/11	16:05	0.07	20.55	8.11	539	9.1	102	425
Minimum Value:			**0.07**	**17.22**	**8.11**	**539**	**7.1**	**74**	**339**
Maximum Value:			**0.79**	**28.77**	**8.74**	**853**	**11.7**	**150**	**425**
Log Normal Mean Value:			**0.29**	**23.30**	**8.48**	**690**	**9.3**	**109**	**382**
Site 18	11/16/10	14:46	0.77	24.16	7.73	789	10.8	129	409
Site 18	12/7/10	14:08	0.34	14.29	7.59	743	7.5	73	461
Site 18	1/18/11	15:05	0.13	21.19	7.10	334	5.9	66	481
Minimum Value:			**0.13**	**14.29**	**7.10**	**334**	**5.9**	**66**	**409**
Maximum Value:			**0.77**	**24.16**	**7.73**	**789**	**10.8**	**129**	**481**
Log Normal Mean Value:			**0.32**	**19.41**	**7.47**	**581**	**7.8**	**85**	**449**

APPENDIX C

CHARACTERISTICS OF SURFACE WATER SAMPLES COLLECTED IN THE LONG BRANCH CREEK WATERSHED FROM OCTOBER 2010 - JANUARY 2011

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 1	10/19/10	274	504	727	64	292	1,587	19	7	56	82	53.2	19.5	510	43
Site 1	11/1/10	154	116	166	879	210	1,371	16	46	16	78	10.8	6.8	400	50
Site 1	11/16/10	116	143	192	423	420	1,178	50	11	23	84	3.7	3.9	330	37
Site 1	12/7/10	187	43	491	312	229	1,075	30	5	13	48	5.9	3.0	310	45
Site 1	1/18/11	80.2	204	54	83	1,236	1,577	12	23	66	101	4.7	7.3	664	33
Minimum Value:		**80.2**	**43**	**54**	**64**	**210**	**1,075**	**12**	**5**	**13**	**48**	**3.7**	**3.0**	**310**	**33**
Maximum Value:		**274**	**504**	**727**	**879**	**1,236**	**1,587**	**50**	**46**	**66**	**101**	**53.2**	**19.5**	**664**	**50**
Log Normal Mean Value:		**149**	**149**	**228**	**228**	**374**	**1,342**	**22**	**13**	**28**	**76**	**9.0**	**6.5**	**425**	**41**
Site 2	10/19/10	286	164	19	565	613	1,361	63	111	95	269	7.6	8.0	606	81
Site 2	11/1/10	226	348	160	716	92	1,316	160	57	76	293	1.5	4.0	250	100
Site 2	11/16/10	200	470	33	1,017	260	1,780	137	20	34	191	1.8	5.8	540	74
Site 2	12/7/10	231	120	21	852	96	1,089	43	3	18	64	5.3	8.2	440	54
Site 2	1/18/11	92.6	121	89	1,320	66	1,596	8	15	77	100	4.4	6.2	3,800	42
Minimum Value:		**92.6**	**120**	**19**	**565**	**66**	**1,089**	**8**	**3**	**18**	**64**	**1.5**	**4.0**	**250**	**42**
Maximum Value:		**286**	**470**	**160**	**1,320**	**613**	**1,780**	**160**	**111**	**95**	**293**	**7.6**	**8.2**	**3,800**	**100**
Log Normal Mean Value:		**194**	**208**	**45**	**857**	**156**	**1,408**	**54**	**22**	**51**	**157**	**3.4**	**6.2**	**672**	**67**
Site 3	10/19/10	109	30	3	242	1,170	1,445	1	1	79	81	6.1	9.9	743	31
Site 3	11/1/10	139	43	3	567	911	1,524	1	15	15	31	4.3	12.8	480	43
Site 3	11/16/10	139	36	3	585	637	1,261	1	4	40	45	5.4	6.7	782	39
Site 3	12/7/10	150	40	14	208	453	715	3	1	30	34	5.6	12.0	736	33
Site 3	1/18/11	139	517	30	1,154	481	2,182	3	5	81	89	5.6	9.9	2,700	25
Minimum Value:		**109**	**30**	**3**	**208**	**453**	**715**	**1**	**1**	**15**	**31**	**4.3**	**6.7**	**480**	**25**
Maximum Value:		**150**	**517**	**30**	**1,154**	**1,170**	**2,182**	**3**	**15**	**81**	**89**	**6.1**	**12.8**	**2,700**	**43**
Log Normal Mean Value:		**134**	**63**	**6**	**454**	**682**	**1,341**	**2**	**3**	**41**	**51**	**5.4**	**10.0**	**889**	**34**

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 4	10/19/10	252	75	10	577	107	769	33	30	154	217	2.9	3.7	440	62
Site 4	11/1/10	248	118	49	701	100	968	132	42	101	275	2.8	3.5	3,900	70
Site 4	11/16/10	249	97	19	588	228	932	230	47	172	449	5.2	6.3	1,018	71
Site 4	12/7/10	255	75	14	467	52	608	37	8	28	73	2.3	3.2	360	48
Site 4	1/18/11	168	94	552	345	1,241	2,232	50	35	39	124	1.8	2.1	560	38
Minimum Value:		**168.0**	**75**	**10**	**345**	**52**	**608**	**33**	**8**	**28**	**73**	**1.8**	**2.1**	**360**	**38**
Maximum Value:		**255**	**118**	**552**	**701**	**1,241**	**2,232**	**230**	**47**	**172**	**449**	**5.2**	**6.3**	**3,900**	**71**
Log Normal Mean Value:		**232**	**90**	**37**	**521**	**174**	**988**	**71**	**28**	**78**	**189**	**2.8**	**3.5**	**812**	**56**
Site 5	10/19/10	180	1,096	49	198	675	2,018	184	45	61	290	4.5	8.7	614	50
Site 5	11/1/10	201	1,827	54	1,292	164	3,337	291	147	74	512	1.7	4.9	530	66
Site 5	11/16/10	156	246	7	853	644	1,750	146	30	92	268	4.3	10.2	809	54
Site 5	12/7/10	178	285	50	267	125	727	70	16	16	102	1.1	1.9	27	50
Site 5	1/18/11	93.8	225	92	1,495	380	2,192	39	49	109	197	7.7	14.8	2,100	39
Minimum Value:		**93.8**	**225**	**7**	**198**	**125**	**727**	**39**	**16**	**16**	**102**	**1.1**	**1.9**	**27**	**39**
Maximum Value:		**201**	**1827**	**92**	**1,495**	**675**	**3,337**	**291**	**147**	**109**	**512**	**7.7**	**14.8**	**2,100**	**66**
Log Normal Mean Value:		**157**	**501**	**39**	**614**	**321**	**1,798**	**116**	**43**	**59**	**240**	**3.1**	**6.6**	**431**	**51**
Site 6	10/19/10	290	65	3	827	58	953	41	19	53	113	1.5	4.3	500	83
Site 6	11/1/10	253	101	22	961	30	1,114	139	21	51	211	2.7	22.9	410	97
Site 6	11/16/10	192	101	10	642	192	945	130	15	44	189	0.8	1.0	530	71
Site 6	12/7/10	229	47	9	346	70	472	14	14	40	68	0.8	1.0	520	54
Site 6	1/18/11	97.6	146	186	187	1,498	2,017	35	31	59	125	2.7	3.3	2,100	36
Minimum Value:		**97.6**	**47**	**3**	**187**	**30**	**472**	**14**	**14**	**40**	**68**	**0.8**	**1.0**	**410**	**36**
Maximum Value:		**290**	**146**	**186**	**961**	**1,498**	**2,017**	**139**	**31**	**59**	**211**	**2.7**	**22.9**	**2,100**	**97**
Log Normal Mean Value:		**199**	**85**	**16**	**506**	**128**	**991**	**52**	**19**	**49**	**131**	**1.5**	**3.2**	**653**	**64**

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 7	10/19/10	209	326	130	83	434	973	74	14	34	122	10.0	21.2	1,200	31
Site 7	11/1/10	228	296	234	456	386	1,372	76	20	13	109	4.9	15.2	5,500	35
Site 7	11/16/10	202	243	177	596	90	1,106	107	12	29	148	4.5	10.5	5,100	39
Site 7	12/7/10	225	342	252	359	69	1,022	55	6	15	76	3.4	4.6	5,300	26
Site 7	1/18/11	110	184	104	919	390	1,597	37	50	36	123	6.5	12.8	3,800	22
Minimum Value:		**110**	**184**	**104**	**83**	**69**	**973**	**37**	**6**	**13**	**76**	**3.4**	**4.6**	**1,200**	**22**
Maximum Value:		**228**	**342**	**252**	**919**	**434**	**1,597**	**107**	**50**	**36**	**148**	**10.0**	**21.2**	**5,500**	**39**
Log Normal Mean Value:		**189**	**272**	**170**	**375**	**210**	**1,192**	**66**	**16**	**23**	**113**	**5.5**	**11.5**	**3,683**	**30**
Site 8	10/19/10	234	323	298	452	26	1,099	72	34	47	153	3.1	5.4	2,408	29
Site 8	11/1/10	263	307	418	480	152	1,357	203	24	236	463	12.8	22.9	6,000	45
Site 8	11/16/10	226	36	40	423	411	910	73	21	18	112	1.6	4.6	700	30
Site 8	12/7/10	245	225	309	287	91	912	62	15	21	98	2.6	1.8	5,800	27
Site 8	1/18/11	106	178	107	532	1,333	2,150	38	40	43	121	5.8	10.9	4,900	22
Minimum Value:		**106.0**	**36**	**40**	**287**	**26**	**910**	**38**	**15**	**18**	**98**	**1.6**	**1.8**	**700**	**22**
Maximum Value:		**263**	**323**	**418**	**532**	**1,333**	**2,150**	**203**	**40**	**236**	**463**	**12.8**	**22.9**	**6,000**	**45**
Log Normal Mean Value:		**205**	**170**	**175**	**426**	**182**	**1,216**	**76**	**25**	**45**	**157**	**3.9**	**6.4**	**3,102**	**30**
Site 9	10/19/10	241	19	10	776	16	821	44	20	22	86	1.2	6.2	254	67
Site 9	11/1/10	254	47	36	771	129	983	104	36	45	185	1.6	1.1	420	89
Site 9	11/16/10	226	154	304	553	94	1,105	95	6	64	165	2.0	1.3	1,060	48
Site 9	12/7/10	240	24	33	378	88	523	28	3	17	48	0.9	1.2	340	52
Site 9	1/18/11	88.6	54	191	679	837	1,761	32	50	29	111	3.4	4.8	1,145	41
Minimum Value:		**88.6**	**19**	**10**	**378**	**16**	**523**	**28**	**3**	**17**	**48**	**0.9**	**1.1**	**254**	**41**
Maximum Value:		**254**	**154**	**304**	**776**	**837**	**1,761**	**104**	**50**	**64**	**185**	**3.4**	**6.2**	**1,145**	**89**
Log Normal Mean Value:		**197**	**45**	**59**	**611**	**107**	**961**	**52**	**15**	**32**	**107**	**1.6**	**2.2**	**535**	**57**

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 10	10/19/10	240	18	3	200	246	467	31	14	10	55	2.4	2.8	300	46
Site 10	11/1/10	226	33	4	458	408	903	53	13	4	70	0.4	2.8	156	72
Site 10	11/16/10	229	30	7	707	74	818	47	2	17	66	0.4	0.8	191	71
Site 10	12/7/10	229	26	8	337	100	471	12	4	2	18	0.4	0.5	136	47
Site 10	1/18/11	113	142	128	259	792	1,321	22	15	14	51	1.0	0.7	1,120	33
Minimum Value:		**113.0**	**18**	**3**	**200**	**74**	**467**	**12**	**2**	**2**	**18**	**0.4**	**0.5**	**136**	**33**
Maximum Value:		**240**	**142**	**128**	**707**	**792**	**1,321**	**53**	**15**	**17**	**70**	**2.4**	**2.8**	**1,120**	**72**
Log Normal Mean Value:		**200**	**37**	**10**	**355**	**226**	**735**	**29**	**7**	**7**	**47**	**0.7**	**1.2**	**267**	**52**
Site 11	10/19/10	283	201	16	439	44	700	8	25	52	85	1.8	5.4	390	50
Site 11	11/1/10	241	166	12	553	126	857	23	36	45	104	1.7	2.2	194	64
Site 11	11/16/10	240	113	66	673	340	1,192	40	8	55	103	1.8	2.0	300	61
Site 11	12/7/10	252	37	81	413	90	621	18	3	2	23	0.6	1.4	63	43
Site 11	1/18/11	107	107	161	1,282	399	1,949	29	31	38	98	2.4	4.0	1,054	33
Minimum Value:		**107.0**	**37**	**12**	**413**	**44**	**621**	**8**	**3**	**2**	**23**	**0.6**	**1.4**	**63**	**33**
Maximum Value:		**283**	**201**	**161**	**1,282**	**399**	**1,949**	**40**	**36**	**55**	**104**	**2.4**	**5.4**	**1,054**	**64**
Log Normal Mean Value:		**213**	**108**	**44**	**613**	**147**	**972**	**21**	**15**	**25**	**73**	**1.5**	**2.7**	**273**	**49**
Site 12	10/19/10	267	39	104	184	17	344	23	8	106	137	2.6	6.0	697	41
Site 12	11/1/10	260	71	73	647	15	806	6	28	51	85	2.2	4.0	2,200	61
Site 12	11/16/10	233	38	141	537	154	870	40	5	41	86	2.7	5.8	718	51
Site 12	12/7/10	250	38	81	408	17	544	33	2	7	42	0.9	1.3	618	45
Site 12	1/18/11	104	3	144	1,191	315	1,653	27	35	32	94	2.3	2.7	3,000	35
Minimum Value:		**104**	**3**	**73**	**184**	**15**	**344**	**6**	**2**	**7**	**42**	**0.9**	**1.3**	**618**	**35**
Maximum Value:		**267**	**71**	**144**	**1,191**	**315**	**1,653**	**40**	**35**	**106**	**137**	**2.7**	**6.0**	**3,000**	**61**
Log Normal Mean Value:		**211**	**26**	**105**	**499**	**46**	**737**	**22**	**10**	**35**	**83**	**2.0**	**3.4**	**1,153**	**46**

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 13	10/19/10	220	101	221	188	18	528	38	2	81	121	2.5	2.6	711	43
Site 13	11/1/10	218	167	280	422	69	938	55	34	123	212	6.7	12.9	10,300	61
Site 13	11/16/10	226	78	224	519	18	839	59	41	46	146	4.2	8.8	7,100	74
Site 13	12/7/10	227	89	185	110	24	408	47	9	44	100	2.9	3.2	3,800	50
Site 13	1/18/11	134	114	218	1,424	250	2,006	60	54	34	148	1.3	1.5	4,700	42
Minimum Value:		**134**	**78**	**185**	**110**	**18**	**408**	**38**	**2**	**34**	**100**	**1.3**	**1.5**	**711**	**42**
Maximum Value:		**227**	**167**	**280**	**1,424**	**250**	**2,006**	**60**	**54**	**123**	**212**	**6.7**	**12.9**	**10,300**	**74**
Log Normal Mean Value:		**201**	**106**	**224**	**365**	**42**	**806**	**51**	**17**	**59**	**141**	**3.1**	**4.3**	**3,923**	**53**
Site 14	10/19/10	266	30	119	224	417	790	21	31	11	63	2.2	3.8	869	49
Site 14	11/1/10	239	61	207	494	5	767	19	13	1	33	1.9	2.7	2,100	64
Site 14	11/16/10	235	43	170	599	16	828	39	27	10	76	1.6	1.2	800	55
Site 14	12/7/10	265	35	71	426	25	557	24	2	11	37	1.3	0.6	500	45
Site 14	1/18/11	105	105	160	1,226	657	2,148	30	31	55	116	2.3	3.6	2,800	36
Minimum Value:		**105**	**30**	**71**	**224**	**5**	**557**	**19**	**2**	**1**	**33**	**1.3**	**0.6**	**500**	**36**
Maximum Value:		**266**	**105**	**207**	**1,226**	**657**	**2,148**	**39**	**31**	**55**	**116**	**2.3**	**3.8**	**2,800**	**64**
Log Normal Mean Value:		**211**	**49**	**137**	**510**	**56**	**903**	**26**	**15**	**9**	**58**	**1.8**	**1.9**	**1,154**	**49**
Site 15	10/19/10	161	44	170	77	87	378	28	6	14	48	1.3	2.2	1,597	41
Site 15	11/1/10	200	78	147	588	74	887	46	14	3	63	1.0	1.2	10,600	54
Site 15	11/16/10	153	220	130	347	99	796	39	13	28	80	3.2	4.6	5,100	48
Site 15	1/18/11	115	164	250	1,156	64	1,634	4	20	17	41	2.2	2.2	2,000	32
Minimum Value:		**115**	**44**	**130**	**77**	**64**	**378**	**4**	**6**	**3**	**41**	**1.0**	**1.2**	**1,597**	**32**
Maximum Value:		**200**	**220**	**250**	**1,156**	**99**	**1,634**	**46**	**20**	**28**	**80**	**3.2**	**4.6**	**10,600**	**54**
Log Normal Mean Value:		**154**	**105**	**169**	**367**	**80**	**813**	**21**	**12**	**12**	**56**	**1.7**	**2.3**	**3,625**	**43**

Characteristics of Surface Water Samples Collected in Long Branch Creek from October 2010 - January 2011

