STORMWATER MANAGEMENT

NORTH AUGUSTA
STREAM WATER QUALITY
BASELINE ASSESSMENT

June 2007

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This report prepared by

Tanya Strickland
Environmental Coordinator
City of North Augusta
Stormwater Management Department

Questions or comments:
803-441-4246 or 803-441-4295
Or email
stormwater@northaugusta.net

2007 North Augusta
Stormwater Management Department
Stream and Water Quality Analysis

1. Overview

In 2003, North Augusta was designated a small municipal separate storm sewer system (sMS4) by the state as part of the federally mandated Phase II program of the Clean Water Act. In response to and in anticipation of these requirements, a stormwater utility program was created in 2002 through city ordinance. The resulting program was designated the North Augusta Stormwater Management Department (SWMD). The goal of the department is to meet the requirements of the state mandated sMS4 program. One of the key goals of the sMS4 program is to identify the watershed and to implement programs that will minimize impacts from non-point source pollution.

To determine if the programs will be effective at reducing pollution during storm events, a baseline assessment of water quality in North Augusta was conducted to learn present conditions. This report will present the findings of the initial assessment of water quality and the physical conditions of streams assessed within the city. The information here will be used as a comparison for future program development and to measure the effectiveness of the efforts to improve stream water quality by the community and the North Augusta SWMD.

2. Assessment Approach

2.1 Physical Stream Assessments

In 2003, initial strategies were developed to investigate the physical integrity of streams located in North Augusta. Several protocols for conducting stream assessments were investigated. They are listed below:

- The National Resource Conservation Service (NRCS) - Stream Visual Assessment Protocol, 1998 NWCC Technical Note 99-1
- The Rapid Stream Assessment Technique (RSAT) Evaluation Method
- EPA Rapid Bio-assessment Protocols Habitat Assessment

Using these techniques as a guide, the SWMD developed a simplified form for use in the field to conduct these investigations. The form includes a section to describe the drainage area, owner, land uses of the area, and physical conditions at the site. A site diagram is included through a GIS mapping system to identify the location of the investigation and the part of the stream assessed (reach). The site is scored on physical conditions including channel condition, hydrologic alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers, and fish cover. The resulting overall score can determine if the conditions at the stream segment are Poor, Fair, Good, or Excellent. A more comprehensive assessment that includes a habitat

assessment (macro-invertebrate) was conducted at several locations. The protocols for these assessments are included when questions pertaining to the simplified form arise. All assessments include photographs of the site at the time of the evaluation and at subsequent visits to the sites.

Streams are rated on the following criteria:

Features	**Scoring Range**
Channel Condition	10 – 1 (10 being best)
Bank Stability	10 – 1 (10 being best)
Barriers to Fish Movement	10 – 1 (10 being best)
Riffle Embeddedness (fine sediments in riffle habitat)	10 – 1 (10 being best)
Hydrologic Alteration	10 – 1 (10 being best)
Water Appearance	10 – 1 (10 being best)
In-stream Fish Cover	10 – 1 (10 being best)
Macro-invertebrates Observed	10 – 1 (10 being best)
Riparian Zone Condition	10 – 1 (10 being best)
Nutrient Enrichment	10 – 1 (10 being best)
Insect/invertebrate habitat	15 – -3 (-3 being worst)

Once these conditions are scored, the overall resulting score is calculated. Ratings for stream condition are determined by the following overall scores:

Overall Score	**Rating**
0 – 6.0	Poor
6.1 – 7.4	Fair
7.5 - 8.9	Good
9.0 and up	Excellent

Data collected is logged into a database and printed in a binder in the SWMD records department. The data is also stored in the Alchemy information management system that the city maintains.

2.2 Mapping SW Infrastructure

In addition to the assessment protocols, a basin-wide geographical information system (GIS) survey of stormwater infrastructure in North Augusta was initiated in 2004. Physical mapping of the stormwater infrastructure within the city is ongoing. To date 95% of the mapping of city infrastructure has been completed. In addition to these efforts, all new subdivisions developed within the city provide a digitized storm sewer system map (as built) to our Engineering Department upon completion. These maps are uploaded directly into the GIS storm sewer database.

2.3 North Augusta Basin Assessment

The city has been divided into basins using hydrology, topography, and flow information. Perennial, intermittent or ephemeral streams lead to a main branch or receiving water at the lowest point in a watershed or drainage basin.

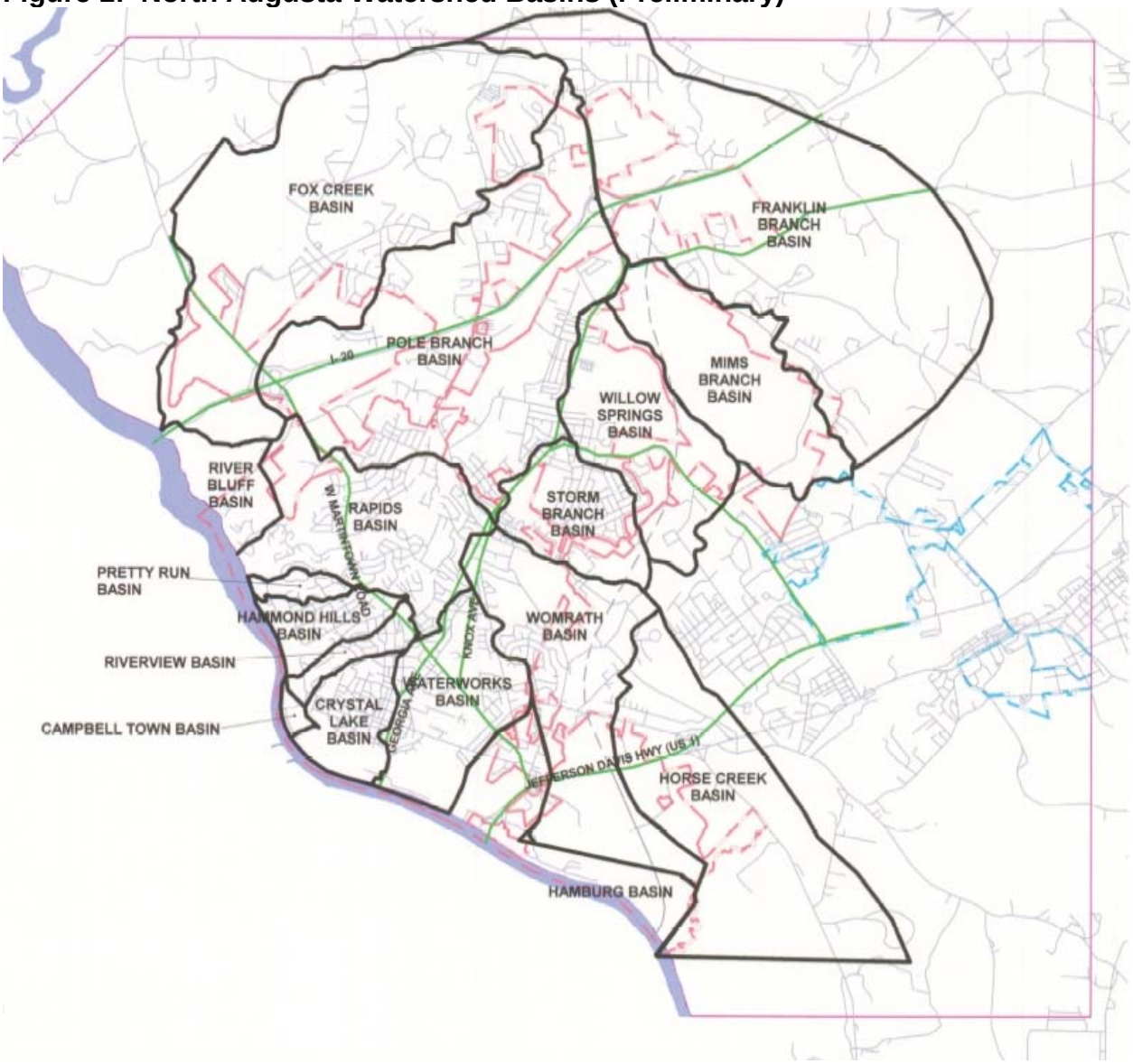
- Perennial streams are identified by well-defined banks and natural channels that have continuously flowing water year round.

- Intermittent streams have well-defined banks and natural channels that typically have flowing water from a headwater source for only a portion of the year.

- Ephemeral streams do not have well-defined channels and flow only in response to rainfall.

Figure 1 shows a map of the drainage basins in North Augusta. All of North Augusta's drainage basins are part of the larger Middle Savannah watershed and ultimately flow to the Savannah River. This map is an earlier attempt to define North Augusta's watershed. The map is being reviewed for accuracy. New maps will be developed from this one that more clearly represents North Augusta's watershed.

Figure 1: North Augusta Watershed Basins (Preliminary)



Notes: Willow Springs and Franklin Branch have so little impact from the city that currently, they are not being studied. Other basins have been renamed or combined to more accurately reflect conditions in the city.

Basins that are being assessed and monitored for water quality, illicit discharges, and infrastructure integrity are described in further detail in this report. Assessments have begun at several stream segments throughout the city. Basins with little or no flow and basins that are less impacted by residential, commercial, or industrial uses are not being included in this initial baseline assessment.

2.4 Water Quality Sampling Approach

Using the GIS maps, a sampling regime was initiated. Each basin's surface hydrology was reviewed and a sample point was designated at the lowest point prior to the stream entering the Savannah River. Table 1 represents the basin names and sample locations generated from a review of GIS maps. Several of these locations were sampled during dry weather events for various contaminants known to be present in urban area streams.

Specific basin sampling locations were chosen based on areas with the least pervious surface (most densely populated). Additionally, basins with industrial uses, high concentrations of active development, larger watersheds, or that contain a SC DHEC sample point location were investigated.

As a comparative sample point, a complete assessment was conducted at the only remaining undeveloped natural basin in North Augusta, Mims Branch. Data generated in this basin most likely represent conditions that the city would want to see in its other basins, and the data can be used as part of the stormwater management goals for streams throughout North Augusta. Also, with the pending development of this area, the data can be used to verify or assess if best management practices (BMPs) implemented during and after construction are working as designed.

Table 1: City of North Augusta Watershed Basin Primary Sampling Stations

BASIN	ID	Location	Coordinates
Fox Creek Basin	NA-FC-01	Bergen Road, last accessible point	Lat 33°32'15.5594'N Long 82°00'02.3130'W
River Bluff Basin	NA-RiB-01	Shoals Way at end (steps lead to creek) off of Barony Drive	Lat 33°31'16.1208'N Long 81°59'59.4716'W
Pole Branch Basin	NA-PB-01	Bergen Road at Willow Wick	Lat 33°32'34.5374'N Long 81°59'37.8097'W
Rapids Basin	NA-PR-01	Pretty Run Creek, Riverbluff Drive, service Rd on left by creek	Lat 33°31'01.7116'N Long 81°59'22.9954'W
Hammond Hills Basin	NA-HH-01	HH Pool on left, turn right on Greeneway, 2 ponds on right	Lat 33°30'34.9339'N Long 81°59'30.9520'W
Waterworks Basin	NA-WW-01	At Ditch on Shoreline Dr.	Lat 33°28'52.5332'N Long 81°57'50.3401'W
Storm Branch Basin	NA-SB-01	Power House Road crossing Storm Branch	Lat 33°30'43.8856'N Long 81°55'41.4954'W
Womrath Basin	NA-WB-01	At TTX Bridge in front of plant	Lat 33°29'28.7978'N Long 81°56'35.4559'W
Mims Branch Basin	NA-MB-01	Old Sudlow Lake Rd (creek)	Lat 33°32'15.5594'N Long 82°00'02.3130'W
Horse Creek Basin	NA-HC-01	Bridge at AikenPSA/Mayson Turf (aprox. 800 ft from Sav. River)	Lat 33°31'54.3591'N Long 81°54'12.0144'W
Crystal Lake Basin	NA-RV-01	End of Savannah Point Dr in Campbell Town Landing	Lat 33°29'23.0309'N Long 81°59'14.3328'W

Ambient monitoring of streams in North Augusta is conducted at most of the locations listed in Table 1. Samples are pulled either as grab samples during dry events, or

composite samples during rain events. In some instances, grab and composite samples are pulled. The field parameters taken at each sampling event include pH, temperature, dissolved oxygen (DO), turbidity, and sometimes residual chlorine (Cl_2). The samples are analyzed by independent laboratories for concentrations of a variety of constituents. The city uses the same routine sampling methods and analyzes for the same parameters as the South Carolina Department of Health and Environmental Control (SCDHEC) ambient stream monitoring program does for streams in South Carolina. These include total suspended solids (TSS) and nutrients including ammonia, phosphorus, nitrate/nitrite, and total Kjeldahl nitrogen. Metal concentration analysis is conducted on each sample including copper, cadmium, manganese, iron, lead, and zinc. Some metals that SCDHEC checks for have been omitted due to the rarity of a detectable concentration including. These include mercury, nickel and cadmium. In earlier sampling events, the city tested for nickel and cadmium but have since stopped unless an illicit discharge is detected in a stream.

Investigations of illicit discharges can require additional tests depending on the contaminant in question. If an illicit discharge is identified, a complete suite of analyses will be conducted including pesticides, herbicides, and volatile organic compounds (VOCs).

Results of all sampling during the past three years are compiled in this report for each basin. Comparisons of the data collected have been reviewed. The samples were compared to averages of other sampling efforts either by the National Storm Water Quality Database (NSQD) or by the state and federal standards. Results of the comparisons are shown by highlighting samples that are outside the range or above the averages based on these data. A complete table of the comparison data is presented in Table 21. An overall assessment is given at the end of this report.

Within various tables throughout the document, several terms or acronyms are given regarding standards. A brief overview of these terms or acronyms is given below as described in SCDHEC's Water Classification & Standards R-61-69, July 2004.

> **Criteria Maximum Concentrations – (CMC)** The criteria maximum concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.
>
> **Criterion Continuous Concentration – (CCC)** The criterion continuous concentration is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

The CMC and CCC are just two of the six parts of aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence.

2.5 Basins not Presented in this Baseline Report

Several basins have not been included in this baseline assessment. Each are listed below with a brief overview of reasons they were excluded from this baseline assessment.

- **Horse Creek Basin** is monitored by SCDHEC year round so ample data is being compiled. The reach of Horse Creek within the city limits is minimal. We will assist in developing better BMPs for Horse Creek through our teamed effort with Clemson Extension and others through a grant described in the Pretty Run Basin section of this report.
- **Franklin Branch Basin** has little to no impact from the city of North Augusta
- **Willow Springs Basin** has little to no impact from the city of North Augusta
- **Storm Branch Basin** is dry within the city limits of North Augusta. The location along Powerhouse Road where water from this basin would enter the stream system is checked routinely during sampling and has been dry during each event. This is due to the elimination of a city owned wastewater lagoon that was located within the basin and was the original headwaters. The new headwaters for Storm Branch Creek are located below the city limits.
- **Hamburg Basin** is a large wetland with no true channel to be sampled. Most of the waters within the basin are fed through the wetlands at various places into Horse Creek or the Savannah River.
- **Campbell Town Basin** is very small and will be sampled at a later date. Impacts from this basin to the Savannah River would be nominal due to land use being a soccer field and one residential street.
- **Hammond Hills Basin** is being studied and limited sampling results indicate low water quality. The basin streams and stormwater conveyances are spread throughout the community and the SWMD will be focusing on this basin within the next few years to better understand water transport. This basin contains an older highly dense residential community. Most of the stormwater infrastructure is overland flow or concrete ditches located behind the homes along property lines. A complete study of this basin is underway and will be reported as it is completed.

