Total Maximum Daily Load

Evaluation

for

Woodall Creek

in the

Chattahoochee River Basin

for

Copper, Lead, and Zinc

Submitted to:
The U.S. Environmental Protection Agency
Region 4
Atlanta, Georgia

Submitted by:
The Georgia Department of Natural Resources
Environmental Protection Division
Atlanta, Georgia

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1.0 INTRODUCTION

1.1 Background

The State of Georgia assesses its water bodies for compliance with water quality standards criteria established for their designated uses as required by the Federal Clean Water Act (CWA). Assessed water bodies are placed into one of three categories, depending on water quality assessment results: supporting designated use, not supporting designated use, or assessment pending. These water bodies are found on Georgia's 305(b) list as required by that section of the CWA that addresses the assessment process, and are published in *Water Quality in Georgia* (GA EPD, 2010 – 2011). This document is available on the Georgia Environmental Protection Division (EPD) website.

A subset of the water bodies that do not meet designated uses are included under Category 5 of the 305(b) list, and are assigned to Georgia's 303(d) list, named after that section of the CWA. Water bodies included in the 303(d) list are required to have a Total Maximum Daily Load (TMDL) evaluation for the water quality constituent(s) in violation of the water quality criteria. The TMDLs in this document are based on the 2012 303(d) listing, which is available on the EPD website. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and in-stream water quality conditions. This allows water quality based controls to be developed to reduce pollution and restore and maintain water quality.

The State of Georgia has identified three miles of Woodall Creek, from its headwaters to its confluence with Peachtree Creek, located in the City of Atlanta, Fulton County, as not supporting its designated use due to exceedances of water quality standards for the parameters copper, lead, and zinc. In addition, the same segment is listed as not supporting its use due to exceedances of the water quality standard for tetrachloroethylene (PCE). The PCE contamination is being managed by EPD's Hazardous Waste Branch with a Correction Action Plan (CAP).

1.2 Watershed Description

The Chattahoochee River Basin is located primarily in west Georgia and east Alabama, with a small portion in north Florida. It occupies an area of 8,770 square miles, of which 6,140 square miles (70%) lie in Georgia. The Chattahoochee River basin falls within the Level III Blue Ridge, Piedmont, and Coastal Plain Ecoregions that extend throughout the southeastern United States. The Chattahoochee River originates in the southeast corner of Union County, in north Georgia, within the Blue Ridge Mountains. The river flows southwest to Lake Sidney Lanier, then through the Atlanta metropolitan area to West Point Lake, where it forms the border between Georgia and Alabama. It continues flowing south through Walter F. George Reservoir and converges with the Flint River in Lake Seminole, at the Georgia-Florida border. The outflow from Lake Seminole forms the Apalachicola River in Florida, which ultimately discharges to the Gulf of Mexico.

The Chattahoochee River basin includes four United States Geologic Survey (USGS) eight-digit hydrologic units, HUCs 03130001 – 03130004. Figure 1 shows the locations of the four hydrologic units in the Chattahoochee River Basin. The Woodall Creek watershed is located within the Atlanta city limits in the Chattahoochee River Basin in HUC 03130001 (see Figure 2). The watershed is in the Piedmont Physiographic Province, and is part of the Piedmont Ecoregion. The water use classification of Woodall Creek from its headwaters to its confluence with Peachtree Creek is "Fishing" (EPD, 2011)

The land use characteristics of the Woodall Creek watershed were determined using data from the Georgia Land Use Trends (GLUT) for Year 2008, which was developed by the University of Georgia – Natural Resources Spatial Analysis Laboratory (NARSAL). This is an urban watershed, consisting of mostly land uses associated with high-intensity industrial and commercial activities. Table 1 lists the watershed land use distribution for the Woodall Creek watershed.

Table 1
Woodall Creek Watershed Land Cover Distribution, Acres (Percentage)

Open Water	Low Intensity Residential	High Intensity Residential	High Intensity Commercial/Industrial/ Transportation	Bare Rock/Sand/Clay	Transitional	Forest	Pasture/Hay	Other Grasses (Urban/Recreational; e.g. parks/lawns)	Total
13	271	407	789	1	15	146	18	294	1,953
(0.6)	(13.9)	(20.9)	(40.4)	(0.1)	(0.8)	(7.5)	(0.9)	(15.0)	(100.0)

1.3 Water Quality Standards

The water use classification for Woodall Creek is Fishing. The Fishing classification, as stated in Georgia's Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(6)(a), is established to protect "Propagation of Fish, Shellfish, Game and Other Aquatic Life; secondary contact recreation in and on the water; or for any other use requiring water of a lower quality."

Chapter 391-3-6-.03(5)(e)(ii) of Georgia's Rules and Regulations establishes criteria for metals that apply to all waters in the State. The established chronic criterion and acute criterion for dissolved copper, lead, and zinc are as follows:

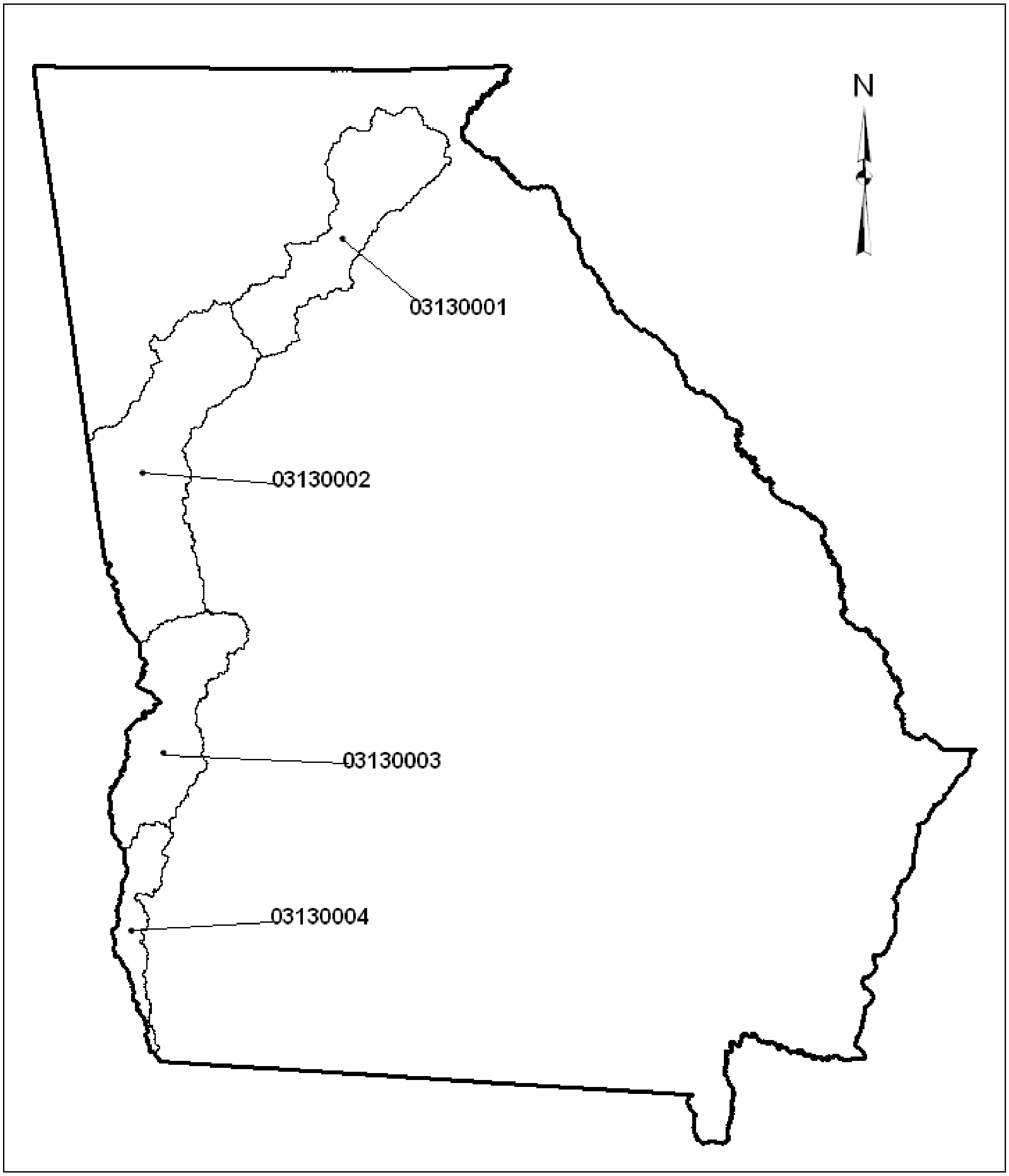
acute criteria for dissolved copper = $(e^{(0.9422[\ln(\text{hardness})] - 1.700)})(0.96)$ µg/L
chronic criteria for dissolved copper = $(e^{(0.8545[\ln(\text{hardness})] - 1.702)})(0.96)$ µg/L

acute criteria for dissolved lead = $(e^{(1.273[\ln(\text{hardness})] - 1.460)})(1.46203 - [\ln \text{hardness})(0.145712)])$ µg/L
chronic criteria for dissolved lead = $(e^{(1.273[\ln(\text{hardness})] - 4.705)})(1.46203 - [\ln \text{hardness})(0.145712)])$ µg/L

acute criteria for dissolved zinc = $(e^{(0.8473[\ln(\text{hardness})] + 0.884)})(0.978)$ µg/L
chronic criteria for dissolved zinc = $(e^{(0.8473[\ln(\text{hardness})] + 0.884)})(0.986)$ µg/L

The hardness of the water body is used in the above equations, and is expressed in mg/L as $CaCO_3$.

The regulation cited above requires that instream concentrations of the dissolved metals shall not exceed the acute criteria, under 1Q10 or higher stream flow conditions, and shall not exceed the chronic criteria indicated above, under 7Q10 or higher stream flow conditions. The 1-day, 10-year minimum (1Q10) statistical flow value associated with this segment of Woodall Creek is 0.23 cubic feet per second (cfs). The 7-day, 10-year minimum (7Q10) statistical flow value associated with Woodall Creek is 0.25 cfs.



TMDL Evaluation - Copper, Lead, Zinc
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Figure 1. USGS 8-Digit HUCs for Chattahoochee River Basin

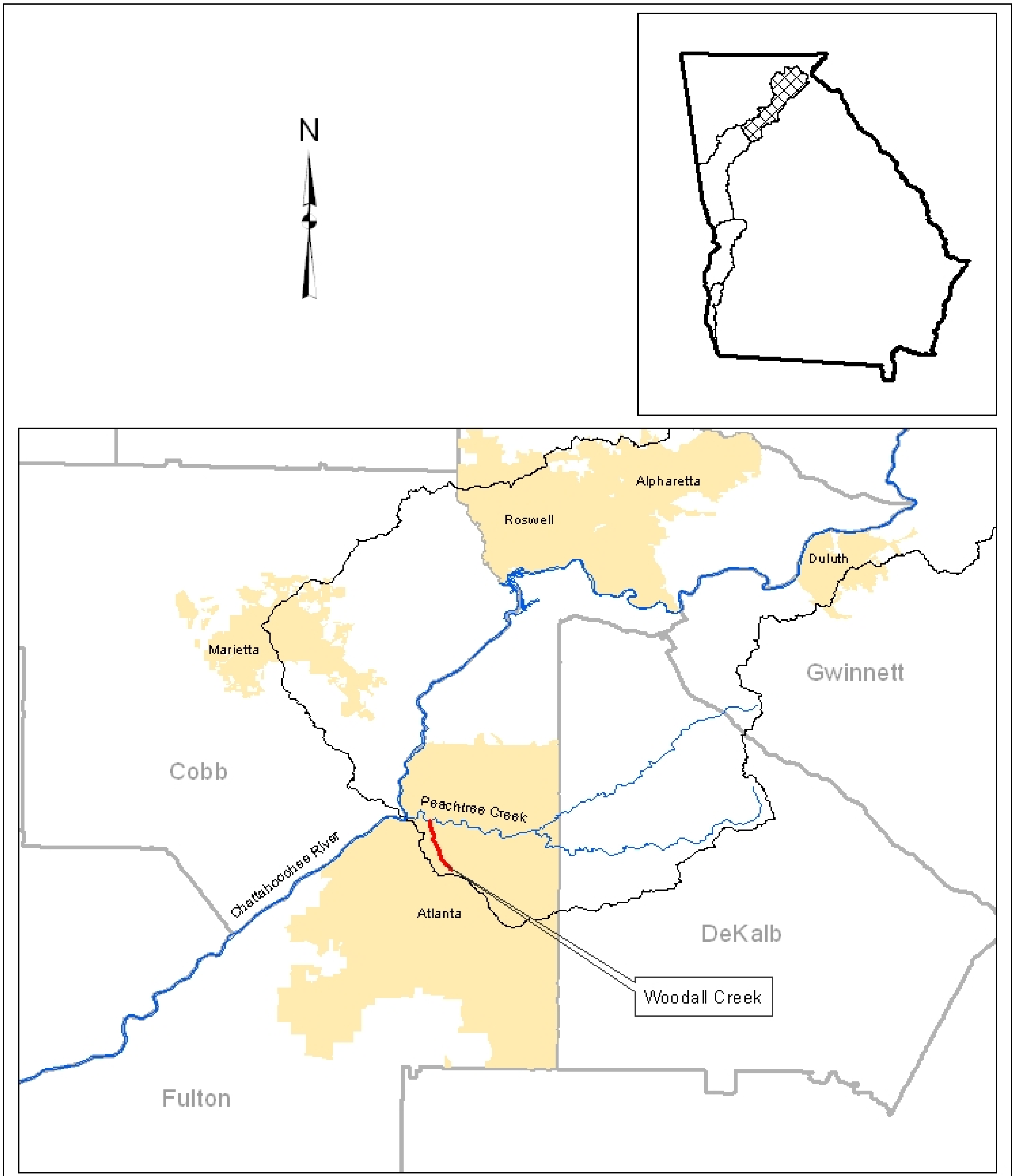

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Figure 2. Impaired Stream Segment:
Woodall Creek
HUC03130001

In accordance with Georgia Rules and Regulations for Water Quality Control 391-3-6-.03(5)(e)(ii), guidance found in EPA's "Guidance Document of Dynamic Modeling and Translators August 1993" may be used to determine the relationship between the total recoverable concentration of a metal and the dissolved form of a metal. The metals translator is determined using default linear partition coefficient values found in an EPA document entitled, "Technical Guidance Manual for Performing Waste Load Allocations – Book II: Streams and Rivers."

In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Metals effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c). Therefore, the TMDL will be expressed as both the total maximum daily load of total recoverable copper that will be protective of the dissolved copper chronic criterion and the total maximum daily load of total recoverable copper that will be protective of the dissolved copper acute criterion.

1.4 Background Information for Metals of Concern

Background information is presented regarding the characteristics, uses, and environmental impacts of copper, lead, and zinc.

1.4.1 Copper

Copper is a naturally occurring metal. It is used in electronics, household plumbing fixtures, in pigments and dyes, pharmaceuticals, fertilizers, and pesticides. Copper alloys include bronze (with tin) and brass (with zinc) (CCME, 1999; USEPA, 2008).

Copper is an essential nutrient for the human body in trace amounts. However, consumption of water containing elevated levels over many years can cause liver or kidney damage (USEPA, 2008). Humans are most often exposed to copper through corrosion of copper household pipes.

The copper (II) ion, which is commonly found in natural waters, is potentially toxic to aquatic life, both acutely and chronically. Copper is known to bioaccumulate in fish tissues. It can be introduced to surface waters through runoff from paved roads and parking areas where motor vehicles are used, from industrial areas as air emissions, where copper products are produced, urban and agricultural areas where fertilizers and pesticides are applied, and copper mining and smelting areas (USEPA, 2008).

1.4.2 Lead

Lead is also a naturally occurring element. The most common man-made sources of lead include lead-based paint in homes and buildings built before 1978, air emissions from industrial sources, plumbing materials, and leaded aviation gasoline. Although commercial and industrial uses of lead have been greatly curtailed, it is still commonly used in batteries, ammunition, metal products (solder and pipes), and for radiation shielding in TV screens and computer monitors, and for devices to shield against X-rays (CCME, 1999; NRC, 1980).

Long term human exposure to low levels of lead can cause anemia, loss of appetite, stomach pain, fatigue, affects on the nervous system, behavioral problems and learning disabilities, seizures, and even death. Young children absorb the metal more easily than adults, and even low level exposure may harm intellectual development, behavior, size and hearing of infants (CCME, 1999).

Prior to the banning of lead as an automobile fuel additive in1996, it commonly entered waterways through settling of particulate exhausts from motor vehicles and runoff from pavements. Lead also enters waterways through corrosion of leaded pipelines, corrosion of leaded paints, and runoff from industrial facilities manufacturing lead products. Aquatic ecosystems exposed to elevated levels of lead demonstrate losses in biodiversity. Decreases in growth and reproductive rates of aquatic animals and plants have been observed. Fish exposed to lead have exhibited blood and neurological changes. Lead shot and sinkers left from recreational hunting and fishing activities can be fatal to waterfowl and other wildlife that ingest these items (CCME, 1999; NRC, 1980).

1.4.3 Zinc

Zinc is a naturally occurring element found in soils, rocks, and aquatic and marine environments. Zinc is commonly used in galvanizing to provide a protective coat for iron and steel products. Zinc compounds are found in paint pigments, cosmetics, antiseptics, sunscreens, fertilizers, pesticides, and dry cell batteries. Brass is a zinc alloy (with copper) used for plumbing components (RWQCP, 1999; CCME, 1999).

