

NEW HANOVER COUNTY WATER QUALITY MONITORING PROGRAM

SECOND PROGRESS REPORT

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INTRODUCTION

The creeks in New Hanover County, North Carolina provide a wide range of recreational activities for thousands of local citizens and visiting tourists each year. Protection of the water quality within these creeks is a high priority of New Hanover County (County). As growth and development continue within the City of Wilmington and the County, water quality has been increasingly threatened due to many factors including aging infrastructure, increased impervious surface area and subsequent stormwater runoff. To address these issues, the County has administered a long-standing water quality monitoring program since 1993 designed to assess the water quality within the creeks located within the County.

New Hanover County signed a contract with Coastal Planning & Engineering of North Carolina, Inc. in October 2007 to perform a water quality monitoring project within seven tidal creeks between the months of November 2007 and June 2008. The creeks included in this study are Pages and Futch Creek, which drain into the Intracoastal Waterway (ICW) and Lords, Motts, Barnards, Smith, and Prince Georges Creek, which drain into the Cape Fear River. As listed in Table 1 and displayed in Figure 1, a total of 22 sampling sites have been established for this project. Fifteen (15) of the 22 sampling sites were previously monitored by the University of North Carolina at Wilmington. This historical data will be available for further analysis of trends within and between sites and will be incorporated into the Final Report.

Table 1. *List of Sampling Sites*

<u>Creek Name</u>	<u>Site Name</u>	<u>Site Code</u>	<u>Latitude</u>	<u>Longitude</u>
Motts Creek	Carolina Beach Road	MOT-CBR	34° 08.610	77° 53.830
Motts Creek	Normandy Drive	MOT-ND	34° 08.373	77° 54.580
Motts Creek	River Road	MOT-RR	34° 07.752	77° 54.966
Lords Creek	River Road	LC-RR	34° 05.185	77° 55.275
Barnards Creek	Carolina Beach Road	BC-CBR	34° 09.522	77° 54.712
Barnards Creek	River Road	BC-RR	34° 09.525	77° 56.281
Smith Creek	Castle Hayne Road	SC-CH	34° 15.541	77° 56.325
Smith Creek	23rd Street	SC-23	34° 15.472	77° 55.178
Smith Creek	Candlewood Drive	SC-CD	34° 17.438	77° 51.332
Smith Creek	North Kerr	SC-NK	34° 15.744	77° 53.256
Smith Creek	Gordon Road	SC-GR	34° 16.639	77° 52.037
Prince Georges Creek	Marathon Landing	PG-ML	34° 21.088	77° 55.349
Prince Georges Creek	Castle Hayne Road	PG-CH	34° 20.675	77° 54.217
Prince Georges Creek	North College	PG-NC	34° 20.331	77° 53.607
Futch Creek	4	FC-4	34° 18.068	77° 44.760
Futch Creek	6	FC-6	34° 18.178	77° 45.038
Futch Creek	8	FC-8	34° 18.25	77° 45.222
Futch Creek	13	FC-13	34° 18.214	77° 45.451
Futch Creek	Foy Branch	FC-FOY	34° 18.405	77° 45.358
Pages Creek	Mouth	PC-M	34° 16.209	77° 46.270
Pages Creek	Bayshore Drive Down Stream	PC-BDDS	34° 16.685	77° 47.673
Pages Creek	Bayshore Drive Up Stream	PC-BDUS	34° 16.623	77° 48.104

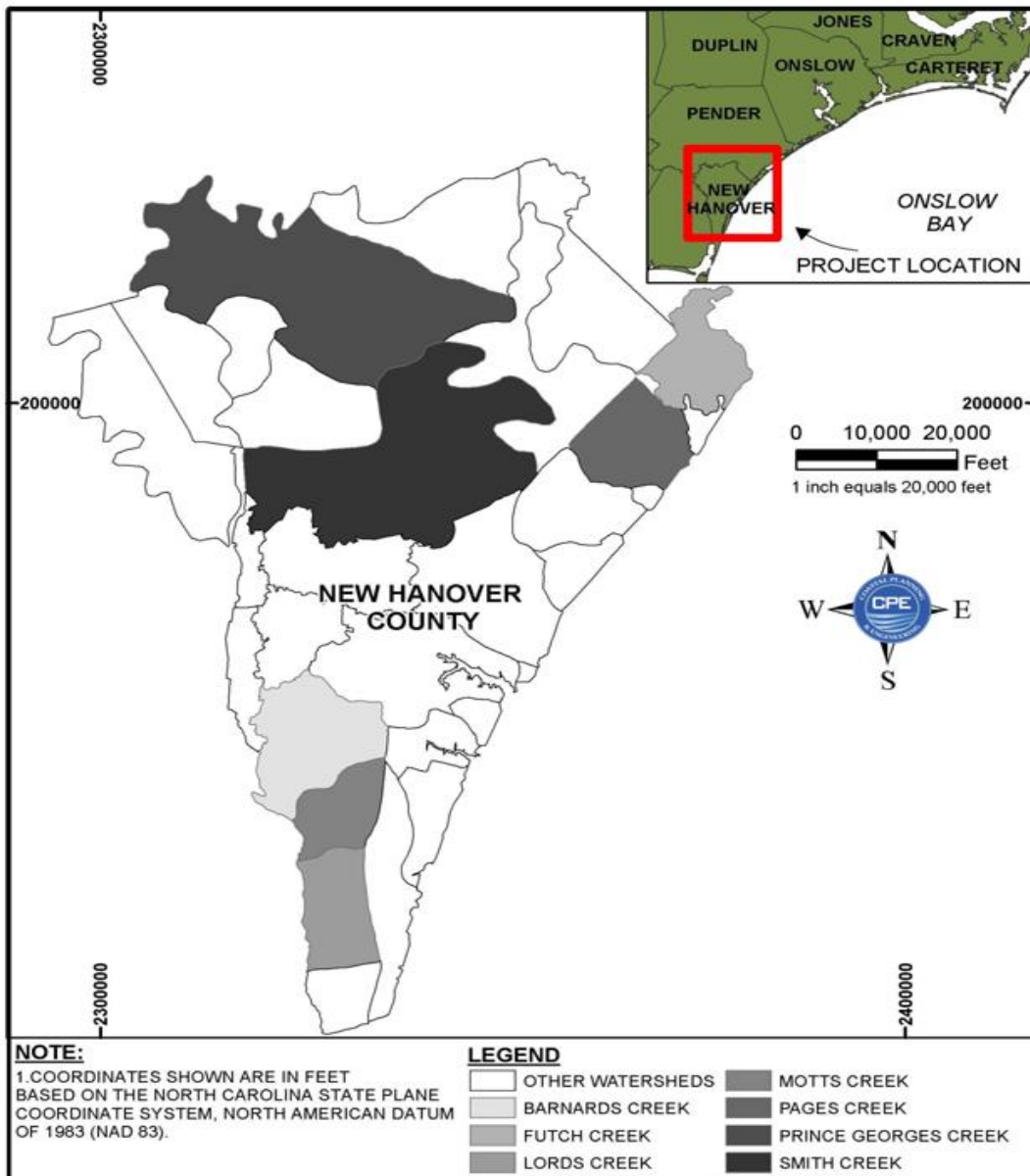


Figure 1: Map of New Hanover County and watersheds included in this study

The State of North Carolina has employed a series of classifications that apply to all waters in the State including streams, rivers, and lakes (NC Administrative Code, section 15A NCAC 2B .0200). These classifications are each meant to protect water bodies certain specified uses, such

as aquatic life survival and reproduction, secondary recreation, primary recreation, shellfishing, and water supply. The classifications that apply to the creeks examined in this study are:

C Sw: Freshwater that is protected for aquatic life and secondary recreation uses. The “Sw” supplemental classification indicates that these are swamp waters, and so are likely to have lower dissolved oxygen and pH than non-swamp streams due to natural conditions. However, a majority of the sites, including Lords Creek, Motts Creek, Barnards Creek, Smith Creek, and Prince Georges Creek, designated as C Sw by the State, are tidally influenced and have a brackish salinity range.