3. Stream Assessments

Mims Branch

Description

The Mims Branch basin drains a large undeveloped area located off of Highway 25 from Ascauga Lake Road to Blanchard Road and is bordered by Old Sudlow Lake Road. It is the only basin in the city that is nearly 100% undeveloped. The basin contains a perennial stream that is fed by groundwater percolation from an area located on the tract of land known as the Blanchard Tract. The basin was routinely sampled at Old Sudlow Lake Road where it leaves the city limits. In addition to this location, two other sample locations are currently being assessed to get an overall indication of stream and habitat quality.

At the present time, this basin is considered a “representative basin” since it is in a relatively undeveloped area and is not impacted by industrial, commercial or residential use. Data collected from this location can be considered representative of undeveloped conditions. Based on this, the stream water quality of this basin can be considered a target or goal for other streams located in the watershed. The basin is being sampled

and assessed in several locations to capture valuable data prior to development activities.

Physical Characteristics

Three different segments of the Mims Branch basin were investigated. The results of the assessments are represented in Table 2 below.

Table 2: Mims Branch Stream Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Mims Branch at Old Sudlow Lake Rd at bridge crossing (01)	8-10	95% Sand with 5% small gravel & silt	Heavily vegetated open wetland area upstream and wooded forest downstream, minnows present	**9** excellent
Mims Branch at dirt crossing off access road in headwater areas (02)	3-4	95% Sand with 5% small gravel & silt	Heavy forest and canopy, fish & macro invertebrate cover abundant, pools, minnows present, stable banks and wrested vegetation	**9.5** excellent
Mims Branch at Power Line easement at Old Sudlow Lake Rd. (03)	18-22	95% Sand with 5% small gravel & silt	Forest edges, open grassland power line right of way, braided channel, wetland vegetation, minnows present	**8.5** good

Water Quality Assessments

Mims Branch has been sampled at three locations. The data is represented in Table 3. The water quality standards or other non-regulatory risk levels proposed by EPA or SCDHEC are given if applicable. In addition, a chart showing the average concentrations found in streams in South Carolina is given in the section entitled: Overall Water Quality (Table 21). Since this basin is relatively undeveloped, the only comparison data are the average stream concentrations (five year) and the standards set by the state or federal government.

Table 3. Water Sampling results for Mims Branch at station NAMB-01, NAMB-02, and NAMB-03 (highlighted=high)

Parameter Tested	10/13/05 NAMB01	3/21/06 NAMB01	06/30/06 NAMB01	06/30/06 NAMB02	06/30/06 NAMB03	State Avg[1]	EPA or State Guideline[2]
pH (su)	5.88	5.45	6.11	6.76	6.49		
DO (mg/l)	6.7	10.45	8.1	8.60	8.86		
Temp (^{o}C)	21.3	14.0	19.9	19.0	19.5		
Turbidity (ntu)	16.5	-	3.18	1.40	3.40	<16	
Total Phos (mg/l)	-	-	0.15	0.15	0.17	<0.14	0.10 (Aq)
TKN (mg/l)	-	-	0.6	0.3	0.3	<0.58	
Ammonia (mg/l)	-	-	0.1	0.2	0.3	<0.2	
Nitrite/Nitrate (mg/l)	-	-	1.2	0.60	0.62	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)	-	-					200 (I), 400 (avg)
Copper (mg/l)	-	-	n/d			<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)	-	-	n/d				
Iron (mg/l)	-	-	0.134			<1.17	0.3
Manganese (mg/l)	-	-	n/d			<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)	-	-	n/d				0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)	-	-	n/d			<0.02	0.61
Zinc (mg/l)	-	-	0.04			<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration, I = instantaneous result, Avg = average

Baseline Results for Mims Branch

The preliminary physical stream assessments at Mims Branch indicate that this is a healthy stream channel that effectively transports the current load of stormwater. Each segment assessed scored higher than other streams in the city. This is due to the location of the stream, topography, and current land use which is "undeveloped". Water quality sampling results also indicate that pollutant loads entering the stream are minimal at this time. Based on these results in comparison to Table 21, pollutant concentrations are at or below the average or standards set for freshwater streams. This stream system is healthy and has not been impacted by development. Other streams in North Augusta were most likely in a similar condition prior to development of the area. For this reason, the results of the baseline assessment for Mims Branch will be used as a "representation" of a healthy stream system in comparison to all other

streams in the city. Future development in this area of the city is in the early planning stages. The city SWMD will work closely with other departments to ensure that the stream and its integrity will be protected during construction.

Crystal Lake Basin

Description

The Crystal Lake basin is located in the area of the city that encompasses parts of Jackson Avenue, Mokateen, Crystal Lake Drive, Forest and Lake Avenues, lower West Avenue from Sno-Cap and below, Bluff and Cumberland Avenues and Crystal Lake. The large drainage depression located near Woodlawn Avenue accepts stormwater from the streets' stormwater pipes in the basin. The water flows from these areas across Buena Vista Avenue and along Crystal Lake drive to Crystal Creek. It travels through the basin until it reaches the Savannah River at the end of Savannah Point Drive. The sample point is at that location.

Physical Characteristics

The Crystal Lake basin perennial stream, (Crystal Creek) is routinely inundated with stormwater flows that exceed its capacity. Upstream locations are filled with debris and trash including cans, bottles, toys, tires, and grocery carts. Storm events move debris down the channel and most of it is captured on the upstream side of Buena Vista Avenue. Some sewer service lines cross the creek and have been found broken in the

past. Channel erosion is evident upstream above the Mokateen pond to Woodlawn Avenue and downstream of the creek near and below the North Augusta Greeneway along Hammond's Ferry. The creek is situated in an older part of the city with land use that is 90% residential, and 10% wooded at the lower reach, although development in that area is underway. Table 3 presents the stream segment assessments that have been completed to date.

Table 4: Crystal Lake Basin Stream Assessment Results

Sample Location	**Channel Width (ft)**	**Substrate**	**Land Use & Appearance**	**Overall Score**
Crystal Creek at Buena Vista Ave	4-5	45% boulders, 25% sand/silt 20% gravel	Heavy canopy, low bank stability, channel condition poor, trash & debris evident, flooded conditions routinely	**5.6** poor
Crystal Creek at Hanna property	3-4	30% boulders, 30% gravel 20% sand 20% clay	Some forested canopy, channel degradation and sediment transport, manmade structures, overtops banks routinely, extreme bank erosion at low end of reach, boulders	**5.9** poor
Crystal Creek at Campbell Town	7-8	85% sand, 10% silt/mud, 5% rock/stone	Channel is widened and inundated with sand in several locations, banks are scoured flooding routinely	**4.8** poor

Water Quality Assessments

Sampling was conducted at the foot bridge that is located on private property at the end of Savannah Point Drive with the owner's permission. The results are presented in Table 5.

Table 5. Water Quality sampling results for Crystal Lake Basin at NARV01 off of Savannah Point Drive (highlighted = high)

Parameter Tested	Date 10/11/05	Date 12/07/05	Date 03/22/06	Date 06/30/06	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.01	7.49	7.85	6.68		
DO (mg/l)	9.8	10.7	9.95	6.65		
Temp (^{o}C)	21.9	11.1	17.5	26.0		
Turbidity (ntu)		9.7	16.9	4.2	<16	
Total Phos (mg/l)		0.2		0.15	<0.14	0.10 (Aq)
TKN (mg/l)		0.8		1.2	<0.58	
Ammonia (mg/l)		1.6		0.3	<0.2	
Nitrite/Nitrate (mg/l)		1.10		0.98	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)						200 (I), 400 (avg)
Copper (mg/l)		n/d		n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)		n/d		n/d		
Iron (mg/l)		0.825		0.471	<1.17	0.3
Manganese (mg/l)		0.102		0.111	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)		n/d		n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d		0.61
Zinc (mg/l)		0.014		0.023	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for Crystal Lake Basin

The preliminary physical stream assessments at Crystal Creek indicate that this stream channel is currently not effective at transporting loads of stormwater during heavy storm events. The three assessments that were conducted along the stream channel resulted in poor condition ratings, with each scoring less than 6.0. Channel erosion is evident, trash and debris are present, and the banks frequently overtop in some locations during heavy storms. In addition, flooding has been reported and observed at the lower reaches of the channel and ponds located in the system have overflowed their banks on occasion (Crystal Lake). Sediment deposition at the final reach of the channel is evident, and the channel near Hammond's Ferry is cutting deeper. Sediment is being deposited at the river's edge, creating a sand-bar effect. Channel widening and deepening is ongoing.

Water quality sampling results indicate that pollutant concentrations in the stream are high for ammonia, total Kjeldahl nitrogen, and nitrogen. All other sample results compared with data in Table 21 indicate that pollutant concentrations are at or below the average or standards set for freshwater streams.

This stream system is in a highly residential area, and this usually results in nutrient loads to the system from many sources including possible leaking sewer lines, pets, and over fertilization of gardens and lawns. The stream channel will not sustain further development without implementing measures to mitigate for stormwater runoff being added to the current system.

This area of the city would benefit from low impact development (LID) on future projects. LID techniques that would be beneficial could include rain gardens, collection and reuse of stormwater, and pervious parking areas. A current project under development, the Oak Leaf Condominiums, is utilizing an underground stormwater detention and filtering system. In addition, the city retrofitted and repaired a failing storm sewer system at a road crossing in the lower reaches of the system. This has improved the transport of stormwater and eliminated the flooding that recently occurred in that location. The city is looking at additional ways to improve the channel conditions and is working with local stakeholders to implement new best management practices (BMPs) to decrease the possibility of flooding and overtopping of ponds in the system.

Fox Creek Basin

Description

This basin is located at the edge of the city near the Edgefield County line. All creeks and streams that flow into Gregory Lake located on Gregory Lake Road are part of the Fox Creek Basin. Most of this area is outside the city limits. The basin does converge with Pole Branch basin within the city limits. The basin is sampled at the location just prior to its convergence with Pole Branch. Once the two basins meet, water is carried directly to the Savannah River along the undeveloped portion of Bergen Road (formerly Frontage Road) that heads toward Savannah River. There are plans for development in this area over the next few years. Currently, Bergen West development, a small commercial area, and private homes under development along Gregory Lake Road have the potential to impact Fox Creek.

Continuous sampling is being conducted by Southeastern Natural Sciences Academy (SNSA) at the end of the channel as it enters Savannah River.

Physical Characteristics

Table 6: Fox Creek Basin Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Fox Creek at Martintown Rd	~15	5% boulder, 85% gravel, 10% sand	Ample cover and canopy, rocky substrate, abundant with mosquito fish. Mostly forested with several large new residential developments under construction.	**7.7** good

Water Quality Assessments

Fox creek has been sampled at one location over several visits. The results are presented in Table 7.

Table 7. Water quality sampling results for Fox Creek. (highlighted = high)

Parameter Tested	Date 10/11/05	Date 12/07/05	Date 3/22/05	Date 06/30/06	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.05	7.85	7.83	6.55		
DO (mg/l)	5.90	10.17	8.8	7.5		
Temp (^{o}c)	22.4	11.8	18.3	26.7		
Turbidity (ntu)	17.4	3.7	6.96	4.0	<16	
Total Phos (mg/l)		0.2		0.19	<0.14	0.10 (Aq)
TKN (mg/l)		0.6		0.7	<0.58	
Ammonia (mg/l)		1.8		0.4	<0.2	
Nitrite/Nitrate (mg/l)		0.1		3.81	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)						200 (I), 400 (avg)
Copper (mg/l)		n/d		n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)		n/d		n/d		
Iron (mg/l)		0.44		2.157	<1.17	0.3
Manganese (mg/l)		0.078		2.227	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)		n/d		n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d		0.61
Zinc (mg/l)		0.035		0.03	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for Fox Creek Basin

The preliminary physical stream assessment at Fox Creek (observed at Martintown Road just before its confluence with Pole Branch) indicates that this stream channel is currently effective at transporting stormwater during light or heavy storm events. The assessment conducted along the stream channel resulted in a good condition rating scoring 7.7. Ample cover and substrate is present. Observations included notes of abundant aquatic plant and animal life at the stream. Bank stability at this section of the steam appeared sound. Sediment deposition was not obvious. Fallen logs and other natural debris provided suitable habitat for macroinvertebrates, although no assessment was conducted for these aquatic insects.

Water quality sampling results indicate that nitrogen concentrations in the stream were high during one sample event. The high nitrate level that was observed is inconclusive. All other sample results compared with data in Table 21 indicate that pollutant concentrations are at or below the average or standards set for freshwater streams. Water quality at Fox Creek is currently not a concern. Further sampling during rain events will be conducted to determine if nitrates are a true concern for this stream.

This stream channel is currently located in an area of the city that is undergoing rapid development. Historically, the residential area located adjacent to this channel has been large lot, low density with a small block of commercial facilities. This area is rapidly developing and it is anticipated that over the next three years, high density, small lot residential development will be established. The city will continue to monitor this basin.

Pole Branch Basin

Description

Pole Branch basin is one of the city's largest basins. The basin borders along Highway 25 at I-20 to Arbor Place off of Walnut Lane and then encompasses Bergen Road and its communities. It also collects rainfall from Belvedere to Five Notch road at I-20 and also Knobcone Avenue. It includes a large area bordering Edgewood Heights Subdivision and the shops that border it at Highway 25 and areas near the North Augusta High School, Paul Knox Middle School through and along Five Notch Road leading to I-20. All creeks and streams located in the area converge into Pole Branch. The stream crosses I-20 at Bergen Road. Pole Branch converges with Fox Creek just below Martintown Road and then the confluence stream empties to the Savannah River.

The Pole Branch watershed includes high density residential, high density commercial, and some industrial areas. Major traffic corridors including Highway 25, I-20, Five Notch Road, and all the neighboring communities impact this watershed. In addition, a

main sanitary sewer trunk line winds through the watershed and includes two lift stations.

Physical Characteristics

The two assessments were conducted within the lower reaches of the basin. The final reach of Pole Branch along Bergen Road shows the most evidence of unsuitable conditions. The results are presented in Table 8.

Table 8: Pole Branch Stream Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Pole Branch off Bergen Road along sanitary sewer right-of-way road	6-10	85% slate/rock, 10% clay/sand 5% gravel	Mostly forest with residential construction underway. Scoured channel in some areas, bank incised, often floods	**5.3** poor
Pole Branch tributary below Waffle House at Martintown Rd	1	90% gravel, 10% sand/mud	Bank stability low, barriers to fish movement, channel eroding, shallow pools absent, forested area with residential influence upstream, pond located above reach. Adjacent acreage clear-cut, relict trillium present	**6.6** fair

Water Quality Assessments

Sampling data indicate that a high nutrient load is impacting Pole Branch. To determine the source of the pollutants, Pole Branch was sampled in several locations throughout 2006. The routine sampling results are presented in Table 9.