Zinc is an essential trace element for plants and animals. However, long-term human exposure to excessive zinc levels can cause anemia, pancreas damage, interference with absorbing other essential minerals, and may act as a carcinogen (CCME, 1999). Elevated levels may be ingested through contaminated drinking water near industrial sites or water flowing through galvanized pipes. Inhalation of zinc particulates from air emissions can occur near industrial sites or smelting and mining operations.

Major sources of zinc to aquatic environments include electroplaters, smelting and ore processors, domestic and industrial sewage, runoff from industrial sites, road surface runoff, corrosion of zinc alloys and galvanized surfaces, and erosion of agricultural soils. Zinc is most harmful to aquatic life during early life stages. Zinc toxicity affects freshwater fish by destruction of the gill tissue, which results in hypoxia. Elevated zinc concentrations have an especially strong impact on crustaceans, molluscs, and more sensitive aquatic insect species. Zinc can biomagnify up the aquatic food chain (U.S. Fish and Wildlife Service, 1993).

2.0 WATER QUALITY ASSESSMENT

Woodall Creek's use support determination was made for copper, lead, and zinc based on past water quality samples taken by the U.S. Geological Survey (USGS) between years 2003 through 2009. Additional samples were collected in 2010. The samples were taken at USGS Site 02336313 at Defoors Ferry Road. This site is located approximately 0.2 miles upstream from the convergence of Woodall Creek with Peachtree Creek. The water quality data are presented in Table A-1 (Appendix A).

Samples were taken for copper on 115 separate days. In many cases, several samples were collected on the same day. A total of 61 percent of the days sampled showed exceedances of the acute criterion for copper, while 71 percent showed exceedances of the chronic criterion for copper.

Samples were taken for lead on 119 separate days. In many cases, several samples were collected on the same day. There were no exceedances of the acute criterion for lead. However, a total of 56 percent of the days sampled showed exceedances of the chronic standard for lead.

Samples were taken for zinc on 115 separate days. In many cases, several samples were collected on the same day. A total of 31 percent of the days sampled showed exceedances of both the acute and chronic criteria for zinc.

The highest concentrations of the metals were observed from late 2005 through early 2008. There appeared to be some improvement in water quality after this time. This is shown in Figure B-1 (Appendix B).

To gain a better understanding of the role that stormwater runoff plays in contributing metals to Woodall Creek, the response of metals concentrations to storm events was examined. Meteorological data collected at a rain gage maintained by the University of Georgia (UGA) at Clark University – Atlanta was obtained for years 2005 through 2009. This gage is located approximately three miles south of the Woodall Creek headwaters. Plots of the precipitation data with copper, lead, and zinc concentrations were prepared and are presented in Figures C-1 through C-3 (Appendix C). These figures show that increases in copper, lead, and zinc concentrations often occurred with rainfall events. However, these increases did not happen consistently.

Several storm runoff hydrographs were recorded between the years 2005 through early 2007 at the Woodall Creek USGS flow gage. Gage levels were recorded and water quality samples collected concurrently throughout each hydrograph event. The water quality samples were analyzed for copper, lead, and zinc. For certain storm events, the concentrations of the metals increased during the rising limb of the hydrograph, indicating that stormwater runoff was transporting metals which had accumulated on adjacent land surfaces from various sources to Woodall Creek. The relationship between concentration and hydrograph flows was strongest for copper, and somewhat less apparent for lead. Zinc concentrations were least impacted by runoff events, often decreasing as stream flow increased due the effects of dilution. Metals concentrations and gage levels for events where a positive relationship was apparent are presented in Figures D-1 through D-3 (Appendix D).

In many instances, there appeared to be little or no relationship between precipitation/runoff events and concentrations for any of the metals. In some cases, elevated concentrations were observed in the creek during extended dry periods (Figures C-1 through C-3), suggesting that sources other than stormwater runoff are also contributing metals to the Woodall Creek.

3.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of the potential sources of pollutants. Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Nonpoint sources are diffuse, and generally, but not always, involve accumulation of pollutants on land surfaces that wash off as a result of storm events.

3.1 Point Source Assessment

Title IV of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) permit program. There are two basic categories of NPDES permits: 1) municipal and industrial wastewater treatment facilities, and 2) regulated stormwater discharges.

3.1.1 Wastewater Treatment Facilities

In general, municipal and industrial wastewater treatment facilities have NPDES permits with effluent limits. These permit limits are either based on federal and state effluent guidelines (technology-based limits) or on water quality standards (water quality-based limits).

Discharges from municipal and industrial wastewater treatment facilities can contribute metals to receiving waters. Currently, there are no NPDES permitted wastewater treatment facilities located within the Woodall Creek watershed, or that are discharging to the Creek.

Combined sewer systems convey a mixture of raw sewage and stormwater in the same conveyance structure to a wastewater treatment plant. These are considered a component of municipal wastewater treatment facilities. When the combined sewage exceeds the capacity of the wastewater treatment plant, the excess is diverted to a combined sewage overflow (CSO) discharge point. There are no CSO outfalls located within the Woodall Creek watershed.

3.1.2 Regulated Stormwater Discharges

Some stormwater runoff is covered under the NPDES Permit Program as a point source. Regulated stormwater discharges that may contain metals consist of those associated with industrial activities and large, medium, and small municipal separate storm sewer systems (MS4s) that serve populations of 50,000 or more.

3.1.2.1 Industrial General Stormwater NPDES Permit

Stormwater discharges associated with industrial activities are currently covered under the 2012 General Storm Water NPDES Permit (GAR050000), also called the Industrial General Permit (IGP). This permit requires visual monitoring of stormwater discharges, site inspections, implementation of Best Management Practices (BMPs), and record keeping. The IGP requires that stormwater discharging into an impaired stream segment or within one linear mile upstream of, and within the same watershed as, any portion of an impaired stream segment identified as “not supporting” its designated use(s), must satisfy the requirements of Appendix C of the 2012 IGP if the pollutant(s) of concern for which the impaired stream segment has been listed may be exposed to stormwater as a result of industrial activity at the site. If a facility is covered under Appendix C of the IGP, then benchmark monitoring for the pollutant(s) of concern is required.

A total of seven industrial sites in the Woodall Creek watershed that are covered under the IGP are considered to have the potential for discharging copper, lead, or zinc, based on their SIC Codes and Sector designations (Table 2). These metals are included in the benchmark monitoring for these sites.

Table 2
Industrial General Permit Facilities That Are Potential Sources for Copper, Lead, and Zinc in Stormwater Runoff

Facility Name	Metals of Concern	SIC Code	Sector No.	Type of Business	Facility Status
Liberty Tire Recycling	copper, lead, zinc	5093	N1	tire reclamation, tire-derived industrial kiln fuels	active
Momar, Inc.	zinc	2841	C3	maintenance and sanitation chemicals	active
Southern Aluminum Finishing Co. - Chattahoochee Ave.	zinc	3471	AA1	pre-finished and mill finished aluminum sheets	active
Southern Aluminum Finishing Co. - Huber Street	zinc	3471	AA1	pre-finished and mill finished aluminum sheets	active
Southern Graphic Systems, Inc.	zinc	3442	AA1	plate making, gravure for printing equipment	active
ZEP	zinc	2841	C3	commercial, industrial cleaning solutions	active
Zumar Industries	zinc	2821	C4	sign manufacturing	active

Two major railroad yards, CSX's Tilford Yard and Howell Yard, are located in the south-southwest portion of the Woodall Creek watershed, and are covered under the IGP. A third large railroad yard, Norfolk Southern's Inman Yard, lies immediately outside the watershed. It is unknown whether these railroad yards contribute metals to the creek.

3.1.2.2 MS4 NPDES Permits

Stormwater discharges from MS4s are very diverse in pollutant loadings and frequency of discharge. At present, all cities and counties within the state of Georgia that had a population of greater than 100,000 at the time of the 1990 Census, are permitted for their stormwater discharge under Phase I. Small MS4s serving urbanized areas are required to obtain a stormwater permit under the Phase II stormwater regulations. An urbanized area is defined as an area with a residential population of at least 50,000 people and an overall population density of at least 1,000 people per square mile.

Phase I MS4 permits require the prohibition of non-stormwater discharges (i.e., illicit discharges) into the storm sewer systems, and require controls to reduce the discharge of pollutants to the maximum extent practicable, including the use of management practices, control techniques and systems, as well as design and engineering methods (Federal Register, 1990). An area-specific Stormwater Management Plan (SWMP) outlining appropriate controls is required by, and referenced in, the permit.

The City of Atlanta is a Phase I permittee. Woodall Creek is located within the jurisdictional limits of Atlanta, and 83 percent of its watershed is an MS4 urbanized area. There are four MS4 outfalls located along the length of Woodall Creek that receive a large portion of the stormwater runoff from the watershed. In some cases, the MS4 conveyance structures receive the stormwater discharges from facilities that are included under the IGP. The MS4 can also include runoff from city and county roads, commercial business properties, and the limited number of residential properties in the watershed.

3.2 Nonpoint Source Assessment

In general, nonpoint sources cannot be identified as entering a waterbody through a discrete conveyance at a single location. In urban areas, a large portion of the stormwater contribution may enter waterways as point sources from MS4 NPDES permitted outfalls and nonpermitted outfalls, or from industrial sites covered under the IGP. The remainder of the stormwater runoff will come from nonpoint sources.

Woodall Creek is an urban stream located in the center of the Atlanta metro area. In the past, several industrial facilities existed within the Woodall Creek watershed. More recently, the area has been in gradual transition, with some of the industrial facilities being replaced by commercial businesses, and medium and high density housing. However, there are still active industrial sites in the watershed. Both closed facilities and some of the currently active facilities have handled chemical compounds or products containing one or more of the metals of concern. Most of the stormwater pollutant contributions are from permitted stormwater structures. Potential nonpoint sources include the following:

- Stormwater runoff as overland flow from improper disposal of waste materials;
- Deposition of particulates from air emissions;
- Contaminated groundwater seepage;
- Leaking or overflowing sanitary sewer lines;
- Failing septic systems;
- Leachate from landfills within the watershed;

An assessment of the potential sources of copper, lead, and zinc in Woodall Creek was performed using available resources, which included the following:

- USEPA Toxics Release Inventory (TRI)
- EPD Hazardous Site Inventory (HSI)
- USEPA List of Superfund Sites (CERCLIS)
- EPD Inventory of Permitted Solid Waste Disposal Facilities

3.2.1 Toxic Release Inventory (TRI)

The TRI is a database maintained by the USEPA that provides information about facilities that handle toxic chemicals. It contains information about releases of these chemicals to the environment, including air emissions, surface water discharges, releases to the land, and off-site transport to disposal facilities.

A review of the TRI revealed that two industries within the Woodall Creek watershed had reported releases of copper and zinc compounds into the environment through air emissions from stacks or as fugitive dust. Three facilities reported releases of lead compounds into the environment, also as stack emissions and fugitive dust. Information for these facilities is presented in Table 3.

Table 3
Facilities on the Toxics Release Inventory (TRI) with Reported Releases of Copper, Lead, or Zinc in the Woodall Creek Watershed

Facility Name	Metals of Concern	Form of Release	Reported Dates of Releases	Type of Business	Production Status
Flint Ink North America Corp.	copper, zinc, lead	air emissions	1994	printing ink manufacturing	active
Glidden Company	copper, zinc	air emissions	1989 - 1993	paint and coating manufacturing	closed
Ennis Paint, Inc.	lead	air emissions	1987 – 2010	paint and coating manufacturing	active
Sonoco Products Co.	lead	air emissions	2001	paperboard mill	active
ZEP, Inc.	lead	air emissions	2001 – 2002 2006 – 2007	soaps and detergent manufacturing	active

The potential exists for a fraction of the particulates from the air emissions to settle in the watershed, and to be washed into Woodall Creek during storm events. It should be noted that the air emissions from these facilities were in compliance with current limits. These sites and others within the Woodall Creek watershed were also included on the TRI list for offsite transfers of metal compounds to waste disposal facilities, but there were no reported releases to the environment from these transfers.

3.2.2 Hazardous Site Index (HSI)

The HSI is maintained by EPD. Industrial sites are placed on the list by EPD when there has been a known release into the environment of a regulated substance above a reportable quantity. Three industrial sites within the Woodall Creek watershed are included on the HSI (Table 4) that are known to have released copper, lead, or zinc, or compounds of these metals above a reportable quantity as determined by EPD.

Table 4
Industrial Sites on the Hazardous Site Index (HSI) for Releases of Copper, Lead, or Zinc within the Woodall Creek Watershed

Site Name	HSI No.	Metals of Concern	Medium of Contamination	Production Status
Estech General Chemicals	10196	copper, lead, zinc	groundwater, soil	closed
Seaboard Industrial Blvd	10459	lead	groundwater	active
Westinghouse Warehouse	10120	lead	soil	active

The HSI site summary sheet provided by EPD's Response & Remediation Program indicate that cleanup of the soils has been completed at the Westinghouse Warehouse site (HSI Site No. 10120).

The site of the former Estech General Chemicals, where agricultural fertilizers and pesticides were manufactured, is included on the HSI (HSI Site No. 10196) as a potential source for copper, lead, or zinc. This site is located in the upper portion of the Woodall Creek watershed. Moderate levels of these metals have been found in the soils at the site. Moderate to high levels of the metals have been detected in the groundwater at the site and in a small tributary located immediately north of the site that flows into Woodall Creek. BFEL Indemnitor, Inc., the current owner of the site, has developed a Voluntary Remediation Program (VRP) approved by EPD for implementation, to control contaminant leaching of the groundwater and contamination of surface waters (EPD Response & Remediation Program). This site is included on the USEPA CERCLIS list as a Hazardous Waste Site, although it is not on the National Priority List (NPL). In 1994, the USEPA gave the site No Further Remedial Action Planned (NFRAP) status. However, it remains a State Superfund site.

The Seaboard Industrial Boulevard Site (HIS Site No. 10459) consists of a total of eight contiguous properties. It has been determined that groundwater seepage contaminated with lead has occurred from the site. The HSI Site Summary sheet indicates that cleanup activities are being conducted for source materials, soil, and groundwater.

3.2.3 Solid Waste Disposal Facilities

A former B.F.I. sanitary landfill is located within the Woodall Creek watershed near the headwaters. This landfill was closed in 1978. There is little information available about the history of this landfill. Therefore, it is unknown if there is a potential for metals in the leachate to seep into Woodall Creek.

3.3 Additional Potential Sources

There are several other potential sources of copper, zinc, and lead that can sometimes be significant. In general, runoff from parking lots and streets can contain elevated levels of all three metals as a result of residuals left by motor vehicles. Sanitary sewer line breaks and overflows can contain these metals from household products containing copper and zinc. Lead may be present as a result of old water lines made of lead pipes. Runoff from landscaped areas treated with excessive amounts of fertilizers and pesticides containing copper and zinc can be a significant source. Stormwater from old building sites where lead-based paints were used has been shown in some instances to be significant.

4.0 TMDL DEVELOPMENT APPROACH

An important component of TMDL development is to establish relationships between source loadings and in-stream water quality. In this section, the mathematical modeling techniques used to develop the TMDL are discussed.

4.1 Steady-State Approach

Steady-state models are applied for "critical" environmental conditions that represent extremely low assimilative capacity. Critical environmental conditions correspond to drought flows. The assumption behind steady-state modeling is that point and nonpoint source discharge concentrations that protect water quality during low-flow critical conditions will be protective for the large majority of environmental conditions that occur. Mass balance equations are used to model the critical conditions and calculate allocations.

4.2 Critical Conditions

The critical flow conditions for these TMDLs occur when the ratio of effluent or contaminated stormwater to stream flow is the greatest. The TMDLs are presented in two ways: first, as total daily mass loads for the low flow conditions; and second, loads as a function of the total flow at any given time.

In the first case, total daily mass loads for the low flow conditions of 7Q10 and 1Q10 are given. It is assumed that these are the critical conditions for aquatic life. The 7Q10 and chronic criteria provide protection of the chronic standard, and the 1Q10 and the acute criteria provide protection of the acute standard.

Available flow data for Woodall Creek was limited. Therefore, the critical 1Q10 and 7Q10 flows were developed using 1Q10 and 7Q10 data determined by the USGS for several nearby streams (Carter, et. al., 1989). These streams had relatively similar watershed characteristics, including land use, slope, and drainage area. The critical stream flows for Woodall Creek were estimated by first calculating the average productivity values (i.e., ratio of flow and drainage area) for the 1Q10 and 7Q10 flows of the nearby streams. The 1Q10 and 7Q10 critical flows for Woodall Creek were estimated by determining the product of the average productivity values and Woodall Creek's drainage area. These calculations are presented in Appendix E. The resulting estimated 1Q10 and 7Q10 flows for Woodall creek are presented in Table 5.

Table 5
Critical Flow Conditions for Woodall Creek

Source of Flow	Flow value (MGD / cfs)
Woodall Creek (during 7Q10 conditions)	0.16 / 0.25
Woodall Creek (during 1Q10 conditions)	0.15 / 0.23

In the second case, the TMDLs are also expressed as equations that show the loads as a function of the total flow at any given time. Since instantaneous samples are used to evaluate compliance with the standards, as well as the need for a TMDL, this flow dependent load, or concentration approach, is more meaningful. This approach takes into account seasonal variability and makes it easier to evaluate compliance with the TMDL.

The acute and chronic criteria for metals are expressed as the dissolved fraction. The criteria are calculated based on the hardness of the receiving stream (see Section 2 for equations). A lower hardness results in a higher proportion of metal in the dissolved form, resulting in a more conservative criterion.

A total of 203 samples were collected from Woodall Creek between March 2003 and December 2010 for analysis of total hardness. During this time period, the hardness exhibited a broad range in values, varying from 11 to 140 mg/L as $CaCO_3$, with an average of 54 mg/L as $CaCO_3$. However, over the last two years, the water quality in Woodall Creek has changed somewhat, with hardness ranging between 17 and 134 mg/L as $CaCO_3$, and averaging 38 mg/L as $CaCO_3$. A total hardness of 40 mg/L was used to determine the acute and chronic criteria for calculating the acute and chronic TMDLs for the creek.

