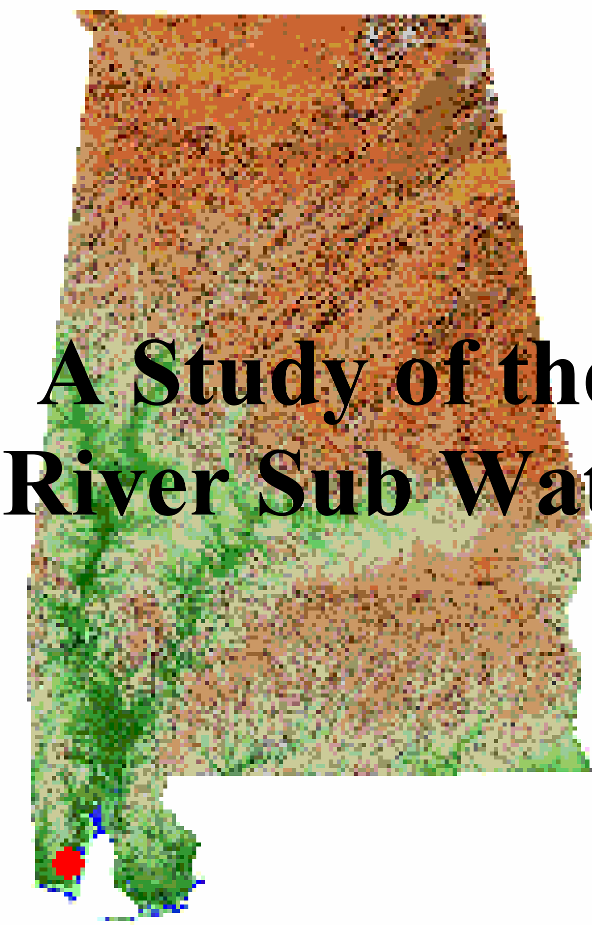
TECHNICAL REPORT

A Study of the Fowl River Sub Watershed



September 2006

Alabama Department of Environmental Management
Mobile Branch
2204 Perimeter Road, Mobile, Alabama 36615

An Examination of Water and Sediment Quality and a Report on the Characteristics, History, and Current Land Uses for the Fowl River Drainage Basin.

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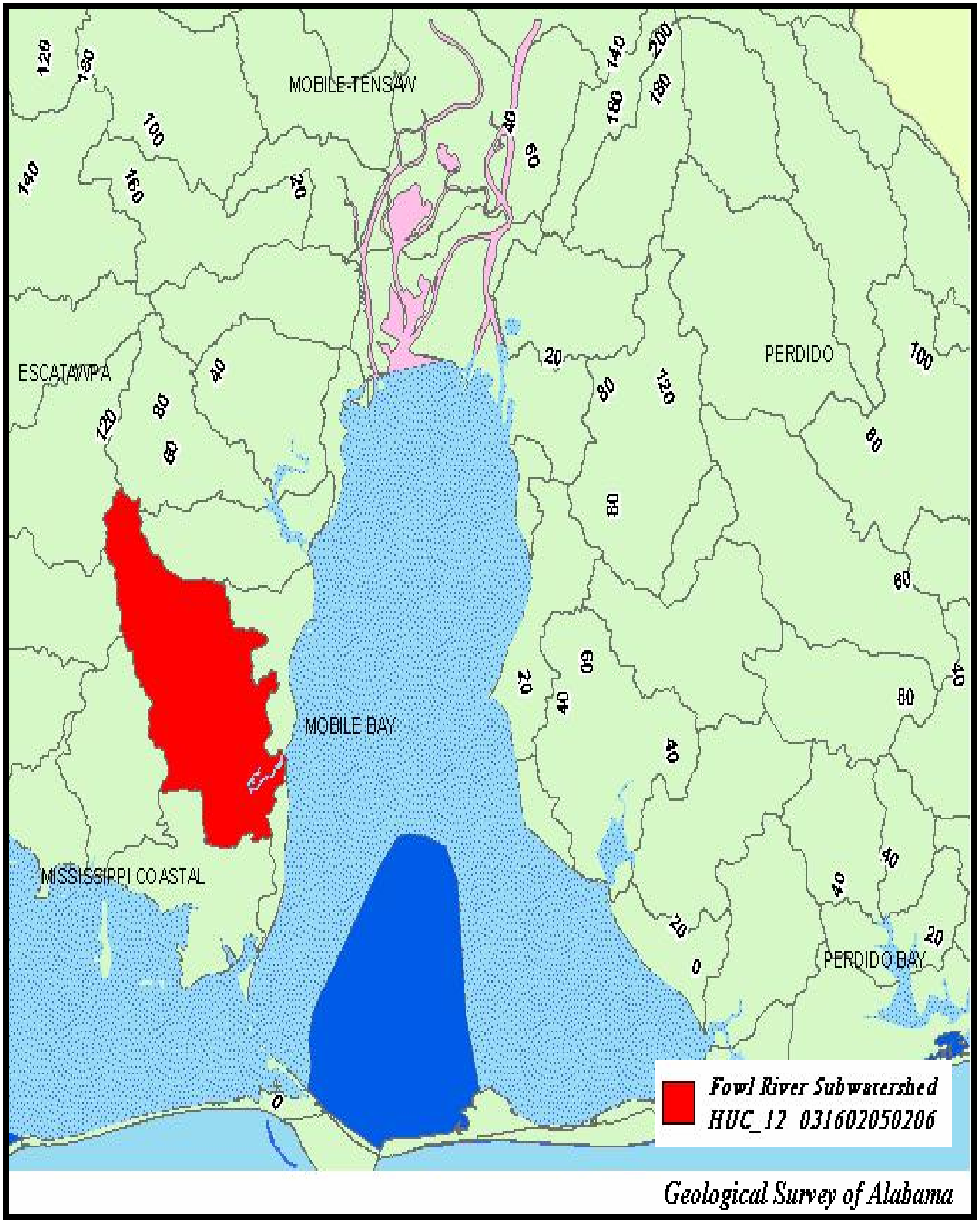
EXECUTIVE SUMMARY

Starting in October of 2004, and continuing through July of 2006, the Mobile Branch of the Department's Field Operations Division conducted a survey of the Fowl River sub watershed. Located in southeastern Mobile County, the Fowl River sub watershed (52,782 acres) is a contributor to the Mobile Bay. The survey endeavored to assess water quality within the sub watershed, to identify stream segments impaired by pollution, to identify any potential sources of impairment, and, ultimately, to provide support and information for more effective implementation of pollution control strategies and NPS management practices. Analysis of data collected in the field was coupled with the information garnered on established land use and demographic characteristics of the study area to target the specified objectives of the study.

The Fowl River sub watershed is predominantly rural with no centralized urban or industrial concentrations. During the course of the study there was one National Pollutant Discharge Elimination System permitted facility located within the watershed. On several occasions, study stations within the watershed exhibited fecal coliform bacteria concentrations above the minimum required to maintain the existing water use classification. Fowl River appears on the Department's 2002 303(d) list of impaired streams because of excessive mercury concentrations. The Alabama Department of Public Health has issued a fish consumption advisory for Largemouth Bass (*micropterus salmoides*) taken from Fowl River as a result of mercury concentrations encountered in members of that species retrieved from within the watershed. Sediment samples within the watershed during this study did not exhibit elevated concentrations of mercury or any other metal. Negative water quality indicators that were observed during the study were, invariably, encountered during and following rain events. These data may be attributed to non point source discharge via runoff, during and immediately following rain events.

Apart from the elevated fecal coliform bacteria concentrations observed along segments of the sub watershed, overall water quality may, from the results of this study, be characterized as satisfactory. Such a conclusion is based on average values for collected data acquired over a period when the area was experiencing less than normal rainfall amounts. Further, it must be observed that the study area's population is expected to increase. New construction of housing continues throughout the watershed. Such growth will, most likely, contribute to habitat loss, stream modification, and water quality degradation as a result of increased pollutant pressure from impervious surface runoff, septic systems, and additional, miscellaneous stressors of residential congestion.

A Survey of the Fowl River Sub Watershed



INTRODUCTION

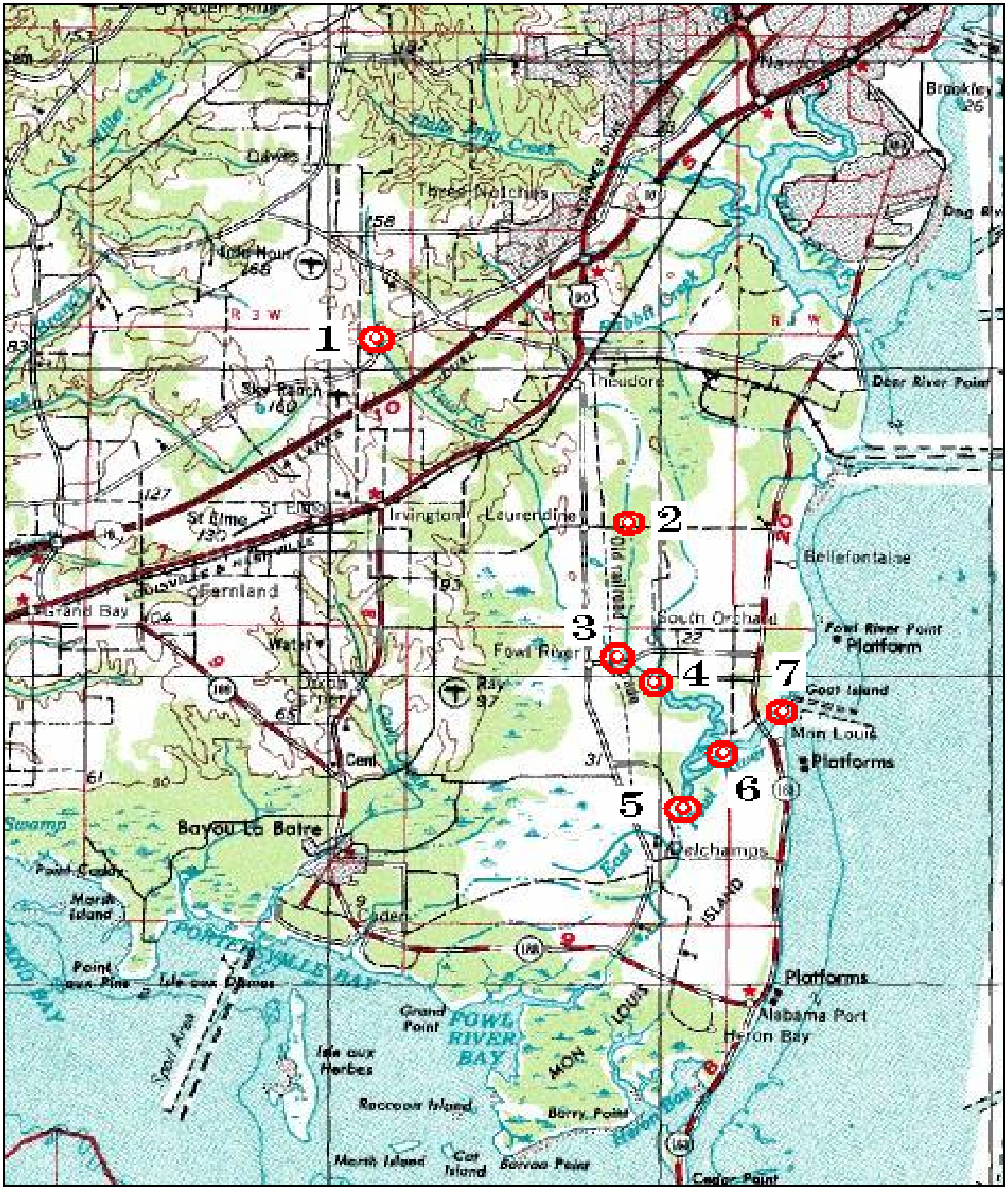
As water drains off the land, it can introduce an array of pollutants into the receiving streams. Recognizing this is important to effectively monitor and protect water resources. The Alabama Department of Environmental Management (ADEM) adopted the watershed assessment strategy in 1996 as an integrated, holistic strategy for more effectively restoring and protecting aquatic ecosystems by examining water resources and the land from which water drains to those resources (ADEM. 2000.) By defining a geographical region's drainage pathways and focusing on the individual basins, the ADEM is provided an objective, targeted approach toward meaningful water quality monitoring, assessment, and implementation of control activities. Over the past decade, the ADEM has conducted watershed surveys in the coastal areas of Mobile and Baldwin counties as part of its "Water Quality and Natural Resource Monitoring Strategy for Coastal Alabama." These studies have included Bay Minette Creek, Bayou Sara, Bon Secour River, Chickasaw Creek, Dog River, and Little Lagoon. Each of the watershed studies attempts to define potential pollutant sources and explore potential avenues toward improving the water quality.

The Fowl River sub watershed (HUC 031602050206) is a contributor to the Mobile Bay watershed (HUC 03160205.) Beginning in October of 2004 and continuing through July of 2006, personnel from the Alabama Department of Environmental Management monitored the water quality of surface waters within the Fowl River sub watershed and assessed the entire sub watershed in accordance with the protocols outlined in the ADEM Technical Report, *Methodology For Coastal Watershed Assessments* (2001.)

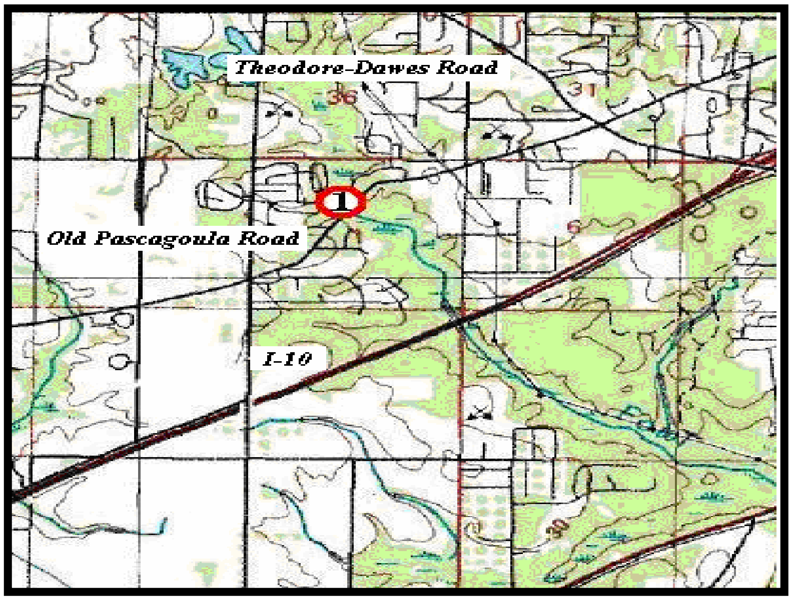
Sampling stations within the sub watershed were chosen through topographic map review and field observation to represent a randomized cross section of the drainage area based upon predominate land uses within the sub watershed. Seven stations were selected and named FLR 1 through FLR 7. FLR 1 was located near the headwaters of Fowl River and represented a rural residential stream segment. FLR 2 was located on Muddy Creek in a primarily forested area. FLR 3 was also located on Muddy Creek just upstream of that tributary's confluence with Fowl River and represented a rural residential stream segment. FLR 4 was located on Fowl River just downstream of the confluence with Dyke Creek and represented a rural residential stream segment. FLR 5 was located on East Fowl River just downstream of a residential concentration. FLR 6 was located on East Fowl River and represented a rural residential stream segment. FLR 7 was located on East Fowl River just upstream of the point where the river empties into Mobile Bay and also represented a rural residential stream segment. Each of the selected stations were monitored, at least monthly, for dissolved oxygen, pH, salinity, specific conductivity, temperature, total suspended solids, total dissolved solids, turbidity, fecal coliform bacteria, ammonia, nitrates/nitrites, total Kjeldahl nitrogen, chlorophyll a, total phosphorous, and dissolved reactive phosphate. The stations were also sampled once for metals concentrations in the sediment.

In presenting the water quality data derived from the study, stations are represented in groups and by individual station. Charts are used to facilitate comparison between stations. Average values recorded are an arithmetic mean of the total determinations made throughout the study period. These average values are, unless otherwise specified, inclusive of all monitored levels along the water column.

Sample Stations



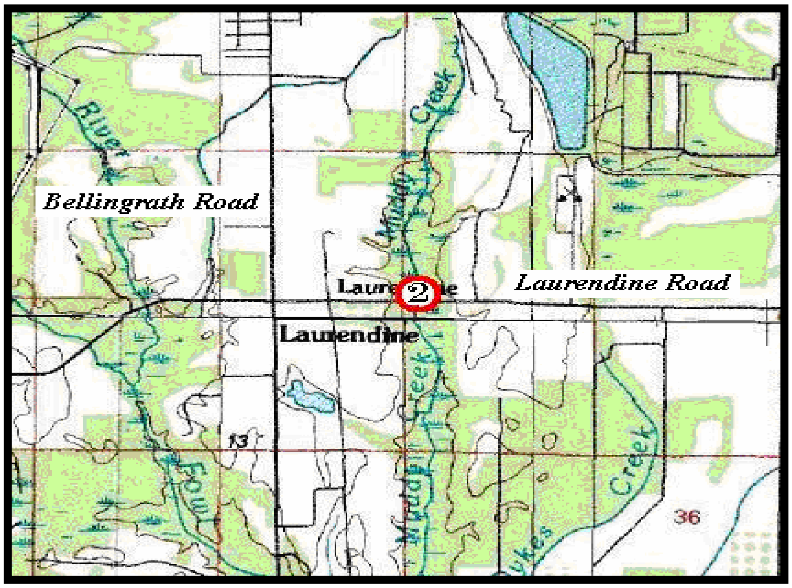
FLR 1 -　　Fowl River at Old Pascagoula Road　　30^0 33' 19"
88^0 14' 05"



FLR 1 was located at the upper reaches of Fowl River, near that stream's source, along the northwestern corner of the sub watershed, north of the bridge on Old Pascagoula Road. FLR 1 was selected as a study station to represent rural and forested land use. It was also selected as the most accessible station nearest Fowl River's source. In Rule 335-6-11-.02 (9) of the ADEM Administrative Code, this section of Fowl River carries a water use classification of Fish and Wildlife and Swimming and other Whole Body Contact Water Sports. Impervious surface was limited to the paved roadway adjacent the station. Immediately upstream and downstream of FLR 1, Fowl River consisted of a fairly wide, deepwater stream. Flows encountered at the station were either very slow or non-discernible. Land use was, primarily forest, although there were some residences located nearby. Vegetation was abundant along both banks with limited canopy cover along the stream's edges. The stream's bank height was about two feet. No substantial erosion was observed at the station during the study. Trash discarded by passing motorists was a normal observation at the station.

FLR 1 FACING UPSTREAM

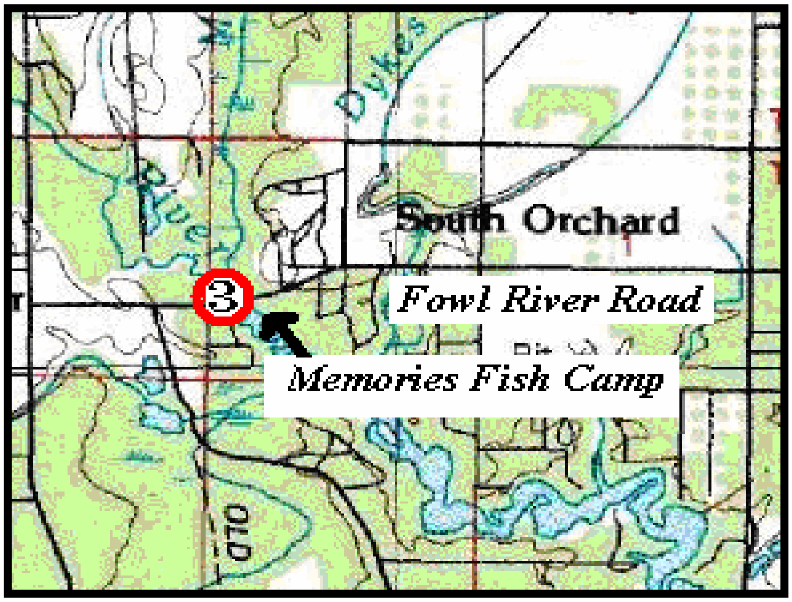
FLR 2 - **Muddy Creek at Laurendine Road** **30⁰ 30' 08"**
88⁰ 09' 26"



FLR 2 was located on Muddy Creek north of Laurendine Road in the north central portion of the sub watershed. FLR 2 was selected to represent forested land use. Muddy Creek is not listed in Rule 335-6-11-.02 of the ADEM Administrative Code, so carries a water use classification of Fish and Wildlife. The paved road lying south of the station was the only impervious surface observed. Stream flow was generally very slow or non-discernible throughout the study period. Vegetation was abundant on both banks. No substantial erosion was observed at the station during the study. The stream's width was, generally, around twenty (20) feet. Trees along the stream's banks provided for about a forty (40) percent canopy cover. Both banks were generally low. Macrophytes, submerged vegetation, and fish were common and abundant. No water odor, or sediment odor was encountered during the course of the study. The water was generally tannic stained. Pollution from non point sources, apart from trash discharged from passing vehicles, was not apparent.

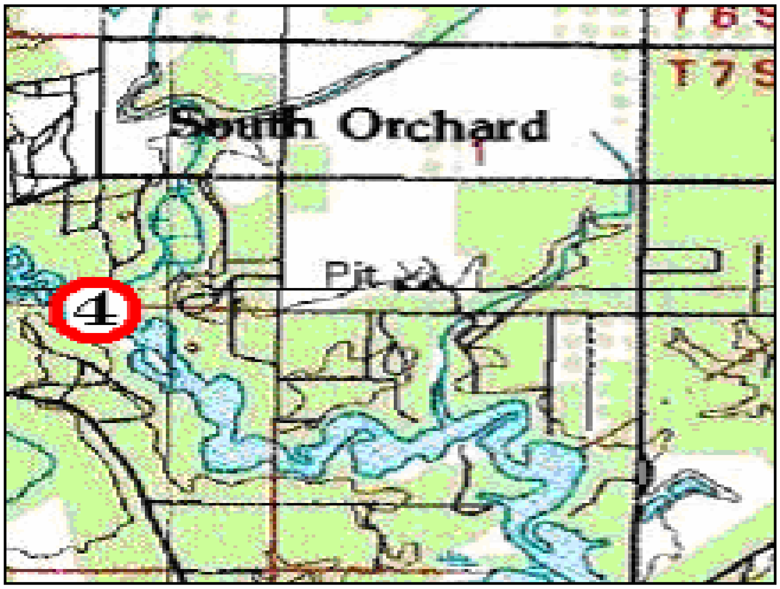
FLR 2 FACING UPSTREAM

FLR 3 - Fowl River at Fowl River Road **30⁰ 27' 47"** **88⁰ 09' 20"**



FLR 3 was located on Muddy Creek just upstream of that tributary's confluence with Fowl River in the central portion of the sub watershed. This station was just upstream of *Memories Fish Camp* on Fowl River Road. FLR 3 was selected as a rural land use station. As a part of Muddy Creek, this segment of stream carried a water use classification of Fish and Wildlife. Impervious surface was estimated to be less than 20% coverage at this station. A residence with a mound septic system was located immediately up gradient of the left bank at this station. Domesticated geese were commonly observed. Some erosion was observed along the left bank. The stream was, typically, in excess of fifteen (15) feet in width and was often slightly to moderately tannic stained. Domestic trash was not uncommon at the station. Stream flow was often very slow or not observed at all. No significant water odors were encountered at FLR 3 during the study.

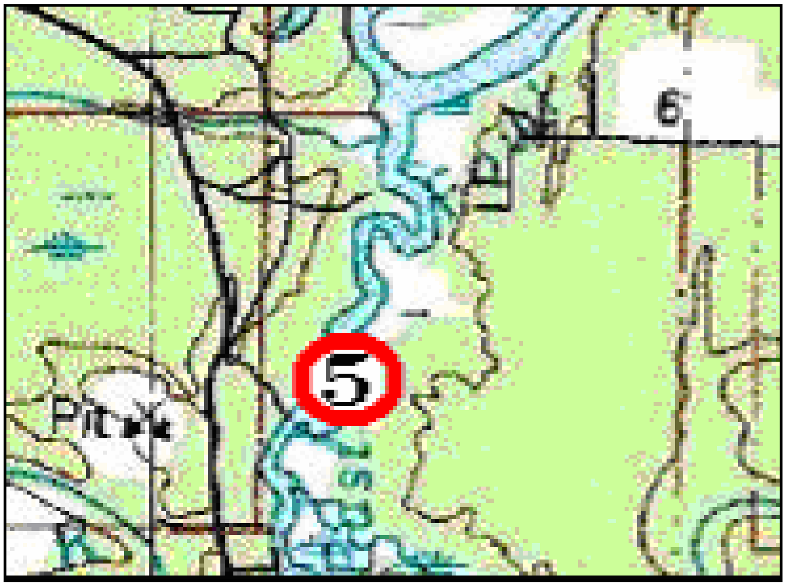
FLR 4 - **Fowl River below Dykes Creek Confluence** **30^0 27' 28"**
88^0 08' 55"



Also located in the central portion of the sub watershed, just below the confluence of Dykes Creek and Fowl River, was FLR 4. Station FLR 4 represented rural/forested land use. In Rule 335-6-11-.02 of the ADEM Administrative Code, this section of Fowl River carries a water use classification of Fish and Wildlife and Swimming and Other Whole Body Contact Water Sports. The impervious surface area was estimated to be less than 5% for this station. The stream above and below FLR 4 was deep water (> 20 feet) and was, invariably, tannic stained. Flow at this station was generally slow. Land use on both banks was rural/forested. No substantial erosion was observed during the study. Vegetation was abundant along both banks. Aquatic vegetation, both submerged and emerging, was observed. No water odors were encountered during the study.

FLR 4 FACING DOWNSTREAM

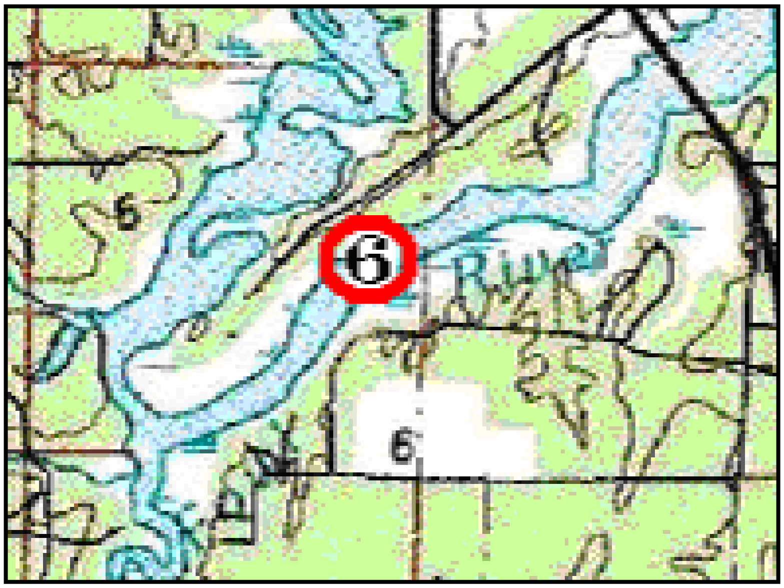
FLR 5 - East Fowl River 30^0 25' 07"
88^0 08' 18"



Station FLR 5 was located on East Fowl River at a point approximately midway between its origin and Mobile Bay. The station represented rural/forested land use. According to Rule 335-6-11-.02 of the ADEM Administrative Code, this section of East Fowl River carries a water use classification of Fish and Wildlife and Swimming and Other Whole Body Contact Water Sports. The impervious surface area was estimated to be less than 5% for this station. The stream above and below FLR 5 was winding, relatively shallow (< 10 feet) and was, invariably, tannic stained. Flow at this station was generally slow. Land use on both banks was rural/forested. No substantial erosion was observed during the study. Vegetation was abundant along both banks. Aquatic vegetation, both submerged and emerging, was observed. No water odors were encountered during the study.

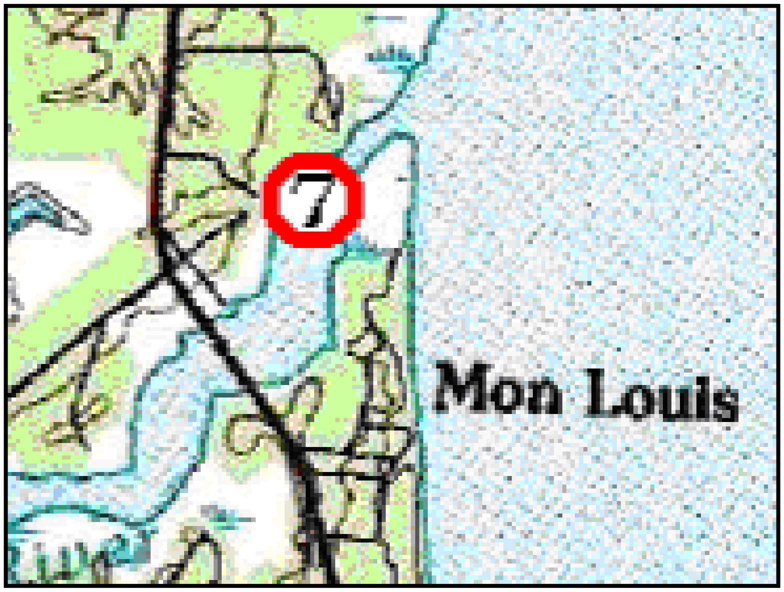
FLR 5 FACING DOWNSTREAM

FLR 6 -   East Fowl River   **30^0 26' 13"**
88^0 07' 30"



Station FLR 6 was located on East Fowl River at a point about midway between the confluence of East Fowl River and Fowl River and the Dauphin Island Parkway bridge. The station represented residential land use. Rule 335-6-11-.02 of the ADEM Administrative Code, lists this section of East Fowl River with a water use classification of Fish and Wildlife and Swimming and Other Whole Body Contact Water Sports. The impervious surface area was estimated to be less than 10% for this station. Flow at this station was generally slow to moderate. Land use on both banks was residential, although the right bank was less heavily populated and possessed substantial marshland. No substantial erosion was observed during the study. Vegetation was abundant along both banks. Aquatic vegetation, both submerged and emerging, was observed. No water odors were encountered during the study.

FLR 7 - East Fowl River **30^0 26’ 52”**
88^0 06’ 37”

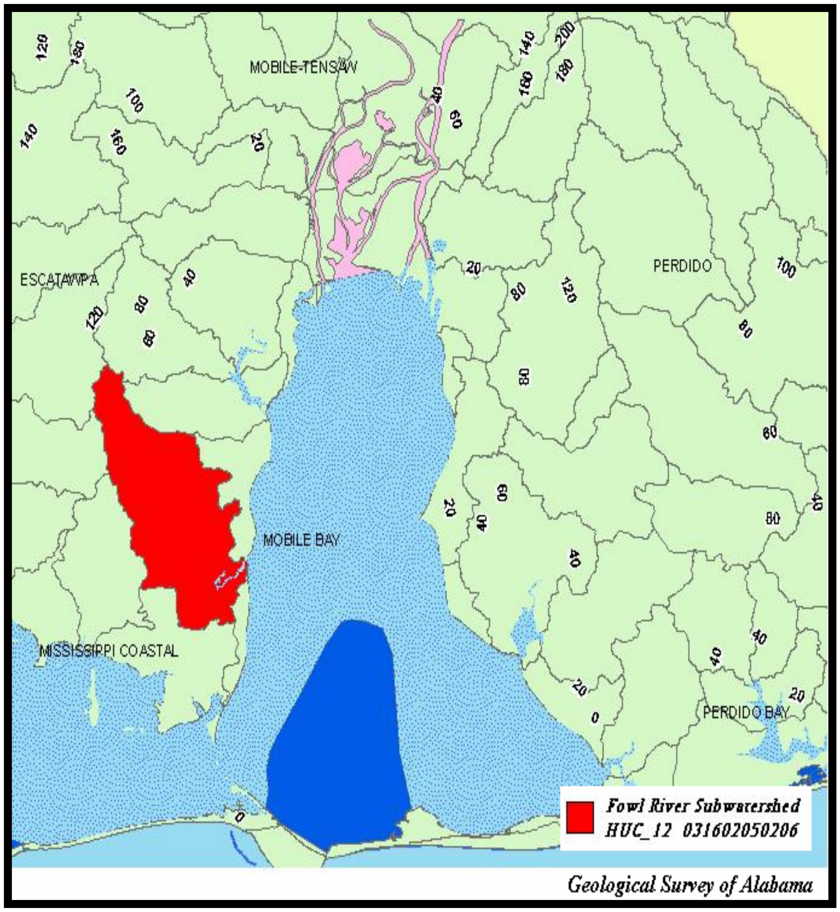


Station FLR 7 was located on East Fowl River near where that river empties into Mobile Bay. FLR 7 represented residential and commercial land use. Boat marinas were present on both banks. Rule 335-6-11-.02 of the ADEM Administrative Code, lists this section of East Fowl River with a water use classification of Fish and Wildlife and Swimming and Other Whole Body Contact Water Sports. The impervious surface area was estimated to be less than 10% for this station. Flow at this station was generally slow to moderate. No substantial erosion was observed during the study. Vegetation was abundant along both banks. Aquatic vegetation, both submerged and emerging, was observed. No water odors were encountered during the study.