During one torrential rain event, the SWMD sampled the basin at the routine sample location NAPB01 with its compositing stormwater sampler. The total rainfall for the event was 1.5 inches of rain at the Operations Facility across town. At Pole Branch, that number most likely reached 2 inches. After one (1) inch of rainfall, the sampler is triggered by a float device to pull a full sample bottle of the stream water. Once the bottle is full, the sampler stops. This is the first flush sample. The first inch of rainfall washes all surfaces and transports the debris and contaminants into the stream. The first flush sample will sometimes contain higher concentrations of contaminants.

After the first flush sample is pulled, the sampler pulls a sample every thirty (30) minutes for 24 hours. This is the 24 hour composite sample. The data generated from this sampling event is presented in Table 10.

Table 9. Water quality sampling results for Pole Branch Basin at stations NAPB01, NAPB02, and NAPB03 during routine sampling. (highlighted = high)

Parameter Tested	10/11/05 NAPB01	12/07/05 NAPB01	03/22/06 NAPB01	06/30/06 NAPB01	08/22/06 NAPB01	08/22/06 NAPB02	08/22/06 NAPB03	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.34	6.99	7.63	4.02	7.50	6.72			
DO (mg/l)	10.5	10.6	11.1	5.9	8.03	5.75			
Temp (^{o}C)	21.7	12.2	17.0	26.6	24.9	24.8			
Turbidity (ntu)	6.9	8.40	12.2	19.0	6.40	5.50		<16	
Total Phos (mg/l)		0.8		0.17		0.01	**7.06***	<0.14	0.10 (Aq)
TKN (mg/l)		0.7		1.2	0.9	0.9	1.2	<0.58	
Ammonia (mg/l)		1.7		0.5	1.4	0.4	2.5	<0.2	
Nitrite/Nitrate (mg/l)		0.4		10.09	0.18	0.37	4.9	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)					250	140	17		200 (I), 400 (avg)
Copper (mg/l)		n/d		0.013				<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)		n/d		n/d					
Iron (mg/l)		1.27		1.367				<1.17	0.3
Manganese (mg/l)		0.052		0.061				<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)		n/d		0.0068					0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d					0.61
Zinc (mg/l)		0.02		0.054				<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

* sample pulled just below strawberry farm at Knobcone in semi stagnant beaver dam pool

Table 10. Water quality sampling results for Pole Branch at NAPB01 during a heavy rain event (24 hour composite and 1st Flush) (highlighted = high)

Parameter Tested	Date 8/25/06 1st Flush	Date 8/25/06 24 hour composite	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.19	6.69		
DO (mg/l)	6.69	7.43		
Temp (°C)				
Turbidity (ntu)	180.0	115.6	<16	
Total Phos (mg/l)	0.85	0.90	<0.14	0.10 (Aq)
TKN (mg/l)	0.60	0.50	<0.58	
Ammonia (mg/l)	1.60	1.60	<0.2	
Nitrite/Nitrate (mg/l)	13.9	0.1	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)				200 (I), 400 (avg)
Copper (mg/l)	0.022	0.03	<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)	n/d	n/d		
Iron (mg/l)	3.447	1.87	<1.17	0.3
Manganese (mg/l)	0.091	0.165	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)	n/d	0.0022		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)	n/d	n/d		0.61
Zinc (mg/l)	0.093	0.066	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for Pole Branch Basin

Pole Branch basin is the largest basin in North Augusta. It receives water from a large part of the city along with a large portion of non-city residential and commercially developed land in Belvedere, SC. The preliminary physical stream assessments at Pole Branch indicate that this stream channel is currently not effective at transporting current loads of stormwater during heavy storm events. The two assessments that were conducted along the stream channel resulted in fair and poor conditions scoring less than 6.0 and just above at 6.3. Channel erosion is evident and the banks frequently overtop in some locations during heavy storms. In addition, bank flooding has been reported and observed at the lower reaches of the channel below Bergen Road. Sediment deposition and bank instability is evident causing hydrologic alteration and channel widening.

Due to the high nutrient concentrations identified after the first sample event, Pole Branch has been a focus of the city monitoring program. During rain events, the city conducted routine grab, composite, and first flush sampling. Overall, sampling results

indicate that this basin water quality is in poor condition. Nitrate loads are significant during rain events and high during non rain events. Routine sampling results and rainfall event sampling suggest that the water has high concentrations of other nutrients (ammonia, phosphorus, TKN). High nutrient levels were observed in most of the samples pulled.

The basin has several features that could result in increased nutrient levels. These include; a tract of land upstream of the sample point where annual crop farming occurs, a small cattle farm that has animals that utilize creek fed ponds for water and cooling, large residential areas with well maintained lawns and gardens, and also commercial areas. Belvedere is an unincorporated community located within the basin. This community has had little maintenance of storm sewers in the past, and the mapping of these systems has not begun (although it is planned by Aiken County). It is most likely that unidentified infrastructure problems exist within the system. As Aiken County gets its stormwater program in place, problems will be identified and/or repaired.

Pole Branch will continue to be monitored for improvements. Throughout 2007, attempts to identify sources of pollution will continue in the basin. As problems are identified, solutions will be implemented in conjunction with increased public education and outreach about the problems in this basin.

Currently the lower reaches of the basin are showing signs of stress. Failing banks and sediment deposition is increasing in near Willow Wick apartments and beyond. The banks are falling into the channel during large rain events at and below the sample location at Bergen Road. Tributaries that feed Pole Branch along Knobcone Avenue are deeply incised and crossings under Knobcone are failing. Future development in this area is planned in the next two years. The basin needs to be studied further and there is a need for more physical stream segment assessments throughout the basin.

Pretty Run Basin (aka Rapids Basin)

Description

The basin called the Rapids Basin on Figure 1 contains a stream system named Pretty Run Creek. A smaller basin just below the Rapids Basin is called Pretty Run. The Pretty Run Basin does not contain any of the stream system related to Pretty Run Creek although a road by that name exists in that part of the city. Due to the stream system and the study that will be required in the basin, the name of these basins will be changed. For this report, we will refer to both of these basins as one called the Pretty Run Basin. Updated maps of the city's basins will reflect the changes and separate names will be given to identify these two distinct basins.

Pretty Run Basin is a large basin that drains older neighborhoods such as Lynnhurst, the North Augusta Greeneway Trail along Bolin Road, Knollwood, Hammond Pond drainage and associated neighborhoods near it, Marion Avenue and portions of Georgia Avenue at McDonald's restaurant. Most of the area located east of Five Notch Road is included. In addition, newer residential areas are drained to the Pretty Run basin including; the Rapids, Herron Cove, and others along Martintown Road and the North Augusta Greeneway Trail. The main branch of this basin is Pretty Run Creek. This

basin is sampled in the Rapids subdivision on Riverbluff Drive at the utility maintenance right-of-way just before the stream enters the Savannah River.

Pretty Run basin was sampled in 2004 by SCDHEC as a random sample point and was assigned a state station number RS-04544. During the twelve (12) months that it was sampled, 67% of the samples exceeded the standard of 400 cfu/100 mils for fecal coliform. When more than 10% of samples for a particular stream are out of limits for a specific constituent (in this case, fecal coliform), the stream is listed as impaired and placed on the federal 303d list of impaired streams. Pretty Run creek was placed on the 2006 303d list for South Carolina. When a stream is placed on the list, it triggers the development of a Total Maximum Daily Load (TMDL). SCDHEC has developed the TMDL for Pretty Run, and at the time of this report, it is being reviewed by the EPA and it is still in draft form. The TMDL requires a 31% reduction in fecal coliform loads to Pretty Run creek. Currently, SCDHEC states that the most likely causes of fecal coliform contamination in Pretty Run creek is from urban runoff (includes pet waste), leaking sewers, and possibly failing septic systems. The development of this TMDL focuses more attention to Pretty Run Basin and increases the cities responsibilities to address fecal coliform impacts to the stream system through its MS4 program.

To address the issues in Pretty Run Creek and also Horse Creek another 303d listed stream in our community, North Augusta teamed with Clemson Extension in Aiken, Aiken County, Aiken Public Service Authority (Aiken PSA), the Natural Resource Conservation Service (NRCS) and others to develop a plan to reduce fecal coliform pollution in these two streams. Horse Creek has a federally (EPA) approved TMDL in place currently. The team submitted a grant proposal to SCDHEC to study and address fecal coliform sources in the two streams systems. The team was awarded the 319 Grant by SCDHEC. The grant funds the following activities:

- aerial infrared thermographic imaging survey (IRt) of the two stream systems to identify sewer leaks or illicit discharges
- funds to assess the results of the aerial survey
- education and outreach through the Aiken Clemson Extension office,
- community septic tank studies and surveys,
- and funding assistance to residents that wish to repair failing septic systems.

Pretty Run creek and Horse Creek were surveyed during one of the coldest nights of the year (February 16, 2007) with an infrared camera by Stockton Infrared Thermographic Services, Inc. (SITS). The resulting survey data indicated eight hot spots in the Pretty Run creek stream system where warmer water was flowing into the stream system. Crews from the SWMD and Public Utilities walked the sewer lines in these eight areas. No leaking sewer lines were found during this field investigation. Subsequent field surveys of the areas after heavy rain events revealed no overflowing manholes or other potential problems in the sewer lines. In addition to the IRt study, public education and outreach activities are continuing in the basin. Fecal coliform testing will continue in the basin by the city SWMD. Results of sampling for 2006 - 2007 are reported in Table 13.

Physical Characteristics

Pretty Run basin assessments completed to date are detailed below in Table 11.

Table 11: Pretty Run Basin Stream Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Pretty Run at utility easement along River Bluff Dr.	7-8	90% rock/boulder, 10% gravel and sediment	Mostly residential with wooded buffer, sediment impact from upstream construction activity, floods routinely, bank is stable, some barriers to fish movement, few pools, cover and canopy available	**6.5** fair
Pretty Run at Reynolds home at Bolin	8-10	90% sand, 10% gravel & silt	This reach is in a 95% residential area with 5% wooded, some foam and odor, channel condition and bank stability is poor, barriers to fish movement.	**4.6** poor

Water Quality Assessments

Pretty Run basin is sampled at River Bluff Road in the Rapids subdivision. The results for sample events are presented in Table 12. Due to the 303d listing of Pretty Run creek as being impaired by fecal coliform, a separate table showing data for this constituent is provided in Table 13.

Table 12. Water quality sampling results for Pretty Run Basin (highlighted = high)

Parameter Tested	Date 10/11/05	Date 12/07/05	Date 3/22/06	Date 6/30/06	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.41	7.62	7.58	7.13		
DO (mg/l)	8.4	9.91	9.79	7.81		
Temp (^{o}C)	21.9	13.1	17.5	24.2		
Turbidity (ntu)	12.8	6.3	6.64	24.0	<16	
Total Phos (mg/l)		0.7		0.21	<0.14	0.10 (Aq)
TKN (mg/l)		1		0.5	<0.58	
Ammonia (mg/l)		1.4		0.0	<0.2	
Nitrite/Nitrate (mg/l)	n/d	1.7	n/d	1.07	<0.62	10.0 (HH)
Copper (mg/l)		n/d		n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq),
Cadmium (mg/l)						
Iron (mg/l)		0.462		0.553	<1.17	0.3

Table 12. Water quality sampling results for Pretty Run Basin (highlighted = high) continued.

Parameter Tested	Date 10/11/05	Date 12/07/05	Date 3/22/06	Date 6/30/06	State Avg[1]	EPA or State Guideline[2]
Manganese (mg/l)		n/d		0.038	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)		n/d		n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d		0.61
Zinc (mg/l)		n/d		0.51	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Table 13: Pretty Run
Fecal Coliform Sampling Data (highlighted = high)

Parameter Tested	Date NAPR01 2/16/06	Date NAPR01 1/11/07	Date NAPR02 1/11/07	Date NAPR04 1/11/07	Date NAPR01 5/14/07
Fecal coliform (col/100 ml)	242	160	6	80	426

Baseline Results for Pretty Run/Rapids Basin

Pretty Run basin is located in a highly dense residential part of North Augusta. The preliminary physical stream assessments at two reaches of the stream indicate that this stream channel is currently not effective at transporting current loads of stormwater during heavy storm events. The two assessments that were conducted along the stream channel resulted in poor conditions, scoring less than 6.0 on both. Channel erosion is evident, and the banks frequently overtop in some locations during heavy storms. In addition, bank flooding has been reported and observed at the lower reaches and middle reaches of the channel along Bunting Drive and River Bluff Road. Sediment deposition and bank instability is evident at both locations causing hydrologic alteration and channel widening. Water appearance during storm events is very cloudy and sometimes an odor is present. Upstream construction sites that are not well maintained have impacted the channel. A main sewer line runs along and in the stream channel and some of its tributaries. Overtopping of banks is obvious in several locations and manholes present in those locations may overflow if surcharging occurs.

High nutrient concentrations have been detected in two samples during the period. The results indicate that urban runoff is impacting the stream channel. Many homes back up to the creek along its way through the city. The high density residential area contains

well maintained lawns in many instances. In addition, animals are penned at or near the creek along most of its reach. The city will continue to reach out to residents in the area to provide information that may help reduce pollutant loads. Most of the fecal coliform testing in 2006 – 2007 are well below the state standard of 400 cfu/100ml. Only one event has exceeded the standard on May 14, 2007. More testing is planned in the creek during rain events. Overall sampling results indicate that the basin water quality in Pretty Run Basin is low. Nutrient loads are higher than standards, averages, and stormwater comparison data in Table 21. The city is continuing investigation of this basin. We have conducted IR studies, smoke testing, and field observations of sewer lines. No problems have been identified to date. Based on this assessment, it appears that urban runoff is the primary cause for fecal coliform exceedences in Pretty Run creek. Studies and outreach activities will continue.

River Bluff Basin

Description

This basin is the area just below the ridge of SC Department of Natural Resources (SCDNR) Bluffs Heritage Preserve in North Augusta near Old Plantation Road. The basin collects stormwater from the Savannah Barony Subdivision and parts of the Rapids and Herron Cove area where the land ridge slopes back toward this basin. The city monitors this basin at the end of Shoals Way just before the stream enters Savannah River.

Physical Characteristics

The assessment of this channel was conducted at the routine sample point. This is near the Savannah River. Assessments need to be conducted further up into the channel. The result from the assessment is presented in Table 14.

Table 14: River Bluff Basin Stream Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Riverbluff at end of Shoals Way Ct.	5-7	60% sand 25% gravel, 10% mud/silt, some boulders	Mostly wooded with new residential, sediment impact from upstream routinely, channel is incised, fish cover and canopy present, barriers to fish movement	**5.7** poor

Water Quality Assessments

The River Bluff sampling was conducted over several visits. Since this is a low-density area of the city, nutrient and metals sampling only occurred on one event. The data generated are presented in Table 15.