Site	Date Collected	Alkalinity (mg/l)	NH_3 (µg/l)	NO_X (µg/l)	Diss Org N (µg/l)	Part. N (µg/l)	Total N (µg/l)	SRP (µg/l)	Diss Org P (µg/l)	Part. P (µg/l)	Total P (µg/l)	Turbidity (NTU)	TSS (mg/l)	Fecal (cfu/100 ml)	Color (Pt-Co)
Site 16	10/19/10	197	71	120	575	39	805	52	22	19	93	1.2	2.2	1,546	49
Site 16	11/1/10	240	109	174	177	569	1,029	79	16	17	112	1.6	2.6	6,600	64
Site 16	11/16/10	178	78	164	567	17	826	57	9	20	86	1.3	1.6	8,200	48
Site 16	12/7/10	255	80	82	428	15	605	51	1	12	64	1.3	0.9	1,283	45
Site 16	1/18/11	111	98	178	354	46	676	29	26	37	92	2.7	2.7	2,550	33
Minimum Value:		**111**	**71**	**82**	**177**	**15**	**605**	**29**	**1**	**12**	**64**	**1.2**	**0.9**	**1,283**	**33**
Maximum Value:		**255**	**109**	**178**	**575**	**569**	**1,029**	**79**	**26**	**37**	**112**	**2.7**	**2.7**	**8,200**	**64**
Log Normal Mean Value:		**189**	**86**	**138**	**388**	**48**	**775**	**51**	**10**	**20**	**88**	**1.5**	**1.9**	**3,072**	**47**
Site 17	10/19/10	137	59	3	564	431	1,057	1	36	29	66	6.2	17.6	44	36
Site 17	11/1/10	224	75	3	582	564	1,224	1	4	25	30	6.4	12.6	128	45
Site 17	11/16/10	131	49	6	703	347	1,105	7	7	15	29	6.8	6.8	540	37
Site 17	12/7/10	140	43	10	468	113	634	3	12	5	20	5.3	7.1	57	32
Site 17	1/18/11	125	60	47	1,184	347	1,638	6	33	5	44	1.4	1.1	330	25
Minimum Value:		**125**	**43**	**3**	**468**	**113**	**634**	**1**	**4**	**5**	**20**	**1.4**	**1.1**	**44**	**25**
Maximum Value:		**224**	**75**	**47**	**1,184**	**564**	**1,638**	**7**	**36**	**29**	**66**	**6.8**	**17.6**	**540**	**45**
Log Normal Mean Value:		**148**	**56**	**8**	**663**	**319**	**1,082**	**3**	**13**	**12**	**35**	**4.6**	**6.5**	**142**	**34**
Site 18	11/16/10	241	35	65	489	75	664	31	2	40	73	2.9	5.4	560	58
Site 18	12/7/10	233	37	25	296	49	407	26	2	9	37	0.9	2.2	1,020	48
Site 18	1/18/11	103	48	19	834	347	1,248	17	26	17	60	1.1	1.3	1,204	34
Minimum Value:		**103**	**35**	**19**	**296**	**49**	**407**	**17**	**2**	**9**	**37**	**1**	**1**	**560**	**34**
Maximum Value:		**241**	**48**	**65**	**834**	**347**	**1,248**	**31**	**26**	**40**	**73**	**3**	**5**	**1,204**	**58**
Log Normal Mean Value:		**180**	**40**	**31**	**494**	**108**	**696**	**24**	**5**	**18**	**55**	**1**	**2**	**883**	**46**

APPENDIX D

MASS LOADING CALCULATIONS FOR LONG BRANCH CREEK BASED ON THE FIELD MONITORING PROGRAM

Estimated Mass Loadings of SRP in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	1	1	1	3	3	0.000	0.000	0.000	0.000	0.000	0.000
Site 5	0.003	0.001	0.007	0.001	0.387	184	291	146	70	39	0.001	0.001	0.002	0.000	0.037	0.008
Site 7	0.242	0.093	0.050	0.020	3.993	74	76	107	55	37	0.044	0.017	0.013	0.003	0.361	0.088
Site 8	0.317	0.001	0.104	0.042	2.403	72	203	73	62	38	0.056	0.000	0.019	0.006	0.223	0.061
Site 1	1.220	0.032	0.098	0.001	2.854	19	16	50	30	12	0.057	0.001	0.012	0.000	0.084	0.031
Site 2	0.156	0.001	0.227	0.045	1.123	63	160	137	43	8	0.024	0.000	0.076	0.005	0.022	0.025
Site 6	0.274	0.063	0.220	0.080	3.831	41	139	130	14	35	0.027	0.021	0.070	0.003	0.328	0.090
Site 9	0.491	0.067	0.102	0.087	5.617	44	104	95	28	32	0.053	0.017	0.024	0.006	0.440	0.108
Site 11	1.220	0.712	0.321	0.220	5.233	8	23	40	18	29	0.024	0.040	0.031	0.010	0.371	0.095
Site 12	0.608	0.739	1.207	0.450	12.974	23	6	40	33	27	0.034	0.011	0.118	0.036	0.857	0.211
Site 14	0.661	0.372	0.908	0.290	8.322	21	19	39	24	30	0.034	0.017	0.087	0.017	0.611	0.153
Site 16	5.241	4.392	5.971	3.210	20.500	52	79	57	51	29	0.667	0.849	0.833	0.400	1.454	0.841
Site 4	0.001	0.001	0.001	0.001	0.001	33	132	230	37	50	0.000	0.000	0.001	0.000	0.000	0.000
Site 10	0.221	0.221	0.221	0.078	0.406	31	53	47	12	22	0.017	0.029	0.025	0.002	0.022	0.019
Site 13	0.076	0.091	0.146	0.100	0.303	38	55	59	47	60	0.007	0.012	0.021	0.011	0.044	0.019
Site 15	0.072	0.001	0.008	0.001	0.762	28	46	39		4	0.005	0.000	0.001	0.000	0.007	0.003
Site 17	0.001	0.001	0.001	0.001	4.550	1	1	7	3	6	0.000	0.000	0.000	0.000	0.067	0.013
Site 18	0.000	0.000	0.134	0.080	0.619			31	26	17	0.000	0.000	0.010	0.005	0.026	0.008

Estimated Mass Loadings of Particulate P in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	79	15	40	30	81	0.022	0.000	0.000	0.000	0.000	0.004
Site 5	0.003	0.001	0.007	0.001	0.387	61	74	92	16	109	0.000	0.000	0.002	0.000	0.103	0.021
Site 7	0.242	0.093	0.050	0.020	3.993	34	13	29	15	36	0.020	0.003	0.004	0.001	0.352	0.076
Site 8	0.317	0.001	0.104	0.042	2.403	47	236	18	21	43	0.036	0.001	0.005	0.002	0.253	0.059
Site 1	1.220	0.032	0.098	0.001	2.854	56	16	23	13	66	0.167	0.001	0.006	0.000	0.461	0.127
Site 2	0.156	0.001	0.227	0.045	1.123	95	76	34	18	77	0.036	0.000	0.019	0.002	0.212	0.054
Site 6	0.274	0.063	0.220	0.080	3.831	53	51	44	40	59	0.036	0.008	0.024	0.008	0.553	0.126
Site 9	0.491	0.067	0.102	0.087	5.617	22	45	64	17	29	0.026	0.007	0.016	0.004	0.398	0.090
Site 11	1.220	0.712	0.321	0.220	5.233	52	45	55	2	38	0.155	0.078	0.043	0.001	0.486	0.153
Site 12	0.608	0.739	1.207	0.450	12.974	106	51	41	7	32	0.158	0.092	0.121	0.008	1.016	0.279
Site 14	0.661	0.372	0.908	0.290	8.322	11	1	10	11	55	0.018	0.001	0.022	0.008	1.120	0.234
Site 16	5.241	4.392	5.971	3.210	20.500	19	17	20	12	37	0.244	0.183	0.292	0.094	1.855	0.534
Site 4	0.001	0.001	0.001	0.001	0.001	154	101	172	28	39	0.000	0.000	0.000	0.000	0.000	0.000
Site 10	0.221	0.221	0.221	0.078	0.406	10	4	17	2	14	0.005	0.002	0.009	0.000	0.014	0.006
Site 13	0.076	0.091	0.146	0.100	0.303	81	123	46	44	34	0.015	0.027	0.016	0.011	0.025	0.019
Site 15	0.072	0.001	0.008	0.001	0.762	14	3	28		17	0.002	0.000	0.001	0.000	0.032	0.007
Site 17	0.001	0.001	0.001	0.001	4.550	29	25	15	5	5	0.000	0.000	0.000	0.000	0.056	0.011
Site 18	0.000	0.000	0.134	0.080	0.619			40	9	17	0.000	0.000	0.013	0.002	0.026	0.008

Estimated Mass Loadings of Total P in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	81	31	45	34	89	0.022	0.001	0.000	0.000	0.000	0.005
Site 5	0.003	0.001	0.007	0.001	0.387	290	512	268	102	197	0.002	0.001	0.005	0.000	0.186	0.039
Site 7	0.242	0.093	0.050	0.020	3.993	122	109	148	76	123	0.072	0.025	0.018	0.004	1.201	0.264
Site 8	0.317	0.001	0.104	0.042	2.403	153	463	112	98	121	0.119	0.001	0.029	0.010	0.711	0.174
Site 1	1.220	0.032	0.098	0.001	2.854	82	78	84	48	101	0.245	0.006	0.020	0.000	0.705	0.195
Site 2	0.156	0.001	0.227	0.045	1.123	269	293	191	64	100	0.103	0.001	0.106	0.007	0.275	0.098
Site 6	0.274	0.063	0.220	0.080	3.831	113	211	189	68	125	0.076	0.032	0.102	0.013	1.171	0.279
Site 9	0.491	0.067	0.102	0.087	5.617	86	185	165	48	111	0.103	0.031	0.041	0.010	1.525	0.342
Site 11	1.220	0.712	0.321	0.220	5.233	85	104	103	23	98	0.254	0.181	0.081	0.012	1.254	0.356
Site 12	0.608	0.739	1.207	0.450	12.974	137	85	86	42	94	0.204	0.154	0.254	0.046	2.983	0.728
Site 14	0.661	0.372	0.908	0.290	8.322	63	33	76	37	116	0.102	0.030	0.169	0.026	2.361	0.538
Site 16	5.241	4.392	5.971	3.210	20.500	93	112	86	64	92	1.192	1.203	1.256	0.503	4.613	1.754
Site 4	0.001	0.001	0.001	0.001	0.001	217	275	449	73	124	0.001	0.001	0.001	0.000	0.000	0.001
Site 10	0.221	0.221	0.221	0.078	0.406	55	70	66	18	51	0.030	0.038	0.036	0.003	0.051	0.031
Site 13	0.076	0.091	0.146	0.100	0.303	121	212	146	100	148	0.023	0.047	0.052	0.024	0.110	0.051
Site 15	0.072	0.001	0.008	0.001	0.762	48	63	80		41	0.008	0.000	0.002	0.000	0.076	0.017
Site 17	0.001	0.001	0.001	0.001	4.550	66	30	29	20	44	0.000	0.000	0.000	0.000	0.490	0.098
Site 18	0.000	0.000	0.134	0.080	0.619			73	37	60	0.000	0.000	0.024	0.007	0.091	0.024

Estimated Mass Loadings of Ammonia in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	30	43	36	40	517	0.008	0.001	0.000	0.000	0.001	0.002
Site 5	0.003	0.001	0.007	0.001	0.387	1096	1827	246	285	225	0.008	0.004	0.004	0.001	0.213	0.046
Site 7	0.242	0.093	0.050	0.020	3.993	326	296	243	342	184	0.193	0.067	0.030	0.017	1.797	0.421
Site 8	0.317	0.001	0.104	0.042	2.403	323	307	36	225	178	0.251	0.001	0.009	0.023	1.046	0.266
Site 1	1.220	0.032	0.098	0.001	2.854	504	116	143	43	204	1.504	0.009	0.034	0.000	1.424	0.594
Site 2	0.156	0.001	0.227	0.045	1.123	164	348	470	120	121	0.063	0.001	0.261	0.013	0.332	0.134
Site 6	0.274	0.063	0.220	0.080	3.831	65	101	101	47	146	0.044	0.015	0.054	0.009	1.368	0.298
Site 9	0.491	0.067	0.102	0.087	5.617	19	47	154	24	54	0.023	0.008	0.039	0.005	0.742	0.163
Site 11	1.220	0.712	0.321	0.220	5.233	201	166	113	37	107	0.600	0.289	0.089	0.020	1.370	0.473
Site 12	0.608	0.739	1.207	0.450	12.974	39	71	38	38	3	0.058	0.128	0.112	0.042	0.095	0.087
Site 14	0.661	0.372	0.908	0.290	8.322	30	61	43	35	105	0.048	0.055	0.095	0.025	2.137	0.472
Site 16	5.241	4.392	5.971	3.210	20.500	71	109	78	80	98	0.910	1.171	1.139	0.628	4.914	1.753
Site 4	0.001	0.001	0.001	0.001	0.001	75	118	97	75	94	0.000	0.000	0.000	0.000	0.000	0.000
Site 10	0.221	0.221	0.221	0.078	0.406	18	33	30	26	142	0.010	0.018	0.016	0.005	0.141	0.038
Site 13	0.076	0.091	0.146	0.100	0.303	101	167	78	89	114	0.019	0.037	0.028	0.022	0.085	0.038
Site 15	0.072	0.001	0.008	0.001	0.762	44	78	220		164	0.008	0.000	0.004		0.306	0.080
Site 17	0.001	0.001	0.001	0.001	4.550	59	75	49	43	60	0.000	0.000	0.000	0.000	0.668	0.134
Site 18	0.000	0.000	0.134	0.080	0.619			35	37	48			0.011	0.007	0.073	0.030

Estimated Mass Loadings of NO_x in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	3	3	3	14	30	0.00	0.00	0.00	0.00	0.00	0.00
Site 5	0.003	0.001	0.007	0.001	0.387	49	54	7	50	92	0.00	0.00	0.00	0.00	0.09	0.02
Site 7	0.242	0.093	0.050	0.020	3.993	130	234	177	252	104	0.08	0.05	0.02	0.01	1.02	0.24
Site 8	0.317	0.001	0.104	0.042	2.403	298	418	40	309	107	0.23	0.00	0.01	0.03	0.63	0.18
Site 1	1.220	0.032	0.098	0.001	2.854	727	166	192	491	54	2.17	0.01	0.05	0.00	0.38	0.52
Site 2	0.156	0.001	0.227	0.045	1.123	19	160	33	21	89	0.01	0.00	0.02	0.00	0.24	0.05
Site 6	0.274	0.063	0.220	0.080	3.831	130	234	177	252	104	0.09	0.04	0.10	0.05	0.97	0.25
Site 9	0.491	0.067	0.102	0.087	5.617	10	36	304	33	191	0.01	0.01	0.08	0.01	2.62	0.55
Site 11	1.220	0.712	0.321	0.220	5.233	16	12	66	81	161	0.05	0.02	0.05	0.04	2.06	0.44
Site 12	0.608	0.739	1.207	0.450	12.974	104	73	141	81	144	0.15	0.13	0.42	0.09	4.57	1.07
Site 14	0.661	0.372	0.908	0.290	8.322	119	207	170	71	160	0.19	0.19	0.38	0.05	3.26	0.81
Site 16	5.241	4.392	5.971	3.210	20.500	120	174	164	82	178	1.54	1.87	2.40	0.64	8.93	3.07
Site 4	0.001	0.001	0.001	0.001	0.001	10	49	19	14	552	0.00	0.00	0.00	0.00	0.00	0.00
Site 10	0.221	0.221	0.221	0.078	0.406	3	4	7	8	128	0.00	0.00	0.00	0.00	0.13	0.03
Site 13	0.076	0.091	0.146	0.100	0.303	221	280	224	185	218	0.04	0.06	0.08	0.05	0.16	0.08
Site 15	0.072	0.001	0.008	0.001	0.762	170	147	130		250	0.03	0.00	0.00		0.47	0.12
Site 17	0.001	0.001	0.001	0.001	4.550	3	3	6	10	47	0.00	0.00	0.00	0.00	0.52	0.10
Site 18	0.000	0.000	0.134	0.080	0.619			65	25	19			0.02	0.00	0.03	0.02

Estimated Mass Loadings of Particulate N in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	1170	911	637	453	481	0.32	0.02	0.00	0.00	0.00	0.07
Site 5	0.003	0.001	0.007	0.001	0.387	675	164	644	125	380	0.00	0.00	0.01	0.00	0.36	0.08
Site 7	0.242	0.093	0.050	0.020	3.993	434	386	90	69	390	0.26	0.09	0.01	0.00	3.81	0.83
Site 8	0.317	0.001	0.104	0.042	2.403	26	152	411	91	1333	0.02	0.00	0.10	0.01	7.84	1.59
Site 1	1.220	0.032	0.098	0.001	2.854	292	210	420	229	1236	0.87	0.02	0.10	0.00	8.63	1.92
Site 2	0.156	0.001	0.227	0.045	1.123	613	92	260	96	66	0.23	0.00	0.14	0.01	0.18	0.11
Site 6	0.274	0.063	0.220	0.080	3.831	58	30	192	70	1498	0.04	0.00	0.10	0.01	14.04	2.84
Site 9	0.491	0.067	0.102	0.087	5.617	16	129	94	88	837	0.02	0.02	0.02	0.02	11.50	2.32
Site 11	1.220	0.712	0.321	0.220	5.233	44	126	340	90	399	0.13	0.22	0.27	0.05	5.11	1.15
Site 12	0.608	0.739	1.207	0.450	12.974	17	15	154	17	315	0.03	0.03	0.45	0.02	10.00	2.10
Site 14	0.661	0.372	0.908	0.290	8.322	417	5	16	25	657	0.67	0.00	0.04	0.02	13.37	2.82
Site 16	5.241	4.392	5.971	3.210	20.500	39	569	17	15	46	0.50	6.11	0.25	0.12	2.31	1.86
Site 4	0.001	0.001	0.001	0.001	0.001	107	100	228	52	1241	0.00	0.00	0.00	0.00	0.00	0.00
Site 10	0.221	0.221	0.221	0.078	0.406	246	408	74	100	792	0.13	0.22	0.04	0.02	0.79	0.24
Site 13	0.076	0.091	0.146	0.100	0.303	18	69	18	24	250	0.00	0.02	0.01	0.01	0.19	0.04
Site 15	0.072	0.001	0.008	0.001	0.762	87	74	99		64	0.02	0.00	0.00		0.12	0.03
Site 17	0.001	0.001	0.001	0.001	4.550	431	564	347	113	347	0.00	0.00	0.00	0.00	3.86	0.77
Site 18	0.000	0.000	0.134	0.080	0.619			75	49	347			0.02	0.01	0.53	0.19