Based on the hardness data, Table 6 presents the instream copper, lead, and zinc dissolved chronic and acute criteria to protect against chronic and acute effects. These are given as dissolved concentrations.

Table 6
Instream Dissolved Acute and Chronic Criteria
for Copper, Lead, and Zinc for Woodall Creek

Metal	Dissolved Acute Criterion (µg/L)	Dissolved Chronic Criterion (µg/L)
Copper	5.7	4.1
Lead	23.5	0.9
Zinc	53.9	54.4

Results for sample analyses of metals are commonly reported as a total (or total recoverable) concentration. Because the criteria are for the dissolved fraction of the metals, Georgia Regulation 391-3-6-.03(5)(e)(ii) (EPD, 2011a) allows USEPA's "Guidance Document of Dynamic Modeling and Translators, August 1993" to be used for "translating" the total recoverable concentration to the dissolved form. In addition, Georgia Regulation 391-3-6-.06(4)(d)5.(ii)(b)(2) allows methods from this EPA guidance document to be used to translate dissolved criteria concentrations into total recoverable permit limits. Metals effluent permit limitations are required to be expressed as total recoverable metal per 40 CFR §122.45(c).

5.0 ALLOCATIONS

A Total Maximum Daily Load (TMDL) is the amount of a pollutant that can be assimilated by the receiving waterbody without exceeding the applicable water quality standard. For Woodall Creek, the TMDLs for copper, lead, and zinc are based on the acute and chronic instream standards for these metals. A TMDL is the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources, as well as natural background (40 CFR 130.2) for a given waterbody. The TMDL must also include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the water quality response of the receiving water body. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. For copper, lead, and zinc the TMDLs are expressed as mass per day and as a concentration. A TMDL is expressed as:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{MOS}$$

The TMDL calculates the WLAs and LAs with margins of safety to meet the stream's water quality standards. The allocations are based on estimates that use the best available data and provide the basis to establish or modify existing controls so that water quality standards can be achieved. In developing a TMDL, it is important to consider whether adequate data exists to identify the sources, fate, and transport of the pollutant to be controlled.

TMDLs may be developed using a phased approach. Under a phased approach, the TMDL includes: 1) WLAs that confirm existing limits and controls or lead to new limits, and 2) LAs that confirm existing controls or include implementing new controls (USEPA, 1991). A phased TMDL requires that additional data be collected to determine if load reductions required by the TMDL are leading to the attainment of water quality standards.

The TMDL Implementation Plan establishes a schedule or timetable for the installation and evaluation of point and nonpoint source control measures, data collection, assessment of water quality standard attainment, and if needed, additional modeling. Future monitoring of the listed segment's water quality will then be used to evaluate this phase of the TMDL, and if necessary, to reallocate the loads.

5.1 Waste Load Allocations

5.1.1 Wastewater Treatment Facilities

The waste load allocation (WLA) is the portion of the receiving water's loading capacity that is allocated to existing or future point sources represented by municipal and industrial wastewater treatment systems that have NPDES effluent limits. Currently, there are no NPDES-permitted wastewater treatment facilities discharging into Woodall Creek. In the future, if any wastewater treatment facilities are permitted to discharge copper, lead, or zinc to Woodall Creek, the WLA loads will be calculated using the effluent design flow. Since some NPDES permits do not have a flow limitation, a TMDL expressed only in mass per day is not appropriate. It is more accurate and conservative to assign a wasteload allocation as a concentration. The mass limit for any value of flow (Q) will then be calculated by multiplying flow times concentration. The WLA requires that the effluent concentration from each point source not exceed the allowable instream metal concentration at the end of pipe without any dilution. The WLA is represented by the equation:

$$\text{WLA} = \Sigma Q_{WLA} \times \text{metal criterion (acute or chronic)}$$

where: ΣQ_{WLA} = sum of all current, potential, and future NPDES permitted wastewater treatment discharges

5.1.2 Regulated Stormwater Discharges

State and Federal Rules define stormwater discharges covered by NPDES permits as point sources. However, stormwater discharges are from diffuse sources and there are multiple stormwater outfalls. Stormwater sources (point and nonpoint) are different than traditional NPDES permitted sources in four respects: 1) they do not produce a continuous (pollutant loading) discharge; 2) their pollutant loading depends on the intensity, duration, and frequency of rainfall events, over which the permittee has no control; 3) the activities contributing to the pollutant loading may include various allowable activities of others, and control of these activities is not solely within the discretion of the permittee; and 4) they do not have wastewater treatment plants that control specific pollutants to meet numerical limits.

The intent of stormwater NPDES permits is not to treat the water after collection, but to reduce the exposure of stormwater to pollutants by implementing various controls. It would be infeasible and prohibitively expensive to try to control pollutant discharges from each stormwater outfall. Therefore, stormwater NPDES permits require the establishment of controls or BMPs to reduce pollutants from entering the environment.

The waste load allocations from stormwater discharges associated with MS4s (WLAsw) are estimated based on the percentage of urban area in each watershed covered by the MS4 stormwater permit. At this time, the portion of each watershed that goes directly to a permitted storm sewer and that which goes through non-permitted point sources, or is sheet flow or agricultural runoff, has not been clearly defined. Thus, it is assumed that approximately 70 percent of stormwater runoff from the regulated urban area is collected by the municipal separate storm sewer systems. This can be represented by the following equation:

$$Q_{WLASW} = \Sigma Q_{urban} \times 0.7$$

$$WLA_{SW} = Q_{WLASW} \times \text{metal criterion (acute or chronic)}$$

where:
WLA_{SW} = Wasteload Allocation for permitted stormwater runoff from all MS4 urban areas
Q_{WLASW} = runoff from all MS4 urban areas conveyed through permitted stormwater structures
ΣQ_{urban} = sum of all stormwater runoff from all MS4 urban areas

5.2 Load Allocations

The load allocation (LA) is the portion of the receiving water's loading capacity that is attributed to existing or future nonpoint sources or to natural background sources. Nonpoint sources are identified in 40 CFR 130.6 as follows:

- Residual waste
- Land disposal
- Agricultural and silvicultural
- Mines
- Construction
- Saltwater intrusion
- Urban stormwater (non-permitted)

It is not known how much of the metals contributions to Woodall Creek are from nonpoint sources. Generally, there are two types of load allocations in the creek: loads associated with the accumulation of metals on land surfaces that is washed off during storm events; and, loads independent of precipitation, such as seepage of contaminated groundwater, leachate from landfills, failing septic systems, leaking sewer system collection lines, and background loads. Available data suggests that copper, lead, and zinc are introduced to Woodall Creek from both stormwater runoff, and from other sources not related to storm events. At this time, it is not possible to partition the various sources of load allocations. In the future, after additional data has been collected, it may be possible to partition the load allocation by source.

The allowable instream concentrations for copper, lead, and zinc, along with historical low-flow data are used to determine the load allocations for each of these metals for Woodall Creek under critical conditions. The load allocations during 1Q10 and 7Q10 flow conditions are calculated as follows:

To protect against the acute effects of dissolved metals:

allowable loading (kg/d) = dissolved acute criterion (µg/L) x 1Q10 (MGD) x units conversion

where: units conversion = 3.785 L/gallon x 10^{-9} kg/µg

To protect against the chronic effects of dissolved metals:

allowable loading (kg/d) = dissolved chronic criterion (µg/L) x 7Q10 (MGD) x units conversion

where: units conversion = 3.785 L/gallon x 10^{-9} kg/µg

The load allocations for copper, lead, and zinc for critical conditions are presented in Table 7.

Table 7
Load Allocations (LA) for Dissolved Copper, Lead, and Zinc under Critical Conditions for Woodall Creek

Parameter	Criteria	Dissolved Concentration (µg/L)	Critical Flow (MGD)	Allowable Load Allocation (kg/day)
Copper	Acute	5.7	0.15	3.2 x 10^{-3}
	Chronic	4.1	0.16	2.5 x 10^{-3}
Lead	Acute	23.5	0.15	1.3 x 10^{-2}
	Chronic	0.9	0.16	5.5 x 10^{-4}
Zinc	Acute	53.9	0.15	3.1 x 10^{-2}
	Chronic	54.4	0.16	3.3 x 10^{-2}

5.3 Seasonal Variation

The low flow critical conditions incorporated in this TMDL are assumed to represent the most critical design conditions and provide year-round protection of water quality. The base flow of a stream will generally range from low flows during critical conditions to higher flows at other times. Runoff from storm events will contribute additional flow to the stream. Seasonal variability in flow is addressed by expressing the TMDL as a concentration, as well as a load associated with different flows. The LA for all flows and conditions can be described by the following equation:

$$LA = Q_{LA} \times \text{metal criterion (acute or chronic)}$$

$$Q_{LA} = [Q_{Total} - (\Sigma Q_{WLA} + \Sigma Q_{WLASW})]$$

where:
- LA = load allocation
- Q_{LA} = flow from all nonpoint sources
- Q_{Total} = total flow in the creek
- ΣQ_{WLA} = sum of all current, potential, and future NPDES permitted wastewater treatment discharges
- ΣQ_{WLASW} = sum of all permitted stormwater runoff from MS4 urban areas

5.4 Margin of Safety

The MOS is a required component of TMDL development. As specified by section 303(d) of the CWA, the margin of safety must account for any lack of knowledge concerning the relationship between effluent limitations and water quality. There are two basic methods for incorporating the MOS: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations.

The MOS was implicitly incorporated into the TMDLs for Woodall Creek through the use of the critical conditions established in Section 4.2 of this report. Through the use of low flow conditions and conservative hardness values the margin of safety for these TMDLs adequately accounts for the lack of knowledge concerning the relationship between effluent limitations and water quality.

5.5 TMDL Results

The TMDL for any condition will be based on the flow of Woodall Creek, as well as the discharge flow of a permitted discharger. The TMDLs for copper, lead, and zinc are summarized in Tables 8 through 10.

Table 8. Copper TMDL Summary for Woodall Creek

Parameter	Criteria	WLA	WLA_{SW}*	LA	MOS	TMDL
Total Dissolved Copper	Chronic	ΣQ_{WLA} x 4.1 µg/L for all conditions and flows	ΣQ_{WLASW} x 4.1 µg/L for all conditions and flows	2.5×10^{-3} kg/day for the 7Q10 ΣQ_{LA} x 4.1 µg/L for all conditions and flows	Implicit	2.5×10^{-3} kg/day + WLA for the 7Q10 Q_{total} x 4.1 µg/L for all conditions and flows
Total Dissolved Copper	Acute	ΣQ_{WLA} x 5.7 µg/L for all conditions and flows	ΣQ_{WLASW} x 5.7 µg/L for all conditions and flows	3.2×10^{-3} kg/day for the 1Q10 ΣQ_{LA} x 5.7 µg/L for all conditions and flows	Implicit	3.2×10^{-3} kg/day + WLA for the 1Q10 Q_{total} x 5.7 µg/L for all conditions and flows

* Based on the Draft EPA Interoffice Memorandum on "*Estimating Water Quality Loadings from MS4 Areas,*" dated 12/19/02: "If the critical period is a low flow event, the load from the MS4 does not have to be quantified and a WLA for the stormwater sources is not necessary…"

Table 9. Lead TMDL Summary for Woodall Creek

Parameter	Criteria	WLA	WLA_{SW}*	LA	MOS	TMDL
Total Dissolved Lead	Chronic	ΣQ_{WLA} x 0.9 µg/L for all conditions and flows	ΣQ_{WLASW} x 0.9 µg/L for all conditions and flows	5.5×10^{-4} kg/day for the 7Q10 ΣQ_{LA} x 0.9 µg/L for all conditions and flows	Implicit	5.5×10^{-4} kg/day + WLA for the 7Q10 Q_{total} x 0.9 µg/L for all conditions and flows
Total Dissolved Lead	Acute	ΣQ_{WLA} x 23.5 µg/L for all conditions and flows	ΣQ_{WLASW} x 23.5 µg/L for all conditions and flows	1.3×10^{-2} kg/day for the 1Q10 ΣQ_{LA} x 23.5 µg/L for all conditions and flows	Implicit	1.3×10^{-2} kg/day + WLA for the 1Q10 Q_{total} x 23.5 µg/L for all conditions and flows

* Based on the Draft EPA Interoffice Memorandum on "*Estimating Water Quality Loadings from MS4 Areas,*" dated 12/19/02: "If the critical period is a low flow event, the load from the MS4 does not have to be quantified and a WLA for the stormwater sources is not necessary…"

Table 10. Zinc TMDL Summary for Woodall Creek

Parameter	Criteria	WLA	WLA_{SW}*	LA	MOS	TMDL
Total Dissolved Zinc	Chronic	ΣQ_{WLA} x 54.4 µg/L for all conditions and flows	ΣQ_{WLASW} x 54.4 µg/L for all conditions and flows	3.3×10^{-2} kg/day for the 7Q10 ΣQ_{LA} x 54.4 µg/L for all conditions and flows	Implicit	3.3×10^{-2} kg/day + WLA for the 7Q10 Q_{total} x 54.4 µg/L for all conditions and flows
Total Dissolved Zinc	Acute	ΣQ_{WLA} x 53.9 µg/L for all conditions and flows	ΣQ_{WLASW} x 53.9 µg/L for all conditions and flows	3.1×10^{-2} kg/day for the 1Q10 ΣQ_{LA} x 53.9 µg/L for all conditions and flows	Implicit	3.1×10^{-2} kg/day + WLA for the 1Q10 Q_{total} x 53.9 µg/L for all conditions and flows

* Based on the Draft EPA Interoffice Memorandum on "*Estimating Water Quality Loadings from MS4 Areas,*" dated 12/19/02: "If the critical period is a low flow event, the load from the MS4 does not have to be quantified and a WLA for the stormwater sources is not necessary…"

6.0 RECOMMENDATIONS

The TMDL process consists of an evaluation of the subwatersheds for each 303(d) listed stream segment to identify, as best as possible, the sources of copper, lead, and zinc causing the stream to exceed instream standards. The TMDL analysis was performed using the best available data to specify WLAs and LAs that will meet copper, lead, and zinc water quality criteria so as to support the use classification specified for each listed segment.

This TMDL represents part of a long-term process to reduce loading of the metals copper, lead, and zinc to meet water quality standards in the Chattahoochee River Basin. Implementation strategies will be reviewed and the TMDLs will be refined as necessary. The phased approach will support progress toward water quality standards attainment in the future. In accordance with USEPA TMDL guidance, these TMDLs may be revised based on the results of future monitoring and source characterization data efforts. The following recommendations emphasize further source identification and involve the collection of data to support the current allocations and subsequent source reductions.

6.1 Monitoring

Water quality monitoring was initiated by the USGS at Woodall Creek Site USGS02336313, located at Defoors Ferry Road, in March 1976, which included limited sampling for copper, lead, and zinc through August 1977. No further sampling for these metals was performed for several years. Beginning in March 2003, the City of Atlanta provided funding for the USGS to expand the water quality monitoring program at the Woodall Creek site, which has included sampling for copper, lead, and zinc on an annual basis. These and several other parameters were eliminated from the monitoring program at the end of 2010. There are currently no plans to resume sampling for these parameters in the future (personnel communication, USGS, 2012).

6.2 Management Practices

Based on findings of the source assessment, there are several potential point source and nonpoint source loads for the metals of concern to Woodall Creek. These are discussed in more detail in Section 3. To summarize, potential point sources primarily include permitted stormwater runoff from industrial sites, commercial properties, and residential areas discharging to Woodall Creek. Potential nonpoint sources include: overland flow into the creek from land surfaces where waste materials are improperly disposed and metal particulates have accumulated; contaminated groundwater seepage; leachate from a closed landfill; leakage or overflows from sanitary sewer lines; and contributions from failing septic systems.

Management practices are recommended to reduce copper, lead, and zinc source loads to Woodall Creek, with the result of achieving the instream standard criteria for these metals. These recommended management practices include:

- Compliance with NPDES MS4 permit requirements;
- Compliance with NPDES Industrial General Permit requirements, including where applicable, achieving benchmarks for monitored constituents;
- Application of Best Management Practices (BMPs) appropriate to urban land uses, where applicable.

6.2.1 Point Source Approaches

Point sources are defined as discharges of treated wastewater or stormwater into rivers and streams at discrete locations. The NPDES permit program provides a basis for municipal, industrial, and stormwater permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations. In accordance with EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times.

As previously noted, there are currently no NPDES permitted wastewater treatment facilities discharging to the Woodall Creek watershed. The entire Woodall Creek watershed is covered under the Atlanta NPDES MS4 Phase 1 Permit. This permit prohibits illicit discharges into the storm sewer system, and requires that BMPs be put in place to reduce the discharge of pollutants to the maximum extent possible. Stormwater discharges from industrial sites are covered under the IGP. Under this permit implementation of BMPs are required. Stormwater from industrial sites that discharge within one linear mile of a 303(d) listed stream and that potentially might contain the listed constituent must be monitored to determine that benchmarks are met.

6.2.2 Nonpoint Source Approaches

EPD is responsible for administering and enforcing laws to protect the waters of the State. EPD is the lead agency for implementing the State's Nonpoint Source Management Program. Regulatory responsibilities that have a bearing on nonpoint source pollution include establishing water quality standards and use classifications, assessing and reporting water quality conditions, and regulating land use activities that may affect water quality.