FLR 7 FACING UPSTREAM

GENERAL DESCRIPTION

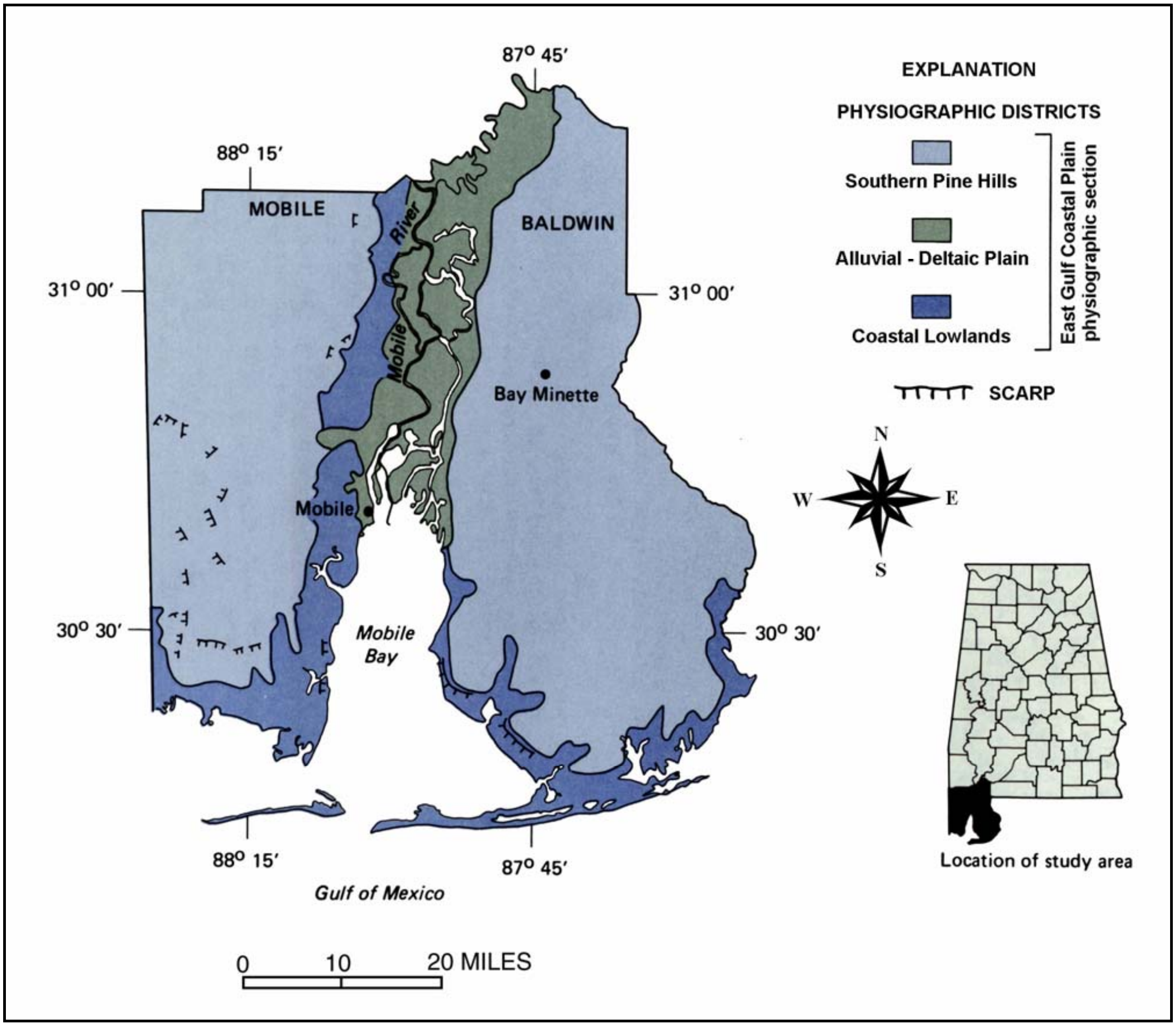
Fowl River Sub Watershed
HUC 031602050206



Mobile County is situated in extreme lower Alabama. The Fowl River sub watershed lies entirely within and along the southeastern edge of Mobile County and encompasses 52,782 acres. The physiographic regions represented in the Fowl River Sub watershed are the Southern Pine Hills (SPH) and the Coastal Lowlands (CL). The basin consists of approximately sixty three (63) percent forested land, twenty one (21) percent urban land, ten (10) percent crop land, five (5) percent pasture, and one (1) percent ponds/lakes. According to the Alabama Soil and Water Conservation District County watershed assessments of 2000, the Fowl River sub watershed has two thousand four hundred (2,400) acres of land using pesticides, seven thousand two hundred seventy-eight (7,278) septic tanks, two hundred thirty-five (235) cattle, and thirteen (13) hogs. Fowl River appears on the Department's 2000 303(d) listing of impaired streams as a result of excessive mercury concentrations.

PHYSICAL CHARACTERISTICS

The physiographic regions represented in the Fowl River Sub watershed are the Southern Pine Hills (SPH) and the Coastal Lowlands (CL). The Southern Pine Hills, located in the northwest portion of the sub watershed, are underlain by terrigenous sediments. The Coastal Lowlands run north to south through the eastern portion of the study area and are characterized by flat to gently undulating, locally swampy plains underlain by terrigenous deposits of Holocene and late Pleistocene age.



Geological Survey of Alabama, 2000

Originating in south central Mobile County, Fowl River flows south and east for approximately nine (9) miles before joining with East Fowl River. From its origin to its confluence with East Fowl River, Fowl River falls less than eighty (80) feet. This represents a vertical fall of about nine (9) feet for every mile traveled. East Fowl River originates northwest of the community of Delchamps and flows east and north about four (4) miles to Mobile Bay. From its origin to its confluence with the Mobile Bay, East Fowl River falls less than ten (10) feet. This represents a vertical fall of about two and a half (2.5) feet for every mile traveled.

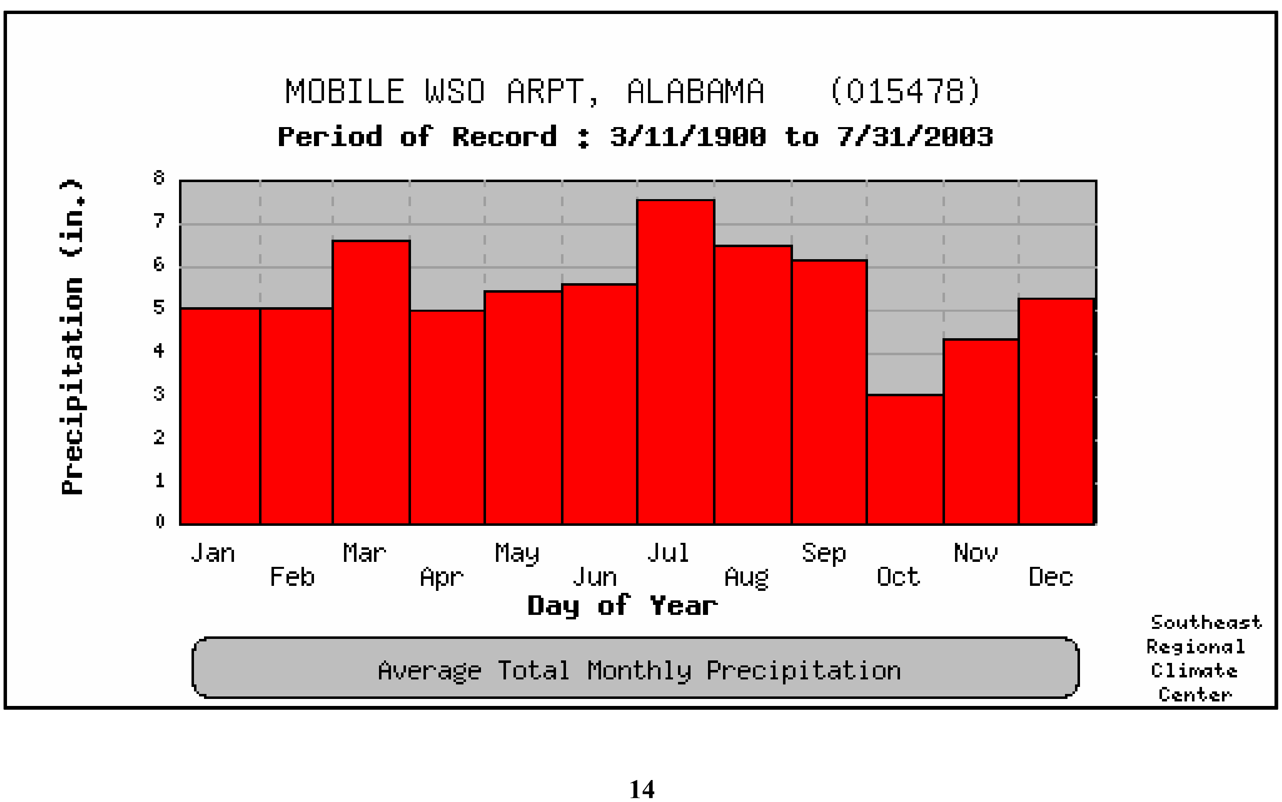
Fowl River has only two (2) named tributaries. Both of these are located in the central portion of the sub watershed. Muddy Creek originates east of Bellingrath Road about two (2) miles north of

Laurendine Road and travels almost due south about four and a half (4.5) miles to its junction with Fowl River at Fowl River Road. Muddy Creek falls about forty (40) feet from its origin to the confluence with Fowl River. This represents a vertical fall of about nine (9) feet for every mile traveled. Dykes Creek originates less than a mile east of Muddy Creek and about two (2) miles north of Fowl River Road and travels south and west about two and a half (2.5) miles to its confluence with Fowl River about one half (0.5) miles south of Fowl River Road. Dykes Creek falls about twenty (20) feet from its origin to the junction with Fowl River. This represents a vertical fall of about eight (8) feet for every mile traveled.

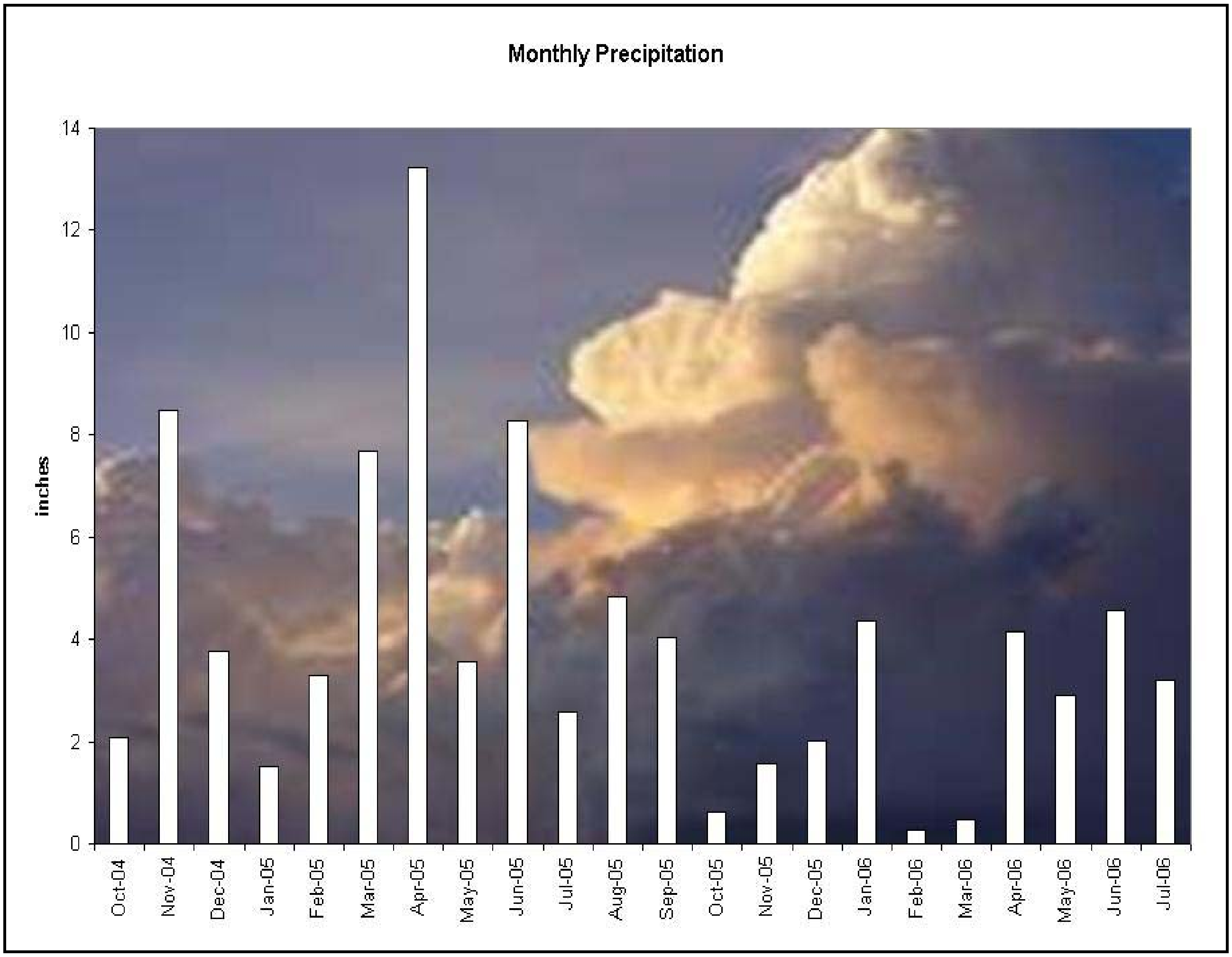
Climate

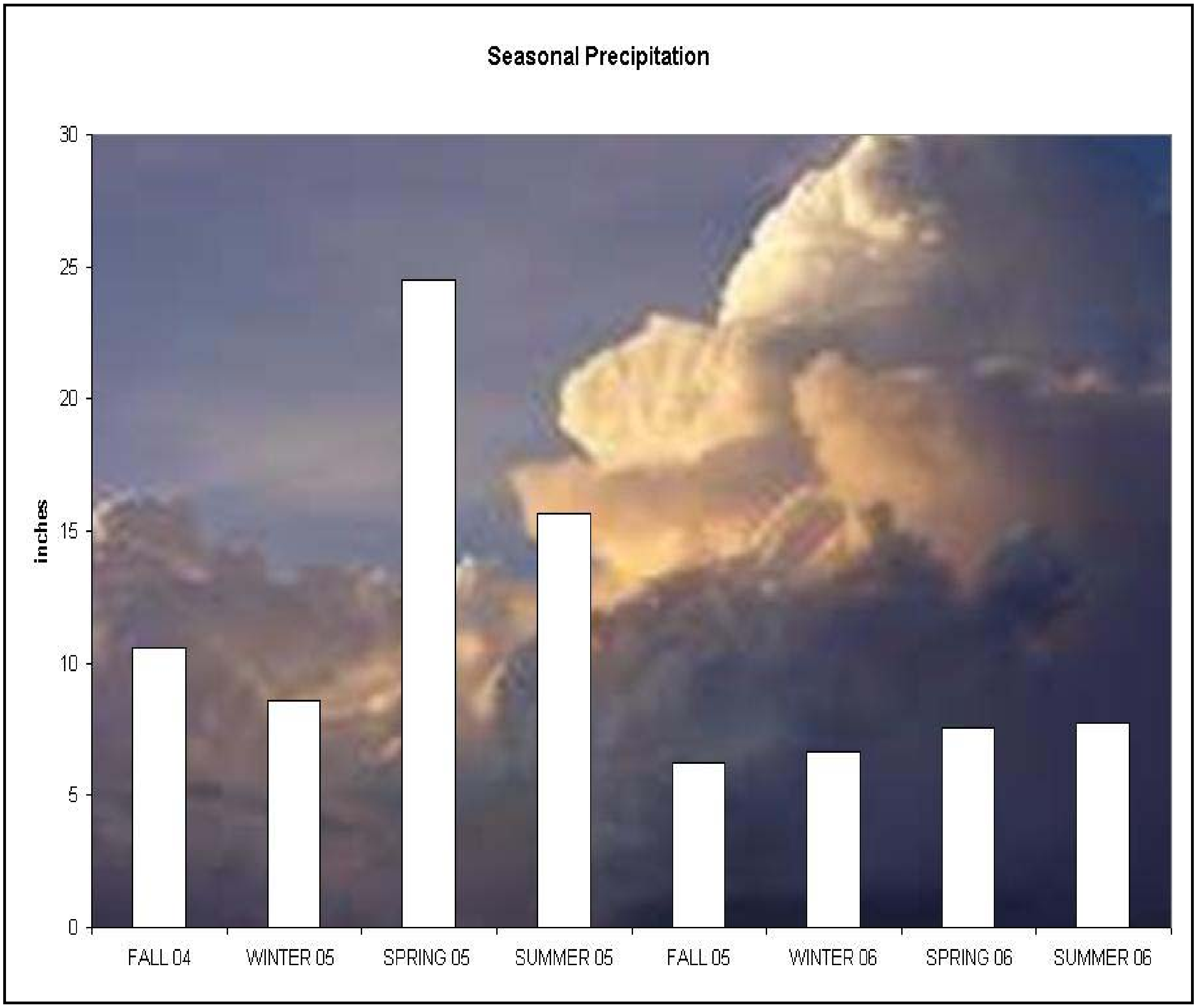
Summers in the Fowl River sub watershed are, typically, hot and humid with an average temperature of 81^0 F, and an average daily maximum temperature of 91^0 F. Winters are mild, with an average temperature of 53^0 F, and an average daily minimum temperature of 43^0 F. The lowest temperature on record, 7^0 F, occurred on January 1, 1963. The highest temperature, 104^0 F, was recorded on July 25, 1952. Rain occurs year round, with the heaviest rainfall occurring in April through September. Total average yearly rainfall is approximately 64 inches. Relative humidity is high in the area, averaging about 60 percent in mid afternoon. The highest relative humidity readings are, typically, at night, with measurements of about 90 percent not uncommon in the dawn hours (U.S. Geological Survey.)

The area in which the Fowl River sub watershed experiences precipitation that is usually of the shower type with long periods of continuous rain being rare. Precipitation is usually greatest in the summer and least in the fall. Thunderstorms may occur at any time of the year, regardless of season. The inserted chart illustrates the normal average rainfall by month for the Mobile area and the recorded amounts of rainfall for the Fowl River sub watershed during the study period. Over



the past several years, as in other parts of the state and nation, rainfall averages have been lower than usual. The rainfall recorded during the study period, especially in 2005 and 2006, was lower than the historical average. As can be seen in the inserted charts, following the advent of Hurricane Katrina in August of 2005, the study area experienced precipitation amounts far below the historical average. With the exception of a short stretch of stream at the headwaters of Fowl River, all of Fowl River, East Fowl River and tributaries within the Fowl River sub watershed lie within the 100 year flood plain for a distance of several hundred feet along both banks.

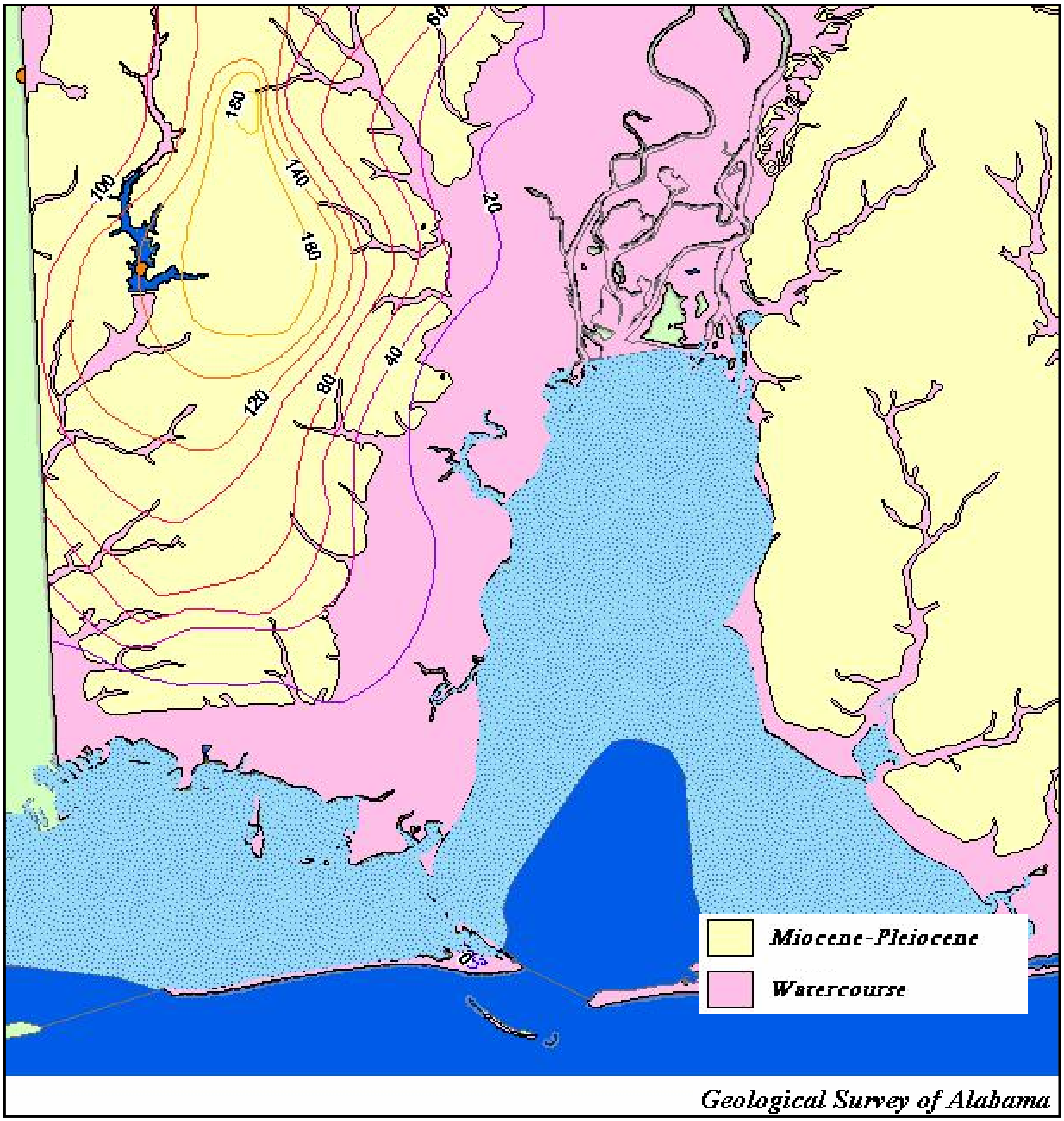




Hydrogeology

The Fowl River sub watershed is underlain, for the most part, by the alluvial-coastal (Watercourse) aquifer. The northwestern portion of the sub watershed, however, is underlain by the Pliocene-Miocene aquifer. The Pliocene-Miocene aquifer consists of the Citronelle Formation and undifferentiated deposits of the Miocene Series. The Miocene Series undifferentiated consists of sedimentary deposits of marine and estuarine origin which, in turn, consist of laminated to thinly-bedded clays, sands, and sandy clays. The Citronelle Formation, which overlies the Miocene Series undifferentiated, consists of sediments of gravelly sands and sandy clays. As no continuous confining units appear to exist between the Citronelle Formation and the undifferentiated deposits of the Miocene Series, these two units act as a single hydraulic unit. Ground water in the Pliocene-Miocene aquifer occurs in beds of gravel and sand. These beds in the Citronelle Formation and those in the shallower portions of the Miocene Series undifferentiated are hydraulically connected to the land surface thus making the Pliocene-Miocene aquifer an unconfined aquifer. There are discontinuous lenses of clay in the aquifer which retard the vertical movement of water, but do not separate the aquifer's components. In the deeper portions of the undifferentiated sediments of the Miocene Series, clayey sediments are semi-confining and reduce the vertical infiltration of water which causes this aquifer to respond to short-term pumping (U.S. Geological Survey.)

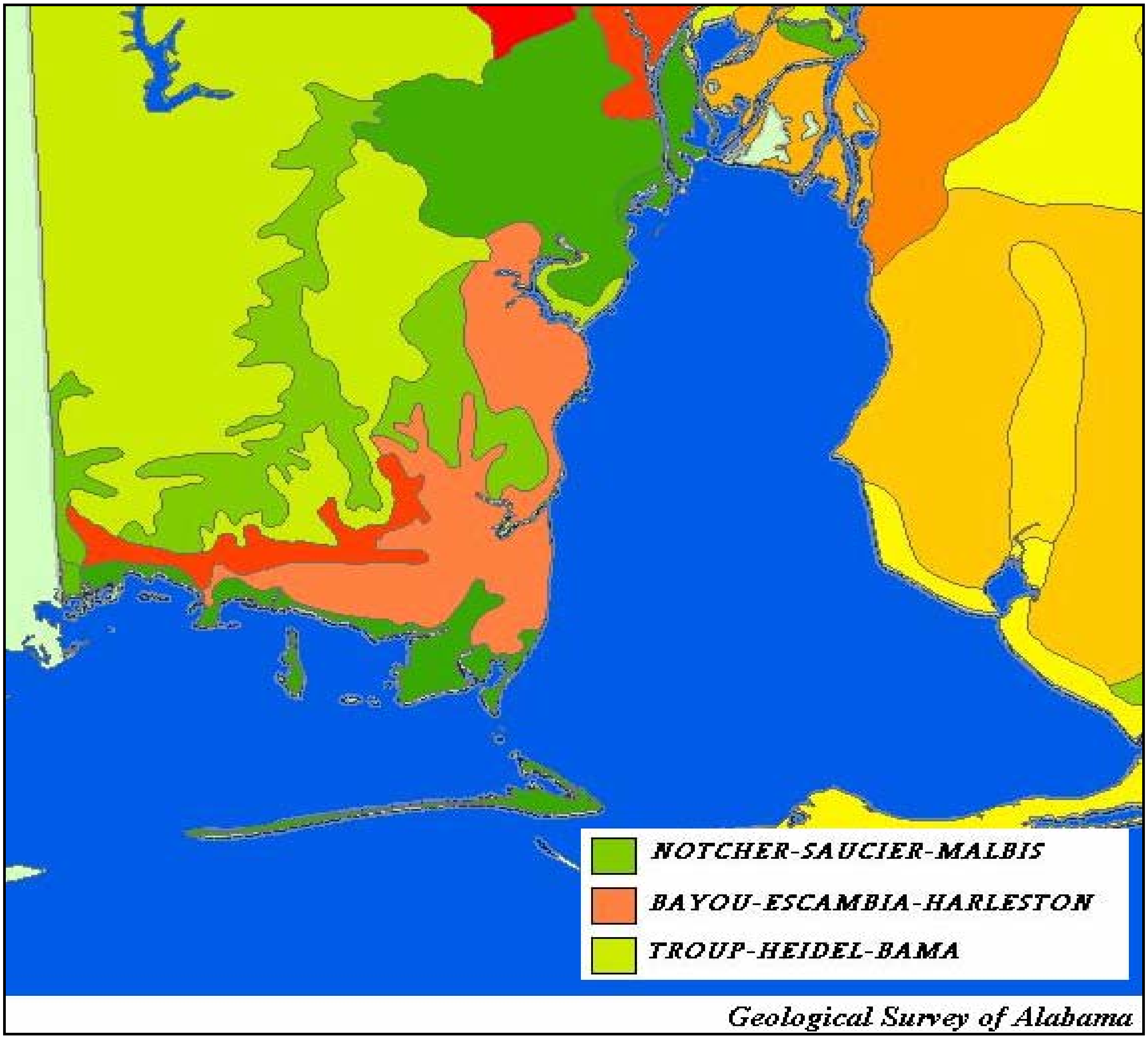
Graphical Representation of Underlying Aquifers of the Fowl River Sub Watershed



The alluvial-coastal aquifer is composed of channels of sand and gravel arising from coastal deposits and buried river sediments. These channels are surrounded by silty and clayey sediments that allow slow infiltration of water to the sand and gravel beds. Some of these channels may be directly connected to the present channels of the Mobile River. The alluvial-coastal aquifer is hydraulically connected to the Pliocene-Miocene aquifer. As a result of this interconnection, the aquifers often respond to stress as one aquifer. This is significant owing to the relative permeability of the underlying sediments in the Fowl River sub watershed, which allows for the rapid infiltration of surface water. Wells constructed in the Pliocene-Miocene aquifer typically yield 0.5 to 2.0 million gallons per day. Wells constructed in the alluvial-coastal aquifer yield from 0.5 to 1.0 million gallons per day (U.S. Geological Survey.)

Recharge to the aquifers underlying the Fowl River sub watershed is, primarily, accomplished through rainfall. Of the average 64 inches of rain that fall annually, about 28 of those inches run off during and immediately after rain events. The remainder either enters the underlying aquifers as recharge, or is returned to the atmosphere via evaporation and transpiration of trees and other plants.

Soil Associations



It has been demonstrated that a sub watershed's physical characteristics, among them soil types, are, often, primary factors in influencing the effects that land-use practices have upon a sub watershed, particularly upon that sub watershed's water quality and aquatic habitats (ADEM, 1997.) With the exception of FLR 1, the soils of the entire Fowl River sub watershed are, principally, of the Bayou-Escambia-Harleston classification and are characterized as poorly drained, moderately slowly permeable soils that formed in loamy marine sediments. Such soils are saturated near the surface in winter and early spring and have slope* ranges from 0 to 2 percent. The soils around FLR 1 carry the Troup-Heidel-Bama classification. These soils are characterized as nearly level to undulating, well drained soils with loamy sub soils formed in loamy marine sediments on uplands. The principle soil type along both banks of stations FLR 1, FLR 2 and FLR 3 are the Pamlico-Bibb Complex soils with 0 to 1% slopes. These soils are characterized as very poorly drained, moderately permeable soils that have water near or above the surface for extended periods. Station

FLR 4 also has Pamlico-Bibb Complex soils along both banks as well as Lafitte Muck. The Lafitte series soils are characterized as nearly level, very poorly drained, moderately rapidly permeable soils formed in thick accumulations of herbaceous plants. The Lafitte series soils are subject to inundation with brackish water at high tides. Station FLR 5 also demonstrated Lafitte series soils on both banks as well as soils of the Heidel Sandy Loam series. This series consists of well drained, moderately permeable soils that formed in loamy marine sediments. Stations FLR 6 and FLR 7 demonstrated Lafitte Muck soil along both banks. The east central portion of the Fowl River sub watershed demonstrates a sizeable area of Notcher series soils. These consist of moderately well drained soils with iron concretions and plinthite. They are formed in loamy marine sediments on Coastal Plain uplands and have a seasonal high water table during the winter and spring of about 3 to 4 feet below the surface (U.S. Dept. of Agriculture. 1980.)

A list of the soil types by station is provided below. The information concerning soil classifications was obtained from the U.S. Department of Agriculture Soil Conservation Service's 1980 publication, *Soil Survey of Mobile County, Alabama*.

SAMPLING STATION	**SOIL ASSOCIATION**
FLR 1 -	Pamlico-Bibb Complex, 0 to 1% slopes
FLR 2 -	Pamlico-Bibb Complex, 0 to 1% slopes
FLR 3 -	Pamlico-Bibb Complex, 0 to 1% slopes
FLR 4 -	Pamlico-Bibb Complex, 0 to 1% slopes & Lafitte Muck
FLR 5 -	Heidel Sandy Loam & Lafitte Muck
FLR 6 -	Lafitte Muck
FLR 7 -	Lafitte Muck

*slope is a measure of the inclination of the land surface from the horizontal. The percentage of slope is the vertical distance divided by the horizontal distance – then multiplied by 100, e.g. a drop of 20 feet in a 100 feet run is a 20% slope.

Tidal Influence

As a consequence of its proximity to the Gulf of Mexico, the lowermost portions of the Fowl River sub watershed experience tidal influence. It should be observed that tidal influence is a dynamic process. Periods of very low tides and prevailing southerly winds will decrease the stretch of tidal influence within the sub watershed. Conversely, periods of abnormally high tides, prevailing northerly winds, or storm surges will expand the stretch of tidal influence. Based on field observations and analytical testing, it appears that stations FLR 5, FLR 6, and FLR 7 are tidally influenced stations. Stations FLR 3 and FLR 4 are also tidally influenced, but not so much as the downstream stations. Stations FLR 1 and FLR 2 do not appear to experience tidal influence except in extraordinary circumstances such as during periods of excessive storm surge.

Water Use Classifications

Rule 335-6-11-.02 of the Alabama Department of Environmental Management Administrative Code contains the water use classifications for interstate and intrastate waters. Fowl River carries the water use classification of Swimming and Other Whole Body Contact Water Sports and Fish and Wildlife along its entire course. Likewise, East Fowl River carries the water use classification of Swimming and Other Whole Body Contact Water Sports and Fish and Wildlife along its entire course. Muddy Creek and Dykes Creek are not specifically listed within Division 6 of the Department's Administrative Code and, therefore, carry a water use classification of Fish and Wildlife.

Swimming and Other Whole Body Contact Water Sports

Criteria	**Standard**
pH	6.0 to 8.5 s.u.
Water Temperature	$\leq 90^0$ F
Dissolved Oxygen	$\geq$ 5.0 mg/l (at mid depth or 5 ft depth dependent on total depth)
Fecal Coliform Bacteria	$\leq$ 200 colonies/100 ml (geometric mean)
Fecal Coliform Bacteria Coastal*	$\leq$ 100 colonies/100ml (geometric mean)
Turbidity	$\leq$ 50 ntu above background

Fish and Wildlife

Criteria	**Standard**
pH	6.0 to 8.5 s.u.
Water Temperature	$\leq 90^0$ F
Dissolved Oxygen	$\geq$ 5.0 mg/l (at mid depth or 5 ft depth dependent on total depth)
Fecal Coliform Bacteria	< 200 colonies/100ml (geometric mean June – Sept.) < 1000 colonies/100ml (geometric mean Oct. - May) < 2000 colonies/100ml (single sample max.)
Fecal Coliform Bacteria Coastal*	< 1000colonies/100ml (geometric mean Oct. - May) < 2000 colonies/100ml (single sample max.) < 100 colonies/100ml (geometric mean June –Sept.)
Turbidity	< 50 ntu above background

* Pre 2004 criteria and standards

(ADEM Admin. Code R. 335-6-10-.09.)

Threatened and Endangered Species

The Fowl River sub watershed exhibited a diverse and prolific array of flora and fauna throughout the course of the study. Habitat, for the most part, was ideal for a great array of plants and animals. It has been generally accepted that the presence or absence of wading birds is indicative of environmental trends within an area (Geological Survey of Alabama. 1983.) Wading birds such as the Great Blue Heron, *Ardea herodias*, Great Egret, *Casmerodius albus*, Green Heron, *Butorides virescens*, American Bittern, *Botaurus lentiginosus*, and others were ubiquitous during field patrols. Also prevalent were varying Hawk species, the Osprey, *Pandion haliaetus*, Kingfisher, *Ceryle alcyon*, and Turkey Vulture, *Cathartes aura*. All of which are indicators of ample food supply and acceptable habitat. It may also be observed that one species that formally was considered threatened or endangered was present in significant numbers throughout the study. This was the Brown Pelican, *Pelecanus occidentalis*, removed from listing on February 4, 1985.

Below is a current Federal listing of threatened and endangered species for the study area.

THREATENED -	Piping plover *Charadrius melodus*
THREATENED -	Eastern indigo snake *Drymarchon corais couperi*
THREATENED -	Gopher tortoise *Gopherus polyphemus*
THREATENED -	Loggerhead sea turtle *Caretta caretta*
THREATENED -	Green sea turtle *Chelonia mydas*
THREATENED -	Gulf sturgeon *Acipenser oxyrinchus desotoi*
THREATENED -	Flatwoods salamander *Ambystoma cingulatum*
ENDANGERED -	Louisiana quillwort *Isoetes louisianensis*
ENDANGERED -	Red-cockaded woodpecker *Picoides borealis*
ENDANGERED -	Least tern *Sterna antillarum*
ENDANGERED -	Alabama red-bellied turtle *Pseudemys alabamensis*
ENDANGERED -	Kemp's ridley sea turtle *Lepidochelys kempii*
CANDIDATE SPECIES -	Black pine snake *Pituophis melanoleucus lodingi*

(Daphne Ecological Services Field Office. 2002.)