Estimated Mass Loadings of Total N in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (µg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	1445	1524	1261	715	2182	0.4	0.0	0.0	0.0	0.0	0.1
Site 5	0.003	0.001	0.007	0.001	0.387	2018	3337	1750	727	2192	0.0	0.0	0.0	0.0	2.1	0.4
Site 7	0.242	0.093	0.050	0.020	3.993	973	1372	1106	1022	1597	0.6	0.3	0.1	0.0	15.6	3.3
Site 8	0.317	0.001	0.104	0.042	2.403	1099	1357	910	912	2150	0.9	0.0	0.2	0.1	12.6	2.8
Site 1	1.220	0.032	0.098	0.001	2.854	1587	1371	1178	1075	1577	4.7	0.1	0.3	0.0	11.0	3.2
Site 2	0.156	0.001	0.227	0.045	1.123	1361	1316	1780	1089	1596	0.5	0.0	1.0	0.1	4.4	1.2
Site 6	0.274	0.063	0.220	0.080	3.831	953	1114	945	472	2017	0.6	0.2	0.5	0.1	18.9	4.1
Site 9	0.491	0.067	0.102	0.087	5.617	821	983	1105	523	1761	1.0	0.2	0.3	0.1	24.2	5.1
Site 11	1.220	0.712	0.321	0.220	5.233	700	857	1192	621	1949	2.1	1.5	0.9	0.3	24.9	6.0
Site 12	0.608	0.739	1.207	0.450	12.974	344	806	870	544	1653	0.5	1.5	2.6	0.6	52.5	11.5
Site 14	0.661	0.372	0.908	0.290	8.322	790	767	828	557	2148	1.3	0.7	1.8	0.4	43.7	9.6
Site 16	5.241	4.392	5.971	3.210	20.500	805	1029	826	605	676	10.3	11.1	12.1	4.8	33.9	14.4
Site 4	0.001	0.001	0.001	0.001	0.001	769	968	932	608	2232	0.0	0.0	0.0	0.0	0.0	0.0
Site 10	0.221	0.221	0.221	0.078	0.406	467	903	818	471	1321	0.3	0.5	0.4	0.1	1.3	0.5
Site 13	0.076	0.091	0.146	0.100	0.303	528	938	839	408	2006	0.1	0.2	0.3	0.1	1.5	0.4
Site 15	0.072	0.001	0.008	0.001	0.762	378	887	796		1634	0.1	0.0	0.0		3.0	0.8
Site 17	0.001	0.001	0.001	0.001	4.550	1057	1224	1105	634	1638	0.0	0.0	0.0	0.0	18.2	3.6
Site 18	0.000	0.000	0.134	0.080	0.619			664	407	1248			0.2	0.1	1.9	0.7

Estimated Mass Loadings of TSS in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (mg/l)					Loading by Collection Date (kg/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	9.9	12.8	6.7	12.0	9.9	2.7	0.2	0.0	0.1	0.0	0.6
Site 5	0.003	0.001	0.007	0.001	0.387	8.7	4.9	10.2	1.9	14.8	0.1	0.0	0.2	0.0	14.0	2.9
Site 7	0.242	0.093	0.050	0.020	3.993	21.2	15.2	10.5	4.6	12.8	12.5	3.5	1.3	0.2	125.0	28.5
Site 8	0.317	0.001	0.104	0.042	2.403	5.4	22.9	4.6	1.8	10.9	4.2	0.1	1.2	0.2	64.1	13.9
Site 1	1.220	0.032	0.098	0.001	2.854	19.5	6.8	3.9	3.0	7.3	58.2	0.5	0.9	0.0	51.0	22.1
Site 2	0.156	0.001	0.227	0.045	1.123	8.0	4.0	5.8	8.2	6.2	3.1	0.0	3.2	0.9	17.0	4.8
Site 6	0.274	0.063	0.220	0.080	3.831	4.3	22.9	1.0	1.0	3.3	2.9	3.5	0.5	0.2	30.9	7.6
Site 9	0.491	0.067	0.102	0.087	5.617	6.2	1.1	1.3	1.2	4.8	7.4	0.2	0.3	0.3	65.9	14.8
Site 11	1.220	0.712	0.321	0.220	5.233	5.4	2.2	2.0	1.4	4.0	16.1	3.8	1.6	0.8	51.2	14.7
Site 12	0.608	0.739	1.207	0.450	12.974	6.0	4.0	5.8	1.3	2.7	8.9	7.2	17.1	1.4	85.7	24.1
Site 14	0.661	0.372	0.908	0.290	8.322	3.8	2.7	1.2	0.6	3.6	6.1	2.5	2.7	0.4	73.3	17.0
Site 16	5.241	4.392	5.971	3.210	20.500	2.2	2.6	1.6	0.9	2.7	28.2	27.9	23.4	7.1	135.4	44.4
Site 4	0.001	0.001	0.001	0.001	0.001	3.7	3.5	6.3	3.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0
Site 10	0.221	0.221	0.221	0.078	0.406	2.8	2.8	0.8	0.5	0.7	1.5	1.5	0.4	0.1	0.7	0.9
Site 13	0.076	0.091	0.146	0.100	0.303	2.6	12.9	8.8	3.2	1.5	0.5	2.9	3.1	0.8	1.1	1.7
Site 15	0.072	0.001	0.008	0.001	0.762	2.2	1.2	4.6		2.2	0.4	0.0	0.1		4.1	1.1
Site 17	0.001	0.001	0.001	0.001	4.550	17.6	12.6	6.8	7.1	1.1	0.0	0.0	0.0	0.0	12.2	2.5
Site 18	0.000	0.000	0.134	0.080	0.619			5.4	2.2	1.3			1.77	0.43	1.97	1.4

Estimated Mass Loadings of Fecal Coliform in Longbranch Creek by Collection Date from October 2010 - January 2011

Site	Discharge by Collection Date (cfs)					Concentration by Collection Date (cfu/100 ml)					Loading by Collection Date (cfu x 10^8/day)					Mean Loading
	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	10/19/10	11/1/10	11/16/10	12/7/10	1/18/11	
Site 3	0.111	0.007	0.001	0.003	0.001	743	480	782	736	2,700	20	1	0	1	1	4
Site 5	0.003	0.001	0.007	0.001	0.387	614	530	809	27	2,100	0	0	1	0	199	40
Site 7	0.242	0.093	0.050	0.020	3.993	1,200	5,500	5,100	5,300	3,800	71	125	62	26	3,712	799
Site 8	0.317	0.001	0.104	0.042	2.403	2,408	6,000	700	5,800	4,900	187	1	18	60	2,880	629
Site 1	1.220	0.032	0.098	0.001	2.854	510	400	330	310	664	152	3	8	0	464	125
Site 2	0.156	0.001	0.227	0.045	1.123	606	250	540	440	3,800	23	0	30	5	1,044	220
Site 6	0.274	0.063	0.220	0.080	3.831	500	410	530	520	2,100	33	6	29	10	1,968	409
Site 9	0.491	0.067	0.102	0.087	5.617	254	420	1,060	340	1,145	30	7	27	7	1,573	329
Site 11	1.220	0.712	0.321	0.220	5.233	390	194	300	63	1,054	116	34	24	3	1,349	305
Site 12	0.608	0.739	1.207	0.450	12.974	697	2,200	718	618	3,000	104	398	212	68	9,521	2,060
Site 14	0.661	0.372	0.908	0.290	8.322	869	2,100	800	500	2,800	140	191	178	35	5,700	1,249
Site 16	5.241	4.392	5.971	3.210	20.500	1,546	6,600	8,200	1,283	2,550	1,982	7,091	11,977	1,007	12,787	6,969
Site 4	0.001	0.001	0.001	0.001	0.001	440	3,900	1,018	360	560	0	1	0	0	0	0
Site 10	0.221	0.221	0.221	0.078	0.406	300	156	191	136	1,120	16	8	10	3	111	30
Site 13	0.076	0.091	0.146	0.100	0.303	711	10,300	7,100	3,800	4,700	13	228	254	93	348	187
Site 15	0.072	0.001	0.008	0.001	0.762	1,597	10,600	5,100		2,000	28	3	10		373	103
Site 17	0.001	0.001	0.001	0.001	4.550	44	128	540	57	330	0	0	0	0	367	73
Site 18	0.000	0.000	0.134	0.080	0.619			560	1,020	1,204			18	20	182	74

APPENDIX E

ISOTOPE ANALYSIS REPORT
FROM CLIMATE-WISE SOLUTIONS, INC.

CLIMATE-WISE SOLUTIONS, LLC

Stable Isotope ($\delta^{15}N$ and $\delta^{18}O$) Composition of Nitrate from Long Branch Creek, Pinellas County, FL

Nutrient source implications

Bruce Hungate

9/18/2011

Introduction

Nitrate (NO_3^-) in surface waters can originate from multiple sources, including fertilizer application, animal waste, septic systems, and soil and natural deposition. Stable isotope analysis can help distinguish which of the sources is more likely to contribute to contamination in a given site, because these multiple sources often differ in stable isotope composition. For example, high $\delta^{15}N$ values can be traced to animal waste and sewage inputs (e.g., Wassenaar 1995; Kendall 1998; Kendall et al. 1996). Atmospheric N deposition as NO_3^- or NH_4^+, N derived from synthetic fertilizers, and soil-derived N typically differ in $\delta^{15}N$ and $\delta^{18}O$ (Table 1). Stable isotopes of oxygen are also useful in source partitioning, in some cases increasing resolution when combined with $\delta^{15}N$. Atmospherically derived NO_3^- is enriched in $\delta^{18}O$ compared to synthetic fertilizer, and both tend to be enriched compared to NO_3^- produced in soils through microbial nitrification (Table 1).

One complication of source partitioning using stable isotopes of N and O in nitrate is that microbial transformations of nitrate can alter its isotopic signature, potentially obscuring the identity of the original source (Kellman 2005). Nitrification and denitrification are the major fractionating processes altering the isotopic composition of nitrate. Both processes preferentially utilize the lighter substrate, such that nitrification produces NO_3^- isotopically depleted compared to the NH_4^+ substrate, whereas denitrification preferentially utilizes isotopically depleted NO_3^-, leaving behind NO_3^- relatively enriched in $\delta^{15}N$ and $\delta^{18}O$. Predictable relationships among NO_3^- concentration, $\delta^{15}N$- NO_3^-, and $\delta^{18}O$-NO_3^- provide one means of detecting whether denitrification is influencing the isotopic composition of NO_3^-. For example, co-varying enrichment of $\delta^{15}N$ and $\delta^{18}O$ in nitrate provides evidence for denitrification, if the ratio of enrichments are between 1.3:1 and 2.1:1 (Aravena and Robertson 1998, Fukada et al. 2003). In a system where nitrate inputs are negligible, a negative relationship between [NO_3^-] and $\delta^{15}N$-NO_3^- with a slope consistent with microbial fractionation during denitrification can also be used as diagnostic for the importance of denitrification as a loss pathway, or, in source identification, for the need to consider internal changes to $\delta^{15}N$ values observed in situ to the expected $\delta^{15}N$ signature of the NO_3^- source. Analysis of $\delta^{15}N$-NH_4^+, and nitrification and denitrification rates at a given site can also constrain the influence of these processes on the observed isotopic signatures.

In the study conducted here, surface and ground waters in the Long Branch Creek system were analyzed for $\delta^{15}N$ and $\delta^{18}O$ composition of nitrite (NO_2^-) and nitrate (NO_3^-), along with putative sources. (Note, analytically, NO2- and NO3- are often analyzed together. However, for most aquatic, mesic systems, NO2- is rapidly converted to NO_3^-, so concentrations of NO_2^- are very low. For this study, the analyte was the sum of NO_2^- + NO_3^-, also referred to as NO_x).

Two general questions were addressed: 1) are there changes in $NO_2^- + NO_3^-$, $\delta^{15}N$ and $\delta^{18}O$ signatures within these systems that is consistent with internal microbial processing, and if so, is it possible to constrain the $\delta^{15}N$ and $\delta^{18}O$ signature of $NO_2^- + NO_3^-$ entering these systems? And 2) do the estimates of the $\delta^{15}N$ and $\delta^{18}O$ signature of source $NO_2^- + NO_3^-$ match any of the putative sources identified?

Methods

Samples were collected in the field and shipped to the Colorado Plateau Stable Isotope Laboratory at Northern Arizona University (NAU) for preparation and analysis. In the lab at NAU, samples were measured for NO_3^- concentrations using automated colorimetry on a Lachat QuikChem 8000, to determine appropriate volumes for isotope analyses. The denitrifier method was used to measure the $\delta^{15}N$ and $\delta^{18}O$ composition of nitrate in each water sample (Sigman et al. 2001, Casciotti et al. 2002, Révész and Casciotte 2007). In this method, isotopes of both elements are measured simultaneously after the nitrate is converted to nitrous oxide (N_2O). Mass ratios of 45:44 and 46:44 distinguish $\delta^{15}N$ and $\delta^{18}O$ signatures, respectively. *Pseudomonas aureofaciens* lacks N_2O reductase, the enzyme that converts N_2O to N_2 during denitrification, so the reaction stops at N_2O, unlike normal denitrification which converts most of the NO_3^- all the way to N_2. *P. aureofaciens* cultures were grown in tryptic soy broth, centrifuged to concentrate bacterial cells, and then concentrated suspensions of cells are added to sealed vials with headspace. The headspace vials were purged with He gas to promote the anaerobic conditions suitable for denitrification, and then environmental samples containing NO_3^- were added to the vials, the volume of sample adjusted to obtain sufficient N_2O for analysis. Several drops of antifoaming agent were added to each vial to reduce bubble formation during the reaction. The vials were allowed to incubate for 8 hours, during which time NO_2^- and NO_3^- are converted completely to N_2O. After the 8-hour period, 0.1 mL of 10N NaOH was added to each vial to stop the reaction, and to absorb CO_2, which can interfere with N_2O analysis (since CO_2 has the same masses as N_2O, 44, 45, and 46). The samples were then placed on an autosampler tray interfaced with the mass spectrometer, and interspersed with standards with known $\delta^{15}N$ and $\delta^{18}O$ composition (USGS32, USGS 34, USGS 35, and IAEA NO3).

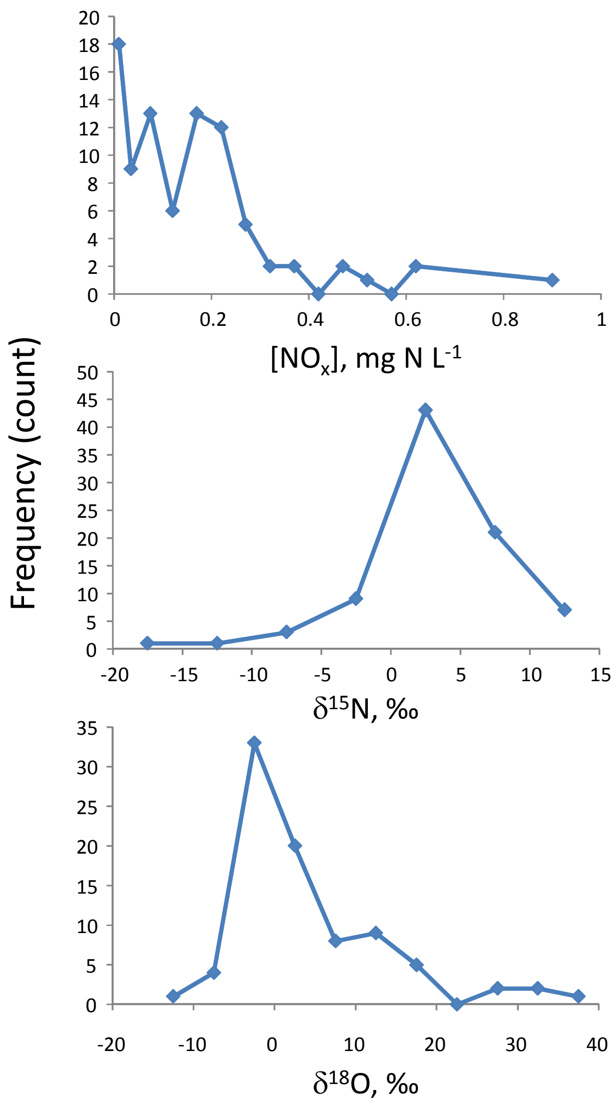

Figure 1. Frequency distributions of $[NO_x]$ concentration, $\delta^{15}N$-NO_x, and $\delta^{18}O$-NO_x throughout the Long Branch Creek system.