Several industrial sites within the Woodall Creek watershed have been placed on the Georgia Hazardous Site Inventory as a result of releases of regulated substances in reportable quantities. EPD's Response and Remediation Program has been working with the owners towards cleanup of the sites, and implementing BMPs that will minimize these releases. EPD has also been working with USEPA towards cleanup of a Superfund site where fertilizers and pesticides were once manufactured, which included use of copper and zinc compounds.

EPD has joined local governments to foster the implementation of BMPs to address nonpoint source pollution. In addition, public education efforts are being targeted to individual stakeholders to provide information regarding the use of BMPs to protect water quality.

6.2.3 Summary of Source Management Practices

The Woodall Creek watershed is located in an urban industrial setting that also includes some commercial areas and limited residential developments. Urban sources can best be addressed using a strategy that involves public participation and intergovernmental coordination to reduce the discharge of pollutants to the maximum extent practicable. Management practices, control techniques, public education, and other appropriate methods and provisions may be employed. In addition to water quality monitoring programs, discussed in Section 6.1, the following activities and programs conducted by cities, counties, and state agencies are recommended:

- Sustain compliance with stormwater NPDES MS4 and IGP permit requirements;
- Ensure that stormwater management plans are in place and being implemented by the local governments, and by the industrial facilities located in the watershed. These Plans are designed to control stormwater runoff and to identify and implement BMPs to reduce the discharge of pollutants associated with stormwater;

- EPD should continue working with Federal, State, and local agencies and owners of sites where further cleanup measures are necessary, and in developing control measures to prevent future releases of the metals of concern.

- Further develop and streamline mechanisms for reporting and correcting illicit discharges, breaks, surcharges, and general sanitary sewer system problems;

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;

- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods.

6.3 Reasonable Assurance

Currently, there are no NPDES permitted wastewater treatment facilities discharging in the Woodall Creek watershed. Should there, in the future, be applicants for discharge permits, EPD will determine whether the applicants have a reasonable potential of discharging copper, lead, or zinc levels equal to or greater than the allocated loads. The results of this reasonable potential analysis will determine the specific type of requirements in an individual facility's NPDES permit. As part of its analysis, EPD will use its EPA approved 2003 NPDES Reasonable Potential Procedures to determine whether monitoring requirements or effluent limitations are necessary.

If effluent limitations are determined to be necessary, they should be established in accordance with *Georgia Rules and Regulations for Water Quality Control*, Section 391-3-6-.06(4)(d)5.(ii)(b)(2), to protect against chronic and acute effects.

All industrial sites that have a stormwater discharge associated with their primary industrial activity are required to submit a Notice of Intent under the NPDES General Industrial Permit (IGP). This authorizes them to discharge stormwater in accordance with the conditions and monitoring requirements established in the IGP. Stormwater from industrial sites that discharge within one linear mile of a 303(d) listed stream and that potentially might contain the listed constituent must be monitored to determine that benchmarks are met. Also, this permit requires implementation of BMPs.

The entire Woodall Creek watershed is covered under the Atlanta NPDES MS4 Phase 1 Permit. This permit prohibits illicit discharges into the storm sewer system, and requires that BMPs be put in place to reduce the discharge of pollutants to the maximum extent possible.

EPD is working with local governments to foster the implementation of best management practices to address nonpoint sources. In addition, public education efforts will be targeted to individual stakeholders to provide information regarding the use of best management practices to protect water quality.

6.4 Public Participation

A thirty day public notice is being provided for this TMDL. During this time, the availability of the TMDL will be public noticed, a copy of the TMDL will be provided on request, and the public is invited to provide comments on the TMDL.

7.0 INITIAL TMDL IMPLEMENTATION PLAN

7.1 Initial TMDL Implementation Plan

This plan identifies applicable State-wide programs and activities that may be employed to manage point and nonpoint sources of copper, lead, and zinc loads for Woodall Creek, which is located in the Chattahoochee River Basin. Local watershed planning and management initiatives will be fostered, supported, or developed through a variety of mechanisms. Implementation may be addressed by watershed improvement projects, assessments for Section 319 (h) grants, the local development of watershed protection plans, or "Targeted Outreach" initiated by EPD. These initiatives will supplement or possibly replace this initial implementation plan.

7.2 Impaired Segment

This initial plan is applicable to Woodall Creek, which was added to Georgia's 303(d) list available on EPD's website (www.gaepd.org). The following table summarizes the descriptive information for Woodall Creek provided in the 303(d) list.

Woodall Creek Listing on the 2012 303(d) List for Copper, Lead, and Zinc, Located in the Chattahoochee River Basin

Stream Segment	Location	Segment Length (miles)	Designated Use
Woodall Creek	Atlanta	3	Fishing

The current water quality standard [*State of Georgia's Rules and Regulations for Water Quality Control*, Chapter 391-3-6-.03(6)(c)(iii) (EPD, 2011)] states that instream concentrations shall not exceed the acute criteria under 1-day, 10-year minimum flow (1Q10) or higher stream flow conditions, and shall not exceed the chronic criteria under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions. The acute and chronic criteria for these metals are determined using the following equations:

acute criteria for dissolved copper = $(e^{(0.9422[\ln(\text{hardness})] - 1.700)})(0.96)$ µg/L
chronic criteria for dissolved copper = $(e^{(0.8545[\ln(\text{hardness})] - 1.702)})(0.96)$ µg/L

acute criteria for dissolved lead = $(e^{(1.273[\ln(\text{hardness})] - 1.460)})(1.46203 - [\ln \text{hardness})(0.145712)])$ µg/L
chronic criteria for dissolved lead = $(e^{(1.273[\ln(\text{hardness})] - 4.705)})(1.46203 - [\ln \text{hardness})(0.145712)])$ µg/L

acute criteria for dissolved zinc = $(e^{(0.8473[\ln(\text{hardness})] + 0.884)})(0.978)$ µg/L
chronic criteria for dissolved zinc = $(e^{(0.8473[\ln(\text{hardness})] + 0.884)})(0.986)$ µg/L.

These criteria are expressed in terms of the dissolved fraction in the water column and are a function of total hardness. Exceedances of these criteria are violations of the water quality standards for these metals, and are the basis for adding a stream segment to the 303(d) listing.

7.3 Potential Sources

An important part of the TMDL analysis is the identification of potential source categories. A source assessment characterizes the known and suspected sources for copper, lead, and zinc in the watershed.

Sources are broadly classified as either point or nonpoint sources. A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point sources of the metals copper, lead, and zinc include stormwater discharges through permitted stormwater systems. Nonpoint sources of these metals are diffuse and cannot be identified as entering the water body at a single location. These sources generally involve land use activities that contribute the metals to streams during rainfall events. However, other potential nonpoint sources exist such as deposition of particulates from air emissions, and seepage of contaminated groundwater.

Potential point sources for the copper, lead, and zinc loads to Woodall Creek include contributions from NPDES permitted stormwater discharges from current and former industrial sites. Many of the industrial facilities have been involved in the manufacture of products or use of compounds containing these metals.

Nonpoint sources for the metals of concern have been attributed primarily to storm runoff in the form of overland flow from industrial sites directly into Woodall Creek, and from contaminated groundwater seepage. Other potential nonpoint sources that may contribute these metals include illicit discharges into storm sewer systems, leaks and overflows from sanitary sewer lines, leaking septic systems, runoff from improper disposal of waste materials, and leachate from a closed landfill located near the headwaters of the creek. Runoff from commercial and residential areas where landscape chemicals have been applied is also a potential source.

7.4 Management Practices and Activities

The NPDES permit program provides a basis for municipal, industrial, and stormwater permits, monitoring and compliance with limitations, and appropriate enforcement actions for violations. In accordance with EPD rules and regulations, all discharges from point source facilities are required to be in compliance with the conditions of their NPDES permit at all times.

EPD is responsible for administering and enforcing laws to protect the waters of the State and is the lead agency for implementing the State's Nonpoint Source Management Program. Georgia is working with federal, county, and local governments, and other State and county agencies to foster implementation of BMPs that address nonpoint source pollution. The following management practices are recommended to reduce copper, lead, and zinc loads to Woodall Creek:

- Sustain compliance with stormwater NPDES MS4 and IGP permit requirements;

- Ensure that stormwater management plans are in place and being implemented by the local governments, and by the industrial facilities located in the watershed. These Plans are designed to control stormwater runoff and to identify and implement BMPs to reduce the discharge of pollutants associated with stormwater;

- EPD should continue working with Federal, State, and local agencies and owners of sites where further cleanup measures are necessary, and in developing control measures to prevent future releases of the metals of concern.

- Further develop and streamline mechanisms for reporting and correcting illicit discharges, breaks, surcharges, and general sanitary sewer system problems;

- Uphold requirements that all new and replacement sanitary sewage systems be designed to minimize discharges into storm sewer systems;

- Adoption of local ordinances (i.e. septic tanks, stormwater, etc.) that address local water quality;

- Continue efforts to increase public awareness and education towards the impact of human activities in urban settings on water quality, ranging from the consequences of industrial and municipal discharges to the activities of individuals in residential neighborhoods.

Public education efforts target individual stakeholders to provide information regarding the use of BMPs to protect water quality. EPD will continue efforts to increase awareness and educate the public about the impact of human activities on water quality.

7.5 Monitoring

EPD encourages local governments and municipalities to develop water quality monitoring programs. These programs can help pinpoint various pollutant sources, as well as verify the 303(d) stream segment listings. Water quality monitoring was initiated by the USGS at Woodall Creek Site USGS02336313, located at Defoors Ferry Road, in March 1976, which included limited sampling for copper, lead, and zinc through August 1977. Beginning in March 2003, the City of Atlanta provided funding for the USGS to expand the water quality monitoring program at the Woodall Creek site, which included sampling for copper, lead, and zinc on an annual basis. Sampling for these constituents was discontinued at the end of year 2010. EPD recommends that periodic monitoring of these metals, total hardness, and TSS be resumed at the site to determine if implementation of BMPs results in the improvement of water quality in the creek over time. EPD is available to assist in completing a monitoring plan, preparing a Sampling Quality Assurance Plan (SQAP), and/or providing necessary training as needed.

7.6 Future Action

This Initial TMDL Implementation Plan includes a general approach to pollutant source identification as well as management practices to address pollutants. In the future, EPD will continue to determine and assess the appropriate point and non-point source management measures needed to achieve the TMDLs and also to protect and restore water quality in impaired waterbodies.

For point sources, any wasteload allocations for wastewater treatment plant facilities will be implemented in the form of water-quality based effluent limitations in NPDES permits. Any wasteload allocations for regulated stormwater will be implemented in the form of best management practices in the NPDES permits. Contributions of the metals copper, lead, and zinc from regulated communities may also be managed using permit requirements such as watershed assessments, watershed protection plans, and long term monitoring. These measures will be directed through current point source management programs.

EPD will work to support watershed improvement projects that address non-point source pollution. This is a process whereby EPD and/or Regional Commissions or other agencies or local governments, under a contract with EPD, will develop a Watershed Management Plan intended to address water quality at the small watershed level (HUC 10 or smaller). These plans will be developed as resources and willing partners become available. The development of these plans may be funded via several grant sources, including but not limited to, Clean Water Act Section 319(h), Section 604(b), and/or Section 106 grant funds. These plans are intended for implementation upon completion.

Any Watershed Management Plan that specifically address waterbodies contained within this TMDL will supersede the Initial TMDL Implementation Plan once EPD accepts the plan. Future Watershed Management Plans intended to address this TMDL and other water quality concerns, written by EPD and for which EPD and/or the EPD Contractor are responsible, will contain at a minimum the USEPA's 9 Elements of Watershed Planning:

1) An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load allocations or achieve water quality standards. Sources should be identified at the subcategory level with estimates of the extent to which they are present in the watershed (e.g., X numbers industrial sites needing upgrading, Y acres of contaminated soils needing remediation, or Z linear miles of eroded stream bank needing restoration);

2) An estimate of the load reductions expected for the management measures;

3) A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;

4) An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;

5) An information/education component that will be used to enhance public understanding of and participation in implementing the plan;

6) A schedule for implementing the management measures that is reasonably expeditious;

7) A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

8) A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9) A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8).

The public will be provided an opportunity to participate in the development of Watershed Management Plans that address impaired waters and to comment on them before they are finalized.

EPD will continue to offer technical and financial assistance (when and where available) to complete Watershed Management Plans that address the impaired waterbodies listed in this and other TMDL documents. Assistance may include but will not be limited to:

- Assessments of pollutant sources within watersheds;
- Determinations of appropriate management practices to address impairments;
- Identification of potential stakeholders and other partners;
- Developing a plan for outreach to the general public and other groups;
- Assessing the resources needed to implement the plan upon completion; and
- Other needs determined by the lead organization responsible for plan development.

EPD will also make this same assistance available, if needed, to proactively address water quality concerns. This assistance may be in the way of financial, technical, or other aid and may be requested and provided outside of the TMDL process or schedule.

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Appendix A

Water Quality Sampling Results for Woodall Creek Showing Exceedances of Copper, Lead, and Zinc Acute and Chronic Criteria: 2003 – 2010

Table A-1
Water Quality Sampling Results for Woodall Creek
Showing Exceedances of Copper, Lead, Zinc
Acute and Chronic Criteria: 2003 – 2010

Sample Date	Total Hardness (mg/L CaCO3)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)
3/21/2003	123	16.3 (b)	0.42	144.0 (a)
7/18/2003	133	1.9	0.09	73.9
10/25/2004	NS	2.3	0.21	58.4
1/28/2005	131	2.8	0.37	168.0 (a)
3/18/2005	140	3.9	0.25	169.0 (a)
6/1/2005	41.3	7.7 (a)	0.88	37.4
6/1/2005	41.5	4	0.69	26.1
6/1/2005	48.3	4.4	0.75	34.1
6/1/2005	46.8	4	0.73	26.6
6/7/2005	120	7	0.54	60.6
6/7/2005	111	8.1	0.52	72.1
6/7/2005	114	8.1	0.54	72.5
6/21/2005	117	3.5	0.29	41.2
6/21/2005	76.8	4.4	0.53	32.1
6/21/2005	43.5	5.5 (b)	0.52	55.0
6/21/2005	45.2	4.6 (b)	0.53	32.4
6/21/2005	47.0	6.4 (b)	0.57	22.5
6/21/2005	41.0	6.3 (a)	0.68	22.6
6/23/2005	133	7.2	0.43	34.3
6/28/2005	124	4.2	0.25	39.9
7/28/2005	136	2.9	0.38	58.6
8/3/2005	128	8.3	1.00	50.9
8/25/2005	117	4.4	0.20	55.8
8/29/2005	132	4.1	0.15	25.7
9/8/2005	128	NS	0.40	NS
9/19/2005	125	12.6 (b)	0.65	46.4
9/27/2005	94.3	NS	0.22	63.2
10/25/2005	124	1.5	0.29	69.9
11/16/2005	112	3.6	0.30	55.5
11/16/2005	82.5	5.4	1.04	73.8
11/16/2005	39.7	9.3 (a)	1.11 (b)	80.3 (a)
11/16/2005	48.5	10 (a)	1.18 (b)	105.0 (a)
11/16/2005	43.2	11.9 (a)	1.36 (b)	87.4 (a)
11/16/2005	50.4	15.9 (a)	1.36 (b)	92.2 (a)
11/16/2005	40.9	53.5 (a)	2.37 (b)	69.3 (a)
11/16/2005	44.6	15 (a)	1.10 (b)	73.9 (a)
11/16/2005	50.4	29.5 (a)	1.78 (b)	76.4 (a)
11/16/2005	49.7	10.1 (a)	0.88	67.1 (a)
11/21/2005	68.3	42.8 (a)	2.37 (b)	121.0 (a)
11/21/2005	56.9	9.4 (a)	2.39 (b)	130.0 (a)
11/21/2005	24.9	44.8 (a)	1.92 (b)	66.5 (a)
11/21/2005	35.8	14.8 (a)	0.62	71.0 (a)
11/21/2005	36.4	9.1 (a)	0.80	62.6 (a)
11/21/2005	35.8	12.9 (a)	0.61	58.7 (a)
11/21/2005	45.5	8.8 (a)	2.1 (b)	59.4
11/21/2005	38.0	12.8 (a)	3.19 (b)	57.4 (a)
11/21/2005	25.4	36.1 (a)	2.15 (b)	69.6 (a)

