Analysis of Georgia's Regulation of NPDES Storm Water Discharges Associated with Construction Activities: Policies and Practices

by

Jordia Phillips Waller

(Under the direction of Todd C. Rasmussen)

Abstract

Nonpoint-source (NPS) pollution is a major source of water quality impairment in Georgia's waters. With rapid development in Georgia, turbid storm-water discharges from construction sites has become the leading cause of NPS pollution. From August 1, 2000, to the present the Georgia Environmental Protection Division (EPD) has accumulated turbidity data from storm-water discharges associated with land-disturbing activities at construction sites. A small sample of these data (20 sites) were used here to evaluate whether variations in turbidity can be explained by the type of disturbance (spatial vs. linear), magnitude of the disturbance area, the time of year, or the amount of precipitation. Recommendations were made to EPD on their current National Pollutant Discharge Elimination Systems (NPDES) permit based on these data plus an analysis of similar programs in three other Southeastern states.

Index words: Sediment, Storm Water, NPDES, Georgia, Land Disturbing Activities, Construction, Nonpoint-Source Pollution

Analysis of Georgia's Regulation of NPDES Storm Water Discharges Associated with Construction Activities: Policies and Practices

by

Jordia Phillips Waller

B.S., The University of Georgia, 1999

A Thesis Submitted to the Graduate Faculty
of The University of Georgia in Partial Fulfillment
of the
Requirements for the Degree

Master of Science

Athens, Georgia

2004

ANALYSIS OF GEORGIA'S REGULATION OF NPDES STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES: POLICIES AND PRACTICES

by

JORDIA PHILLIPS WALLER

Approved:

Major Professor: Todd C. Rasmussen

Committee: C. Rhett Jackson
Lawrence A. Morris

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2004

Dedication

This project is dedicated to the memory of my grandfathers, L.L. "Pete" Phillips and Treutlen Waller. Also, I would like to express my deep appreciation to all of my family, particularly my mother and father, who have inspired me in so many ways and have always supported me. I would also like to thank my wife, Key, for her love and support. She is the love of my life and I thank the Lord everyday for putting her in my life.

Acknowledgments

I thank my major professor, Todd Rasmussen, for his guidance and encouragement on this project. I am also grateful to the members of my committee, Rhett Jackson and Larry Morris for their advice. I would also like to thank the Georgia EPD Northeast Regional Office for providing me access to turbidity data that allowed me to complete this project. In particular I would like to thank Bob Fulmer and Bob Bishop with the Georgia EPD.

Preface

The idea for this research originated when I worked for an environmental firm conducting construction site inspection and sampling for Georgia's NPDES permit. I spent three years working in this area, during which time I had the opportunity to interact with contractors, environmental consultants and State of Georgia employees. I was able to observe many of the practices from each of these participants. This gave me a unique perspective of the Georgia NPDES with respects to construction activity and motivated me to work on this project.

Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Problem Statement

Nonpoint source (NPS) pollution is the nation's largest source of water quality problems. NPS pollution occurs whenever rainfall or irrigation runs over land or through the ground, picks up pollutants and sediments, and deposits them into rivers, lakes, and coastal waters, or introduces them into ground water.

The U.S. Environmental Protection Agency (EPA) reports that NPS pollution is the main reason that approximately 40 percent of surveyed rivers, lakes, and estuaries are not clean enough to meet basic uses such as fishing or swimming (EPA, 2001). Areas of our nation and state are being developed at rapid rates, and with this development, storm water from construction sites is one of the leading causes of NPS pollution (EPD, 2001).

Erosion from construction sites, exposed soils, street runoff, and streambank erosion are the primary sources of sediment in urban runoff (EPD, 2001). Water quality degradation in urbanizing watersheds starts when development begins. As land is developed and disturbed, sediment moving off-site can be significant unless proper erosion control measures are implemented. Urbanization increases the amount of runoff contributed to channels and quickens the amount of travel time to receiving streams (Pate, 1983). Erosion from construction sites and other disturbed areas contributes large amounts of sediment to streams.

Excessive sediment can be detrimental to aquatic life by interfering with photosynthesis, respiration, growth, and reproduction. In addition, sediment particles transport other pollutants that are attached to their surfaces including nutrients, trace metals, and hydrocarbons. High turbidity due to sediment increases the cost of treating drinking water and reduces the value of surface waters for industrial and recreational use. Sedimentation can also reduce the capacity of reservoirs and lakes, block navigation channels, fill harbors and silt estuaries (EPD, 2001).

In an effort to reduce the sediment lost from these sites, construction Best Management Practices (BMPs) have been developed. BMPs are methods that have been determined to be the most effective, practical means of preventing or reducing pollution from storm-water runoff. These include controls on scheduling activities, prohibitions of practices, maintenance procedures, and other management practices (Dodson, 1998). The primary purpose of using BMPs is to protect beneficial uses of water resources through the reduction of pollutant loads and concentrations, and through reduction of discharges (volumetric flow rates) causing stream channel erosion (DOE, 2002).

Because storm-water runoff is the major cause of impaired water quality in Georgia's streams, rivers, and lakes (EPD, 2001), the state of Georgia passed the National Pollutant Discharge Elimination System (NPDES) in February of 2000 to regulate this growing problem. Under the NPDES permit, land developers are required to have authorization from the Georgia Environmental Protection Division (EPD), in order to discharge storm water into state waters (EPD, 2000). As part of the NPDES permit, anyone disturbing more than five acres of land must:

- Submit a Notice of Intent (NOI), develop an Erosion, Sedimentation & Pollution Control Plan;
- Complete a Comprehensive Monitoring Plan;
- Monitor the construction site during construction; and
- Submit a Notice of Termination after the site has stabilized.

Samples of storm water are taken at outfalls and/or receiving streams, after rainfall events and tested for turbidity. This allows EPD to keep track of inadequate erosion and sedimentation practices that occur on large construction sites.

Studies of BMP effectiveness have tended to focus on the forest and agricultural industries and their effects on water quality within a particular watershed. For example, Vowell (2001) conducted a multiple site bioassessment study in the northern region of Florida. Each of four sites was adjacent to a perennial stream and was assessed before and after the forest was clearcut. Leaving only a Streamside Management Zone (SMZ), no significant water quality impairments were attributed to forestry activities. SMZs are buffers of vegetation left adjacent to streams to help slow the velocity of storm water and allow sediments to filter out. The post-treatment assessment of habitat smothering due to sediment overload and stream bank stability also showed no change when compared to pre-treatment observations, and all four sites remained in the optimal range in habitat assessment.

Hill investigated how tillage and wheel traffic effects runoff and sediment losses from crop inter-rows. The researcher used two established tillage experimental sites in Maryland. Each site had randomized complete-block designs with three replicates of continuous corn plots. In each type of tillage, rainfall amount and intensity had a significant effect on runoff and sediment loss.

Park et al. (1994) evaluated the effectiveness of BMPs on a watershed level. The researchers focused on cropland BMPs on Nomini Creek watershed in eastern Virginia. Using data from pre- and post-BMP implementation on a watershed scale, significant decreases in sediment concentration were observed in the watershed following storm events during the entire sampling period due to the implementation of the BMPs.

A similar study was conducted by Walker et al. (1995) on Garfoot and Brewery Creeks in southern Wisconsin. Data was collected in each watershed from 1985–1986 before Dane County's voluntary NPS pollution conservation program was initiated. Data for this research was again collected from 1991–1992. Over half of the barnyard and agricultural operations in each watershed had voluntarily installed BMPs. Substantial decreases in storm mass transport of suspended sediments were detected in Brewery Creek watershed after the BMP installation. In contrast, there were no significant differences in suspended sediments between pre- and post-BMP installation in the Garfoot Creek watershed.

The cumulative effects of development and the resulting changes to both storm-water quantity and quality in the entire watershed determines the conditions of ecosystems in that watershed (EPD, 2001). Extensive review of the available literature failed to uncover research projects that dealt strictly with construction sites and the input of turbid storm water into receiving waters.

In Georgia, the concentration of development in the northern part of the state is resulting in high levels of erosion and sedimentation. (Kundell and Rasmussen, 1995). Significant strides have been taken to reduce erosion and sedimentation from agricultural and forestry operations through the use of best management practices (BMPs). BMPs have also been used in an effort to control erosion from construction sites but institution of an effective erosion control program for construction activities has proven less effective (Kundell and Rasmussen,1995).

In 2000, Georgia adopted the National Pollutant Discharge Elimination System (NPDES). Until this time, no state regulations existed regarding storm water exiting construction sites. This regulation makes developers and contractors accountable for storm water that exits large construction sites. They must report turbidity levels of storm water leaving disturbed sites over five acres in size to EPD. Since the NPDES permit became effective in August of 2000, EPD has had neither the staff - nor the funds - to fully review turbidity data that it has collected from the permittees.

This new step in storm-water regulation should benefit water quality in Georgia's streams and rivers; however, if this new law is not sufficiently enforced then it will soon be overlooked by the developers and contractors. If enforcers of this regulation concentrate their efforts to critical areas first, this would make improvements in enforcement effectiveness to the NPDES permit. The goal of this research is to analyze the two years of turbidity data and define what should be considered critical characteristics of the disturbed areas by studying different variables such as area of disturbance, severity of storm, time of year, and linear vs. spatial construction and determining their relationship to NPS pollution.

1.2 Factors Affecting Sediment and Erosion

Sediment is generated by the erosion of soils from the landscape. While erosion is found in natural forests, it is accelerated by land disturbing activities, such as development, agriculture, and timber harvesting.

Erosion begins with the impact of rainfall on the earth's surface. If vegetation is present, then the energy is absorbed by the leaves and stems of the cover canopy, or by the litter on the soil surface. If however, bare soil is left exposed to the rain, then each raindrop transfers some of its kinetic energy into the detachment of soil particles.

In addition to raindrop, or *splash*, erosion, water running across the surface of the soil can also detach and transport sediment. This is called *sheet* erosion because the water is flowing across the soil surface, and not in a defined channel.

Once in a channel, however, then the flowing water can form *gullies*, especially where steep slopes are present.

Splash Erosion - Erosion caused by the impact of raindrops on the ground surface.

Sheet Erosion - Erosion caused by the overland flow of water.

Gully Erosion - Scouring from concentrated overland flow or ground-water sapping from subsurface flow.

1.2.1 Splash Erosion

Splash erosion results from the energy contained in individual raindrops. The energy, E, available in each raindrops is just:

$$E = \frac{m\ v^2}{2} \tag{1.1}$$

where m is the mass of the drop, estimated using the volume, V, and density, ρ:

$$m = \rho\, V = \rho\, \left(\frac{4}{3}\, \pi\, r^3\right) = \frac{\pi}{6}\, \rho\, d^3 \tag{1.2}$$

where d is the raindrop diameter. The terminal velocity of each raindrop, v, can also be estimated using the raindrop diameter:

$$v = 120\, d^{0.35} \tag{1.3}$$

resulting in:

$$E = \frac{1}{2}\, \left(\rho\, \frac{\pi}{6}\, d^3\right)\, \left(120\, d^{0.35}\right) = 10\, \pi\, \rho\, d^{\,3.35} \tag{1.4}$$

Fogs, with droplet diameters less than 100 μm, essentially have no downward velocity. *Drizzles*, with droplet diameters between 100 and 500 μm, have a very small fall velocity, and *rain*, with droplets greater than 0.5 mm, are the primary contributors to splash erosion.

A light rain with an intensity $< 2.5\ mm/hr$ has little erosion potential, a moderate rain of between 2.5 and 7.5 mm/hr has a greater potential for erosion, while heavy rains, intensity $> 7.5\ mm/hr$ has substantial erosion potential. Clearly, however, the duration of energy is the key, so that a long-duration storm creates more favorable conditions for soil splash erosion. Using data from Table 1.1, a rainfall intensity of 250 mm/hr (equal to one inch in six minutes) produces $(2\ W/m^2) \times (10,000\ m^2/ha) = 20\ kW/ha$ of energy.

Table 1.1: Energy as a function of precipitation intensity

Intensity	Energy
mm/hr	W/m^2
0.25	0.000565
0.5	0.00128
1	0.00290
2.5	0.00855
5	0.0194
10	0.0439
25	0.129
50	0.293
100	0.664
250	1.96

1.2.2 Sheet Erosion

Sheet erosion refers to the overland flow of stormwater. Once soil particles have been detached, it is sheet erosion that keeps the soil particles moving to local rivers and streams. A predictive model that describes this process is the *Universal Soil Loss Equation*:

$$A = R \cdot K \cdot LS \cdot C \cdot P \tag{1.5}$$

R Factor - Rainfall Energy factor, a function of the number, intensity, and duration of storms throughout the year.

K Factor - Soil Erodibility factor, a function of particle size distribution of the soil and the organic matter content.

LS Factor - Length-Slope factor, a function of the topography of the area contributing to streams.

C Factor - Vegetation or crop factor, a function of the canopy density, type of crop, type of plowing method, etc.

P Factor - Conservation practice factor, a function of management practices that can be used to reduce erosion, such as contour tillage.

1.2.3 Channel Erosion

Once sediment has reached a channel, then the energy available to lift and transport the sediment determines what materials are carried as *suspended* load, versus that component that moves along the bed of the stream.

Suspended Sediment - Sediments entrained within the water column

Bedload Sediment - Sediments moving along the channel bottom

Stokes' Law

The fall time of a particle in water can be determined using a balance of forces. We first calculate the gravitational force, F_g, that causes a soil particle to settle in the water:

$$F_g = g\ M_s \tag{1.6}$$

where g is the force of gravity, and M_s is the buoyant mass of the sediment particle, adjusting for the weight of water, equal to:

$$M_s = (\rho_s - \rho_w)\ V_s = (\rho_s - \rho_w)\ \left(\frac{4\ \pi}{3}\ r^3\right) \tag{1.7}$$

so that:

$$F_g = g\ \ (\rho_s - \rho_w)\ V_s = \frac{4\ \pi}{3}\ \Delta\gamma\ r^3 \tag{1.8}$$

where $\Delta\gamma = g\ \ (\rho_s - \rho_w)$ is the net specific weight of the soil particle. Note that if the particle is lighter than water, such as dry wood or an air bubble, then the specific weight is negative, and the particle will rise.