SA: Saline water bodies that are protected for shellfishing uses. This use requires a more stringent standard for fecal coliform. Protection for this use is in addition to protections for the uses specified by the “lower” classifications of SC and SB, which include aquatic life, secondary recreation, and primary recreation. This designation applies to Futch Creek and Pages Creek.

Physical, chemical, and biological water quality monitoring data are currently being collected for this study. Physical parameters include temperature, salinity, conductivity, pH, turbidity, and dissolved oxygen. Chemical parameters monitored in this study include orthophosphate and nitrate/nitrite. Biological parameters include chlorophyll-*a* and two suites of fecal indicator bacteria: *Enterococci* and fecal coliform bacteria. Due to limited funding, fecal coliform samples were only collected from sampling sites located within Futch Creek and Pages Creek. Fecal coliform bacteria have been collected within these two watersheds in recent years. By continuing the collection of this bacteria indicator, a long term analysis of fecal coliform levels within these watersheds will be possible.

Standards

Water quality standards have been established legislatively for a number of these parameters (Table 2). Many of the water quality standards are described in the NC Administrative Code, section 15A NCAC 2H .0100. The water quality standards for *Enterococci* bacteria are described by the US EPA (US EPA, 1986) and in the NC Administrative Code, section 15A NCAC 18A .3402. The US EPA standards for *Enterococci* bacteria are based on incidents of gastrointestinal illness following contact with bathing waters. Single sample maximum allowable *Enterococci* density is 104 CFU/100ml, 158 CFU/100ml, 276 CFU/100ml, and 501 CFU/100ml for designated beach areas, swimming areas with moderate to full body contact, lightly used full body contact swimming areas, and infrequently used full body contact swimming areas, respectively (Table 3). When at least five samples are collected within a 30 day period, the US EPA recommends utilizing a geometric mean standard of 35 CFU/100ml. Geometric means are often useful summaries for highly skewed data, as are often found with bacteriological datasets. The North Carolina Recreational Water Quality Program (RWQ) adopted similar standards for *Enterococci* bacteria, also determined by the frequency of swimming activity. As defined by RWQ, Tier I swimming areas are used daily during the swimming season, Tier II swimming areas are used three days a week during the swimming season, and Tier III swimming areas are used on average 4 days a month during the swimming season. Single sample standards for Tiers I, II, and III are 104 CFU/100ml, 276 CFU/100ml, and 500 CFU/100ml, respectively (Table 4). A geometric mean of 35 CFU/100ml within Tier I

swimming areas may also be utilized if at least five samples are collected within 30 days. The creeks included in this study have not been designated within the RWQ tier system; however an analysis of accessibility as a proxy for swimming and boating usage has been performed (Table 5). Of the 22 sampling sites, 3 have been designated as Tier II and 18 have been designated as Tier III.

Table 2. *North Carolina Water Quality Standards*

Parameter	Standard for SA Waters	Standard for C Sw Waters
Dissolved Oxygen	5.0 mg/l	4.0 mg/l ^a
Turbidity	25 NTU	50 NTU
pH	6.8-8.5	6.0-9.0 ^b
Chlorophyll- <i>a</i>	40.0 ug/l	40.0 ug/l
Fecal Coliform	Geometric Mean (5 samples within 30 days) <14 CFU/100ml; or single sample <43 CFU/100ml	Geometric Mean (5 samples within 30 days) <200 CFU/100ml; or single sample <400 CFU/100ml
<i>Enterococci</i> ^c	Geometric Mean (5 samples within 30 days) <35 CFU/100ml	Geometric Mean (5 samples within 30 days) <35 CFU/100ml

^(a) Swamp waters may have lower values if caused by natural conditions

^(b) For swamp streams, pH may be as low as 4.3 if caused by natural conditions

^(c) See Table 4 for single sample standards based off the tiered system employed by NC DENR Recreational Water Quality Program

Table 3. *Single sample standards for Enterococci as determined by the US EPA*

	Single sample maximum
Designated beach areas	< 104 CFU/100ml
Swimming areas with moderate full body contact	< 158 CFU/100ml
Lightly used full body contact swimming areas	< 276 CFU/100ml
Infrequently used full body contact swimming areas	< 501 CFU/100ml

Table 4. *Single sample standards for Enterococci as determined by the NC DENR Recreational Water Quality Program*

	Single sample maximum
Tier I, swimming areas used daily during the swimming season	<104 CFU/100ml
Tier II, swimming areas used three days a week during the swimming season	<276 CFU/100ml
Tier III, swimming areas used on average four days a month during the swimming season	<500 CFU/100ml

Table 5. *Proposed Tier Classification for New Hanover County Water Quality Monitoring Sampling Sites*

Site Name	Proposed Tier Classification	Accessible for Boating or Swimming	Comments
MOT-CBR	Tier III	No	Adjacent to culvert off Carolina Beach Road
MOT-ND	Tier III	No	Adjacent to small bridge on Normandy Drive
MOT-RR	Tier III	No	Adjacent to bridge on River Road
LC-RR	Tier III	No	Adjacent to bridge on River Road
BC-CBR	Tier III	No	Adjacent to culvert off Carolina Beach Road
BC-RR	Tier III	No	Adjacent to bridge on River Road
SC-CH	Tier III	No	Adjacent to bridge on Castle Hayne Road
SC-23	Tier III	No	Adjacent to bridge on 23rd Street
SC-CD	Tier III	No	Narrow, shallow. Adjacent to Candlewood Drive
SC-NK	Tier II	Yes	Small boat launch site off North Kerr
SC-GR	Tier III	No	Adjacent to culvert on Gordon Road
PG-ML	Tier III	No	Small boat launch site on private property
PG-CH	Tier III	No	Adjacent to culvert on Castle Hayne Road
PG-NC	Tier III	No	Adjacent to culvert on North College Road
FC-4	Tier III	No	Private docks are the only means of direct access
FC-6	Tier III	No	Private docks are the only means of direct access
FC-8	Tier III	No	Private docks are the only means of direct access
FC-13	Tier III	No	Private docks are the only means of direct access
FC-FOY	Tier III	No	No clear access points (no docks on Foy branch)
PC-M	Tier II	Yes	Direct access via docks and boat ramp at Pages Creek Marina
PC-BDDS	Tier III	No	Private docks are the only means of direct access
PC-BDUS	Tier II	Yes	Public boat ramp off Bayshore Drive

METHODS

The seven creeks included in this study were selected by County staff and individual sampling sites were selected by County staff in consultation with Coastal Planning & Engineering of North Carolina, Inc. These seven creeks are primarily located in the unincorporated portion of New Hanover County. Sampling sites were accessed from land, generally near a bridge or culvert crossing, or by boat. Each site was sampled one time per month during a high ebb tide. Tides were determined utilizing the National Oceanic and Atmospheric Administration's (NOAA) Tides and Currents website (<http://tidesandcurrents.noaa.gov/>).