Sample Date	Total Hardness (mg/L CaCO3)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)
11/21/2005	32.9	11.5 (a)	0.87 (b)	50.8 (a)
11/21/2005	29.8	15.9 (a)	0.85 (b)	36.7
11/21/2005	16.3	9.8 (a)	2.96 (b)	33.3 (a)
12/4/2005	52.5	5.7 (b)	0.50	86.3 (a)
12/15/2005	29.8	40.6 (a)	1.01 (b)	62.3 (a)
12/15/2005	24.3	67.3 (a)	1.62 (b)	73.8 (a)
12/15/2005	24.3	24 (a)	5.73 (b)	62.4 (a)
12/15/2005	21.9	10 (a)	1.78 (b)	40.8 (a)
12/15/2005	25.1	28.8 (a)	1.07 (b)	74.4 (a)
12/15/2005	22.4	40.4 (a)	1.63 (b)	61.0 (a)
1/23/2006	24.5	19 (a)	4.52 (b)	53.6 (a)
1/23/2006	21.7	36.7 (a)	10.20 (b)	70.4 (a)
2/22/2006	93.8	58.2 (a)	3.81 (b)	80.3
2/22/2006	95.3	16 (a)	2.16	93.8
2/22/2006	82.7	17.2 (a)	2.22 (b)	90.7
2/22/2006	65.8	12 (a)	0.66	69.7
2/22/2006	57.9	69.3 (a)	3.61 (b)	80.5 (a)
2/22/2006	63.0	65.6 (a)	5.09 (b)	73.4
2/22/2006	21.1	17.8 (a)	1.85 (b)	75.3 (a)
2/22/2006	54.9	26.6 (a)	4.76 (b)	79.1 (a)
3/7/2006	125	26.5 (a)	6.24 (b)	177 (a)
3/20/2006	87.1	10.2 (b)	0.37	79.4
3/20/2006	63.4	29.0 (a)	0.89	79.3
3/20/2006	26.9	92.5 (a)	2.45 (b)	74.4 (a)
3/20/2006	15.7	25.8 (a)	5.40 (b)	48.3 (a)
3/20/2006	11.0	18.2 (a)	4.31 (b)	39.6 (a)
5/3/2006	126	11.3 (b)	2.83	43.6
5/10/2006	86.6	9.9 (b)	1.45	36.2
5/10/2006	35.2	47.7 (a)	1.71 (b)	51.0 (a)
5/10/2006	23.5	52.5 (a)	1.79 (b)	48.6 (a)
5/10/2006	20.3	37.6 (a)	2.83 (b)	143.0 (a)
5/10/2006	29.4	24.1 (a)	2.53 (b)	49.5 (a)
5/11/2006	36.6	93.8 (a)	2.81 (b)	45.3
6/7/2006	92.7	43.5 (a)	1.76	75.7
6/12/2006	78.1	29.8 (a)	0.96	21.1
6/12/2006	106	44.4 (a)	1.45	20.6
6/12/2006	54.0	48.6 (a)	1.78 (b)	36.0
6/12/2006	49.7	36.1 (a)	1.62 (b)	32.2
6/12/2006	58.7	28.5 (a)	1.18	16.1
6/12/2006	79.1	16.2 (a)	0.50	16.0
6/22/2006	101	3.6	0.36	12.5
7/12/2006	120	4.9	0.23	11.5
7/15/2006	106	4.6	0.51	18.8
7/15/2006	92.3	16.3 (a)	0.64	27.3
7/15/2006	53.4	22.8 (a)	1.32 (b)	69.2 (a)
7/15/2006	62.9	41 (a)	0.91	131.0 (a)
7/15/2006	63.1	43.4 (a)	1.21	88.5 (a)
7/15/2006	63.8	34.4 (a)	1.70 (b)	61.1
7/18/2006	104.0	9.0	0.62	48.5
8/20/2006	70.1	27.8 (a)	3.79	42.8
8/20/2006	26.4	13.7 (a)	1.61 (b)	30.9
8/20/2006	61.9	20.4 (a)	2.09 (b)	49.7

Sample Date	Total Hardness (mg/L CaCO3)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)
8/20/2006	48.1	10.1 (a)	1.93 (b)	25.1
8/20/2006	15.5	19.2 (a)	3.24 (b)	48.8 (a)
8/20/2006	24.5	9.0 (a)	1.52 (b)	22.9
8/28/2006	69.9	22.9 (a)	2.71 (b)	46.7
8/28/2006	32.9	15.3 (a)	2.68 (b)	31.9
8/28/2006	20.9	14.9 (a)	2.35 (b)	44.4 (a)
8/28/2006	19.3	16.3 (a)	2.36 (b)	45.4 (a)
8/28/2006	39.2	14.9 (a)	1.77 (b)	48.4
8/28/2006	59.0	17.5 (a)	1.79 (b)	37.5
8/30/2006	47.7	11.4 (a)	0.93	40.6
8/30/2006	52.6	6.6 (b)	0.54	29.4
9/8/2006	94.4	8.3	1.54	30.8
9/19/2006	61.2	10.5 (a)	2.10 (b)	33.1
9/19/2006	59.1	5.3	0.53	18.6
10/11/2006	135	2.3	0.37	13.0
11/15/2006	27.7	4.7 (a)	0.44	11.4
1/16/2007	61.5	6.1 (b)	0.32	74.8
2/1/2007	69.4	5.3	0.56	85.4
2/1/2007	45.4	15.8 (a)	2.45	105.0 (a)
2/1/2007	34.5	20.2 (a)	3.34 (b)	93.7 (a)
2/1/2007	19.4	18.1 (a)	3.08 (b)	74.8 (a)
2/1/2007	19.9	18.7 (a)	2.47 (b)	87.2 (a)
2/1/2007	15.5	56.4 (a)	2.17 (b)	133.0 (a)
2/13/2007	87.4	18.6 (a)	2.61 (b)	103.0
2/13/2007	79.2	13.5 (a)	1.90	88.2
2/13/2007	54.7	18.6 (a)	1.49 (b)	169.0 (a)
2/13/2007	47.1	16.5 (a)	1.22 (b)	88.6 (a)
2/13/2007	43.1	25.4 (a)	2.69 (b)	108.0 (a)
2/13/2007	49.3	48.4 (a)	1.56 (b)	85.3 (a)
2/15/2007	83.8	3.0	0.31	82.3
2/27/2007	105	2.2	0.43	57.6
3/1/2007	33.5	11.9 (a)	1.07 (b)	53.6 (a)
3/1/2007	33.4	4.6 (b)	0.50	46.5 (a)
3/1/2007	27.2	4.0 (a)	0.70 (b)	10.5
3/1/2007	27.8	4.2 (a)	0.55	12.2
3/9/2007	128	2.0	0.16	63.1
6/18/2007	31.6	9.2 (a)	1.66 (c)	15.2
7/8/2007	18.6	5.3 (a)	0.94 (c)	18.9
7/10/2007	19.2	7.9 (a)	1.11 (c)	22.5
7/25/2007	18.9	8.1 (a)	1.11 (c)	27.1
8/22/2007	87.7	2.0	0.21	4.0
8/24/2007	39.8	9.5 (a)	0.83	26.0
8/29/2007	20.3	102.0 (a)	7.64 (b)	85.6 (a)
8/30/2007	24.8	65.5 (a)	3.33 (b)	79.2 (a)
9/13/2007	16.3	82.9 (a)	6.57 (b)	58.8 (a)
9/14/2007	13.9	14.5 (a)	2.40 (b)	19.2
10/23/2007	29.9	4.4 (a)	0.90 (b)	20.5
11/15/2007	45.0	8.4 (a)	1.33 (b)	43.6
12/11/2007	88.9	1.8	0.22	10.7
1/10/2008	25.0	85.7 (a)	7.04 (b)	77.2 (a)
2/1/2008	13.6	4.2 (a)	1.15 (b)	27.8 (a)
2/17/2008	24.7	2.9 (b)	0.95 (b)	12.8

Sample Date	Total Hardness (mg/L CaCO3)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)
2/26/2008	31.1	3.3	1.32 (b)	27.1
3/19/2008	29.0	6.2 (a)	0.76 (b)	42.0 (a)
3/29/2008	26.3	5.6 (a)	1.00 (b)	42.0 (a)
4/26/2008	NS	NS	2.30	40.0
5/5/2008	80.0	2.0	0.40	NS
6/30/2008	81.2	3.0	0.70	20.0
7/11/2008	24.8	4.0 (a)	2.50 (b)	10.0
7/31/2008	38.9	7.0 (a)	2 (b).00	20.0
10/8/2008	32.1	3.3	1.60 (b)	11.7
12/10/2008	24.4	4.0 (a)	1.30 (b)	NS
12/24/2008	27.1		0.70 (b)	14.0
1/5/2009	25.6	4.9 (a)	0.60 (b)	22.0
2/27/2009	25.0	3.8 (a)	0.80 (b)	20.0
3/26/2009	NS	NS	NS	25.0
4/1/2009	33.7	3.2	14.20 (b)	21.6
4/9/2009	108	2.0	0.73	61.9
4/10/2009	27.6	4.5 (a)	2.35 (b)	23.6
4/19/2009	39.0	9.5 (a)	1.55 (b)	30.7
4/23/2009	18.8	4.0 (a)	2.10 (b)	15.9
5/1/2009	27.2	5.4 (a)	1.64 (b)	15.8
5/16/2009	43.0	7.2 (a)	1.33 (b)	32.9
5/23/2009	63.2	6.5 (b)	0.95	26.5
6/4/2009	49.4	5.6 (b)	1.11	29.2
6/11/2009	21.0	9.1 (a)	1.36 (b)	29.3
7/30/2009	34.4	5.1 (a)	1.26 (b)	22.5
8/18/2009	35.4	5.5 (a)	1.64 (b)	27.5
8/21/2009	19.4	9.0 (a)	1.22 (b)	59.3 (a)
8/27/2009	19.9	4.1 (a)	1.05 (b)	26.2
10/7/2009	55.4	7 (b)	1.85 (b)	76.6 (a)
10/12/2009	17.0	4.3 (a)	1.49 (b)	21.2
10/14/2009	44.2	6.3 (a)	1.62 (b)	37.9
10/21/2009	131	3.0	0.37	67.3
10/27/2009	25.4	10.9 (a)	1.08 (b)	46.3 (a)
11/10/2009	25.7	6.5 (a)	1.20 (b)	45.1 (a)
11/22/2009	42.7	5.9 (b)	0.79	59.4 (a)
12/2/2009	22.1	5.8 (a)	0.78 (b)	45.8 (a)
1/16/2010	41.4	6.0 (a)	0.73	80.9 (a)
1/21/2010	33.1	6.5	0.73	43.9
1/30/2010	47.5	4.2	0.68	71.8 (a)
3/10/2010	26.8	5.1 (a)	0.78 (b)	52.7 (a)
4/8/2010	27.4	10.3 (a)	1.55 (b)	54.3 (a)
4/13/2010	134	3.5	0.29	77.8
5/21/2010	28.0	4.2 (a)	0.61	20.6
6/2/2010	29.6	4.7 (a)	1.00 (b)	30.9
7/9/2010	44.9	5.2 (b)	0.69	64.4 (a)
7/12/2010	29.5	4.4 (a)	1.08 (b)	25.9
8/20/2010	20.0	4.8 (a)	0.82 (b)	26.6
9/26/2010	36.7	6.6 (a)	0.80	30.3
10/12/2010	39.1	5.3 (b)	0.97 (b)	10.1
10/25/2010	36.0	6.1 (a)	0.91 (b)	38.0
10/27/2010	28.4	6.8 (a)	3.42 (b)	33.6
11/3/2010	45.0	4.5	0.82	38.7

Sample Date	Total Hardness (mg/L CaCO3)	Dissolved Copper (µg/L)	Dissolved Lead (µg/L)	Dissolved Zinc (µg/L)
11/15/2010	19.8	3.1 (a)	1.31 (b)	23.8
11/30/2010	16.6	3.8 (a)	2.09 (b)	14.7
12/12/2010	51.8	4.3	0.80	59.4

Notes: a = exceedance of acute criteria
b = exceedance of chronic criteria
NS = not sampled

Appendix B

Plots of Copper, Lead, and Zinc Concentrations in Woodall Creek 2003 - 2010

Figure B-1a. Copper Concentrations in Woodall Creek 2003 - 2010

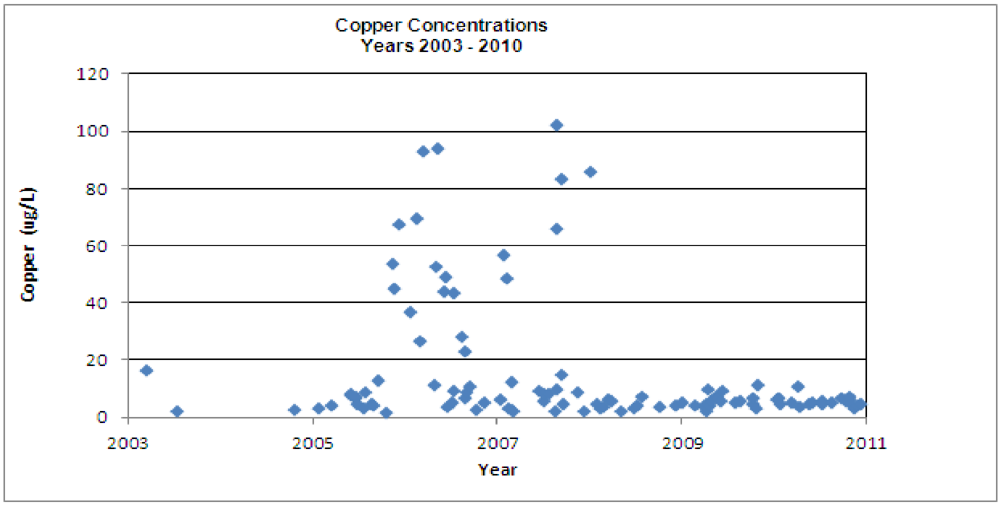


Figure B-1b. Lead Concentrations in Woodall Creek 2003 - 2010

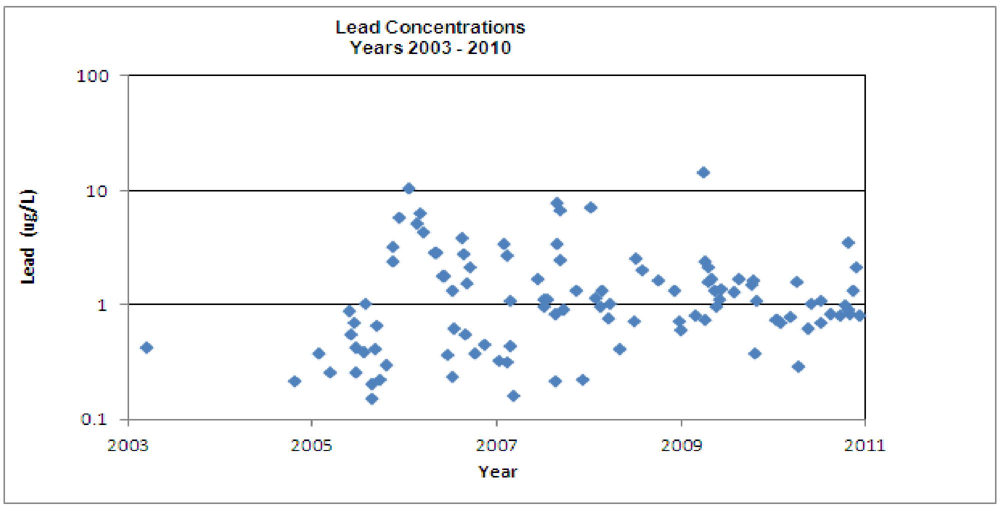
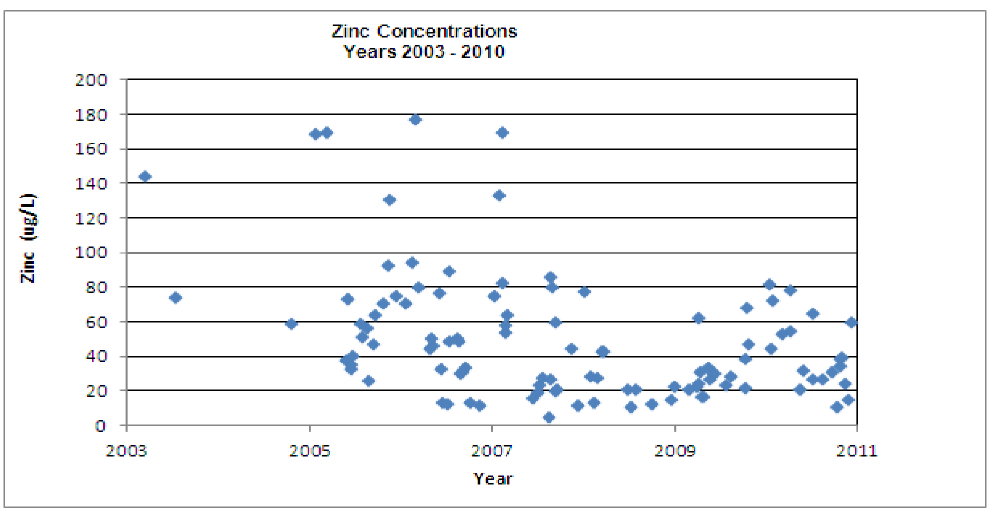