Table 15. Water quality sampling results for River Bluff Basin (highlighted = high)

Parameter Tested	Date 10/11/05	Date 3/22/06	Date 6/30/06	State Avg[1]	EPA or State Guideline[2]
pH (su)	7.8	8.16	7.0		
DO (mg/l)	7.78	10.58	5.92		
Temp (^{o}C)	21.9	17.4	26.9		
Turbidity (ntu)		15.7	22.8	<16	
Total Phos (mg/l)			0.21	<0.14	0.10 (Aq)
TKN (mg/l)			0.4	<0.58	
Ammonia (mg/l)			0.3	<0.2	
Nitrite/Nitrate (mg/l)			0.79	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)					200 (I), 400 (avg)
Copper (mg/l)			n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq)
Cadmium (mg/l)			n/d		
Iron (mg/l)			0.84	<1.17	0.3
Manganese (mg/l)			0.14	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)			n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)			n/d		0.61
Zinc (mg/l)			<0.04	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for River Bluff Basin

The preliminary physical stream assessments at the sample location for River Bluff basin indicate that this stream channel currently is effective at transporting current loads of stormwater during heavy storm events. The small channel is slightly incised and bank stability is fair although deepening and widening at the assessment point is obvious. The assessment conducted along the lower reach of stream channel resulted in poor conditions overall scoring less than 6.0. Channel erosion is evident, and sediment deposition in the channel was observed. This is a low density large lot residential area of the city with some development ongoing. Upstream construction sites in Savannah Barony II and in Savannah Barony I have impacted this channel. During heavy storm events, sediment and channel substrate is washed to the river. Increased development in this area might create unfavorable conditions since the channel is relatively small throughout the entire reach of the creek bed. Adequate installation and maintenance of BMPs within the developing area will prevent further degradation of the channel in the future.

The results of the limited sampling at this time show no real concerns regarding pollutants. Overall sampling results indicate that this basin water quality is in good condition.

Waterworks Basin

Description

The Waterworks basin is a very large basin in the city that handles tremendous flows during rain events. Flows from this basin incorporate stormwater from residential and higher density commercial entities throughout the area. The basin enters the river through two separate channels within the River Golf Club.

The upper reach of the basin drains the areas from Knox Avenue near the Channel 12 television station and below including Lowes, Walmart, North Augusta and Kroger Shopping Centers, and Martintown Road. Drainage from parts of downtown Georgia Avenue, West Spring Grove and North Augusta Elementary flow into the main channel through Edenfield Park. The communities along Old Edgefield Road are part of this basin as well, including Edgefield Heights, Summerfield Park and the area below them down to Atomic Road. Stormwater from these communities flows through this basin along Atomic Road to pipes that send the stormwater down Buena Vista and Mealing Avenue to converge with the main channel at the Municipal Building. Stormwater from these upper reach areas of the basin flows through the primary basin stream that runs along Riverside Boulevard and then through River Golf Club and its pond systems

before emptying into the Savannah River at Shoreline Drive. This is the cities sample location for the basin.

Stormwater that originates from the west side of the Business & Technology Center, Philpot and Gentry Lanes, Old Martintown and Fleetwood Drive flows through the basin behind Barton Road and into River Golf Club under the railroad tracks. This stormwater converges in the ponds of the River Golf Club.

The city, along with the University of South Carolina at Aiken, have been working together to study the water quality in this basin. Currently, the city is implementing a capital improvement project of storm sewers and roads to eliminate the flooding problems that occur during heavy rainfalls. The stormsewer infrastructure at Buena Vista Avenue is currently being replaced with larger culverts and additional piping to help support the current volume of stormwater during heavy rain events. The improved infrastructure will improve conditions and are intended to alleviate flooding problems along Buena Vista Avenue near the Mealing Road communities and the Edenfield Park area that routinely occur and disrupt traffic flow. Figures 2 and 3 depict a typical flooding event that occurs at this location.

Figure 2: 2007- Flooding at Buena Vista and Mealing Avenue

Figure 3: 2007 - Flooding at Buena Vista near Blockers' Barber Shop

Physical Characteristics

The Waterworks basin assessment was conducted in one location to date. Further assessments will be conducted. Areas that have not been formally assessed have been observed to be in very poor condition. Deep incision and channel deepening and widening has been seen throughout the basin. The assessment results to date are presented in Table 16.

Table 16: Waterworks Physical Stream Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Un-named tributary to Savannah River near Veterans Center on West Pine Grove	5-6	70% gravel 30% sand	Heavy residential area with forest stream buffer, large commercial area upstream, channel condition ok, bank stability fair, culverts, piping in place, floods during rain events	**6.6** fair

Water Quality Assessments

The waterworks basin has been studied by the SWMD and the University of South Carolina – Aiken since 2005. Data collected during that time is presented in the Appendix section of this report. The data suggests that the wetlands located within the River Golf Club filters nutrients and other contaminants that are present during rain events. Results from analyses of the water that drains from the wetlands to the Savannah River show lower concentrations of nutrients and other contaminants. A city sample location at the end of this channel has been designated as NAWW01. It is located at the last point along Riverclub Drive, prior to the drainage of water into the river. Data collected by the city at this location is presented in Table 17.

During two large rain events, the SWMD sampled the basin at the routine sample location NAWW01 with a compositing stormwater sampler. An additional location was added during the second rain event sampling at the Municipal Building NAWW04a with compositing sampling equipment. After one (1) inch of rainfall, the sampler is triggered by a float device to pull a full sample bottle of the stream water. Once the bottle is full, the sampler stops. This is the first flush sample. The first inch of rainfall generally washes all surfaces and transports the debris and contaminants into the stream. The first flush sample will sometimes contain higher concentrations of contaminants. During the August 25, 2006 sample events, the city triggered the sampler to pull the sample at the time that the flow in the stream increased tremendously shortly after the initial rain event began. Approximately within 30 minutes. One inch of rain had not fallen at that time but enough volume of stormwater had fallen to create a "flush" effect at the sample point identified as NAWW04a. This effect was not seen in the NAWW01 sample location due to the significant wetland system that the water enters prior to reaching the sample location. The sampler at that location was triggered by ½" of rainfall measured in the rain gauge attached to the equipment.

After the first flush sample is pulled (either manually as in NAWW04a or automatically), the sampler pulls a sample every thirty (30) minutes for 24 hours. This is the 24 hour composite sample. The data generated during the event is presented in Table 18.

Table 17. Water quality sampling results - Waterworks basin. (highlighted = high)

Parameter Tested	**Date 10/12/05**	**Date 12/07/05**	**Date 3/22/06**	**Date 6/30/06**	**State Avg[1]**	**EPA or State Guideline[2]**
pH (su)	7.41	7.60	7.56	6.41		
DO (mg/l)	6.73	11.3	8.6	7.42		
Temp (^{o}C)	23.7	12.2	18.2	28.3		
Turbidity (ntu)	-	9.0	5.2	5.6	<16	
Total Phos (mg/l)		0.30		0.23	<0.14	0.10 (Aq)
TKN (mg/l)		0.7		0.2	<0.58	
Ammonia (mg/l)		1.5		0.4	<0.2	
Nitrite/Nitrate (mg/l)		0.5		n/d	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)						200 (I), 400 (avg)
Copper (mg/l)		n/d		n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq)
Cadmium (mg/l)						
Iron (mg/l)		0.385		0.992	<1.17	0.3
Manganese (mg/l)		0.05		0.178	<0.084	0.05 (HH), 1.0 (CCC Aq)

Lead (mg/l)		n/d		n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d		0.61
Zinc (mg/l)		n/d		0.037	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Table 18. Water quality sampling results for Water Works Basin during heavy rain events 1st Flush and 24 hour composite (highlighted = high)

Parameter Tested	Date 7/06/07 1st Flush NAWW01	Date 7/07/07 24 hour NAWW01	Date 8/25/06 1st Flush NAWW01	Date 8/25/06 24 hour NAWW01	Date 8/25/06 1st Flush NAWW04a	Date 8/25/06 24 hour NAWW04a	State Avg[1]	EPA or State Guideline[2]
pH (su)			6.68	7.23	6.7	6.68		
DO (mg/l)			6.09	6.67	2.23	6.26		
Temp (^{o}C)			27.1	29.4	26.0	29.6		
Turbidity (ntu)			352.00	49.1	132	61.5	<16	
Total Phos (mg/l)	0.47		2.15	1.5	0.12	0.43	<0.14	0.10 (Aq)
TKN (mg/l)	4.7		16.0	0.50	3.0	3.3	<0.58	
Ammonia (mg/l)			0.28	2.5	1.9	1.9	<0.2	
Nitrite/Nitrate (mg/l)	1.24		0.24	n/d	n/d	n/d	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)								200 (I), 400 (avg)
Copper (mg/l)	0.017	0.019	0.021	0.025	0.026	n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq)
Cadmium (mg/l)	n/d	n/d	n/d	n/d	n/d	n/d		
Iron (mg/l)	4.968	2.514	2.161	1.102	1.179	0.362	<1.17	0.3
Manganese (mg/l)	0.267	0.142	0.411	0.177	0.133	0.077	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)	0.0583	n/d	0.0178	0.0418	0.0645	0.0175		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)	n/d	n/d	n/d	n/d	n/d	n/d		0.61
Zinc (mg/l)	0.133	0.166	0.072	0.201	0.194	0.106	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for Water Works Basin

The preliminary physical stream assessments for Water Works basin indicate that this stream channel is currently not effective at transporting current loads of stormwater during heavy storm events. The assessment that was conducted along the stream channel near the Veterans Center resulted in a fair rating. Channel erosion is evident, but the banks are not overtopped during rain events in this location. Banks are overtopped repeatedly along the Buena Vista corridor of this stormwater channel and behind the Elementary School located near Spring Oak lane. Sediment deposition and bank instability is evident causing hydrologic alteration and channel widening along most of the reach of this stream. Improvements to infrastructure will alleviate many of the flooding issues along Buena Vista. Channel erosion may continue to be a problem.

Overall sampling results indicate that the water quality at the outfall of this basin (below the River Golf Club ponds) is good. At reaches farther up in the channel prior to the River Golf Club, sampling results indicate higher levels of pollutants. During storm events, the data shows increased levels of pollutants making it to the river. The wetlands remove many of the solids during heavy rain events as indicated by the turbidity results dropping from 325 NTUs to 49 NTUs during the rain event that occurred in August 2006. That being said, the nutrient loads and metal loads were not reduced to lower levels in all cases. The ammonia and lead level increased with the 24 hour composite sample. Other constituents dropped from elevated levels to acceptable levels. This data suggest that while the Water Works Basin is transporting higher levels of pollution during rain events, much of it is filtered out as it passes through the wetland ponds at River Golf Club, but not entirely. During routine sampling and dry weather, the ponds work well at filtering pollutants. Early study results from USC-Aiken researchers, indicate the same. The city will continue to monitor the basin and implement further improvements to regain stability within the basin. In addition, it would be beneficial to initiate further discussions and plans to implement additional BMPs within the basin that will help to reduce pollutant loads during storm events.

Womrath Basin

Description

This basin includes the area located from the junction of Knox Avenue and Old Edgefield Road back to Carolina Springs/Womrath Road. The water flows from these areas and then crosses Old Aiken Road and beyond until it crosses Highway 1 (Aiken/Augusta Highway). From there the unnamed creek empties into wetlands located adjacent to Horse Creek. This basin is sampled at the TTX Plant located off of Hamburg Road.

Physical Characteristics

Womrath basin assessment was conducted in three locations. The basin channel is large and more assessments need to be conducted. The results of the initial assessments are presented in Table 19.

Table 19: Womrath Basin Assessment Results

Sample Location	Channel Width (ft)	Substrate	Land Use & Appearance	Overall Score
Carolina Springs creek at Claypit Road (01)	10	90% Sand with 10% small gravel & silt	Wooded buffer area in residential setting, erosion, marginal substrate, channel alteration, bank instability, flooding routine, canopy and cover present, deeply incised	**6.9** fair
Carolina Springs at Carolina Springs spur (02)	10-12	80% sand, 20% mud	Channel braided, beaver activity, flooding routine overtopping road, residential setting with large forested area, hydrologically altered, barriers to fish movement	**6.6** fair
Crystal Creek at TTX Hamburg	2-4	85% mud 15% silt & sand	Braided channel, iron bacteria, groundwater percolation, mostly forested, channel condition stable, barriers to fish movement, low fish cover in stream	**6.0** fair

Water Quality Assessments

Water quality sampling has been conducted only at the routine sample location. The results from the study are presented in Table 20.

Table 20. Water quality sampling results for Womrath Basin (highlighted = high)

Parameter Tested	Date 10/11/05 NAWB01	Date 12/7/05 NAWB01	Date 3/22/06 NAWB01	Date 6/30/06 NAWB01	State Avg[1]	EPA or State Guideline[2]
pH (su)	6.64	7.1	7.9	6.8		
DO (mg/l)	8.8	11.14	8.68	6.3		
Temp (^{o}C)	22.2	9.7	18.4	25.0		
Turbidity (ntu)	27.8	16.5	43.6	18.6	<16	
Total Phos (mg/l)		0.9		0.21	<0.14	0.10 (Aq)

Table 20. Water quality sampling results for Womrath Basin (highlighted = high) *continued:*

Parameter Tested	Date NAWB01 10/11/05	Date NAWB01 12/7/05	Date NAWB01 3/22/06	Date NAWB01 6/30/06	State Avg[1]	EPA or State Guideline[2]
TKN (mg/l)		0.8		0.2	<0.58	
Ammonia (mg/l)		3.2		0.3	<0.2	
Nitrite/Nitrate (mg/l)		0.4		3.99	<0.62	10.0 (HH)
Fecal coliform (col/100 ml)						200 (I), 400 (avg)
Copper (mg/l)		n/d		n/d	<0.01	1.3 (HH) 0.0038 (CMC Aq)
Cadmium (mg/l)		n/d		n/d		
Iron (mg/l)		3		3.69	<1.17	0.3
Manganese (mg/l)		0.091		0.08	<0.084	0.05 (HH), 1.0 (CCC Aq)
Lead (mg/l)		n/d		n/d		0.013 (HH) 0.014 (CMC Aq)
Nickel (mg/l)		n/d		n/d		0.61
Zinc (mg/l)		n/d		0.037	<0.04	7.4 (HH) 0.03 (CMC Aq)

(1) State average is used from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(2) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

Notes: Aq = aquatic life, HH = human health, CMC Aq = Criteria Maximum Concentration for aquatic life, CCC Aq = Criterion Continuous Concentration for aquatic life, I = instantaneous result, Avg = average

Baseline Results for Womrath Basin

The preliminary physical stream assessments for Womrath basin indicate that this stream channel is currently effective at transporting current loads of stormwater during heavy storm events. The reach of the stream assessed located at the TTX plant entrance is braided and no bank incision or instability is evident. Some reaches of the channel along Womrath Road and Claypit Road have been impacted routinely with sediment from a mining site and other earth moving activities along the stream channel. Prior to these impacts reaching the routine sample point and assessment location (at TTX) there are several wetland areas that have been created by beaver dams. These ponds act as a filter and have prevented much of the sediment from moving down the channel.