The viscous force, F_v, resisting the fall of the particle was determined by Stokes, in 1851. He found the viscous drag for a spherical particle to be:

$$F_v = 6\ \pi\ \mu\ v\ r \tag{1.9}$$

At steady state, the gravitational force must exactly counterbalance the viscous drag force, $F_g = F_v$, yielding:

$$\frac{4\ \pi}{3}\ \Delta\gamma\ r^3 = 6\ \pi\ \mu\ v\ r \tag{1.10}$$

Solving for the unknown velocity yields:

$$v = \frac{2}{9}\ \frac{r^2}{\mu}\ \Delta\gamma \tag{1.11}$$

The settling time, τ, for a specified distance, Δz, is:

$$\tau = \frac{\Delta z}{v} = 4.5\ \frac{\mu}{r^2}\ \frac{\Delta z}{\Delta\gamma} \tag{1.12}$$

1.3 Construction Site Runoff Regulations in the Southeast

1.3.1 Georgia's NPDES Regulation, 2000–2003

Since 1992, the Georgia Environmental Protection Division (EPD) has attempted - on five separate occasions - to establish an NPDES permit system for regulating storm water exiting construction sites. With each attempt, there was an appeal by the environmental community, citizens and/or the development industry. On August 1, 2000, the first NPDES permit became effective in the State of Georgia. This made Georgia the last state in America to have an NPDES storm-water construction permit in place.

Beginning on August 1, 2000, all sites that disturb five acres or greater and less than 250 acres must obtain an NPDES permit from EPD. There are three tiers of permittees that need a general storm-water permit in Georgia for land disturbance. The first is the *Primary Permittee* which includes owners, general contractors and operators of a project that are in charge of daily operations. Next is the *Secondary Permittee*, which includes individual builders, utility companies, and utility contractors within a common development. The third is the *Tertiary Permittee*, which includes individual builders within the surface water drainage area. Normally, the Primary Permittee is also responsible for submitting a Notice of Termination for the surface water area (EPD, 2000).

There are five main requirements that are necessary to complete under the NPDES permit.

1. A Notice of Intent (NOI) must be completed and delivered to EPD before construction begins at the site. Information in the NOI includes:

    - the type of construction that will occur,
    - the amount of land that will be disturbed,
    - information about the developer,
    - the size of the watershed, and

- the type of stream that will be receiving storm water that exits the construction site.

2. An Erosion, Sedimentation and Pollution Control (ES&PC) plan must be designed by a certified professional. The ES&PC plan gives a description on the type of erosion control measures and the phasing of these measures that will be used during the construction phase of the project. The Primary Permittee must amend changes that are necessary during the construction phase (EPD, 2000).

3. A Comprehensive Monitoring Plan (CMP) must be prepared by a licensed professional, and describes the basic components of the monitoring program for the site. It details the sampling, inspecting and reporting that will occur during the construction of the project.

4. The actual implementation of the inspections and record-keeping. The site must be inspected a minimum of once every seven days and after every one-half inch of of rain in a 24-hour period.

5. A Notice of Termination (NOT) must be submitted to EPD. The NOT notifies EPD that the site is 70% stabilized and no other monitoring will be conducted (EPD, 2000).

Required NOI and NOTE forms, along with example forms for Stormwater Monitoring, Site Inspection and Maintenance, and Site Field Report are shown in Appendix B.

During construction, the site must be inspected on a weekly basis by *Qualified Personnel*. *Qualified Personnel* is a person who has successfully completed an erosion and sediment control short course eligible for continuing education units, or an equivalent course approved by EPD and the Georgia Soil and Water Conservation Commission (EPD, 2000). *Qualified Personnel* must also inspect the site following every half inch of rainfall in a 24 hour period until an NOT is submitted. An inspection report must be completed with each inspection and kept on file and available for EPD upon request (EPD, 2000).

During the construction phase, samples must be collected of storm-water discharges from the site and tested for turbidity. Samples are collected from outfalls or upstream/downstream of the construction site, these points are identified in the CMP. Once the construction begins, a sample of the storm-water discharge must be collected after the first one-half inch rain event. Samples must also be taken after the first one-inch rain event of the month and every two-inch rain event of the month during the construction phase. A final sample must be taken after the last one-half inch of rainfall after the site has been stabilized. The samples must be collected either manually or automatically within 45 minutes of a rainfall event or when discharge begins. The turbidity results along with the associated rainfall amounts are sent to EPD at the end of each month (EPD, 2000).

As part of the CMP, a rationale must be included for the NTU limits for the disturbance. This rationale is determined by a table in the permit (shown as Appendix C), which takes into account the size of the site disturbance, the size of the surface water drainage area, and the type of receiving waters (either trout stream or warm water fisheries). For example, if a site of 51 acres in a warm water drainage area of 70 square miles, the NTU value used is 100 NTU. Therefore, there should be less than 100 NTU difference between the upstream and downstream turbidity samples for the site.

1.3.2 Georgia's NPDES Regulation, 2003–PRESENT

On August 13, 2003, an amended *Authorization to Discharge Under the National Pollutant Discharge Elimination System Storm Water Discharges Associated with Construction Activity* became effective. Much of the original general permit's regulations remained intact but there were several important changes in the permit.

One of the main changes Georgia instituted in the amended permit was to divide the original permit into three separate permits. One permit was for *stand-alone* construction projects (EPD, 2003a). This permit was intended for sites that have no secondary permittees and are not infrastructure projects. Examples include convenience stores and strip malls. A second permit was for *infrastructure* construction projects (EPD, 2003b). This permit was intended for linear projects constructed by utility contractors such as road construction, transmission of gas, water or sewer. The last permit was for *common-development* construction projects (EPD, 2003c) This permit covers construction activity with secondary and/or tertiary permittees such as residential subdivisions and malls with out-parcels.

Another major change between the first permit and the amended permit was the size of the land disturbance that requires a permit. The original permit required sites five acres or larger to obtain authorization to discharge storm water from the construction site. Under the amended permits the site size was reduced to one acre or larger.

The monitoring requirements were also altered in the amended version of the state permit. The original permit required that a *Comprehensive Monitoring Plan* be developed for construction sites. The monitoring plan identified the outfalls and/or streams that were to be monitored during construction phase of the site. This part of the permit was eliminated and a Comprehensive Monitoring Plan is no longer required as part of the permit (EPD, 2003a).

The sampling frequencies were also changed from the original permit. Under the permit from 2000–2003 construction sites were required to sample outfalls and/or streams after the first one-half inch of rainfall once construction had begun. It was also a requirement to sample after the first inch of rainfall and every two inches in a 24-hour period of every month during the construction phase. The site was also to be sampled after a one-half inch of rainfall after the site was 70% stabilized. The amended permit only requires that the outfall and/or streams be sampled after the first one-half inch of rainfall after all clearing and grubbing operations have been completed and after the first one-half inch of rainfall after all mass grading has been completed or ninety days after the first sample, whichever comes first. This was expected to substantially reduce the number of sampling events during the duration of the construction phase (EPD, 2003a; EPD, 2003b; EPD, 2003c).

Finally, a storm-water fee was also instituted that was not required in the original permit. The state now requires $80 per disturbed acre that is sent to EPD if the project is not regulated by a *Local Issuing Authority*. If a County or Municipality is a Local Issuing Authority, then $40 per disturbed acre fee should be sent to the County or Municipality and $40 per disturbed acre fee should be sent to EPD. A completed General Permit Fee form should be included with the fee when sent to EPD. This fee should generate money that will assist EPD with enforcement issues (EPD, 2003d).

1.3.3 Other Southeastern States' Regulations

Sedimentation of streams and rivers is not a problem limited to Georgia - it is an issue in every state in America. To help reduce the amount of sediment loads in streams, many states have established programs to regulate storm-water discharges from construction sites.

Regulations of several states in the Southeast were examined to provide examples that could be used to compare with the NPDES regulations established by Georgia. Three states were chosen due to their proximity to Georgia and availability of information regarding their NPDES programs. The three states discussed below are Tennessee, South Carolina, and Florida.

Tennessee

Tennessee's first NPDES Permit for Storm Water Discharges Associated with Construction Activities was promulgated on September 26, 1992, as State Rule 1200-4-10-.05. The original permit expired September 26, 1997. A second NPDES Permit for Storm Water Discharges Associated with Construction Activities followed the original permit with minor changes and is still in effect today. Tennessee's NPDES permit sets forth a set of minimum controls that operators of construction sites must use (DEC, 2003).

The original permit required the following:

1. That a site-specific erosion and sediment control plan be prepared and implemented for the site (a copy of the plan retained on site);

2. That storm-water discharges not have adverse effects on streams (no visible pollution such as floating scum, oil or an objectionable color contrast in the receiving stream, or toxic effect);

3. That checks and repairs of controls be performed and certain record keeping (checks and repairs weekly in dry periods, and within 24 hours after any rainfall of one-half inch or greater); and

4. That the site plan take into consideration the effects of runoff from the site after the site has been completed, *post-construction storm-water controls*, such as open, vegetated swales and natural depressions; structures for storm-water retention, detention, or recycling; velocity dissipation devices to be placed at the outfalls of detention or retention structures or along the length of outfall channels.

There were several changes from the original permit to the latest permit. The state of Tennessee now requires that operators of all construction sites that disturb more than five acres send in a Notice of Intent before authorization to discharge runoff from construction sites is granted. A Storm Water Pollution Prevention Plan must also be completed and submitted along with the NOI. This plan outlines the Best Management Practices that will be used during construction to assist in preventing storm water from reaching state waters.

Operators of construction sites also must fill out an inspection form once a week and after one-half inch of rain. The inspection forms are sent to the Tennessee Department of Environment and Conservation for review at the end of each month. The State of Tennessee also requires a fee of $150 for sites between one and five acres and $250 for sites five acres and greater (DEC, 2003).

South Carolina

In 1991, South Carolina passed the Storm Water Management and Sediment Reduction Act. This act authorized the Department of Health and Environmental Control (DHEC) to delegate the implementation of the Sediment, Erosion, and Storm water Management Program to qualifying local entities. Permitting, inspection, and enforcement activities are included in this act and the Department began encouraging local entities to enforce these actions on land disturbing activities (DHEC, 2003).

Storm-water management and sediment and erosion control plans are reviewed by DHEC in the appropriate division office. Each division office is staffed with an engineer and a storm-water inspector. These district offices have an understanding for the types of activities, which are going on in the surrounding area and the varying site conditions in the region. The regional offices are also responsible for handling inspections and complaints on permitted projects (DHEC, 2003).

Once the storm-water management and sediment and erosion control plans have been approved, construction activities may begin at the project site. The District Office is responsible for conducting on-site inspections of the project and their duties are as follows (DHEC, 2003):

1. Ensure that the approved storm-water management and sediment control plans are on the project site and are complied with;

2. Ensure that every active site is inspected for compliance with the approved plan on a regular basis;

3. Provide the person responsible for the land disturbing activity with a written report following every inspection that describes:

   (a) The date and location of the site inspection;

   (b) Whether the approved plan has been properly implemented and maintained;

   (c) Approved plan deficiencies; and

   (d) The actions taken.

4. Notification of the person responsible for the land disturbing activity in writing when violations are observed, describing the:
   (a) Nature of the violation;
   (b) Required corrective action; and
   (c) Time period for violation correction.

South Carolina uses fees for land-disturbing activities to help fund erosion control enforcement. Projects that disturb more than two acres must pay the storm-water management and sediment and erosion control permit application fee of $100 per disturbed acre with a maximum fee of $2,000. These projects are also required to pay the $125 storm-water NPDES Construction General Permit coverage fee (DHEC, 2003).

Florida

In October 2000, the Florida Department of Environmental Protection (DEP) adopted the Generic Permit for Storm Water Discharge from Construction Activities. The rule affects sites that disturb five or more acres of land. In May of 2003 acreage of disturbance was reduced from five acres to one acre. The requirements of the Construction Generic Permit (CGP) are as follows (DEP, 2003):

1. A Notice of Intent (NOI) must be submitted to obtain permit coverage. Latitude and Longitude coordinates must be given for the site along with information on receiving waters;
2. A storm-water pollution prevention plan (SWPPP) must be developed and implemented to be in compliance with the permit. The SWPPP must include the following:
   (a) A site evaluation of how and where pollutants may be mobilized by storm water;
   (b) A site plan for managing storm-water runoff; and

   (c) Identification of appropriate erosion and sediment controls and storm-water best management practices (BMPs) to reduce erosion, sedimentation, and storm-water pollution.

   (d) A maintenance and inspection schedule;

   (e) A record keeping process; and

   (f) Identification of storm-water exit areas.

3. A Notice of Termination (NOT) must be submitted to discontinue the permit coverage. The site must be 70% stabilized before submittal of the NOT.

4. An application fee must be paid upon the arrival of the NOI. The fee amounts are $300 for a site larger than five acres and $150 for sites disturbing between one and five acres (DEP, 2003).

Comparison to Georgia NPDES Regulations

Many similarities exist among regulations in the three states that were reviewed and Georgia. The one major difference is the sampling requirements for the NPDES regulations of Georgia. The State of Georgia requires that outfalls and receiving streams adjacent to construction sites be sampled and tested for turbidity after rainfall events.

The sampling requirements are a proactive approach that the state of Georgia has taken in an attempt to quantify the negative effects that storm-water runoff from disturbed construction sites have on the state's waters. The turbidity results are sent each month to local EPD offices for review. The turbidity results should help EPD enforcement to concentrate their efforts on the sites that are allowing highly turbid storm water to exit the construction sites.

Another obvious difference between the state of Georgia's NPDES regulations and those of the three Southeastern states that were researched is an application fee. Tennessee, South Carolina, and Florida require applicants to pay a fee before obtaining an NPDES permit. In

Georgia's NPDES permit from 2000–2003, there were no fees required to obtain authorization to discharge storm from construction sites.

Recently, in the amended permit, Georgia has adopted the fee system which will allow the state to generate funds. EPD is understaffed and do not have the manpower to review all of the turbidity data and inspect the sites that are in violation of the permit. Now that EPD requires fees be paid upon submittal of the NOI, hopefully that will generate the necessary funds to hire employees that could enforce the NPDES regulations in Georgia.

1.4 Research Objective and Hypotheses

This project evaluated variables associated with construction site BMPs in an effort to determine which variables were most closely associated with pollutant reduction. Specific variables that were examined include the areal extent of land-disturbing activities, storm severity, time of year, and linear vs. spatial construction. These variables were selected with the intent of providing a means for prioritizing enforcement of the Georgia's National Pollutant Discharge Elimination System regulation.

Four hypotheses were evaluated:

1. *Greater turbidities are associated with larger areas of land-disturbing activities.*

   Definitive research data in support of this hypothesis is lacking, yet the issue of disturbance area was an important issue during the policy debate related to regulating stormwater discharge from construction sites. While splash and sheet erosion are clearly independent of disturbance area, channel erosion may increase with area due to larger velocities associated with channelized flows.

2. *Greater turbidities are associated with larger precipitation events.*

   The Universal Soil Loss Equation predicts that sheet erosion should increase with increasing rainfall energy. Thus, larger precipitation events should be positively correlated with turbidity if the energy increases with the precipitation rate.

3. *Time of year does not affect turbidity.*

   The effects of soil moisture variation on runoff were not considered during the policy debate in Georgia. Time-of-Year BMPs were not included in the development of Erosion, Sedimentation, and Pollution Control Plans, as were consideration of wet season vs. dry season construction activities. From a scientific perspective, variations in seasonal turbidities should be expected due to variations in the propensity of runoff and erosion.