Figure B-1c. Zinc Concentrations in Woodall Creek 2003 - 2010



Appendix C

Woodall Creek:
Plots of Copper, Lead, and Zinc Concentrations
and
Precipitation

Figure C-1a. Copper Concentrations vs. Precipitations in Woodall Creek, 2005

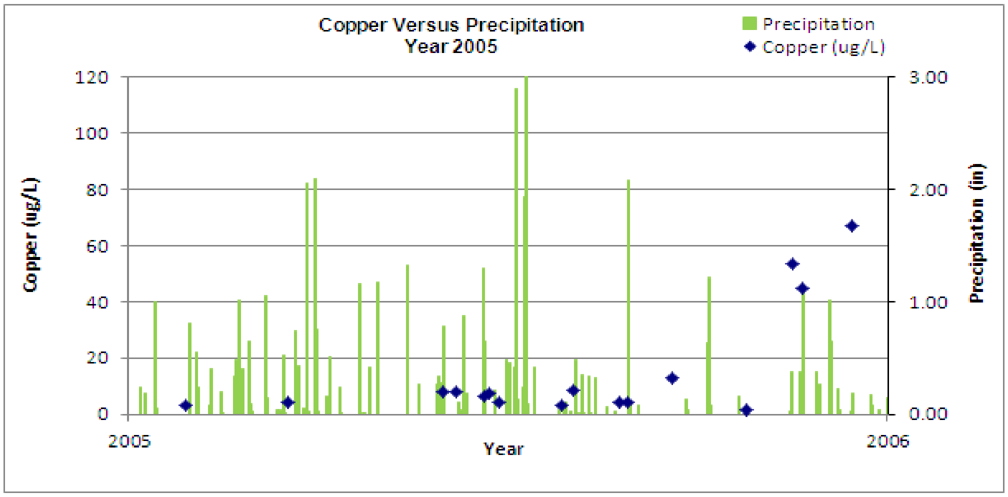


Figure C-1b. Copper Concentrations vs. Precipitations in Woodall Creek, 2006

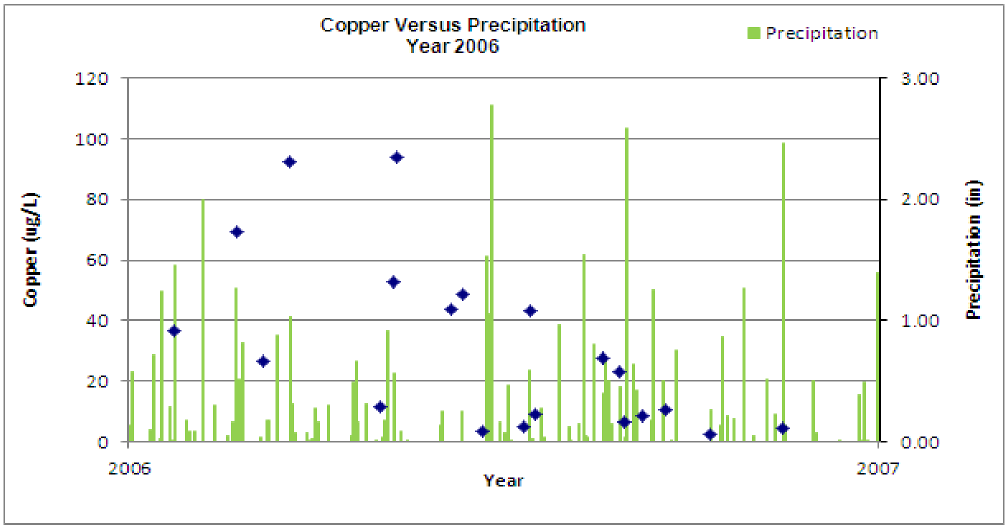


Figure C-1c. Copper Concentrations vs. Precipitations in Woodall Creek, 2007

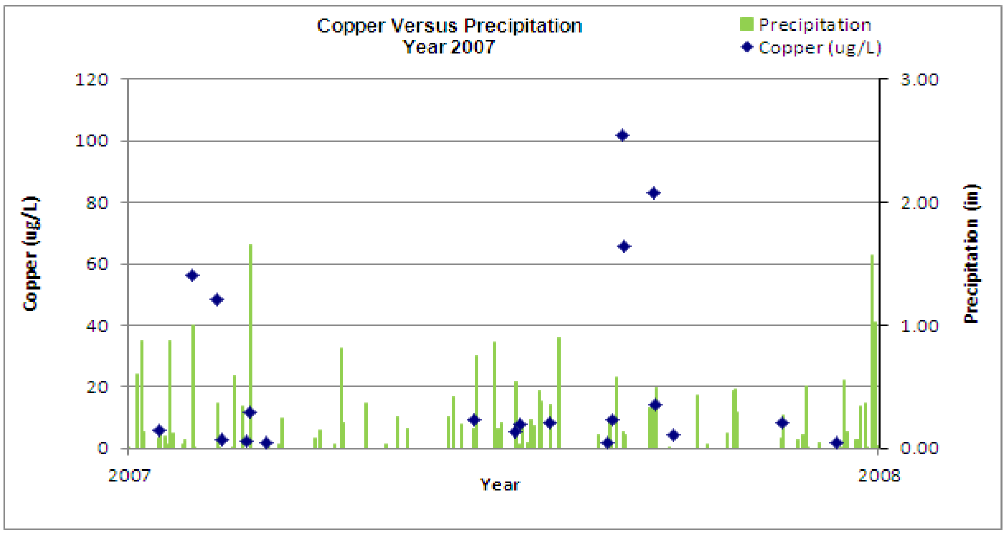


Figure C-1d. Copper Concentrations vs. Precipitations in Woodall Creek, 2008

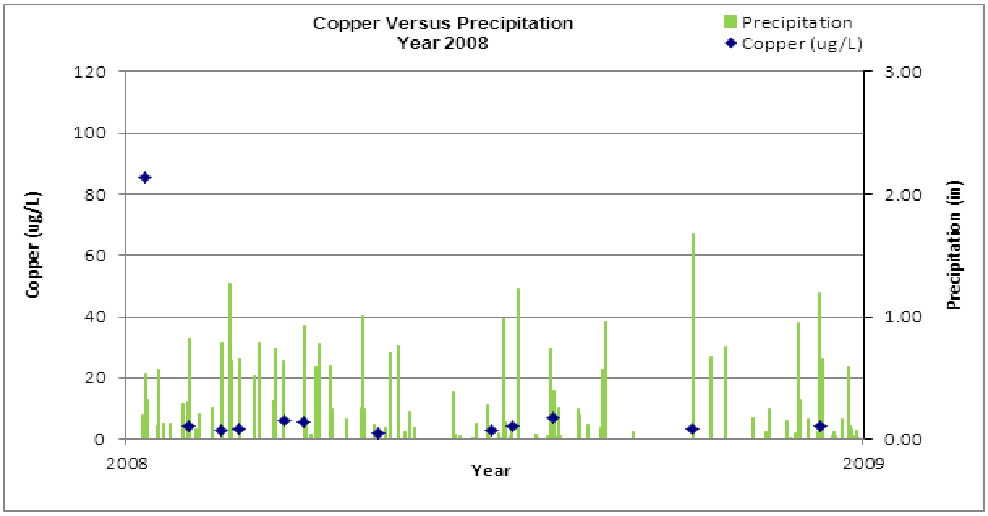


Figure C-1e. Copper Concentrations vs. Precipitations in Woodall Creek, 2009

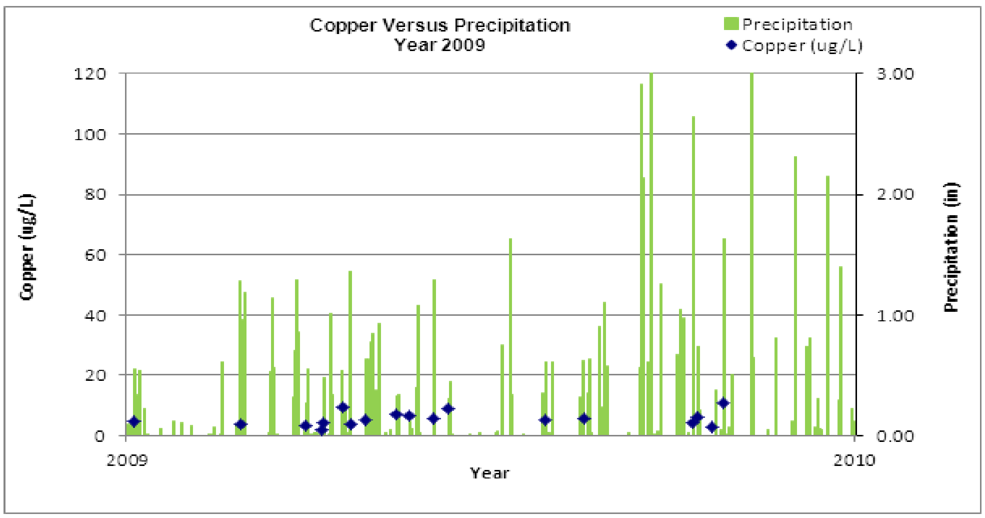


Figure B-1f. Copper Concentrations vs. Precipitations in Woodall Creek, 2010

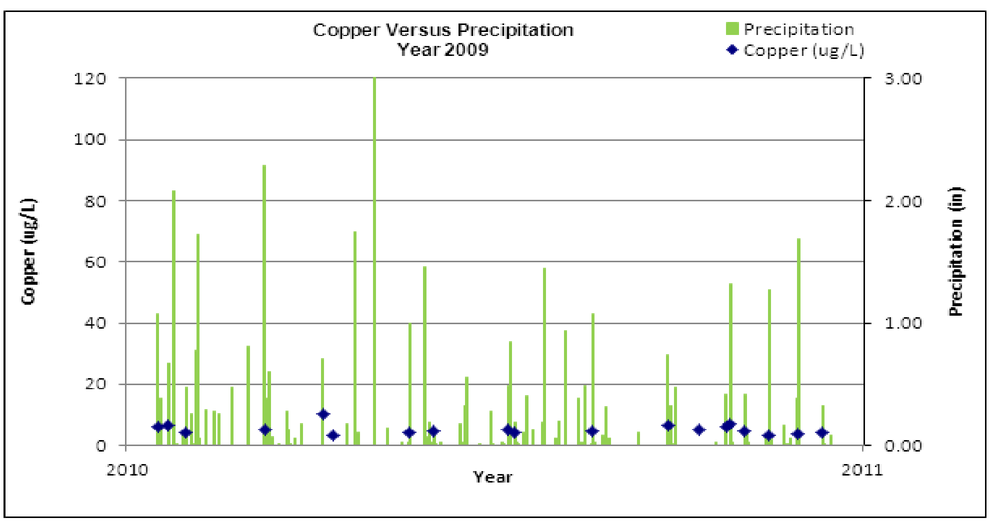


Figure C-2a. Lead Concentrations vs. Precipitations in Woodall Creek, 2005

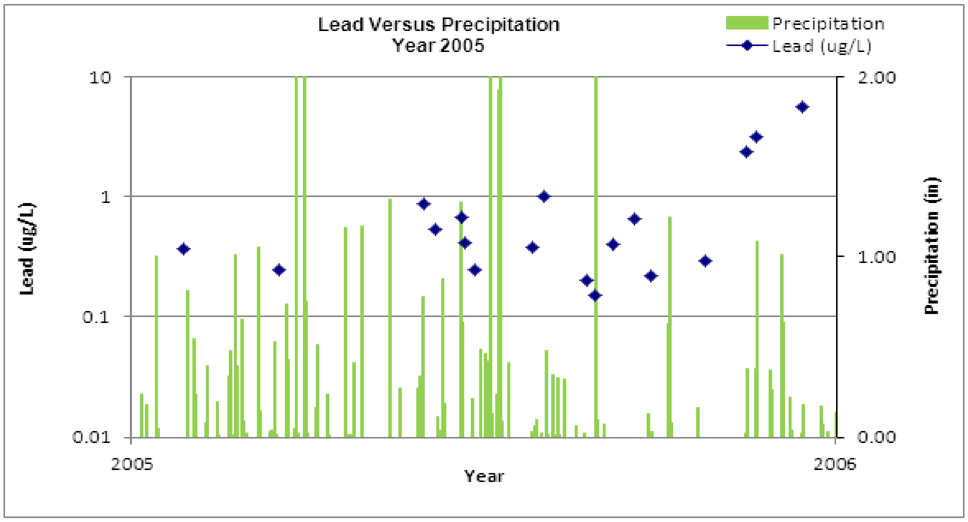


Figure C-2b. Lead Concentrations vs. Precipitations in Woodall Creek, 2006

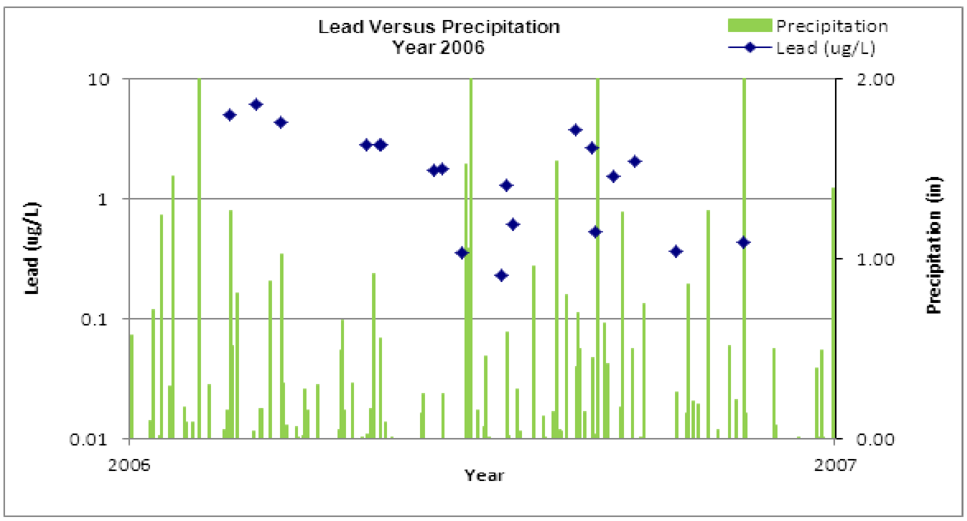


Figure C-2c. Lead Concentrations vs. Precipitations in Woodall Creek, 2007