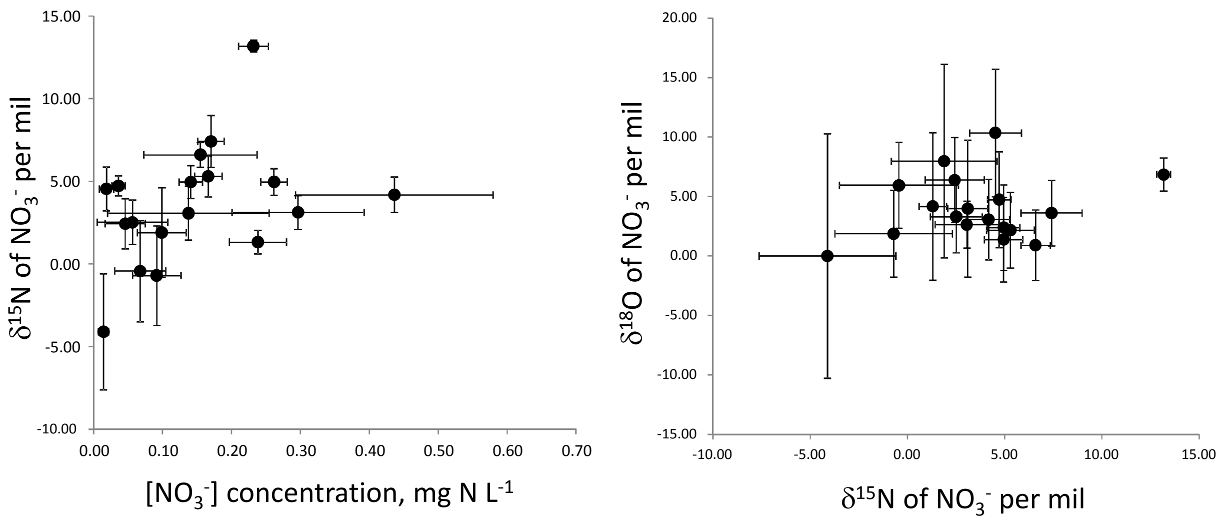

Figure 2. Left panel, $\delta^{15}N$ signatures of nitrate as a function of nitrate concentration. A negative relationship indicates fractionating removal processes, like denitrification, which can complicate source partitioning. The slope found is weakly positive, inconsistent with denitrification as a major influence on the isotopic signature. Right panel, $\delta^{18}O$ of nitrate versus $\delta^{15}N$ of nitrate. A positive relationship can indicate denitrification, with characteristic slopes between 1.3 and 2.1. The data do not follow this pattern. Thus, denitrification does not appear to have a major influence on patterns of $\delta^{15}N$ and $\delta^{18}O$ in nitrate in Long Branch Creek.

Results & Discussion

Overview

All but one of the 86 samples received had sufficient NO_2^- + NO_3^- (hereafter, NO_x) for isotope analysis, although 18 were at or below the detection limits for the method utilized to determine NO_x concentrations (0.02 mg NO_x-N L^{-1}). In 17 of these cases, the mass spectrometry method nevertheless obtained sufficient N_2O for isotopic determination.

[NO_x] concentrations averaged 0.15 mg N L^{-1}, with a standard deviation of 0.16 (Figure 1). $\delta^{15}N$-NO_x averaged 3.52 ‰ with a standard deviation of 5.05 ‰, and $\delta^{18}O$-NO_x averaged 3.99 ‰ with a standard deviation of 10.03 ‰.

Evidence for in situ denitrification

Two lines of evidence could support *in situ* denitrification as a major pathway of NO_x removal, and thus as a confounding signal for interpreting isotopes in source partitioning. One sign of denitrification is a negative slope for the relationship between [NO_3^-] and $\delta^{15}N$-NO_x, reflecting preferential removal of ^{14}N-NO_x through denitrification. A second sign of *in situ* denitrification is co-varying enrichment of $\delta^{15}N$ and $\delta^{18}O$ in nitrate, if the ratios of enrichments are between 1.3 and 2.1 to 1 (Aravena and Robertson 1998, Fukada et al. 2003). However, there was no evidence for any such relationship in the Long Branch Creek system, including for any given sampling date across sites (Table 3), within individual sites sampled over time (Table 4), and across the entire dataset (Figure 2).

Nitrate throughout the system in space and time

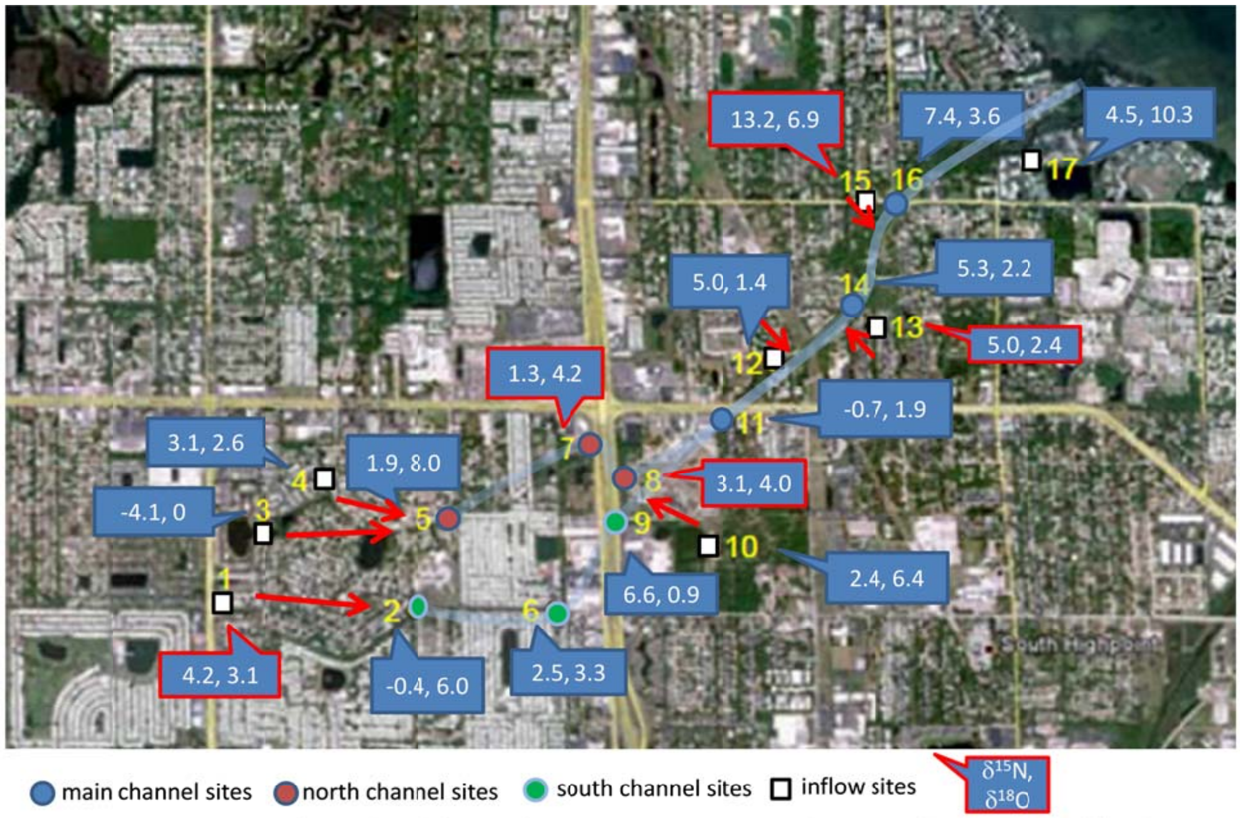

Figure 3. Map of Long Branch Creek and the sample sites, numbered 1-17. Red arrows indicate presumed flow from inflow stations to channel stations. Callout boxes show mean $\delta^{15}N$ and $\delta^{18}O$ values of nitrate measured for each site. Red outline indicates sites with average NO_3^- concentrations > 0.2 mg N L^{-1}

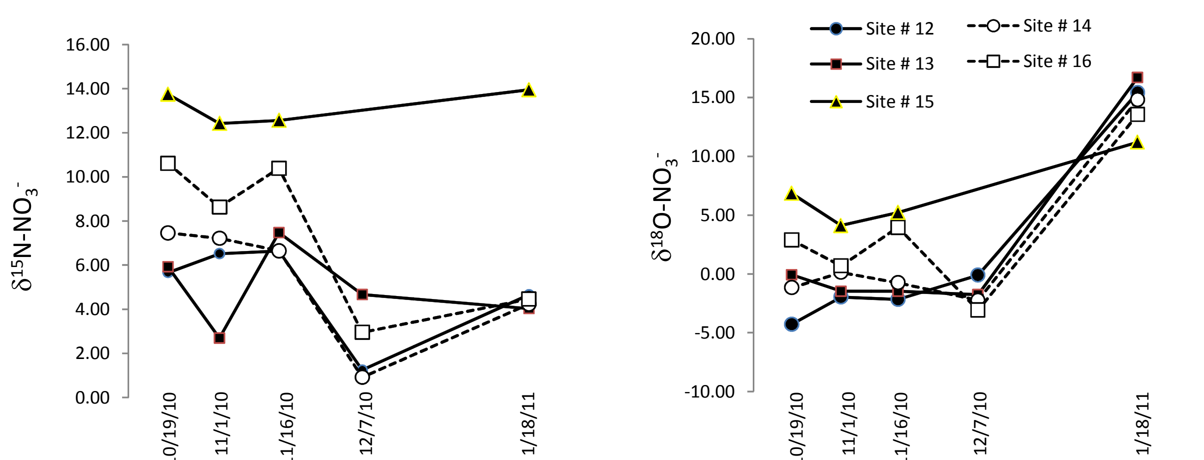

Figure 4. Temporal covariance between putative NO_3^- sources (sites 12, 13, and 15) and the nearby (downstream) recipient main channel (sites 14 and 16). The decline in $\delta^{15}N$ from 16 Nov to 7 Dec is apparent across all sites, and the subsequent increase apparent in all but site 13. For $\delta^{18}O-NO_3^-$, values are steady over time until the last sample, where the simultaneous increase in $\delta^{18}O$ across all sites suggests a common source (i.e., sites 12, 13 and 15 feed sites 14 and 16). Overall, this temporal covariance across sites suggest that sites 12 and 13 are significant sources of NO_3^- to the water sampled at sites 14 and 16.

The spatial configuration of the sampling scheme used in the Long Branch Creek system enabled testing for correspondence between putative sources of nitrate and nitrate found in the main channel (Figure

3). For example, if inlet sites 12 and 13 are significant sources to the main channel, there should be correspondence between variation at these sites and at downstream sampling sites 14 and 16 in the main channel (Figure 5). Similarly, if inlet sites 3 and 4 have a strong influence, their signatures should be reflected in downstream main channel sites 5, 7, and 8 (Figure 6). In general there was evidence for such temporal-spatial covariation in the study system. For example, the decline in δ^{15}N values at inlet sites 12 and 15 from 16 Nov to 7 Dec was also observed in main channel sites 14 and 16 (Figure 4). In general, inlet sites with high [NO_x] concentrations (13, 15) tended to show higher temporal covariation with downstream main channel sites.

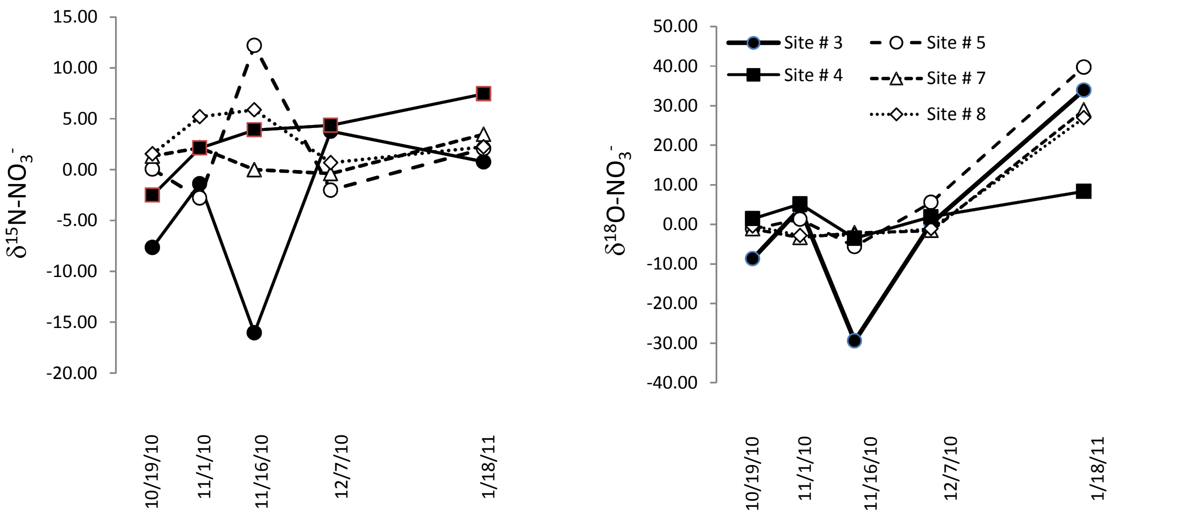

Figure 5. Temporal covariance between putative NO_3^- sources (sites 3 and 4) and the nearby (downstream) recipient main channel (sites 5, 7, and 8). The left panel shows δ^{15}N-NO_3^-, and the right panel δ^{18}O-NO_3^-. Covariance is weak for δ^{15}N, though there may be a lagged response in sites 5, 7 and 8 to variation in site 3. The covariance is stronger (with no time lag) for δ^{18}O, particularly between the 7 Dec and 18 Jan sampling dates.

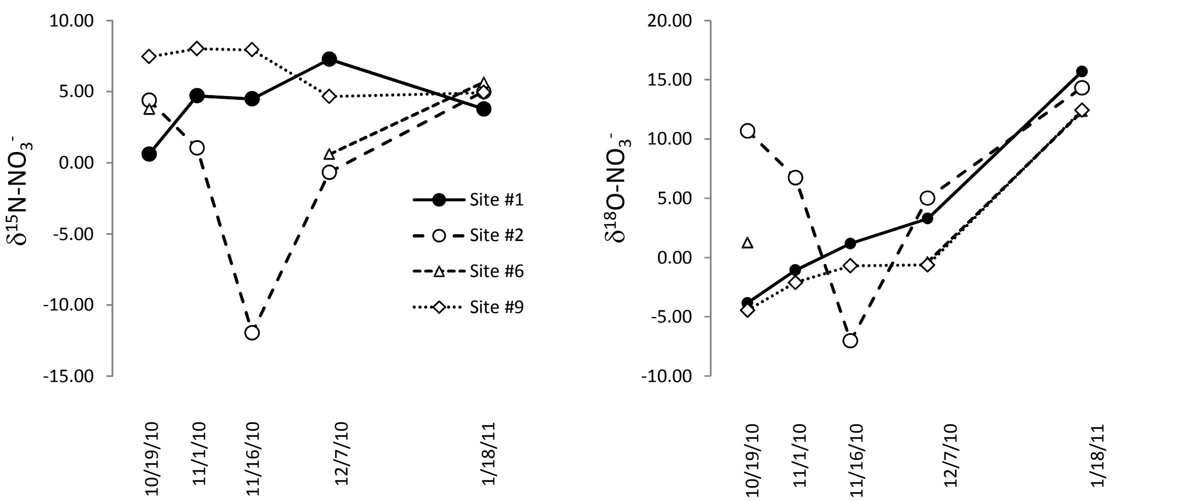

Figure 6. Temporal covariance between putative NO_3^- source (site 1) and the nearby (downstream) recipient main channel (sites 2, 6, and 9). The left panel shows δ^{15}N-NO_3^-, and the right panel δ^{18}O-NO_3^-. δ^{15}N is fairly constant over time at site 1, consistent with the pattern observed at site 9. The strong deviation at site 2 for both δ^{15}N and δ^{18}O is not captured at the other sites.

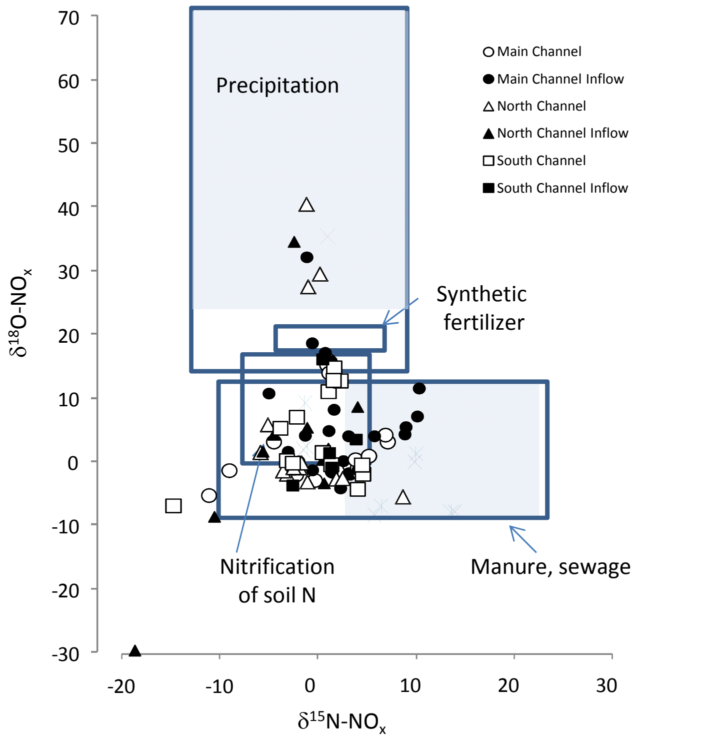

Figure 7. δ^{15}N and δ^{18}O of NO_x in tributary inflow (filled symbols) and channel (open symbol) sites, for the main channel (circles), north channel (triangles), and south channel (squares). Also shown are typical ranges of isotopic signatures for primary sources of N to ecosystems (blue boxes, from Kendall 1998 and Kool 2010, shaded regions for 90% confidence intervals, where constrained, Table 1).