Due to time constraints, monthly sampling events were conducted on three subsequent days each month. Lords Creek, Motts Creek, and Barnards Creek were visited on the first sampling day while Smith Creek and Prince Georges Creek were visited the second day. Futch Creek and Pages Creek were visited on the third day. Rainfall totals for the 24 hours prior to each sampling event were obtained from observations recorded at Wilmington International Airport as reported by NOAA's National Weather Service web site (<http://www.srh.noaa.gov/data/RAH/RTPRAH>).

Physical Parameters

All physical measurements (temperature, salinity, conductivity, turbidity, dissolved oxygen, and pH) were taken *in situ* utilizing a 6820 YSI Multiparameter Water Quality Probe linked to a YSI 650 MDS display unit. The YSI Probe was calibrated each day prior to use. Physical measurements were taken from the surface at all sites (depth = 0.1m) and near the creek bottom at sites with depths greater than 0.5m. Following each sampling trip, the YSI Probe was post-calibrated to ensure physical parameters measured were within an acceptable range.

Chemical and Biological Parameters

Water samples were obtained for the laboratory analysis of chemical (nitrate/nitrite and orthophosphate) and biological (*Enterococci*, fecal coliform, and chlorophyll-*a*) parameters. These grab samples were collected in sterile bottles during a high ebb tide from the surface at each site (depth = 0.1m). Trained volunteers from Cape Fear Community College's Marine Technology Department assisted Coastal Planning & Engineering of North Carolina, Inc. staff with the collection of water samples. Water samples were placed on ice immediately following collection and were delivered in coolers to Tritest Inc. of Wilmington, North Carolina for analysis. All analyses performed by Tritest, Inc. were conducted utilizing the following standard EPA approved methods:

Orthophosphate:	SM 4500E
Nitrate/Nitrite:	EPA 353.2
Chlorophyll- <i>a</i> :	SM 10200H
Fecal Coliform:	SM 9222D
Enterococcus:	EnterolertE

RESULTS

The preliminary results described in this report represent data collected following the January, February, and March 2008 sampling events. The results are organized by watershed and include data summaries displayed by parameter (physical, biological, and chemical).

Barnards Creek

Sampling was conducted on 23 January, 20 February, and 19 March 2008 at both sites (BC-CBR and BC-RR) within the Barnards Creek watershed. Dissolved oxygen within the creek ranged between 6.3 mg/l and 11.5 mg/l with a mean value of 8.5 mg/l. These values were within an acceptable level above the State standard of 4.0 mg/l for C Sw waters during all sampling events at both the surface and near the bottom of the water column. Chlorophyll-*a* ranged between 1.0 ug/l and 10.3 ug/l with a mean value of 2.9 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 51 CFU/100ml and 145 CFU/100ml with a geometric mean value of 90 CFU/100ml, which is within the NCDENR standard of 500 CFU/100ml for Tier III waters. Nitrate/nitrite levels ranged between 0.09 mg/l and 0.52 mg/l with a mean of 0.27 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.11 mg/l with a mean of 0.04 mg/l. While there is no applicable Federal or State standard for nitrate/nitrite or orthophosphate, values for these parameters observed in Barnards Creek during this quarter were the highest in this study.

Physical data collected from Barnards Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
1/23/08	BC-CBR	0.1	0.1	11.6	162	0.1	7.6	68%	6.5	0
1/23/08	BC-CBR	0.1	1.1	11.1	157	0.1	7.0	62%	6.6	2
1/23/08	BC-RR	0.1	0.1	10.1	14136	11.8	7.1	67%	7.4	11
1/23/08	BC-RR	0.1	1.4	10.1	14113	11.8	6.3	57%	7.5	11
2/20/08	BC-CBR	0.0	0.1	12.2	152	0.1	11.5	107%	7.1	1
2/20/08	BC-CBR	0.0	1.0	12.0	150	0.1	9.5	89%	7.0	11
2/20/08	BC-RR	0.0	0.1	12.2	7540	5.6	9.2	89%	7.0	16
2/20/08	BC-RR	0.0	1.6	12.2	7500	5.6	9.1	88%	7.1	16
3/19/08	BC-CBR	0.0	0.1	15.6	185	0.1	8.2	83%	6.7	3
3/19/08	BC-CBR	0.0	1.3	15.5	188	0.1	7.9	80%	6.7	3
3/19/08	BC-RR	0.0	0.1	15.0	3933	2.6	9.4	95%	7.0	14
3/19/08	BC-RR	0.0	2.1	15.1	3930	2.6	9.5	95%	7.0	14
						Min.	6.3	57%	6.5	0
						Max.	11.5	107%	7.5	16
						Mean	8.5	82%	7.0	9
						Std. Dev.	1.5	15%	0.3	6

Biological data collected from Barnards Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Chl-a (ug/l)
1/23/08	BC-CBR	0.1	0.1	56	1.0
1/23/08	BC-RR	0.1	0.1	143	1.0
2/20/08	BC-CBR	0.1	0.0	122	2.0
2/20/08	BC-RR	0.1	0.0	73	2.0
3/19/08	BC-CBR	0.1	0.0	145	1.0
3/19/08	BC-RR	0.1	0.0	51	10.3
		Min.	0.0	51	1.0
		Max.	0.1	145	10.3
		Mean	0.0	90 ¹	2.9
		Std. Dev.	0.1	43	3.7

⁽¹⁾*Enterococci* expressed as geometric mean

Chemical data collected from Barnards Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/23/08	BC-CBR	0.1	0.1	0.09	0.01
1/23/08	BC-RR	0.1	0.1	0.37	0.06
2/20/08	BC-CBR	0.1	0.0	0.09	0.01
2/20/08	BC-RR	0.1	0.0	0.52	0.11
3/19/08	BC-CBR	0.1	0.0	0.10	0.01
3/19/08	BC-RR	0.1	0.0	0.44	0.04
		Min.	0	0.09	0.01
		Max.	0.1	0.52	0.11
		Mean	0.0	0.27	0.04
		Std. Dev.	0.1	0.20	0.04

Futch Creek

Five sampling sites within Futch Creek were monitored on 25 January, 22 February, and 24 March, 2008. Dissolved oxygen within the creek ranged between 3.8 mg/l and 9.2 mg/l with a mean value of 7.1 mg/l. A number of these values obtained during February sampling were below the State standard of 5.0 mg/l for SA waters. Chlorophyll-*a* ranged between 1.0 ug/l and 4.0 ug/l with a mean value of 1.6 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 51 CFU/100ml and 145 CFU/100ml with a geometric mean value of 90 CFU/100ml, which is within the NCDENR standard of 500 CFU/100ml for Tier III waters. Nitrate/nitrite levels ranged between 0.01 mg/l and 0.04 mg/l with a mean of 0.02 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.04 mg/l with a mean of 0.01 mg/l. It is important to note that a significant rainfall (1.3 inches) was measured within 24 hours of sampling in February when low dissolved oxygen and samples high in bacteria were collected. Despite these high bacteria levels, chlorophyll-*a*, turbidity, nitrate/nitrite, and orthophosphate values were well within their respective standards and expected levels during this period at all sites.