ECONOMIC DEVELOPMENT AND LAND USE

History

The first European explorers probably set eyes on the area covered in this study around 1519, but it was not until the early 18th century that Europeans began to set up residence on the lands surrounding what is now Fowl River. French, Spanish, English, Swedish, and Russian immigrants built homes in the woods and along creek banks. Native Americans had, of course, been established in the area for centuries, but these, as those elsewhere in the nation, were driven away by the arrival of settlers. Mobile, Alabama, located just north and east of the Fowl River sub watershed, originally founded in 1702, was moved to its present location in 1711. Mobile is the oldest of all Alabama cities. Until the final years of the 19th century, Mobile was the largest population center in the state, and that population reached well into the Fowl River sub watershed. The majority of the area's industry, however, remained in Mobile. Apart from the occasional fish camp, there was very little industry in the Fowl River area until well into the 20th century (Loveman. 1976.) By the year 1820, 2,672 people had settled in the area now known as Mobile County. In 1900, that number had grown to 62,740. In the year 2000, the population of Mobile County was 399,843 (U.S. Census Bureau. 2002.)

Land Use

The Fowl River sub watershed has a total land area of greater than 52,000 acres. Of this area, five thousand three hundred (5,300) acres is in crops, two thousand six hundred (2,600) acres is used as pasture, ten thousand nine hundred (10,900) acres is urban land, and ponds and lakes took up three hundred (300) acres. The greater majority of the study area, thirty three thousand four hundred (33,400) acres of it, was forested. There were no significant concentrations of livestock observed in the study area. The number of cattle in the area was estimated to be two hundred thirty-five (235.) The number of hogs was estimated to be thirteen (13) (Alabama State Soil and Water Conservation District. 2000.)

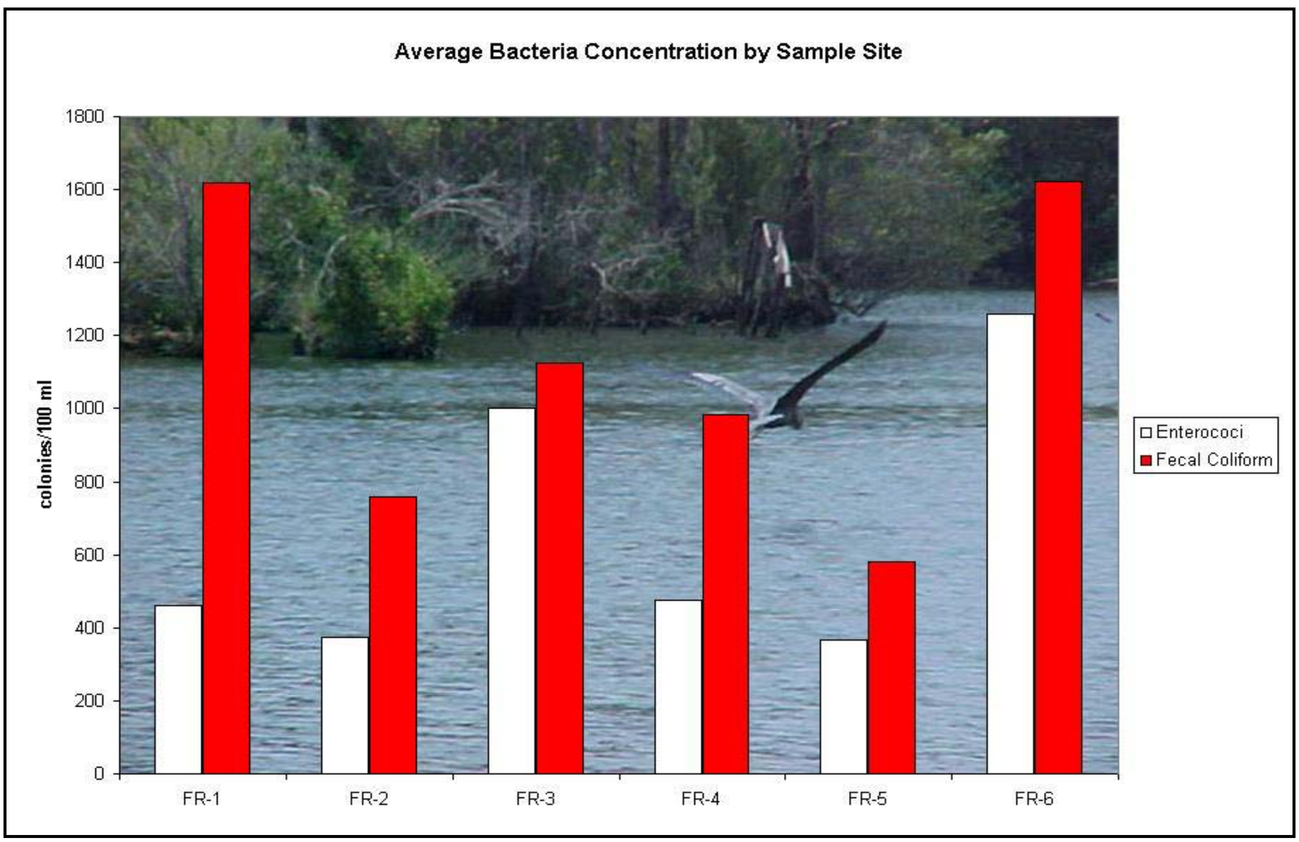
Impervious Surface Cover

In the course of the last several years, more attention has been paid to the effects of non-point source pollution as a significant contributor to water quality degradation in receiving streams. The term 'non-point source' covers a broad spectrum of pollutants present in runoff from a myriad of sources ranging from unauthorized solid waste dumps, to animal waste, to paved surfaces. Of particular import is the attention given to impervious surfaces. Runoff quantities and velocities are increased over impervious surfaces thus facilitating a greater likelihood for pollutant transport. Of equal concern are the associated physical changes increased runoff might cause in the land's surface as well as the stream's morphology that may lead to habitat destruction. Imperviousness can be defined as the sum of roads, parking lots, sidewalks, rooftops and other impermeable surfaces of the urban landscape or, simply, any material that prevents the infiltration of water into the soil (Methodology for Coastal Watershed Assessments, 2001.) As the population continues to increase and more impervious surfaces are constructed, the potential for impairment to water quality from non-point surfaces also increases. The significance of such impact is reflected in assessing population effects upon water quality. Compared to population density, dwelling units, or other factors, impervious cover is a superior measure to gauge the impacts of growth (Watershed Protection Techniques, 1994.)

Arriving at the estimated impervious surface cover area for the Fowl River sub watershed involved acquisition of aerial photographs for the area. A standard size English area grid was placed over the aerial photos and a manual count of impervious surface areas was performed. Rooftops, roadways, driveways, parking lots, and any other impervious surface were identified and roughly measured. The total area arrived at by this method was then compared to the total surface area for the sub watershed to arrive at a percent coverage for impervious surfaces. By use of this method, impervious surface coverage for the Fowl River sub watershed was determined to be approximately four thousand one hundred sixty (4,160) acres, or, approximately, an eight (8) percent impervious surface cover. The most substantial concentrations of impervious surfaces were observed in the areas along the surface roads within the sub watershed. As the communities within the Fowl River sub watershed continue to expand, increasing impervious surface cover will likely have an impact upon the basin's water quality.

EXISTING DATA

In 2005 the Alabama Coastal Foundation (ACF) concluded a study of the Fowl River sub watershed. The study was designed to serve as an initial screening tool of the Fowl River Watershed and not statistically designed to be utilized for water quality use determination. The results of this study are contained in the ACF report *Fowl River Bacteriological Assessment Mobile County, AL Project No. MCP-229-04*. The report was funded in part by the Mobile County Commission, Alabama Department of Conservation and Natural Resources, State Lands Division and the Coastal Zone Management Act of 1972, as amended, administered by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration. The ACF stated in their findings that because of the brevity and structure of the study, there was considerable margin for error in drawing conclusions from the report. The study was conducted over a sampling period of 381 days at six (6) sites within the Fowl River sub watershed. These sites were labeled FR-1 through FR-6.



Based on their analytical results, the ACF determined that there appeared to be a correlation of bacteriological contamination to the seasons. Both fecal and enterococcus bacteria counts were higher in the spring and summer months and decreased during fall and winter. The ACF concluded that this made biological sense since bacteria grows more readily in warmer waters.

As a part of the ADEM water quality trends program, station FR-1 (located at the Fowl River Marina at a point between stations FLR 6 and FLR 7) has been sampled on a monthly basis since at least 1985. A summation of the analytical results derived from this trends station during the period October 1985 to November 2004 is included in the table appearing below.

Fowl River Trend Station FR-1	Water Temperature (°C)	pH (su)	Conductivity (umhos @25C)	Dissolved Oxygen (mg/l)	Turbidity (NTU)
Averages from October 1985	22	7.44	9922	7.59	14.52
to November 2004					
	Chlorophyll a (mg/m^3)	TDS (mg/l)	TSS (mg/l)	Total-P (mg/l)	Salinity (ppt)
	13.6	6141	17	0.064	5.6
	Fecal Coli (colonies/100 ml)	TKN (mg/l)	NO2/NO3 (mg/l)	NH3 (mg/l)	
	65	0.86	0.091	0.04	

As a part of the ADEM and ADPH Beach Monitoring Program, Fowl River at Highway 193 (this site corresponds with the abovementioned FR-1) has been sampled, at least monthly, since June of 2003. A summation of the analytical results derived from this beach monitoring station during the period June 2003 to August 2006 is included in the table appearing below.

ADEM/ADPH Beach Monitoring Program
Microbiological Analyses
Fowl River at HW 193

Latitude: 30.44427° N
Longitude: 88.11362° W

	Enterococcus Count/100 ml *	Temp. (°C)	DO (mg/l)	pH (su)	Cond (µmhos/cm)	Salinity (ppt)	Turbidity (ntu)
Average	75	25.4	7.07	6.87	10893	6.8	17

Permitted Facilities

At the time of this study, the Fowl River sub watershed had one NPDES permitted facility, Sonneborn Estates WWTP, located at 3900 Windsor Road in Theodore, Alabama. The facility's permit number is AL0044059. The receiving stream is East Fowl River. Below are the facility's discharge limitations and permitting requirements.

Effluent Parameter	Discharge Limitation Monthly Average	Weekly Average
Flow (MGD)	0.002	
BOD5 (mg/l)	30.0	45.0
TSS (mg/l)	30.0	45.0
	Daily Minimum	**Daily Maximum**
pH (s.u.)	6.0	9.0
TRC (mg/l)		0.01
Fecal Coliform (col/100 ml)		2000

MATERIALS AND METHODS

This study was conducted in accordance with the ADEM *Methodology for Coastal Sub watershed Assessments, 2001* and executed under the requirements established in the ADEM *Standard Operating Procedures and Quality Control Assurance Manual*.

The Fowl River sub watershed was delineated using U.S. Department of the Interior Geological Survey 7.5 Minute Series topographic maps. The quadrangles: Bellefontaine, Coden, and Theodore were used in mapping the contour lines to determine the extent of the basin. As discussed in the introduction, sampling stations were selected to represent the land use within the study area. Land use determinations were obtained from the Alabama Soil and Water Conservation Needs Assessment Unit. Station accessibility was a significant factor in the final designation of stations. The entire sub watershed was predominately rural with isolated urban segments. Each station was given the designation FLR and a number. Stations FLR 1 – FLR 3 were accessible by public roadway and were sampled at their banks. Stations FLR 4 – FLR 7 were only accessible by boat. None of the selected stations were wadeable stations. Whenever possible, sampling events were accomplished during, or immediately following, rain events. At stations FLR 1 – FLR 3 field parameters and samples were retrieved from the surface. At stations FLR 4- FLR 7 field parameters were taken at the surface, mid depth, and bottom. Samples were retrieved at the surface for these stations.

Each of the stations were visited, at least monthly, and monitored for; dissolved oxygen, pH, salinity, conductivity, and temperature, as well as sampled for total suspended solids, total dissolved solids, turbidity, fecal coliform bacteria, ammonia, nitrates/nitrites, total Kjeldahl nitrogen, total phosphorous, and dissolved reactive phosphate. Stations were also sampled, on a one time basis, for metals concentrations in the sediment. Field parameters were taken *in-situ* using the *YSI 600XLM®* and the *YSI 650MDS®*. Turbidity was measured using the *Orbeco-Hellige Model 966 Portable Turbidimeter®.*

Dissolved Reactive Phosphate samples were field filtered through a 0.45 micrometer cellulose filter using a hand operated vacuum. Samples were transported to the laboratory for analysis on the same day as the sampling event. Chain of custody records were maintained for each sampling event. All samples were analyzed at the ADEM Mobile Field Operations laboratory.

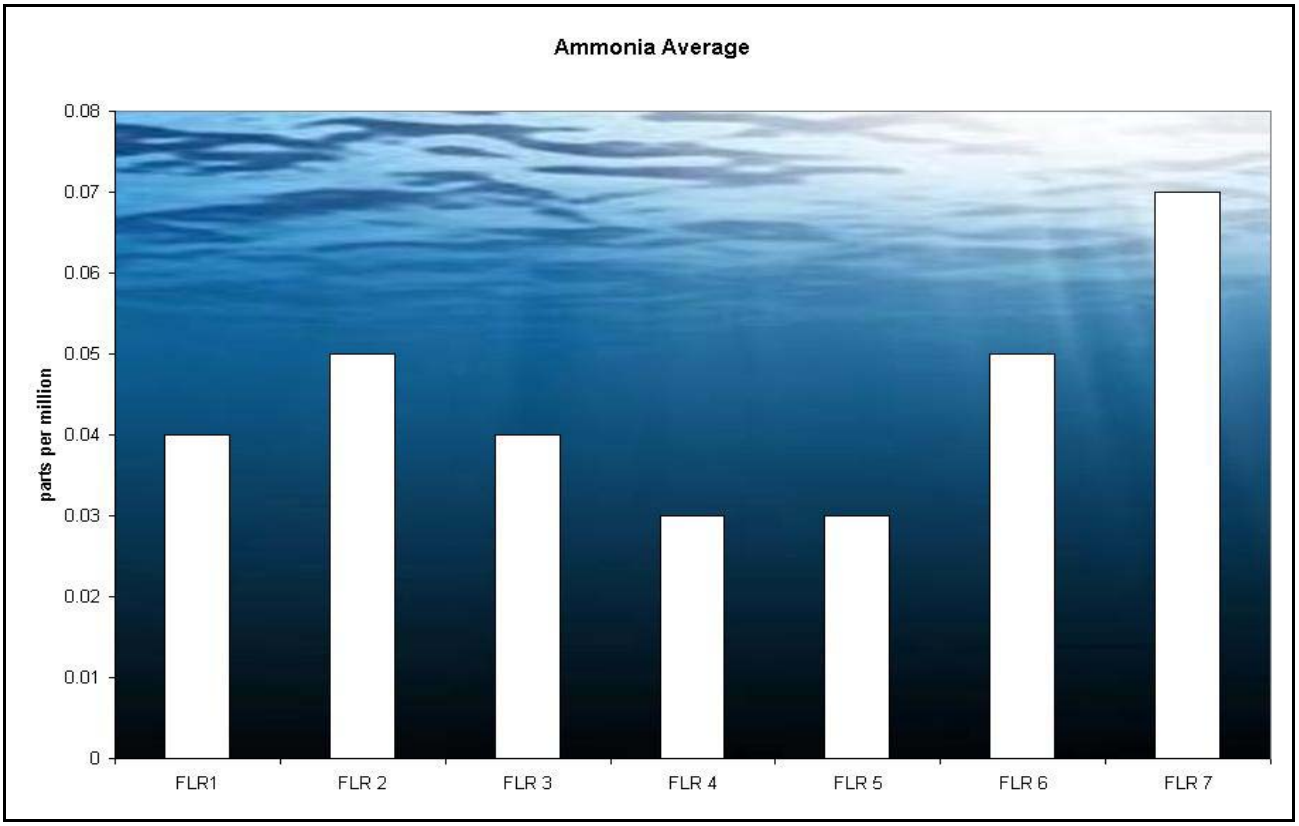
SAMPLING RESULTS AND DISCUSSION

Ammonia

Ammonia is a colorless gas with a very sharp odor. It is a very important source of nitrogen for plants and animals and may be found in water, soil, and air, but does not last very long in the environment. Ammonia is suspected to remain in the atmosphere less than two weeks, depending on weather and other factors, before being deposited or chemically altered. It is recycled naturally by a substantial number of plants and microscopic organisms that rapidly take up ammonia. Most of the ammonia in the environment comes from the natural breakdown of organic matter, like feces, and dead plants and animals. The amount of ammonia produced by man is very small compared to that produced by nature every year. The majority of man-made ammonia goes toward the manufacture of fertilizer. Ammonia is also used to manufacture synthetic fibers, plastics, and explosives (Microsoft® Encarta® Online Encyclopedia 2002). It may be introduced to a watershed through surface water runoff, direct discharge, or directly from the atmosphere.

Ammonia readily dissolves in water, disassociating to ammonium ion (NH4+) and hydroxide ion (OH-). Although ammonia and ammonium can change back and forth in water with ease, the ammonium ion is the most common form in aquatic environments. The ammonium ion is considered non-toxic and of little concern to organisms.

Problems occur when too much ammonia becomes available and the free ammonia accumulates in the body tissues. Such accumulation can lead to metabolism alterations or increases in internal pH. Generally, the total percentage of ammonia in water is expected to increase with temperature and pH. Concentrations of the principal form of toxic ammonia (NH_3) of less than half a part per million may be toxic to some aquatic organisms. Such toxicity is directly correlated with both temperature and pH (Grimwood, M.J. & Dixon, E. 1997).



Ammonia in Parts Per Million

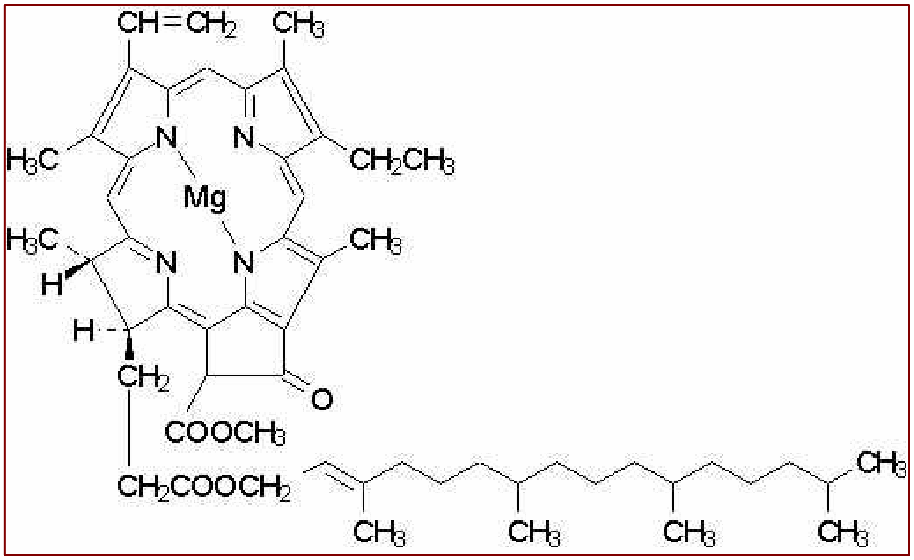
FLR 1	Average	< 0.04	
	Maximum	0.14	
	Minimum	< 0.01	
FLR 2	Average	< 0.05	
	Maximum	0.27	
	Minimum	< 0.01	
FLR 3	Average	< 0.04	
	Maximum	0.11	
	Minimum	< 0.01	
FLR 4	Average	< 0.03	
	Maximum	0.14	
	Minimum	< 0.01	
FLR 5	Average	< 0.03	
	Maximum	0.09	
	Minimum	< 0.01	
FLR 6	Average	< 0.05	
	Maximum	0.1	
	Minimum	< 0.01	
FLR 7	Average	0.07	
	Maximum	0.25	
	Minimum	< 0.01	

Existing data seem to indicate that pH plays a larger role than does temperature. Above a pH of 9, un-ionized ammonia (NH_3) replaces ammonium ion as the predominant species. This fact, coupled with the knowledge that un-ionized ammonia may cross cell membranes more readily at higher pH values, demonstrates how water conditions may heighten the toxic effects of ammonia on aquatic organisms.

Other factors influencing the toxicity of ammonia in an aquatic environment are dissolved oxygen concentrations, historical ammonia loading, CO_2 concentrations, and the presence of other toxic compounds. Plants appear to be more tolerant of ammonia than are animals. Invertebrates also appear to demonstrate a greater ammonia tolerance than do higher life forms (NCSU Water Quality Group. August 1994.)

Excessive levels of ammonia were not encountered at any station during the course of this study. The station exhibiting the greatest average concentration of ammonia during the study was FLR 7. The station exhibiting the greatest single event concentration of ammonia was FLR 2.

Chlorophyll a

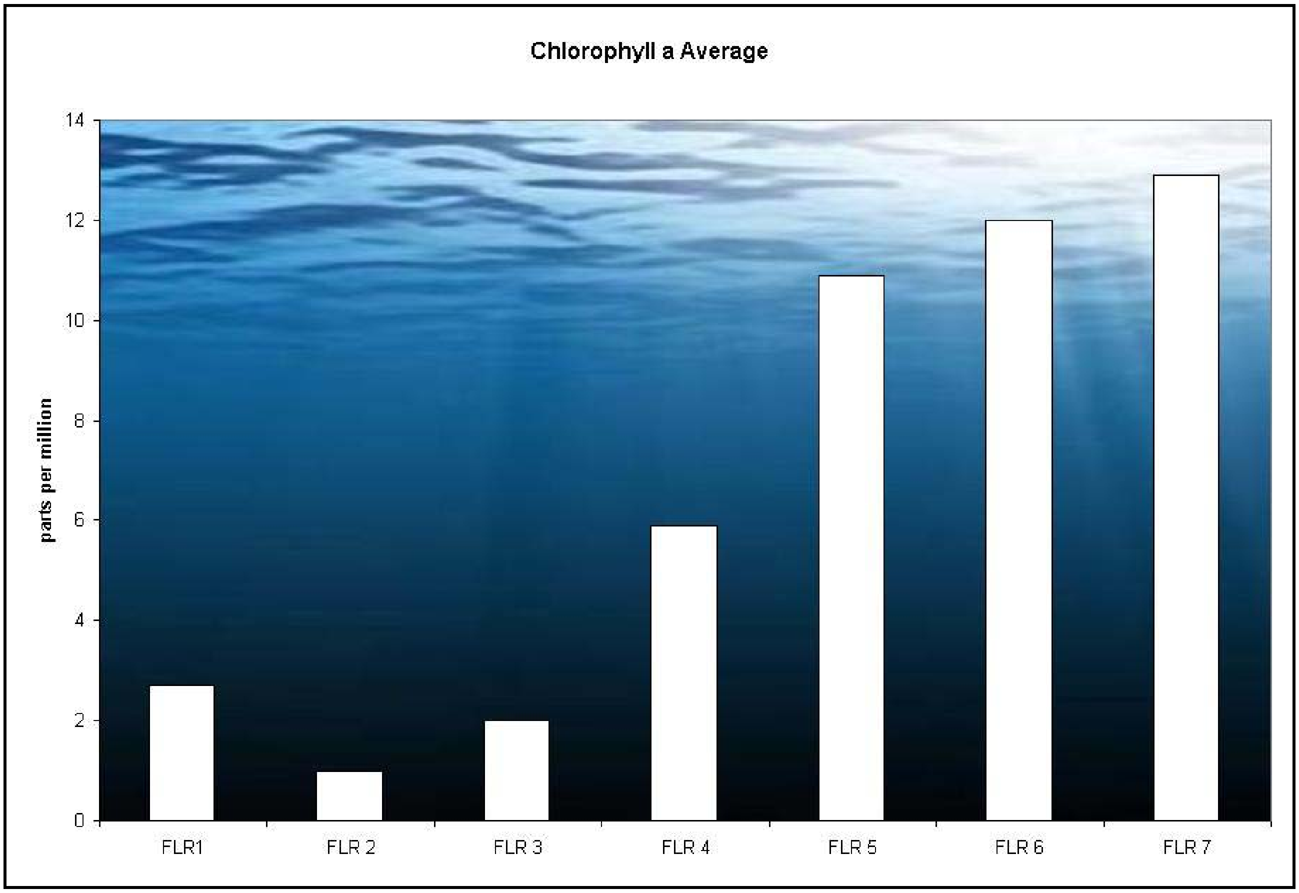


Chlorophyll is the green colored material found in the chloroplasts of plants, algae, and some bacteria. It is one of the most important chelates (molecules with ring structures that usually contain a metal ion) in the environment. It is a large molecule composed mostly of carbon and hydrogen. At the center of the molecule is a single atom of magnesium surrounded by a porphyrin ring (a nitrogen-containing group of atoms). A long chain of carbon and hydrogen atoms proceeds from this central core. This chain couples the chlorophyll molecule to the inner membrane of the chloroplast (the cell organelle in which photosynthesis takes place.)

By use of chlorophyll, organisms are able to convert light energy into chemical energy. In photosynthesis, the energy absorbed by chlorophyll transforms carbon dioxide and water into carbohydrates and oxygen. In the process, a molecule of chlorophyll absorbs a photon of light. Having done so, the chlorophyll's electrons are excited and move to higher energy levels, which in turn initiates a series of chemical reactions that enable the resulting energy to be stored in chemical bonds (Microsoft® Encarta® Online Encyclopedia. 2000).

There are several known forms of chlorophyll. The varying forms differ from each other in molecular structure and absorb slightly different wavelengths of light. The most common form is chlorophyll a, which comprises about seventy-five percent of the chlorophyll in green plants. It is also found in cyanobacteria and other complex photosynthetic cells (NCSU. 1984.)

Measuring chlorophyll a concentrations in water is an inexpensive means of measuring algae biomass. Substantial concentrations of chlorophyll a might indicate the presence of algae blooms. It is generally accepted that chlorophyll a concentrations in excess of 20 ppm promote eutrophication and facilitate severe diurnal dissolved oxygen fluctuations.



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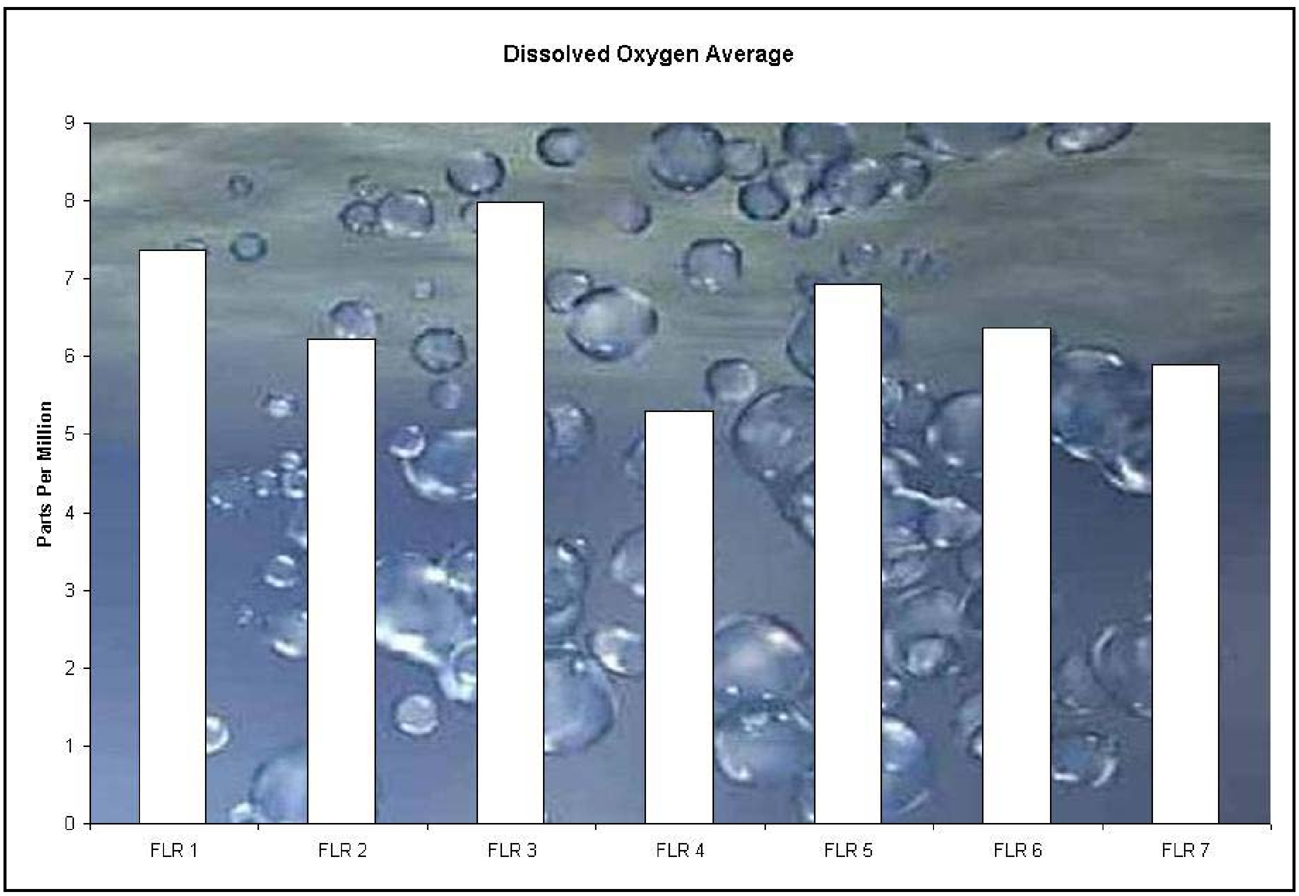
Chlorophyll a in Parts Per Million				
	FLR 1	Average	< 2.7	
		Maximum	9.9	
		Minimum	< 1.0	
	FLR 2	Average	< 1.0	
		Maximum	20	
		Minimum	< 1.0	
	FLR 3	Average	< 2.0	
		Maximum	7.8	
		Minimum	< 1.0	
	FLR 4	Average	< 5.9	
		Maximum	37	
		Minimum	< 1.0	
	FLR 5	Average	< 10.9	
		Maximum	26	
		Minimum	< 1.0	
	FLR 6	Average	< 12.0	
		Maximum	23	
		Minimum	< 1.0	
	FLR 7	Average	12.9	
		Maximum	29	
		Minimum	1.6	

At thirty seven (37) ppm, station FLR 4 exhibited the greatest single event concentration of chlorophyll a. The greatest overall average concentrations of chlorophyll a were observed at station FLR 7. Station FLR 2 exhibited the lowest average chlorophyll a concentrations. Overall, chlorophyll a concentrations generally increased with each downstream station as all of the average values exhibited at the tidally influenced stations were greater than those recorded for the remaining stations. None of the seven Fowl River sub watershed study stations exhibited excessive chlorophyll a concentrations.

Dissolved Oxygen

Dissolved oxygen is defined as the amount of free molecular oxygen, O_2, dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Regardless of its vehicle of introduction, the dissolved oxygen content in a water body may be considered one of the most important and principal measurements of water quality and indicator of a water body's ability to support aquatic life. Dissolved oxygen levels in aquatic systems can range from 0-18 parts per million, but most natural water systems require 5-6 parts per million to support a diverse population (NCSU. 1994.) Adequate dissolved oxygen is essential in aquatic systems for the growth and survival of biota. Dissolved oxygen levels above 5 milligrams per liter (mg O_2/L) are considered optimal. Levels below 1 milligram per liter are considered *hypoxic* (oxygen deficient). When O_2 is totally absent, the system is considered *anoxic*. Dissolved oxygen in aquatic systems is necessary for plants and animals to carry on respiration. Some bacteria consume oxygen during the process of decomposition. Decreases in the dissolved oxygen levels can cause changes in the types and numbers of aquatic macroinvertebrates, which live in a water ecosystem. Some organisms, like mayflies, stone flies, caddis flies, and aquatic beetles, require high dissolved oxygen levels to survive. Worms and fly larvae, which can survive in low dissolved oxygen environments, can be indicators of an unhealthy water body. Very little water movement coupled with substantial organic decay often results in associated low dissolved oxygen levels (NCSU. 1994.)



Dissolved oxygen levels change and vary according to the time of day, the weather, the temperature, applied stress, and any number of other variables. The lowest dissolved oxygen values observed during this study generally corresponded to the deeper stations, along the bottom or otherwise well below the surface where there was very little air/water mixing. The highest dissolved oxygen concentrations were observed during the winter months. During the summer months, measured dissolved oxygen concentrations at mid depth frequently fell below 5.0 ppm. Further, dissolved oxygen concentrations less than 1.0 ppm were not uncommon along the bottom.

Division 6 of the ADEM Administrative Code provides a water quality criteria for dissolved oxygen of at least five (5.0) parts per million in those waters with a water use classification of Fish and Wildlife, and Swimming and Other Whole Body Contact Water Sports. Average dissolved oxygen values for all stations were at least five (5.0) parts per million.

Station FLR 4 exhibited both the lowest single event dissolved oxygen concentration and the highest single event dissolved oxygen concentration. This station also had the lowest average dissolved oxygen concentration. Station FLR 3 had the highest average dissolved oxygen concentration.

The following table provides the maximum, minimum, and average values for dissolved oxygen concentrations observed during the study period.