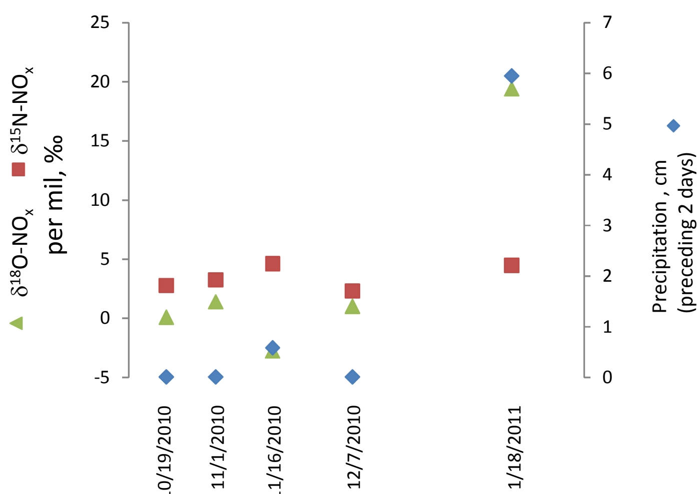

Figure 8. Temporal variation in the isotopic composition of NO_x and precipitation. The positive excursion in δ^{18}O-NO_x for 18 Jan 2011 was coincident with high rainfall during the preceding two days, consistent with an atmospheric source of NO_x in the watershed.

One strong pattern throughout the system was the systematic increase in d18O-NOx between 7 Dec 2010 and 18 Jan 2011 (Figures 4-6).

Source partitioning

δ^{15}N and δ^{18}O values of NO_x – with an average value just below 4 ‰ for both – were consistent with NO_x derived from nitrification of native soil organic matter, synthetic fertilizers, and sewage sources of N (Figure 7). Although synthetic fertilizers in the form of nitrate have constrained figures for d18O, ammonium-based fertilizer sources will carry the same d18O signature as N derived from native organic matter, because these sources are nitrified under similar conditions.

The positive anomaly for the last sample date – and the fact that this occurred at virtually all sites – suggests N input through precipitation, which typically carries a more positive δ^{18}O signature in NO_x compared to other sources (Figure 7). The δ^{18}O anomaly immediately followed a 1.5 cm precipitation event that occurred in the region on 6 January 2011. This precipitation event was fairly large, and occurred after several weeks of little rain (Figure 8). This finding is consistent with other estimates from the region that identify atmospheric deposition as an important source of inorganic N input to watersheds. For example, bulk atmospheric deposition has been estimated to contribute 32% of nitrogen loading to the Tampa Bay watershed (Poor 2002).

Table 1. Typical values and ranges (10-90% confidence limits) for $\delta^{15}N$ of ammonium and nitrate and $\delta^{18}O$ of nitrate from various sources.

Source	Species	$\delta^{15}N$ ‰	$\delta^{18}O$ ‰
Synthetic Fertilizer	Ammonium	-1.0 (-5.6 to 4.8)	
	Nitrate	1.0 (-4.4 to 6.1)	22.1(15.5 to 25.6)
Precipitation	Ammonium	-1.6 (-13.4 to 12.8)	
	Nitrate	0.2 (-7.8 to 8.7)	57.9 (25.6 to 77.2)
Manure	Ammonium	10.5 (5.3 to 25.3)	
Sewage and Wastewater	Ammonium	10.0 (4.3 to 19.6)	
Nitrification	Nitrate	3.5 (-4.1 to 7.9)	7.4 (0.4 to 15.1)[+]
Soils	Bulk	4.0 (-2.0 to 8.0)[*]	

*Unpublished data of Hungate et al. from Florida spodosols shows typical values of -6 to -2 for soil organic nitrogen in the region. Negative $\delta^{15}N$ values are typical of surface horizons with low clay content.

+ For the region in question, the $\delta^{18}O$ of precipitation is -2 to -6 ‰ vs SMOW (GNIP, www-naweb.iaea.org/napc/ih/GNIP/). In nitrification, two atoms of oxygen are derived from local water, and one from atmospheric O_2 (22.5 ‰), allowing theoretical prediction of the $\delta^{18}O$ of nitrate derived from nitrification, after allowing for 5 per mil enrichment of local water due to evaporative enrichment (Mayer et al. 2001). Therefore, the expected $\delta^{18}O$ of nitrate produced by nitrification is 3.8 to 11.5 ‰. Values within this range are consistent with *in situ* microbial origin.

Table 2. Slopes and r^2 values for indicators of *in situ* denitrification, including the relationships between NO_3^- concentration and $\delta^{15}N$-NO_3^- (a slope with a negative value is one indicator), and between $\delta^{15}N$ and $\delta^{18}O$ values in NO_3^- (a slope with a value between 1.3 and 2.1 are indicators). Each value shows the slope and r^2 for multiple samples taken over time from a single site (n=4-5 for each site).

	slope		r^2	
	$[NO_3]$ vs $\delta^{15}N$	$\delta^{15}N$ vs $\delta^{18}O$	$[NO_3]$ vs $\delta^{15}N$	$\delta^{15}N$ vs $\delta^{18}O$
Site # 1	*-3.48*	0.77	0.22	0.06
Site # 2	*-57.97*	1.17	0.49	0.98
Site # 3	77.26	2.26	0.07	0.60
Site # 4	9.69	0.44	0.48	0.13
Site # 5	73.99	-0.52	0.96	0.03
Site # 6	20.38	**1.92**	0.62	0.72
Site # 7	*-12.12*	6.51	0.51	0.55
Site # 8	-5.03	-1.60	0.22	0.08
Site # 9	2.13	-2.46	0.06	0.38
Site # 10	9.36	-0.72	0.03	0.09
Site # 11	82.51	0.60	0.92	0.24
Site # 12	43.54	-0.71	0.56	0.04
Site # 13	14.76	-1.16	0.12	0.07
Site # 14	56.43	-0.30	0.82	0.01
Site # 15	22.22	**2.04**	0.57	0.71
Site # 16	42.89	-0.04	0.34	0.00
Site # 17	*-27.91*	-1.88	0.08	0.22
Site # 18	61.79	-4.80	0.92	0.52

Table 3. Slopes and r^2 values for indicators of *in situ* denitrification, including the relationships between NO_3^- concentration and $\delta^{15}N$-NO_3^- (a slope with a negative value is one indicator), and between $\delta^{15}N$ and $\delta^{18}O$ values in NO_3^- (a slope with a value between 1.3 and 2.1 are indicators). Each value shows the slope and r^2 for multiple sites sampled on a given date (n=17 for each date).

	slope		r^2	
Date	$[NO_3]$ vs $\delta^{15}N$	$\delta^{15}N$ vs $\delta^{18}O$	$[NO_3]$ vs $\delta^{15}N$	$\delta^{15}N$ vs $\delta^{18}O$
10/19/2010	3.56	0.39	0.02	0.22
11/1/2010	12.71	0.00	0.16	0.00
11/16/2010	11.45	0.80	0.03	0.65
12/7/2010	3.55	-0.08	0.03	0.01
1/18/2011	13.26	-2.03	0.34	0.42

Table 4. $\delta^{15}N$ and $\delta^{18}O$ values of NO_3^- collected in the Long Branch Creek system. Values are means ± standard deviations for each site sampled in the system.

	$\delta^{15}N$-NO_x ‰		$\delta^{18}O$-NO_x ‰	
Site 1	4.18	± 1.07	3.06	± 3.37
Site 2	-0.43	± 3.06	5.95	± 3.62
Site 3	-4.11	± 3.52	-0.01	± 10.27
Site 4	3.06	± 1.64	2.63	± 1.98
Site 5	1.89	± 2.71	7.97	± 8.14
Site 6	2.51	± 1.34	3.30	± 3.03
Site 7	1.31	± 0.71	4.16	± 6.21
Site 8	3.10	± 1.03	3.99	± 5.76
Site 9	6.59	± 0.74	0.91	± 2.96
Site 10	2.43	± 1.52	6.39	± 3.57
Site 11	-0.71	± 3.01	1.87	± 3.65
Site 12	4.95	± 0.99	1.38	± 3.57
Site 13	4.96	± 0.82	2.38	± 3.59
Site 14	5.30	± 1.23	2.16	± 3.19
Site 15	13.17	± 0.35	6.85	± 1.40
Site 16	7.41	± 1.57	3.61	± 2.76
Site 17	4.53	± 1.33	10.34	± 5.35
Site 18	4.72	± 0.61	4.74	± 4.04

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Appendix I. [NO_x], $\delta^{15}N-NO_x$, and $\delta^{18}O-NO_x$ for individual sites and sampling events from the Long Branch Creek System

Sample ID	Sample Location	Date Collected	[NO_x] (mg N/L)	$\delta^{15}N_{Air}$ (‰)	$\delta^{18}O_{VSMOW}$ (‰)
2715	Site # 1	10/19/10	0.90	0.61	-3.82
2716	Site # 2	10/19/10	0.02	4.39	10.68
2717	Site # 3	10/19/10	<0.02	-7.66	-8.69
2718	Site # 4	10/19/10	<0.02	-2.52	1.40
2720	Site # 5	10/19/10	0.05	0.05	-1.12
2721	Site # 6	10/19/10	<0.02	N.D.	N.D.
2722	Site # 7	10/19/10	0.20	1.32	-1.13
2723	Site # 8	10/19/10	0.60	1.54	-0.37
2725	Site # 9	10/19/10	0.03	7.44	-4.44
2726	Site # 10	10/19/10	<0.02	0.14	1.40
2727	Site # 11	10/19/10	0.02	-6.05	-1.55
2728	Site # 12	10/19/10	0.17	5.66	-4.29
2729	Site # 13	10/19/10	0.29	5.93	-0.08
2730	Site # 14	10/19/10	0.19	7.46	-1.16
2731	Site # 15	10/19/10	0.26	13.75	6.85
2732	Site # 16	10/19/10	0.19	10.61	2.89
2733	Site # 17 Pond	10/19/10	<0.02	4.42	4.61
2938	Site # 1	11/1/10	0.53	4.71	-1.06
2939	Site # 2	11/1/10	<0.02	1.05	6.74
2940	Site # 3	11/1/10	<0.02	-1.39	4.03
2941	Site # 4	11/1/10	0.02	2.13	5.11
2942	Site # 5	11/1/10	0.05	-2.80	1.27
2943	Site # 6	11/1/10	<0.02	3.78	1.24
2945	Site # 7	11/1/10	0.25	2.16	-3.30
2946	Site # 8	11/1/10	0.37	5.20	-2.83
2947	Site #9	11/1/10	0.05	8.01	-2.11
2949	Site # 10	11/1/10	<0.02	-1.90	10.41
2950	Site # 11	11/1/10	<0.02	-8.19	-5.44
2951	Site # 12	11/1/10	0.12	6.52	-1.97
2953	Site # 13	11/1/10	0.28	2.69	-1.47
2954	Site # 14	11/1/10	0.18	7.21	0.14
2955	Site # 15	11/1/10	0.22	12.42	4.11
2956	Site # 16	11/1/10	0.18	8.63	0.69
2957	Site # 17 Pond	11/1/10	<0.02	4.98	7.89

Sample ID	Sample Location	Date Collected	**[NO_x] (mg N/L)**	**$\delta^{15}N_{Air}$ (‰)**	**$\delta^{18}O_{VSMOW}$ (‰)**
3052	Site # 1	11/16/10	0.22	4.49	1.19
3053	Site # 2	11/16/10	0.20	-11.95	-7.02
3054	Site # 3	11/16/10	0.01	-16.03	-29.45
3055	Site # 4	11/16/10	0.05	3.90	-3.52
3056	Site # 5	11/16/10	0.23	12.19	-5.60
3059	Site # 7	11/16/10	0.38	-0.01	-2.09
3060	Site # 8	11/16/10	0.06	5.87	-2.76
3061	Site #9	11/16/10	0.45	7.93	-0.70
3063	Site # 10	11/16/10	0.06	4.74	-1.84
3064	Site # 11	11/16/10	0.16	7.73	-2.02
3065	Site # 12	11/16/10	0.18	6.65	-2.16
3067	Site # 13	11/16/10	0.30	7.47	-1.47
3068	Site # 14	11/16/10	0.20	6.65	-0.75
3069	Site # 15	11/16/10	0.17	12.56	5.22
3070	Site # 16	11/16/10	0.18	10.39	3.97
3071	Site # 17 Pond	11/16/10	0.02	9.24	3.80
3072	Site # 18	11/16/10	0.06	6.28	-2.14
3265	Site # 1	12/7/10	0.47	7.28	3.29
3266	Site # 2	12/7/10	0.01	-0.67	5.02
3267	Site # 3	12/7/10	<0.01	3.76	0.16
3268	Site # 4	12/7/10	<0.01	4.36	1.88
3269	Site # 5	12/7/10	0.05	-2.01	5.56
3270	Site # 6	12/7/10	<0.01	0.61	-0.38
3272	Site # 7	12/7/10	0.24	-0.40	-1.60
3273	Site # 8	12/7/10	0.33	0.67	-1.08
3274	Site #9	12/7/10	0.03	4.65	-0.63
3276	Site # 10	12/7/10	<0.01	6.51	3.78
3277	Site # 11	12/7/10	0.09	-1.36	2.89
3279	Site # 12	12/7/10	0.08	1.25	-0.10
3280	Site # 13	12/7/10	0.20	4.66	-1.77
3281	Site # 14	12/7/10	0.09	0.92	-2.24
3282	Site # 16	12/7/10	0.10	2.95	-3.06
3283	Site # 17 Pond	12/7/10	<0.01	1.92	3.87
3284	Site # 18	12/7/10	0.02	4.05	1.39

Sample ID	Sample Location	Date Collected	**$[NO_x]$ (mg N/L)**	**$\delta^{15}N_{Air}$ (‰)**	**$\delta^{18}O_{VSMOW}$ (‰)**
178	Site # 1	1/18/11	0.06	3.79	15.70
179	Site # 2	1/18/11	0.10	5.00	14.32
180	Site # 3	1/18/11	0.04	0.77	33.92
181	Site # 4	1/18/11	0.60	7.45	8.30
182	Site # 5	1/18/11	0.11	2.05	39.74
183	Site # 6	1/18/11	0.21	5.65	12.34
185	Site # 7	1/18/11	0.12	3.47	28.95
186	Site # 8	1/18/11	0.13	2.24	26.96
187	Site # 9	1/18/11	0.22	4.92	12.43
188	Site # 10	1/18/11	0.16	2.66	18.19
189	Site # 11	1/18/11	0.18	4.35	15.47
190	Site # 12	1/18/11	0.16	4.66	15.41
192	Site # 13	1/18/11	0.24	4.03	16.70
193	Site # 14	1/18/11	0.18	4.23	14.82
195	Site # 15	1/18/11	0.28	13.95	11.21
196	Site # 16	1/18/11	0.20	4.46	13.55
197	Site # 17 Pond	1/18/11	0.06	2.09	31.55
198	Site # 18	1/18/11	0.03	3.82	14.97