Physical data collected from Futch Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)	
1/25/08	FC-13	0.0	0.1	7.5	36077	35.3	9.2	77%	8.0	1	
1/25/08	FC-13	0.0	0.5	7.5	36120	35.3	9.2	77%	8.0	0	
1/25/08	FC-4	0.0	0.1	8.2	37472	36.2	8.6	73%	8.1	0	
1/25/08	FC-4	0.0	1.1	8.2	37688	36.2	8.6	73%	8.1	0	
1/25/08	FC-6	0.0	0.1	8.1	37369	36.1	8.8	75%	8.1	0	
1/25/08	FC-6	0.0	1.2	8.1	37391	36.1	8.8	75%	8.1	0	
1/25/08	FC-8	0.0	0.5	7.8	36923	35.9	8.9	75%	8.1	0	
1/25/08	FC-8	0.0	0.1	7.7	36650	35.7	9.0	76%	8.1	1	
1/25/08	FC-FOY	0.0	0.7	7.7	36525	35.6	8.9	75%	8.1	1	
1/25/08	FC-FOY	0.0	0.1	7.7	36512	35.6	8.9	75%	8.1	1	
2/22/08	FC-13	1.3	0.1	9.8	33701	30.8	5.8	62%	8.0	1	
2/22/08	FC-13	1.3	0.7	9.9	34109	31.0	5.7	61%	8.0	1	
2/22/08	FC-4	1.3	0.1	10.3	37989	34.6	3.8 ¹	43%	8.1	1	
2/22/08	FC-4	1.3	0.5	10.3	38042	34.7	3.8 ¹	43%	8.1	1	
2/22/08	FC-6	1.3	0.1	10.0	37363	34.2	4.2 ¹	46%	8.1	0	
2/22/08	FC-6	1.3	0.6	10.1	37451	34.3	4.3 ¹	47%	8.1	1	
2/22/08	FC-8	1.3	0.5	10.0	36281	33.2	5.5	57%	8.1	2	
2/22/08	FC-8	1.3	0.1	9.9	36202	33.2	5.6	58%	8.1	0	
2/22/08	FC-FOY	1.3	0.7	9.8	18222	15.6	4.1 ¹	42%	8.1	1	
2/22/08	FC-FOY	1.3	0.1	9.8	18446	15.9	4.2 ¹	43%	8.1	1	
3/24/08	FC-13	0.0	0.1	13.5	39775	33.4	8.1	78%	7.9	0	
3/24/08	FC-13	0.0	0.1	13.6	40145	33.6	8.0	78%	8.0	0	
3/24/08	FC-4	0.0	1.3	13.6	42322	35.7	8.0	77%	8.1	0	
3/24/08	FC-4	0.0	0.1	13.7	42349	35.7	8.2	79%	8.1	0	
3/24/08	FC-6	0.0	0.1	13.7	41760	35.1	7.9	76%	8.1	0	
3/24/08	FC-6	0.0	1.1	13.7	41907	35.3	7.9	76%	8.1	2	
3/24/08	FC-8	0.0	0.1	13.5	40950	34.5	7.8	75%	8.0	4	
3/24/08	FC-8	0.0	0.6	13.5	41235	34.7	7.8	75%	8.0	0	
3/24/08	FC-FOY	0.0	0.1	13.6	40956	34.4	7.2	70%	8.0	0	
3/24/08	FC-FOY	0.0	0.6	13.6	41560	35.0	7.1	69%	8.1	0	
							Min.	3.8	42%	7.9	0
							Max.	9.2	79%	8.1	4
							Mean	7.1	67%	8.1	1
							Std. Dev.	1.9	13%	0.1	1

⁽¹⁾ values below State Standard for dissolved oxygen

Biological data collected from Futch Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Fecal Coliform (CFU/100ml)	Chl-a (ug/l)
1/25/08	FC-13	0.1	0.0	77	10	4.0
1/25/08	FC-4	0.1	0.0	28	30 ¹	1.0
1/25/08	FC-6	0.1	0.0	21	20 ¹	2.0
1/25/08	FC-8	0.1	0.0	17	6	1.0
1/25/08	FC-FOY	0.1	0.0	26	1	1.0
2/22/08	FC-13	0.1	1.3	417	580 ¹	4.0
2/22/08	FC-4	0.1	1.3	10	12	1.0
2/22/08	FC-6	0.1	1.3	20	23 ¹	1.0
2/22/08	FC-8	0.1	1.3	85	170 ¹	1.0
2/22/08	FC-FOY	0.1	1.3	158	380 ¹	1.0
3/24/08	FC-13	0.1	0.0	31	290 ¹	1.0
3/24/08	FC-4	0.1	0.0	5	2	1.0
3/24/08	FC-6	0.1	0.0	10	9	1.0
3/24/08	FC-8	0.1	0.0	41	18 ¹	3.3
3/24/08	FC-FOY	0.1	0.0	31	15 ¹	1.0
		Min.	0.0	5	1	1.0
		Max.	1.3	417	580	4.0
		Mean	0.4	32 ²	24 ^{1,2}	1.6
		Std. Dev.	0.6	105	176	1.2

⁽¹⁾ values exceeding State Standard for fecal coliform

⁽²⁾ *Enterococci* and fecal coliform expressed as geometric mean

Chemical data collected from Futch Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/25/08	FC-13	0.1	0.0	0.01	0.01
1/25/08	FC-4	0.1	0.0	0.02	0.01
1/25/08	FC-6	0.1	0.0	0.01	0.01
1/25/08	FC-8	0.1	0.0	0.01	0.01
1/25/08	FC-FOY	0.1	0.0	0.01	0.01
2/22/08	FC-13	0.1	1.3	0.04	0.04
2/22/08	FC-4	0.1	1.3	0.02	0.01
2/22/08	FC-6	0.1	1.3	0.03	0.01
2/22/08	FC-8	0.1	1.3	0.03	0.01
2/22/08	FC-FOY	0.1	1.3	0.03	0.01
3/24/08	FC-13	0.1	0.0	0.02	0.01
3/24/08	FC-4	0.1	0.0	0.02	0.01
3/24/08	FC-6	0.1	0.0	0.02	0.01
3/24/08	FC-8	0.1	0.0	0.03	0.01
3/24/08	FC-FOY	0.1	0.0	0.01	0.01
		Min.	0.0	0.01	0.01
		Max.	1.3	0.04	0.04
		Mean	0.4	0.02	0.01
		Std. Dev.	0.6	0.01	0.01