			FLR 1	FLR 2	FLR 3	FLR 4	FLR 5	FLR 6	FLR 7
D.O.		Average	7.37	6.22	7.99	5.29	6.93	6.36	5.9
ppm		Maximum	11.64	10.09	13.6	14.4	11.71	11.63	11.59
		Minimum	2.52	1.42	3.16	0.25	0.45	0.45	0.41

Fecal Coliform Bacteria

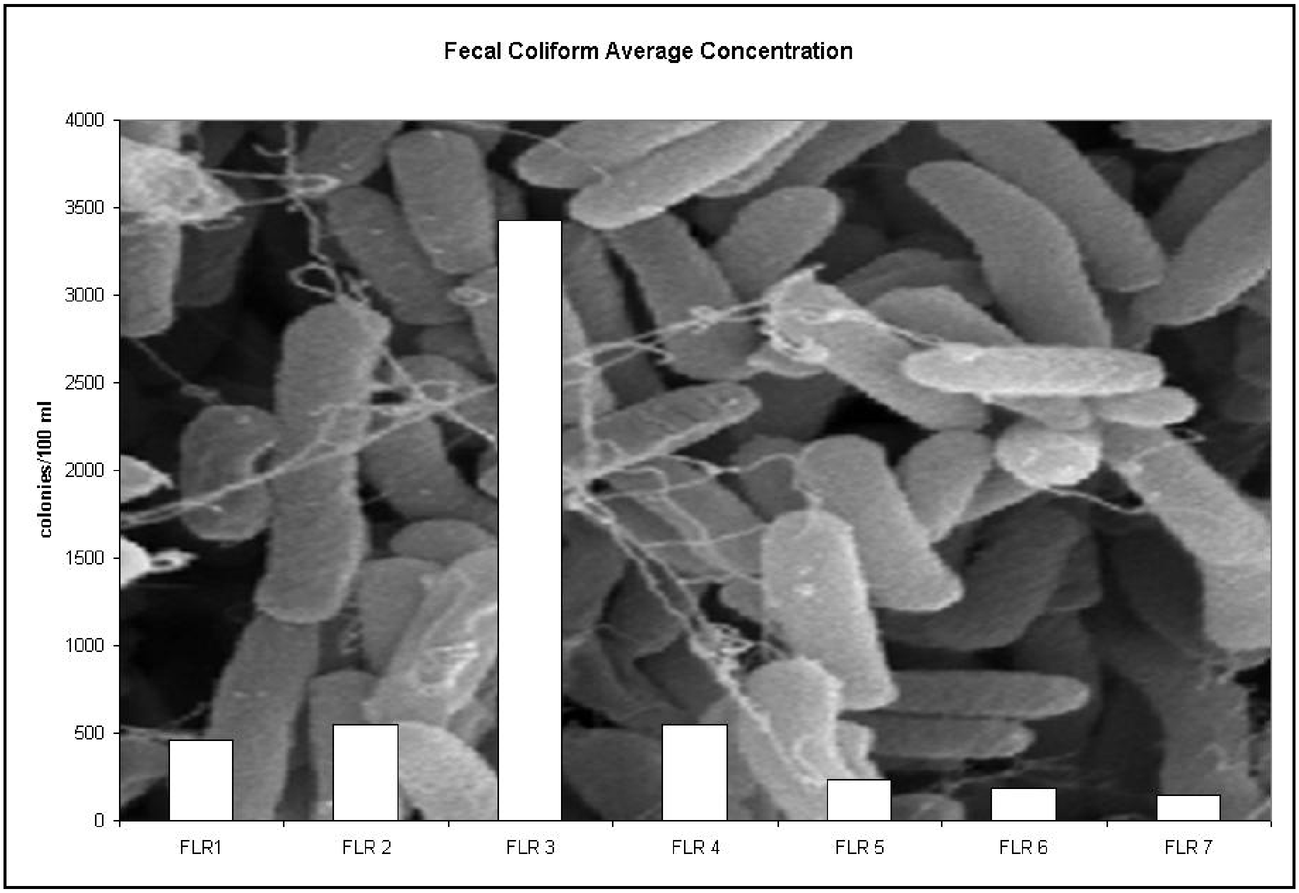
Bacteria are prokaryotes of the Kingdom Monera. Monerans are the most numerous and the most ubiquitous organisms in the environment. Total coliform bacteria are a collection of relatively harmless microorganisms that live in large numbers in the intestines of man and warm and cold-blooded animals. These bacteria are essential for the digestion of certain foods. One of the total coliform bacteria subgroups is the fecal coliform bacteria. Of this subgroup, the most common member is *Escherichia coli*. Coliform bacteria are not considered to be pathogenic organisms, having been demonstrated to be only mildly infectious. Fecal coliform bacteria serve as a group of indicator organisms, i.e., their presence indicates recent fecal pollution by animals or man, and the possible presence of other disease causing organisms that may potentially infect those that come into contact with the water. It is generally accepted that the presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals.

Fecal Coliform Bacteria in Colonies per 100 ml						
		FLR 1	Average	461		
			Maximum	3000		
			Minimum	22		
		FLR 2	Average	551		
			Maximum	5000		
			Minimum	8		
		FLR 3	Average	3429		
			Maximum	84000		
			Minimum	12		
		FLR 4	Average	549		
			Maximum	4400		
			Minimum	4		
		FLR 5	Average	232		
			Maximum	2000		
			Minimum	2		
		FLR 6	Average	182		
			Maximum	2900		
			Minimum	2		
		FLR 7	Average	149		
			Maximum	2800		
			Minimum	2		

Substantial numbers of these fecal coliform bacteria in an aquatic environment give rise to concern that pathogenic organisms, also present in fecal matter, may be present. As such, the presence of fecal coliform bacteria is an indicator that a potential health risk exists for individuals exposed to this water. Such health risks include ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis and hepatitis A. It should also be noted that the presence of fecal coliform tends to affect humans more than it does aquatic creatures.

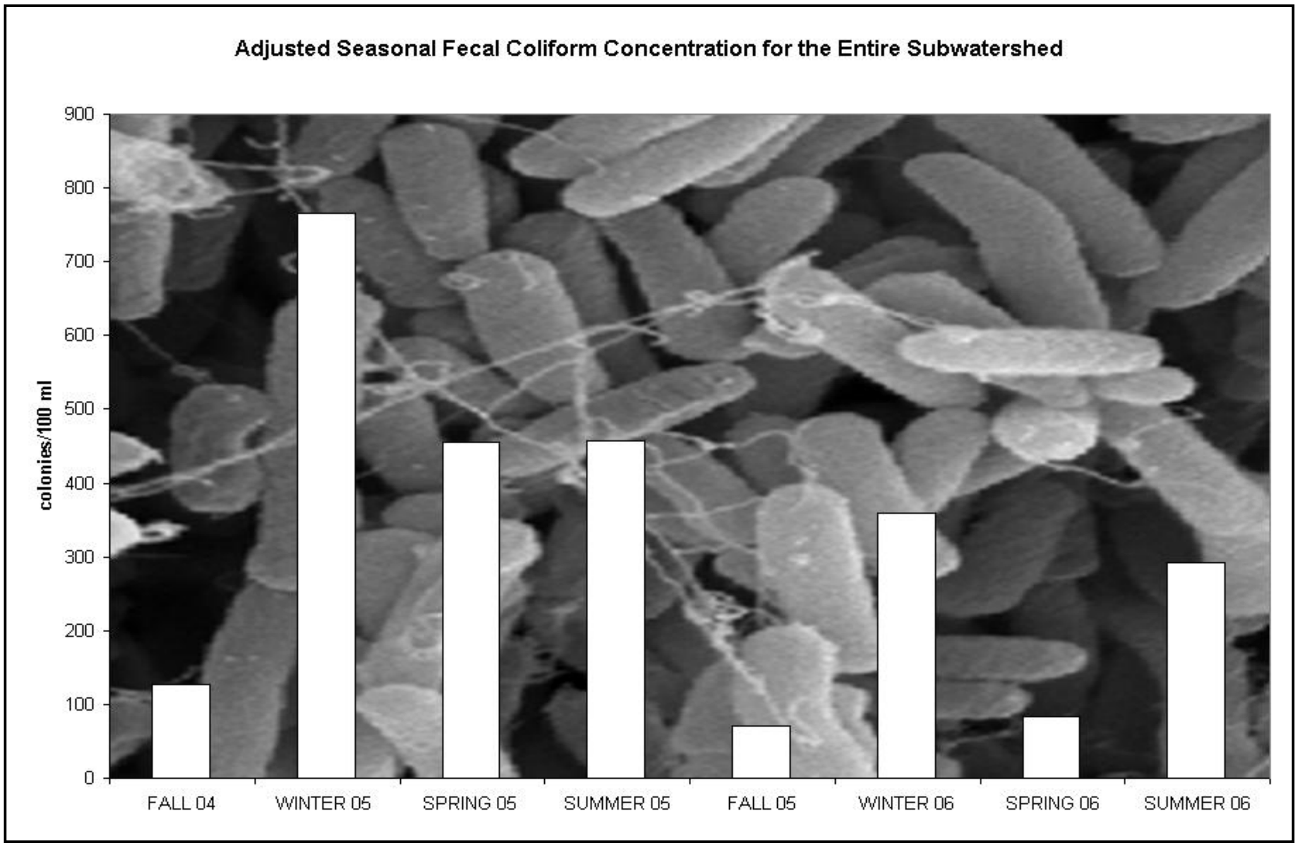
Fecal coliform bacteria can enter surface water through direct discharge of waste from mammals and birds, from agricultural and storm runoff, and from untreated human sewage. Individual home septic systems can become overloaded during rain events and allow untreated human wastes to flow into drainage ditches and nearby waters. Agricultural practices also may contribute to bacterial contamination through such practices as allowing animal wastes to wash into nearby streams, spreading manure and fertilizer on fields during rainy periods, and allowing livestock to water in streams.

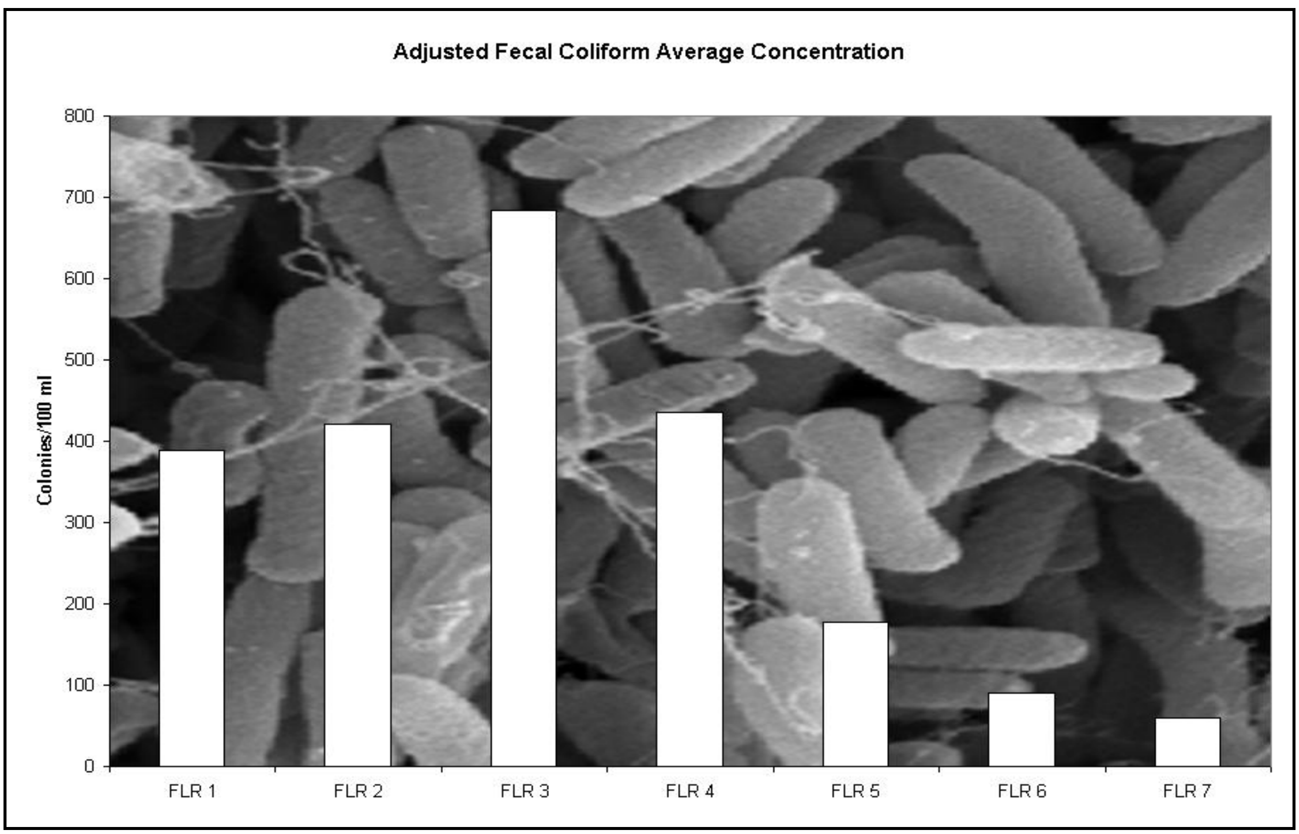
Fecal coliform bacteria concentrations exceeded the established ADEM one time water use criteria of 2,000 colonies/100ml on three occasions at FLR 1, FLR 2, and FLR 4, six occasions at FLR 3, and on one occasion at FLR 5, FLR 6, and FLR 7. In all instances where these elevated levels were observed, the sampling events corresponded to substantial rainfall events. In the cases of FLR 5 – FLR 7, Tropical Storm Cindy had just passed through the area. As is evidenced by the inserted graph, FLR 3 exhibited the highest average fecal coliform bacteria concentrations. These elevated levels may be attributed to the almost constant presence of two, large domesticated geese. It should also be noted that immediately up gradient of this site was a residence with a mound septic system.



Adjusted Fecal Coliform Average in Colonies/100 ml		
FLR 1	389	
FLR 2	421	
FLR 3	684	
FLR 4	435	
FLR 5	177	
FLR 6	91	
FLR 7	59	

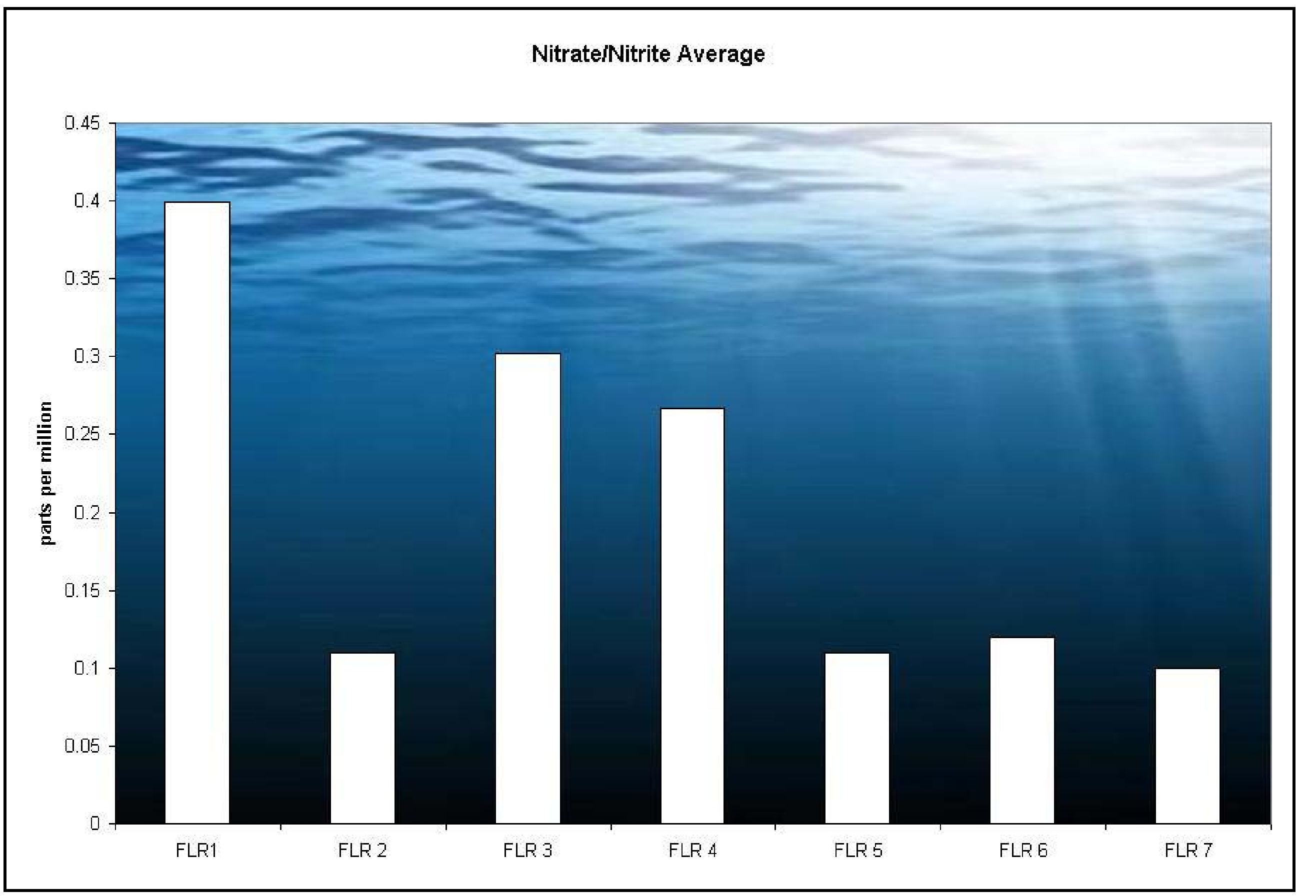
Adjusting the fecal coliform bacteria concentration data by removing the largest and smallest reported values for each station reduces the overall average substantially. Even so, average fecal coliform bacteria concentrations for the Fowl River sub watershed are, with the exception of stations FLR 6 and FLR 7, significantly elevated. The high levels of bacteria encountered are most likely attributable to the large number of residential septic tank systems and the wastes deposited by the prolific wildlife within the basin. As no geometric mean sampling was included in this study, the water quality criteria established for those waters carrying a use classification of swimming and other whole body water contact sports is not applicable in terms of comparison to the data presented.


Adjusted Seasonal Fecal Coliform Concentration for the Entire Subwatershed
colonies/100 ml
900
800
700
600
500
400
300
200
100
0
FALL 04
WINTER 05
SPRING 05
SUMMER 05
FALL 05
WINTER 06
SPRING 06
SUMMER 06


Adjusted Fecal Coliform Average Concentration
Colonies/100 ml
800
700
600
500
400
300
200
100
0
FLR 1
FLR 2
FLR 3
FLR 4
FLR 5
FLR 6
FLR 7

Nitrate/Nitrite

Nitrogen (N) is one of the planet's most abundant elements. It is a principal component of our atmosphere. The air we breath is composed of approximately eighty percent nitrogen. Nitrogen is found in the cells of all living things and is an essential component of proteins. Inorganic nitrogen exists in nature in the free state as a gas (N_2), or as nitrate (NO_3-), nitrite (NO_2-), or ammonia (NH_3+). Nitrogen enters water bodies by means of runoff (animal wastes and septic tanks), municipal and industrial wastewater, and even discharges from car exhausts. In aquatic environments, nitrogen-containing compounds act as nutrients. Aquatic plants and animals continually recycle the available nitrogen. Depending on the predominant form, too much or too little nitrogen in the system may have deleterious effects. Too little nitrogen may cause the exposed to experience nitrogen deprivation. Too much nitrogen may enable algae, plants that are fed by nutrients, to thrive and rapidly overpopulate an ecosystem. Such algae blooms pose a number of problems in an aquatic environment by contributing to turbidity and substantially reducing the amount of light penetrating the water. And, though algae produce oxygen as a by product of photosynthetic activity, the amount of dissolved oxygen they contribute to the aquatic system is not sufficient to overcome the oxygen demand created by their subsequent decay. Further, the bacteria feeding upon the decaying algae quickly convert nitrites to nitrates. Nitrate reactions in aquatic environments can cause oxygen depletion.



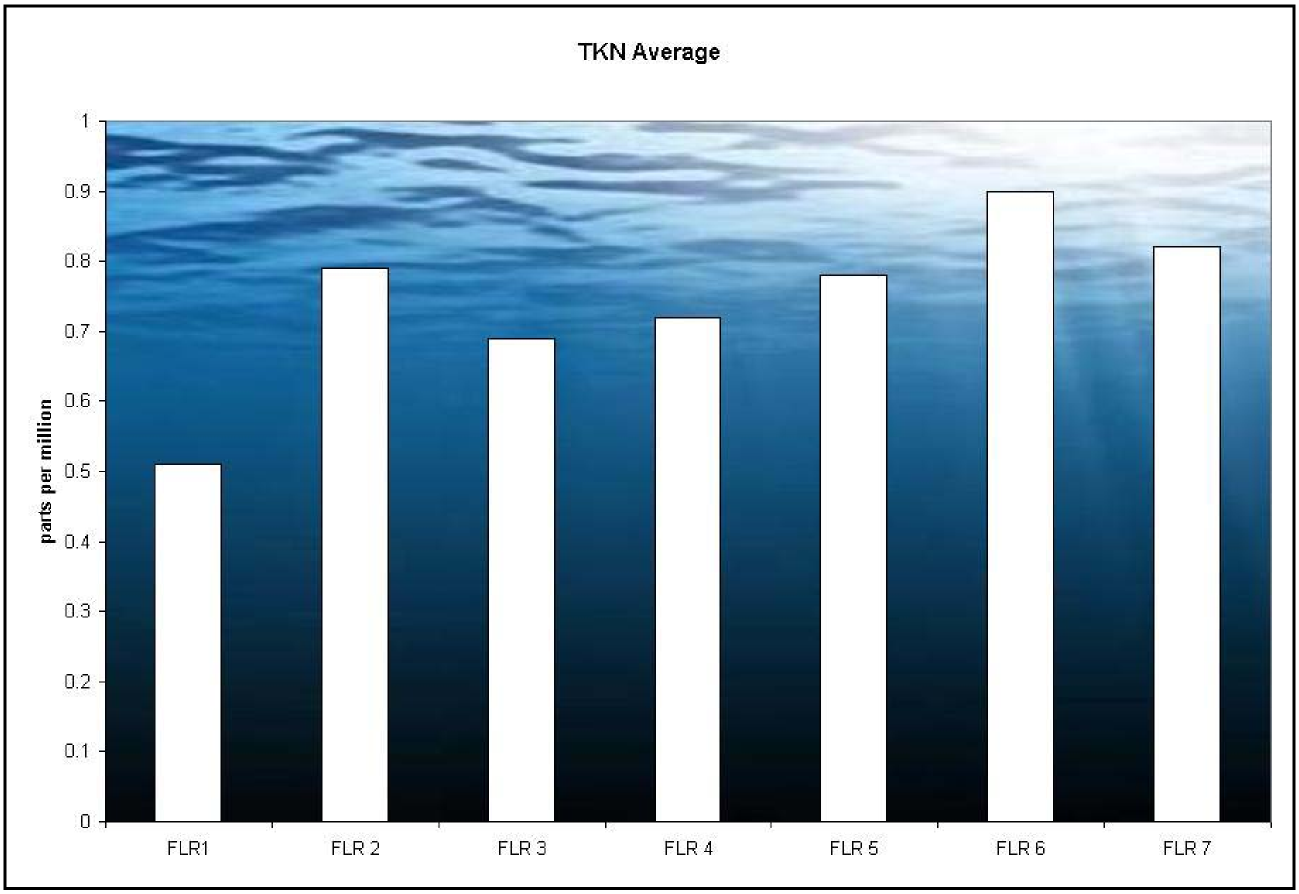
The sum effect of eutrophication on aquatic systems is decreased dissolved oxygen levels. Decreased dissolved oxygen levels, in turn, leads to hypoxic or even anoxic conditions (NCSU. 1984.)

Excessive concentrations of nitrates/nitrites were not observed at any station during this study. As may be seen in the inserted graphics, station FLR 1 demonstrated the highest average concentrations for the sub watershed, followed by FLR 3 and FLR 4 respectively. Station FLR 7 exhibited the lowest average concentration of nitrates/nitrites.

Nitrate/Nitrite in Parts Per Million				
	FLR 1	Average	0.399	
		Maximum	2.12	
		Minimum	0.016	
	FLR 2	Average	0.11	
		Maximum	0.463	
		Minimum	0.008	
	FLR 3	Average	0.302	
		Maximum	0.752	
		Minimum	0	
	FLR 4	Average	< 0.267	
		Maximum	0.683	
		Minimum	< 0.005	
	FLR 5	Average	< 0.11	
		Maximum	0.338	
		Minimum	< 0.005	
	FLR 6	Average	< 0.12	
		Maximum	0.37	
		Minimum	< 0.005	
	FLR 7	Average	< 0.10	
		Maximum	0.43	
		Minimum	< 0.005	

Total Kjeldahl Nitrogen

It has already been demonstrated that Nitrogen is a very important nutrient to a stream ecology and that, while some nitrogen is necessary as a nutrient for aquatic plant growth, too much nitrogen adversely affects that ecology. Since the nitrogen cycle is very complex, and nitrogen can exist in so many forms simultaneously, the Total Kjeldahl Nitrogen (TKN) test was developed using digestion and distillation to determine the sum concentration of the various nitrogen compounds. Kjeldahl nitrogen, therefore, refers to the total of organically bound nitrogen and ammonia nitrogen. Typically, high Total Kjeldahl Nitrogen values are indicative of pollution in an aquatic system.



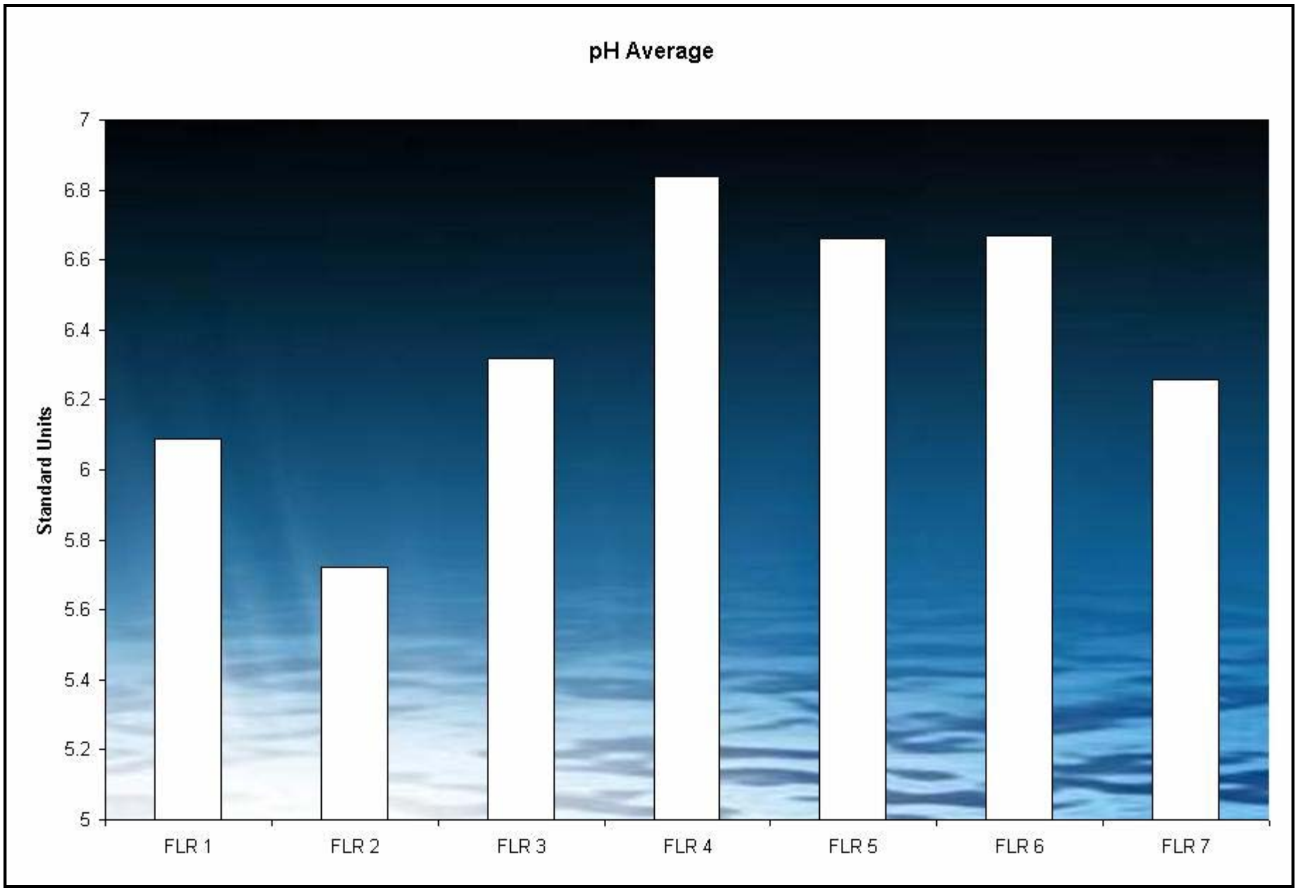
On average, the TKN values observed during this study were not excessive. Station FLR 6 exhibited the highest average TKN concentration. Station FLR 1 had the lowest average TKN concentration. Station FLR 3 exhibited the highest single event concentration at three point eight (3.8) parts per million.

Total Kjehldahl Nitrogen in Parts Per Million						
		FLR 1	Average	0.51		
			Maximum	1.5		
			Minimum	0.18		
		FLR 2	Average	0.79		
			Maximum	3		
			Minimum	0.17		
		FLR 3	Average	0.69		
			Maximum	3.8		
			Minimum	0.2		
		FLR 4	Average	0.72		
			Maximum	2.2		
			Minimum	0.23		
		FLR 5	Average	0.78		
			Maximum	2.3		
			Minimum	0.27		
		FLR 6	Average	0.9		
			Maximum	3.3		
			Minimum	0.25		
		FLR 7	Average	0.82		
			Maximum	1.6		
			Minimum	0.5		

pH

A measure of a solution's acidity is termed pH. This measure is based upon the concentration of positively charged hydrogen atoms (hydrogen ions) in a solution. For the purposes of this study, pH may be defined as the negative logarithm of the concentration of hydronium ions in solution. Hydronium ions are chosen because hydrogen ions readily associate with water molecules to form hydronium ions. In pure water, hydronium and hydroxyl ions exist in equal quantities which results in a neutral solution. Neutral solutions have a pH of 7. When hydronium ion concentrations exceed the concentration of hydroxyl ions, the solution becomes acidic. As a result, pH values falling below 7 are considered acidic solutions. Conversely, when hydroxyl ion concentrations are greater than hydronium ion concentrations, the solution is considered basic and the pH values range from greater than 7 to 14 (NCSU. 1994.)

			FLR 1	FLR 2	FLR 3	FLR 4	FLR 5	FLR 6	FLR 7
pH		Average	6.09	5.72	6.32	6.84	6.66	6.67	6.26
s.u.		Maximum	8.03	7.28	8.12	8.82	7.67	7.49	7.85
		Minimum	5	4.94	5.4	4.89	4.61	5.6	4.75

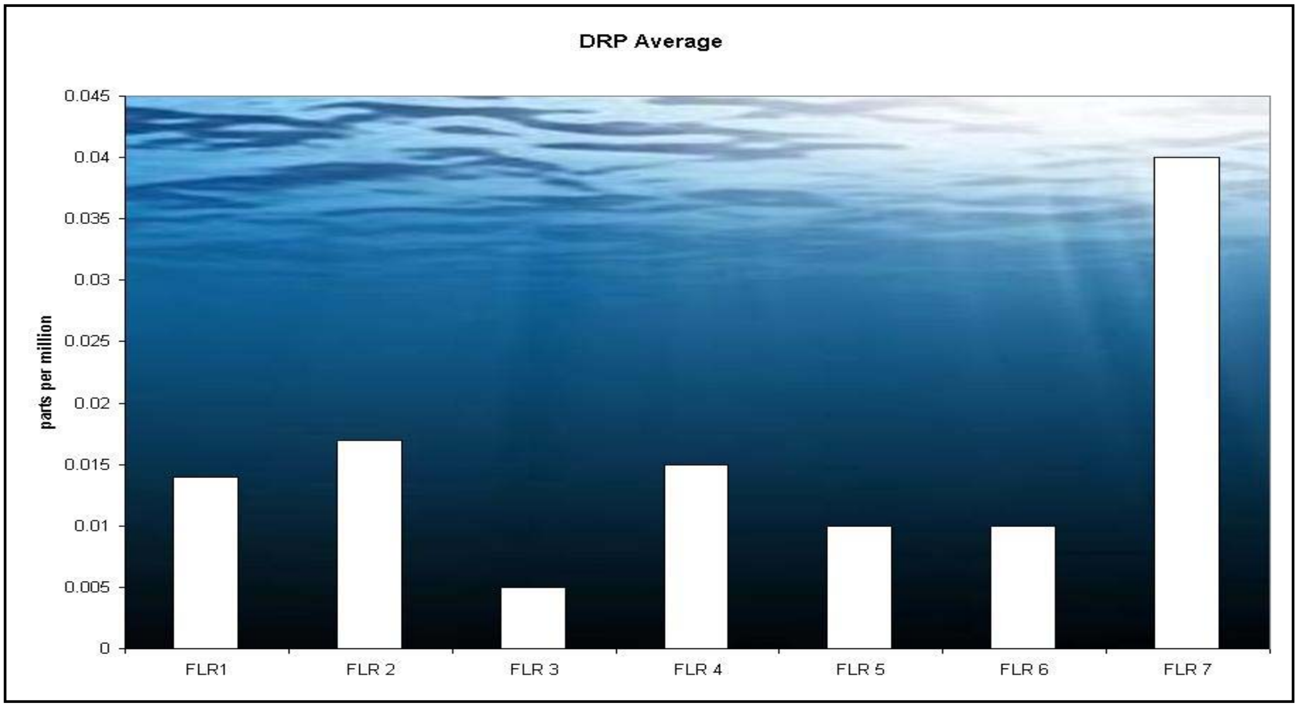


On average, the pH values for the Fowl River sub watershed are satisfactory. Station FLR 4 demonstrated the highest average pH at six point eighty-four (6.84) standard units. Station FLR 2 demonstrated the lowest average pH at five point seventy-two (5.72) standard units. The lowest pH value encountered in the study was four point sixty-one (4.61) standard units at station FLR 5. The highest pH value encountered in the study was eight point eighty-two (8.82) standard units at station FLR 4.

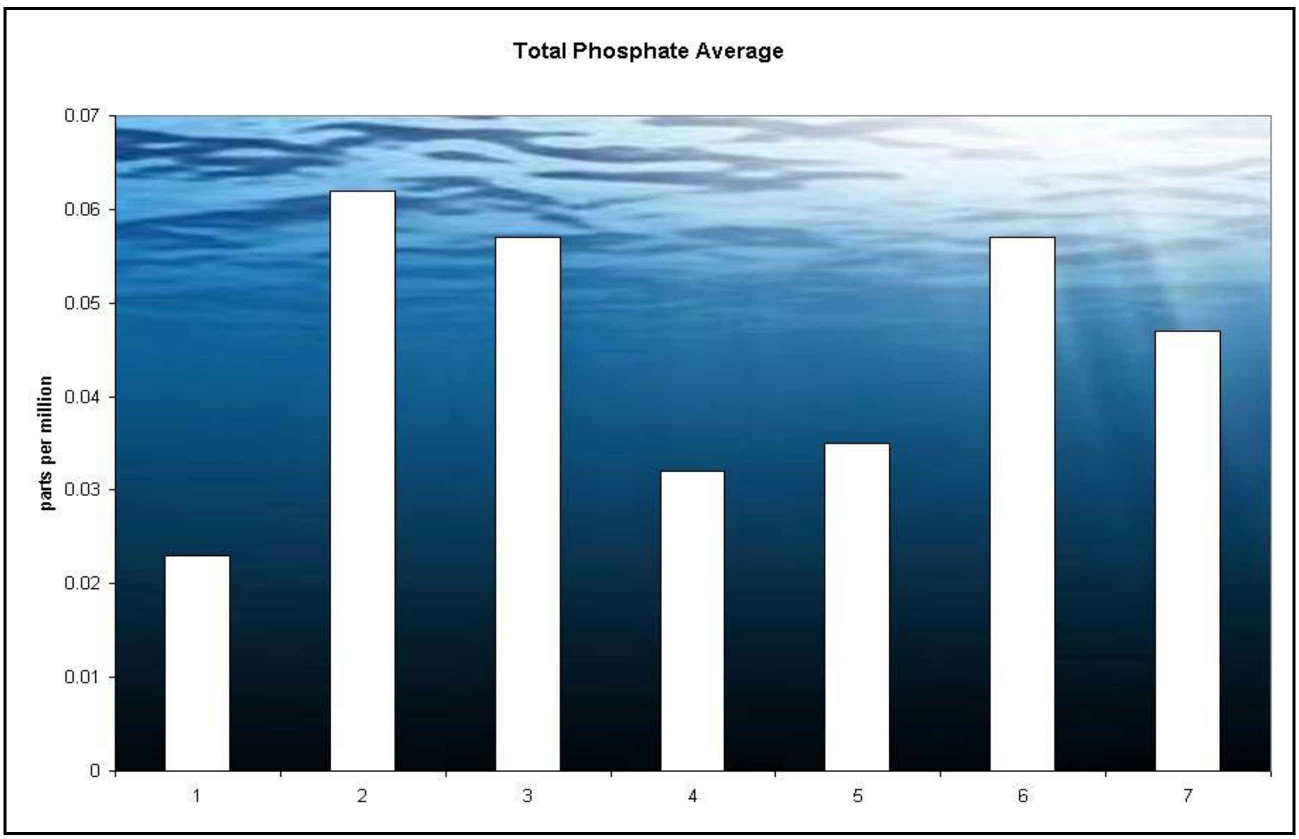
Phosphate

Total phosphate is a measure of both suspended and dissolved phosphates. Of high nutritive value to plants and animals, phosphates are used in fertilizers and as animal feed supplements. They are also used in the manufacture of numerous industrial chemicals. Phosphorous is a major nutritional and structural component of biota. It is also the least abundant of biota's required components. Phosphorous exists in aquatic systems almost exclusively as phosphates.