Water quality at the sample location NAWB01 indicate high loads of nutrients were within the system. The area upstream of the location is heavily wooded and is not a residential area. A sewer line runs within the channel. No problems were found during

initial observations of the line nearest the sample location. The city will be conducting more testing and field studies in this area to determine potential pollutant sources. Many impacts occur in the Womrath Basin that are within and outside of the city limits. Impacts observed and noted to date are occurring at the Wertz Mine located on Old Aiken Road, the Beverly Grading Company laydown yard or office and other Beverly activities where backfilling is occurring along the creek area, SCDOT stormwater infrastructure failures at the Golf Driving Range on Womrath Road, failure of stormwater systems within the city limits below Sycamore and Euclid Avenue, and road construction along the Highway 1 corridor that impacted the Seven Lakes area of the city. Pipes within that area are inundated with sediments and ponds that were used in conjunction with the road construction are completely filled with sediments.

Construction of the Interstate 520 (I-520 or Bobby Jones Expressway extension) within this basin is ongoing. Infrastructure for the highway will positively impact the Womrath Basin. The mining operation located along Old Aiken Highway that has routinely impacted the basin will be eliminated by the new highway. In addition, areas where garbage and other refuse has been historically dumped along Radio Station Road next to a wetland has been removed and properly disposed of. The SC DOT contractors working on the road project have shown exemplary BMP installation and maintenance along the entire reach of the project. As the road construction continues, the SWMD will continue to monitor its impact on this basin and the Mims Branch Basin.

The Womrath Basin is impacted by activities outside the control of the SWMD where they occur outside the city limits. The SWMD will continue to monitor the basin and work with Aiken County and other entities that have authority to correct or resolve issues ongoing within the basin due to lower reaches being within the city. Projects within the city would improve conditions. The SWMD will work toward identifying potential areas where BMPs will alleviate the failing banks and deep incision that is occurring along the upper reaches of the basin channel. A complete physical assessment of the upper reaches of the channel will be conducted within the next two years.

4. Conclusions

The data collected over the past few years in North Augusta indicate that the watershed basins are under stress in the more developed areas of the city, as to be expected. The current level of growth of the community will further impact the stream channels that exist. To determine exactly how water quality compares to other standards or studies in comparison to other communities, we developed Table 21. This table will be used to compare data generated by our sampling events to see what the numbers are telling us. The table includes information from other communities that have been sampling under the NPDES Phase I MS4 regulations. Data generated by other communities in the United States that are considered urbanized areas from the National Stormwater Quality Database (NSQD) findings were published in January 2004. The project has complied thousands of data from large MS4 communities that are sampling in the United States. We also reviewed the state SC Water Classification and Standards Regulation 61-9 from March 2004 to provide actual numeric standards if available. EPA also may have imposed numeric standards or guidelines and we provide that data as well. This data is presented below in Table 21. The city will update this table with new it is available.

Table 21: Comparison Data Water Quality Sampling Averages, Standards, or Guidelines

		Average Concentrations for SW (NSQD)[1]				SC Streams 5 Year Average[2]	SCDHEC or EPA Water Quality Standards or Guidelines[3] (if available)		
Parameter	Measure	Land Use							
		Open Space	Residential	Commercial	Industrial	Grab	Human Health	Aquatic Health	Nutrification
pH	NTU								
DO	mg/l								
BOD5	mg/l	4.2	9	11.9	9				
COD	mg/l	21	55	63	60				
TSS	mg/l	51	48	43	77				
Turbidity	NTU					<16			
Phosphorus	mg/l	0.25	0.3	0.22	0.26	<0.14			0.1
TKN	mg/l	0.6	1.4	1.6	1.4	<0.58			
Nitrate	mg/l	0.6	0.6	0.6	0.7	<0.62	10		
Ammonia	mg/l	0.3	0.31	0.5	0.5	<0.20			
Copper	mg/l	0.0053	0.012	0.018	0.022	<0.01	1.3	0.0038	
Iron	mg/l					<1.17	0.3	1	
Nickel	mg/l	ND	0.0054	0.007	0.016				
Zinc	mg/l	0.039	0.073	0.15	0.21	<0.04	7.4	0.037	
Manganese	mg/l					<0.084	0.052		
Lead	mg/l	0.005	0.012	0.017	0.022		0.048	0.014	
Fecal Coliform	col/100 ml						200	400	

(1) Data from the National Storm Water Quality Database (NSDQ) Robert Pitt, et.al., Univ. of Alabama, January 2004

(2) State average from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997).

(3) Data retrieved from SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004

The data generated during this preliminary baseline assessment was reviewed and compared with existing data for communities. The review resulted in the basins being ranked and is presented in Table 22. These rankings were developed using all the available data and with an understanding of the development trends in the area.

Since Mims Branch data shows its condition as outstanding when compared to all other streams in the city, the SWMD will use it as a representative stream for our area. The water quality and integrity of the stream is excellent. Two other basins appear to be good at this time. They are River Bluff and Fox Creek. Increased development in Fox Creek will require strict adherence to storm water pollution prevention plans (SWP3) developed for the construction. The approved plans are designed to protect the integrity and water quality of the streams that contribute to Fox Creek.

Crystal Lake, Pole Branch, Pretty Run, Waterworks, and Womrath basins are below where they need to be regarding water quality and integrity of the channels. These are the heaviest populated and commercial areas of North Augusta. An outreach campaign and implementation of BMPs in these basins could significantly improve the conditions in those areas. At this time the most critical areas of concern would be Crystal Lake basin, Pole Branch basin, and Waterworks.

Table: 23 Basin Integrity Ranking in North Augusta (preliminary)

Basin	**Assessment Rating (s) within basin to date.**	**Water Quality Impairment (overall) based on baseline samples only.**	**Channel degraded and unstable Y/N?**	**Overall Rating (based on baseline assessment data only).**
Mims Branch	2 Excellent 1 Good	No	No	Excellent
Fox Creek	1 Good	No	No	Good
River Bluff	1 Poor	No	No	Good
Crystal Lake	3 Poor	Yes	Yes	Poor
Pole Branch	1 Poor 1 Fair	Yes	Yes	Poor
Pretty Run	1 Fair 1 Poor	Yes	Yes	Poor
Riverview Basin	1 Poor	No	No	Fair
Waterworks	1 Fair	Yes	Yes	Poor
Womrath	3 Fair	Yes	Yes *	Poor

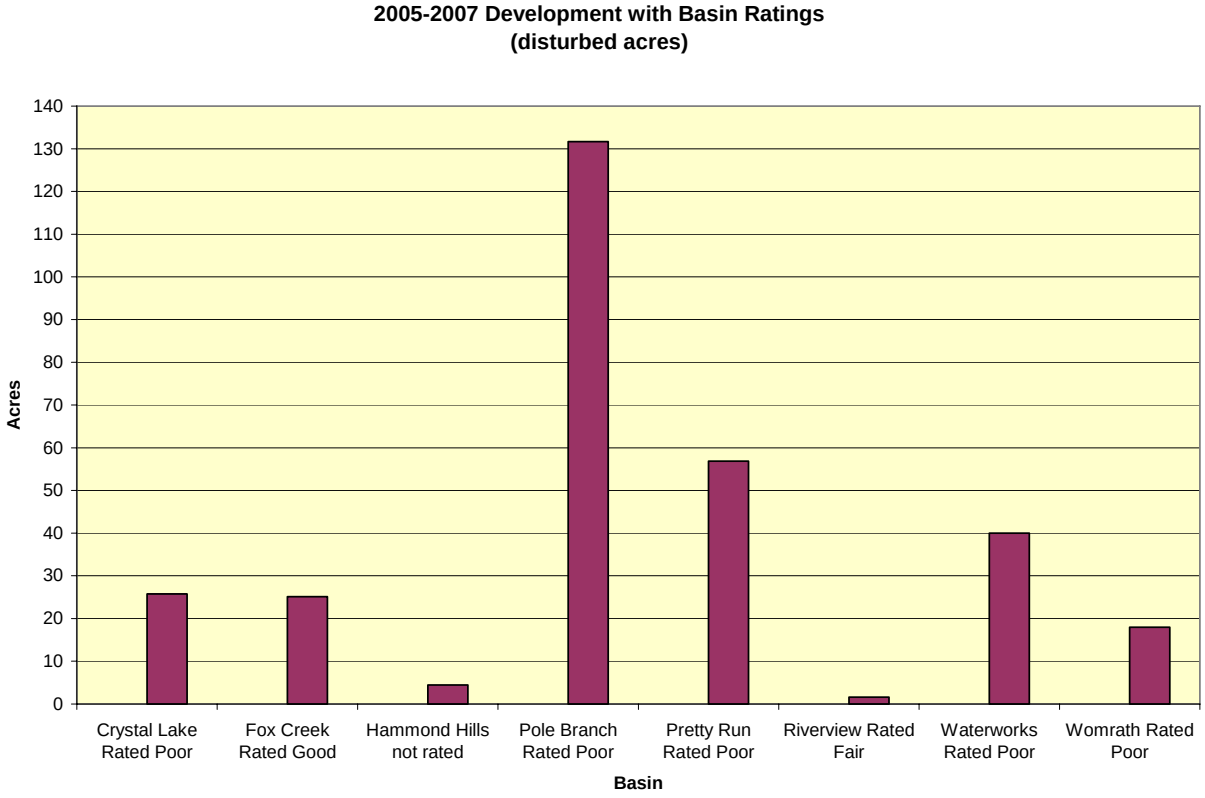
* Womrath basin channel is degraded and unstable in the upper reaches of the channel.

Development in the Basins

Since 2005, the stormwater management program has been logging all developments through our construction permitting program. To September 2007, approximately 303

acres have been developed in North Augusta. Of these most of the development approximately 130 acres were developed in Pole Branch Basin and another 68 acres has been developed in Pretty Run basin (see Figure 2). These are basins that are rated poor in this initial assessment of water quality in North Augusta's watershed. To help offset the impact to water quality from these developments, the city has a water quality requirement for new developments. All development projects greater than one acre must treat the first one inch of rainfall prior to it leaving the site. Many of the projects are using small wetland forebays in their stormwater detention ponds, and others are installing underground stormwater treatment devices. These measures will ensure that the runoff from development projects will be treated prior to its release into local streams.

Figure 1: 2005 – 2007 Development



5. Path Forward

The stormwater management department will continue to monitor and assess the streams within the basins in the community. Public outreach activities are underway. On July 21, 2007, a workshop entitled "North Augusta Streams & Creeks" will be held at the community center. This will be a first in a series of outreach activities to get community support and involvement in the process. There are several items on the agenda including reaching out for water quality volunteers in the community.

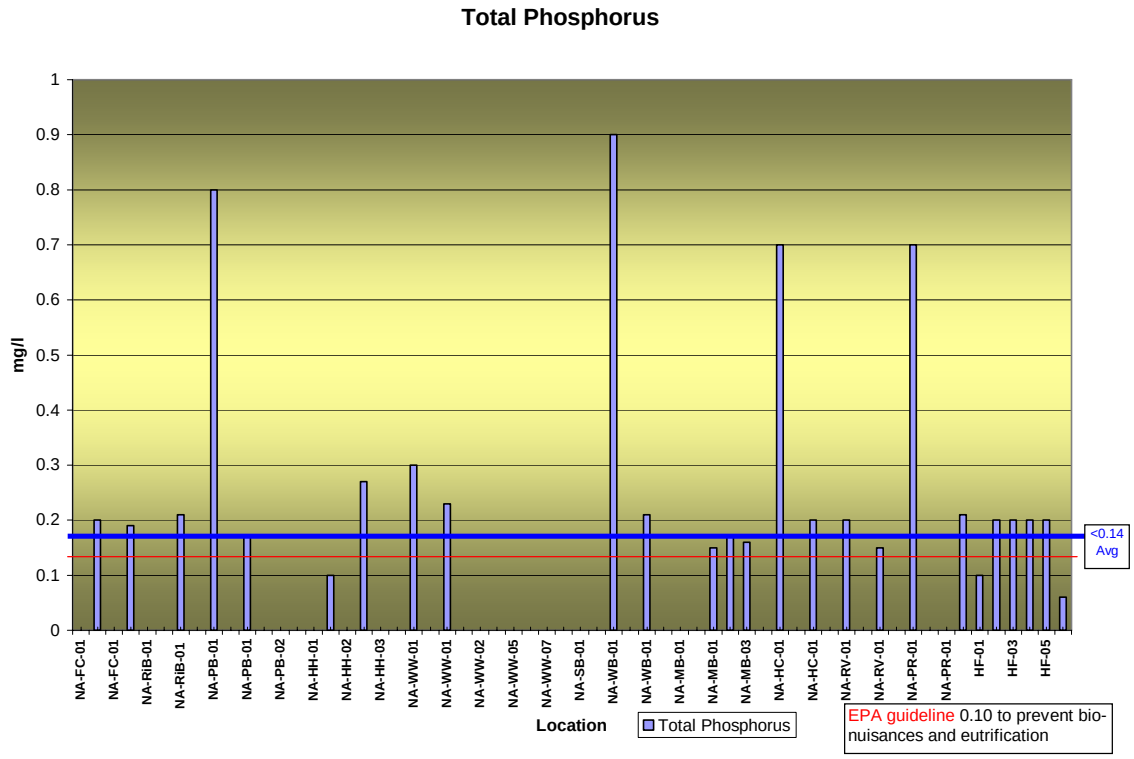
The SWMD also has planned several other events over the next 18 months to bring attention to our watershed issues.

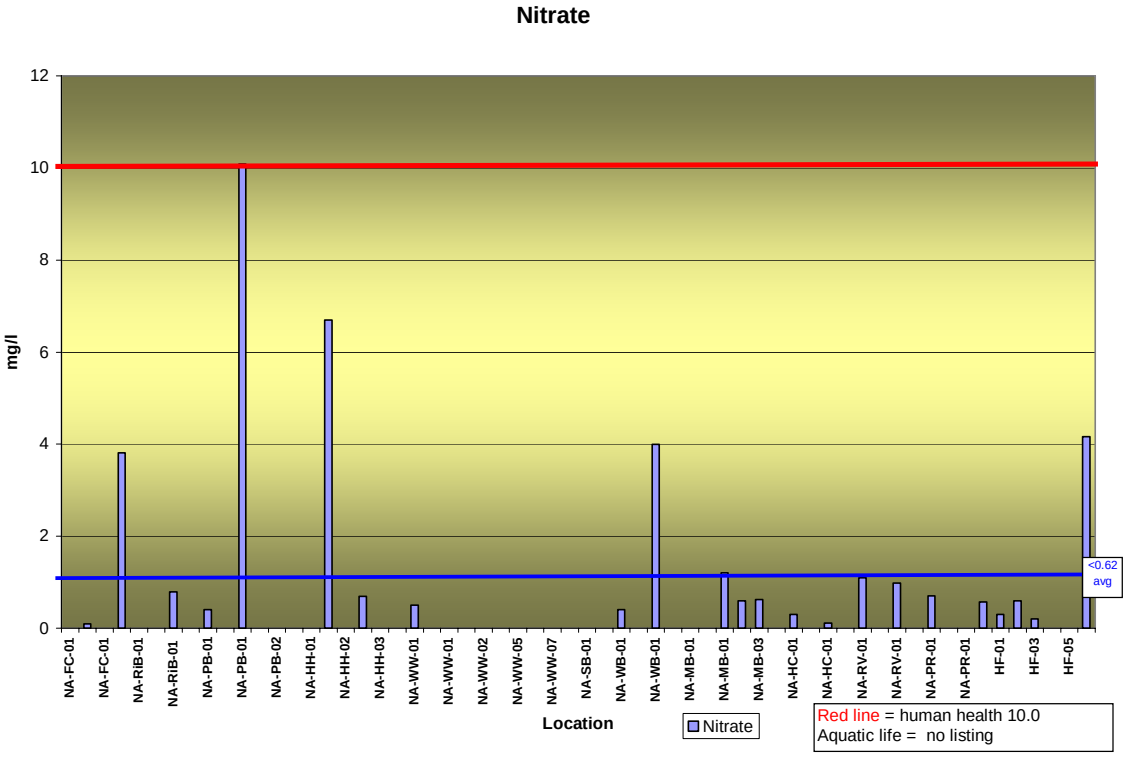
- We would like to use volunteers to assist us with putting up signage to identify watershed basins as you enter or leave them on the major roadways.
- Articles will be published in the upcoming Resource newsletter.
- An outreach campaign is being planned that involves billboards and local radio and television PSA's. At this time, Aiken County and Clemson Extension are on board to assist with this campaign.
- We are planning workshops for contractors to train them on proper installation of BMPs on their projects.
- We are working with Clemson's CEPSCI training event coordinators to bring a CEPSCI certification course to North Augusta.
- We will be presenting the Preliminary Stream Assessment to the North Augusta Planning Commission and City Council to get their input and ideas on how to protect our resources.

