IMPLEMENTING A REGIONAL URBAN STORM WATER MONITORING PROGRAM

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INTRODUCTION

The impacts of storm water runoff on water quality are becoming more significant as urban areas continue to expand and improvements are made in treated wastewater effluent quality. Urban storm water runoff can contain significant amounts of various pollutants including bacteria, sediments, nutrients and heavy metals (U.S. EPA, 1983). Urbanization or development of a watershed can have a variety of impacts on the stream, including increased flooding, streambank erosion and pollutant export (Schueler, 1987).

This paper describes a regional monitoring plan developed and implemented in the Atlanta Region to comply with Clean Water Act rules, to characterize local storm water discharges, evaluate storm water control measures and identify long-term trends.

Coordinated Response to Regulatory Requirements

The Environmental Protection Agency (EPA) issued final rules in 1990 requiring certain industries and municipalities to submit an application for NPDES permits for storm water discharges (U.S. EPA, 1990). The Georgia Environmental Protection Division (EPD) required local governments within a five county Metro Atlanta area to submit an application to be covered by a regionwide permit. The governments of the five county area of Clayton, Cobb, DeKalb, Fulton and Gwinnett Counties have been working together through the Atlanta Region Storm Water Management Task Force (facilitated by the staff of the Atlanta Regional Commission) to develop efficient and consistent storm water management programs.

By coordinating their efforts and reducing duplication, the local governments were able to reduce the resources required in all aspects of the application process including the storm water characterization or sampling work. The Task Force has also worked together to develop a regional approach for a long-term monitoring plan.

To comply with the permit application requirements, a regional characterization plan was developed and each major government was assigned appropriate sampling responsibilities. A number of different governments and agencies were involved in instrumenting these sites and collecting information from appropriate storm events. The data collected from each site will then be pooled and used to develop local storm water event mean concentrations (the average pollutant concentration during a runoff event) and pollutant loading estimates for the region.

MONITORING PROGRAM OBJECTIVES

The storm water monitoring program implemented by the Task Force can be separated into two parts: 1) a program to comply with the NPDES permit application rules; and 2) a long-term storm water monitoring program. The objectives of these two programs are slightly different.

NPDES Requirements

The rules promulgated by the U.S. EPA, required that each permit applicant collect "quantitative data from representative outfalls" of storm water runoff. This data are intended to provide information on the characteristics of storm water runoff from commercial, residential and industrial land uses and to be used to develop storm water pollutant loading estimates. The objectives of this sampling work can be summarized as follows: a) provide basic information on the characteristics of storm water quality; and b) characterize storm water quality based on land use.

An important consideration is to collect enough samples to develop statistically valid event mean concentrations for each pollutant by land use (the rules require that 3 storm events be sampled at each site). Also, it may be important to collect samples during different seasons to determine if there are seasonal fluctuations in storm water quality.

Long-Term Monitoring Program Objectives

A long-term monitoring program should be more concerned with the effectiveness of storm water quality controls and long-term storm water quality trends. The objectives developed by the Task Force for this program include: a) evaluate the effectiveness of particular storm water quality controls; b) evaluate the overall effectiveness of the storm water management programs; c) measure

Table 1. Land Use Types and Number of Sampling Sites.

Land Use Type	Number of Sites
Residential	9
Commercial	5
Commercial/Transportation	3
Light Industry/Ind. Park	8
Heavy Industry	2
Total	27

The regional consultant recommended that at least 10 samples be collected in each land use category. The above 27 sites will be sampled a minimum of three times and some up to seven times. By grouping land uses, more than 10 samples will be collected in each land use category. The collection of samples will be spaced out over the year to evaluate the effects of seasonal climate changes on storm water quality.

LONG-TERM MONITORING PROGRAM

The initial characterization of storm water quality by land use will be completed in two years. The Task Force will then reassign some of the monitoring sites to be used to evaluate the efficiency of specific storm water structural controls. The number of monitoring sites will be reduced over the long-term as objectives of the program are met. Eventually, only long-term trend sites will be routinely monitored.

The Task Force will focus on evaluating the efficiency of different storm water structural controls and programs during the beginning stages of the long-term program. The elements and general schedule of the long-term program are listed below.

Year 1: Complete the characterization sampling work.

Year 2 & 3: Begin collecting data from long-term water quality trend sites; conduct inflow and outflow analysis of wet detention ponds.

Year 4 & 5: Continue long-term trend sampling; and conduct sampling of watersheds containing numerous dry detention ponds.

Year 6+: Continue long-term trend sampling; and conduct special studies and investigations of local interest.

SAMPLING PROCEDURES & INSTRUMENTATION

There are several things to consider when developing procedures for a regional storm water monitoring program, including: a) appropriate storm event sampling criteria; b) automatic versus manual sample collection; c) specific pollutants to be analyzed for; d) analytical procedures; and e) consistency.