There are several classifications of phosphates: ortho phosphates (or dissolved reactive phosphate), condensed phosphates, and organically bound phosphates. Phosphates occur in solution, in detritus, or in the bodies of aquatic organisms. The forms of phosphate are introduced via a variety of sources including wastewater discharge, fertilizer runoff, and runoff from sewage. Phosphorus is



found in the Earth's rocks primarily as the ion ortho phosphate (PO_4^{3-}), which is the most significant form of inorganic phosphorus in aquatic systems.



The phosphorous cycle is very complex, but the majority of phosphate in aquatic systems is bound up in the particulate phase as living biota such as bacteria and plants, effectively removing it from the primary productive zone. With the algae/bacteria interaction comes a colloidal substance,

Total Phosphate in Parts Per Million				
	FLR 1	Average	< 0.023	
		Maximum	0.064	
		Minimum	< 0.01	
	FLR 2	Average	0.062	
		Maximum	0.1	
		Minimum	0.02	
	FLR 3	Average	0.057	
		Maximum	0.56	
		Minimum	0.009	
	FLR 4	Average	0.032	
		Maximum	0.059	
		Minimum	0.01	
	FLR 5	Average	0.035	
		Maximum	0.065	
		Minimum	0.015	
	FLR 6	Average	0.057	
		Maximum	0.57	
		Minimum	0.017	
	FLR 7	Average	0.047	
		Maximum	0.081	
		Minimum	0.026	

through which some phosphorous is lost to the sediment, while still more is lost through hydrolyzation and conversion to dissolved reactive phosphate. Dissolved reactive phosphate, since it is soluble, is quickly taken up by macrophytes and algae. The colloidal and particulate forms of phosphorus must be replaced by regeneration of solubilized phosphorus from decomposition, precipitation, and runoff (NCSU. 1984). Given that the primary source of phosphorous in the environment is igneous rocks and that there are a pronounced lack of rocks of any description in the Fowl River watershed, it is easy to see how phosphorous may be considered a major limiting nutrient in the aquatic systems of the watershed.

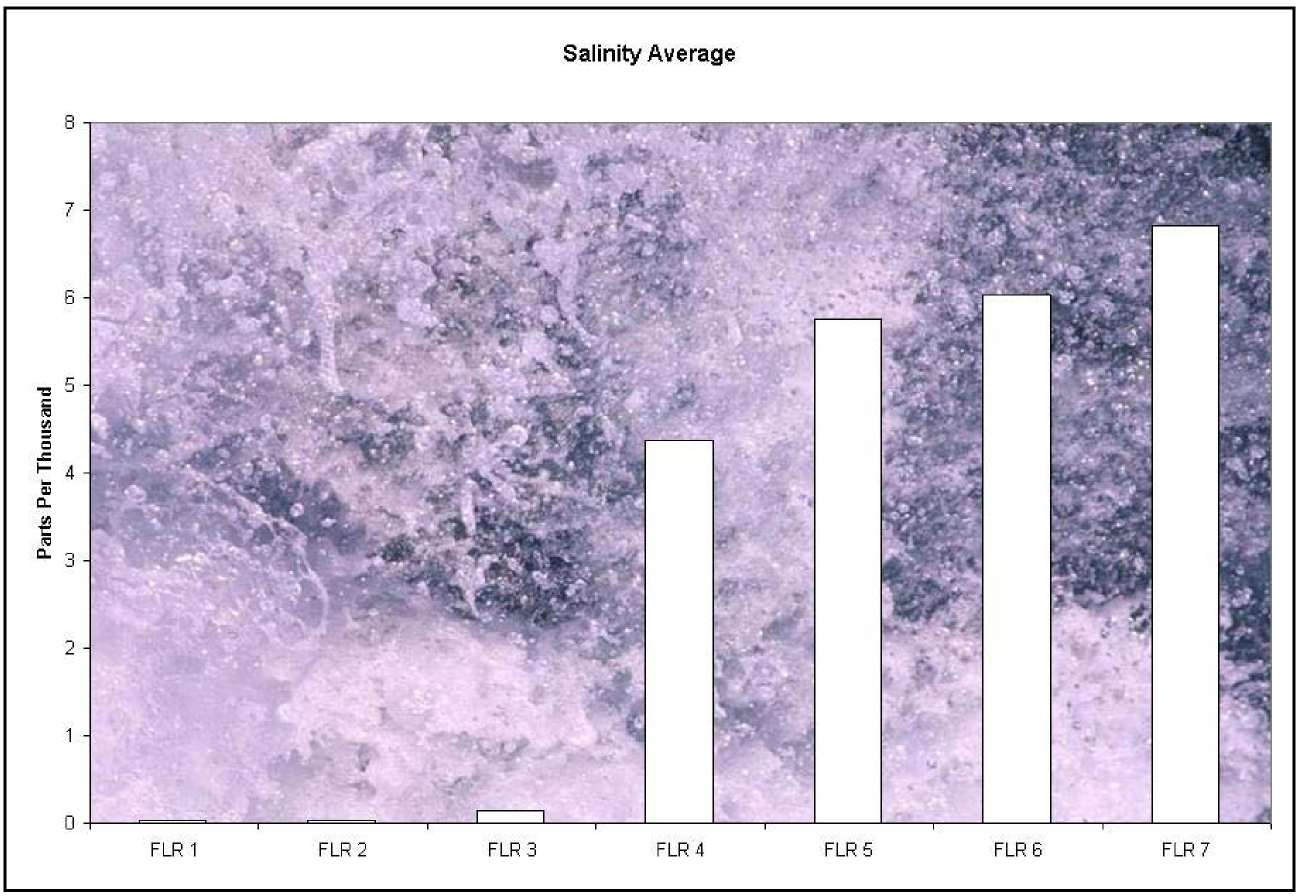
Although phosphates in the aquatic environment are usually poly-phosphates or organically bound, all will degrade to dissolved reactive phosphates with time. Overloading of phosphate concentrations may result in the proliferation of algae or other aquatic plant life. As previously discussed, such eutrophication causes decreased dissolved oxygen levels in the water resulting from the accelerated decay of organic matter. Excessive dissolved reactive phosphate concentrations are an indicator of such overloading (NCSU. 1984.)

Dissolved Reactive Phosphate in Parts Per Million						
		FLR 1	Average	< 0.014		
			Maximum	0.035		
			Minimum	0		
		FLR 2	Average	0.017		
			Maximum	0.042		
			Minimum	0.005		
		FLR 3	Average	< 0.005		
			Maximum	0.041		
			Minimum	< 0.005		
		FLR 4	Average	< 0.015		
			Maximum	0.04		
			Minimum	< 0.005		
		FLR 5	Average	< 0.01		
			Maximum	0.021		
			Minimum	< 0.005		
		FLR 6	Average	< 0.01		
			Maximum	0.021		
			Minimum	< 0.005		
		FLR 7	Average	< 0.04		
			Maximum	0.57		
			Minimum	< 0.005		

The greatest average total phosphate concentrations were encountered at station FLR 2, followed by stations FLR 3 and FLR 6. Station FLR 1 had the lowest average concentrations for total phosphate. Station FLR 6 exhibited the highest, single event concentration of total phosphate and FLR 1 had the lowest, single event concentration. For dissolved reactive phosphate, station FLR 1 had the lowest average value. Station FLR 2 had the highest average concentration. Station FLR 7 had the highest, single event concentration of dissolved reactive phosphate and FLR 1 had the lowest single event concentration.

Salinity

Salinity is the total amount of dissolved salts present in water. Salt concentrations play a significant role in plant and animal habitat and water quality. Salinity effects dissolved oxygen concentrations, pH, and conductivity. The average salinity of world oceans is around thirty five (35) ppt. Freshwater, conversely, is expected to have a salinity approaching zero (0) ppt (NOAA 2001.)

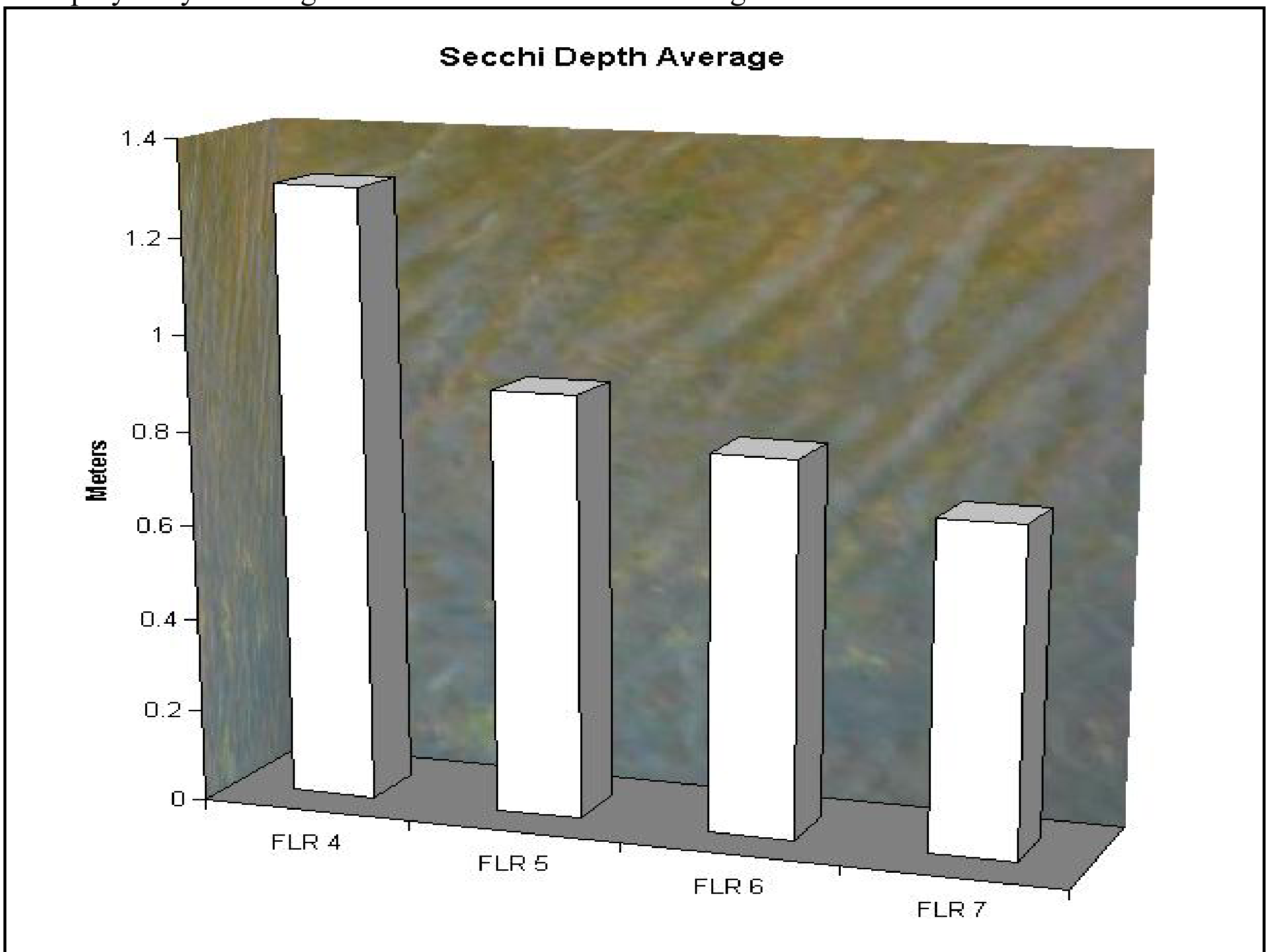


Station FLR 1 had the lowest average salinity values and FLR 7 had the highest average. Station FLR 4 exhibited the highest, single event concentration and FLR 3 and FLR 4 had the lowest, single event values. As would be expected, salinity concentrations increased in a downstream vector with those stations closer to Mobile Bay exhibiting greater values than the upstream stations.

			FLR 1	FLR 2	FLR 3	FLR 4	FLR 5	FLR 6	FLR 7
Salinity		Average	0.03	0.04	0.15	4.37	5.76	6.04	6.83
ppt		Maximum	0.04	0.09	0.98	17.95	17.59	15.37	16.08
		Minimum	0.02	0.02	0.01	0.01	0.06	0.39	0.72

Secchi Disk Depth

Clear water allows light to penetrate more deeply than does murky water. This light allows photosynthesis to occur and oxygen to be produced. Secchi disk depth is a measure of water clarity. A Secchi disk is a circular plate divided into quarters painted alternately black and white. The disk is employed by lowering it into the water until it is no longer visible.

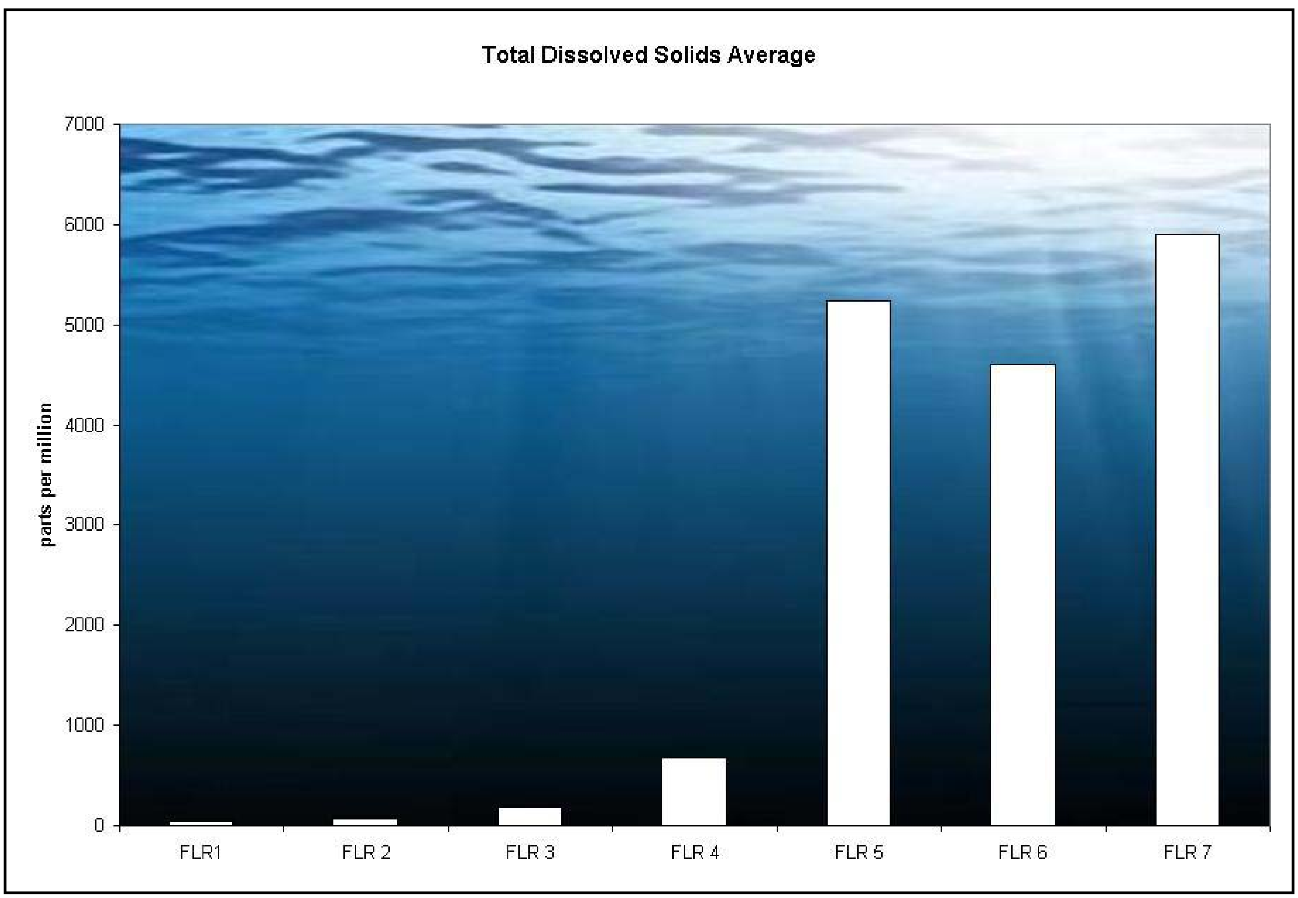


			FLR 4	FLR 5	FLR 6	FLR 7
Secchi Depth		Average	1.3	0.9	0.8	0.7
m		Maximum	2.6	2.1	1.3	1.1
		Minimum	0.5	0.5	0.5	0.4

Higher Secchi readings indicate clearer water. Lower readings indicate turbid or colored water (The American Heritage® Dictionary of the English Language. 2000. Washington State Department of Ecology. 2000.) Those stations in closest proximity to the Mobile Bay exhibited the lowest average Secchi disk depths. This indicates that the available light at depth for these stations was less than that available at those stations further upstream. A distinct correlation between Secchi disk depth and turbidity values may be inferred from the data gathered during this study. Rising turbidity values corresponded with lower Secchi disk depths.

Total Dissolved Solids

Total Dissolved Solids is a measure of the amount of material dissolved in water, or the concentration of solids in water that can pass through a filter. These solids typically include nitrate, calcium, magnesium, sodium, carbonate, bicarbonate, chloride, sulfate, phosphate, organic ions, and other ions. A certain level of these ions in water is necessary for aquatic life. Their presence effects the density of the surrounding solution. And, since density is directly correlated to the osmotic potential of water with relation to the metabolic processes of aquatic organisms, changes in total dissolved solids concentrations may have a profound effect upon those organisms. Excessively high or low total dissolved solids concentrations may even lead to impaired growth or death. High concentrations of total dissolved solids may also reduce water clarity, contribute to a decrease in



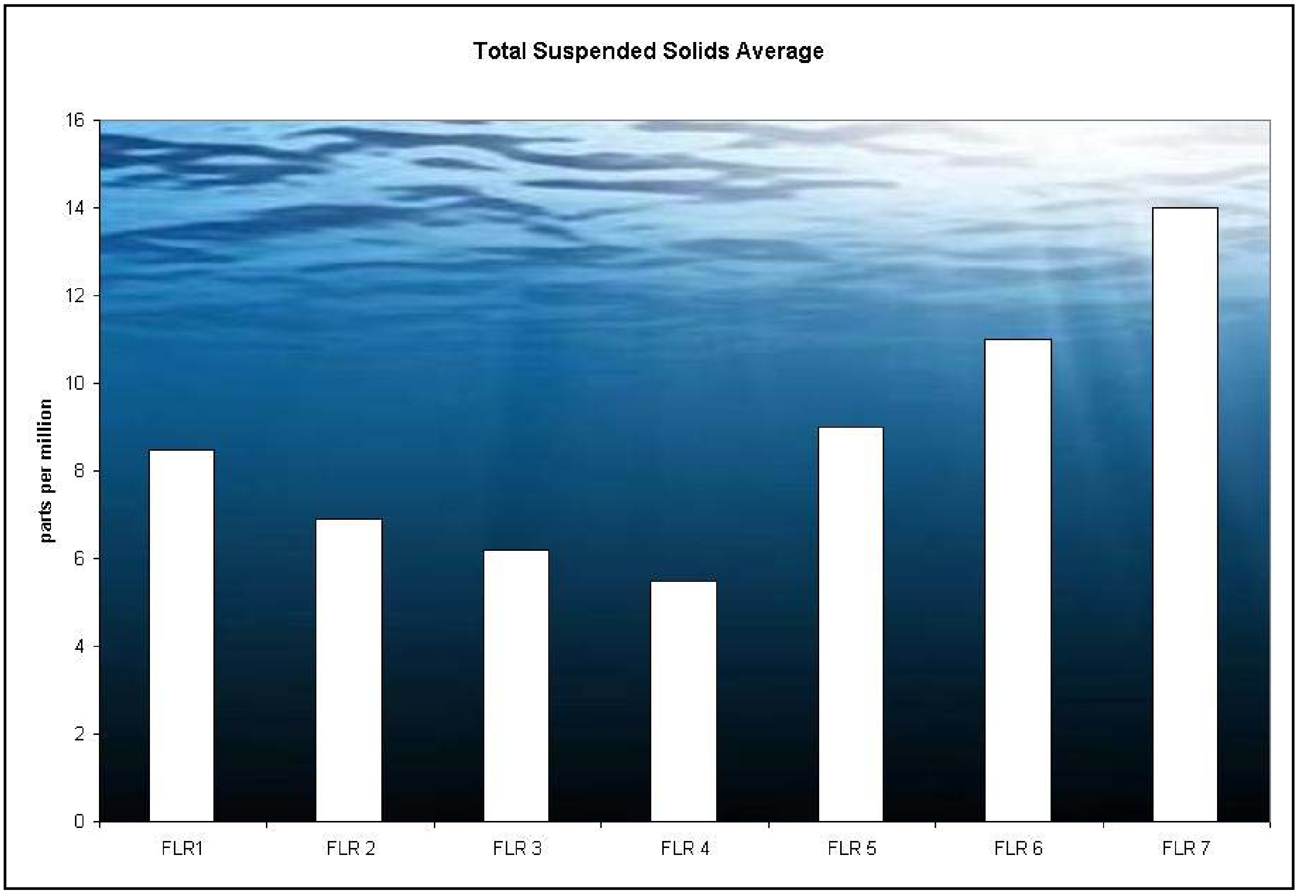
photosynthesis, and serve to increase the water's temperature, thereby depleting the available dissolved oxygen (NCSU. 1994.)

Total Dissolved Solids in Parts Per Million				
	FLR 1	Average	43	
		Maximum	57	
		Minimum	27	
	FLR 2	Average	70	
		Maximum	113	
		Minimum	46	
	FLR 3	Average	189	
		Maximum	1060	
		Minimum	35	
	FLR 4	Average	684	
		Maximum	2880	
		Minimum	6	
	FLR 5	Average	5241	
		Maximum	30100	
		Minimum	303	
	FLR 6	Average	4607	
		Maximum	13100	
		Minimum	364	
	FLR 7	Average	5894	
		Maximum	16500	
		Minimum	813	

Station FLR 7 demonstrated the largest average value for total dissolved solids and FLR 1 had the lowest average value. The greatest, single event value was recorded at station FLR 7 and the lowest, single event concentration was at FLR 5. As is indicated in the associated graphic in this section, total dissolved solids concentrations tended to increase with proximity to Mobile Bay. The tidally influenced stations exhibited substantially higher concentrations of dissolved solids than did the other stations.

Total Suspended Solids

Total suspended solids (TSS) concentration is a measure of suspended solids per volume of water. The measured solids are those that can be captured by a filter. These solids include a varied assortment of materials, either mineral or organic, including, but not limited to, sand and silt, decaying plant and animal matter, and waste particulates. High concentrations of suspended solids may cause many problems for water quality. Apart from diminishing the available light, increased siltation may alter a stream's dynamics as well as destroy existing habitat. Suspended particles also serve as substrates for other pollutants such as pathogens and some heavy metals. Suspended solids, therefore, effect the aquatic system both physically and biochemically. Geology and land use are the primary factors influencing suspended solids concentrations. As watersheds develop, there is an increase in disturbed areas, a decrease in vegetation, and an increase in impervious surface area, all of which reduce the watershed's ability to filter runoff. This contributes to increases in erosion, loading of particulate matter, nutrients, and pollutants. Such overloading leads to increased algal growth among other complications, which ultimately leads to decreased dissolved oxygen levels. Further, suspended solids can also clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development (NCSU. 1994.)



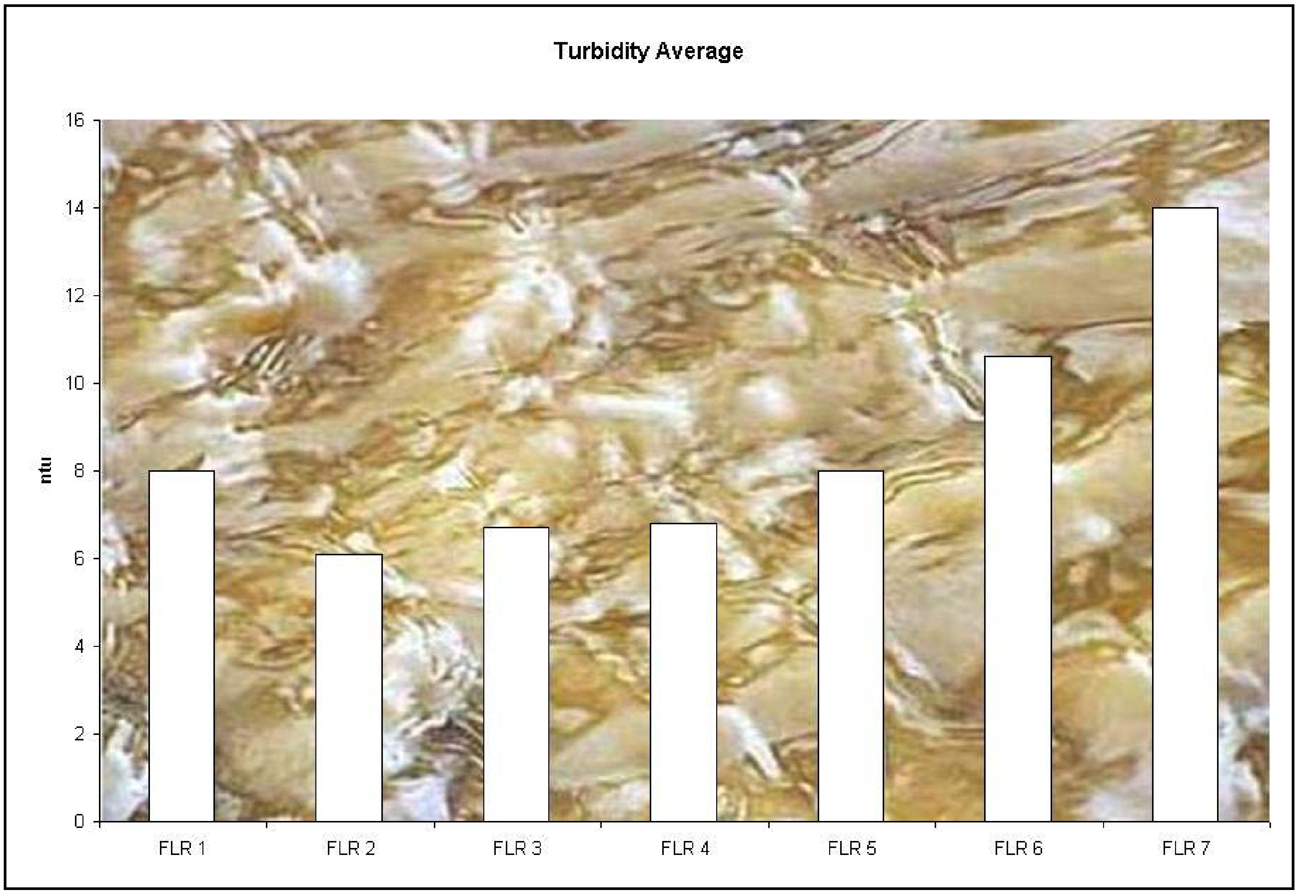
For the greater part of the study, total suspended solids concentrations were less than five parts per million at all stations. For this reason, the recorded values appearing in the table are preceded by the ' < ' symbol. The greatest average value for TSS was observed at station FLR 7. The lowest average value occurred at FLR 4. The largest, single event concentration was recorded at FLR 7.

Total Suspended Solids in Parts Per Million		
FLR 1	Average	< 8.5
	Maximum	15
	Minimum	< 5.0
FLR 2	Average	< 6.9
	Maximum	14
	Minimum	< 5.0
FLR 3	Average	< 6.2
	Maximum	10
	Minimum	< 5.0
FLR 4	Average	< 5.5
	Maximum	7
	Minimum	< 5.0
FLR 5	Average	< 9.0
	Maximum	18
	Minimum	< 5.0
FLR 6	Average	< 11.0
	Maximum	23
	Minimum	< 5.0
FLR 7	Average	< 14.0
	Maximum	27
	Minimum	< 5.0

Turbidity

Turbidity may be described as a function of total suspended solids. But, whereas, total suspended solids are determined by weight per unit volume, turbidity is measured as the amount of light scattered from a sample, making it a measure of cloudiness or murkiness in water. Turbidity reduces the amount of light that penetrates the water. Since aquatic plants require light for growth, a reduction in the amount of available light may impair plant growth. Fish or other aquatic organisms that depend on such plants for survival, be it for food or shelter, are also impacted. Further, since aquatic plants also provide oxygen to the water body, a reduction in the number of plants results in less oxygen being introduced to the aquatic system. Compounding this problem, turbid waters are generally warmer than non-turbid waters as a result of the suspended particles absorbing the sun's electromagnetic radiation. Increases in the water's temperature decreases the amount of available dissolved oxygen and depleted oxygen, in turn, results in fewer aquatic invertebrates and fish (NCSU. 1994.)

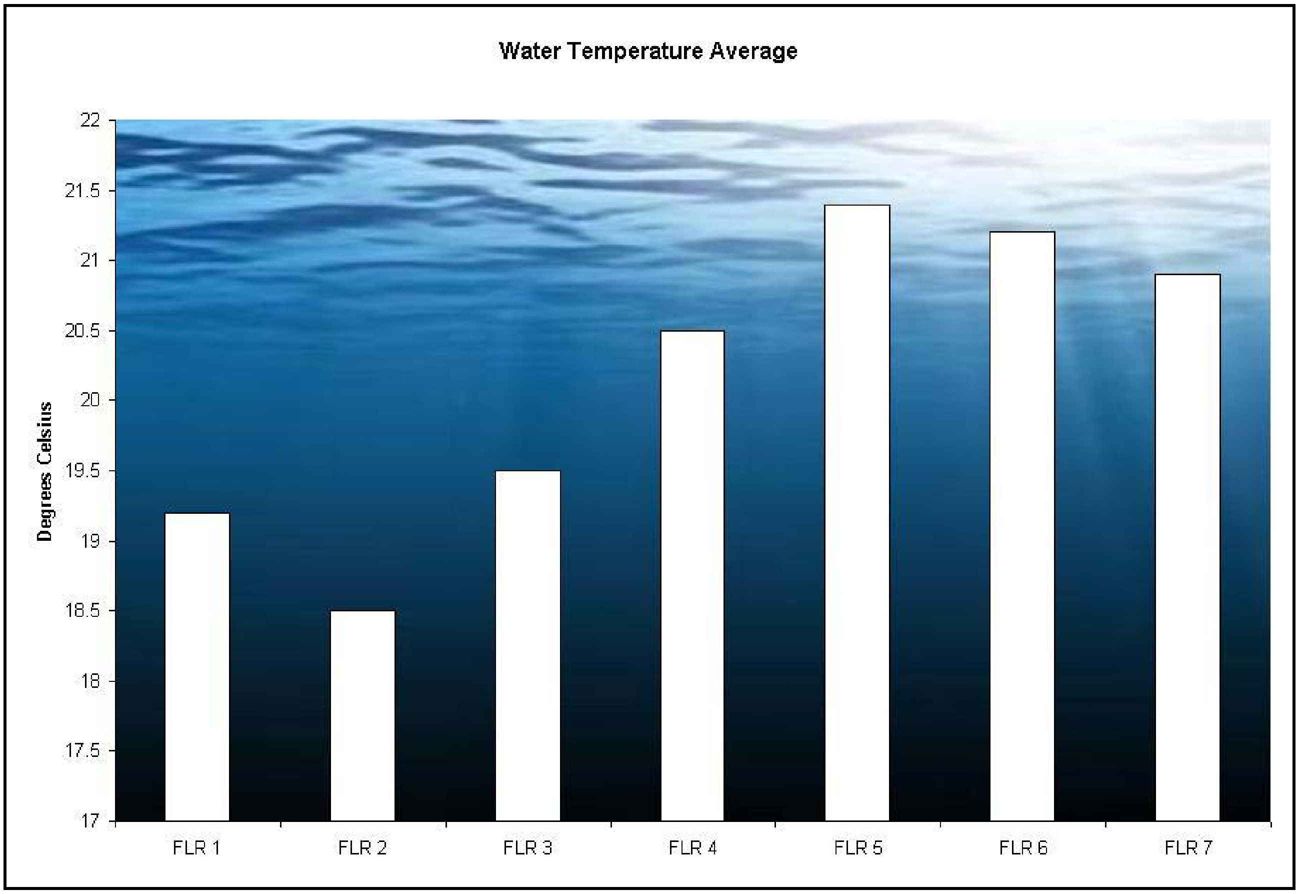
Apart from its impact on light penetration, turbidity offers other complications in the aquatic environment. The suspended particles that contribute to the turbidity can affect the way aquatic invertebrates and fish feed and breathe. Filter feeders are particularly impacted as their feeding mechanisms become choked by increased amounts of suspended particles. Likewise, fish can also experience clogging and damage of gills. Excessive suspended particles may also decrease aquatic organisms' disease resistance, reduce growth rates, interfere with reproductive development, or, simply, smother eggs and larvae. Turbidity can be caused by any number of sources. The most common causes are erosion, runoff, waste discharges, algal activity, and stirring of the bottom sediments (NCSU. 1994.)



The average turbidity values for the tidally influenced stations exceeded those values experienced at the fresh water stations. Station FLR 2 had the lowest average turbidity value among the study stations. Station FLR 7 had the greatest average turbidity.