Lords Creek

One sampling site was monitored within Lords Creek on 25 January, 22 February, and 24 March, 2008. Dissolved oxygen LC-RR ranged between 8.3 mg/l and 9.4 mg/l with a mean value of 8.6 mg/l. These values were within an acceptable level above the State standard of 4.0 mg/l for C Sw waters during all sampling events at both the surface and near the bottom of the water column. Chlorophyll-*a* ranged between 1.0 ug/l and 6.0 ug/l with a mean value of 3.0 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 52 CFU/100ml and 75 CFU/100ml with a geometric mean value of 64 CFU/100ml, which is within the NCDENR standard of 500 CFU/100ml for Tier III waters. Nitrate/nitrite levels ranged between 0.12 mg/l and 0.30 mg/l with a mean of 0.19 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.07 mg/l with a mean of 0.03 mg/l.

Physical data collected from Lords Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
1/23/08	LC-RR	0.1	0.1	11.3	168	0.1	9.4	89%	6.7	4
1/23/08	LC-RR	0.1	1.1	10.4	17128	14.4	8.7	86%	7.0	7
2/20/08	LC-RR	0.0	0.1	12.4	4211	3.0	8.5	82%	6.2	3
2/20/08	LC-RR	0.0	0.8	11.4	8021	6.2	8.3	79%	6.4	9
3/19/08	LC-RR	0.0	0.1	15.2	8204	5.7	8.3	86%	6.7	11
3/19/08	LC-RR	0.0	1.5	15.2	8215	5.7	8.3	86%	6.8	15
						Min.	8.3	79%	6.2	3
						Max.	9.4	89%	7.0	15
						Mean	8.6	85%	6.6	8
						Std. Dev.	0.4	4%	0.3	4

Biological data collected from Lords Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Chl- <i>a</i> (ug/l)
1/23/08	LC-RR	0.1	0.1	68	2.0
2/20/08	LC-RR	0.1	0.0	52	1.0
3/19/08	LC-RR	0.1	0.0	75	6.0
		Min.	0.0	52	1.0
		Max.	0.1	75	6.0
		Mean	0.0	64 ¹	3.0
		Std. Dev.	0.1	12	2.7

⁽¹⁾ *Enterococci* expressed as geometric mean

Chemical data collected from Lords Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/23/08	LC-RR	0.1	0.1	0.15	0.07
2/20/08	LC-RR	0.1	0.0	0.12	0.01
3/19/08	LC-RR	0.1	0.0	0.30	0.02
	Min.		0.0	0.12	0.01
	Max.		0.1	0.30	0.07
	Mean		0.0	0.19	0.03
	Std. Dev.		0.1	0.10	0.03

Motts Creek

Three sampling sites within the Motts Creek watershed were included in this study. Water quality within these three sites was monitored on 25 January, 22 February, and 24 March, 2008. Dissolved oxygen within Motts Creek ranged between 6.9 mg/l and 9.1 mg/l with a mean value of 8.2 mg/l. These values were within an acceptable level above the State standard of 4.0 mg/l for C Sw waters during all sampling events at both the surface and near the bottom of the water column. Chlorophyll-*a* ranged between 1.0 ug/l and 9.3 ug/l with a mean value of 2.3 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 31 CFU/100ml and 272 CFU/100ml with a geometric mean value of 121 CFU/100ml, which is within the NCDENR standard of 500 CFU/100ml for Tier III waters. Nitrate/nitrite levels ranged between 0.11 mg/l and 0.29 mg/l with a mean of 0.16 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.10 mg/l with a mean of 0.03 mg/l.

Physical data collected from Motts Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
1/23/08	MOT-CBR	0.1	0.1	11.6	258	0.2	7.3	86%	6.8	6
1/23/08	MOT-ND	0.1	0.1	11.3	131	0.1	8.1	93%	7.0	5
1/23/08	MOT-RR	0.1	1.4	10.6	4553	3.5	6.9	82%	7.1	13
1/23/08	MOT-RR	0.1	0.1	10.6	4594	3.5	6.9	82%	7.2	9
2/20/08	MOT-CBR	0.0	0.1	12.7	266	0.2	9.1	86%	6.9	12
2/20/08	MOT-ND	0.0	0.1	12.1	254	0.2	8.9	83%	7.1	7
2/20/08	MOT-RR	0.0	1.4	12.0	420	0.3	8.9	83%	7.1	8
2/20/08	MOT-RR	0.0	0.1	11.9	429	0.3	9.0	84%	7.1	6
3/19/08	MOT-CBR	0.0	0.1	15.8	330	0.2	8.6	87%	6.7	9
3/19/08	MOT-ND	0.0	0.1	15.3	307	0.2	8.0	80%	6.7	6
3/19/08	MOT-RR	0.0	1.8	15.2	4463	3.0	8.1	82%	7.0	8
3/19/08	MOT-RR	0.0	0.1	15.3	4462	3.0	8.1	82%	7.0	7
	Min.						6.9	80%	6.7	5
	Max.						9.1	93%	7.2	13
	Mean						8.2	94%	7.0	8
	Std. Dev.						0.8	3%	0.2	2

Biological data collected from Motts Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Chl-a (ug/l)
1/23/08	MOT-CBR	0.1	0.1	135	2.0
1/23/08	MOT-ND	0.1	0.1	155	1.0
1/23/08	MOT-RR	0.1	0.1	125	1.0
2/20/08	MOT-CBR	0.1	0.0	171	3.3
2/20/08	MOT-NB	0.1	0.0	272	1.0
2/20/08	MOT-RR	0.1	0.0	243	1.0
3/19/08	MOT-CBR	0.1	0.0	31	1.0
3/19/08	MOT-NB	0.1	0.0	142	1.0
3/19/08	MOT-RR	0.1	0.0	41	9.3
		Min.	0.0	31	1.0
		Max.	0.1	272	9.3
		Mean	0.0	121 ¹	2.3
		Std. Dev.	0.1	80	2.8

⁽¹⁾*Enterococci* expressed as geometric mean

Chemical data collected from Motts Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/23/2008	MOT-CBR	0.1	0.1	0.18	0.01
1/23/2008	MOT-NB	0.1	0.1	0.14	0.01
1/23/2008	MOT-RR	0.1	0.1	0.14	0.02
2/20/2008	MOT-CBR	0.1	0.0	0.21	0.01
2/20/2008	MOT-NB	0.1	0.0	0.13	0.03
2/20/2008	MOT-RR	0.1	0.0	0.12	0.03
3/19/2008	MOT-CBR	0.1	0.0	0.11	0.1
3/19/2008	MOT-NB	0.1	0.0	0.12	0.01
3/19/2008	MOT-RR	0.1	0.0	0.29	0.03
		Min.	0.0	0.11	0.01
		Max.	0.1	0.29	0.10
		Mean	0.0	0.16	0.03
		Std. Dev.	0.1	0.06	0.03