APPENDIX F

FIELD AND LABORATORY QA / QC DATA

Long Branch Creek Project
Matrix Spike Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETER	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE RECEIVED	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	Dilution Factor	THEOR. CONC.	MEAS. CONC.	PERCENT RECOVERY	ACCEPTANCE RANGE
Alkalinity	mg/l	10-2723	Site #8	10/19/10	10/19/10	10/25/10	234	50	1000	0.6	1	246	246	100%	91-105
Alkalinity	mg/l	10-2957	Site #17	11/01/10	11/01/10	11/09/10	224	50	1000	0.6	1	236	237	100%	91-105
Alkalinity	mg/l	10-3072	Site #18	11/16/10	11/16/10	11/22/10	241	50	1000	0.6	1	253	252	100%	91-105
Alkalinity	mg/l	10-3277	Site #11	12/07/10	12/07/10	12/09/10	252	50	1000	0.6	1	264	264	100%	91-105
Alkalinity	mg/l	10-2949	Site #10	11/01/10	11/01/10	11/09/10	226	50	1000	0.6	1	238	239	100%	91-105
Alkalinity	mg/l	11-0189	Site 11	01/18/11	01/18/11	01/21/11	107	50	1000	0.3	1	113	112	99%	91-105
Alkalinity	mg/l	11-0188	Site #10	01/18/11	01/18/11	01/21/11	113.0	50	1000	0.3	1	119	119	100%	91-105
Turbidity	NTU	10-2733	Site #17	10/19/10	10/19/10	10/21/10	6.2	25	1000	0.25	1	16.2	15.5	96%	87.4 - 110
Turbidity	NTU	10-3072	Site #18	11/16/10	11/16/10	11/18/10	2.9	25	1000	0.25	1	12.9	12.8	99%	87.4 - 110
Turbidity	NTU	10-3284	Site #18	12/07/10	12/07/10	12/08/10	0.9	25	1000	0.25	1	10.9	10.1	93%	87.4 - 110
Turbidity	NTU	10-2731	Site #15	10/19/10	10/19/10	10/21/10	1.3	25	1000	0.25	1	11.3	10.7	95%	87.4 - 110
Turbidity	NTU	10-2957	Site #17	11/01/10	11/01/10	11/02/10	6.4	25	1000	0.25	1	16.4	17.2	105%	87.4 - 110
Turbidity	NTU	10-3068	Site #14	11/16/10	11/16/10	11/18/10	1.6	25	1000	0.25	1	11.6	12.0	103%	87.4 - 110
Turbidity	NTU	11-0194	Site 14 F.D.	01/18/11	01/18/11	01/20/11	2.1	50	4000	0.25	1	22.1	20.3	92%	87.4 - 110
Turbidity	NTU	11-0188	Site #10	01/18/11	01/18/11	01/20/11	1	50	4000	0.25	1	21.0	21.4	102%	87.4 - 110
SRP	µg/l	10-2719F	Site # 4 FD	10/19/10	10/19/10	11/03/10	34	10	20000	0.15	1	334	352	105%	90-110
SRP	µg/l	10-2956F	Site # 16	11/01/10	11/01/10	11/21/10	79	10	20000	0.175	1	429	438	102%	90-110
SRP	µg/l	10-3070F	Site # 16	11/16/10	11/16/10	12/01/10	57	10	20000	0.15	1	357	331	93%	90-110
SRP	µg/l	10-3269F	Site # 5	12/07/10	12/07/10	12/09/10	70	10	20000	0.15	1	370	386	104%	90-110
SRP	µg/l	11-0183F	Site # 6	01/18/11	01/18/11	01/19/11	35	10	20000	0.2	1	435	441	101%	90-110
NOx	µg/l	10-2719F	Site # 4 FD	10/19/10	10/19/10	11/03/10	0	10	22600	0.15	1	339	324	96%	90-110
NOx	µg/l	10-2956F	Site # 16	11/01/10	11/01/10	11/21/10	174	10	22600	0.15	1	513	553	108%	90-110
NOx	µg/l	10-3070F	Site # 16	11/16/10	11/16/10	12/01/10	164	10	22600	0.15	1	503	545	108%	90-110
NOx	µg/l	10-3269F	Site # 5	12/07/10	12/07/10	12/09/10	50	10	22600	0.15	1	389	359	92%	90-110
NOx	µg/l	11-0183F	Site # 6	01/18/11	01/18/11	01/19/11	186	10	11300	0.4	1	638	624	98%	90-110
Total N	µg/l	10-2733P	Site # 17 Pond	10/19/10	10/19/10	10/31/10	1054	5	22600	0.05	1	1280	1171	91%	90-110
Total N	µg/l	10-2733FP	Site # 17 Pond	10/19/10	10/19/10	10/31/10	623	5	22600	0.175	1	1414	1558	110%	90-110
Total N	µg/l	10-2956p	Site # 16	11/01/10	11/01/10	11/18/10	859	5	22600	0.25	1	1989	2055	103%	90-110
Total N	µg/l	10-2955fp	Site # 15	11/01/10	11/01/10	11/18/10	887	5	22600	0.25	1	2017	2129	106%	90-110
Total N	µg/l	10-3066fp	Site # 12 F.D.	11/16/10	11/16/10	12/10/10	990	5	22600	0.3	1	2346	2293	98%	90-110
Total N	µg/l	10-3068p	Site # 14	11/16/10	11/16/10	12/10/10	812	5	22600	0.3	1	2168	2269	105%	90-110
Total N	µg/l	10-3072fp	Site # 18	11/16/10	11/16/10	12/10/10	589	5	22600	0.3	1	1945	2033	105%	90-110
Total N	µg/l	10-3275p	FCEB	12/07/10	12/07/10	05/02/11	0	5	10000	0.075	1	150	139	93%	90-110
Total N	µg/l	11-0182fp	Site # 5	01/18/11	01/18/11	08/22/11	1812	5	100000	0.3	1	7812	7446	95%	90-110
Total N	µg/l	11-0194fp	Site # 14 F.D.	01/18/11	01/18/11	08/22/11	895	5	100000	0.3	1	6895	7382	107%	90-110

Long Branch Creek Project
Matrix Spike Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETER	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE RECEIVED	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	Dilution Factor	THEOR. CONC.	MEAS. CONC.	PERCENT RECOVERY	ACCEPTANCE RANGE
Total P	µg/l	10-2733P	Site # 17 Pond	10/19/10	10/19/10	12/31/10	37	5	20000	0.16	1	677	680	100%	90-110
Total P	µg/l	10-2733FP	Site # 17 Pond	10/19/10	10/19/10	12/31/10	9	5	20000	0.175	1	709	671	95%	90-110
Total P	µg/l	10-2956p	Site # 16	11/01/10	11/01/10	01/18/11	112	5	20000	0.225	1	1012	1035	102%	90-110
Total P	µg/l	10-2955fp	Site # 15	11/01/10	11/01/10	01/18/11	63	5	20000	0.225	1	963	989	103%	90-110
Total P	µg/l	10-3066fp	Site # 12 F.D.	11/16/10	11/16/10	02/15/11	52	5	20000	0.225	1	952	934	98%	90-110
Total P	µg/l	10-3068p	Site # 14	11/16/10	11/16/10	02/15/11	66	5	20000	0.225	1	966	928	96%	90-110
Total P	µg/l	10-3072fp	Site # 18	11/16/10	11/16/10	02/15/11	33	5	20000	0.225	1	933	921	99%	90-110
Total P	µg/l	10-3275p	FCEB	12/07/10	12/07/10	05/02/11	0	5	10000	0.075	1	150	149	99%	90-110
Total P	µg/l	10-3274fp	Site #9	12/07/10	12/07/10	05/03/11	31	5	10000	0.1	1	231	233	101%	90-110
Total P	µg/l	11-0182fp	Site # 5	01/18/11	01/18/11	08/22/11	88	5	10000	0.3	1	688	706	103%	90-110
Total P	µg/l	11-0194fp	Site # 14 F.D.	01/18/11	01/18/11	08/22/11	57	5	10000	0.3	1	657	651	99%	90-110
Ammonia	µg/l	10-2717P	Site # 3	10/19/10	10/19/10	12/14/10	30	10	10000	0.150	1	180	177	98%	90-110
Ammonia	µg/l	10-2941P	Site # 4	11/01/10	11/01/10	12/15/10	118	10	10000	0.125	1	243	233	96%	90-110
Ammonia	µg/l	10-2957P	Site # 17 Pond	11/01/10	11/01/10	12/15/10	75	10	10000	0.125	1	200	202	101%	90-110
Ammonia	µg/l	10-3062P	FCEB	11/16/10	11/16/10	12/17/10	14	10	10000	1.500	1	1514	1580	104%	90-110
Ammonia	µg/l	10-3272P	Site # 7	12/07/10	12/07/10	12/21/10	342	10	10000	0.100	1	442	457	103%	90-110
Ammonia	µg/l	11-0196P	Site # 16	01/18/11	01/18/11	02/07/11	98	10	10000	0.200	1	298	301	101%	90-110

Long Branch Creek Project
Sample Duplicate Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE RECEIVED	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
pH	s.u.	10-2723	Site #8	10/19/10	10/19/10	10/25/10	7.31	7.34	7	0.0	0.29	0-2
pH	s.u.	10-2733	Site #17	10/19/10	10/19/10	10/25/10	8.49	8.46	8	0.0	0.25	0-2
pH	s.u.	10-2942	Site #5	11/01/10	11/01/10	11/09/10	7.34	7.33	7	0.0	0.10	0-2
pH	s.u.	10-2957	Site #17	11/01/10	11/01/10	11/09/10	7.72	7.69	8	0.0	0.28	0-2
pH	s.u.	10-3061	Site #18	11/16/10	11/16/10	11/22/10	7.87	7.86	8	0.0	0.09	0-2
pH	s.u.	10-3072	Site #18	11/16/10	11/16/10	11/22/10	7.87	7.86	8	0.0	0.09	0-2
pH	s.u.	10-3266	Site #2	12/07/10	12/07/10	12/09/10	7.62	7.61	8	0.0	0.09	0-2
pH	s.u.	10-3277	Site #11	12/07/10	12/07/10	12/09/10	7.44	7.47	7	0.0	0.28	0-2
pH	s.u.	10-3284	Site #18	12/07/10	12/07/10	12/09/10	7.59	7.64	8	0.0	0.46	0-2
pH	s.u.	11-0178	Site #1	01/18/11	01/18/11	01/21/11	7.39	7.37	7	0.0	0.19	0-2
pH	s.u.	11-0188	Site #10	01/18/11	01/18/11	01/21/11	7.36	7.38	7	0.0	0.19	0-2
pH	s.u.	11-0189	Site #11	01/18/11	01/18/11	01/21/11	7.44	7.41	7	0.0	0.29	0-2
Alkalinity	mg/l	10-2733	Site #17	10/19/10	10/19/10	10/25/10	137	136	137	0.7	0.52	0-4
Alkalinity	mg/l	10-2723	Site #8	10/19/10	10/19/10	10/25/10	234	234	234	0.0	0.00	0-4
Alkalinity	mg/l	10-2942	Site #5	11/01/10	11/01/10	11/09/10	201	201	201	0.0	0.00	0-4
Alkalinity	mg/l	10-2957	Site #17	11/01/10	11/01/10	11/09/10	224	225	225	0.7	0.31	0-4
Alkalinity	mg/l	10-3061	Site #9	11/16/10	11/16/10	11/22/10	226	224	225	1.4	0.63	0-4
Alkalinity	mg/l	10-3072	Site #18	11/16/10	11/16/10	11/22/10	241	240	241	0.7	0.29	0-4
Alkalinity	mg/l	10-3266	Site #2	12/07/10	12/07/10	12/09/10	231	230	231	0.7	0.31	0-4
Alkalinity	mg/l	10-3277	Site #11	12/07/10	12/07/10	12/09/10	252	253	253	0.7	0.28	0-4
Alkalinity	mg/l	10-3284	Site #18	12/07/10	12/07/10	12/09/10	233	233	233	0.0	0.00	0-4
Alkalinity	mg/l	11-0178	Site #1	01/18/11	01/18/11	01/21/11	80.2	80.0	80	0.1	0.18	0-4
Alkalinity	mg/l	11-0189	Site #11	01/18/11	01/18/11	01/21/11	107	107	107	0.0	0.00	0-4
Alkalinity	mg/l	11-0188	Site #10	01/18/11	01/18/11	01/21/11	113	112	113	0.7	0.63	0-4
Conductivity	µmho/cm	10-2723	Site #8	10/19/10	10/19/10	11/16/10	921	919	920	1.4	0.15	0-5
Conductivity	µmho/cm	10-2733	Site #17	10/19/10	10/19/10	11/16/10	770	773	772	2.1	0.27	0-5
Conductivity	µmho/cm	10-2946	Site #8	11/01/10	11/01/10	11/30/10	1029	1031	1030	1.4	0.14	0-5
Conductivity	µmho/cm	10-2957	Site #17	11/01/10	11/01/10	11/30/10	723	720	722	2.1	0.29	0-5
Conductivity	µmho/cm	10-3058	Site #6 F.D.	11/16/10	11/16/10	11/30/10	732.0	732	732	0.0	0.00	0-5
Conductivity	µmho/cm	10-3072	Site #18	11/16/10	11/16/10	11/30/10	789	785	787	2.8	0.36	0-5
Conductivity	µmho/cm	10-3269	Site #5	12/07/10	12/07/10	12/17/10	517	519	518	1.4	0.27	0-5
Conductivity	µmho/cm	10-3279	Site #12	12/07/10	12/07/10	12/17/10	742	746	744	2.8	0.38	0-5
Conductivity	µmho/cm	10-3284	Site #18	12/07/10	12/07/10	12/17/10	743	746	745	2.1	0.28	0-5
Conductivity	µmho/cm	11-0182	Site #5	01/18/11	01/18/11	02/07/11	333	331	332	1.4	0.43	0-5
Conductivity	µmho/cm	11-0193	Site #14	01/18/11	01/18/11	02/07/11	371	373	372	1.4	0.38	0-5
Conductivity	µmho/cm	11-0198	Site #18	01/18/11	01/18/11	02/07/11	334	338	336	2.8	0.84	0-5

Long Branch Creek Project

Sample Duplicate Recovery Study

Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE RECEIVED	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
Turbidity	NTU	10-2723	Site #8	10/19/10	10/19/10	10/21/10	3.1	3.0	3	0.1	2.32	0 - 3.7
Turbidity	NTU	10-2733	Site #17	10/19/10	10/19/10	10/21/10	6.2	6.1	6	0.1	1.15	0 - 3.7
Turbidity	NTU	10-2731	Site #15	10/19/10	10/19/10	10/21/10	1.3	1.3	1	0.0	0.00	0 - 3.7
Turbidity	NTU	10-2947	Site #9	11/01/10	11/01/10	11/02/10	1.6	1.6	2	0.0	0.00	0 - 3.7
Turbidity	NTU	10-2957	Site #17	11/01/10	11/01/10	11/02/10	6.4	6.2	6	0.1	2.24	0 - 3.7
Turbidity	NTU	10-3060	Site #8	11/16/10	11/16/10	11/18/10	1.6	1.6	2	0.0	0.00	0 - 3.7
Turbidity	NTU	10-3072	Site #18	11/16/10	11/16/10	11/18/10	2.9	2.8	3	0.1	2.48	0 - 3.7
Turbidity	NTU	10-3273	Site #8	12/07/10	12/07/10	12/08/10	2.6	2.5	3	0.1	2.77	0 - 3.7
Turbidity	NTU	10-3284	Site #18	12/07/10	12/07/10	12/08/10	0.9	0.9	1	0.0	0.00	0 - 3.7
Turbidity	NTU	11-0183	Site #6	01/18/11	01/18/11	01/20/11	2.7	2.7	3	0.0	0.00	0 - 3.7
Turbidity	NTU	11-0194	Site #14 F.D.	01/18/11	01/18/11	01/20/11	2.1	2.0	2	0.1	3.45	0 - 3.7
Turbidity	NTU	11-0188	Site #10	01/18/11	01/18/11	01/20/11	1.0	1.0	1	0.0	0.00	0 - 3.7
TSS	mg/L	10-2720	Site #5	10/19/10	10/19/10	10/25/10	8.7	8.5	9	0.1	1.64	0 - 13
TSS	mg/L	10-2733	Site #17	10/19/10	10/19/10	10/25/10	17.6	16.5	17	0.8	4.56	0 - 13
TSS	mg/L	10-2946	Site #8	11/01/10	11/01/10	11/02/10	22.9	24.5	24	1.1	4.77	0 - 13
TSS	mg/L	10-2957	Site #17	11/01/10	11/01/10	11/02/10	12.6	12.2	12	0.3	2.28	0 - 13
TSS	mg/L	10-3055	Site #4	11/16/10	11/16/10	11/18/10	6.3	7.0	7	0.5	7.44	0 - 13
TSS	mg/L	10-3066	Site #12 F.D.	11/16/10	11/16/10	11/18/10	5.3	5.2	5	0.1	1.35	0 - 13
TSS	mg/L	10-3072	Site #18	11/16/10	11/16/10	11/18/10	5.4	6.2	6	0.6	9.75	0 - 13
TSS	mg/L	10-3269	Site #5	12/07/10	12/07/10	12/08/10	1.9	1.6	2	0.2	12.12	0 - 13
TSS	mg/L	10-3280	Site #13	12/07/10	12/07/10	12/08/10	3.2	3.2	3	0.0	0.00	0 - 13
TSS	mg/L	11-0182	Site #5	01/18/11	01/18/11	01/20/11	14.8	16.4	16	1.1	7.25	0 - 13
TSS	mg/L	11-0194	Site #14 Field Dup	01/18/11	01/18/11	01/20/11	4.4	4.5	4	0.1	1.59	0 - 13
TSS	mg/L	11-0185	Site #7	01/18/11	01/18/11	01/20/11	12.8	13.2	13	0.3	2.18	0 - 13
SRP	µg/l	10-2719F	Site # 4 FD	10/19/10	10/19/10	11/03/10	34	35	35	0.7	2.05	0-5
SRP	µg/l	10-2729F	Site # 13	10/19/10	10/19/10	11/03/10	38	35	36	1.4	3.89	0-5
SRP	µg/l	10-2946F	Site # 8	11/01/10	11/01/10	11/21/10	203	197	200	4.2	2.12	0-5
SRP	µg/l	10-2956F	Site # 16	11/01/10	11/08/10	11/21/10	79	85	82	3.9	4.74	0-5
SRP	µg/l	10-3060F	Site # 8	11/16/10	11/16/10	12/01/10	73	73	73	0.0	0.00	0-5
SRP	µg/l	10-3070F	Site # 16	11/16/10	11/16/10	12/01/10	57	57	57	0.0	0.00	0-5
SRP	µg/l	10-3269F	Site # 5	12/07/10	12/07/10	12/09/10	70	67	69	2.1	3.10	0-5
SRP	µg/l	10-3279F	Site # 12	12/07/10	12/07/10	12/09/10	33	33	33	0.0	0.00	0-5
SRP	µg/l	11-0183F	Site # 6	01/18/11	01/18/11	01/19/11	35	37	36	1.4	3.93	0-5
SRP	µg/l	11-0193F	Site # 14	01/18/11	01/18/11	01/20/11	30	30	30	0.0	0.00	0-5