If you have any questions, comments, or suggestions regarding this document, please contact Tanya Strickland, at 803-441-4246 or email stormwater@northaugusta.net. The SWMD welcome and encourage suggestions and ideas.

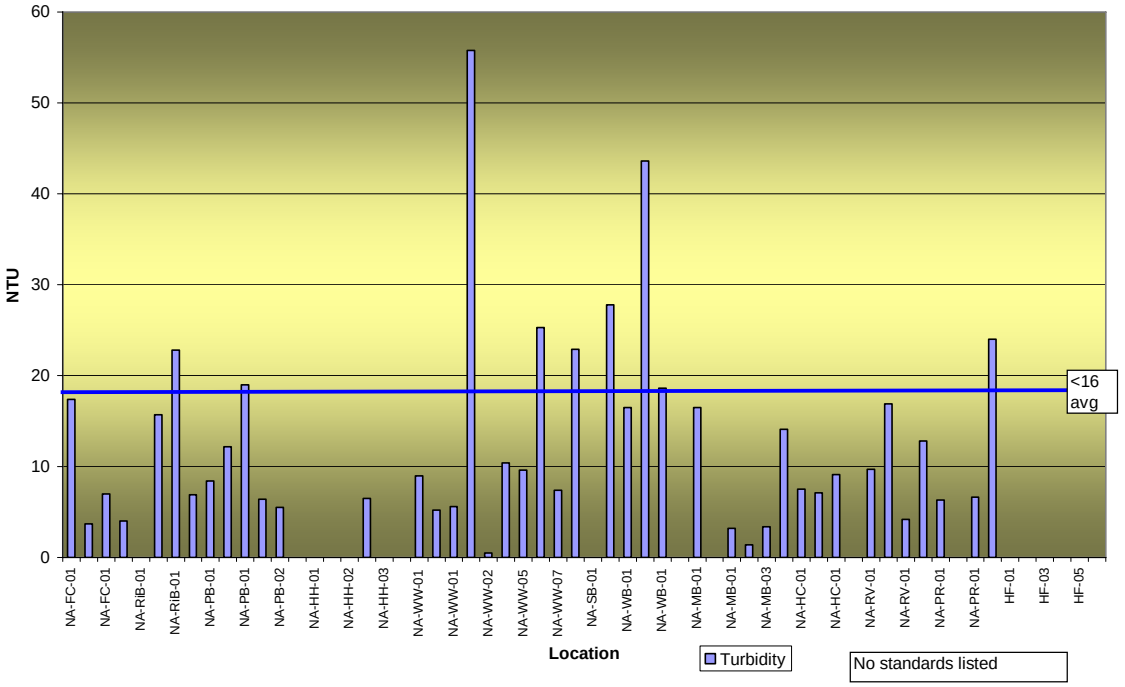
Appendix A – Sampling Data

The following charts represent all samples. Sample locations are listed at the bottom of each graph. State average is generated from an unpublished draft document compiling all ambient stream monitoring sampling across South Carolina during a five year period (1993-1997). The human health, aquatic life, and biological nuisance standards lines (that were available) are from the SC DHEC Water Classification & Standards Regulation 61-68 published July 25, 2004. The NSWQD data is not represented in these graphs.

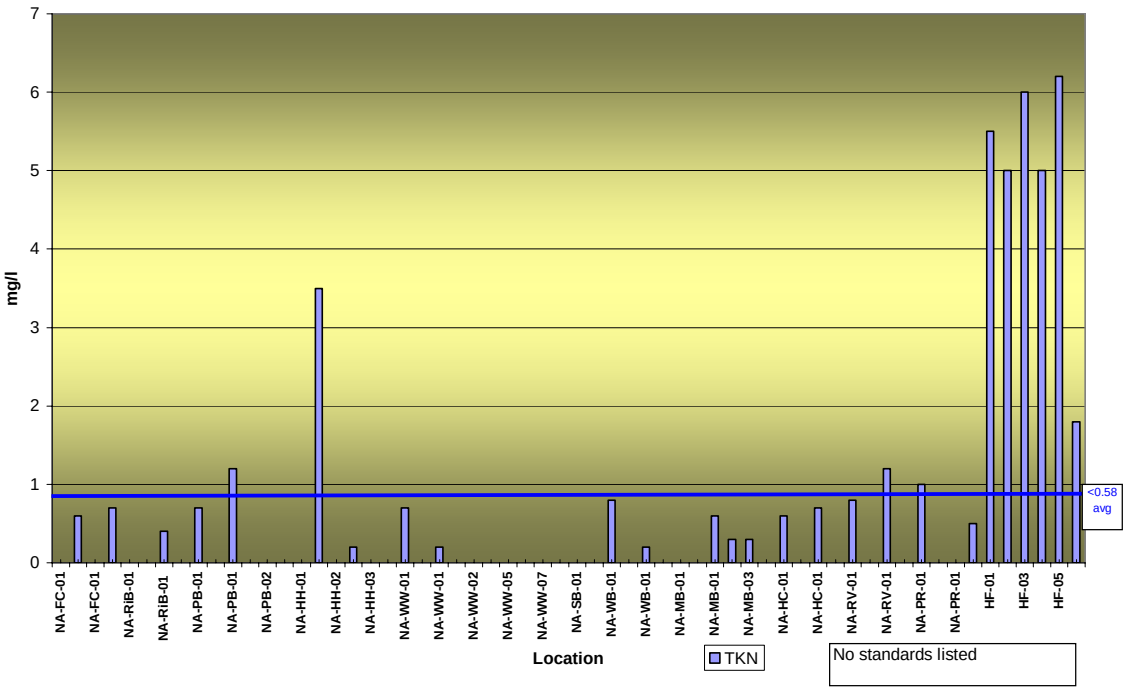



Nitrate
mg/l
12
10
8
6
4
2
0
NA-FC-01
NA-FC-01
NA-RiB-01
NA-RiB-01
NA-PB-01
NA-PB-01
NA-PB-02
NA-HH-01
NA-HH-02
NA-HH-03
NA-WW-01
NA-WW-01
NA-WW-02
NA-WW-05
NA-WW-07
NA-SB-01
NA-WB-01
NA-WB-01
NA-MB-01
NA-MB-01
NA-MB-03
NA-HC-01
NA-HC-01
NA-RV-01
NA-RV-01
NA-PR-01
NA-PR-01
HF-01
HF-03
HF-05
<0.62
avg
Location
Nitrate
Red line = human health 10.0
Aquatic life = no listing