4. *Linear construction sites produce less turbidity than spatial construction sites.*

   One assertion made by utility companies during the policy debate was that linear construction projects (e.g., pipelines, roads) generate less turbidity than spatial projects. This assertion was based on the presumption that only smaller subareas within a linear project are disturbed at any one time and these subareas are stabilized prior to advancing to the next disturbance subarea. This type of project is different from a spatial project, in that the area of disturbance within a spatial project is not staged in a similar manner. In effect, larger areas of the site are left in a disturbed state on a spatial project.

To evaluate these hypotheses, data from twenty sites were analyzed. Chapter 2 outlines the methods used to collect data and focuses on discussing the site variables that may be related to storm-water discharge from construction sites. Chapter 3 presents and discusses data collected from twenty construction sites in Northeast Georgia. Chapter 4 discusses recommendations that is intended to improve the current regulation of storm-water discharge from construction sites in Georgia. Specific guidance is provided for an enhanced set of sampling requirements as well as more effective means of data management. As part of the final chapter a summary of conclusions associated with the research presented in this thesis.

Chapter 2

Methods

This project examines the variables and combinations of variables for their effects on stormwater discharges from construction sites. The purpose of the project is to assist EPD in enforcing the NPDES regulations. The variables that will be considered while conducting this research are area of disturbance, severity of storm, time of year, and linear vs. spatial construction.

2.1 Data Collection Process

At the onset of a development of five acres or more, the developer must notify EPD with a Notice of Intent (NOI). Included in the NOI are what type of construction will occur, the amount of land that will be disturbed, information about the developer, the size of the watershed, and what type of stream will be receiving storm water that exits the construction site.

The developer must also create an Erosion and Sedimentation Pollution Control (ESPC) Plan and a Comprehensive Monitoring Plan (CMP). The ESPC plan is a document that outlines the type of BMP's the developer plans to use to prevent turbid storm water from reaching the state's waters. The CMP is a document that states where the developer plans to collect samples for the construction site. Finally, the developer must submit a Notice of Termination (NOT) once the construction site has been stabilized.

During construction, the site must be inspected on a weekly basis by *Qualified Personnel*. *Qualified Personnel* is a person who has successfully completed an erosion and sediment control short course eligible for continuing education units, or an equivalent course approved by EPD and the Georgia Soil and Water Conservation Commission (EPD, 2000). A *Qualified Personnel* must also inspect the site following every one-half inch of of rainfall in a 24 hour period.

When construction begins, an initial sample must be taken after the first one-half inch of of rainfall at the locations designated by the CMP. Following the initial sample, samples are taken after the first one inch of rainfall and every two inches of rainfall during the month. Turbidity levels are taken of the sample and reported to EPD on a monthly basis. The turbidity is tested at the time the sample is taken with a specific turbidity meter. The sample is stored in a small vile and put into the turbidity meter, light is refracted from the particles in the sample and an nephelometric turbidity unit (NTU) is applied at this time.

Since August 1, 2000, turbidity data has been collected and reported to EPD on stormwater discharges from constructions sites greater than five acres. Accompanying the turbidity data is also the amount of rainfall that the site received at the time the sample is collected.

2.2 Site Selection

Turbidity data was collected from EPD Northeast Regional office in Athens, Georgia between December 2002 and May 2003. The sampling and reporting requirements have changed since that time, so all of the data that will be discussed in this section are from the original NPDES permit from 2000–2003. I was able to obtain turbidity data from twenty sites in the northeast Georgia region. Several of the sites have data that span over a period of several years.

EPD Northeast Regional office supplied a list of NOI's that had been submitted since the inception of the NPDES permit requirement in Georgia. Based on the number of sites that have been constructed over the two-year period, EPD Northeast Regional office has received a large number of monthly turbidity reports. The turbidity data that was received were not filed by the specific site; they were filed by the month and year. For example, all sites under construction in the northeast Georgia region in May 2001 were found in the *May-2001* file.

This system of data management made it particularly difficult to follow the turbidity results for a particular site. I had to choose a site and begin going through each month from the start date and try to determine when the construction at that site was complete. In many instances there would be gaps in the monthly data for a particular site - either there were no reports submitted by the developer or they were not filed in the correct monthly file. There were also variable reporting styles, and in some cases made it hard to make any determination of what was actually happening at the site. I examined monthly reports that were hand written on notebook paper and others that were so technical it was difficult to even find the turbidity results and the associated rainfall.

As mentioned previously, the data is highly variable and during the collection process I tried to choose sites that I felt had reliable results. I made this determination based primarily on the way the results were submitted to EPD. If the reports were legible, professional and consistent then they were considered for use. If there appeared to be gaps in the data that particular site would be excluded from the study. Also if the reports were not legible or I was not able to decipher the information from the reports, those sites were also excluded from the study. This site selection process could have created a bias toward more professional oriented monitoring systems, therefore possibly creating a bias in the overall study.

2.3 Project Types

A *linear* project is a land-disturbing activity that is long and narrow, such as a water or sewer line. Examples of linear projects are shown in Figure 2.1. A *spatial* project is a land-disturbing activity which covers a broader area, such as a shopping mall or a subdivision. Figure 2.2 presents an example of a spatial project.

Figure 2.1: Examples of linear construction projects with Best Management Practices.

Figure 2.2: Example of spatial construction where a large area has been cleared prior to development. Upper photograph taken before erosion and sediment control measures have been installed. Lower photograph taken after installation of erosion and sediment control measures.

Chapter 3

Results

Table 3.1 summarizes the sites selected for investigation. Note that more than one entry is present for some sites. In these cases, there were multiple points on the site that were monitored.

Table 3.2 presents all data analyzed in this study. Note that no data is present during months in which no turbidity data were collected. In these cases the sites did not receive a qualifying amount of rainfall.

3.1 Data Summary

Figure 3.1 provides a time-series plot of monthly averages for all twenty sites for the period of record. Also shown in Figure 3.1 are the increases in turbidity from upstream to downstream sites.

The minimum, average, and maximum turbidities for the upstream sites are shown in Figure 3.2 (top). Equivalent plots for downstream turbidities are also shown in Figure 3.2 (middle), along with the increase in turbidity from upstream to downstream sites, Figure 3.2 (bottom).

A scatterplot between upstream and downstream sites are presented in Figure 3.3 as a function of monthly observations. One can see a weak relationship between the two data series, with many outliers, both for conditions when upstream sites have much higher values than downstream sites, and vice versa.

Figure 3.4 presents boxplots of upstream and downstream turbidities, along with the turbidity increase from upstream to downstream sites. Note the large difference between the

Table 3.1: Characteristics of 20 North Georgia land distured sites used to evaluate variables associated with sediment production associated with construction activities

Site	Year	Type	Area	Sampling
			acres	
1 A	2001	Spatial	12.1	Outfall
1 B	2002	Spatial	12.1	Outfall
1 C	2003	Spatial	12.1	Outfall
2 A	2001	Spatial	12.8	Stream
2 B	2002	Spatial	12.8	Stream
2 C	2003	Spatial	12.8	Stream
2 A1	2002	Spatial	12.8	Outfall
2 B1	2003	Spatial	12.8	Outfall
3 A	2002	Linear	17.5	Stream
3 B	2003	Linear	17.5	Stream
3 A1	2002	Linear	17.5	Stream
3 B1	2003	Linear	17.5	Stream
4	2001	Spatial	89	Stream
5 A	2002	Spatial	12.4	River
5 B	2003	Spatial	12.4	River
6	2002	Spatial	17	Stream
7 A	2002	Linear	38	Stream
7 B	2003	Linear	38	Stream
8	2001	Spatial	14	Stream
9	2001	Spatial	19	Outfall
10	2001	Spatial	24	Stream
11	2001	Spatial	11	Outfall
12	2001	Spatial	54	Stream
13	2001	Spatial	82	Stream
14 A	2001	Spatial	105	Stream
14 B	2002	Spatial	105	Stream
14 C	2003	Spatial	105	Stream
15	2002	Spatial	58	Outfall
16	2002	Spatial	24	Stream
17 A	2002	Linear	13.7	Stream
17 A1	2003	Linear	13.7	Stream
17 B	2002	Linear	13.7	Stream
17 B1	2003	Linear	13.7	Stream
18 A	2001	Spatial	23	Outfall
18 B	2002	Spatial	23	Outfall
18 C	2003	Spatial	23	Outfall
19 A	2001	Linear	8.4	Stream
19 B	2002	Linear	8.4	Stream
20	2001	Linear	7.2	Stream

Table 3.2: Event precipitation (inches) and associated event turbidity (NTU) for each of 20 north Georgia construction sites during the study period

		Month											
Site	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1A	Precip					1.6	1.5	5.4					
	Up					1860	864	600					
	Down					1140	858	1000					
1B	Precip	2.2	1.7	1.7		2	1.3	1.2		3.3		1.5	
	Up	110	42	60		37	32	37		41		48	
	Down	140	28	51		51	41	48		47		39	
1C	Precip		1.5	1.7									
	Up		42	37									
	Down		38	29									
2A	Precip		1.3	1.9		2.4	1.7	4.5					
	Up		502	442		150	280	190					
	Down		751	650		850	1056	420					
2B	Precip	2.4	1.8	1.6		2	1.2			3.3		1.8	
	Up	25	11	11		28	35			230		59	
	Down	30	19	9		31	42			270		71	
2C	Precip		1.5	1.7		1.8		3.5					
	Up		42	38		64		120					
	Down		50	45		70		135					
2A1	Precip	2.4	1.8	1.6		2	1.2			3.3		1.8	
	Up	210	110	45		41	52			400		59	
	Down	305	125	51		32	38			180		71	
2B1	Precip		1.5	1.7		1.8		3.5					
	Up		94	72		74		115					
	Down		NF	NF		58		85					
3A	Precip										2.3	3.1	1.5
	Up										17	67	30
	Down										23	71	38
3B	Precip		1.5	1.8	0.6								
	Up		64	72	32								
	Down		78	89	38								
3A1	Precip										2.3	3.1	1.5
	Up										30	52	41
	Down										36	59	57
3B1	Precip		1.5	1.8	0.6								
	Up		29	30	42								
	Down		34	32	51								
4	Precip		0.8	1.2		1.1	2.2	3.8		1.2		1.1	
	Up		23	550		150	1000	110		100		180	
	Down		36	38		NF	6300	190		650		82	

Table 3.2 (continued)

Site	Type	Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5A	Precip						0.8			3.5	1.2	2.3	
	Up						157			410	150	175	
	Down						142			470	184	133	
5B	Precip		1.5	1.9		2.1		3.5					
	Up		231	471		532		212					
	Down		243	454		511		256					
6	Precip				0.7	2.2	2.3	4.5				1.2	1
	Up				82	101	85	310				57	26
	Down				98	48	110	800				69	29
7A	Precip			1.5	1.6		1.2	2.7		1.9			
	Up			45	55		175	90		55			
	Down			80	70		160	200		130			
7B	Precip	3	1.8	1.5									
	Up	190	21	128									
	Down	380	50	148									
8	Precip				0.8	1	2.8			1.9			
	Up				2800	2200	1600			210			
	Down				2840	2295	6120			245			
9	Precip					1.6	1.4	1.7				1.1	
	Up					80	50	50				45	
	Down					NF	150	95				60	
10	Precip					1.1	1.2	2.5	1.1	1.3		1.1	
	Up					200	180	280	140	140		175	
	Down					140	120	300	160	280		197	
11	Precip						1.3	1.4				1.1	
	Up						280	2600				290	
	Down						300	800				320	
12	Precip						1.2	1.1				1.1	
	Up												
	Down						2400	250				220	
13	Precip					1.5	1.6	2.8	2.6			1.1	
	Up					450	320	3000	700			400	
	Down					540	440	1700	850			540	
14A	Precip		1.7	2.5	2.2	2.2	1.2					1.2	
	Up		160	450	100	220	130					110	
	Down		200	180	65	250	120					140	
14B	Precip	1.3	2.5				1			1.7	1.8	1.6	1.1
	Up	74	64				24			24	37	27	33
	Down	66	90				28			36	55	90	82
14C	Precip		1.2										
	Up		14										
	Down		37										

Table 3.2 (continued)

		Month											
Site	Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
15	Precip	0.6	1.8	1.9	1.7	2.5		1.1			1.1	1.2	1.2
	Up												
	Down	156	195	592	730	730		200			340	60	25
16	Precip	1			1.1	1.2		1.2			1.4	1.5	1.3
	Up	4			12	56		10			14	3	10
	Down	20			22	39		320			72	24	26
17A	Precip							0.7				1.1	
	Up							32				40	
	Down							80				270	
17A1	Precip		1.9	1.6	0.8								
	Up		19	18	20								
	Down		21	27	32								
17B	Precip							0.7				1.1	
	Up							28				35	
	Down							55				350	
17B1	Precip		1.9	1.6	0.8								
	Up		85	12	15								
	Down		55	21	27								
18A	Precip							1.2		2.1			
	Up												
	Down							1100		550			
18B	Precip	3.1	1.8	3		2.9				1.5	2.1	1.3	1.2
	Up												
	Down	120	34	16		260				38	55	65	66
18C	Precip	1.2	0.7										
	Up												
	Down	168	68										
19A	Precip						2.5	1.9		2.1			
	Up												
	Down						8000	800		1400			
19B	Precip	2	3	2	1.3	1.5	1		1	1.2	0.7		
	Up												
	Down	740	1350	707	73	60	225		27	312	201		
20	Precip		0.7	1.5	1		1.8		2.2		0.8		
	Up		12	38	14		45		80		28		
	Down		20	45	25		78		112		34		