Pages Creek

Three sampling sites were visited in the Pages Creek watershed on 25 January, 22 February, and 24 March, 2008. Dissolved oxygen within Pages Creek ranged between 2.9 mg/l and 7.7 mg/l with a mean value of 6.3 mg/l. With the exception of one observation at BC-BDUS of 2.9 mg/l, all other dissolved oxygen values were acceptable (above the State standard of 5.0 mg/l for SA waters). Chlorophyll-*a* ranged between 1.0 ug/l and 3.7 ug/l with a mean value of 1.6 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 5 CFU/100ml and 1542 CFU/100ml with a geometric mean value of 78 CFU/100ml. Samples collected in February at PC-BDUS and PC-BDDS contained enterococci levels higher than the NCDENR standard of 500 CFU/100ml. Fecal coliform levels ranged between 2 CFU/100ml and 3300 CFU/100ml with a geometric mean of 99 CFU/100ml. All samples collected during this quarter

within PC-BDUS and PC-BDDS contained fecal coliform levels above the NCDENR standard of 14 CFY/100ml for SA waters. It is important to note that a significant rainfall (1.3 inches) preceded sampling in February. Nitrate/nitrite levels ranged between 0.01 mg/l and 0.11 mg/l with a mean of 0.03 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.06 mg/l with a mean of 0.02 mg/l.

Physical data collected from Pages Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
1/25/08	PC-BDDS	0.0	0.1	8.1	35481	34.2	5.9	50%	7.9	1
1/25/08	PC-BDUS	0.0	0.1	10.0	28814	25.7	5.3	47%	7.5	1
1/25/08	PC-M	0.0	0.1	8.4	37384	35.9	7.7	66%	8.0	0
1/25/08	PC-M	0.0	1.9	8.4	37470	35.9	7.7	66%	8.0	0
2/22/08	PC-BDDS	1.3	0.1	9.7	6831	5.4	5.6	52%	8.0	4
2/22/08	PC-BDUS	1.3	0.1	10.6	24662	21.3	2.9 ¹	29%	7.8	12
2/22/08	PC-M	1.3	1.5	10.5	38316	34.7	6.4	71%	8.1	3
2/22/08	PC-M	1.3	0.1	10.5	38366	34.8	6.8	73%	8.1	2
3/24/08	PC-BDDS	0.0	0.1	15.1	36838	29.7	6.3	61%	7.9	0
3/24/08	PC-BDUS	0.0	0.1	16.3	29478	22.4	6.5	63%	7.6	1
3/24/08	PC-M	0.0	0.1	13.9	42530	35.6	7.3	71%	8.0	0
3/24/08	PC-M	0.0	1.4	13.9	42524	35.6	7.3	71%	8.1	0
						Min.	2.9	29%	7.5	0
						Max.	7.7	73%	8.1	12
						Mean	6.3	60%	7.9	2
						Std. Dev.	1.3	13%	0.2	3

⁽¹⁾ values below State Standard for dissolved oxygen

Biological data collected from Pages Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Enterococci (CFU/100ml)	Fecal Coliform (CFU/100ml)	Chl-a (ug/l)
1/25/08	PC-BDDS	0.1	0.0	238	2700 ¹	1.0
1/25/08	PC-BDUS	0.1	0.0	133	470 ¹	1.0
1/25/08	PC-M	0.1	0.0	118	2	3.3
2/22/08	PC-BDDS	0.1	1.3	637 ¹	1900 ¹	3.7
2/22/08	PC-BDUS	0.1	1.3	1542 ¹	21 ¹	1.0
2/22/08	PC-M	0.1	1.3	10	3300 ¹	1.0
3/24/08	PC-BDDS	0.1	0.0	20	28 ¹	1.0
3/24/08	PC-BDUS	0.1	0.0	30	47 ¹	1.0
3/24/08	PC-M	0.1	0.0	5	2	1.0
		Min.	0.0	5	2	1.0
		Max.	1.3	1542	3300	3.7
		Mean	0.4	78 ²	99 ²	1.6
		Std. Dev.	0.7	505	1325	1.1

⁽¹⁾ values exceeding State Standard for *Enterococci* and fecal coliform

⁽²⁾ *Enterococci* and fecal coliform expressed as geometric mean

Chemical data collected from Pages Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/25/08	PC-BDDS	0.1	0.0	0.01	0.01
1/25/08	PC-BDUS	0.1	0.0	0.01	0.03
1/25/08	PC-M	0.1	0.0	0.01	0.01
2/22/08	PC-BDDS	0.1	1.3	0.05	0.02
2/22/08	PC-BDUS	0.1	1.3	0.11	0.06
2/22/08	PC-M	0.1	1.3	0.03	0.01
3/24/08	PC-BDDS	0.1	0.0	0.03	0.01
3/24/08	PC-BDUS	0.1	0.0	0.01	0.01
3/24/08	PC-M	0.1	0.0	0.02	0.01
		Min.	0.0	0.01	0.01
		Max.	1.3	0.11	0.06
		Mean	0.4	0.03	0.02
		Std. Dev.	0.7	0.03	0.02

Prince Georges

Three sampling sites were visited in the Prince Georges Creek watershed on 24 January, 21 February, and 21 March 2008. Dissolved oxygen within Prince Georges Creek ranged between 2.5 mg/l and 8.8 mg/l with a mean value of 6.1 mg/l. With the exception of two values obtained near the bottom within PG-NC, these values were acceptable and within the State standard of 4.0 mg/l for C Sw. Chlorophyll-*a* ranged between 1.0 ug/l and 6.7 ug/l with a mean value of 3.0 ug/l. These values did not approach the 40ug/l standard. *Enterococci* ranged between 20 CFU/100ml and 1210 CFU/100ml with a geometric mean value of 69 CFU/100ml. One sample collected from PG-ML in January contained enterococci levels above the NCDENR standard of 500 CFU/100ml for Tier III waters, however all other samples were within the acceptable range. Nitrate/nitrite levels ranged between 0.01 mg/l and 0.03 mg/l with a mean of 0.06 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.02 mg/l with a mean of 0.01 mg/l.