Water Temperature

In an aquatic ecosystem, water temperature can influence dissolved oxygen concentrations, photosynthesis rates, and the metabolic processes of aquatic organisms. A number of factors contribute to the warming of a water body. These factors include, but are not limited to, ambient air temperature, runoff, man made discharges, and suspended solids concentrations. Elevated water temperatures generally result in decreased dissolved oxygen concentrations (NCSU. 1994.) Water temperatures observed during this study fell within the limits listed in Division 6 of the Department's Administrative Code.



The following table provides the maximum, minimum, and average values for water temperatures observed during the study period.

			FLR 1	FLR 2	FLR 3	FLR 4	FLR 5	FLR 6	FLR 7
H20 Temp.		Average	19.2	18.5	19.5	20.5	21.4	21.2	20.9
^{0}C		Maximum	25.7	26.8	26.7	30.3	31.2	31.5	31.1
		Minimum	8.9	7.3	8.1	8.3	8.6	9.2	8.6

Sediment Metals

Since many contaminants entering a watershed become sequestered in the sediment, sediments represent a temporally integrated record of chemical conditions in a watershed. By examining sediment metal concentrations, insight is gained into past conditions as well as current conditions (ADEM, 1997.) The objective of the sediment metal study was to determine the concentrations of metals and the presence of excessive metal enrichment. The data gathered were compared to “Ecological Response” levels developed by Long et al., 1995. These response levels establish three ranges in a given contaminant’s concentration where detrimental effects are rare, occasional, and frequent. The three ranges are defined by two threshold concentrations known as Effects Range – Low (ER-L) and Effects Range – Median (ER-M.) Values below ER-L rarely result in detrimental effects. Values exceeding ER-L, but below ER-M result in occasional detrimental effects. Values exceeding ER-M are likely to result in detrimental effects (ADEM, 2000.)

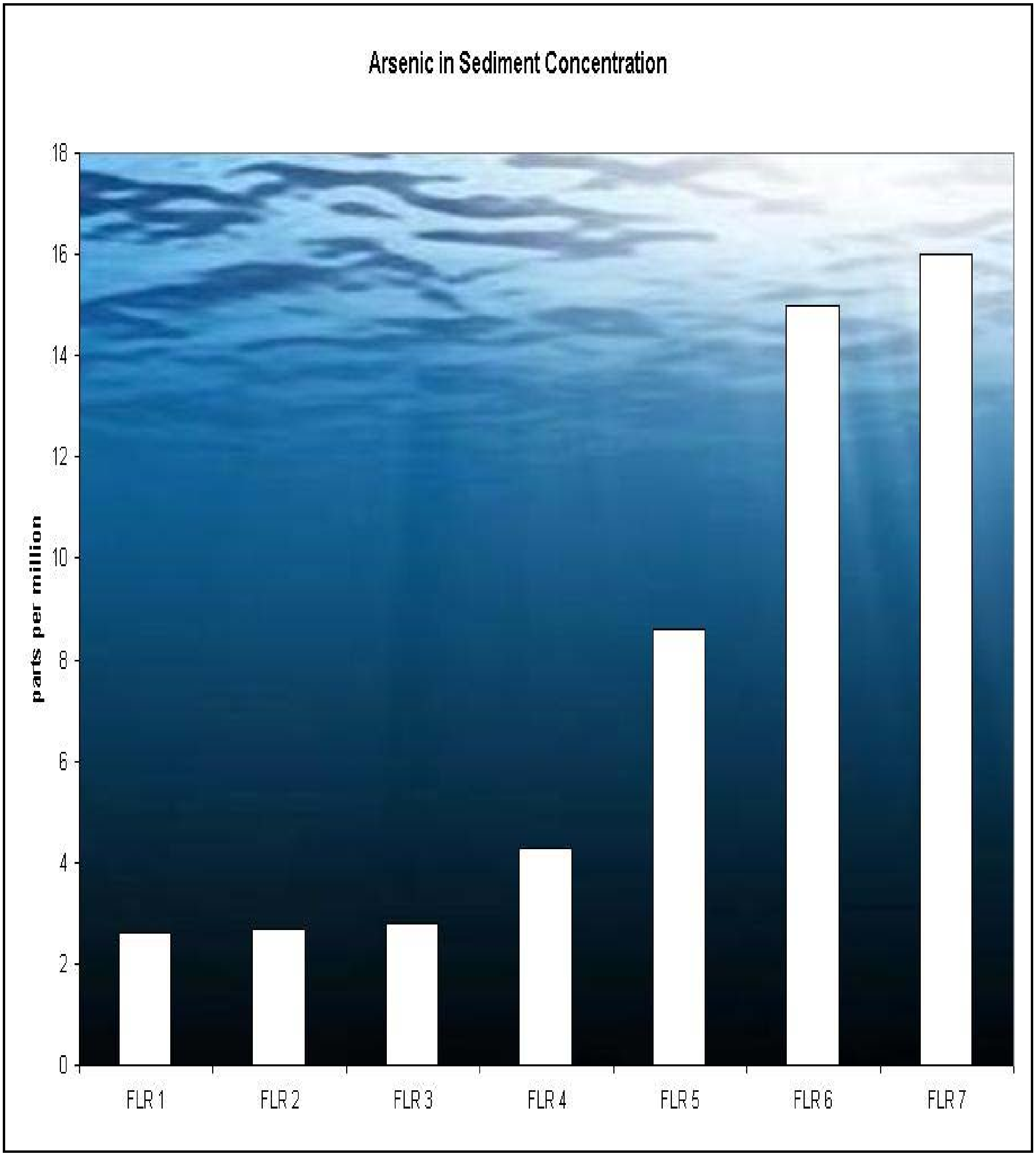
Threshold in Parts Per Million

Metal	ER – L	ER – M
Arsenic	8.2	70.0
Cadmium	1.2	9.6
Chromium	81.0	370.0
Copper	34.0	270.0
Lead	46.7	218.0
Mercury	0.15	0.71
Nickel	20.9	51.6
Zinc	150.0	410.0

(Long, 1995)

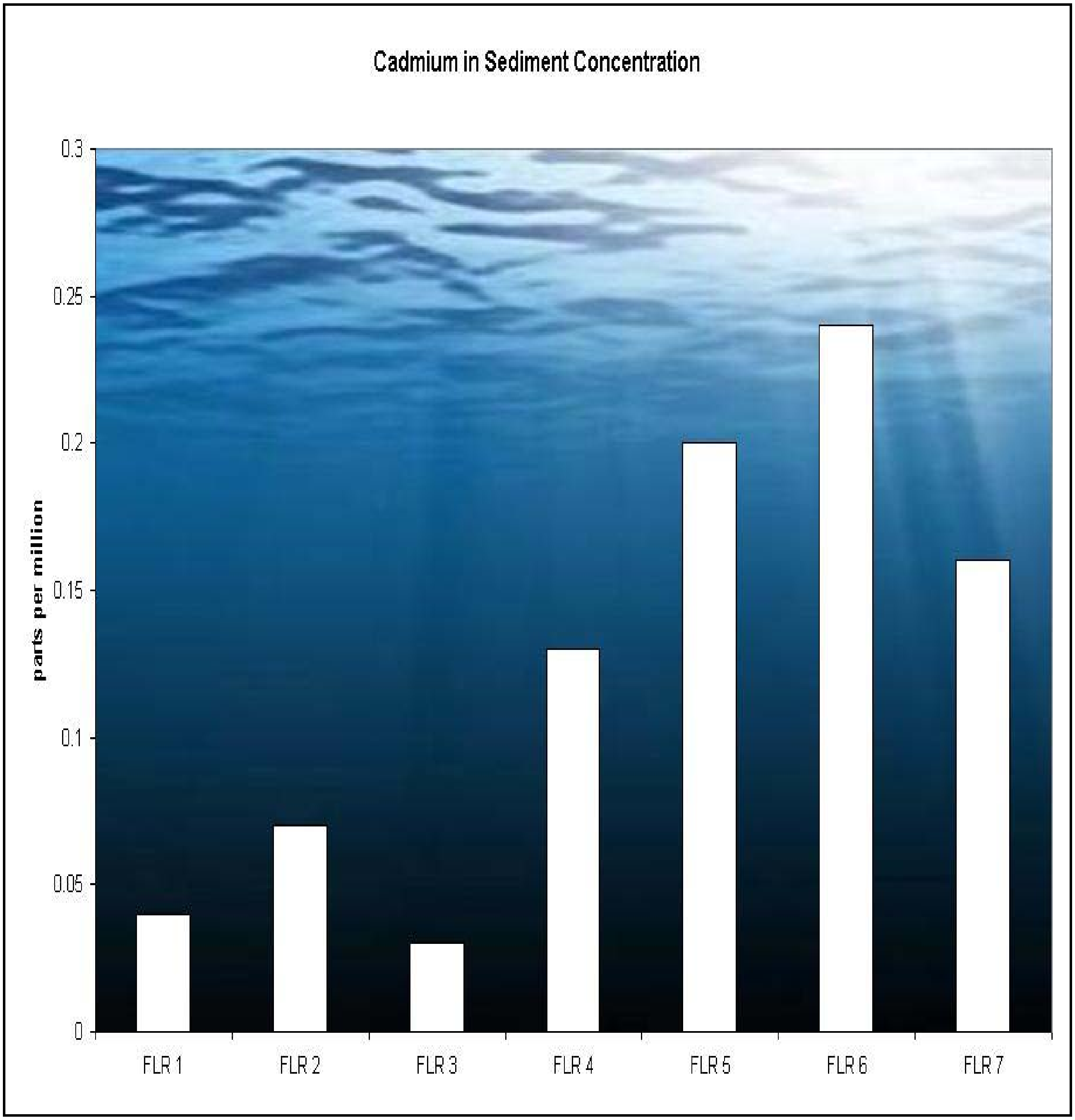
Arsenic

Arsenic is an intermediate between metals and nonmetals. In significant concentrations, it is a potent poison. Excessive levels in surface water may have devastating effects upon aquatic life. Low levels of arsenic were detected in sediment samples at all stations. Stations FLR 6 and FLR 7 exhibited arsenic concentrations in excess of the ER – L but well below the ER-M.



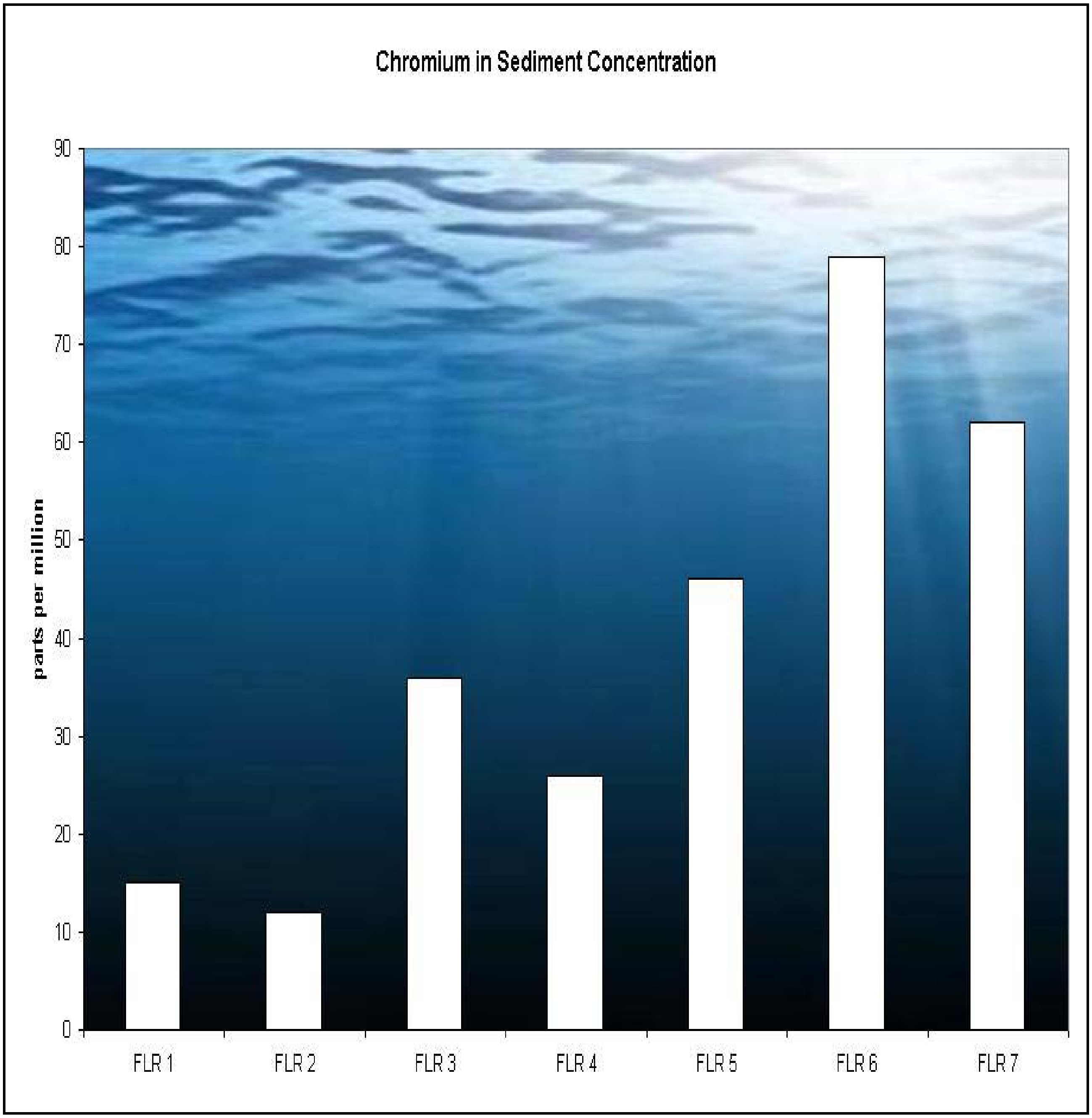
Cadmium

Cadmium is not usually found in its free elemental state, but rather combined with other elements. It is, however, a common substance suspected to be present in all soils and rocks. It is also a persistent element that does not break down readily in the environment. It has been recognized as a probable carcinogen, especially when inhaled. Cadmium was detected in low levels at each of the stations. None of the levels observed were above the ER-L for Cadmium.



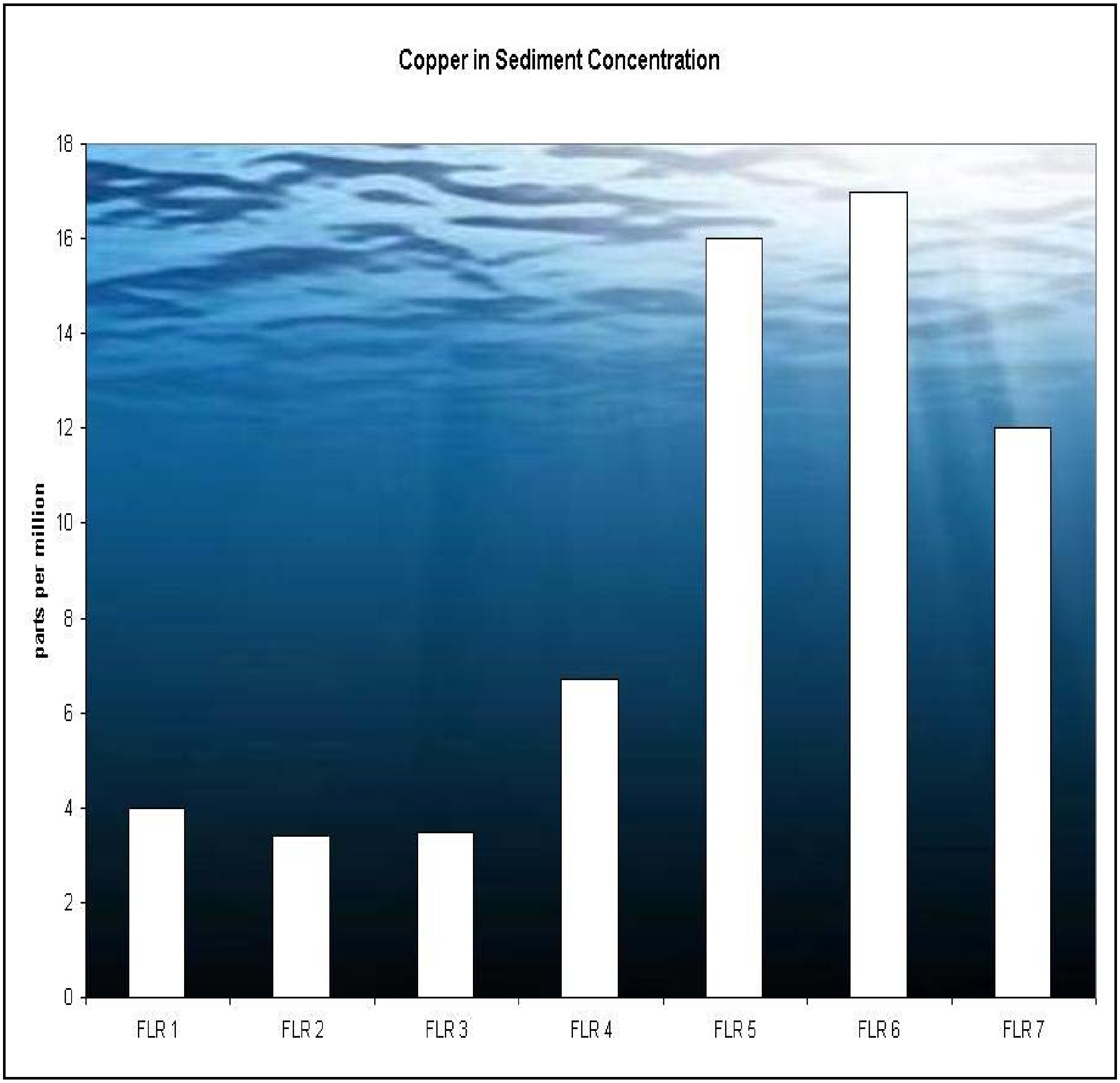
Chromium

Chromium occurs naturally in rocks, soil, air, and water. It normally appears in either trivalent or hexavalent form, depending on pH. It is a necessary trace element for the support of life functions, but, as is the case with many substances, excessive concentrations may lead to complications, i.e. acute toxicity to plants and animals. This is especially true with the hexavalent species of the element. Chromium was detected in the sediment of each station sampled. None of the stations exhibited chromium concentrations in excess of the ER – L.



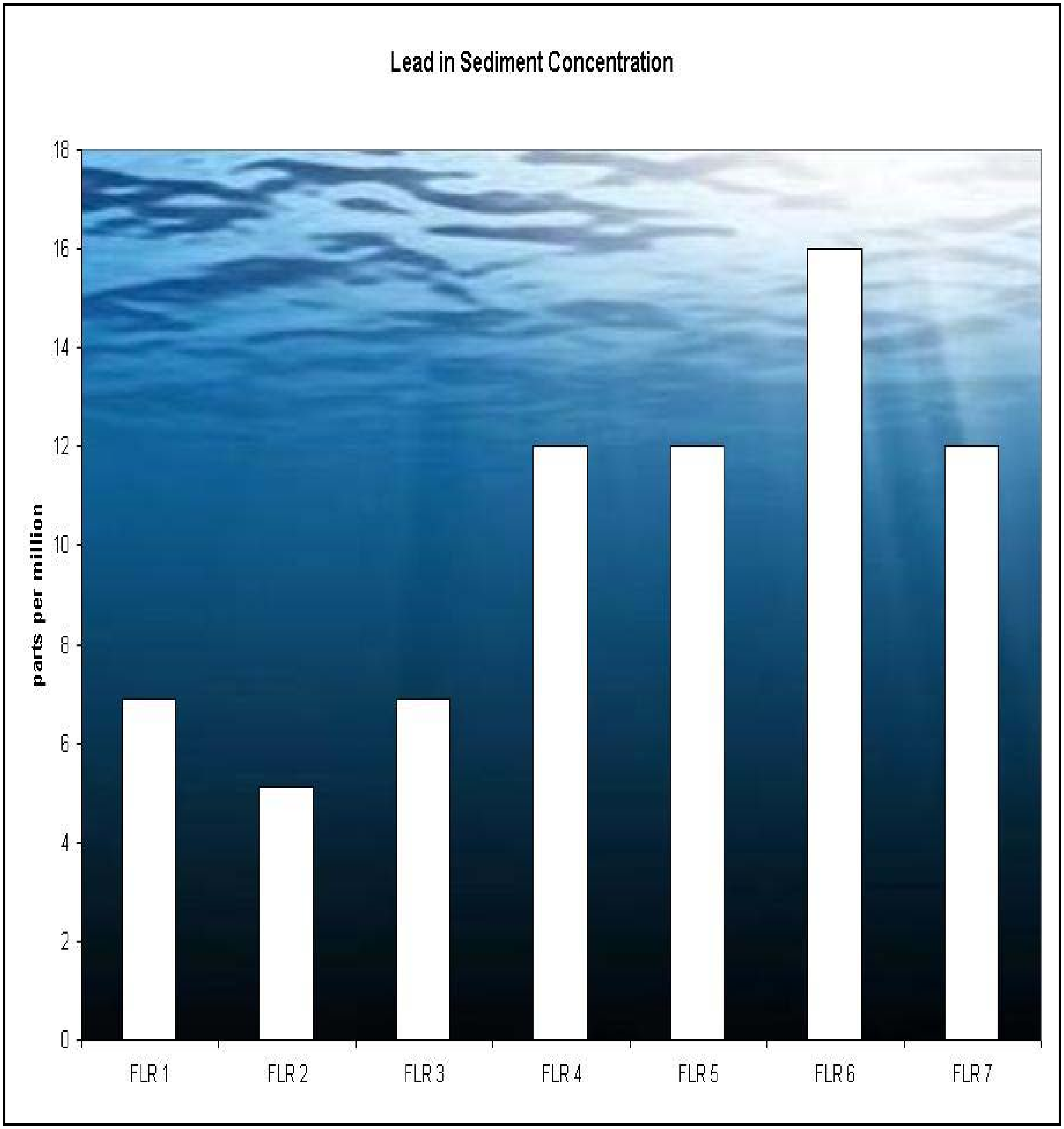
Copper

Copper is a metal that is often found in its elemental form. It was likely the first metal ever used in production by mankind. It is an essential element for normal growth and reproduction in higher plants and animals, as well as being a primary factor in the development of collagen and protective nerve coatings. Although excessive levels of copper may produce nausea and other adverse effects, deficiencies in copper are believed to be more calamitous than excess concentrations. Detectable concentrations of copper in sediment were observed at all stations. None of the detected levels exceeded the ER-L for that metal.



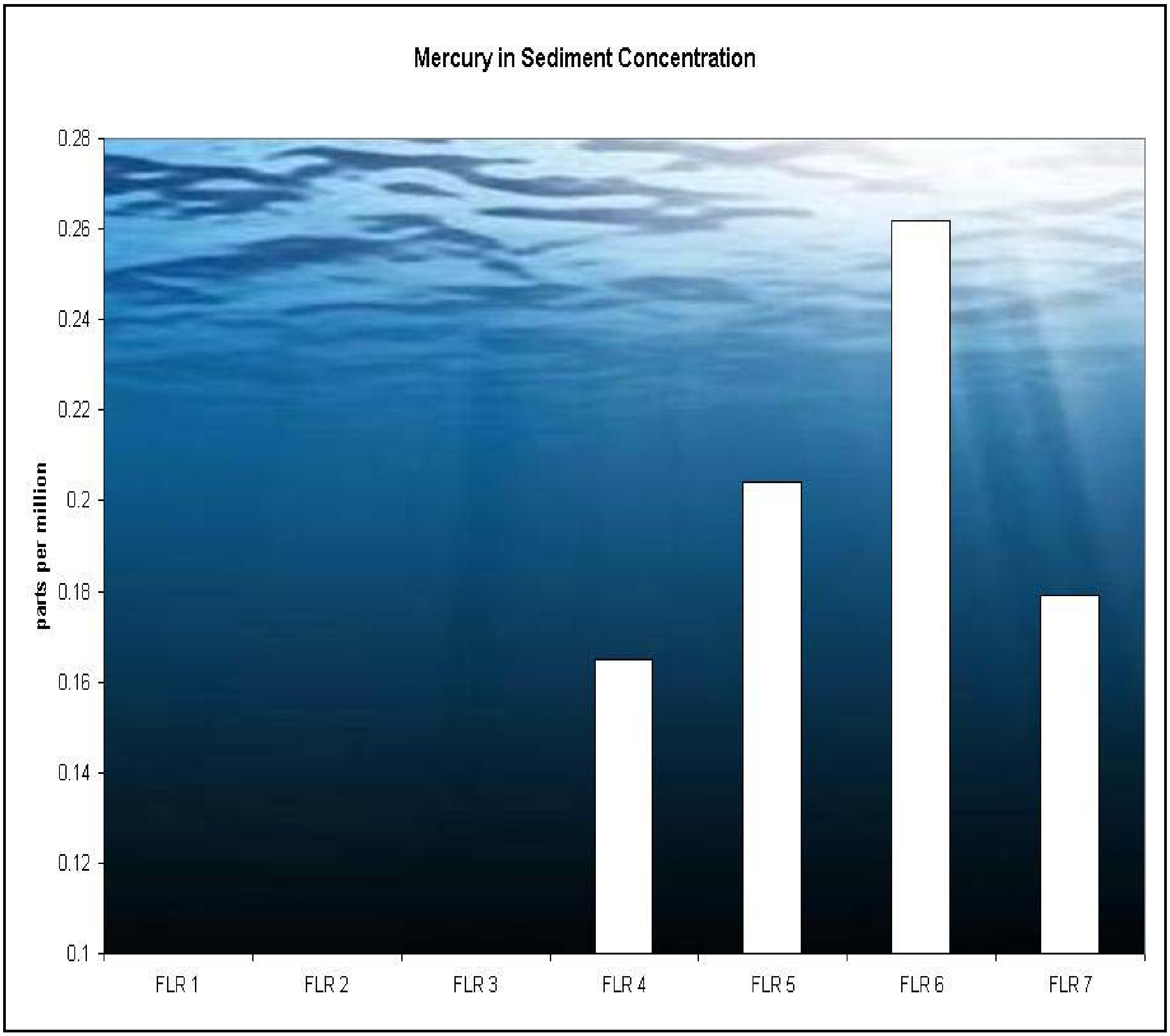
Lead

Lead, in sufficient concentrations, is a toxic metal to both plant and animals. This toxicity is correlated to the lead's solubility, which depends on pH and water hardness. Lead finds its way to water bodies through runoff, industrial discharge, or, even through precipitation. Lead was detected in the sediment of all stations. None of the stations exhibited lead concentrations in excess of the ER – L.



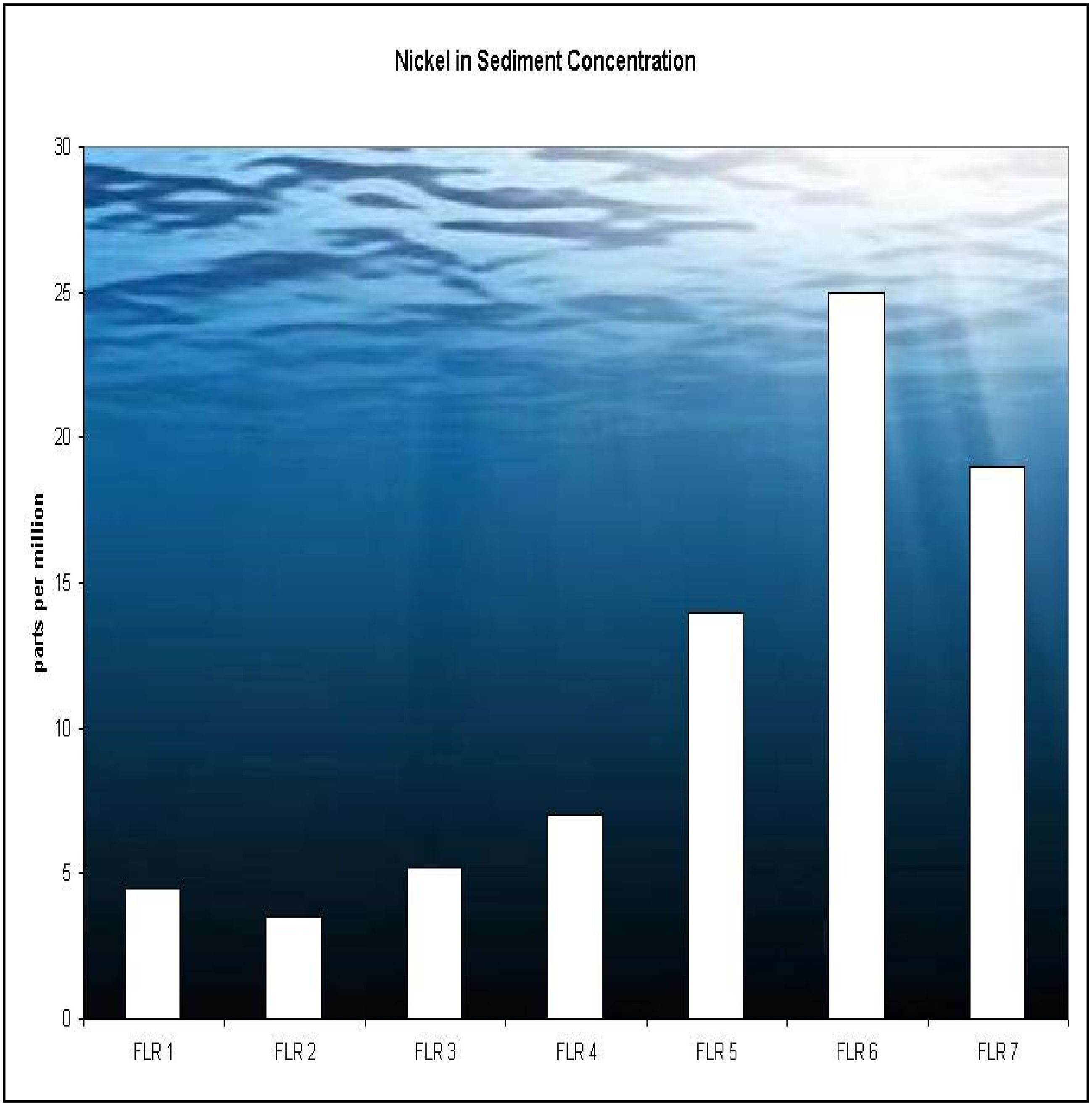
Mercury

Mercury is a toxic metal. It is not usually found in its free elemental state, but rather combined with other elements. Many of these mercury combinations are beneficial, but benefits aside, mercury has been identified as a bioaccumulative poison. Mercury's toxicity is dependent on its chemical form and the route of exposure. It is particularly pernicious in its methylated form. It is suspected that atmospheric deposition of mercury is the major route of that substance into the water. Fowl River appears on the Department's 303(d) list as a result of mercury impairment. Further, the Alabama Department of Public Health has issued a fish advisory for Fowl River Largemouth Bass (*micropterus salmoides*) as a result of mercury concentrations found within members of that species. Detectable concentrations of mercury were observed in the sediment of stations FLR 4, FLR 5, FLR 6, and FLR 7. The mercury concentrations observed at these four stations exceeded the ER-L but were well below the ER-M.



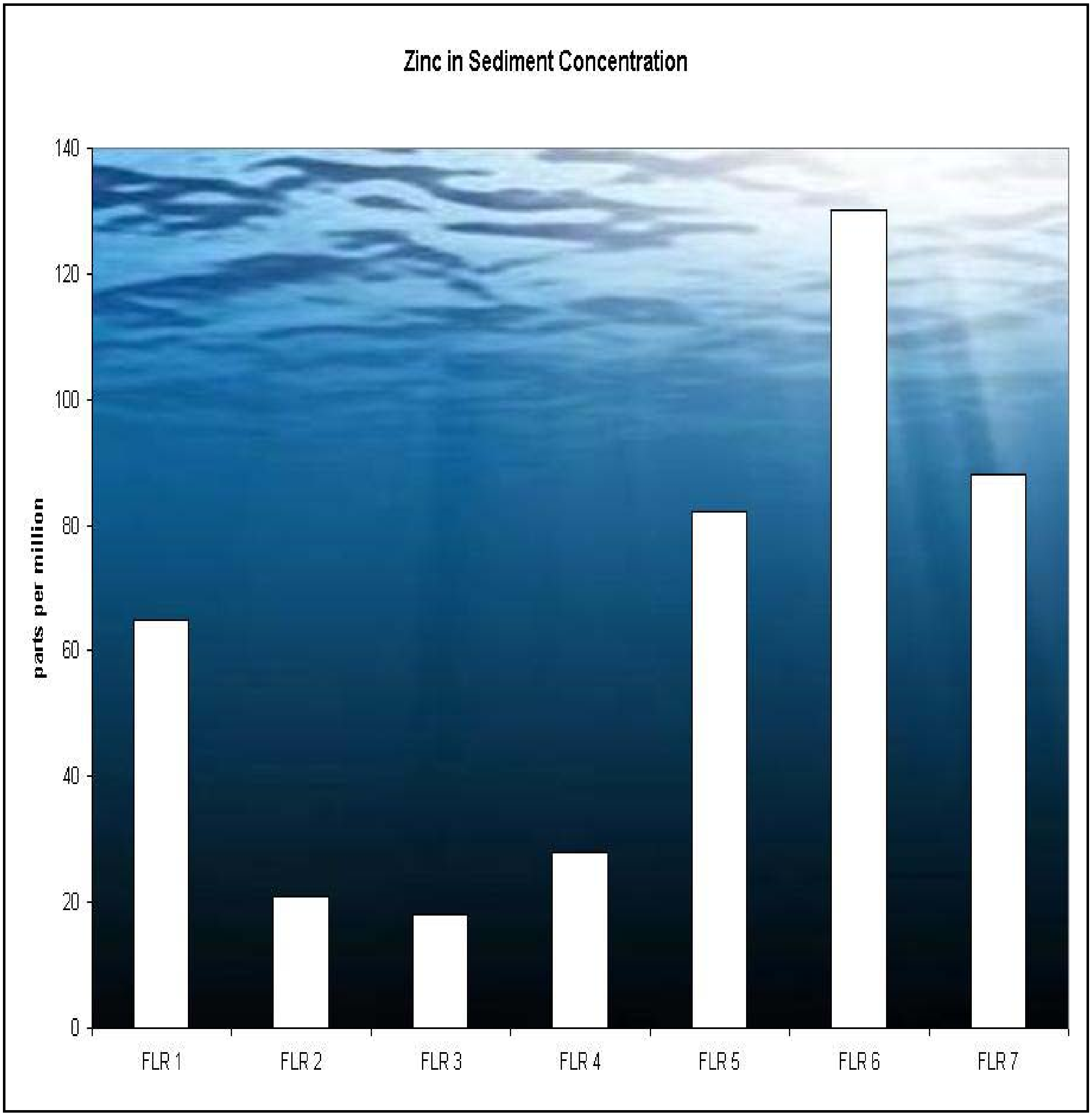
Nickel

Nickel is a hard, corrosion resistant metal that shares many properties in common with iron and cobalt. It occurs naturally in the earth's crust, generally coupled with other elements. It is also present in meteorites. Certain nickel species produce deleterious health effects in living organisms and some of the nickel forms are suspected carcinogens. Nickel was detected in the sediment of all stations. With the exception of FLR 6, all of the nickel concentrations were below the ER-L. All of the observed concentrations were below the ER-M for nickel.