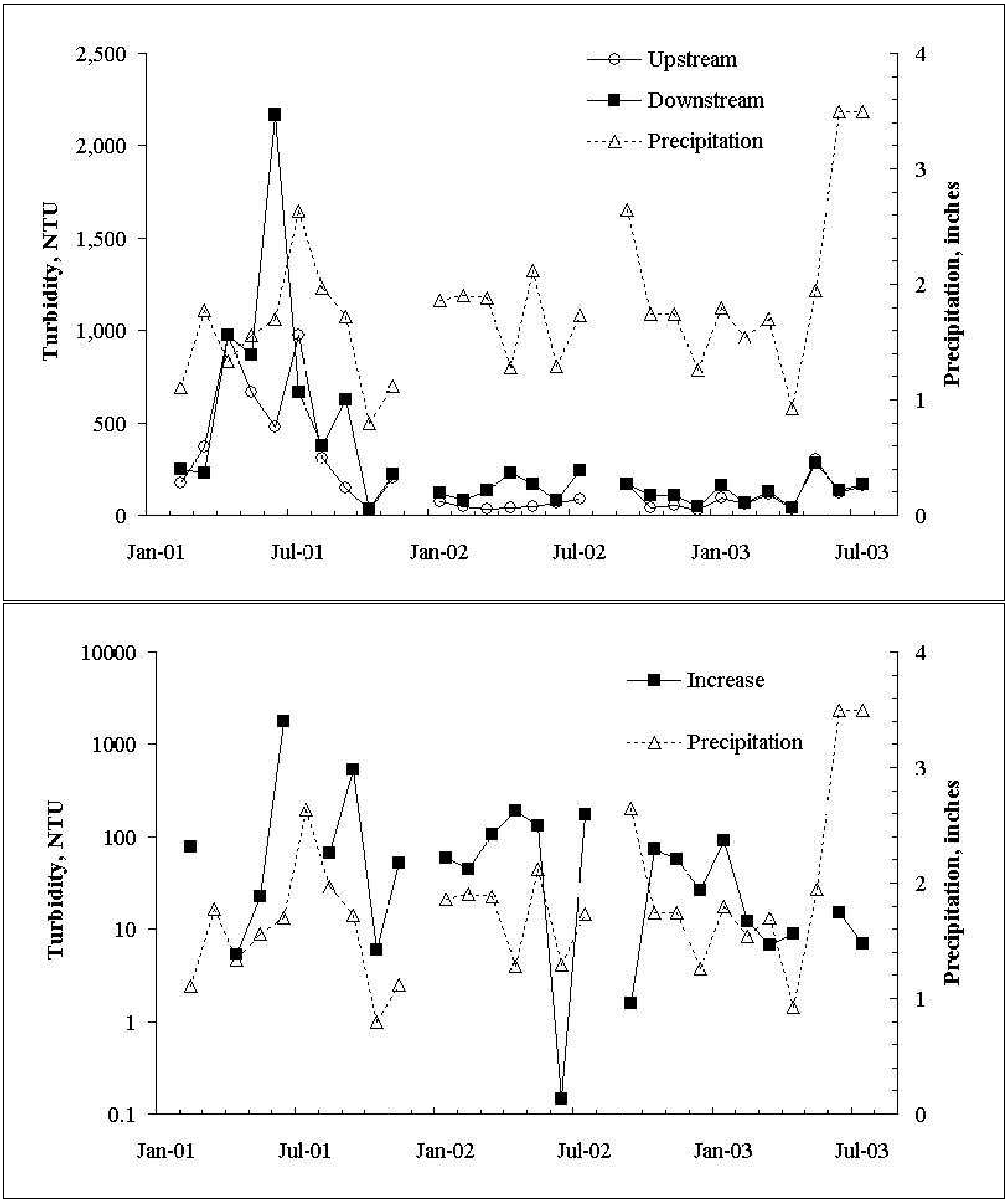


Figure 3.1: Average upstream and downstream turbidities (top, left axis), average turbidity increases (bottom, left axis) and average precipitation (right axis) for all monthly data.

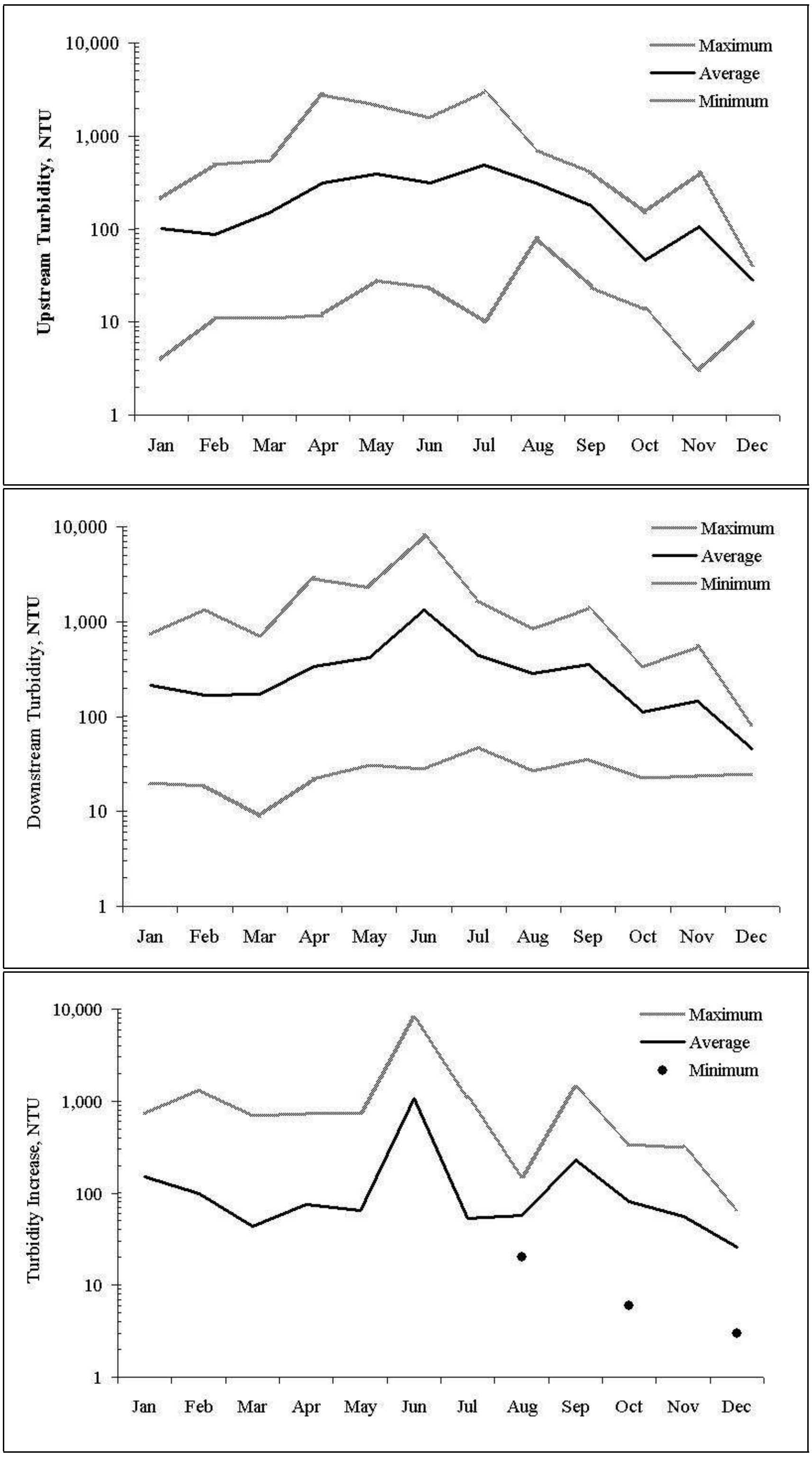


Figure 3.2: Maximum, average, and minimum turbidity readings for upstream (top), downstream (middle), and increase between upstream and downstream sites (bottom).

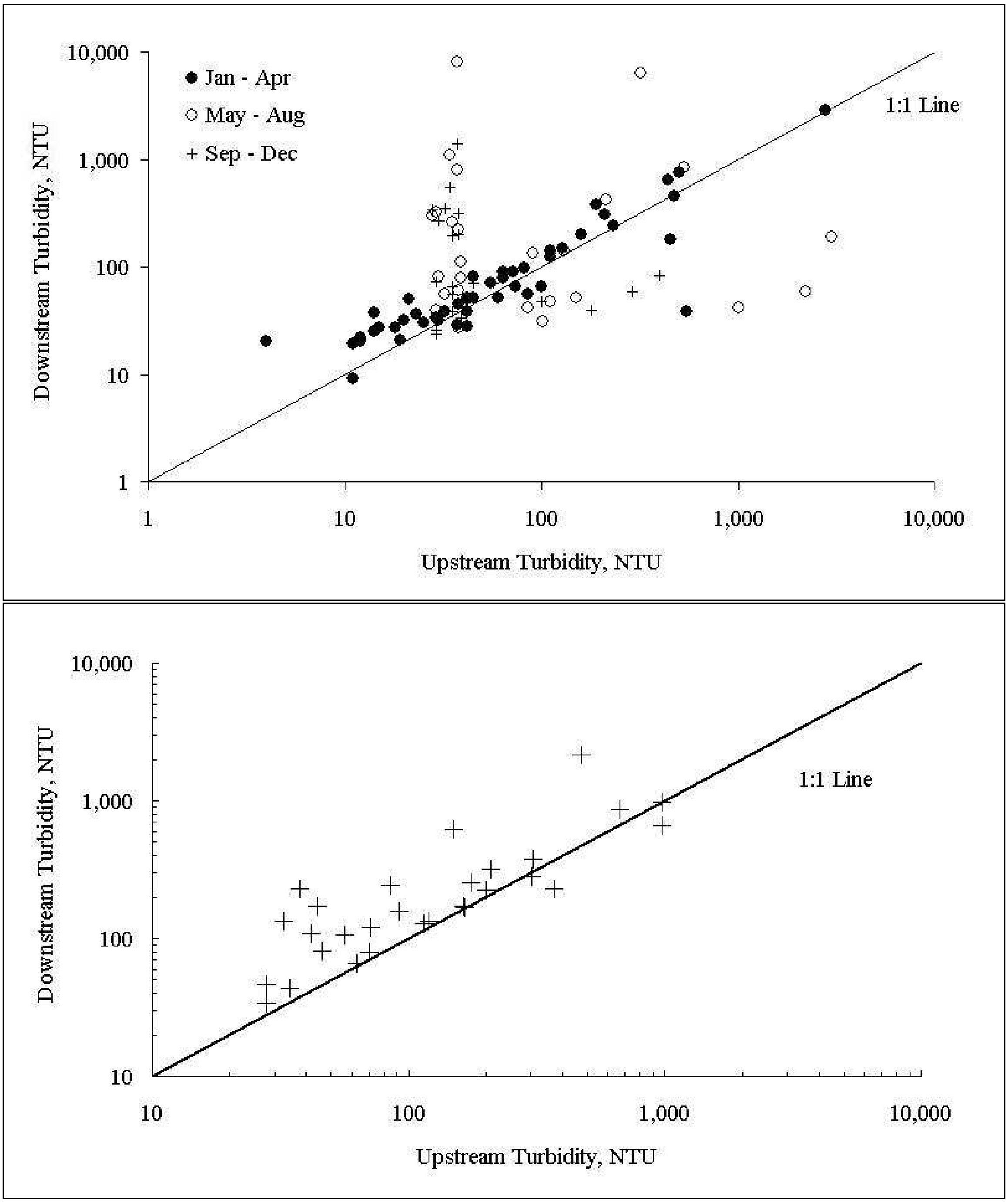


Figure 3.3: Scatterplot between upstream and downstream turbidity for all observations used in the study. Top plot are all data. Bottom plot are monthly averages.

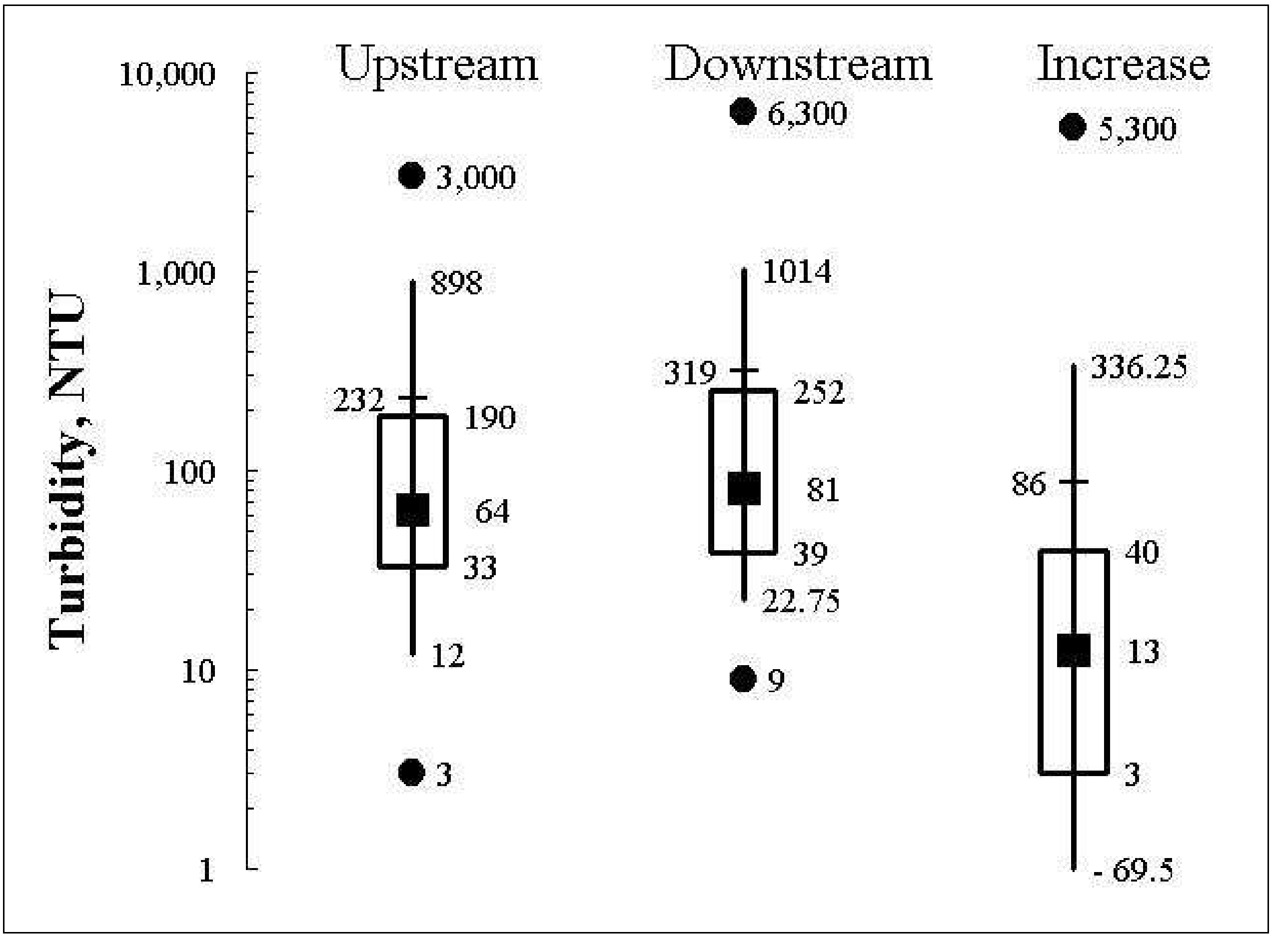


Figure 3.4: Boxplot of upstream turbidity, downstream turbidity, and turbidity increase. Extreme values shown as points, 95% confidence interval shown by solid line, first and third quartiles shown by open box, median shown by solid box, arithmetic mean shown by horizontal line.

average and the median values, due to a substantial skew in turbidity values. Also note the similarity in ranges between upstream and downstream values.