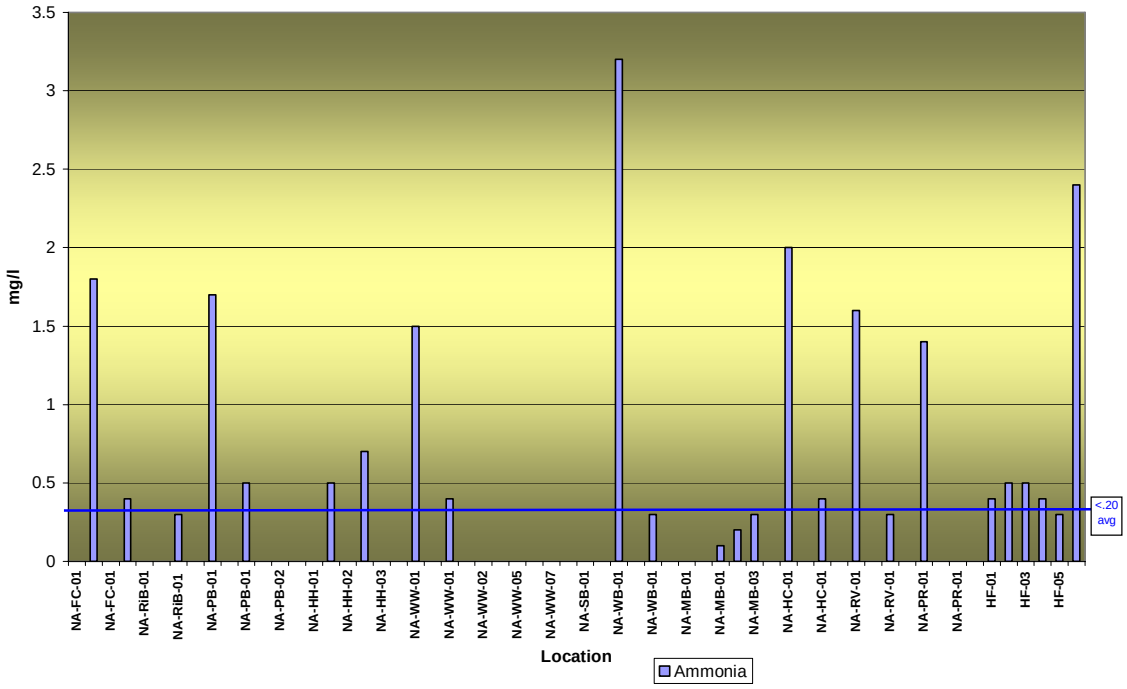
Turbidity



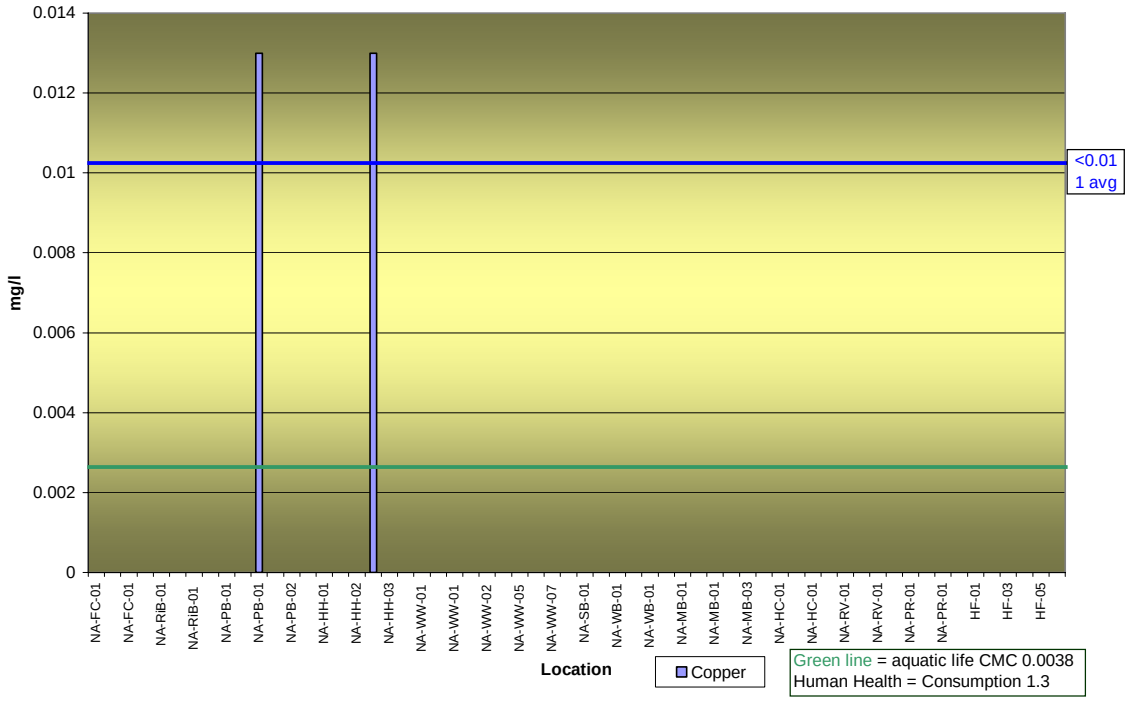
TKN



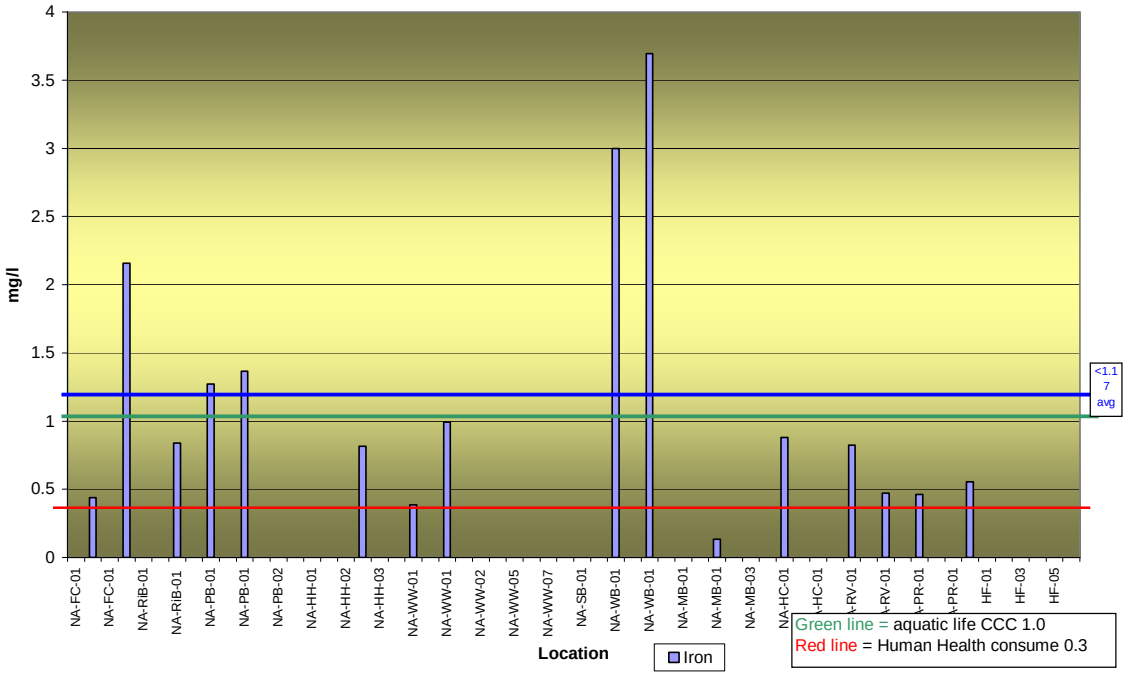
Ammonia



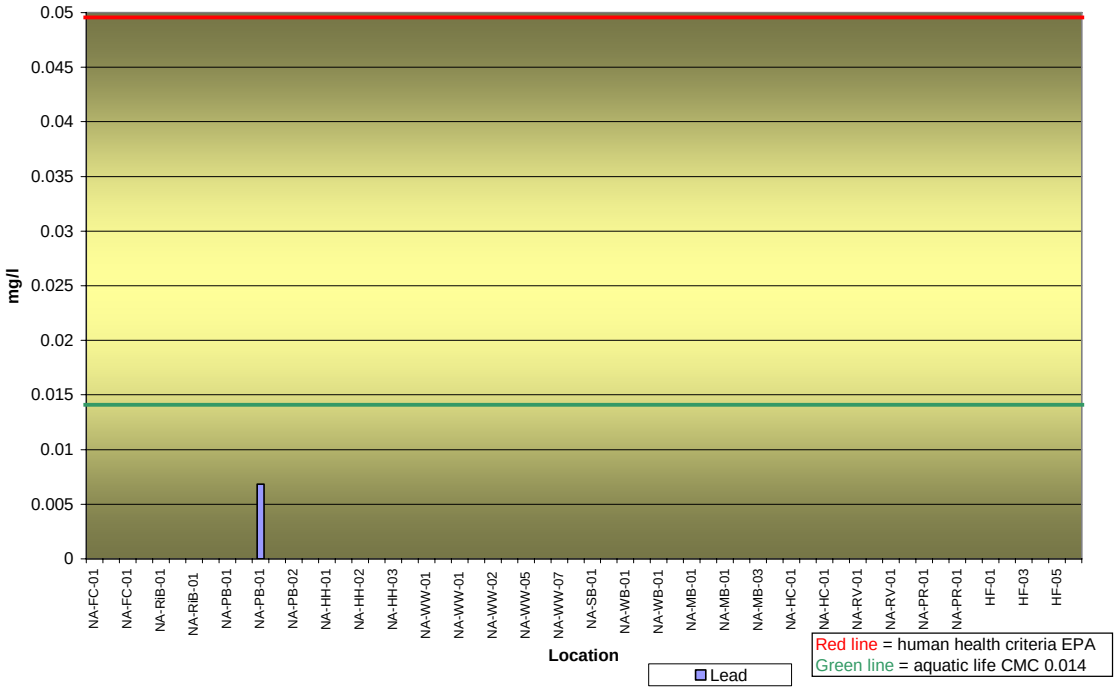
Copper



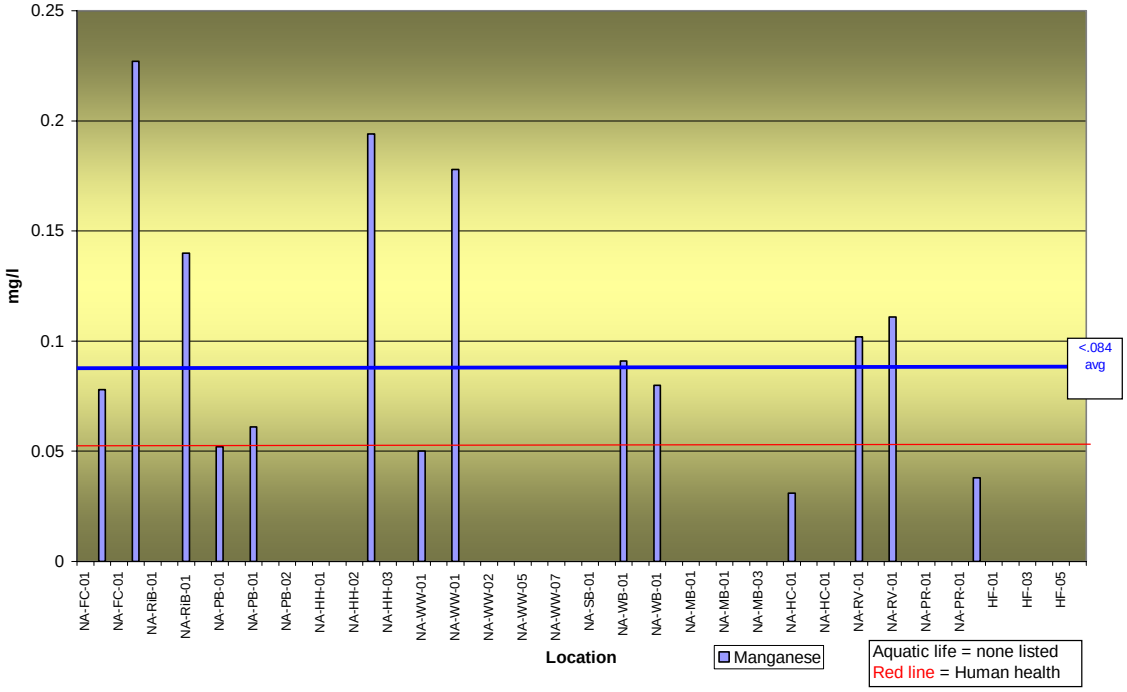
Iron


mg/l
Location
Iron
<1.17 avg
Green line = aquatic life CCC 1.0
Red line = Human Health consume 0.3

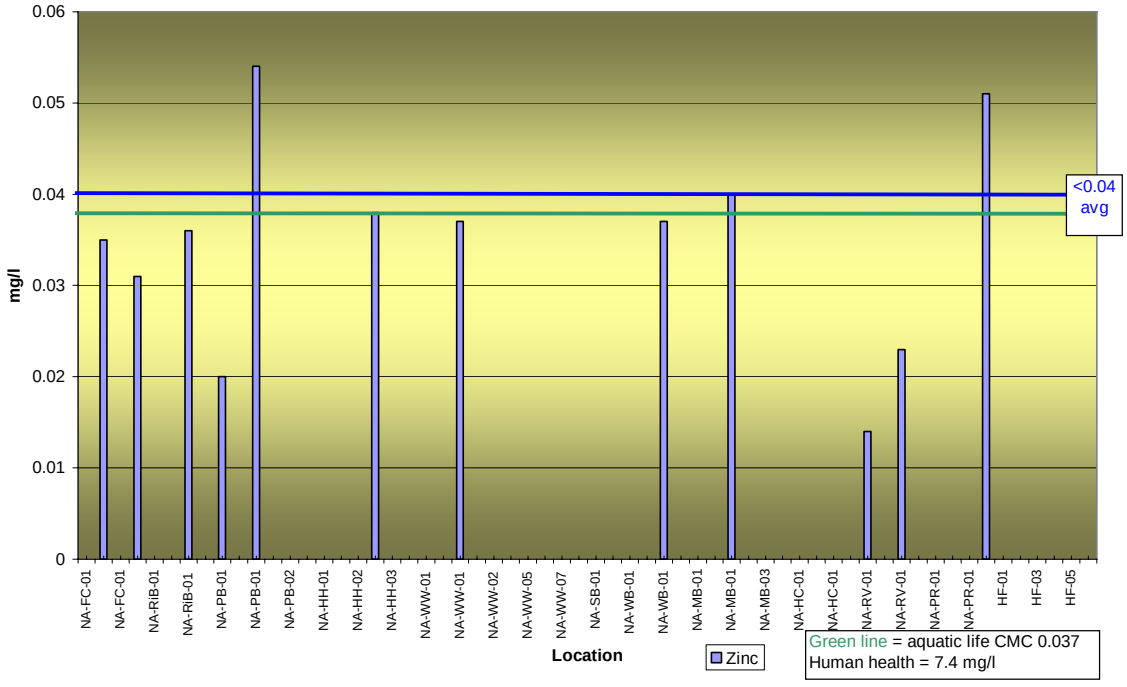
Lead


mg/l
Location
Lead
Red line = human health criteria EPA
Green line = aquatic life CMC 0.014