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PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE RECEIVED	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	s	% RELATIVE STD. DEVIATION (RSD)	ACCEPTANCE RANGE (% RSD)
NOx	µg/l	10-2719F	Site # 4 FD	10/19/10	10/19/10	11/03/10	0	0	0	0.0	0.00	0-4
NOx	µg/l	10-2729F	Site # 13	10/19/10	10/19/10	11/03/10	221	211	216	7.1	3.27	0-4
NOx	µg/l	10-2946F	Site # 8	11/01/10	11/01/10	11/21/10	418	427	423	6.4	1.51	0-4
NOx	µg/l	10-2956F	Site # 16	11/01/10	11/08/10	11/21/10	174	179	177	3.5	2.00	0-4
NOx	µg/l	10-3060F	Site # 8	11/16/10	11/16/10	12/01/10	40	39	40	0.7	1.79	0-4
NOx	µg/l	10-3070F	Site # 16	11/16/10	11/16/10	12/01/10	164	167	166	2.1	1.28	0-4
NOx	µg/l	10-3269F	Site # 5	12/07/10	12/07/10	12/09/10	50	46	48	2.1	4.43	0-4
NOx	µg/l	10-3279F	Site # 12	12/07/10	12/07/10	12/09/10	81	77	79	2.8	3.58	0-4
NOx	µg/l	11-0183F	Site # 6	01/18/11	01/18/11	01/19/11	186	186	186	0.0	0.00	0-4
NOx	µg/l	11-0193F	Site # 14	01/18/11	01/18/11	01/20/11	160	159	160	0.7	0.44	0-4
Total N	µg/l	10-2723P	Site # 8	10/19/10	10/19/10	12/31/10	1073	1053	1063	14.1	1.33	0-5
Total N	µg/l	10-2723FP	Site # 8	10/19/10	10/19/10	12/31/10	1099	1038	1069	43.1	4.04	0-5
Total N	µg/l	10-2733P	Site # 17 Pond	10/19/10	10/19/10	12/31/10	1054	986	1020	48.1	4.71	0-5
Total N	µg/l	10-2733FP	Site # 17 Pond	10/19/10	10/19/10	12/31/10	623	667	645	31.1	4.82	0-5
Total N	µg/l	10-2946p	Site # 8	11/01/10	11/01/10	01/18/11	1357	1318	1338	27.6	2.06	0-5
Total N	µg/l	10-2945fp	Site # 7	11/01/10	11/01/10	01/18/11	1372	1426	1399	38.2	2.73	0-5
Total N	µg/l	10-2956p	Site # 16	11/01/10	11/01/10	01/18/11	859	849	854	7.1	0.83	0-5
Total N	µg/l	10-2955fp	Site # 15	11/01/10	11/01/10	01/18/11	887	862	875	17.7	2.02	0-5
Total N	µg/l	10-3056fp	Site # 5	11/16/10	11/16/10	02/15/11	1106	1112	1109	4.2	0.38	0-5
Total N	µg/l	10-3058p	Site # 6 F.D.	11/16/10	11/16/10	02/15/11	1001	946	974	38.9	3.99	0-5
Total N	µg/l	10-3066fp	Site # 12 F.D.	11/16/10	11/16/10	02/15/11	990	984	987	4.2	0.43	0-5
Total N	µg/l	10-3068p	Site # 14	11/16/10	11/16/10	02/15/11	812	834	823	15.6	1.89	0-5
Total N	µg/l	10-3072fp	Site # 18	11/16/10	11/16/10	02/15/11	589	563	576	18.4	3.19	0-5
Total N	µg/l	10-3265p	Site # 1	12/07/10	12/07/10	05/02/11	875	846	861	20.5	2.38	0-5
Total N	µg/l	10-3275p	FCEB	12/07/10	12/07/10	05/02/11	0	0	0	0.0	0.00	0-5
Total N	µg/l	10-3264fp	PCEB	12/07/10	12/07/10	05/03/11	0	0	0	0.0	0.00	0-5
Total N	µg/l	10-3274fp	Site #9	12/07/10	12/07/10	05/03/11	435	432	434	2.1	0.49	0-5
Total N	µg/l	10-3284fp	Site # 18	12/07/10	12/07/10	05/03/11	358	344	351	9.9	2.82	0-5
Total N	µg/l	11-0186fp	Site # 8	01/18/11	01/18/11	08/22/11	817	797	807	14.1	1.75	0-5
Total N	µg/l	11-0182fp	Site # 5	01/18/11	01/18/11	08/22/11	1812	1760	1786	36.8	2.06	0-5
Total N	µg/l	11-0192p	Site # 13	01/18/11	01/18/11	08/22/11	2006	1942	1974	45.3	2.29	0-5
Total N	µg/l	11-0194fp	Site # 14 F.D.	01/18/11	01/18/11	08/22/11	895	908	902	9.2	1.02	0-5

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Total P	µg/l	10-2723P	Site # 8	10/19/10	10/19/10	12/31/10	153	161	157	5.7	3.60	0-5
Total P	µg/l	10-2723FP	Site # 8	10/19/10	10/19/10	12/31/10	106	102	104	2.8	2.72	0-5
Total P	µg/l	10-2733P	Site # 17 Pond	10/19/10	10/19/10	12/31/10	37	39	38	1.4	3.67	0-5
Total P	µg/l	10-2733FP	Site # 17 Pond	10/19/10	10/19/10	12/31/10	9.4	10	10	0.4	4.37	0-5
Total P	µg/l	10-2946p	Site # 8	11/01/10	11/01/10	01/18/11	463	456	460	4.9	1.08	0-5
Total P	µg/l	10-2945fp	Site # 7	11/01/10	11/01/10	01/18/11	96	104	100	5.0	4.96	0-5
Total P	µg/l	10-2956p	Site # 16	11/01/10	11/01/10	01/18/11	112	105	109	4.9	4.56	0-5
Total P	µg/l	10-2955fp	Site # 15	11/01/10	11/01/10	01/18/11	63	63	63	0.0	0.00	0-5
Total P	µg/l	10-3056fp	Site # 5	11/16/10	11/16/10	02/15/11	176	176	176	0.0	0.00	0-5
Total P	µg/l	10-3058p	Site # 6 F.D.	11/16/10	11/16/10	02/15/11	188	191	190	2.1	1.12	0-5
Total P	µg/l	10-3066fp	Site # 12 F.D.	11/16/10	11/16/10	02/15/11	52	49	50	1.4	2.81	0-5
Total P	µg/l	10-3068p	Site # 14	11/16/10	11/16/10	02/15/11	66	66	66	0.0	0.00	0-5
Total P	µg/l	10-3072fp	Site # 18	11/16/10	11/16/10	02/15/11	33	36	34	1.4	4.12	0-5
Total P	µg/l	10-3265p	Site # 1	12/07/10	12/07/10	05/02/11	48	47	48	0.7	1.49	0-5
Total P	µg/l	10-3275p	FCEB	12/07/10	12/07/10	05/02/11	0	0	0	0.0	0.00	0-5
Total P	µg/l	10-3275p	FCEB	12/07/10	12/07/10	05/02/11	0	0	0	0.0	0.00	0-5
Total P	µg/l	10-3264fp	PCEB	12/07/10	12/07/10	05/03/11	0	0	0	0.0	0.00	0-5
Total P	µg/l	10-3274fp	Site #9	12/07/10	12/07/10	05/03/11	31	31	31	0.0	0.00	0-5
Total P	µg/l	10-3284fp	Site # 18	12/07/10	12/07/10	05/03/11	16	15	15	0.1	0.46	0-5
Total P	µg/l	11-0186p	Site # 8	01/18/11	01/18/11	08/22/11	121	124	123	2.1	1.73	0-5
Total P	µg/l	11-0182fp	Site # 5	01/18/11	01/18/11	08/22/11	88	84	86	2.8	3.29	0-5
Total P	µg/l	11-0192p	Site # 13	01/18/11	01/18/11	08/22/11	148	145	147	2.1	1.4	0-5
Total P	µg/l	11-0194fp	Site # 14 F.D.	01/18/11	01/18/11	08/22/11	57	53	55	2.5	4.5	0-5
Ammonia	µg/l	10-2717P	Site # 3	10/19/10	10/19/10	12/14/10	30	28	29	1.4	4.88	0-5
Ammonia	µg/l	10-2727P	Site # 11	10/19/10	10/19/10	12/14/10	201	195	198	4.2	2.14	0-5
Ammonia	µg/l	10-2941P	Site # 4	11/01/10	11/01/10	12/15/10	118	118	118	0.0	0.00	0-5
Ammonia	µg/l	10-2951P	Site # 12	11/01/10	11/01/10	12/15/10	71	72	72	0.7	0.99	0-5
Ammonia	µg/l	10-2957P	Site # 17 Pond	11/01/10	11/01/10	12/15/10	75	75	75	0.0	0.00	0-5
Ammonia	µg/l	10-3052P	Site # 1	11/16/10	11/16/10	12/17/10	143	139	141	2.8	2.01	0-5
Ammonia	µg/l	10-3062P	FCEB	11/16/10	11/16/10	12/17/10	0	0	0	0.0	0.00	0-5
Ammonia	µg/l	10-3072P	Site # 18	11/16/10	11/16/10	12/17/10	35	35	35	0.0	0.00	0-5
Ammonia	µg/l	10-3282P	Site # 16	12/07/10	12/07/10	12/21/10	80	79	80	0.7	0.89	0-5
Ammonia	µg/l	10-3272P	Site # 7	12/07/10	12/07/10	12/21/10	342	333	338	6.4	1.89	0-5
Ammonia	µg/l	11-0186P	Site # 8	01/18/11	01/18/11	03/07/11	178	173	176	3.5	2.01	0-5
Ammonia	µg/l	11-0196P	Site # 16	01/18/11	01/18/11	03/07/11	98	104	101	3.5	3.51	0-5

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Color	PCU	10-2939F	Site #2	11/01/10	11/01/10	11/02/10	100	100	100	0.0	0.00	0-5
Color	PCU	10-2949F	Site #10	11/01/10	11/01/10	11/02/10	72	71	72	0.7	0.99	0-5
Color	PCU	10-2957F	Site #17 Pond	11/01/10	11/01/10	11/02/10	45	44	45	0.7	1.59	0-5
Color	PCU	10-3060F	Site #8	11/16/10	11/16/10	11/18/10	30	30	30	0.0	0.00	0-5
Color	PCU	10-3070F	Site #16	11/16/10	11/16/10	11/18/10	48	46	47	1.4	3.01	0-5
Color	PCU	10-3072F	Site #18	11/16/10	11/16/10	11/18/10	58	58	58	0.0	0.00	0-5
Color	PCU	10-3269F	Site #5	12/07/10	12/07/10	12/08/10	50	48	49	1.4	2.89	0-5
Color	PCU	10-3279F	Site #12	12/07/10	12/07/10	12/08/10	45	45	45	0.0	0.00	0-5
Color	PCU	11-0177F	PCEB	01/18/11	01/20/11	12/08/10	0	0	0	0.0	0.00	0-5
Fecal Coliform	cfu/100 ml	10-2723W	Site # 8	10/20/10	10/20/10	10/20/10	144	145	2	2.2	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-2733W	Site # 17 Pond	10/20/10	10/20/10	10/20/10	3	3	0	0.5	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-2946W	Site # 8	11/02/10	11/02/10	11/02/10	60	64	2	1.8	0.03	0-0.44
Fecal Coliform	cfu/100 ml	10-2957W	Site # 17 Pond	11/02/10	11/02/10	11/02/10	12	13	1	1.1	0.03	0-0.44
Fecal Coliform	cfu/100 ml	10-3060W	Site # 8	11/17/10	11/17/10	11/17/10	7	7	1	0.8	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-3072W	Site # 17 Pond	11/17/10	11/17/10	11/17/10	62	56	2	1.7	0.04	0-0.44
Fecal Coliform	cfu/100 ml	10-3273W	Site # 8	12/08/10	12/08/10	12/08/10	61	58	2	1.8	0.02	0-0.44
Fecal Coliform	cfu/100 ml	10-3284W	Site # 17 Pond	12/08/10	12/08/10	12/08/10	106	98	2	2.0	0.03	0-0.44
Fecal Coliform	cfu/100 ml	10-0179W	Site # 2	01/26/10	01/26/10	01/26/10	1	1	0	0.0	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-0183W	Site # 6	01/26/10	01/26/10	01/26/10	0	0	0	-0.4	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-0194W	Site # 14 F.D.	01/27/10	01/27/10	01/27/10	0	0	0	-0.4	0.00	0-0.44
Fecal Coliform	cfu/100 ml	10-0198W	Site # 18	01/27/10	01/27/10	01/27/10	0	0	0	-0.4	0.00	0-0.44

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Alkalinity	mg/l	CCV	10/25/10	10/25/10	12.6	12.2	97%	91 - 105
Alkalinity	mg/l	CCV	10/25/10	10/25/10	12.6	12.4	98%	91 - 105
Alkalinity	mg/l	CCV	11/09/10	11/09/10	12.8	12.4	97%	91 - 105
Alkalinity	mg/l	CCV	11/09/10	11/09/10	12.6	12.8	102%	91 - 105
Alkalinity	mg/l	CCV	11/22/10	11/22/10	12.6	12.4	98%	91 - 105
Alkalinity	mg/l	CCV	11/22/10	11/22/10	12.6	12.6	100%	91 - 105
Alkalinity	mg/l	CCV	12/09/10	12/09/10	12.4	12.8	103%	91 - 105
Alkalinity	mg/l	CCV	12/09/10	12/09/10	12.4	12.6	102%	91 - 105
Alkalinity	mg/l	CCV	12/09/10	12/09/10	12.6	12.4	98%	91 - 105
Alkalinity	mg/l	CCV	01/21/11	01/21/11	6.6	6.8	103%	91 - 105
Alkalinity	mg/l	CCV	01/21/11	01/21/11	6.6	6.4	97%	91 - 105
Alkalinity	mg/l	CCV	01/21/11	01/21/11	6.8	6.6	97%	91 - 105
Turbidity	NTU	CCV	10/21/10	10/21/10	10.1	9.9	98%	87.4 - 110
Turbidity	NTU	CCV	10/21/10	10/21/10	10.0	10.3	103%	87.4 - 110
Turbidity	NTU	CCV	11/02/10	11/02/10	10.1	10.1	100%	87.4 - 110
Turbidity	NTU	CCV	11/18/10	11/18/10	10.0	9.9	99%	87.4 - 110
Turbidity	NTU	CCV	11/18/10	11/18/10	10.1	9.9	98%	87.4 - 110
Turbidity	NTU	CCV	12/08/10	12/08/10	10.2	9.9	97%	87.4 - 110
Turbidity	NTU	CCV	12/08/10	12/08/10	10.3	9.4	91%	87.4 - 110
Turbidity	NTU	CCV	10/21/10	10/21/10	10.2	9.3	91%	87.4 - 110
Turbidity	NTU	CCV	11/02/10	11/02/10	10.2	9.7	95%	87.4 - 110
Turbidity	NTU	CCV	01/20/11	01/20/11	20.1	19.7	98%	87.4 - 110
Turbidity	NTU	CCV	01/20/11	01/20/11	20.0	20.0	100%	87.4 - 110
Turbidity	NTU	CCV	01/20/11	01/20/11	20.0	18.9	95%	87.4 - 110
SRP	µg/l	CCV	11/03/10	11/03/10	100	104	104%	90-110
SRP	µg/l	CCV	11/03/10	11/03/10	100	99	99%	90-110
SRP	µg/l	CCV	11/21/10	11/21/10	100	100	100%	90-110
SRP	µg/l	CCV	11/21/10	11/21/10	100	100	100%	90-110
SRP	µg/l	CCV	12/01/10	12/01/10	100	105	105%	90-110
SRP	µg/l	CCV	12/01/10	12/01/10	100	97	97%	90-110
SRP	µg/l	CCV	12/09/10	12/09/10	100	102	102%	90-110
SRP	µg/l	CCV	12/09/10	12/09/10	100	101	101%	90-110
SRP	µg/l	CCV	01/19/11	01/19/11	100	103	103%	90-110
SRP	µg/l	CCV	01/20/11	01/20/11	100	100	100%	90-110
NOx	µg/l	CCV	11/03/10	11/03/10	1000.0	1034	103%	90-110
NOx	µg/l	CCV	11/03/10	11/03/10	1000.0	1005	101%	90-110
NOx	µg/l	CCV	11/21/10	11/21/10	1000.0	1032	103%	90-110
NOx	µg/l	CCV	11/21/10	11/21/10	1000	990	99%	90-110
NOx	µg/l	CCV	12/01/10	12/01/10	1000	1015	102%	90-110
NOx	µg/l	CCV	12/01/10	12/01/10	1000	1019	102%	90-110
NOx	µg/l	CCV	12/09/10	12/09/10	1000	1000	100%	90-110
NOx	µg/l	CCV	12/09/10	12/09/10	1000.0	988	99%	90-110
NOx	µg/l	CCV	01/19/11	01/19/11	1000	1007	101%	90-110
NOx	µg/l	CCV	01/20/11	01/20/11	1000	1019	102%	90-110