3.2 Site Size

The size of the twenty sample sites range from 7.2 to 105 acres. The mean site size is 28.9 acres. However, the majority of the sites are less than 30 acres in size. Of the twenty sites, 14 of the sites are smaller than 30 acres. One of the hypotheses is to examine the effects of the area of disturbance to the turbidity of discharge from the construction site.

Figure 3.5 shows the upstream, downstream, and turbidity increase between the upstream to downstream observations plotted against the area of the land disturbance in acres. The turbidity increase does not significantly increase with the increase of site size. Some of the highest differences occur on sites that are 30 acres or less. When looking at the difference between the mean upstream and the downstream turbidity, one can observe that the larger the disturbance does not necessarily produce higher turbidity levels than smaller disturbances. The statistical summary that is also provided in Figure 3.5 shows no significant correlation between turbidity and the disturbance area.

3.3 Rainfall Amount

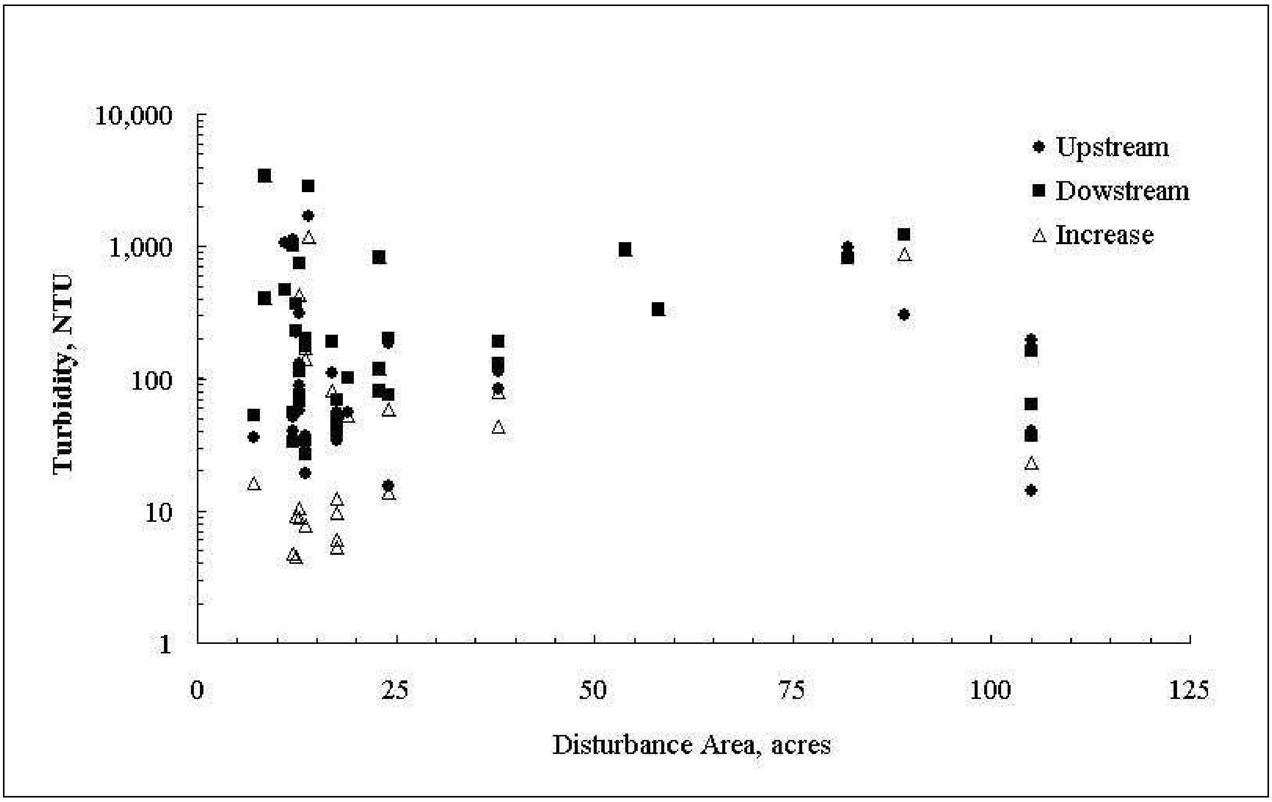
The rainfall amount of the twenty sample sites examined range from 0.6 to 5.4 inches. The mean rainfall of all the data is 1.7 inches. A second hypothesis states that an increase in the rainfall amount at the site also increases the turbidity of storm water that exits the site.

Figure 3.6 presents the average, maximum, and minimum rainfall amounts in inches for all of the sites. Also, Figures 3.7 and 3.8 plot precipitation versus the turbidity increase for both maximum and average conditions. Each of these graphs show that there is no clear correlation between the amount of rainfall and higher levels of turbid storm water that leave the construction site.

Figure 3.9 shows that the mean turbidity difference increases as the average rainfall increases. Figure 3.9 also presents the statistical summary for regression results with the rainfall data.

3.4 Time of Year

Another hypothesis to be tested was whether the time of year should have an effect on the amount of storm-water turbidity that discharges from a construction site. One reason for this



Turbidity	R^2	Regression Coefficient	Standard Error
Upstream	1.41×10^{-3}	0.567	3.30
Downstream	8.45×10^{-9}	0.003	6.83
Increase	5.50×10^{-4}	-0.648	6.03

Figure 3.5: Average upstream, downstream, and increase in turbidity readings as a function of disturbance area. Also shown are linear regression results.

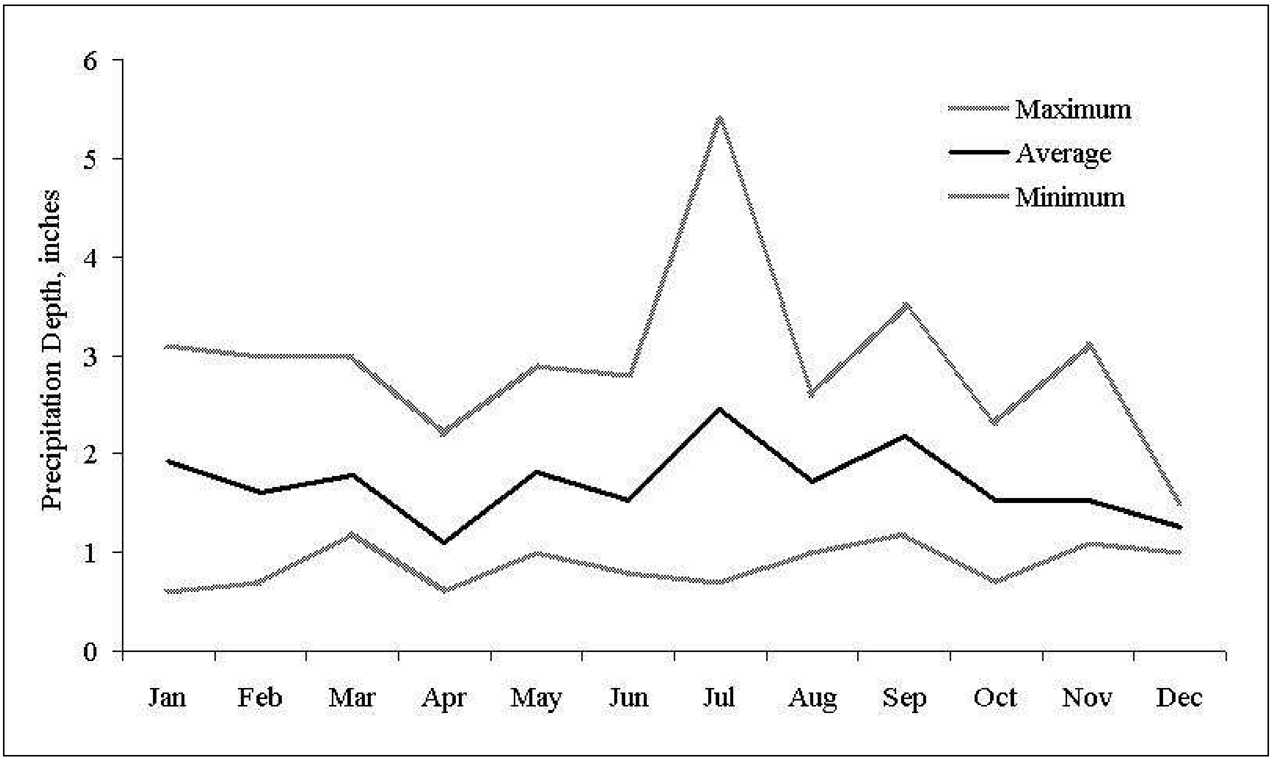


Figure 3.6: Average, minimum, and maximum precipitation as a function of time of year.

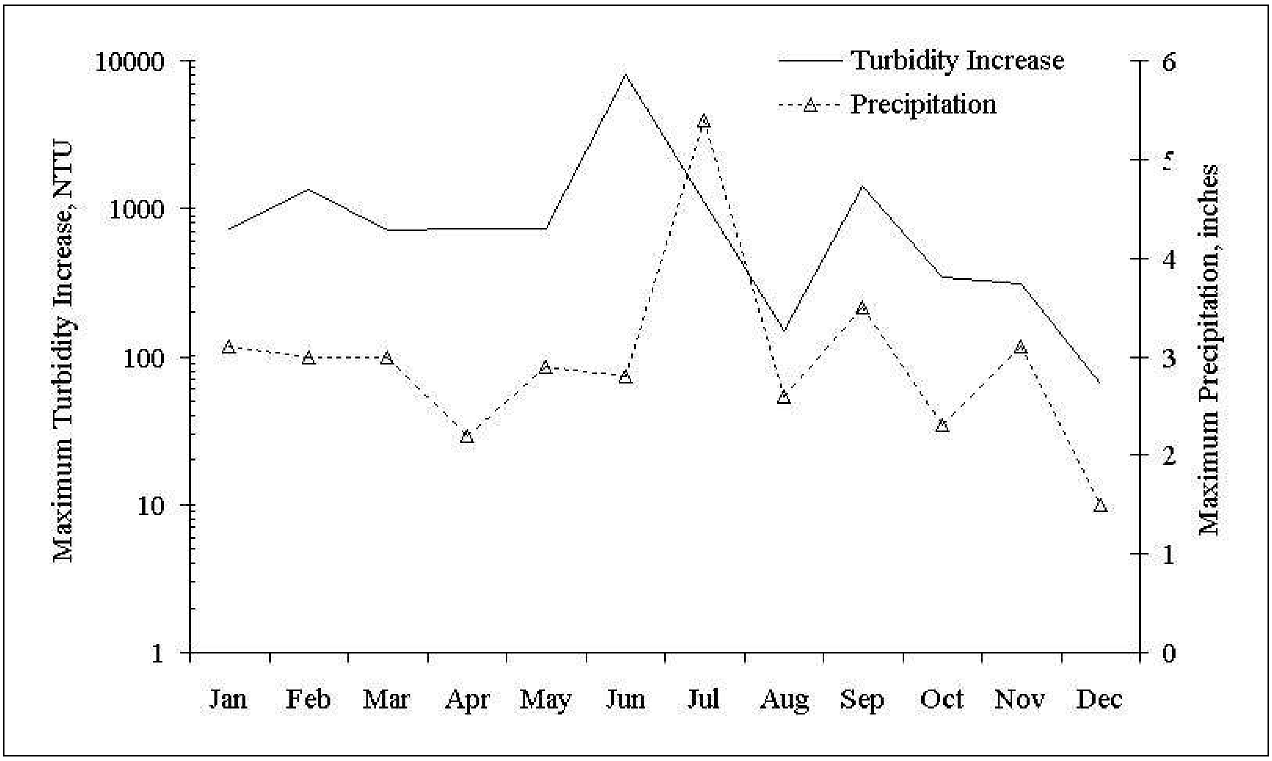


Figure 3.7: Monthly variation in the maximum turbidity increase and maximum precipitation.