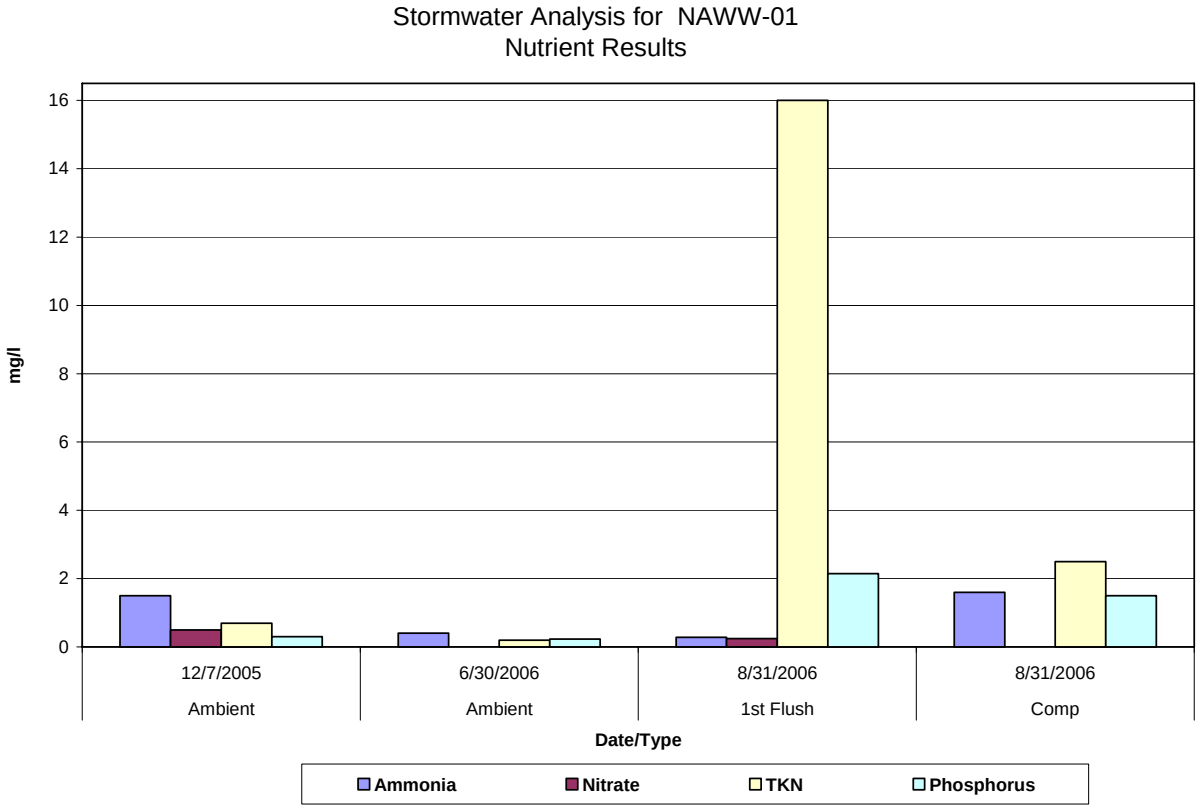
Manganese

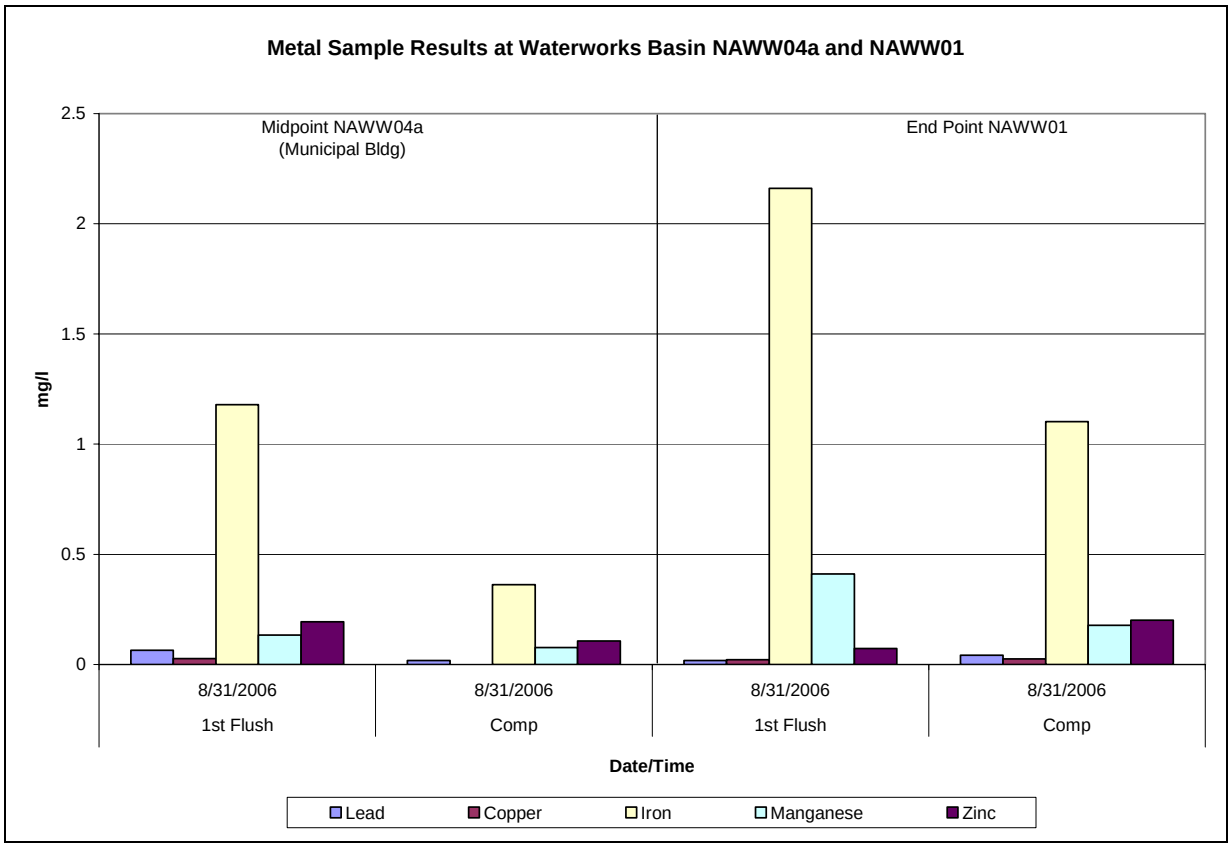


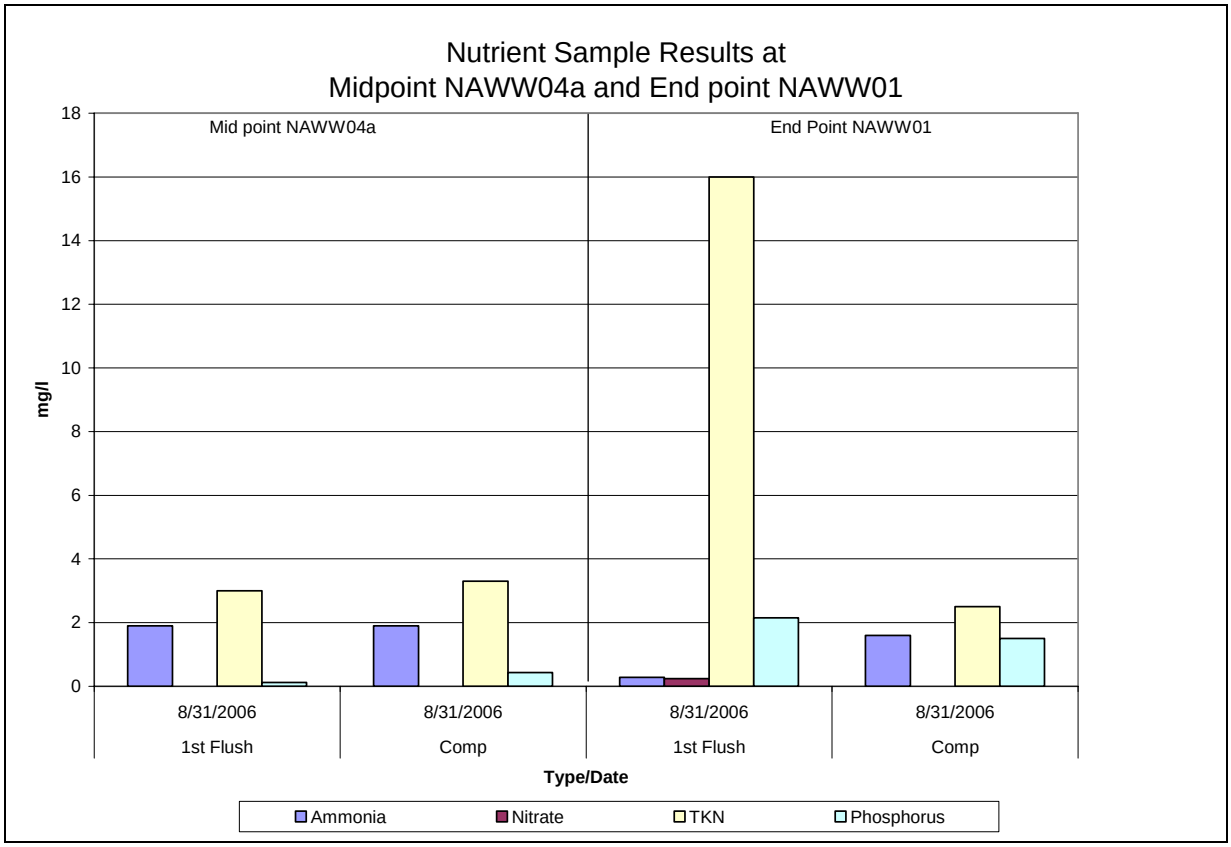
Zinc

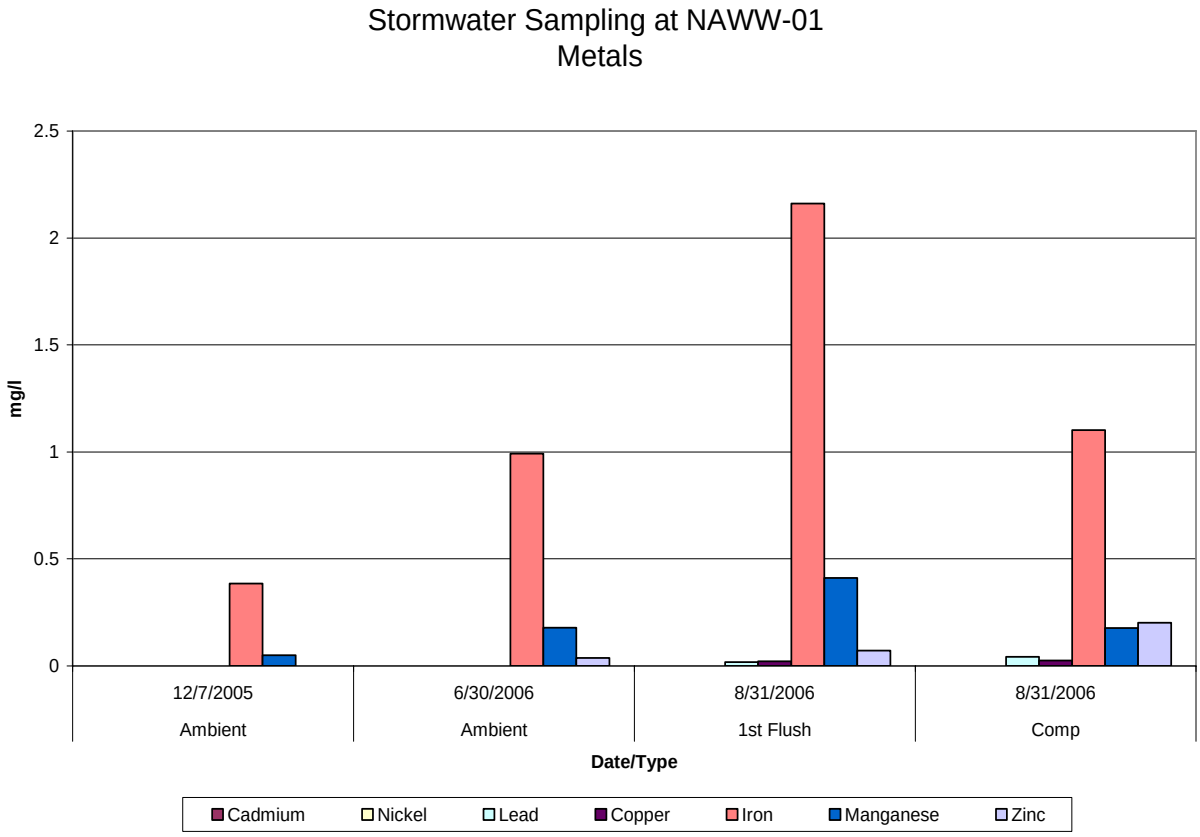


Waterworks Basin Study
Data compiled by Michele Harmon, PhD of USC-Aiken



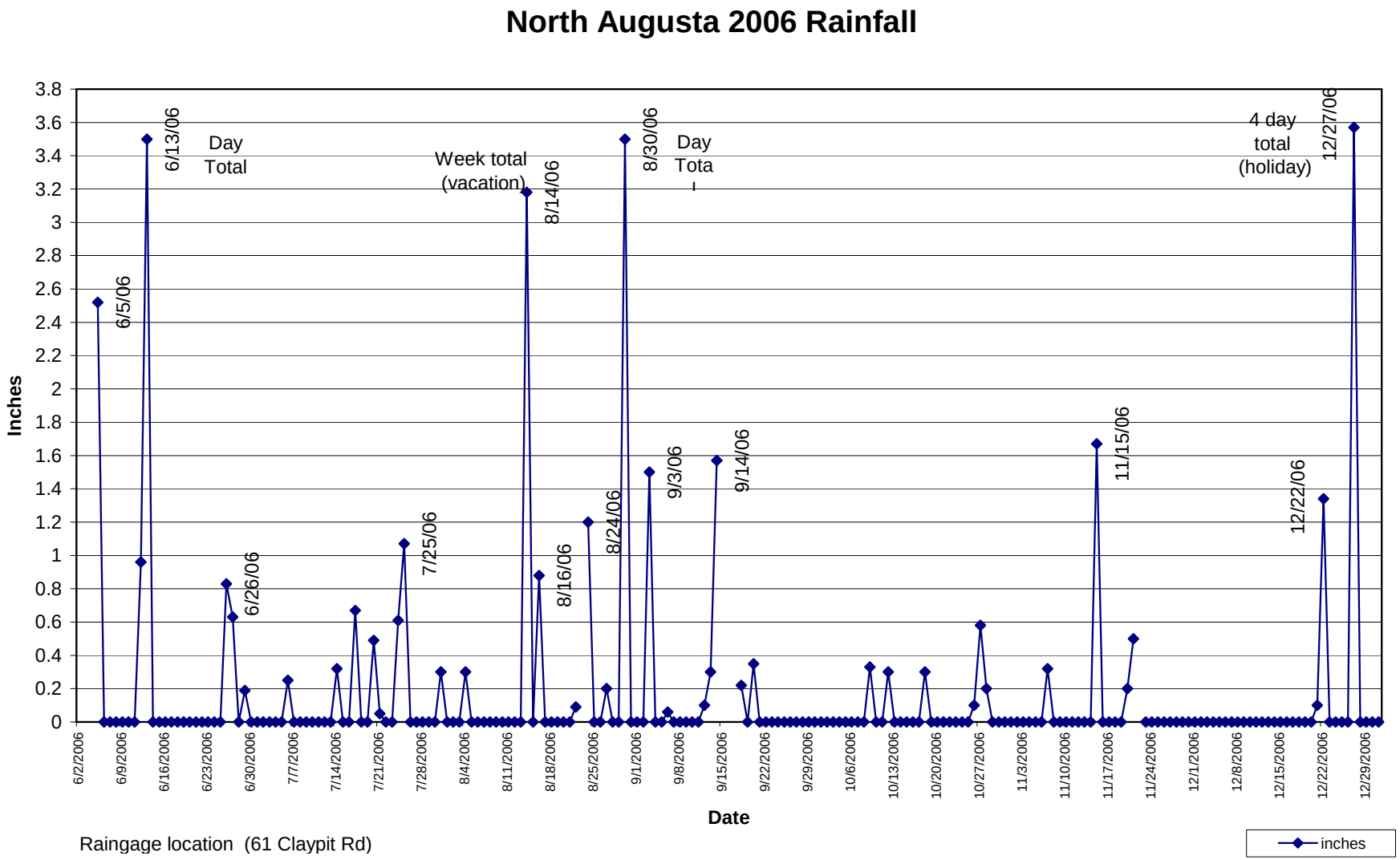

Metal Sample Results at Waterworks Basin NAWW04a and NAWW01
Midpoint NAWW04a
(Municipal Bldg)
End Point NAWW01
2.5
2
1.5
1
0.5
0
mg/l
8/31/2006
1st Flush
8/31/2006
Comp
8/31/2006
1st Flush
8/31/2006
Comp
Date/Time
Lead
Copper
Iron
Manganese
Zinc

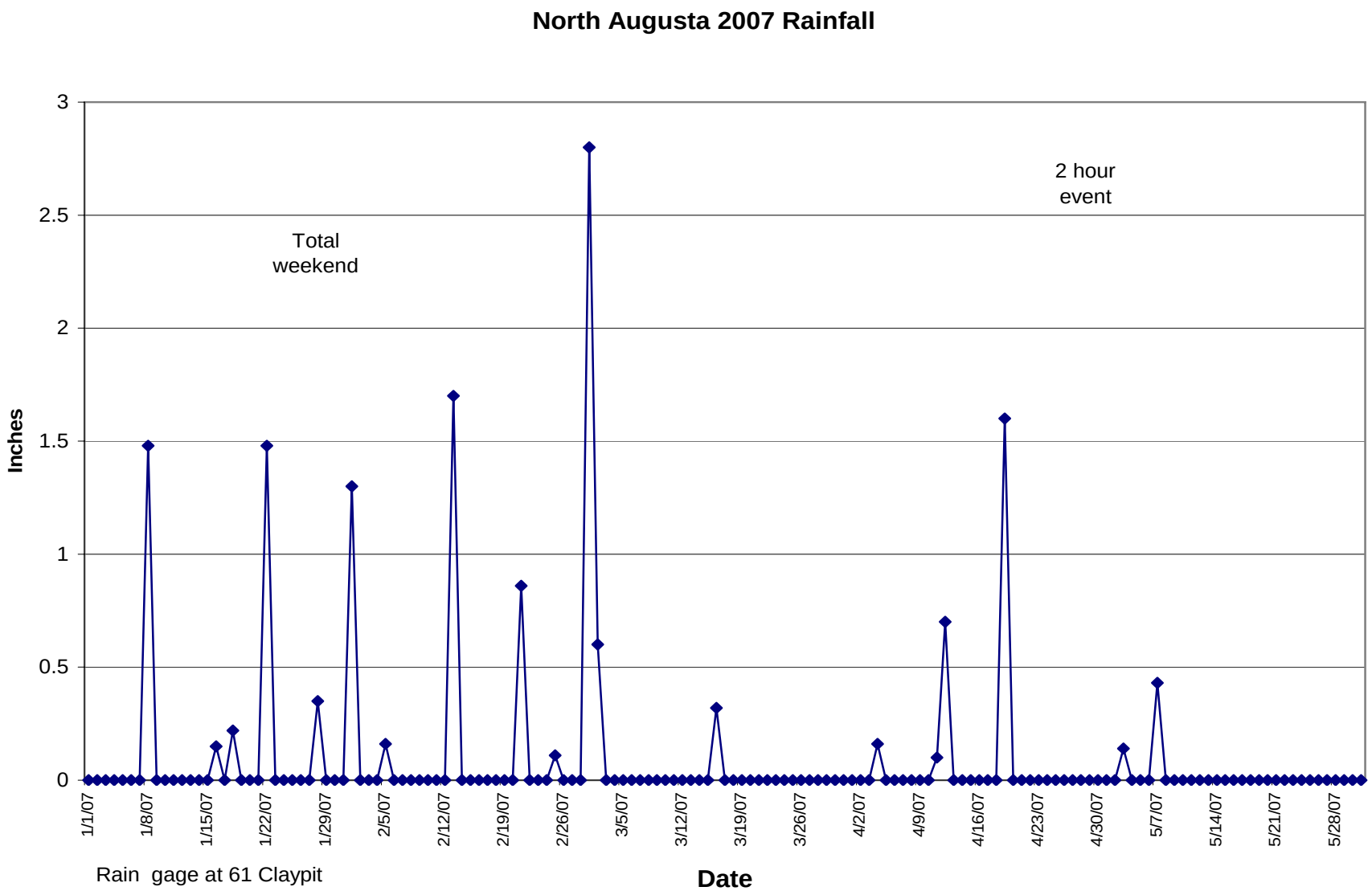

Nutrient Sample Results at
Midpoint NAWW04a and End point NAWW01
Mid point NAWW04a
End Point NAWW01
18
16
14
12
10
8
6
4
2
0
mg/l
8/31/2006
1st Flush
8/31/2006
Comp
8/31/2006
1st Flush
8/31/2006
Comp
Type/Date
Ammonia
Nitrate
TKN
Phosphorus


Stormwater Sampling at NAWW-01
Metals
2.5
2
1.5
1
0.5
0
mg/l
12/7/2005
Ambient
6/30/2006
Ambient
8/31/2006
1st Flush
8/31/2006
Comp
Date/Type
Cadmium
Nickel
Lead
Copper
Iron
Manganese
Zinc

Appendix B - Rainfall Data

Rainfall data collection began in June 2006 at Claypit Road in North Augusta. The following two tables represent all data collected.




North Augusta 2007 Rainfall
Total weekend
2 hour event
Inches
3
2.5
2
1.5
1
0.5
0
1/1/07
1/8/07
1/15/07
1/22/07
1/29/07
2/5/07
2/12/07
2/19/07
2/26/07
3/5/07
3/12/07
3/19/07
3/26/07
4/2/07
4/9/07
4/16/07
4/23/07
4/30/07
5/7/07
5/14/07
5/21/07
5/28/07
Rain gage at 61 Claypit
Date