Zinc

Zinc is a metal used in the production of a number of useful alloys. It is found in many minerals. It is an essential element for many organisms. Zinc is not considered very toxic to humans or other organisms. It may be present in a water body naturally or through deposition from discharge or runoff. Since it is used in the vulcanization of rubber, high concentrations of zinc are not uncommon around roadways. Zinc was detected in the sediment of all stations. None of the stations sediments exhibited zinc concentrations in excess of the ER-L.



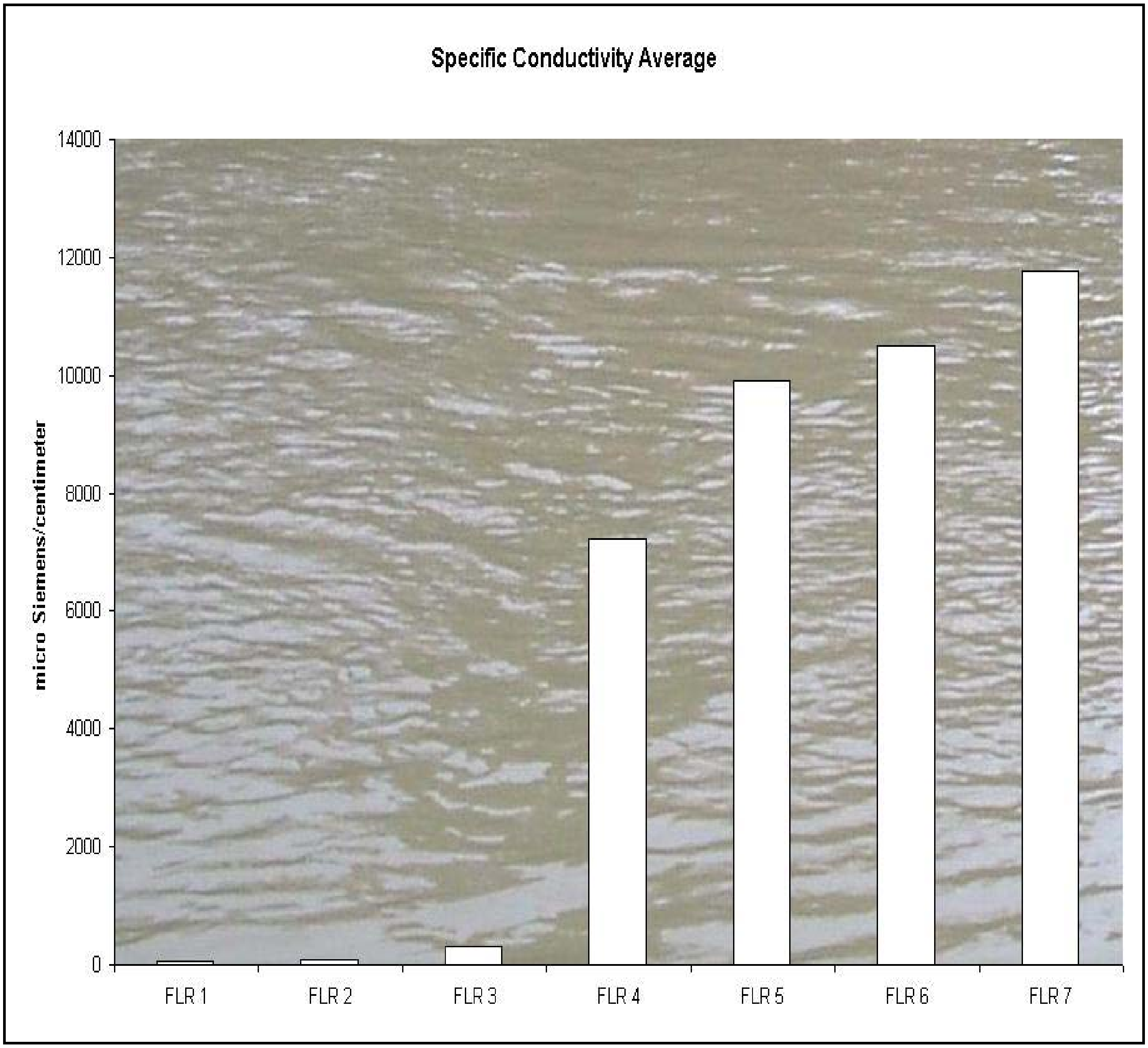
Specific Conductivity

Conductivity is a measure of water's ability to conduct electricity. More specifically, it is a measure of the ionic activity and content within water. Generally, the higher the ionic concentration within water, the higher the conductivity. Temperature, however, has a pronounced effect upon conductivity values. For this reason, specific conductivity (conductivity normalized to a temperature of 25^0 C) is often used in comparative water quality studies. Specific conductivity can be a good measure of total dissolved solids and salinity. It can not, however, provide information on the type of or individual concentrations of ions present. The list of ionic forms that may be present in water and which effect water's conductivity is a long one. The list includes such ions as calcium, magnesium, sodium, potassium, sulfate, chloride, bicarbonate, nitrogen, phosphorous, iron and others. Specific conductivity values are useful as indicators of potential water quality problems. Low values generally indicate low nutrient, high quality waters, while high values suggest nutrient rich waters. Also, sudden changes in specific conductance values may be an indicator of a pollutant discharge. It should be observed, however, that higher specific conductance values are the norm in tidally influenced waters and are not, necessarily, indicators of pollutant stress, but, rather, reflect the increased ionic activity associated with saline inflow.

The inserted table presents the average values for specific conductivity for all stations. For the deeper, tidally influenced stations, the values represent the average of all specific conductivity readings taken along the water column from top to bottom. Throughout the study, the highest specific conductivity values were found, predictably, at the boat stations. Tidal influence had a measurable effect upon these values. Rising specific conductivity values correlated positively with salinity values, with the highest values for both salinity and specific conductance generally occurring nearer the bottom than the surface.

			FLR 1	FLR 2	FLR 3	FLR 4	FLR 5	FLR 6	FLR 7
Sp. Cond.		Average	63	90	301	7239	9909	10498	11782
uS/cm		Maximum	86	191	1940	29080	28650	25420	26450
		Minimum	41	36	31	29	277	799	1440

Station FLR 1 had the lowest average specific conductivity values among all stations. Station FLR 7 had the highest average specific conductivity. The lowest single event specific conductivity value recorded was at station FLR 4 and the highest single event specific conductivity value recorded was at station FLR 5.



REVIEW AND CONCLUSIONS

A review of the data collected during the interval of this study indicates that the Fowl River sub watershed is not severely impacted by any of the monitored pollutants. The sub watershed appears to be free from the stress of multiple point source discharges. Fowl River is on the Department's §303(d) list for mercury impairment. Substantial concentrations of mercury were not observed during this study. Wildlife, both plant and animal, thrive in the sub watershed. Wading birds are a common sight within the sub watershed and are indicators of a healthy ecosystem. Apart from elevated fecal coliform bacteria concentrations encountered during the study, general water quality within the sub watershed may be considered acceptable to good. It may be concluded that rainfall has a substantial influence on the water quality within the sub watershed, particularly those rain events discharging significant volumes of precipitation over short periods. Fecal coliform bacteria concentrations tend to elevate during and following rain events, as do suspended solids. It is expected that increasing the amount of impervious surface cover within the sub watershed will only exacerbate these effects. Trash deposited by passing motorists was a problem within the sub watershed, if only for aesthetic reasons. It is certain, however, that such trash was no benefit to the water quality. An enhanced awareness of environmental concerns and civic duty might reasonably be expected to deter individuals from depositing their trash in such a manner. It is hoped that, with the passage of time, such activities will decline and, ultimately cease. As the volume and frequency of traffic within the sub watershed will only increase with time, continued littering will, most certainly, have a negative impact on the water quality.

LIST OF ACRONYMS AND ABBREVIATIONS

ADEM -	Alabama Department of Environmental Management
ADPH -	Alabama Department of Public Health
BOD_5 -	5 day biochemical oxygen demand
FLR -	Fowl River Watershed
^0C -	degrees Celsius/centigrade
CBOD -	carbonaceous biochemical oxygen demand
cfs -	cubic feet per second
DO -	dissolved oxygen
EPA -	Environmental Protection Agency
^0F -	degrees Fahrenheit
mgd/MGD -	million gallons per day
mg/l -	milligrams per liter
NPDES -	National Pollutant Discharge Elimination System
NPS -	non point source

NTU -	Nephelometric turbidity unit
P -	phosphate
ppb -	parts per billion
ppm -	parts per million
ppt -	parts per thousand
s.u. -	standard units
TKN -	total Kjeldahl nitrogen
TRC -	total residual chlorine
USEPA -	United States Environmental Protection Agency
USGS -	United States Geological Survey
uS/cm -	micro Siemens per centimeter
WWTP -	wastewater treatment plant

DEFINITIONS OF TERMINOLOGY

Aquifer -	a water bearing stratum of sand, gravel, or permeable rock
Geometric Mean -	an average value calculated from no less than five (5) samples collected at a given station over a 30-day period at intervals not less than 24 hours
Impervious surface -	any material that prevents the infiltration of water into the soil
Non-point source -	pollutant introduction from spatially separate origins such as pollution arising from runoff during rain events
Point source -	pollutant introduction from a specific outlet
Potentiometric surface -	a surface of potential, or hydraulic head, for an aquifer
Sample –	physical evidence collected from a facility, site, or from the environment

Terrigenous - relating to ocean sediment derived directly from the destruction of rocks on the earth's surface

Watershed - a geographical area from which water drains along common paths. The area is bounded by topographical or other features that contain or otherwise direct the flow of water falling within the watershed.

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APPENDIX

FIELD PARAMETERS

FLR 1

30^0 33.31'
88^0 14.08'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Turbidity ntu
10/25/2004	920	23	26	78	7.73	0.04	5.62	4.1
11/22/2004	920	20	26	54	8.48	0.02	6.81	18.9
12/6/2004	945	17.4	25	80	7.49	0.04	5.71	14.5
12/27/2004	950	8.9	9	68	10.31	0.03	5.42	2.9
1/10/2005	925	17.3	22	68	6.47	0.03	6.22	3.2
2/3/2005	1250	12.3	13	54	8.94	0.02	6.16	8.4
2/14/2005	1040	16.2	23	55	7.67	0.02	5.8	5
3/16/2005	850	16.8	17	53	8.54	0.02	5.27	10.8
3/31/2005	1205	20.8	23	68	2.52	0.03	6.26	3
4/26/2005	930	17.9	25	51	8.67	0.02	6.17	43.5
5/12/2005	825	21.4	26	66	11.64	0.03	5.4	4.1
5/25/2005	950	24.2	26	60	nm	0.03	5.68	5.4
6/7/2005	935	23.1	30	55	5.74	0.02	5.53	16.3
7/7/2005	850	24.2	26	41	8.98	0.02	6.89	31.8
8/4/2005	935	24.7	33	65	5.43	0.03	5.32	6.5
9/20/2005	1030	25.4	33	73	3.54	0.03	6	17.7
10/11/2005	1417	20.1	31	68	4.18	0.03	5.7	2.8
11/17/2005	915	14.7	9	63	7.64	0.03	5.06	2.2
12/6/2005	905	13.2	9	72	10.05	0.03	6.53	5.4
1/11/2006	830	17	18	63	7.38	0.03	7.25	2.9
1/26/2006	905	13.6	14	62	7.39	0.03	5.32	2.4
2/14/2006	950	11.2	21	59	9.86	0.03	5	3.6
2/23/2006	900	18.9	18	59	6.06	0.03	5.11	2.9
3/16/2006	810	16.6	19	62	6.52	0.03	6.19	2.6
3/29/2006	800	17.5	20	66	9.06	0.03	5.48	2.3
4/19/2006	825	22.4	28	55	5.7	0.02	6.74	3.3
4/27/2006	835	20.8	22	57	6.65	0.03	7.45	6.8
5/8/2006	835	22.4	24	56	6.46	0.03	7.27	3.3
5/31/2006	1010	24.4	32	60	6.51	0.03	6.08	3
6/26/2006	930	23.8	31	62	7.87	0.03	7.26	3.7
7/19/2006	1040	25.7	35	86	7.47	0.04	8.03	3.2

FLR 2

30^0 30.13'
88^0 09.44'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Turbidity ntu
10/25/2004	1040	23.4	28	82	5.33	0.04	5.92	3.2
11/22/2004	950	19.4	26	62	6.75	0.03	6.3	4.2
12/6/2004	1030	17.5	26	74	3.47	0.03	5.7	17.1
12/27/2004	1015	7.3	13	66	10.09	0.03	5.56	3.8
1/10/2005	955	15.8	21	71	8.13	0.03	5.8	5.7
2/3/2005	1210	12	13	45	7.22	0.02	5.92	9.8
2/14/2005	1010	14.3	21	65	7.21	0.03	5.26	8.6
3/16/2005	930	15.4	18	65	6.51	0.03	5.21	15.8
3/31/2005	1145	19.5	24	78	6.53	0.04	6.39	4.8
4/26/2005	100	17.3	26	65	6.93	0.03	5.74	14.8
5/12/2005	850	21.1	26	81	10.05	0.04	5.48	5.4
5/25/2005	1020	23.3	30	85	nm	0.04	5.85	4.4
6/7/2005	955	22.1	33	44	4.22	0.02	5.5	15.7
7/7/2005	925	23.4	29	36	6.32	0.02	5.53	9.1
8/4/2005	1020	24.4	33	78	5.22	0.04	5.53	3.4
9/20/2005	1105	23.3	35	101	1.42	0.05	5.68	3.9
10/11/2005	1349	19.2	29	98	5.71	0.05	5.94	2.6
11/17/2005	955	14.7	9	101	5.43	0.05	5.43	3.7
12/6/2005	935	12	9	129	8.95	0.06	5.36	11.9
1/11/2006	900	15.1	18	95	6.03	0.04	5.31	2.6
field duplicate	910	15.1	18	95	5.81	0.04	5.33	2.6
1/26/2006	930	10.8	14	96	8.59	0.05	5.12	1.8
2/14/2006	1015	8.4	18	90	9.8	0.04	4.94	3.5
2/23/2006	930	17.3	20	90	6.56	0.04	5.13	2.7
3/16/2006	840	14.3	19	92	6.85	0.04	5.77	3.8
3/29/2006	830	15.3	20	83	6.68	0.04	5.4	3.2
4/19/2006	955	23.1	30	82	4.11	0.04	6.09	5.8
4/27/2006	900	18.3	22	89	6.16	0.04	5.92	5.1
5/9/2006	900	20.6	27	101	7.12	0.05	7.28	4.1
5/31/2006	935	25.4	32	90	6.19	0.04	6.19	2.1
6/26/2006	1000	26.8	33	149	5.09	0.07	6.59	3.6
7/19/2006	1105	26.7	36	190	2.35	0.09	5.72	5.6
field duplicate	1110	26.7	36	191	2.35	0.09	5.72	5.8

FLR 3

30^0 27.78'
88^0 09.33'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Turbidity ntu
10/25/2004	1000	23.3	28	390	6.11	0.19	5.43	1.9
11/22/2004	1010	20.6	27	71	8.28	0.03	6.05	2.5
12/6/2004	1055	17.1	26	46	8.08	0.02	5.87	15.8
12/27/2004	1040	8.1	14	62	10.61	0.03	5.7	3.3
1/10/2005	1020	16.6	21	69	8.11	0.03	5.96	3.6
2/3/2004	1105	12.2	12	47	9.02	0.02	6.21	11.7
2/14/2005	940	15.9	22	53	7.93	0.02	5.53	8.3
3/16/2005	1000	16.4	17	58	7.86	0.03	5.65	10.2
Field Duplicate	1003	16.4	17	58	7.79	0.03	5.64	10.2
3/31/2005	1025	18.7	27	62	7.21	0.03	6.61	3.3
4/26/2005	1030	18.4	28	58	8.47	0.03	5.98	4
5/12/2005	915	22.8	27	59	10.66	0.03	5.78	5.1
5/25/2005	1100	25.2	31	62	nm	0.03	6.06	3.5
6/7/2005	1030	23.5	33	46	6.04	0.02	5.67	21.3
7/7/2005	1000	24.1	31	31	7.75	0.01	5.54	11.7
8/3/2005	1200	24.6	33	55	5.53	0.02	6.71	10.5
9/21/2005	1230	23.9	36	467	3.16	0.22	5.77	10
10/11/2005	1107	18.2	28	385	4.1	0.18	6.09	1.6
11/17/2005	1335	16.5	14	1235	9.37	0.62	7.94	2
12/6/2005	1155	13.2	10	538	13.6	0.26	7.8	10.4
1/10/2006	1200	14.7	21	537	8.26	0.26	8.03	1.9
1/26/2006	1200	14.2	14	403	9.34	0.19	7.42	1.3
2/16/2006	1020	14.4	20	80	9.24	0.04	7.06	2.3
2/23/2006	1040	18.2	20	80	8.06	0.04	5.46	2.2
3/15/2006	1150	20.8	22	78	7.3	0.04	7.3	2
3/28/2006	1050	16.5	24	69	9.73	0.03	8.12	1.8
4/19/2006	1055	25.3	29	132	8.21	0.06	7.83	2.1
4/27/2006	930	20.8	24	87	6.6	0.04	5.4	8.4
5/9/2006	935	23	29	1245	7.2	0.62	5.4	5.3
5/31/2006	910	25.6	30	272	8.79	0.13	6.47	3
6/26/2006	1030	26.5	34	1940	8.41	0.98	5.91	29.9
7/19/2006	1145	26.7	36	871	6.8	0.42	5.77	2.3

FLR 4

30^0 27.47'
88^0 08.92'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
10/26/2004	1025	23.9	29	1760	4.03	0.89	7.14		2.6	surface
		24	29	22710	0.25	13.7	6.29			10.7
		24.1	29	25450	0.3	15.5	6.05			21.3
11/23/2004	1140	20.4	27	277	5.62	0.13	6.96	0.7	16.9	surface
		19.7	27	316	5.09	0.16	7.01			10.8
		23.9	27	22110	1.16	12.8	5.66			21.5
12/7/2004	1130	18.1	24	54	6.32	0.02	5.02	0.8	7.5	surface
		17.7	24	56	6.46	0.03	5.07			11.1
		17.7	24	69	7.26	0.03	5.25			22.2
12/28/2004	1100	9	12	72	9.94	0.03	5.15	2	3.7	surface
		8.3	12	77	10.54	0.04	5.5			9.7
		8.3	12	81	10.63	0.04	5.59			19.3
1/11/2005	1145	18.7	21	130	7.54	0.06	6.88	1.3	5.5	surface
		17.4	21	109	7.58	0.05	7.15			9.7
		17.3	21	152	8.04	0.07	6.71			19.4
2/3/2004	1035	12.5	12	64	8.48	0.03	6.47	0.8	12.9	surface
		12.5	12	65	8.48	0.03	6.62			10.9
		12.5	12	65	8.53	0.03	6.94			21.9
2/15/2005	1110	17.3	24	61	7.15	0.03	6.91	1.1	9.9	surface
		15.3	24	99	7.56	0.05	7.07			10.8
		14.3	24	194	7.74	0.09	7.21			21.6
3/17/2005	1115	15.1	13	93	8.91	0.04	7.46	0.7	14.7	surface
		15.1	13	123	8.47	0.06	7.78			12
		16.4	13	6453	6.36	3.54	6.27			24
3/31/2005	955	20.4	28	171	7	0.08	7.07	1	6.5	surface
		18.3	28	93	7	0.04	7.35			10.5
		18.2	28	91	7.13	0.04	7.62			21
4/28/2005	1005	19.5	27	86	6.09	0.04	6.24	0.7	13.1	surface
		18.7	27	72	5.86	0.03	6.44			12.5
		18.7	27	75	6.04	0.03	6.86			25
5/11/2005	1105	24.7	28	86	14.2	0.04	6.91	0.9	6.5	surface
		21	28	86	11.7	0.04	7.27			12.6
		20.9	28	122	12.7	0.06	7.59			25.2

FLR 4

30^0 27.47'
88^0 08.92'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
field duplicate	1108	24.7	28	86	14.4	0.04	6.85	0.9	6.5	surface
		21	28	97	12.1	0.04	6.88			12.6
		20.9	28	135	13.4	0.06	7.21			25.2
5/26/2005	1220	26.9	33	690	6.05	0.33	6.97	1.2	2.4	surface
		25	33	902	4.1	0.44	7.07			12.3
		22.5	33	2047	1.91	1.03	7.19			24.5
6/8/2005	1050	24.1	32	153	4.63	0.07	7.3	0.7	14.3	surface
		23.1	32	56	4.85	0.02	7.76			13.5
		23.1	32	55	5.36	0.02	8.31			27
7/7/2005	1050	24.2	33	29	6.76	0.01	5.24	0.5	27.1	surface
		24.2	33	29	6.74	0.01	5.23			13
		24.1	33	29	6.83	0.01	5.29			26
8/3/2005	1130	26	32	120	5.38	0.06	6.64	1.1	3.9	surface
		24.7	32	64	4.81	0.03	6.92			14
		24.7	32	65	4.91	0.03	7.26			28
9/21/2005	1200	25.5	35	2357	4.45	1.2	6.44	1.2	13	surface
		26.3	35	20015	0.35	11.91	6.74			13
		26	35	20270	0.44	12.08	6.8			25.9
10/11/2005	1041	20.7	27	2396	5.33	1.24	6.72	1.3	2.9	surface
		25	27	25951	0.43	15.84	6.76			12.4
		25	27	29080	0.32	17.95	7.1			24.8
11/17/2005	1255	17.7	12	5454	6.27	2.96	7.49	1.7	2.3	surface
		22.7	12	24600	2.84	14.97	7.06			9.8
		21.7	12	27820	2.63	17.13	7.05			19.6
12/6/2005	1130	14.7	9	3920	6.77	2.08	7.63	0.7	7.9	surface
		18.3	9	25350	1	15.52	6.93			9.8
		17.9	9	27760	1.85	17.12	6.87			19.6
1/10/2006	1125	14.5	20	2710	4.24	1.46	8.06	2.1	1.9	surface
		17.4	20	19580	0.96	11.7	7.22			12.1
		19.1	20	26480	0.77	16.26	7.09			24.1
1/26/2006	1120	14.6	15	1494	6.77	0.76	7.32	2.6	1.7	surface
		16.5	15	16190	1.19	9.52	6.54			10.9
		18.5	15	23820	1.22	15.13	6.27			21.7

FLR 4

30^0 27.47'
88^0 08.92'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
2/16/2006	950	13.1	19	195	8	0.09	7.35	1.4	2.6	surface
		10.9	19	124	5.6	0.06	7.9			13
		18.5	19	22980	0.91	13.91	5.4			26
2/23/2006	1110	16.8	21	535	6.25	0.26	6.65	1.9	2.3	surface
		14.4	21	5213	3.56	2.82	5.72			12.2
		18.1	21	23450	1.3	14.24	4.89			24.4
3/15/2006	1120	20.9	20	167	5.23	0.08	7.76	1.9	2.3	surface
		20.3	20	993	3.79	0.49	7.34			11
		17.6	20	18580	0.92	11.05	6.3			22
3/28/2006	1020	18.1	23	430	7.19	0.21	8.17	2.1	1.8	surface
		16	23	274	4.41	0.13	8.82			11.6
		18.7	23	24010	2.79	14.6	6.68			23.2
4/19/2006	1030	25.1	29	1138	6.03	0.56	7.62	2.1	1.8	surface
		22.6	29	6099	3.67	3.32	7.16			13
		19	29	22320	2.14	13.49	6.68			26
4/26/2006	1145	22.9	21	1890	8.24	0.96	7.08	0.9	5.8	surface
		24.2	21	12560	6.23	7.2	6.47			11
		23.6	21	12800	6.04	7.35	6.43			22
5/10/2006	950	23.3	27	1456	4.45	0.74	7.62	1	5.4	surface
		23.4	27	9810	0.78	5.53	7.06			12
		23.1	27	1086	1.93	6.17	7.06			24
5/30/2006	1055	28.8	32	3654	6.48	1.91	7.3	1.4	1.8	surface
		25.3	32	13130	1.44	7.54	6.94			12.7
		24.6	32	14240	1.7	8.24	6.96			25.4
6/27/2006	1035	28.2	33	6703	6.38	3.75	7.38	1.3	6.2	surface
		29.8	33	22120	0.41	13.23	7.08			11.4
		29.4	33	23220	1.68	13.96	7.08			22.8
7/18/2006	1105	27.7	35	5024	4.47	2.68	7.85	1.5	2.4	surface
		30.3	35	24650	2.83	14.89	7.24			11.4
		30.2	35	24790	3.03	14.96	7.32			22.8

FLR 5

30^0 25.11'
88^0 08.30'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
10/26/2004	1115	26	28	15330	7.38	8.93	6.52		3.3	surface
		26.5	28	19640	4.77	11.67	6.23			2.7
		26.3	28	19890	5.11	11.83	5.98			5.3
11/23/2004	1205	22	27	4652	6.37	2.49	6.39	0.7	11.6	surface
		21.7	27	4814	4.96	2.58	6.31			2.6
		21.5	27	5208	4.66	2.82	6.06			5.1
12/7/2004	1155	18.3	23	1396	7.19	0.7	6.11	0.8	9.6	surface
		18.1	23	1479	6.08	0.74	6.06			3.1
		17.4	23	2096	3.34	1.07	5.16			6.2
12/28/2004	1135	9	15	1237	11.4	0.62	5.86	1	8.4	surface
		9	15	1283	11.42	0.64	6.05			2.6
		8.6	15	1282	10.01	0.65	6.1			5.2
1/11/2005	1115	19.4	23	4488	6.09	2.41	6.85	1.3	5.1	surface
		19.3	23	4614	8.22	2.48	6.85			2.5
		18.8	23	5521	6.34	3	6.79			5
2/3/2005	1005	12.6	12	759	8.87	0.38	7.05	1	7.3	surface
		12.6	12	866	8.85	0.43	7.07			2.3
		12.6	12	1016	8.66	0.51	7.23			4.6
2/15/2005	1010	16.7	23	3709	6.8	1.97	6.81	1.3	4.6	surface
		15	23	7447	0.54	4.13	6.71			3
		15	23	7451	0.66	4.13	6.33			5.9
3/17/2005	1010	14.8	13	2781	10.27	1.45	6.82	0.7	10.5	surface
		14.8	13	2956	9.38	1.55	6.82			5.6
		16.9	13	6038	6.33	3.31	6.48			5.1
3/31/2005	930	21.3	27	5648	8.04	3.07	7.03	1.1	5.8	surface
		20.8	27	5885	7.15	3.2	7.02			3.1
		20.3	27	7072	7.41	3.88	7.02			6.2
4/28/2005	925	21.8	26	1043	10.35	0.52	6.69	0.8	12.2	surface
		21.1	26	1185	6.9	0.59	6.55			3
		21.2	26	1088	8.51	0.54	6.55			6
5/11/2005	1200	25.9	29	2572	8.76	1.32	6.46	0.9	8.3	surface
		24.3	29	3620	8.04	1.9	6.31			3.4
		23.3	29	4840	0.74	2.59	5.94			6.7

FLR 5

30^0 25.11'
88^0 08.30'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
5/26/2005	1150	28	32	10150	7.3	5.7	6.86	1	5.6	surface
		28	32	13120	5.91	7.79	6.72			3.4
		27.7	32	14490	4.16	8.38	6.7			6.8
6/8/2005	1025	28.2	33	7356	5.82	4.03	6.96	0.9	4.9	surface
		28	33	8079	1.09	4.46	6.81			3.4
		27.9	33	8009	1.22	4.42	6.81			6.8
7/7/2005	1115	27.1	34	683	7.8	0.33	5.47	0.7	9.7	surface
		24.8	34	697	7.32	0.34	5.61			3.1
		25.4	34	1260	7.02	1.24	5.12			6.2
8/3/2005	1100	28.9	32	1886	5.52	0.95	7.01	0.6	8.8	surface
		28.6	32	1830	5.15	0.92	7.06			3.5
		28.6	32	2135	1.42	1.08	6.98			7
9/21/2005	1115	28.5	33	14824	8.43	8.57	7.63	0.7	14	surface
		28.4	33	15015	8.42	8.69	7.59			3
		29.3	33	19144	0.7	11.31	6.92			5.9
10/11/2005	1017	22.1	25	12335	8.01	7.07	7.29	0.7	6.1	surface
		22.1	25	12347	7.88	7.09	7.29			2.9
		23	25	18823	0.45	11.18	7.04			5.8
11/17/2005	1210	16.8	13	26230	9.49	16.12	7.14	0.7	11.4	surface
		16.8	13	26670	8.83	16.34	7.08			1.8
		17.3	13	22330	2.97	13.33	6.99			3.7
12/6/2005	1240	14.4	10	22170	11.71	13.38	6.89	0.5	4.1	surface
		14.4	10	22810	11.57	13.83	6.8			2
		14.6	10	23720	11.39	14.43	6.63			4
1/10/2006	1050	15.2	19	14360	6.83	8.36	7.67	2.1	1.9	surface
		15	19	16740	6.68	9.88	7.61			1.7
		14.9	19	20580	6.36	12.34	7.35			3.4
1/26/2006	1050	14.4	13	7900	9.58	4.4	6.6	0.7	9.4	surface
		14.4	13	7895	9.76	4.4	6.6			1.5
		14.4	13	7895	10.82	4.4	6.62			3
2/16/2006	920	14.5	18	5280	10.17	2.86	5.21	0.7	8.3	surface
		13.6	18	6937	10.03	3.82	4.91			2.3
		13.1	18	7472	9.82	4.14	4.61			4.6

FLR 5

30^0 25.11'
88^0 08.30'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
2/23/2006	1125	17.1	20	5150	8.84	2.79	6.08	0.7	9.4	surface
		17.1	20	5166	8.79	2.8	6.04			2.1
		17	20	6940	8.44	3.84	5.64			4.2
3/15/2006	1045	20	19	5062	8.04	2.73	6.87	0.6	10.9	surface
		20	19	5207	7.88	2.81	6.84			2.5
		19.9	19	5412	7.55	2.93	6.79			5
3/28/2006	955	17.1	22	6531	10.03	3.6	7.25	0.7	8.2	surface
		16.5	22	6830	9.11	3.77	7.16			2.7
		17.4	22	9195	8.19	5.18	6.98			5.3
4/19/2006	1010	26.1	28	8850	7.32	4.93	6.96	1	7	surface
		26.2	28	12720	5.5	7.28	6.77			3
		26.1	28	15430	3.42	8.98	6.67			6
4/26/2006	1115	25.1	21	12270	9.87	7.02	6.46	0.7	7.1	surface
		25.6	21	14220	8.93	8.22	6.36			2.9
		25.7	21	15320	7.34	8.9	6.15			5.8
5/10/2006	935	26.2	28	277	6.26	0.06	7.17	0.9	7.9	surface
		26.2	28	10820	5.22	6.2	7.17			3.6
		26.1	28	9849	0.82	5.53	7.12			7.2
5/30/2006	1035	29.8	31	14270	6.61	8.21	7.03	1	5.5	surface
		29.7	31	17120	6.09	10.02	6.87			3.2
		29.5	31	17840	2.31	10.45	6.86			6.4
6/27/2006	1015	29.2	31	26010	7.22	15.81	7.17	0.8	6.9	surface
		29.1	31	27500	6.45	16.81	7.12			3
		29	31	28650	5.75	17.59	7.07			6
7/18/2006	1035	31.2	35	24860	6.9	15	7.37	0.6	13.8	surface
		30.8	35	24890	5.92	15.03	7.35			2.7
		30.6	35	25100	6.26	15.15	7.42			5.4

FLR 6

30^0 26.21'
88^0 07.50'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
10/26/2004	1135	26.1	29	14120	7.31	8.18	6.98		3.5	surface
		26	29	18960	4.14	11.25	6.75			4.4
		25.8	29	20480	3.47	12.2	6.55			8.7
11/23/2004	1220	21.9	28	4226	7.64	2.25	6.85	0.8	9.6	surface
		21.5	28	4862	6.85	2.61	6.77			3.5
		21	28	5708	2.63	3.1	6.41			7
12/7/2004	1215	17.2	23	1056	7.36	0.53	6.8	1	9.6	surface
		17.1	23	1606	5.48	0.82	6.54			4.3
		16.7	23	3256	6.11	1.72	5.61			8.6
12/28/2004	1200	10.2	14	1207	10.45	0.61	6.46	0.9	7.5	surface
		9.2	14	1396	10.89	0.7	6.48			3.7
		9.3	14	3510	5.2	1.8	6.12			7.3
1/11/2005	1040	18.7	24	4026	8.17	2.14	6.93	1.3	5.6	surface
		18.2	24	4265	7.98	2.28	6.79			3.8
		18.1	24	4703	8.45	2.53	6.8			7.5
2/3/2004	950	12.5	11	5350	0.78	2.94	6.09	1	7.6	surface
		12.5	11	5944	1.13	3.25	5.99			3.5
		12.6	11	6151	3.74	3.37	5.83			6.9
2/15/2005	950	16.2	19	3089	9.03	1.62	6.64	1.2	4.9	surface
		15.9	19	6455	8.97	3.54	6.3			4.8
		14.4	19	11120	8.59	6.35	5.96			9.6
3/17/2005	955	15.3	14	6163	9.24	3.38	6.36	1	7.3	surface
		15.9	14	7438	4.15	4.07	6.21			3.3
		16.5	14	8102	5.9	4.52	6.04			6.5
3/31/2005	915	21	26	7931	7.92	4.35	6.98	0.9	9.3	surface
		20.7	26	10520	6.59	5.97	6.81			4.9
		20.5	26	10210	1.21	5.76	6.81			9.9
4/28/2005	910	20.9	26	1677	11.63	0.85	6.63	0.6	19.9	surface
		20.5	26	1924	10.57	0.98	6.55			4.4
		20.6	26	1880	9.84	0.95	6.65			8.8
5/11/2005	1035	25.2	28	6420	5.12	3.5	6.68	0.7	12.1	surface
		24.7	28	9389	4.11	5.26	6.39			4.8
		24.6	28	8222	0.82	4.56	6.27			9.5