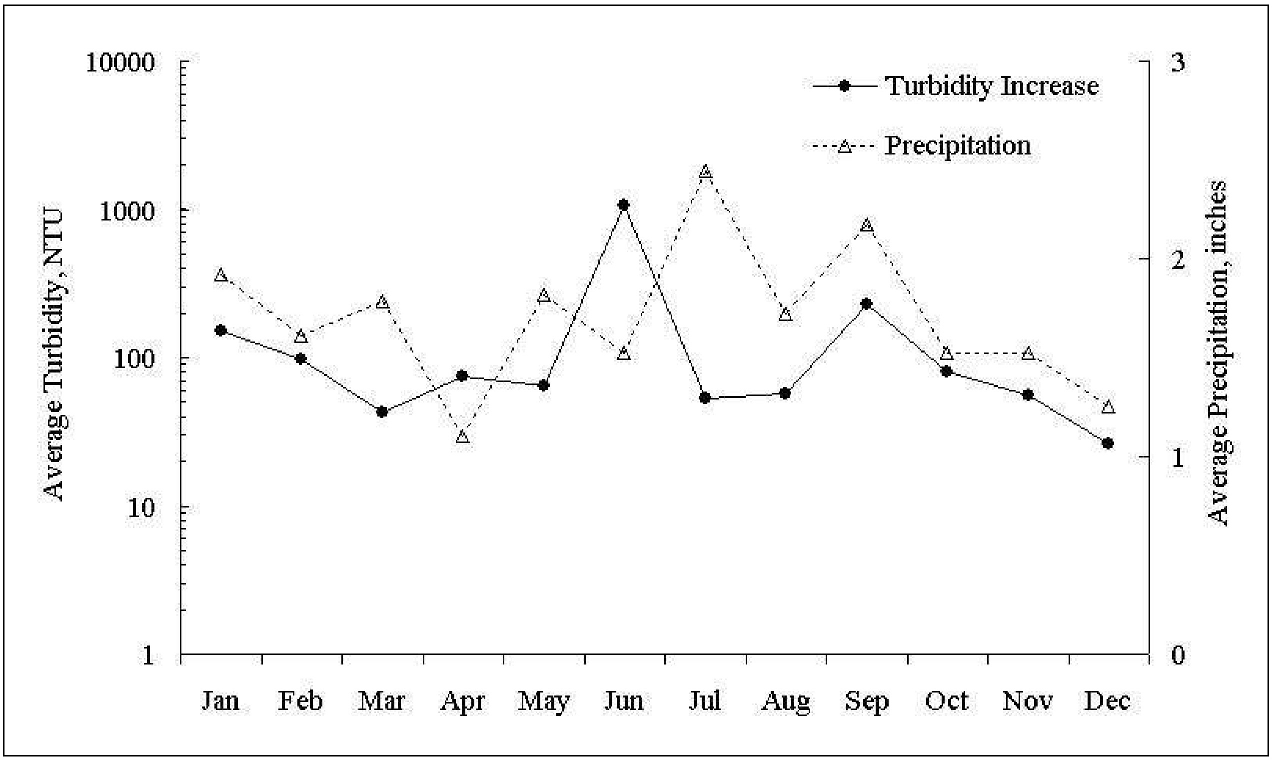
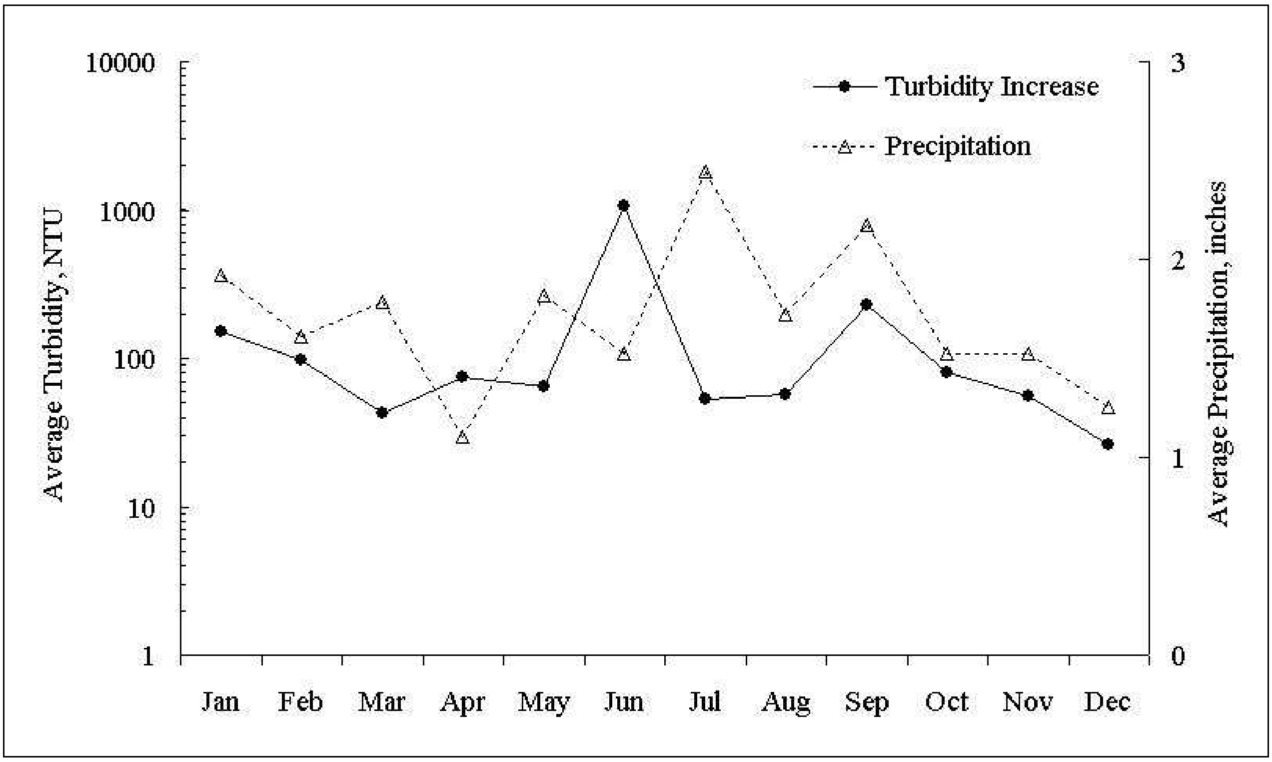


Figure 3.8: Monthly variation in the average turbidity increase and the average precipitation.



Turbidity	R^2	Regression Coefficient	Standard Error
Upstream	1.36×10^{-4}	14.5	271.3
Downstream	3.79×10^{-2}	501.3	551.2
Increase	4.56×10^{-2}	485.6	484.5

Figure 3.9: Scatterplot of average turbidity increase as a function of average precipitation depth. Also shown are summary statistics for linear regression results between rainfall depth and turbidity.

hypothesis is that spring and summer rainfalls in Georgia are usually more intense. Intense rainfall should lead to greater storm-water runoff. Also, between March and October there is normally greater construction activity and, therefore, greater storm-water runoff.

Figure 3.10 shows mean, maximum, and minimum turbidity values plotted against the time of year. This graph shows an increase in activity in the months from March to November. This indicates that the intensity of rainfall may have an effect on the turbidity of the storm-water runoff that is leaving the construction site; however there was no way to determine the intensity of the rain event from the data analyzed for this project. Table 3.3 presents statistical summaries for the monthly data.

3.5 Linear vs. Spatial Disturbances

Of the twenty sites examined during this study, five are linear while fifteen are spatial. One of the hypotheses to be tested revolves around whether linear construction sites produce less storm-water turbidity than spatial construction sites. As noted earlier, a linear construction project is a narrow disturbance that runs a long distance, such as a water, sewer, or power line. For example a construction project may disturb only 30 feet in width but travel for four miles. This is a total land disturbance of 14.5 acres of land. Spatial construction is a type of construction that would mass grade a large area to construct a shopping center or subdivision. Under the NPDES permit from 2000–2003, linear construction sites were treated the same as spatial construction sites.

Figure 3.11 shows the mean upstream, mean downstream and mean upstream-downstream difference turbidity values for linear construction projects. Figure 3.11 also shows the mean upstream, mean downstream and mean difference turbidity values for spatial construction projects. There was no significant correlation between the differences of upstream and downstream turbidity in linear and spatial construction activity.

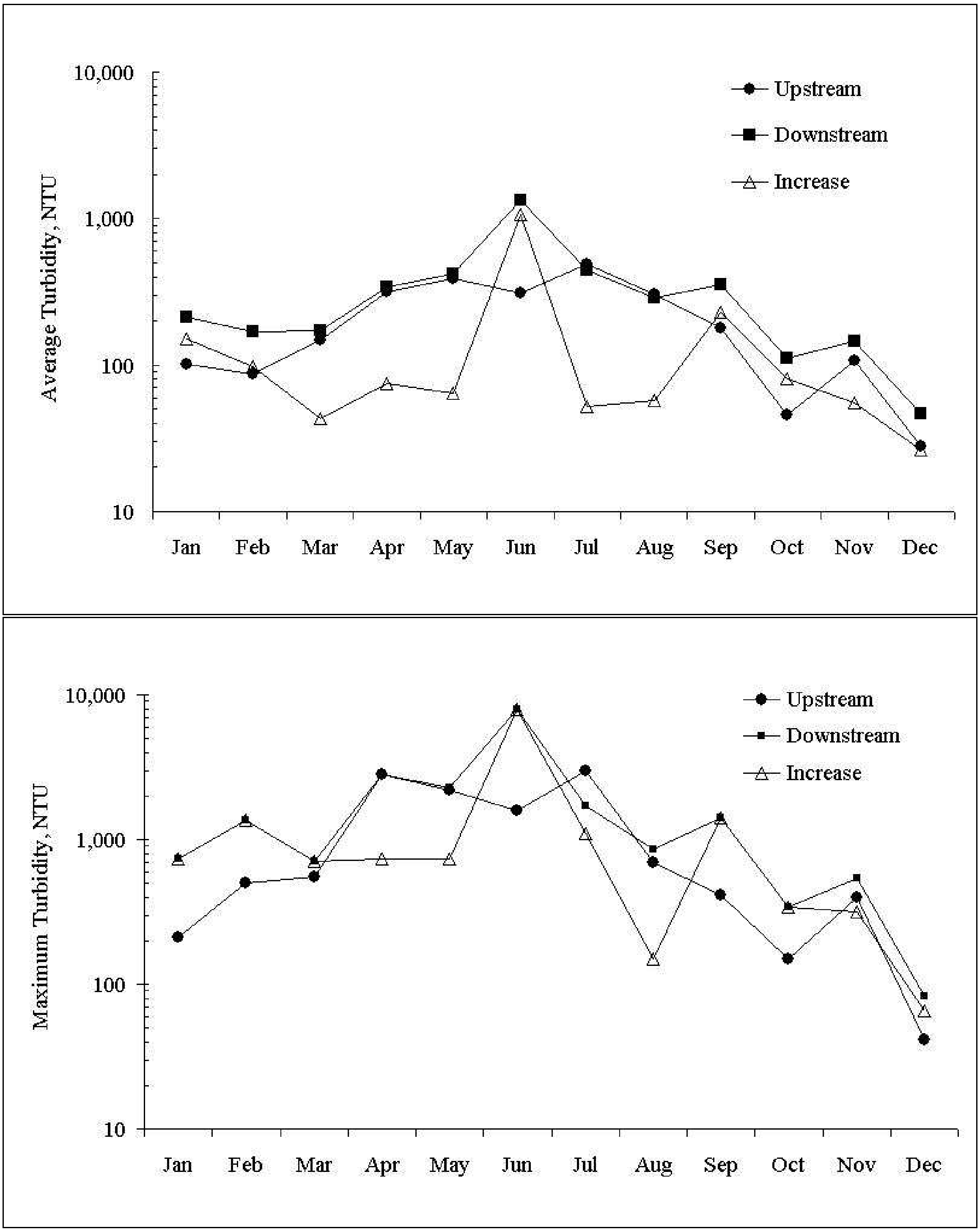


Figure 3.10: Monthly variation in average (top) and maximum (bottom) upstream, downstream, and turbidity increase.

Table 3.3: Summary statistics (mean, μ, standard deviation, s, and number of observations, n) for monthly variation in precipitation, upstream turbidity, downstream turbidity, and turbidity increase.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PRECIPITATION (inches)												
μ	1.92	1.61	1.79	1.10	1.82	1.52	2.45	1.73	2.18	1.52	1.52	1.26
s	0.86	0.52	0.39	0.50	0.58	0.54	1.43	0.80	0.87	0.62	0.63	0.19
n	10	22	20	12	19	20	20	4	13	9	20	7
UPSTREAM TURBIDITY (NTU)												
μ	102.2	86.9	148.2	317.2	390.2	312.3	486.5	306.7	178.9	46.0	107.2	28.0
s	84.6	118.6	191.9	872.9	659.1	435.1	918.0	342.0	146.6	51.7	106.0	11.5
n	6	18	17	10	16	17	16	3	9	6	17	5
DOWNSTREAM TURBIDITY (NTU)												
μ	212.5	167.7	171.8	339.3	417.9	1336	441.7	287.3	354.5	111.1	146.6	46.1
s	217.5	314.9	235.8	811.8	590.3	2444	445.9	379.2	369.2	107.8	133.0	22.4
n	10	21	19	12	17	20	20	4	13	9	20	7
TURBIDITY INCREASE (NTU)												
μ	151.2	97.7	43.0	74.9	64.2	1071	52.5	57.3	230.6	80.4	55.5	26.1
s	219.2	294.4	257.8	207.8	313.1	2248.1	624.2	62.0	413.6	115.0	98.8	23.0
n	10	21	19	12	17	20	20	4	13	9	20	7

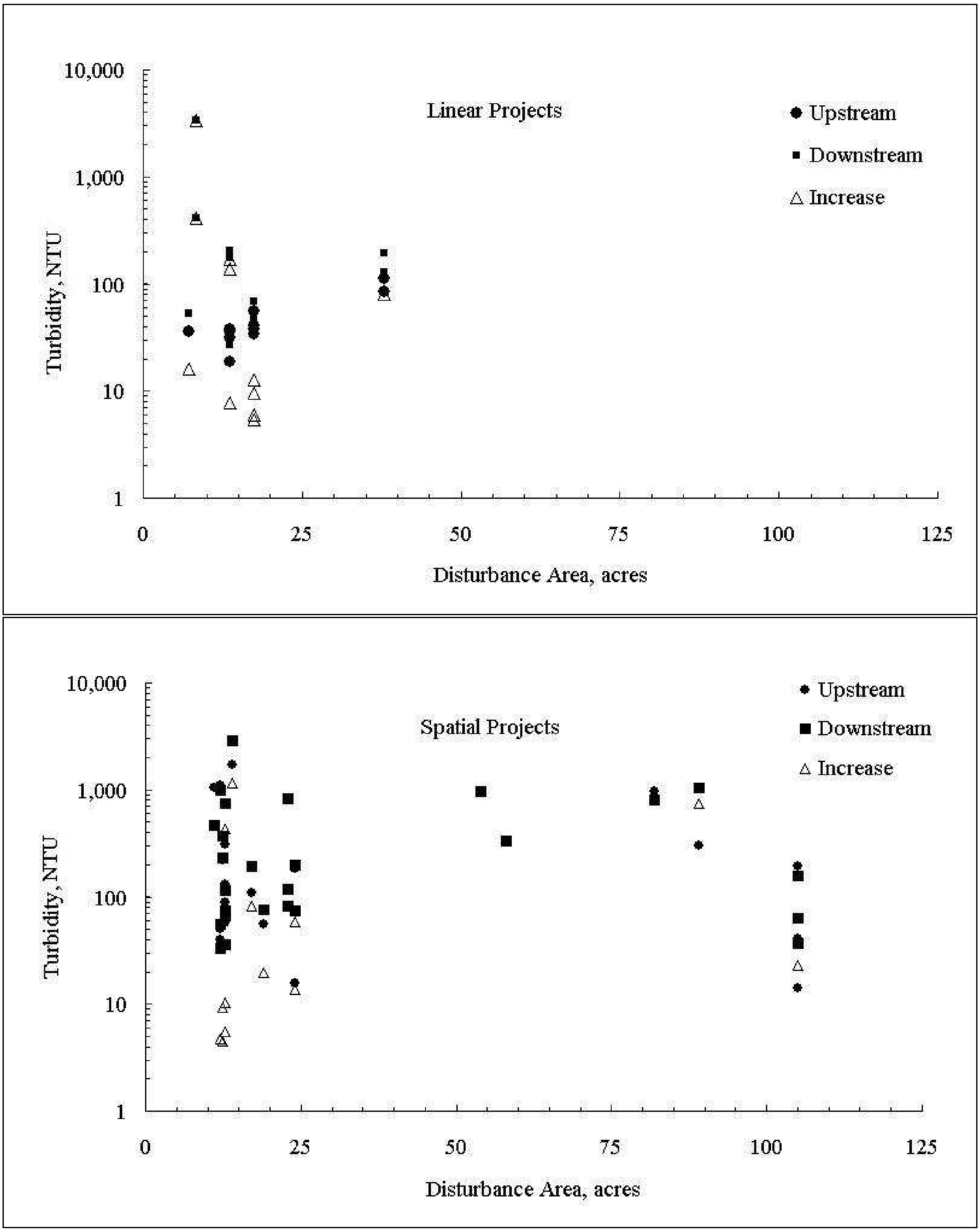
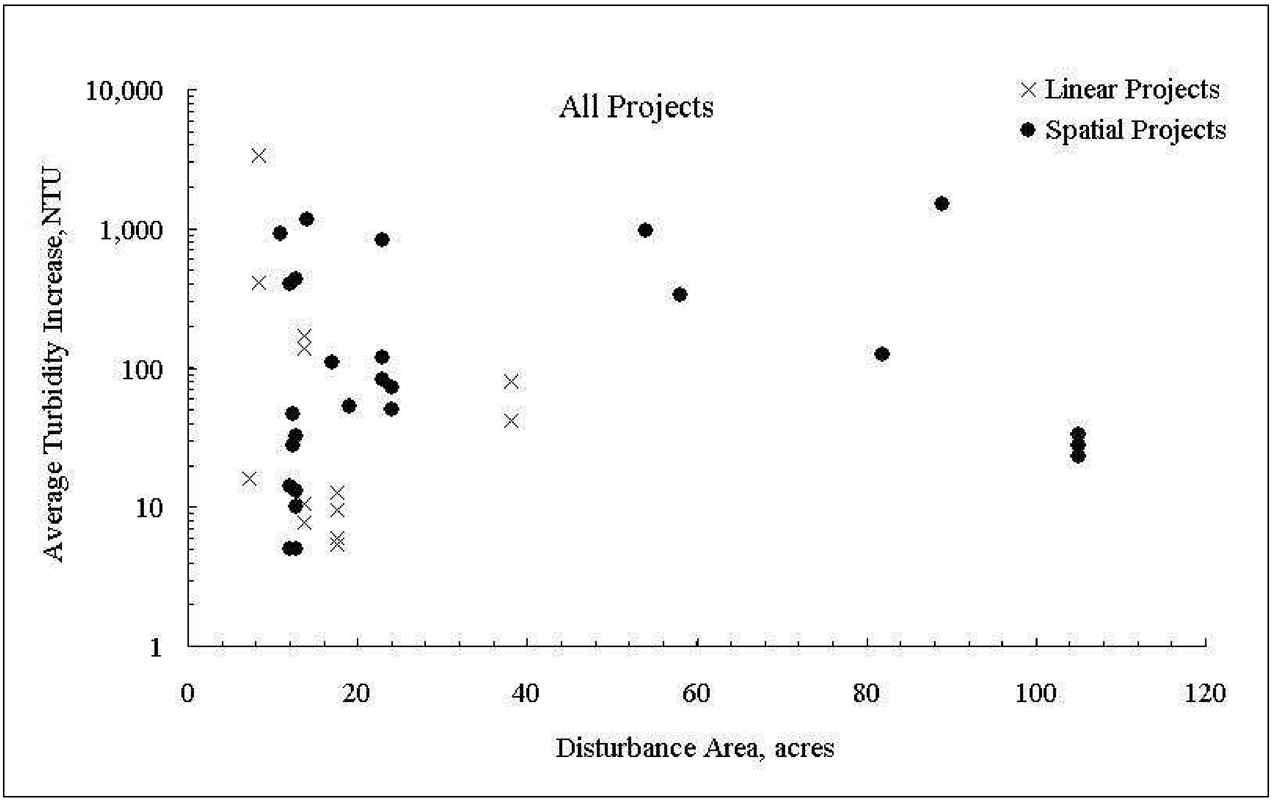