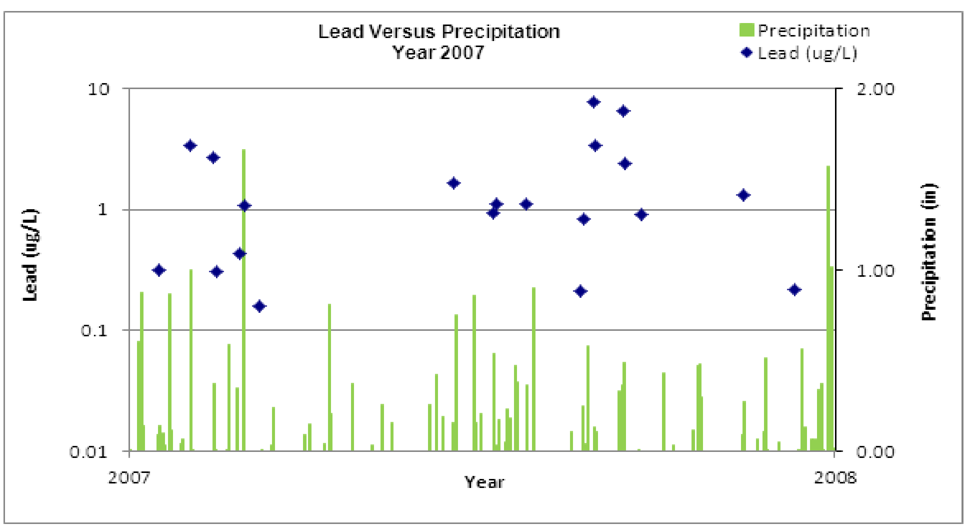


Figure C-2d. Lead Concentrations vs. Precipitations in Woodall Creek, 2008

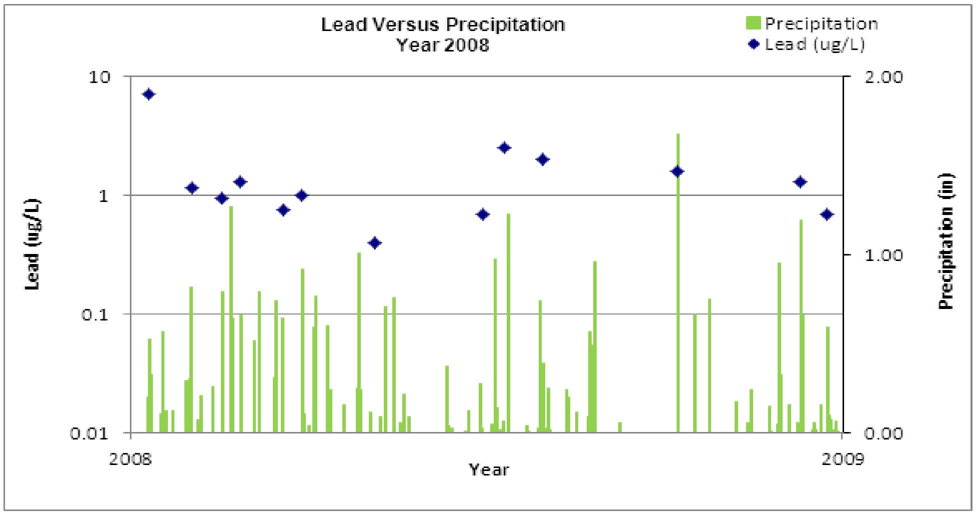


Figure C-2e. Lead Concentrations vs. Precipitations in Woodall Creek, 2009

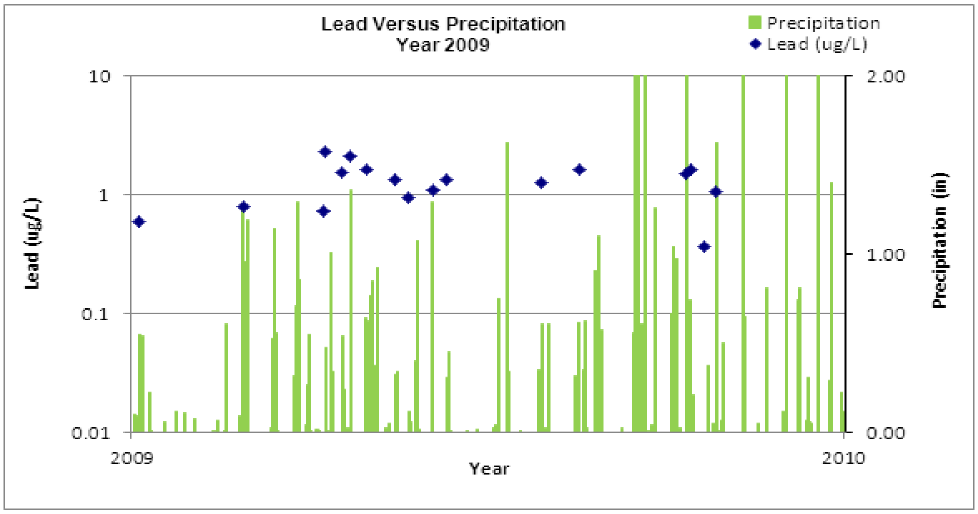


Figure C-2f. Lead Concentrations vs. Precipitations in Woodall Creek, 2010

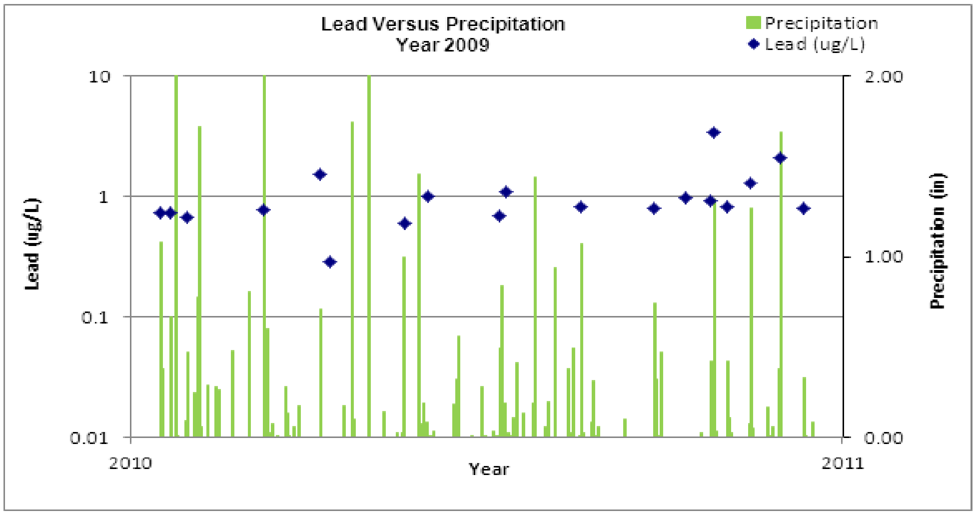


Figure C-3a. Zinc Concentrations vs. Precipitations in Woodall Creek, 2005

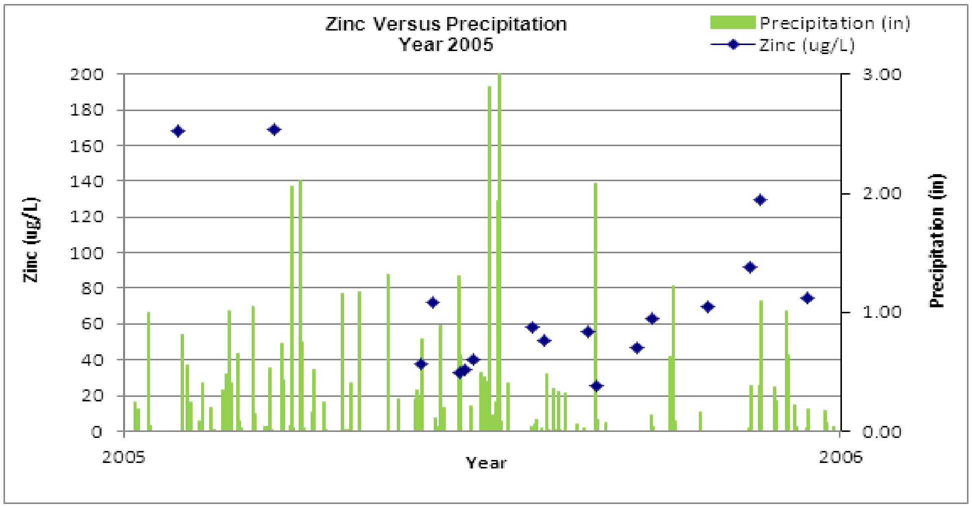


Figure C-3b. Zinc Concentrations vs. Precipitations in Woodall Creek, 2006

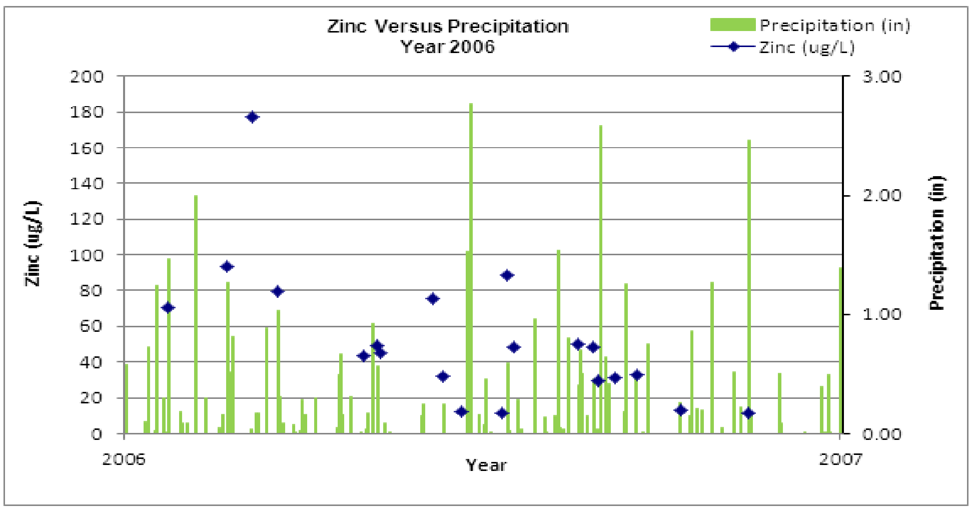


Figure C-3c. Zinc Concentrations vs. Precipitations in Woodall Creek, 2007

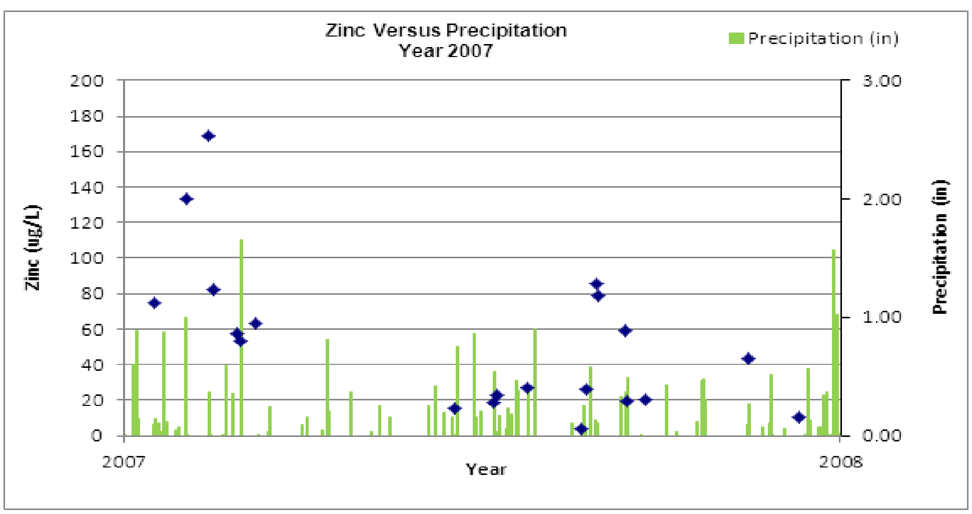


Figure C-3d. Zinc Concentrations vs. Precipitations in Woodall Creek, 2008

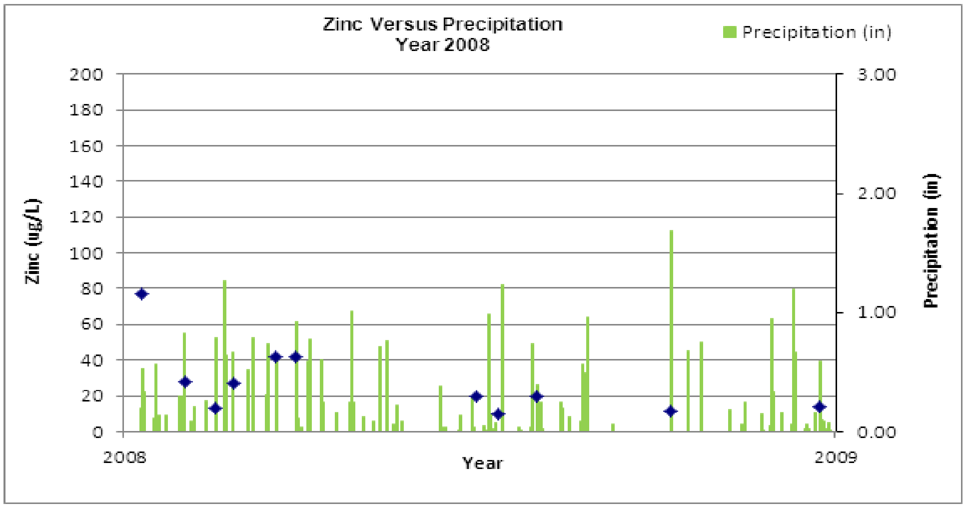


Figure C-3e. Zinc Concentrations vs. Precipitations in Woodall Creek, 2009

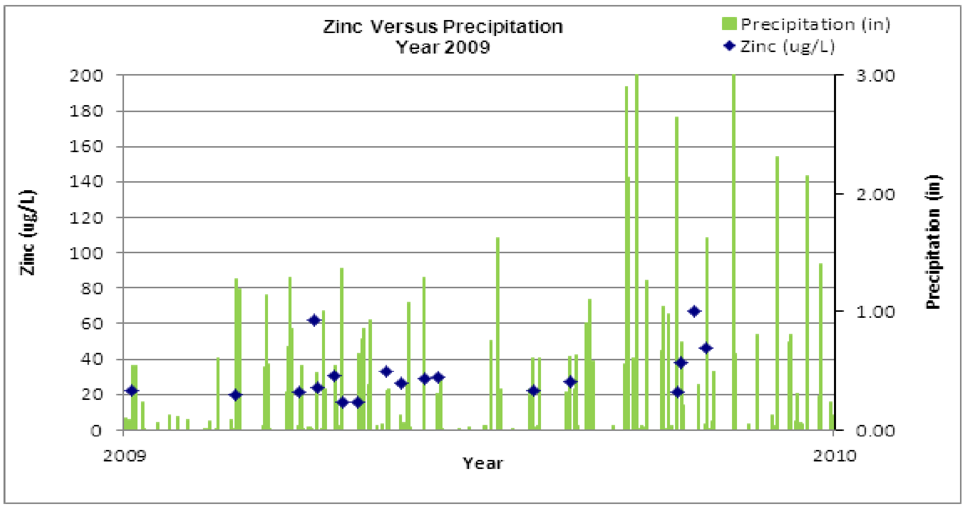
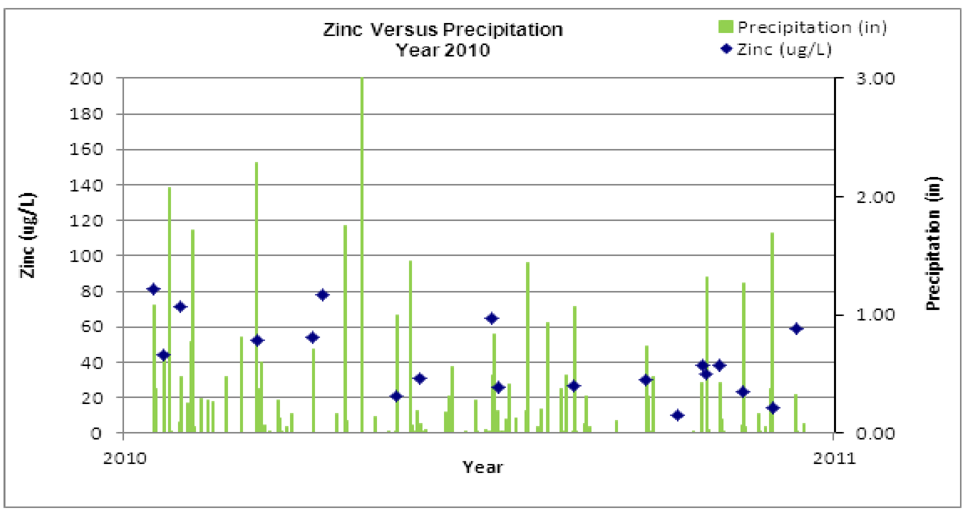


Figure C-3f. Zinc Concentrations vs. Precipitations in Woodall Creek, 2010



Appendix D

Woodall Creek:
Plots of Copper, Lead, and Zinc Concentrations
and
Stormwater Hydrographs