Physical data collected from Prince Georges Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)
1/24/08	PG-ML	0.0	0.1	9.5	570	0.4	7.1	62%	7.1	1
1/24/08	PG-CH	0.0	0.1	9.5	206	0.1	6.6	57%	7.0	0
1/24/08	PG-CH	0.0	0.7	9.0	203	0.1	6.3	55%	6.9	1
1/24/08	PG-NC	0.0	0.1	8.2	126	0.1	8.8	74%	6.7	0
1/24/08	PG-NC	0.0	3.1	4.9	115	0.1	7.0	59%	6.7	3
2/19/08	PG-ML	0.0	0.1	14.0	483	0.3	7.6	74%	7.2	0
2/19/08	PG-CH	0.0	0.1	11.8	197	0.1	7.0	65%	7.2	2
2/19/08	PG-CH	0.0	1.1	11.8	194	0.1	6.6	61%	7.1	18
2/19/08	PG-NC	0.0	0.1	12.7	180	0.1	4.4	41%	6.8	0
2/19/08	PG-NC	0.0	3.4	10.2	183	0.1	2.5 ¹	22%	6.7	1
3/20/08	PG-ML	0.2	0.1	18.2	379	0.2	7.6	81%	7.3	0
3/20/08	PG-CH	0.2	0.1	18.5	285	0.2	6.2	64%	7.1	0
3/20/08	PG-CH	0.2	1.1	17.0	283	0.2	5.8	62%	7.0	4
3/20/08	PG-NC	0.2	0.1	16.7	211	0.1	4.2	43%	6.9	0
3/20/08	PG-NC	0.2	2.4	11.5	173	0.1	3.6 ¹	33%	6.8	4
						Min.	2.5	22%	6.7	0
						Max.	8.8	81%	7.3	18
						Mean	6.1	57%	7.0	2
						Std. Dev.	1.7	16%	0.2	5

⁽¹⁾ values below State Standard for dissolved oxygen

Biological data collected from Prince Georges Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Chl-a (ug/l)
1/24/2008	PG-CH	0.1	0.0	75	4.0
1/24/2008	PG-ML	0.1	0.0	1210 ¹	1.0
1/24/2008	PG-NC	0.1	0.0	33	1.0
2/19/2008	PG-CH	0.1	0.0	30	1.0
2/19/2008	PG-ML	0.1	0.0	52	6.7
2/19/2008	PG-NC	0.1	0.0	40	1.0
3/20/2008	PG-CH	0.1	0.2	52	4.0
3/20/2008	PG-ML	0.1	0.2	187	6.7
3/20/2008	PG-NC	0.1	0.2	20	2.0
		Min.	0	20	1.0
		Max.	0.2	1210	6.7
		Mean	0.1	69 ²	3.0
		Std. Dev.	0.1	386	2.4

⁽¹⁾ values exceeding State Standard for *Enterococci*

⁽²⁾ *Enterococci* expressed as geometric mean

Chemical data collected from Prince Georges Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/24/2008	PG-CH	0.1	0.0	0.12	0.02
1/24/2008	PG-ML	0.1	0.0	0.07	0.02
1/24/2008	PG-NC	0.1	0.0	0.05	0.01
2/19/2008	PG-CH	0.1	0.0	0.03	0.01
2/19/2008	PG-ML	0.1	0.0	0.07	0.01
2/19/2008	PG-NC	0.1	0.0	0.01	0.01
3/20/2008	PG-CH	0.1	0.2	0.13	0.01
3/20/2008	PG-ML	0.1	0.2	0.05	0.01
3/20/2008	PG-NC	0.1	0.2	0.03	0.01
	Min.		0.0	0.01	0.01
	Max.		0.2	0.13	0.02
	Mean		0.1	0.06	0.01
	Std. Dev.		0.1	0.04	0.00

Smith Creek

Five sampling sites were visited in the Smith Creek watershed on 24 January, 21 February, and 21 March 2008. Dissolved oxygen within the creek ranged between 5.8 mg/l and 10.5 mg/l with a mean value of 8.4 mg/l. These values were within an acceptable level above the State standard of 4.0 mg/l for C Sw waters during all sampling events at both the surface and near the bottom of the water column. Chlorophyll-*a* ranged between 1.0 ug/l and 21.4 ug/l with a mean value of 4.1 ug/l. These values did not approach the 40ug/l standard, however the value of 21.4 ug/l collected from SC-NK was the highest value observed from any creek during this quarter. *Enterococci* ranged between 5 CFU/100ml and 860 CFU/100ml with a geometric mean value of 142 CFU/100ml. A number of samples exceeded the NCDENR standard of 500 CFU/100ml for Tier III waters including two (2) from SC-CD. Nitrate/nitrite levels ranged between 0.06 mg/l and 0.49 mg/l with a mean of 0.19 mg/l. Orthophosphate levels ranged between 0.01 mg/l and 0.09 mg/l with a mean of 0.03 mg/l.

Physical data collected from Smith Creek

Date	Site Name	Rainfall (inches)	Depth (m)	Temp. (°C)	Specific Conductivity (us/cm)	Salinity (ppt)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (%)	pH	Turbidity (NTU)	
1/24/08	SC-CH	0.0	0.1	10.0	5848	4.6	5.8	52%	6.5	10	
1/24/08	SC-CH	0.0	1.6	9.8	6277	5.0	7.8	70%	6.7	16	
1/24/08	SC-23	0.0	0.1	9.5	2780	2.1	10.5	90%	7.1	9	
1/24/08	SC-23	0.0	2.2	9.5	2908	2.2	10.2	87%	7.1	9	
1/24/08	SC-CD	0.0	0.1	12.2	182	0.1	9.2	86%	7.0	1	
1/24/08	SC-NK	0.0	0.1	10.0	582	0.4	9.2	82%	7.0	2	
1/24/08	SC-NK	0.0	3.2	9.9	588	0.4	9.2	81%	6.9	6	
1/24/08	SC-GR	0.0	0.1	11.7	182	0.1	8.6	78%	7.0	1	
2/19/08	SC-CH	0.0	0.1	13.7	2309	1.6	7.6	74%	6.8	16	
2/19/08	SC-CH	0.0	1.5	13.7	2259	1.5	8.3	81%	6.9	21	
2/19/08	SC-23	0.0	0.1	15.0	1025	0.6	7.8	78%	7.1	15	
2/19/08	SC-23	0.0	2.3	15.0	1033	0.6	7.8	78%	7.2	16	
2/19/08	SC-CD	0.0	0.1	14.8	167	0.1	9.2	91%	7.1	17	
2/19/08	SC-NK	0.0	0.1	13.9	173	0.1	8.1	79%	7.0	13	
2/19/08	SC-NK	0.0	2.4	13.9	174	0.1	8.1	78%	7.0	15	
2/19/08	SC-GR	0.0	0.1	14.0	154	0.1	8.9	86%	7.0	12	
3/20/08	SC-CH	0.2	0.1	16.2	729	0.4	8.6	89%	7.3	6	
3/20/08	SC-CH	0.2	2.4	16.2	735	0.4	8.5	88%	7.3	18	
3/20/08	SC-23	0.2	0.1	17.1	579	0.3	8.6	89%	7.3	8	
3/20/08	SC-23	0.2	2.5	17.1	580	0.3	8.6	89%	7.3	9	
3/20/08	SC-CD	0.2	0.1	17.7	200	0.1	8.5	89%	7.1	5	
3/20/08	SC-NK	0.2	0.1	17.9	310	0.2	7.5	79%	7.1	3	
3/20/08	SC-NK	0.2	2.8	17.9	310	0.2	7.6	80%	7.1	4	
3/20/08	SC-GR	0.2	0.1	17.1	191	0.1	7.6	79%	7.1	1	
							Min.	5.8	52%	6.5	1
							Max.	10.5	91%	7.3	21
							Mean	8.4	81%	7.0	10
							Std. Dev.	1.0	8%	0.2	6