Figure 3.11: Average upstream, downstream, and turbidity increase for linear (top) and spatial (bottom) construction sites.



Type	Upstream			Downstream		
Linear	39.67	±	28.25	556.17	±	1254.56
Spatial	411.37	±	509.91	531.84	±	708.72

Figure 3.12: Average upstream-downstream differences of turbidity readings as a function of the disturbance area. Also shown are linear regression results (average ± standard deviation) for different types (linear vs. spatial) of land-disturbing activities

Figure 3.12 presents mean difference between upstream and downstream turbidity values for both types of construction. Also shown in Figure 3.12 are summary statistics for both types of construction.

Chapter 4

Conclusions and Recommendations

4.1 Hypothesis Results

No statistically significant conclusions could be drawn from the data that was analyzed for this project. The results for the four hypothesis that were tested in this analysis are reported below:

1. *Greater turbidities are associated with larger areas of land-disturbing activities.*

   Downstream turbidities and turbidity increases were not clearly related to disturbance area. No scientific basis exists for expecting splash or sheet erosion to cause increased turbidities - increased sediment loads are associated with increased storm-water discharges, thus maintaining a constant turbidity.

   Many variables were not considered in this project that could have assisted in the analysis of the data. Three important factors include the slope of the disturbance, soil erodibility at the site, and BMP installation and maintenance at the site. Information from these variables could have produced significant results in the analysis process.

2. *Greater turbidities are associated with larger precipitation events.*

   No clear relationship between turbidity (neither the downstream turbidity, nor the turbidity increase) was observed. While greater sheet erosion is predicted to increase with greater rainfall energy, the manner in which turbidity data were collected precludes effective evaluation of this relationship. Rainfall energy is largely determined by the maximum rainfall intensity - which was not measured. Also, rainfall depth - which was measured - is a function of both rainfall intensity and duration. Thus, long duration storms with low intensity should yield lower rates of sediment production than short duration storms with high intensity.

A second problem lies in the manner in which turbidities were measured. Because turbidities were measured once a specific depth of rainfall was exceeded (either one-half, one, or two inches, depending upon project stage), any subsequent runoff due to additional precipitation was not sampled. Thus, even though the total storm precipitation would continue to accumulate (and the turbidity would likely continue to rise), the storm-water turbidity sample had already been collected. A more rigorous analysis would require the analysis of cumulative precipitation and continuous turbidities. Only in this way could the effects of precipitation on turbidity.

3. *Time of year does not affect turbidity.*

   Only a weak relationship was observed between the time of year and the turbidity. While a slight increase in turbidity is observed during the summer months, the variation from site to site and from year to year was so large as to prevent the estimation of seasonal trends. This was probably the result, in part, to the lack of substantial variation in average monthly rainfall.

4. *Linear construction sites produce less turbidity than spatial construction sites.*

   No significant differences existed between downstream turbidities for linear (556 $\pm$ 1255 NTU) and spatial (532 $\pm$ 709 NTU) sites. Yet, a significant difference is observed between upstream turbidities for linear (40 $\pm$ 28 NTU) and spatial (411 $\pm$ 510 NTU). It is clear that both types of sites contribute substantial quantities of sediment to streams. It remains uncertain, however, why upstream samples above spatial sites are so much higher than above linear sites.

4.2 Discussion and Further Recommendations

While I was only able to draw limited conclusions from my data, I would like to make a few recommendations based on my professional experience with the NPDES regulation. These recommendations are not based on scientific evidence but more on experiences while working for the private sector, monitoring construction sites and working on this project.

4.2.1 Enforcement Efforts

One of the goals of this thesis is to assist EPD in prioritizing their enforcement efforts for the NPDES regulation. While analyzing the data that was collected for this project, I found that prioritizing enforcement was not as clear as I initially felt it would be. I will make several recommendations that I hope will assist EPD in the future.

I felt that larger construction projects would lead to more turbid storm-water runoff that would likely exit the construction site. The data that was analyzed does not fully support my hypothesis. Effective BMPs must be in place to reduce turbid storm water from leaving the construction site whether the site is one acre or 100 acres. Larger sites may make a more concerted effort to implementing effective BMPs than some smaller sites. While larger sites contribute a larger total load of sediments, the turbidity from a site is clearly unaffected by the area of the site. A construction site that does not have adequate erosion control measures will cause turbid storm water to enter adjacent streams and rivers. Without proper erosion control measures, even smaller sites can have large amounts of turbid storm water leaving the site.

Erosion is a function of many variables that were not required by the EPD to include in the NPDES process. Inspection reports could have been useful in this project. The inspection reports are required to be completed on a weekly and rainfall dependent basis but are not required to be submitted to the EPD. The inspection reports could have assisted in determining if the BMPs were installed and that they were maintained during the construction process. Without the inspection reports there is no way of determining if the sites that were analyzed for this project even had BMPs in place when turbidity sampling occured.

For future amended versions of this permit the EPD and its advisors should consider requiring this type of information with the NOI. By submitting the inspection reports the EPD could follow the BMP maintenance process. EPD could also compare the turbidity reports to the inspection reports and possibly determine what is causing high turbidity values on some sites.

It was my hypothesis that larger rain events would produce higher turbidity levels in storm water that exits a construction site. The data that was analyzed does not fully support this hypothesis. If EPD sent more employees in the field to inspect construction sites after rainfalls of one inch or greater this would allow the inspectors to view the site after critical storm-water runoff events.

I also felt that the time of the year would play a key role in the amount of construction projects occurring and intense rainfalls in Georgia. With the data provided for this project, I was unable to determine the intensity of the rainfall event. However, there is more construction activity during the months of March through October. I would suggest that EPD considers hiring additional inspectors during these months. EPD should consider hiring college students in the environmental fields as interns to work summers as inspectors. This would provide good experience for the student and assist EPD during the peak construction season.

I also felt that linear construction projects would produce less turbid storm-water runoff than spatial construction sites. The data that was analyzed does not support this hypothesis. If EPD is having a hard time inspecting all of the construction sites that have submitted NOI's, then I would recommend concentrating their efforts to spatial construction activities. Based on field experiences spatial construction sites leave more land disturbed for longer periods of time than linear construction sites. Linear projects disturb less land in a concentrated area. It is also easier to apply effective BMPs to linear construction projects. Often when a contractor is laying a utility line, they will lay 200 to 300 linear feet of the utility and then stabilize what they have disturbed before proceeding further. This reduces the amount of time a disturbed area is unprotected. A spatial construction project often does not have the ability to stabilize portions of the site until major construction activity has been completed, which could leave large disturbed areas unstable for months at a time.

4.2.2 Design a Better System

Since Georgia adopted the Authorization to Discharge Under the National Pollutant Discharge Elimination System Storm Water Discharges Associated with Construction Activity in 2000 the permit is effective for a three year period. The Georgia legislature has formed a committee that reviews the current permit and considers and recommends changes when the permit expires. So this permit will be restructured and continue to change under the current system. In this section I will make suggestions that I feel are necessary to help EPD prioritize enforcement and keep Georgia's waterways clean and safe for future generations.

4.2.3 Sampling

The requirements of sampling storm-water outfalls and receiving streams have been greatly reduced in the amended NPDES permit which went into effect August 13, 2003. In my opinion, this is due to the enormous amounts of money that owners and contractors had to spend to have the site monitored through the entire construction of the site. A compromise to sample less and to pay a per-acre fee of disturbance was reached in the 2003 amended permit.

The compromise to only sample twice during the entire construction phase of the site does not provide enough information to EPD about the site. As opposed to sampling at the first one inch of rainfall in a 24-hour period and every two inches of rainfall in a 24-hour period, this could equal three or more samples during that month. I would recommend requiring one sample per month after any rainfall event of one inch or greater in a 24-hour period.

This would reduce the number of samplings that were required for the NPDES permit from 2000–2003 but would require more sampling than what is required for the 2003 amended NPDES permit. This would allow turbidity data to be collected throughout the construction period, which in turn would provide EPD the necessary data to make judgments on the state of the site.

It appears that the EPD did not sufficiently review the monthly turbidity reports that were submitted by contractors during the NPDES permit from 2000–2003. The regulation was passed so that EPD could make educated decisions on which sites should be inspected. The turbidity results from these sites were to be used to make these educated decisions. If the EPD does not have the money to allot so that site inspectors can review the monthly results and visit questionable sites, then more samplings should not be required.

4.2.4 Data Management

While gathering the data for this project from EPD, I feel that the turbidity data management could be improved. While I understand that EPD is understaffed and the management of the turbidity data is a significant undertaking, there are ways in which it can be improved. The first suggestion I have is there should be a file for each site. When turbidity data is submitted for a site then those results should be put into the site file. Filing all of the turbidity submittals for each month is overwhelming and very hard to locate when you want to assess a particular site.

Creating an electronic database would be another improvement. With the money that is generated from the recent amended NPDES permit a certain percentage of the money should be appropriated to designing an electronic database. The current system of data management and filing seems to complicate the site assessment which is needed to properly enforce the permit. Once an NOI is submitted for a particular site, that site should be entered into the database. It could display the site location, size, receiving streams, acreage that will be disturbed, owner, and the permittee's. All turbidity results associated with that site should then be linked to the site. This would create easier access to the data and allow EPD personnel the ability to analyze the data and prioritize their efforts to sites which may need more stringent enforcement.

I feel it would also be beneficial to EPD to create a standard form for monthly turbidity reports. The monthly report form should be required as part of the permit. EPD should make the form available on their website much like the NOI and NOT forms. This would eliminate the variable monthly reports that are submitted to EPD and make it easier and more efficient to review the turbidity results for each site.

4.3 Concluding Remarks

The public is becoming increasingly aware of the problems associated with nonpoint source pollution. There is much debate between politicians, researchers, and professionals concerning storm water that exits construction sites. The state of Georgia has taken an aggressive step to try and reduce the amount of turbid storm water that leaves construction sites.

Based on an examination of submitted storm-water monitoring data, it is clear that insufficient information exists to evaluate the effectiveness of current design, implementation, and monitoring related to storm-water discharge from construction sites. Clearly, a regulatory program that provides neither data suitable for scientific evaluation - nor for compliance with regulatory requirements - fails in its intent to be protective of aquatic systems.

The NPDES regulation has been in effect in the state of Georgia for four years, it is now up to the state of Georgia to provide EPD with sufficient funding to enable them to successfully enforce this legislation. If EPD could concentrate their enforcement efforts to construction sites that generate more storm water and higher turbidity levels, then both time and money could be saved. A design of a new system and better data management techniques would be a significant improvement and save EPD time and money when enforcing the NPDES storm-water discharges associated with construction activity.

Additional research is needed to determine how detrimental storm-water runoff from construction sites is to state waters. Future research may generate more public and private response to this growing problem in urbanized areas. Development and evaluation of improved BMPs are one means for reducing sediment loads to streams. Lacking an active research program to evaluate these actions, no scientific basis for existing or proposed BMPs is available.

Bibliography

Dennison, M. S. (1996) *Stromwater Discharges, Regulatory Compliance and Best Management Practices.* Boca Raton, FL: Lewis Publishers.

DEC (2003) *NPDES General Permit TNR10_0000. General NPDES Permit for Strom Water Discharges Associated with Construction Activities.* Nashville, TN: State of Tennessee Department of Environment and Conservation.

DEP (2003) *NPDES Stormwater: NPDES Stormwater Program for Construction Activity Permit Options & Requirements for Construction.* Tallahassee, FL: State of Florida Department of Environmental Protection. Web: http://www.dep.state.fl.us/water/stormwater/npdes/construction3.html

DHEC (2003) *Fees for Sediment, Erosion, and Stormwater Management Program.* Columbia, SC: State of South Carolina, Department of Health and Environmental Control. Web: http://www.scdhec.net/eqc/water/html/erffees.html

Dobson, R. D. (1998) *Stormwater Pollution Control: Municipal, Industrial, and Construction NPDES Compliance.* 2nd ed. New York, NY: McGraw–Hill.