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Total N	µg/l	CCV	12/31/10	12/31/10	2500	2616	105%	90-110
Total N	µg/l	CCV	12/31/10	12/31/10	2500	2676	107%	90-110
Total N	µg/l	CCV	12/31/10	12/31/10	2500	2629	105%	90-110
Total N	µg/l	CCV	12/31/10	12/31/10	2500	2584	103%	90-110
Total N	µg/l	CCV	01/18/11	01/18/11	1000	1045	105%	90-110
Total N	µg/l	CCV	01/18/11	01/18/11	1000	1009	101%	90-110
Total N	µg/l	CCV	01/18/11	01/18/11	1000	1028	103%	90-110
Total N	µg/l	CCV	01/18/11	01/18/11	1000	1018	102%	90-110
Total N	µg/l	CCV	02/15/11	02/15/11	1000	1040	104%	90-110
Total N	µg/l	CCV	02/15/11	02/15/11	1000	1046	105%	90-110
Total N	µg/l	CCV	02/15/11	02/15/11	1000	1017	102%	90-110
Total N	µg/l	CCV	02/15/11	02/15/11	1000	988	99%	90-110
Total N	µg/l	CCV	02/15/11	02/15/11	1000	1007	101%	90-110
Total N	µg/l	CCV	05/02/11	05/02/11	1000	1019	102%	90-110
Total N	µg/l	CCV	05/02/11	05/02/11	1000	1038	104%	90-110
Total N	µg/l	CCV	05/03/11	05/03/11	1000	971	97%	90-110
Total N	µg/l	CCV	05/03/11	05/03/11	1000	1044	104%	90-110
Total N	µg/l	CCV	05/03/11	05/03/11	1000	1056	106%	90-110
Total N	µg/l	CCV	08/22/11	08/22/11	1000	1020	102%	90-110
Total N	µg/l	CCV	08/22/11	08/22/11	1000	1024	102%	90-110
Total N	µg/l	CCV	08/22/11	08/22/11	1000	1006	101%	90-110
Total N	µg/l	CCV	08/22/11	08/22/11	1000	1046	105%	90-110
Total P	µg/l	CCV	12/31/10	12/31/10	200	193	97%	90-110
Total P	µg/l	CCV	12/31/10	12/31/10	200	196	98%	90-110
Total P	µg/l	CCV	12/31/10	12/31/10	200	204	102%	90-110
Total P	µg/l	CCV	12/31/10	12/31/10	200	200	100%	90-110
Total P	µg/l	CCV	01/18/11	01/18/11	200	201	101%	90-110
Total P	µg/l	CCV	01/18/11	01/18/11	200	193	97%	90-110
Total P	µg/l	CCV	01/18/11	01/18/11	200	198	99%	90-110
Total P	µg/l	CCV	01/18/11	01/18/11	200	202	101%	90-110
Total P	µg/l	CCV	02/15/11	02/15/11	200	204	102%	90-110
Total P	µg/l	CCV	02/15/11	02/15/11	200	195	98%	90-110
Total P	µg/l	CCV	02/15/11	02/15/11	200	201	101%	90-110
Total P	µg/l	CCV	02/15/11	02/15/11	200	191	96%	90-110
Total P	µg/l	CCV	02/15/11	02/15/11	200	199	100%	90-110
Total P	µg/l	CCV	05/02/11	05/02/11	200	195	98%	90-110
Total P	µg/l	CCV	05/02/11	05/02/11	200	187	94%	90-110
Total P	µg/l	CCV	05/02/11	05/02/11	200	196	98%	90-110
Total P	µg/l	CCV	05/03/11	05/03/11	200	186	93%	90-110
Total P	µg/l	CCV	05/03/11	05/03/11	200	207	104%	90-110
Total P	µg/l	CCV	05/03/11	05/03/11	200	188	94%	90-110
Total P	µg/l	CCV	08/22/11	08/22/11	200	195	98%	90-110
Total P	µg/l	CCV	08/22/11	08/22/11	200	210	105%	90-110
Total P	µg/l	CCV	08/22/11	08/22/11	200	204	102%	90-110
Total P	µg/l	CCV	08/22/11	08/22/11	200	196	98%	90-110

Long Branch Creek Project
Continuing Calibration Verification Study
Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE DESCRIPTION	DATE PREPARED	DATE ANALYZED	THEOR. CONC.	MEASURED CONC.	PERCENT ACCURACY %	ACCEPTANCE RANGE (% RSD)
Ammonia	µg/l	CCV	12/14/10	12/14/10	100	103	103%	90-110
Ammonia	µg/l	CCV	12/14/10	12/14/10	100	98	98%	90-110
Ammonia	µg/l	CCV	12/15/10	12/15/10	100	106	106%	90-110
Ammonia	µg/l	CCV	12/15/10	12/15/10	100	104	104%	90-110
Ammonia	µg/l	CCV	12/15/10	12/15/10	100	105	105%	90-110
Ammonia	µg/l	CCV	12/17/10	12/17/10	100	100	100%	90-110
Ammonia	µg/l	CCV	12/17/10	12/17/10	100	100	100%	90-110
Ammonia	µg/l	CCV	12/17/10	12/17/10	100	100	100%	90-110
Ammonia	µg/l	CCV	12/21/10	12/21/10	100	98	98%	90-110
Ammonia	µg/l	CCV	12/21/10	12/21/10	100	104	104%	90-110
Ammonia	µg/l	CCV	03/07/11	03/07/11	100	91	91%	90-110
Ammonia	µg/l	CCV	03/07/11	03/07/11	100	106	106%	90-110
Color	PCU	CCV	11/02/10	11/02/10	30	30	100%	90-110
Color	PCU	CCV	11/02/10	11/02/10	30	30	100%	90-110
Color	PCU	CCV	11/02/10	11/02/10	30	30	100%	90-110
Color	PCU	CCV	11/18/10	11/18/10	30	29	97%	90-110
Color	PCU	CCV	11/18/10	11/18/10	30	29	97%	85-115
Color	PCU	CCV	11/18/10	11/18/10	30	29	97%	85-115
Color	PCU	CCV	12/08/10	12/08/10	30	29	97%	85-115
Color	PCU	CCV	12/08/10	12/08/10	30	30	100%	85-115
Color	PCU	CCV	12/08/10	12/08/10	30	30	100%	85-115

Long Branch Creek Project
Method Blank Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE DESCRIPTION	DATE PREPARED	DATE ANALYZED	MEASURED CONC.	ACCEPTANCE RANGE (% RSD)
pH	s.u.	Method Blank	10/25/10	10/25/10	5.59	5.00-6.00
pH	s.u.	Method Blank	10/25/10	10/25/10	5.70	5.00-6.00
pH	s.u.	Method Blank	11/09/10	11/09/10	5.74	5.00-6.00
pH	s.u.	Method Blank	11/09/10	11/09/10	5.70	5.00-6.00
pH	s.u.	Method Blank	11/22/10	11/22/10	5.82	5.00-6.00
pH	s.u.	Method Blank	11/22/10	11/22/10	5.74	5.00-6.00
pH	s.u.	Method Blank	12/09/10	12/09/10	5.72	5.00-6.00
pH	s.u.	Method Blank	12/09/10	12/09/10	5.85	5.00-6.00
pH	s.u.	Method Blank	12/09/10	12/09/10	5.74	5.00-6.00
pH	s.u.	Method Blank	01/21/11	01/21/11	5.69	5.00-6.00
pH	s.u.	Method Blank	01/21/11	01/21/11	5.69	5.00-6.00
pH	s.u.	Method Blank	01/21/11	01/21/11	5.74	5.00-6.00
Alkalinity	mg/l	Method Blank	10/25/10	10/25/10	0.6	<1.0
Alkalinity	mg/l	Method Blank	10/25/10	10/25/10	0.8	<1.0
Alkalinity	mg/l	Method Blank	11/09/10	11/09/10	0.4	<1.0
Alkalinity	mg/l	Method Blank	11/09/10	11/09/10	0.4	<1.0
Alkalinity	mg/l	Method Blank	11/22/10	11/22/10	0.8	<1.0
Alkalinity	mg/l	Method Blank	11/22/10	11/22/10	0.6	<1.0
Alkalinity	mg/l	Method Blank	12/09/10	12/09/10	0.8	<1.0
Alkalinity	mg/l	Method Blank	12/09/10	12/09/10	0.8	<1.0
Alkalinity	mg/l	Method Blank	12/09/10	12/09/10	0.4	<1.0
Alkalinity	mg/l	Method Blank	01/21/11	01/21/11	0.4	<1.0
Alkalinity	mg/l	Method Blank	01/21/11	01/21/11	0.6	<1.0
Alkalinity	mg/l	Method Blank	01/21/11	01/21/11	0.6	<1.0
Conductivity	µmho/cm	Method Blank	11/16/10	11/16/10	0.1	<0.3
Conductivity	µmho/cm	Method Blank	11/16/10	11/16/10	0.1	<0.3
Conductivity	µmho/cm	Method Blank	11/30/10	11/30/10	0.1	<0.3
Conductivity	µmho/cm	Method Blank	11/30/10	11/30/10	0.1	<0.3
Conductivity	µmho/cm	Method Blank	11/30/10	11/30/10	0.2	<0.3
Conductivity	µmho/cm	Method Blank	11/30/10	11/30/10	0.2	<0.3
Conductivity	µmho/cm	Method Blank	12/17/10	12/17/10	0.3	<0.3
Conductivity	µmho/cm	Method Blank	12/17/10	12/17/10	0.3	<0.3
Conductivity	µmho/cm	Method Blank	12/17/10	12/17/10	0.3	<0.3
Conductivity	µmho/cm	Method Blank	02/07/11	02/07/11	0.0	<0.3
Conductivity	µmho/cm	Method Blank	02/07/11	02/07/11	0.2	<0.3
Conductivity	µmho/cm	Method Blank	02/07/11	02/07/11	0.2	<0.3

Long Branch Creek Project

Method Blank Recovery Study

Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE DESCRIPTION	DATE PREPARED	DATE ANALYZED	MEASURED CONC.	ACCEPTANCE RANGE (% RSD)
Turbidity	NTU	Method Blank	10/21/10	10/21/10	0.1	<0.2
Turbidity	NTU	Method Blank	10/21/10	10/21/10	0.2	<0.2
Turbidity	NTU	Method Blank	10/21/10	10/21/10	0.0	<0.2
Turbidity	NTU	Method Blank	11/02/10	11/02/10	0.1	<0.2
Turbidity	NTU	Method Blank	11/02/10	11/02/10	0.0	<0.2
Turbidity	NTU	Method Blank	11/18/10	11/18/10	0.0	<0.2
Turbidity	NTU	Method Blank	11/18/10	11/18/10	0.0	<0.2
Turbidity	NTU	Method Blank	12/08/10	12/08/10	0.0	<0.2
Turbidity	NTU	Method Blank	12/08/10	12/08/10	0.1	<0.2
Turbidity	NTU	Method Blank	01/20/11	01/20/11	0.0	<0.2
Turbidity	NTU	Method Blank	01/20/11	01/20/11	0.0	<0.2
Turbidity	NTU	Method Blank	01/20/11	01/20/11	0.0	<0.2
TSS	mg/L	Method Blank	10/25/10	10/25/10	0.3	<0.7
TSS	mg/L	Method Blank	10/25/10	10/25/10	0.4	<0.7
TSS	mg/L	Method Blank	11/02/10	11/02/10	0.3	<0.7
TSS	mg/L	Method Blank	11/02/10	11/02/10	0.3	<0.7
TSS	mg/L	Method Blank	11/18/10	11/18/10	0.3	<0.7
TSS	mg/L	Method Blank	11/18/10	11/18/10	0.4	<0.7
TSS	mg/L	Method Blank	11/18/10	11/18/10	0.3	<0.7
TSS	mg/L	Method Blank	12/08/10	12/08/10	0.2	<0.7
TSS	mg/L	Method Blank	12/08/10	12/08/10	0.2	<0.7
TSS	mg/L	Method Blank	01/20/11	01/20/11	0.2	<0.7
TSS	mg/L	Method Blank	01/20/11	01/20/11	0.2	<0.7
TSS	mg/L	Method Blank	01/20/11	01/20/11	0.3	<0.7
SRP	µg/l	Method Blank	11/03/10	11/03/10	<1	<1
SRP	µg/l	Method Blank	11/03/10	11/03/10	<1	<1
SRP	µg/l	Method Blank	11/21/10	11/21/10	<1	<1
SRP	µg/l	Method Blank	11/21/10	11/21/10	<1	<1
SRP	µg/l	Method Blank	12/01/10	12/01/10	<1	<1
SRP	µg/l	Method Blank	12/01/10	12/01/10	<1	<1
SRP	µg/l	Method Blank	12/09/10	12/09/10	<1	<1
SRP	µg/l	Method Blank	12/09/10	12/09/10	<1	<1
SRP	µg/l	Method Blank	01/19/11	01/19/11	<1	<1
SRP	µg/l	Method Blank	01/20/11	01/20/11	<1	<1

Long Branch Creek Project
Method Blank Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE DESCRIPTION	DATE PREPARED	DATE ANALYZED	MEASURED CONC.	ACCEPTANCE RANGE (% RSD)
NOx	µg/l	Method Blank	11/03/10	11/03/10	<1	<1
NOx	µg/l	Method Blank	11/03/10	11/03/10	<1	<1
NOx	µg/l	Method Blank	11/21/10	11/21/10	<1	<1
NOx	µg/l	Method Blank	11/21/10	11/21/10	<1	<1
NOx	µg/l	Method Blank	12/01/10	12/01/10	<1	<1
NOx	µg/l	Method Blank	12/01/10	12/01/10	<1	<1
NOx	µg/l	Method Blank	12/09/10	12/09/10	<1	<1
NOx	µg/l	Method Blank	12/09/10	12/09/10	<1	<1
NOx	µg/l	Method Blank	01/19/11	01/19/11	<1	<1
NOx	µg/l	Method Blank	01/20/11	01/20/11	<1	<1
Total N	µg/l	Method Blank	12/31/10	12/31/10	<1	<1
Total N	µg/l	Method Blank	12/31/10	12/31/10	<1	<1
Total N	µg/l	Method Blank	01/18/11	01/18/11	<1	<1
Total N	µg/l	Method Blank	01/18/11	01/18/11	<1	<1
Total N	µg/l	Method Blank	02/15/11	02/15/11	<1	<1
Total N	µg/l	Method Blank	02/15/11	02/15/11	<1	<1
Total N	µg/l	Method Blank	05/02/11	05/02/11	<1	<1
Total N	µg/l	Method Blank	05/02/11	05/02/11	<1	<1
Total N	µg/l	Method Blank	05/03/11	05/03/11	<1	<1
Total N	µg/l	Method Blank	05/03/11	05/03/11	<1	<1
Total N	µg/l	Method Blank	08/22/11	08/22/11	<1	<1
Total N	µg/l	Method Blank	08/22/11	08/22/11	<1	<1
Total P	µg/l	Method Blank	12/31/10	12/31/10	<1	<1
Total P	µg/l	Method Blank	12/31/10	12/31/10	<1	<1
Total P	µg/l	Method Blank	01/18/11	01/18/11	<1	<1
Total P	µg/l	Method Blank	01/18/11	01/18/11	<1	<1
Total P	µg/l	Method Blank	02/15/11	02/15/11	<1	<1
Total P	µg/l	Method Blank	02/15/11	02/15/11	<1	<1
Total P	µg/l	Method Blank	05/02/11	05/02/11	<1	<1
Total P	µg/l	Method Blank	05/02/11	05/02/11	<1	<1
Total P	µg/l	Method Blank	05/03/11	05/03/11	<1	<1
Total P	µg/l	Method Blank	05/03/11	05/03/11	<1	<1
Total P	µg/l	Method Blank	08/22/11	08/22/11	<1	<1
Total P	µg/l	Method Blank	08/22/11	08/22/11	<1	<1

Long Branch Creek Project
Method Blank Recovery Study
Samples Collected from October 2010 - January 2011

PARAMETERS	UNITS	SAMPLE DESCRIPTION	DATE PREPARED	DATE ANALYZED	MEASURED CONC.	ACCEPTANCE RANGE (% RSD)
Ammonia	µg/l	Method Blank	12/14/10	12/14/10	<1	<1
Ammonia	µg/l	Method Blank	12/14/10	12/14/10	<1	<1
Ammonia	µg/l	Method Blank	12/15/10	12/15/10	<1	<1
Ammonia	µg/l	Method Blank	12/15/10	12/15/10	<1	<1
Ammonia	µg/l	Method Blank	12/15/10	12/15/10	<1	<1
Ammonia	µg/l	Method Blank	12/17/10	12/17/10	<1	<1
Ammonia	µg/l	Method Blank	12/17/10	12/17/10	<1	<1
Ammonia	µg/l	Method Blank	12/17/10	12/17/10	<1	<1
Ammonia	µg/l	Method Blank	12/21/10	12/21/10	<1	<1
Ammonia	µg/l	Method Blank	12/21/10	12/21/10	<1	<1
Ammonia	µg/l	Method Blank	03/07/11	03/07/11	<1	<1
Ammonia	µg/l	Method Blank	03/07/11	03/07/11	<1	<1
Color	PCU	Method Blank	11/02/10	11/02/10	<1	<1
Color	PCU	Method Blank	11/02/10	11/02/10	<1	<1
Color	PCU	Method Blank	11/02/10	11/02/10	<1	<1
Color	PCU	Method Blank	11/18/10	11/18/10	<1	<1
Color	PCU	Method Blank	11/18/10	11/18/10	<1	<1
Color	PCU	Method Blank	11/18/10	11/18/10	<1	<1
Color	PCU	Method Blank	12/08/10	12/08/10	<1	<1
Color	PCU	Method Blank	12/08/10	12/08/10	<1	<1
Color	PCU	Method Blank	12/08/10	12/08/10	<1	<1
Fecal Coliform	cfu/100 ml	Method Blank	10/20/10	10/20/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	10/20/10	10/20/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	11/02/10	11/02/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	11/02/10	11/02/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	11/17/10	11/17/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	11/17/10	11/17/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	12/08/10	12/08/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	12/08/10	12/08/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	01/26/10	01/26/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	01/26/10	01/26/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	01/27/10	01/27/10	1µ	1µ
Fecal Coliform	cfu/100 ml	Method Blank	01/27/10	01/27/10	1µ	1µ