Figure D-1a. Copper Concentration vs. Flow Gage Height - June 21, 2005

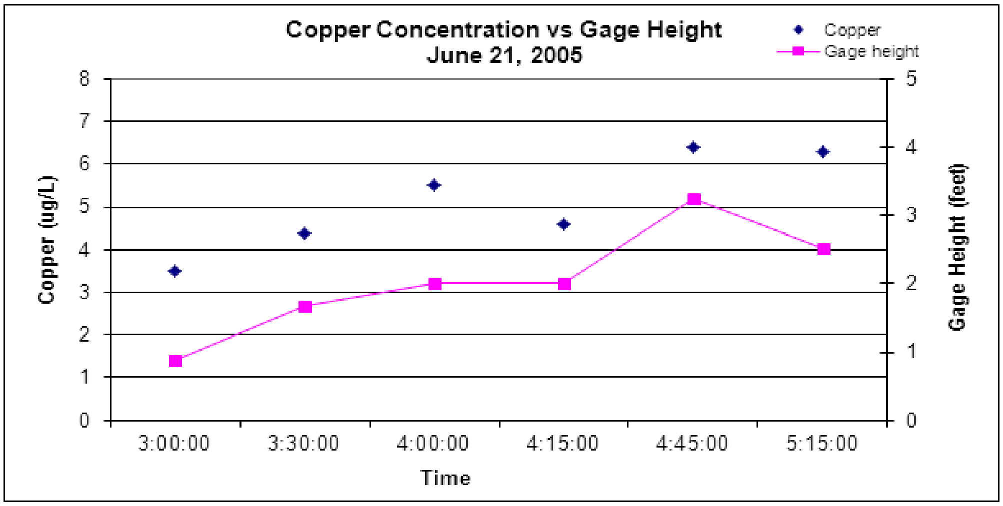


Figure D-1b. Copper Concentration vs. Flow Gage Height - November16, 2005

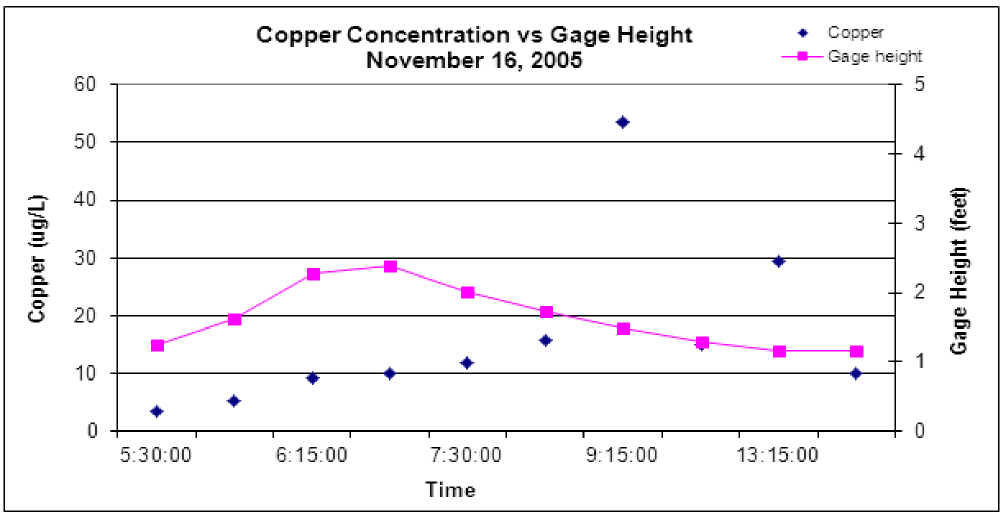


Figure D-1c. Copper Concentration vs. Flow Gage Height - May 10, 2006

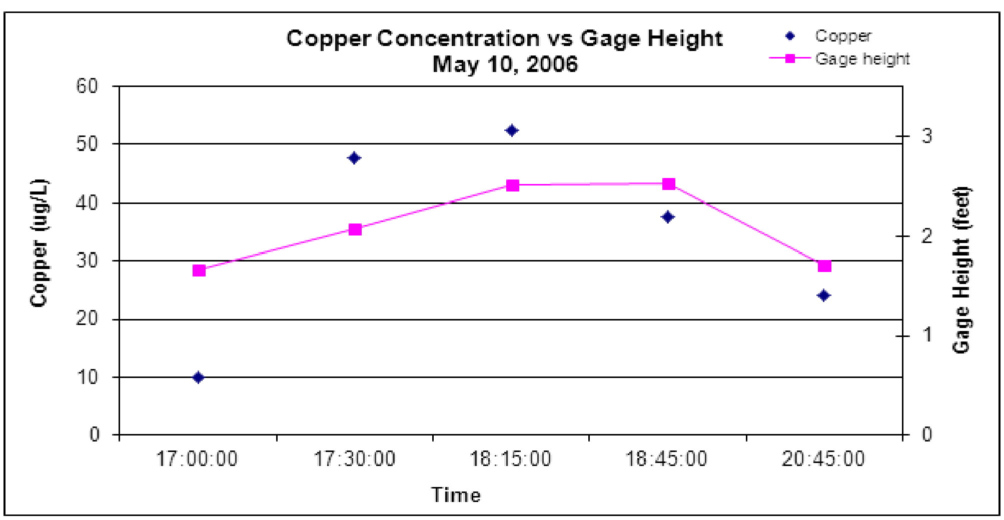


Figure D-1d. Copper Concentration vs. Flow Gage Height - June 12, 2006

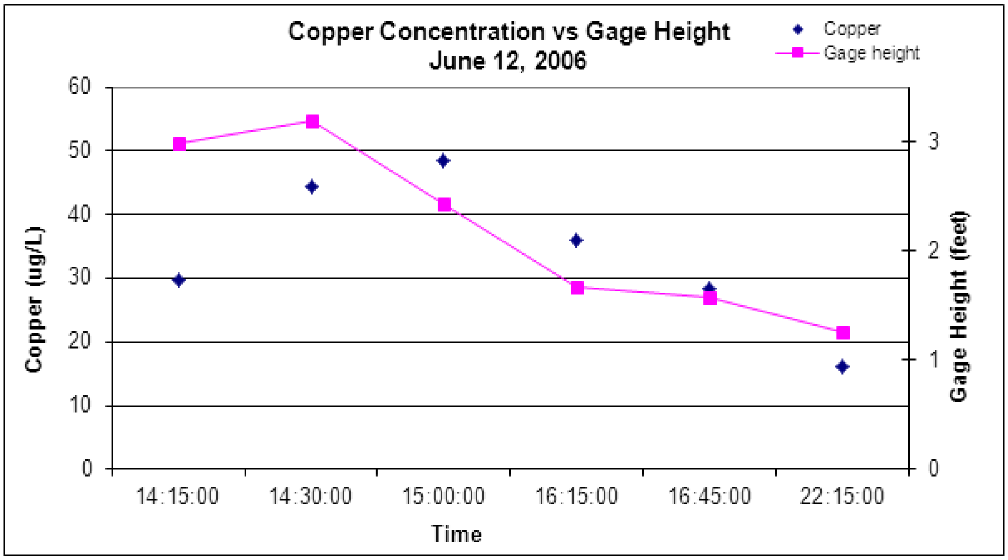


Figure D-1e. Copper Concentration vs. Flow Gage Height - February 1, 2007

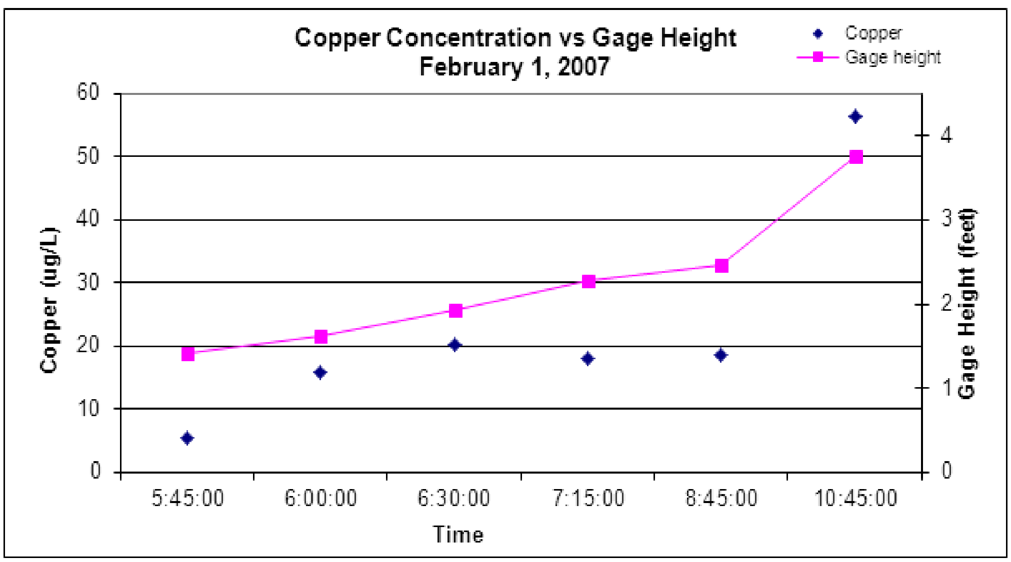


Figure D-2a. Lead Concentration vs. Flow Gage Height - June 21, 2005

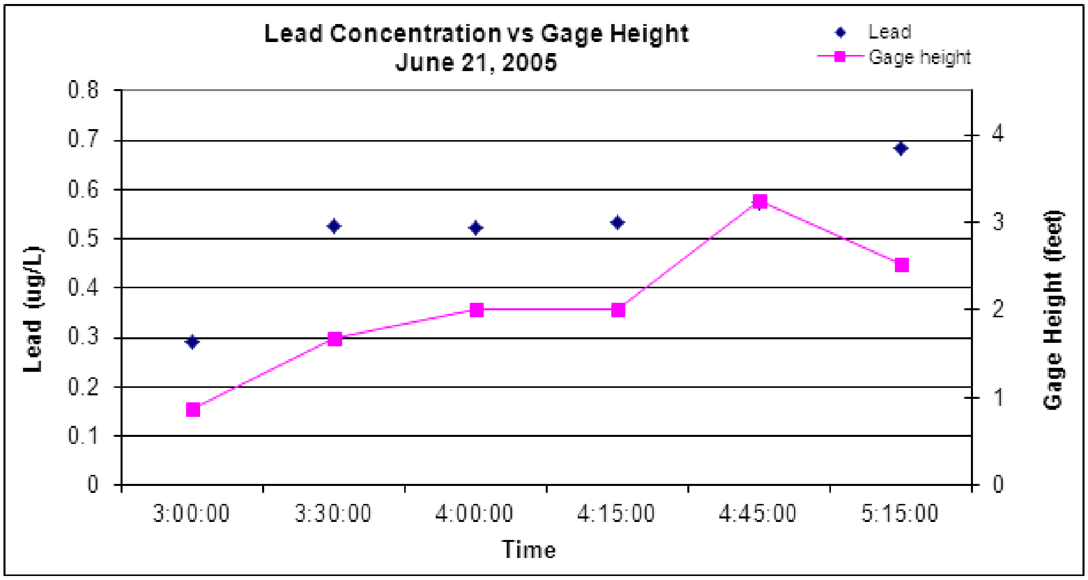


Figure D-2b. Lead Concentration vs. Flow Gage Height - March 20, 2006

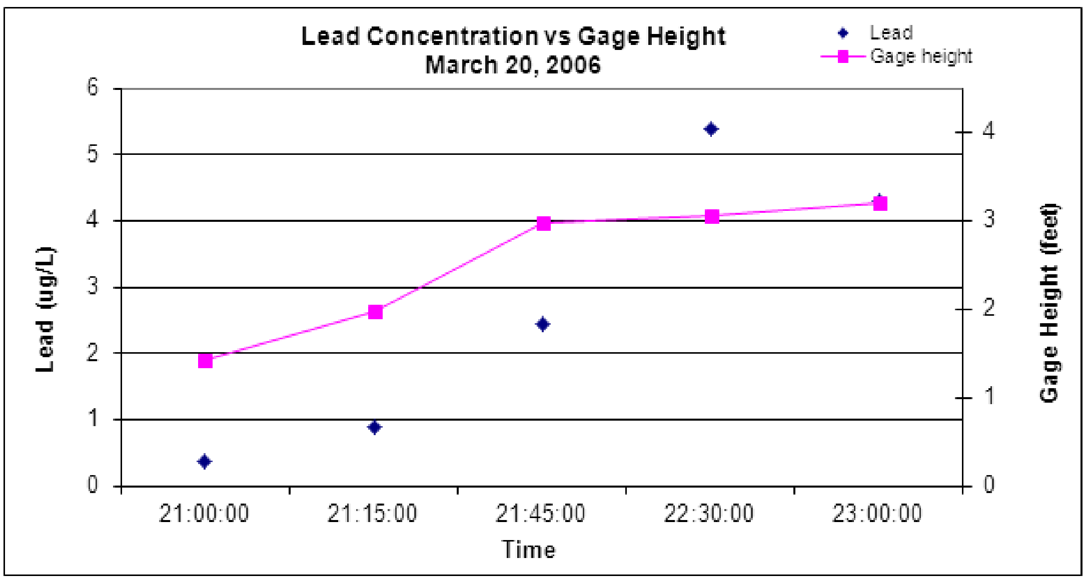


Figure D-2c. Lead Concentration vs. Flow Gage Height - June 12, 2006

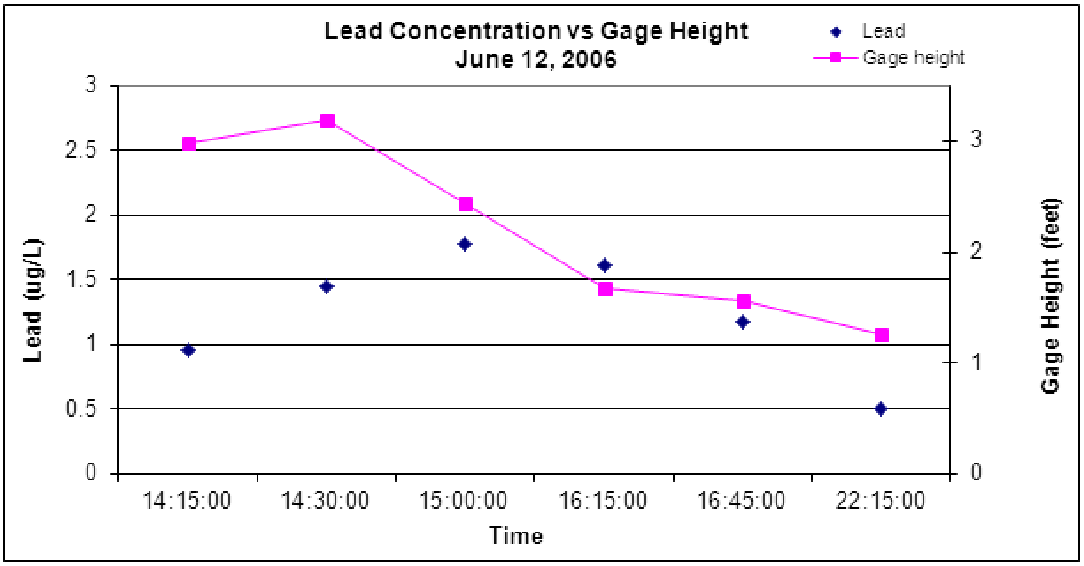


Figure D-2d. Lead Concentration vs. Flow Gage Height - July 15, 2006

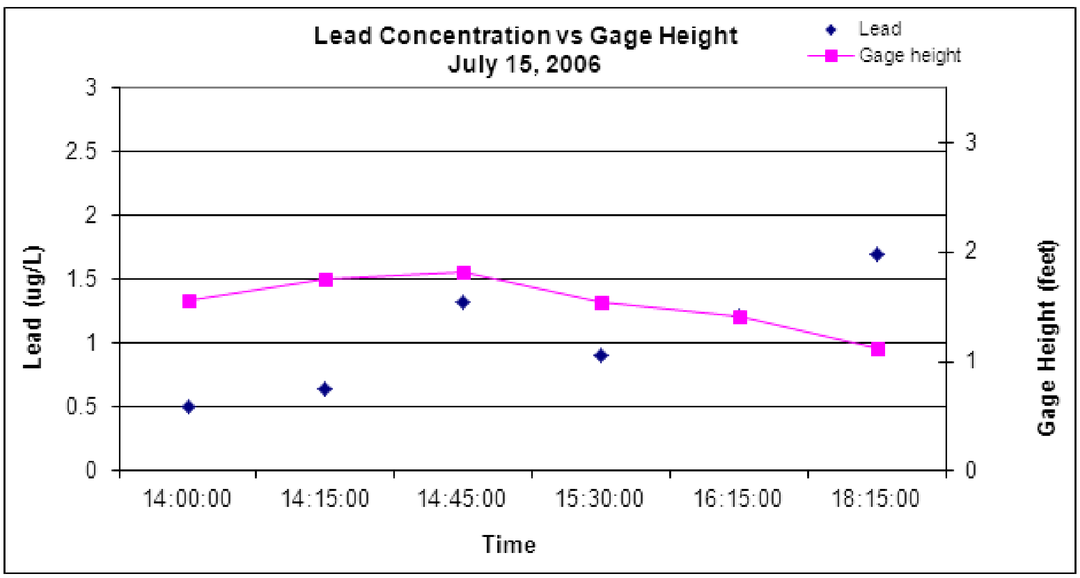


Figure D-3a. Zinc Concentration vs. Flow Gage Height - November 16, 2005

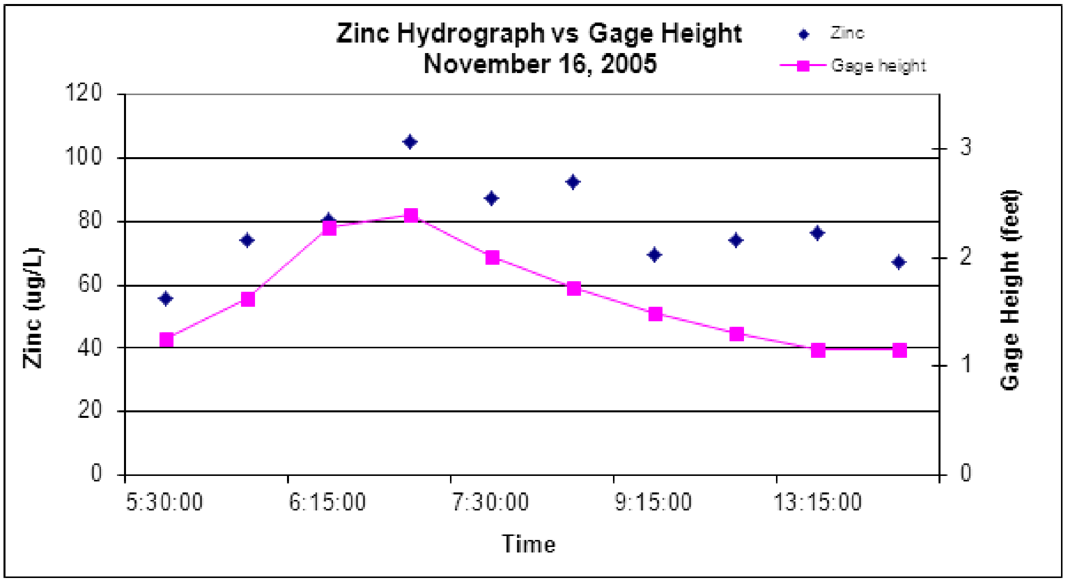
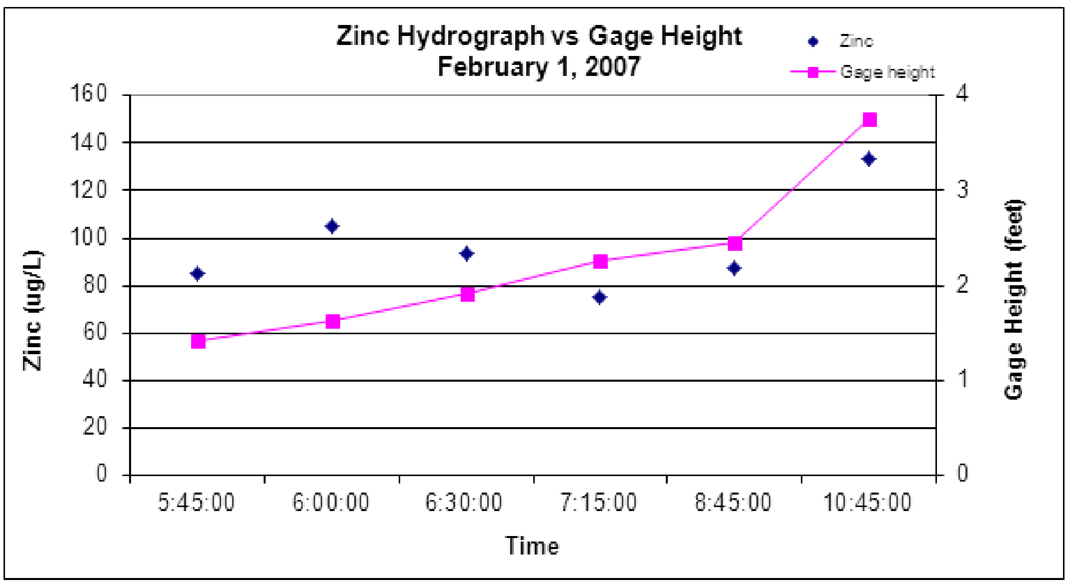


Figure D-3b. Zinc Concentration vs. Flow Gage Height - February 1, 2007



Appendix E

Estimation of 1Q10 and 7Q10 Flows for Woodall Creek

Calculation of Average 1Q10 and 7Q10 Estimates for Streams in Upper Chattahoochee River Basin and Calculation of Estimated 1Q10 and 7Q10 for Woodall Creek.

Source: Carter, R. F., E.H. Hopkins, and H.A. Perlman, 1989, Low-Flow Profiles of the Upper Chattahoochee River and Tributaries in Georgia, Water Resources Investigations Report 89-4056, U.S. Geological Survey, Doraville, GA.

Stream	Drainage Area (sq. mi.)	7Q10 (cfs)	Productivity (cfs/sq. mi.)	Drainage Area (sq. mi.)	1Q10 (cfs)	Productivity (cfs/sq. mi.)
Powder Springs Creek	9.0	0.59	0.07			
Noses Creek	6.2	0.45	0.07			
Ward Creek	6.3	0.60	0.10			
Rottenwood Creek	7.2	1.90	0.26			
Peachtree Creek	10.5	0.43	0.04	86.8	9.2	0.11
South Fork Peachtree Creek	5.6	0.16	0.03			
Nancy Creek	21.2	2.20	0.10			
Proctor Creek	10.7	0.67	0.06			
Nickajack Creek	11.2	1.10	0.10			
Utoy Creek	5.5	0.56	0.10			
South Utoy Creek	7.3	0.66	0.09			
Big Creek				72	5.4	0.08
Sweetwater Creek				246	13	0.05
Averages			0.09			0.08

	Drainage Area (sq. mi.)	7Q10 Productivity (cfs/sq mi)	7Q10 (cfs)	1Q10 Productivity (cfs/sq mi)	1Q10 (cfs)
Woodall Creek	2.82	0.09	0.25	0.08	0.23