DOE (2002) *Stormwater Management Manual for Western Washington.* Olympia, WA: State of Washington Department of Ecology. Web: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

EPA (2001). *Fact on Nonpoint Source Pollution.* Washtington, DC: United States Environmental Protection Agency, Web: http://www.epa.gov/owow/nps/pointsl.html

EPD (2000) *General Permit No. GAR100000. Authorization to Discharge under the National Pollutant Discharge Elimination System Storm Water Discharges Associated with Construction Activity.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division.

EPD (2001) *Georgia Stormwater Management Manual: The Need for Stormwater Management.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division. 2:1.1.

EPD (2003a), *General Permit No. GAR100001. Authorization To Discharge Under The National Pollutant Discharge Elimination System Storm Water Discharges Associated With Construction Activity For Stand Alone Construction Projects.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division.

EPD (2003b), *General Permit No. GAR100002. Authorization To Discharge Under The National Pollutant Discharge Elimination System Storm Water Discharges Associated With Construction Activity For Infrastructure Construction Projects.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division.

EPD (2003c), *General Permit No. GAR100003. Authorization To Discharge Under The National Pollutant Discharge Elimination System Storm Water Discharges Associated With Construction Activity For Common Developments.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division.

EPD (2003d), *National Pollutant Discharge Elimination System General Permits for Construction Activity GAR 100001, GAR 100002 & GAR 100003 Fee Systems.* Atlanta, GA: State of Georgia, Department of Natural Resources, Environmental Protection Division.

Hill, R. L. (1993) Tillage and Wheel Traffic Effects on Runoff and Sediment Losses from Crop Interrows. *Soil Science Society of America Journal* 476–480.

Kundell, J. E.; and Rasmussen, T. C. (1995) *Erosion and Sedimentation: Scientific and Regulatory Issues.* Athens, GA: Carl Vinson Institute of Government, The University of Georgia.

Park, S. W.; Mostaghimi, S.; Cooke, R. A.; and McClellan, P. W. (1994) BMP Impacts on Watershed Runoff, Sediment, and Nutrient Yields *Water Resources Bulletin,* 30(6):1011–1022.

Pate, M. L. (1983) *Introduction to Urban Stormwater Management in Georgia.* Federal Emergency Management Agency. Cooperative Agreement EMA-K-0079.

Strecker, E. W.; Quigley, M. M.; Urbonas, B. R.; Jones, J. E.; and Clary, J. K. (2001) Determining Urban Storm Water BMP Effectiveness. *Journal of Water Resources Planning and Management* 144–149.

Vowell, J. L. (2001) Using Stream Bioassessment to Monitor Best Management Practice Effectiveness. *Forest Ecology and Management* 143:237–244.

Walker, J. F.; Graczyk, D. J.; Corsi, S. R.; Owens, D. W.; and Wierl, J. A. (1995) *Evaluation of Nonpoint-Source Contamination, Wisconsin: Land-Use and Best-Management-Practices Inventory, Selected Streamwater-Quality Data, Urban-Watershed Quality Assurance and Quality Control, Constituent Loads in Rural Streams, and Snowmelt-Runoff Analysis, Water Year 1994.* Madison, WI. U.S. Geological Survey Open-File Report 95-320.

Appendix A

Abbreviations

BMP Best Management Practice

CMP Comprehensive Monitoring Plan

DHEC Department of Health and Environmental Control

EPA Environmental Protection Agency

EPD Georgia Environmental Protection Division

ESPC Erosion and Sedimentation Pollution Control

NOI Notice of Intent

NOT Notice of Termination

NPDES National Pollution Discharge Elimination System

NPS Nonpoint Source

NTU Nephelometric Turbidity Unit

SMZ Streamside Management Zone

Appendix B

Documentation Related to Georgia's Erosion and Sedimentation Control Program

B.1 Notice of Intent Form

For Official Use Only

NOTICE OF INTENT

State of Georgia
Environmental Protection Division
For Coverage Under General Permit GAR100000
To Discharge Storm Water Associated With Construction Activity
Do Not Submit This NOI Prior to August 1, 2000

PRIMARY PERMITTEE

1. SITE /OWNER/OPERATOR INFORMATION

Site/Project Name: ____________________

Site Location and Street Address: ____________________

City: ____________________ County: ____________________

Subdivision Name: ____________________

Owner's Name: ____________________ Phone: ____________________

Address: ____________________ City: ____________________ State: ________ Zip Code: ________

Operator's Name: ____________________ Phone: ____________________

Address: ____________________ City: ____________________ State: ________ Zip Code: ________

Facility Contact: ____________________ Phone: ____________________

II. SITE ACTIVITY INFORMATION

Start Date: ____________________ Completion Date: ____________ Estimated Disturbed Acreage: ____________

Land Disturbance Activity Permit Number: ____________________ Date Issued: ____________

Date Building Permit Issued: ____________________

Type Construction Activity: [ ] Commercial [ ] Industrial [ ] Municipal [ ] Linear [ ] Utility

[ ] Residential / Subdivision Development

Number of Secondary Permittees: ____________________

III. RECEIVING WATER INFORMATION

A. Name of Initial Receiving Water(s): ____________________

[ ] Trout Stream [ ] Warm Water Fisheries Stream

B. Name of Municipal Storm Sewer System Owner/Operator: ____________________

Name of Receiving Water(s): ____________________

[ ] Trout Stream [ ] Warm Water Fisheries Stream

C. [ ] Sampling of Outfall(s) [ ] Sampling of Receiving Stream(s) [ ] Trout Stream

Number of Outfalls: ________ Appendix B NTU Value: ________ Surface Water Drainage Area: ________

IV. ATTACHMENTS

Indicate below the items attached to this Notice of Intent:

____________ Location map showing the receiving stream(s), outfall(s) or combination thereof to be monitored.

____________ Erosion, Sedimentation and Pollution Control Plan (if project is greater than 50 acres).

____________ Comprehensive Monitoring Program (if the project is greater than 50 acres).

____________ List of known secondary permittees.

____________ Schedule for the timing of the major construction activities.

V. CERTIFICATIONS

1. I certify that the location of the receiving water(s) or outfall(s) or a combination of receiving water(s) and outfall(s) to be monitored is shown on a map or drawing of-appropriate scale and a copy of this map or drawing is attached to this Notice.

2. I certify that the Erosion, Sedimentation and Pollution Control Plan (Plan) has been prepared in accordance with Part IV of the General NPDES Permit No. GAR 100000, the Plan will be implemented, and that such Plan will provide for compliance with this permit. If this site is greater than 50 acres of disturbed area, I certify that a copy of the Erosion, Sedimentation and Pollution Control Plan is attached to this Notice.

3. I certify that a copy of the Erosion, Sedimentation and Pollution Control Plan or the applicable portions of the Plan will be provided to each and every secondary permittee. A list of the secondary permittees known- -at the time of making this Notice is attached.

4. I certify that a schedule for the timing of the various major construction activities, if applicable, is attached to this Notice.

5. I certify that the receiving water(s) or the outfall(s) or a combination of receiving water(s) and outfall(s) will be monitored in accordance-with the Comprehensive Monitoring Program. If this site is greater than fifty acres, I certify that a copy of the Comprehensive Monitoring is attached to this notice.

6. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information provided is, to the best of my knowledge and belief, true, acurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Owner's Printed Name: ____________________________ Title: ________________

Signature: ________________________________ Date: ________________

Operator's Printed Name: __________________________ Title: ________________

Signature: ________________________________ Date: ________________

B.2 Notice of Termination Form

For Official Use Only

NOTICE OF TERMINATION

State of Georgia
Environmental Protection Division
To Cease Coverage Under General Permit GAR100000
To Discharge Storm Water Associated With Construction Activity
Do Not Submit This NOT Prior To August 1, 2000

I. SITE / PERMITTEE INFORMATION

Site/Project Name: ______________________________

Site Location and Street Address: ______________________________

City: ________________ County: ________________

Subdivision Name: ______________________________

Permittee's Name: ______________________________ Phone: ____________

Address: ________________ City: ________ State: ______ Zip Code: ________

Type of Permittee: [X] Primary [ ] Secondary [ ] Tertiary

Facility Contact: ______________________________ Title: ____________

If applicable:

Primary Permittee's Name: ______________________________ Phone: ____________

Address: ________________ City: ________ State: ______ Zip Code: ________

II. SITE ACTIVITY INFORMATION

[ ] Construction Activity Completed [ ] No Longer Owner / Operator of Construction Activity

Construction Activity: [ ] Commercial [ ] Industrial [ ] Municipal [ ] DOT [ ] Utility

[ ] Residential
[ ] Primary Permittee of a Subdivision Development; or
[ ] Individual Lot; or
[ ] Individual Lot within a Surface Water Drainage Area when the Primary has ceased Permit Coverage

Land Disturbance Activity Permit Number: ______________________________

Name of Initial Receiving Water(s): ______________________________

Name of Municipal Storm Sewer System Owner/Operator: ______________________________

Name of Receiving Water(s): ______________________________

NOT Type All Information Ver. 7/00

III. ATTACHMENT

Indicate below if this item is attached to this Notice of Termination:

______ Final monitoring report for the receiving water(s) and/or storm water outfall(s).

IV. CERTIFICATIONS

1. I certify that a copy of the final monitoring report, if applicable, is attached to this Notice. This monitoring report shows the monitoring data for a receiving water(s) and/or storm water outfall(s) collected between the period of final stabilization and the filing of this Notice.

2. I certify under penalty of law that either: (a) all storm water discharges associated with construction activity from the portion of the construction activity where I was an Owner or Operator have ceased or have been eliminated; (b) all storm water discharges associated with construction activity from the identified site that are authorized by General NPDES Permit No. GAR 100000 have ceased; (c) I am no longer an Owner or Operator at the construction site and a new Owner or Operator has assumed operational control for those portions of the construction site where I previously had ownership or operational control; and/or if I am a primary permittee filing this Notice of Termination under Part VII.A.4. of this permit, I will notify by written correspondence to the subsequent legal title holder of any remaining lots that these lot Owners and /or Operators will become tertiary permittees for purposes of this permit and I will provide these tertiary permittees with the primary permittee's Erosion, Sedimentation and Pollution Control Plan. I understand that by submitting this Notice of Termination, that I am no longer authorized to discharge storm water associated with construction activity by the general permit, and that discharging pollutants in storm water associated with construction activity to waters of Georgia is unlawful under the Georgia Water Quality Control Act and the Clean Water Act where the discharge is not authorized by a NPDES permit.

3. I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Printed Name: ______________________________ Title: ____________________

Signature: ______________________________ Date: ____________________

B.3 Sample Stormwater Monitoring Form

Project Name ______________________

Project Location ______________________

Storm Water Monitoring Data

To be used within 24-hours of a qualifying rainfall event of 0.5-inches or more.

Date Sampled	Rainfall Amount (Inches)	Exact Location of Sample	Time Sampled	Sampling Technique (Manual or Automatic Grab)	Sampled By	Date of Analysis	Time Analyzed	Analyzed By	Analytical Technique or Method Used (Meter #)	Results (NTU)

B.4 Sample Inspection and Maintenance Form

Erosion & Sedimentation Inspection and Maintenance Report

To be completed every 7 days AND within 24-hours of a qualifying rainfall event of 0.5-inches or more.

Project: ____

Time/date of last rainfall: ______________ Amount of last rainfall: ________ inches

Inspector: Date: Time:

Describe the most recent land disturbance/phase of the project:____________________________

Date of the most recent disturbance: ________

Is site in compliance? Y or N If not, complete the following information for each deficiency.

1. Deficiency(ies):	Location: ____________	Code: **I M GC**
Corrective actions:		
2. Deficiency(ies):	Location: ____________	Code: **I M GC**
Corrective actions:		
3. Deficiency(ies):	Location: ____________	Code: **I M GC**
Corrective actions:		
4. Deficiency(ies):	Location: ____________	Code: **I M GC**
Corrective actions:		

Required under the EPD NPDES Construction Permit for sites between 5 and 250 acres. Sheets developed by : Jordan Jones & Goulding

Photo document deficiencies and retain in permanent file.
Include site map identifying locations of all deficiencies.
Return original reports to construction site file and copy in permanent office file.

Codes:
- **I** — **Immediate – Must be corrected within 24 hours.**
- **M** — **Minor- Must be corrected within 72 hours.**
- **GC** — **General Condition – Must be maintained monthly.**

Please contact ________________________ for questions regarding this report.

B.5 Sample Project Field Reporting Form

Field Report

PROJECT: ______________________ **FIELD REPORT NO:** ______________________

CONTRACTOR: . ______________________ **JOB NO:** ______________________

DATE: ________ **TIME:** ________ **WEATHER:** ________ **TEMP. RANGE:** ________

EST. % OF COMPLETION: ________ **CONFORMANCE WITH SCHEDULE (+,-):** ________

WORK IN PROGRESS: ______________________ **PRESENT AT SITE:** ______________________

OBSERVATIONS:

ITEMS TO VERIFY:

INFORMATION OR ACTION REQUIRED:

BY: ______________________ **DISTRIBUTION:**

Appendix C

Georgia's Requirements for Determining Acceptable Turbidities for Headwater Streams

APPENDIX B

Nephelometric Turbidity Unit (NTU) TABLES

Cold Water (Trout Stream)

Surface Water Drainage Area, square miles

Site Size, acres		0-4.99	5-9.99	10-24.99	25-49.99	50-99.99	100-249.99	250-499.99	500+
	1.00-10	25	50	75	150	300	500	500	500
	10.01-25	25	25	50	75	150	200	500	500
	25.01-50	25	25	25	50	75	100	300	500
	50.01-100	20	25	25	35	59	75	150	300
	100.01+	20	20	25	25	25	50	60	100

Warm Water (Supporting Warm Water Fisheries)

Surface Water Drainage Area, square miles

Site Size, acres		0-4.99	5-9.99	10-24.99	25-49.99	50-99.99	100-249.99	250-499.99	500+
	1.00-10	75	150	200	400	750	750	750	750
	10.01-25	50	100	100	200	300	500	750	750
	25.01-50	50	50	100	100	200	300	750	750
	50.01-100	50	50	50	100	100	150	300	600
	100.01+	50	50	50	50	50	100	200	100

To use these tables, select the size (acres) of the facility or common development. Then, select the surface water drainage area (square miles). The NTU matrix value arrived at from the above tables is the one to use in Part III.C.4.

Example 1: For a site size of 12.5 acres and a cold water drainage area of 37.5 square miles, the NTU value to use in Part III.C.4 is 75 NTU.

Example 2: For a site size of 51.7 acres and a warm water drainage area of 72 square miles, the NTU value to use in Part III.C.4 is 100 NTU.