Biological data collected from Smith Creek

Date	Site Name	Depth (m)	Rainfall (in.)	<i>Enterococci</i> (CFU/100ml)	Chl-a (ug/l)
1/24/08	SC-23	0.1	0.0	649 ¹	2.0
1/24/08	SC-CD	0.1	0.0	41	1.0
1/24/08	SC-CH	0.1	0.0	107	2.7
1/24/08	SC-GR	0.1	0.0	53	2.0
1/24/08	SC-NK	0.1	0.0	122	2.7
2/19/08	SC-23	0.1	0.0	292	1.0
2/19/08	SC-CD	0.1	0.0	703 ¹	1.0
2/19/08	SC-CH	0.1	0.0	85	2.0
2/19/08	SC-GR	0.1	0.0	345	1.0
2/19/08	SC-NK	0.1	0.0	860 ¹	1.0
3/20/08	SC-23	0.1	0.2	5	17.4
3/20/08	SC-CD	0.1	0.2	708 ¹	4.7
3/20/08	SC-CH	0.1	0.2	52	1.0
3/20/08	SC-GR	0.1	0.2	275	1.0
3/20/08	SC-NK	0.1	0.2	41	21.4
	Min.		0.0	5	1.0
	Max.		0.2	860	21.4
	Mean		0.1	142	4.1
	Std. Dev.		0.1	296	6.3

⁽¹⁾ values exceeding State Standard for *Enterococci*

⁽²⁾ *Enterococci* expressed as geometric mean

Chemical data collected from Smith Creek

Date	Site Name	Depth (m)	Rainfall (in.)	Nitrate/Nitrite (mg/l)	Orthophosphate (mg/l)
1/24/08	SC-23	0.1	0.0	0.21	0.05
1/24/08	SC-CD	0.1	0.0	0.06	0.06
1/24/08	SC-CH	0.1	0.0	0.36	0.06
1/24/08	SC-GR	0.1	0.0	0.11	0.04
1/24/08	SC-NK	0.1	0.0	0.16	0.09
2/19/08	SC-23	0.1	0.0	0.14	0.02
2/19/08	SC-CD	0.1	0.0	0.07	0.01
2/19/08	SC-CH	0.1	0.0	0.49	0.04
2/19/08	SC-GR	0.1	0.0	0.13	0.02
2/19/08	SC-NK	0.1	0.0	0.14	0.01
3/20/08	SC-23	0.1	0.2	0.16	0.02
3/20/08	SC-CD	0.1	0.2	0.08	0.01
3/20/08	SC-CH	0.1	0.2	0.46	0.04
3/20/08	SC-GR	0.1	0.2	0.10	0.02
3/20/08	SC-NK	0.1	0.2	0.12	0.02
	Min.		0.0	0.06	0.01
	Max.		0.2	0.49	0.09
	Mean		0.1	0.19	0.03
	Std. Dev.		0.1	0.14	0.02

DISCUSSION

This report summarizes the water quality monitoring conducted by Coastal Planning & Engineering of North Carolina, Inc. within New Hanover County between January and March, 2008. The purpose of this report is to provide the public and County staff information on the current state of the creeks. Water quality is an important issue in the region due to the fact that there are many economic and recreational opportunities that are supported by the aquatic resources in and around these waterways. One of the greatest threats to water quality in this area is stormwater runoff created by increased impervious surface coverage (Mallin et al., 2000). Polluted stormwater runoff can have many adverse effects on plants, fish, animals and people. Excess nutrients can cause algae blooms while bacteria and other pathogens can wash into swimming areas and create health hazards. New Hanover County has experienced rapid growth and development over the past several decades. In 1990, the population within the County was 120,284. By 2006, the population grew over 50% to 182,591 (U.S. Census Bureau, 2006). Along with this population increase and subsequent stormwater runoff, numerous septic tanks, aging wastewater infrastructure, and other factors potentially impact the water quality within the County's creeks. With this in mind, it is important to monitor the water quality of these local systems to determine potential impacts to both human health and ecosystem function.

Algal blooms were not present at any site during the sampling events conducted between January and March. While sometimes problematic in the summer months, algal blooms are less common in the fall and winter when water temperature decreases. High levels of nutrients along with other physical conditions may trigger an algal bloom. Algal blooms may be indicated by high chlorophyll-*a*, low dissolved oxygen, and elevated pH values. Nitrite/nitrate and orthophosphate levels observed in this study were relatively low ranging between 0.01-0.52 mg/l and 0.01-0.11 mg/l, respectively. Chlorophyll-*a* levels ranged between 1.0 and 21.4 ug/l which was within the acceptable level of 40ug/l as determined by the State. The pH values were also found to be within acceptable ranges (6.2 to 8.1). By evaluating these factors together, it was apparent that no algal blooms were present during either sampling period.

Dissolved oxygen levels at a number of sites were below the State standard of 5.0 ml/l in SA waters and 4.0 mg/l in C Sw waters. The low dissolved oxygen values observed in previous months within MOT-CBR, MOT-ND, and SC-GR, which may have been attributable to recent brush clearing of the right-of-way adjacent to the creek banks, have rebounded within acceptable levels as anticipated. The dissolved oxygen within Futch Creek and Pages Creek observed during sampling conducted in February was 4.7 mg/l and 5.4, respectively, which is relatively low compared to previous years (Mallin, pers. comm.).

As observed in previous months, high levels of bacteria (*Enterococci* and fecal coliform) persisted during this quarter in Futch Creek and Pages Creek. The high levels of bacteriological indicators collected within PC-BDUS, PC-M, and SC-NK are of particular concern as these sites have been classified as Tier II sites due to their proximity to boat ramps and/or docks (Table 5). In February, sampling was conducted within Futch Creek and Pages Creek following a substantial rainfall of 1.3 inches, which could have increase the loading of bacteria into the system by way of stormwater runoff. Although fecal indicator bacteria are not pathogenic themselves, they correlate well with levels of illness in swimmers, in particular *Enterococci* (US EPA 1986). The US EPA has determined that the *Enterococci* provide the best correlation

between swimming-associated gastrointestinal illnesses (US EPA, 1984, US EPA, 1986). As a result of the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, State governments were mandated by the US EPA to adopt *Enterococci* bacteria as an indicator of human health risk in coastal recreational waters. Due to their ability to survive longer in salt water, *Enterococci* is considered to be more conservative indicator of pathogenic contaminants compared to fecal coliform (Hanes and Fragela, 1967; del Mar Lleò et al., 2005). Other research supports the functionality of utilizing either or both indicators to test for risks associated with contact with water (Harrington and Cahoon, 2007).

Additional data collected through the course of this eight month study will help provide insight as to the state of the water quality within the creeks in New Hanover County. In order to fully assess the water quality, it will be important to continue monitoring through the summer months when recreational activity increases within the creeks and water quality often diminishes. Long-term monitoring can help distinguish seasonal variation in the measured parameters.

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APPENDIX A

Maps of Watersheds and Sampling Sites