FLR 6

30^0 26.21'
88^0 07.50'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
5/26/2005	1135	25.1	33	12340	7.31	7.06	6.67	0.6	18.9	surface
		24.9	33	12370	6.93	7.08	6.52			4.9
		25.2	33	10500	2.07	5.93	6.4			9.8
6/8/2005	1010	28.7	34	10370	6.86	5.82	6.86	0.8	10.7	surface
		28.4	34	10810	6.14	6.09	6.77			4.5
		28.1	34	9093	1.04	5.06	6.65			9
7/7/2005	1135	27.7	33	799	7.92	0.39	6.17	0.5	22.3	surface
		25.8	33	5011	5.95	2.69	6.04			4.6
		26.5	33	11740	1.31	6.68	5.75			9.2
8/3/2005	1025	28.3	30	3400	6.7	1.77	7.11	0.5	16.8	surface
		28.1	30	3672	6.38	1.92	7.07			4.9
		28.3	30	3110	0.91	1.56	6.93			9.9
9/20/2005	1055	28.3	32	15306	7.73	8.88	7.49	0.6	15	surface
		28.2	32	15362	7.58	8.92	7.43			3.6
		28.8	32	20015	0.81	11.87	6.99			7.2
10/11/2005	1000	22.5	25	10730	8.61	6.09	7.46	0.7	6.4	surface
		22.3	25	11575	7.56	6.61	7.33			4.2
		22.3	25	14254	0.45	8.27	7.11			8.3
11/17/2005	1135	17.9	12	21270	8.19	12.8	6.98	0.9	8.7	surface
		17.8	12	20350	1.83	12.2	6.84			2.4
		18	12	19830	4.07	11.86	6.8			4.8
12/6/2005	1050	14.5	9	19560	11.32	11.69	7.1	0.6	3.5	surface
		15.1	9	21700	10.75	13.13	7.02			3.4
		15.5	9	22230	8.98	13.4	6.91			6.8
1/10/2006	1030	14.8	19	16480	6.3	9.71	7.46	1.1	3.9	surface
		14.8	19	19880	4.32	11.87	7.21			3.9
		14.6	19	18280	4.35	10.96	7.1			7.8
1/26/2006	1035	14.2	13	8405	8.74	4.7	6.48	0.7	12.2	surface
		14.2	13	8454	7.72	4.74	6.45			3.5
		15.7	13	11720	4.57	6.72	6.27			7
2/16/2006	1105	15.1	23	5196	10.19	2.81	6.53	0.8	8.9	surface
		14.8	23	5430	9.88	2.94	6.21			4.4
		12.7	23	9215	7.23	5.19	5.6			8.8

FLR 6

30^0 26.21'
88^0 07.50'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
2/23/2006	1205	16.5	20	4821	8.42	2.6	6.43	0.5	18.9	surface
		16.3	20	4636	8.44	2.49	6.32			3.5
		16.2	20	4659	7.78	2.5	6.26			7
3/15/2006	1030	20.3	19	6145	8.01	3.36	6.71	0.5	17.9	surface
		20.1	19	6205	7.93	3.39	6.67			3.9
		19.8	19	6352	7.38	3.48	6.59			7.8
3/28/2006	935	17.5	23	6070	9.51	3.31	7.04	0.8	7.2	surface
		17.4	23	10450	8.38	4.94	6.7			3.9
		17.4	23	11040	8	6.29	6.59			7.8
4/19/2006	1000	25.6	28	9653	8.23	5.41	6.95	0.8	7.3	surface
		24.9	28	12560	7.63	7.2	6.75			4.9
		24.7	28	15410	2.6	9.03	6.62			9.8
4/26/2006	1100	25.8	21	10990	8.72	6.23	6.14	0.6	11.8	surface
		26	21	11310	8.78	6.42	6.06			4.8
		25.7	21	11670	8.82	6.64	5.94			9.7
5/10/2006	915	26	28	12570	6.84	7.19	7.2	0.8	8.7	surface
		25.8	28	14350	4.91	8.31	7.06			4.8
		25.9	28	12960	2.42	7.42	7.11			9.6
5/30/2006	1020	28.8	31	13190	6	7.55	7.05	0.6	12.8	surface
		28.6	31	13210	5.73	7.56	6.9			4.8
		28.7	31	12430	1.55	7.06	6.74			9.6
6/27/2006	1005	29	31	24460	6.92	14.78	7.11	0.6	11.4	surface
		28.6	31	24650	5.71	14.91	7.06			3.8
		28.5	31	22680	5.11	13.31	6.99			7.6
7/18/2006	1020	31.3	36	23670	7.19	14.23	7.4	0.7	9.1	surface
		31.1	36	24910	5.52	15.1	7.27			4.5
		31.5	36	25420	2.65	15.37	7.18			9

FLR 7

30^0 26.87'
88^0 06.61'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
10/26/2004	1155	26	30	13580	9.53	7.8	7.69		12.1	surface
		25.9	30	15520	6.2	9.04	7.3			4.6
		25.9	30	19290	0.5	11.46	6.96			9.1
11/23/2004	1235	22	28	7216	9.78	3.98	7.18	0.6	17.4	surface
		22	28	7232	9.05	3.99	6.95			2.6
		21.8	28	7318	4.28	4.04	6.72			7.2
12/7/2004	1235	17.8	25	1644	8.03	0.83	6.82	0.8	14.9	surface
		17.8	25	2185	7.68	1.14	6.69			4.8
		17.7	25	3524	1.69	1.85	6.69			9.6
12/28/2004	1220	8.8	15	3541	0.58	1.85	6.7	1	9.7	surface
		8.7	15	4720	0.73	2.53	6.51			4.4
		8.6	15	4816	3.29	2.59	6.37			8.8
1/11/2005	1020	17.8	23	2780	3.14	2.8	5.55	1.1	6.5	surface
		18	23	5570	2.38	3.05	5.99			4.1
		17.9	23	5710	4.3	3.27	6.1			8.2
2/3/2005	925	12.4	10	5720	7.93	3.12	5.79	1.1	7.4	surface
		12.4	10	5984	6.85	3.26	5.7			4.5
		12.5	10	6227	4.16	3.41	5.25			9
2/15/2005	930	16	17	6142	8.5	3.36	5.73	0.7	11.3	surface
		15.2	17	6750	4.58	3.72	5.4			4
		15.1	17	8588	4.87	4.8	4.81			8
3/17/2005	925	15.4	12	7523	10.21	4.18	5.12	0.8	8.1	surface
		15.4	12	7528	10.4	4.18	5.32			2.9
		15.7	12	8130	10.3	4.57	5.73			5.9
3/31/2005	850	20.5	25	11750	8.63	6.71	6.68	0.5	18.2	surface
		20.5	25	12280	8.46	7.04	6.52			3.6
		20.5	25	11110	8.12	6.23	6.04			7.1
4/28/2005	850	20.1	28	3995	9.28	2.12	5.88	0.4	27.9	surface
		20.2	28	3760	8.24	1.99	5.76			4.2
		20.2	28	3613	6.64	1.91	5.46			8.4
5/11/2005	1015	24.6	26	12530	4.06	7.18	5.62	0.6	12.4	surface
		24.6	26	12580	4.13	7.22	5.94			3.6
		24.4	26	10510	1.45	5.94	6.15			7.1

FLR 7

30^0 26.87'
88^0 06.61'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
5/26/2005	1115	25.6	32	12280	7.69	7.02	6.16	0.7	19.1	surface
		25.5	32	12280	7.57	7.02	6.84			5.4
		25.5	32	12100	7.24	6.91	6.45			10.7
6/8/2005	945	28.7	34	9840	7.63	5.5	6.77	0.9	8.8	surface
		28.7	34	9871	7.35	5.52	6.46			6
		28.4	34	9917	3.75	5.55	5.84			12.1
7/7/2005	1155	27.7	34	1440	8.44	0.72	7.21	0.4	21.4	surface
		26.8	34	15360	9.17	8.92	6.48			6
		26.8	34	12920	1.48	7.39	6.26			12
8/3/2005	1000	28.3	29	4113	6.84	2.17	6.5	0.6	16.8	surface
		28.4	29	4135	6.83	2.18	6.36			6.1
		28.4	29	5729	2.3	1.94	5.68			12.2
9/21/2005	1005	28.9	30	18236	6.45	10.74	7.47	0.5	19	surface
		28.9	30	18306	6.1	10.77	7.49			5.1
		29.1	30	19215	1.32	11.35	7.14			10.2
10/11/2005	934	21.9	22	13086	8.64	7.53	7.85	0.6	11.1	surface
		21.9	22	13811	7.29	7.99	7.81			5.5
		22.3	22	16217	0.62	9.51	7.22			11
11/17/2005	1105	17	11	23260	9.14	14.1	6.58	0.7	11.8	surface
		17	11	23380	8.67	14.2	6.46			2
		17	11	22480	6.44	13.06	6.22			4
12/6/2005	1025	14.5	9	22340	11.59	13.51	6.34	0.4	7.9	surface
		14.7	9	22470	7.66	13.59	5.82			4.2
		14.5	9	20270	8.25	12.08	5.42			8.3
1/10/2006	1005	14.6	19	18780	6.85	11.18	6.96	0.9	11.1	surface
		14.7	19	19760	5.22	11.84	6.68			4.5
		14.7	19	19610	4.79	11.72	6.52			8.9
1/26/2006	1010	13	14	7158	8.72	3.96	5.54	0.5	11.4	surface
		13.4	14	6852	5.72	3.78	5.41			3.5
		13.5	14	6762	8.07	3.73	5.16			7
2/16/2006	1125	14.8	22	8508	9.56	4.77	7.15	0.5	21.4	surface
		14.3	22	8261	9.23	4.62	7.03			5.1
		13.9	22	8185	3.52	4.57	6.51			10.2

FLR 7

30^0 26.87'
88^0 06.61'

Date dd/mm/yy	Time	H_20 Temp. ^0C	Air Temp. ^0C	Sp. Cond. uS/cm	D.O. ppm	Salinity ppt	pH s.u.	Secchi Depth m	Turbidity ntu	Depth feet
2/23/2006	1225	14.7	19	11490	7.36	6.57	6.71	0.9	9.4	surface
		14.5	19	11690	6.58	6.69	6.45			4.7
		13.5	19	10010	3.23	5.69	6.26			9.4
3/15/2006	950	18.1	17	6692	1.48	3.68	5.62	0.5	24.2	surface
		18	17	6172	0.41	3.37	5.27			4.2
		18	17	6480	3.38	3.55	4.86			8.4
3/28/2006	920	17.1	23	9207	4.48	5.22	5.68	0.6	15.2	surface
		17.1	23	10130	3.91	5.7	5.5			4.9
		17	23	9807	3.79	5.55	5.16			9.8
4/19/2006	940	25.1	28	12760	1.76	7.31	6.34	0.7	8.3	surface
		25	28	12890	1.9	7.4	5.97			4.9
		24.9	28	12000	2.44	6.85	5.69			9.8
4/26/2006	1020	24.5	20	11940	8.58	6.82	5.5	0.5	15.4	surface
		24.7	20	12430	8.06	7.12	5.17			4.8
		24.9	20	10490	4.32	5.92	4.75			9.6
5/10/2006	900	25.6	27	17990	6.83	10.62	6.92	0.6	18.6	surface
		25.6	27	18010	5.24	10.6	6.67			5.4
		25.5	27	15870	2.17	9.27	6.57			10.8
5/30/2006	1000	29.2	30	13030	7.13	7.44	6.48	0.7	11.5	surface
		29	30	13110	6.44	7.5	6.06			4.9
		28.9	30	11850	1.21	6.71	5.29			9.8
6/27/2006	950	28.6	31	26270	9.57	16	6.9	0.7	12.3	surface
		28.6	31	26310	8.95	16.02	6.65			4.8
		28.6	31	26270	4.11	16	6.08			9.6
7/18/2006	1000	31.1	36	25800	7.22	15.64	7.07	0.6	13.9	surface
		30.7	36	26450	6.37	16.08	6.82			4.6
		30.6	36	24260	3.78	14.61	6.42			9.2

LABORATORY ANALYSIS

FLR 1

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/25/2004	930	200	1.6	< 5.0	39	0.06	0.25	0.4	< 0.005	< 0.005
11/22/2004	930	3000	2.9	< 5.0	33	0.06	0.45	0.25	0.043	0.031
12/6/2004	950	380	1.7	< 5.0	41	0.03	0.49	0.33	0.022	0.035
Field Duplicate	950	340	1.1	< 5.0	42	0.03	0.49	0.32	0.022	0.029
12/27/2004	955		< 1.0	< 5.0	38	0.05	0.90	0.027	0.015	0.017
1/10/2005	930	48	1.6	< 5.0	41	0.04	0.74	0.17	0.018	0
2/3/2005	1255	420	1.1	< 5.0	34	0.06	0.52	0.13	0.027	0.009
2/14/2005	1040	150	1.7	< 5.0	35	0.07	0.34	0.46	0.018	0.014
3/16/2005	855	1400	< 1.0	7	44	0.11	1.00	0.016	0.027	0.006
3/31/2005	1210	44	1.1	< 5.0	57	< 0.01	0.30	0.502	0.012	0.006
4/26/2005	935	3000	8.2	15	44	0.06	0.70	0.331	0.064	< 0.005
5/12/2005	830	54	< 1.0	< 5.0	52	0.04	0.22	0.568	0.017	
5/25/2005	955	54	2.2	< 5.0	27	0.04	0.32	0.462	0.048	0.01
6/7/2005	940	480	3.9	5	45	0.06	0.45	0.203	0.04	0.018
7/7/2005	900	2600	5.7	7	53	0.04	1.50	0.19	0.057	0.014
8/4/2005	940	230	5	< 5.0	44	0.01	0.38	0.09	0.036	< 0.005
9/20/2005	1035	280	5.6	< 5.0	54	0.01	0.76	0.212	0.023	< 0.005
10/11/2005	1420	110	1.1	< 5.0	48	0.05	1.2	0.503	0.022	0.005
11/17/2005	920	50	1	< 5.0	45	0.14	0.32	2.12	0.008	0.018
12/6/2005	910	360	< 1.0	< 5.0	46	0.01	0.44	0.68	0.018	0.013
1/11/2006	835	78	9.9	< 5.0	52	0.01	0.73	0.345	0.017	0.012
1/26/2006	910	32	< 1.0	< 5.0	30	0.05	0.19	0.607	0.009	0.01
2/14/2006	955	22	1.1	< 5.0	40	0.01	0.29	0.575	0.014	0.016
2/23/2006	905	48	< 1.0	< 5.0	39	< 0.01	0.18	0.485	0.008	0.009
3/16/2006	815	22	1.1	< 5.0	40	0.04	0.23	0.377	0.01	0.012
3/28/2006	805	24	< 1.0	< 5.0	39	0.03	0.39	0.313	0.009	0.007
4/19/2006	830	52	1.1	< 5.0	37	< 0.01	0.50	0.374	0.013	0.028
4/27/2006	840	250	1.7	< 5.0	51	< 0.01	0.40	0.2	0.022	0.017
5/8/2006	840	100	1.1	< 5.0	42	< 0.01	0.27	0.398	0.012	0.01
5/31/2006	1015	110	1.1	< 5.0	40	< 0.01	0.41	0.308	0.012	0.006
6/26/2006	935	130	< 1.0	< 5.0	43	< 0.01	0.70	0.386	0.032	0.012
7/19/2006	1045	230	1.6	< 5.0	49	0.01	0.21	0.446	0.01	0.006

FLR 2

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/25/2004	1050	120	< 1.0	< 5.0	75	0.05	0.78	0.12	0.1	0.042
11/22/2004	955	64	1.4	< 5.0	56	0.27	0.79	0.057	0.091	0.028
12/6/2004	1035	2000	< 1.0	< 5.0	48	< 0.01	0.74	0.13	0.062	0.041
12/27/2004	1020		< 1.0	< 5.0	53	0.03	1.6	0.016	0.032	0.015
1/10/2005	1000	52	< 1.0	< 5.0	46	0.03	2.3	0.009	0.056	0.026
Field Duplicate	1000	100	< 1.0	< 5.0	65	0.01	3	0.008	0.057	0.028
2/3/2005	1215	1100	< 1.0	< 5.0	49	< 0.01	0.7	0.019	0.068	0.005
2/14/2005	1015	370	1.7	5	47	0.1	0.55	0.16	0.059	0.02
3/16/2005	935	5000	1.1	14	66	0.1	1	0.036	0.096	0.026
3/31/2005	1150	68	1.1	8	69	0.01	0.7	0.255	0.059	0.014
4/26/2005	1005	2000	1.8	7	52	0.02	0.74	0.273	0.082	0.009
5/12/2005	855	98	1.7	6	73	0.02	0.62	0.312	0.057	
5/25/2005	1025	230	5	< 5.0	56	0.03	0.66	0.265	0.091	0.02
6/7/2005	1000	570	1.1	5	59	0.03	0.72	0.042	0.067	0.027
7/7/2005	930	450	1.2	< 5.0	63	0.01	1.1	0.059	0.07	0.035
8/4/2005	1025	72	< 1.0	< 5.0	62	< 0.01	0.69	0.039	0.076	0.014
9/20/2005	1110	30	10	5	96	0.08	0.98	0.047	0.1	0.009
10/11/2005	1350	44	1.1	< 5.0	79	0.02	0.44	0.159	0.079	0.011
11/17/2005	1000	62	1.6	< 5.0	78	0.02	0.68	0.36	0.056	0.012
12/6/2005	940	2900	1.6	< 5.0	98	< 0.01	0.53	0.463	0.061	0.017
1/11/2006	905	70	11	< 5.0	85	< 0.01	0.36	0.121	0.034	0.009
1/26/2006	935	32	< 1.0	< 5.0	65	< 0.01	0.46	0.1	0.024	0.008
2/14/2006	1020	110	1.1	< 5.0	71	< 0.01	0.34	0.069	0.02	0.009
2/23/2006	935	170		< 5.0	68	< 0.01	0.47	0.1	0.028	0.009
3/16/2006	845	120	14	< 5.0	70	< 0.01	0.56	0.075	0.065	0.011
3/28/2006	835	80	2.2	< 5.0	55	< 0.01	0.37	0.065	0.03	0.007
4/19/2006	1000	850	20	5	71	0.02	0.96	0.042	0.083	0.021
4/27/2006	905	380	1.1	< 5.0	78	< 0.01	0.59	0.054	0.039	0.008
5/9/2006	905	310	1.7	< 5.0	70	< 0.01	0.72	0.04	0.06	0.017
5/31/2006	940	20	5.8	< 5.0	84	< 0.01	0.17	0.021	0.042	0.008
6/26/2006	1005	8	1.8	< 5.0	86	< 0.01	0.38	0.008	0.077	0.005
7/19/2006	1110	72	1	< 5.0	113	0.04	0.59	0.062	0.062	0.011
Field Duplicate	1111	76	< 1.0	< 5.0	113	0.04	0.63	0.088	0.065	0.012

FLR 3

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/25/2004	1010	48	<1.0	< 5.0	217	0.03	0.53	0.25	0.04	0.026
11/22/2004	1015	110	1	< 5.0	59	< 0.01	< 0.1	0.1	0.069	0.035
12/6/2004	1100	2000	1.2	5	60	< 0.01	0.86	0.12	0.053	0.041
12/27/2004	1045		2.2	< 5.0	52	0.01	0.99	0	0.56	0.016
1/10/2005	1025	110	1.1	< 5.0	61	< 0.01	3.8	0.045	0.042	0.027
2/3/2005	1110	900	1.7	5	49	< 0.01	0.94	0.023	0.063	0.007
2/14/2005	945	> 6000	1.1	< 5.0	36	0.11	0.67	0.21	0.046	0.016
3/16/2005	1005	2650	1.1	< 5.0	66	0.1	0.72	0.057	0.037	0.011
Field Duplicate	1006	2550	<1.0	6	56	0.09	0.59	0.064	0.051	0.007
3/31/2005	1030	110	1.2	< 5.0	63	< 0.01	0.6	0.388	0.058	0.011
4/26/2005	1035	68	<1.0	< 5.0	38	< 0.01	0.44	0.619	0.021	< 0.005
5/12/2005	920	72	1.1	< 5.0	54	< 0.01	0.39	0.545	0.023	
5/25/2005	1105	62	1.1	< 5.0	35	0.02	0.36	0.505	0.128	0.016
6/7/2005	1035	1400	1.1	6	56	0.01	0.66	0.166	0.066	0.019
7/7/2005	1005	1200	1.7	5	60	0.01	1	0.052	0.058	0.027
8/3/2005	1205	350	<1.0	< 5.0	55	< 0.01	0.92	0.07	0.043	0.01
9/21/2005	1235	180	2.2	< 5.0	321	0.01	0.5	0.198	0.046	0.009
10/11/2005	1110	88	<1.0	< 5.0	206	< 0.01	0.5	0.372	0.04	0.01
11/17/2005	1340	110	1.2	< 5.0	595	< 0.01	0.68	0.539	0.009	0.005
12/6/2005	1200	3500	<1.0	< 5.0	257	< 0.01	0.77	0.696	0.03	0.011
1/10/2006	1205	42	1.1	< 5.0	289	< 0.01	0.38	0.752	0.012	< 0.005
1/26/2006	1205	50	3.2	< 5.0	127	< 0.01	0.65	0.475	0.041	0.005
2/16/2006	1025	54	<1.0	< 5.0	51	< 0.01	0.29	0.349	0.014	0.007
2/23/2006	1045	190	1.1	< 5.0	45	< 0.01	0.2	0.446	0.009	0.006
3/15/2006	1155	12	<1.0	< 5.0	59	< 0.01	0.28	0.216	0.013	0.01
3/28/2006	1055	18	1.1	< 5.0	42	< 0.01	0.37	0.649	0.014	0.012
4/19/2006	1100	28	1	< 5.0	76	< 0.01	0.41	0.439	0.015	0.014
4/27/2006	935	84000	2.3	< 5.0	84	< 0.01	0.93	0.278	0.11	0.017
5/9/2006	940	82	<1.0	< 5.0	683	< 0.01	0.48	0.286	0.014	0.007
5/31/2006	915	40	7.3	< 5.0	683	< 0.01	0.68	0.244	0.016	0.008
6/26/2006	1035	140	7.8	10	1060	< 0.01	0.29	0.353	0.053	0.014
7/19/2006	1150	3000	1.6	< 5.0	464	< 0.01	0.49	0.17	0.028	0.006

FLR 4

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/26/2004	1030	78	2.8	< 5.0	931	0.04	0.49	0.35	0.024	0.021
11/23/2004	1145	600	< 1.0	6	164	0.02	0.84	0.18	0.059	0.034
12/7/2004	1135	750	< 1.0	< 5.0	57	0.04	0.81	0.062	0.041	0.04
12/28/2004	1105		< 1.0	< 5.0	59	0.02	2.2	0.01	0.023	0.021
1/11/2005	1150	170	2.2	< 5.0	80	0.01	2.1	0.13	0.031	0.035
2/3/2005	1040	1100	1.2	5	6.1	0.01	0.74	0.037	0.052	0.01
2/15/2005	1115	4400	1.7	< 5.0	52	0.14	0.57	0.27	0.036	0.027
3/17/2005	1120	2050	1.1	5	83	0.07	0.87	0.022	0.043	0.01
3/31/2005	1000	84	2.9	< 5.0	114	0.01	0.7	0.257	0.026	0.006
4/28/2005	1010	250	2.2	< 5.0	72	0.01	0.54	0.273	0.035	< 0.005
5/11/2005	1110	40	12	< 5.0	68	0.01	0.84	0.234	0.04	< 0.005
Field Dulicate	1110	34	8.4	< 5.0	68	0.01	0.71	0.191	0.04	< 0.005
5/26/2005	1225	26	4.6	< 5.0	354	0.02	0.52	0.285	0.023	0.01
6/8/2005	1055	290	6.4	7	159	0.03	0.72	0.185	0.056	0.016
7/7/2005	1055	1400	< 1.0	5	68	0.03	0.96	0.061	0.054	0.019
8/3/2005	1135	430	9.2	5	80	< 0.01	0.65	0.074	0.042	0.008
9/21/2005	1205	84	3.3	< 5.0	1230	0.03	0.54	0.163	0.055	0.006
10/11/2005	1045	84	3.4	< 5.0	1260	0.02	0.73	0.301	0.028	< 0.005
11/17/2005	1300	78	1.1	< 5.0	2880	0.02	0.52	0.634	0.011	< 0.005
12/6/2005	1130	4000	< 1.0	< 5.0	2020	< 0.01	0.7	0.653	0.032	< 0.005
1/10/2006	1130	48	< 1.0	< 5.0	1440	0.01	0.74	0.683	0.013	< 0.005
1/26/2006	1125	34	< 1.0	< 5.0	773	0.01	0.53	0.39	0.01	< 0.005
2/16/2006	955	34	1.6	< 5.0	98	< 0.01	0.4	0.339	0.026	0.005
2/23/2006	1115	72	3.2	< 5.0	213	< 0.01	0.23	0.414	0.011	0.005
3/15/2006	1125	8	1.6	< 5.0	97	< 0.01	0.23	0.207	0.016	0.018
3/28/2006	1025	4	2.2	< 5.0	191	< 0.01	0.28	0.455	0.013	0.007
4/19/2006	1035	38	2.2	< 5.0	616	< 0.01	0.45	0.312	0.016	0.008
4/27/2006	1150	200	18	< 5.0	1209	< 0.01	0.69	0.208	0.042	0.014
5/10/2006	955	190	15	< 5.0	661	0.02	0.68	0.33	0.048	< 0.005
5/30/2006	1100	34	37	< 5.0	1830	< 0.01	0.78	< 0.005	0.027	0.005
6/27/2006	1040	82	2.3	< 5.0	2360	< 0.01	0.51	0.305	0.044	< 0.005
7/18/2006	1105	340	2.2	< 5.0	2600	0.02	0.74	0.276	0.016	< 0.005

FLR 5

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/26/2004	1120	80	13	9	8980	< 0.01	0.56	0.08	0.027	0.015
11/23/2004	1210	120	4	9	2550	0.05	0.54	0.069	0.037	0.007
12/7/2004	1200	450	1.7	6	738	0.04	0.75	0.065	0.03	0.014
12/28/2004	1140		3.7	< 5.0	664	0.04	1	0.023	0.035	0.011
1/11/2005	1120	560	26	7	2390	< 0.01	2.3	0.032	0.035	0.007
2/3/2005	1010	1500	1.8	< 5.0	303	0.01	0.45	< 0.005	0.021	0.006
2/15/2005	1015	110	5.9	6	1930	0.07	0.51	0.16	0.027	0.021
3/17/2005	1015	1300	< 1.0	7	1360	0.09	0.71	< 0.005	0.033	< 0.005
3/31/2005	935	60	13	9	2760	0.01	0.6	0.132	0.03	< 0.005
4/28/2005	930	54	11	9	566	< 0.01	0.78	< 0.005	0.052	< 0.005
5/11/2005	1205	16	8.8	< 5.0	1400	0.03	0.66	0.065	0.036	< 0.005
5/26/2005	1155	20	9.8	6	5600	0.01	0.62	0.024	0.026	0.013
6/8/2005	1030	34	9.2	7	3940	0.01	0.54	0.082	0.046	0.016
7/7/2005	1120	2000	2.4	6	417	0.02	0.95	0.033	0.056	0.014
8/3/2005	1105	22	20	9	913	< 0.01	1	< 0.005	0.065	0.005
9/21/2005	1120	8	25	12	1400	< 0.01	1.3	< 0.005	0.056	0.01
10/11/2005	1020	16	10	9	6730	0.02	0.27	0.007	0.037	0.006
11/17/2005	1215	92	9.8	16	11000	< 0.01	0.87	0.293	0.033	0.011
12/6/2005	1245	190	8.1	15	30100	0.02	0.64	0.338	0.041	< 0.005
1/10/2006	1055	36	< 1.0	11	7650	< 0.01	1	0.304	0.021	0.007
1/26/2006	1055	22	11	12	4150	0.05	0.91	0.195	0.034	< 0.005
2/16/2006	925	38	13	5	2990	< 0.01	0.79	0.072	0.024	0.005
2/23/2006	1130	22	20	7	2660	< 0.01	0.64	0.138	0.028	0.005
3/15/2006	1050	8	20	12	2550	< 0.01	0.56	0.013	0.031	< 0.005
3/28/2006	1000	26	9.4	8	3450	< 0.01	0.64	0.17	0.022	< 0.005
4/19/2006	1015	12	7.6	9	7900	< 0.01	0.64	0.009	0.015	< 0.005
4/26/2006	1120	150	6.3	7	7320	< 0.01	0.77	< 0.005	0.023	0.007
5/10/2006	940	6	12	12	6140	< 0.01	0.77	0.006	0.033	< 0.005
5/30/2006	1040	2	6.2	6	6720	< 0.01	0.85	< 0.005	0.026	0.008
6/27/2006	1020	8	12	12	13300	< 0.01	0.64	< 0.005	0.05	< 0.005
7/18/2006	1040	2	15	18	13900	< 0.01	0.8	< 0.005	0.051	< 0.005

FLR 6

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/26/2004	1140	20	14	8	730	< 0.01	0.45	0.094	0.029	0.014
11/23/2004	1225	66	17	8	2390	0.05	3.3	0.15	0.038	0.009
12/7/2004	1220	900	2.8	< 5.0	566	0.06	0.25	0.19	0.034	0.014
12/28/2004	1205		2.2	< 5.0	635	0.05	2.4	0.03	0.037	0.013
1/11/2005	1045	34	20	9	2090	< 0.01	1.6	0.088	0.035	0.007
2/3/2005	955	1000	4.3	< 5.0	2400	0.03	0.77	0.044	0.03	0.01
2/15/2005	955	72	5.2	5	1670	0.1	0.52	0.19	0.025	0.021
3/17/2005	1000	88	8.5	8	3430	0.08	0.73	0.017	0.035	0.005
3/31/2005	920	20	10	11	3120	< 0.01	0.6	0.163	0.029	< 0.005
4/28/2005	915	22	18	14	985	0.02	0.76	0.048	0.061	< 0.005
5/11/2005	1040	24	11	9	3190	0.04	0.68	0.079	0.045	< 0.005
5/26/2005	1140	6	5.9	23	6880	0.02	0.62	0.015	0.04	< 0.005
6/8/2005	1015	6	8.6	12	5790	0.02	0.56	0.056	0.039	0.015
7/7/2005	1140	2900	3.6	7	364	0.03	1.1	0.128	0.068	0.019
8/3/2005	1030	16	21	14	1690	< 0.01	0.59	< 0.005	0.072	0.005
9/21/2005	1100	4	20	16	9960	< 0.01	0.79	< 0.005	0.054	< 0.005
10/11/2005	1005	12	10	8	6330	< 0.01	0.62	0.007	0.04	0.005
12/6/2005	1055	68	5.4	6	10500	0.03	0.61	0.37	0.017	< 0.005
1/10/2006	1035	34	< 1.0	10	8670	< 0.01	1.1	0.357	0.025	< 0.005
1/26/2006	1040	10	16	11	4620	0.07	0.9	0.179	0.037	0.005
Field Duplicate	1040	12	15	9	4650	0.07	0.97	0.188	0.039	0.005
2/16/2006	1110	14	14	7	2640	< 0.01	0.68	0.104	0.57	< 0.005
2/23/2006	1210	56	20	13	2450	< 0.01	0.67	0.175	0.046	< 0.005
3/15/2006	1035	8	23	15	3120	< 0.01	0.8	0.008	0.055	< 0.005
3/28/2006	940	4	13	< 5.0	3090	< 0.01	0.89	0.167	0.023	< 0.005
4/19/2006	1005	12	8.6	7	5650	< 0.01	0.66	0.005	0.021	< 0.005
4/26/2006	1105	10	10	7	6400	< 0.01	0.72	< 0.005	0.04	0.006
5/10/2006	920	2	12	10	6490	< 0.01	0.84	< 0.005	0.03	0.005
5/31/2006	1025	14	15	15	6730	< 0.01	1.3	< 0.005	0.041	0.007
6/27/2006	1010	4	14	14	12500	< 0.01	0.74	< 0.005	0.06	< 0.005
7/18/2006	1110	8	11	14	13100	< 0.01	0.76	< 0.005	0.045	< 0.005

FLR 7

Date dd/mm/yy	Time	F. Coli. colonies/100mL	Chlorophyll a ppm	TSS ppm	TDS ppm	NH3 ppm	TKN ppm	Nitrate/Nitrite ppm	Total-P ppm	DRP ppm
10/26/2004	1200	6	17	15	8740	0.03	0.59	< 0.005	0.045	0.014
11/23/2004	1240	68	29	18	4130	0.08	0.76	0.048	0.049	0.008
12/7/2004	1240	120	3.9	8	864	0.13	0.63	0.16	0.041	0.014
12/28/2004	1225		1.6	6	1510	0.06	1.6	0.03	0.043	0.013
1/11/2005	1025	40	13	6	2720	< 0.01	0.52	0.012	0.032	0.006
2/3/2005	930	950	3.4	< 5.0	3100	0.04	0.74	0.035	0.029	0.009
2/15/2005	935	38	13	10	3350	0.12	0.59	0.13	0.04	0.02
3/17/2005	930	78	9.9	12	4080	0.1	0.81	0.014	0.041	0.005
3/31/2005	855	4	22	25	6090	< 0.01	0.8	0.044	0.054	0.009
4/28/2005	855	12	20	7	3870	0.04	0.77	< 0.005	0.081	< 0.005
5/11/2005	1020	4	16	18	7380	< 0.01	0.83	0.026	0.053	< 0.005
5/26/2005	1120	2	5.4	27	7440	0.02	0.66	0.023	0.044	0.014
6/8/2005	950	6	8.6	11	5720	< 0.01	0.59	< 0.005	0.041	0.015
7/7/2005	1200	2800	3.9	12	813	0.05	1.1	0.131	0.071	0.019
8/3/2005	1005	14	13	17	2370	< 0.01	0.67	< 0.005	0.071	0.006
9/21/2005	1010	6	22	17	2790	< 0.01	0.89	< 0.005	0.07	0.011
10/11/2005	940	18	15	12	7020	< 0.01	1.2	0.009	0.051	0.005
11/17/2005	1110	110	9.1	14	11000	0.01	0.81	0.369	0.028	< 0.005
12/6/2005	1030	64	11	15	10800	0.01	0.74	0.361	0.026	< 0.005
1/10/2006	1010	2	7.6	14	9780	< 0.01	1.2	0.426	0.038	< 0.005
1/26/2006	1015	20	11	11	3890	0.03	0.85	0.112	0.04	< 0.005
2/16/2006	1130	12	18	15	4800	< 0.01	0.75	0.022	0.04	0.57
2/23/2006	1230	12	5.6	8	5910	0.02	0.57	0.148	0.029	0.006
3/15/2006	955	14	25	19	3700	< 0.01	0.5	0.011	0.055	< 0.005
3/28/2006	925	4	9.2	11	4540	< 0.01	0.67	0.17	0.03	< 0.005
4/19/2006	945	4	20	17	8090	< 0.01	0.9	< 0.005	0.051	< 0.005
4/26/2006	1025	36	11	16	7000	< 0.01	0.89	< 0.005	0.055	0.009
5/10/2006	905	4	9	12	8950	< 0.01	0.77	< 0.005	0.046	< 0.005
5/30/2006	1005	4	19	14	6760	< 0.01	1.1	0.005	0.043	0.007
6/27/2006	955	2	13	18	9020	0.25	1.1	0.005	0.059	< 0.005
7/18/2006	1005	8	16	20	16500	< 0.01	0.67	< 0.005	0.055	< 0.005