Storm Event Sampling Criteria

Guidelines must be developed which specify what is an acceptable storm event for sampling. The EPA rules required that each applicant sample 3 storm events, at least 30 days apart, with a 72-hour dry period preceding the storm event. The rules also recommended that storm events be sampled which are between $\pm$50% of the average storm event duration and depth. These criteria were proposed to insure that "representative" storm events are sampled and that a preceding dry period is provided to allow a normal period of pollutant deposition on land surfaces.

A statistical evaluation of long-term rainfall records for the Atlanta Region conducted by the Atlanta Regional Commission (ARC) determined that only an average of 6.2 storms per year would meet these criteria (ARC, 1992b). An additional analysis was conducted to determine if expanding the criteria to $\pm$75% of depth and duration would significantly improve the number of acceptable storms. This adjustment increased the average number of acceptable events to 14 per year. However, this still did not prove to be practical operating criteria once the actual sampling work began. Seasonal differences in rainfall patterns and the required 30 day period between events made collection of samples from an acceptable storm event very difficult.

The Task Force requested a modification of storm event criteria from EPD and received approval to sample any storm event of a depth of 0.1 inches or more with a 72-hour dry period preceding it. No restrictions were placed on duration of the storm event or the time period between sampling events. Storm events are just too variable to place very restrictive criteria on the storm depth and duration.

Automatic Versus Manual Sample Collection

Even though some of the pollutants to be analyzed for must be grab samples, automatic sampling was selected for several reasons. The concentration of pollutants in storm water runoff is greatest during the "first flush" of runoff, early in the storm event. Because of the variability of rainfall coverage and intensity, it would be difficult for field crews to always be on site at the beginning of a storm event. By utilizing automatic equipment which is triggered by a flow meter or rain gauge, the sampler will begin collecting composite samples at the beginning of the storm event. The required grab samples can then be collected by the field crews within the first three hours of the storm event. All sites were outfitted with automatic samplers, flow meters and rain gages.

Other considerations such as safety and manpower requirements were also reasons for utilizing automatic sampling equipment. Although field crews must still visit

long-term water quality trends; d) refine the parameters and event mean concentrations used in the pollutant loading model; and e) evaluate specific pollutant sources.

In order to make educated decisions about storm water structural and nonstructural controls, data on their specific impacts on water quality is needed. The monitoring program will include inflow and outflow sampling of structural controls such as wet detention ponds and sampling small watersheds to evaluate the overall effectiveness of storm water management programs. The model used to develop pollutant loading estimates is based on a national data base for pollutant concentrations and the efficiencies of structural controls. The monitoring results should enable the Task Force to determine if these parameters are appropriate in the Atlanta area.

SAMPLING SITE SELECTION

One of the first issues addressed by the Task Force was how many sites should be monitored and who would be responsible for instrumenting the sites and collecting and analyzing the samples. The EPA rules required that each applicant select 5 to 10 representative outfalls from which to collect samples of three storm events. The five county Atlanta area contains over 40 cities, all of whom were required to submit permit applications. The cities in Clayton, DeKalb and Gwinnett Counties, except for Snellville, decided to apply with their respective county. This left 21 governments which submitted permit applications. The Task Force negotiated with EPD to limit the number of sites to an average of five per county, assuming all applicants would share the data collected in order to more efficiently meet the goals of the monitoring programs.

The Task Force assigned 27 sampling sites to the local governments according to population and employment. Population and employment was used as a reasonable representation of the relative amounts of storm water runoff that would be generated by each local government's land area. The five counties and four largest cities were assigned from one to six sampling sites each. The smaller cities, which lack the resources to conduct this type of work, were not assigned a sampling site but were asked to share in the cost of the monitoring work based on the percentage of their population in their respective county.

A regional consultant was selected by the Task Force to develop procedures for the monitoring program and to implement the first phase of the study. The use of the regional consultant allowed the work to be done quickly and consistently. Some of the larger local governments were able to use their own staffs to conduct some of the monitoring work. As the local governments move out of the permit application phase and into the long-term monitoring program, most of them will conduct the work with their own staff.

After the number of sites per government was selected, general site locations were determined based on a river basin priority and land use. Specific monitoring sites were then located based on size of the drainage area, type and continuity of land use and use of storm water pipe or stream sites. Existing local government stream monitoring sites were utilized where possible. Sites were evaluated based on accessibility, safety, security and suitability for flow measurement and sample collection.

More of the five county area lies within the Chattahoochee River basin than any other basin and this river is of great significance to the region; therefore, most of the sites are located in this river basin. Figure 1 shows the general location of the 27 sites. Land use is the main factor which impacts the quality of storm water runoff and is often used in models to predict storm water quality (ARC, 1992a). Therefore, sites were selected to represent the major land uses in the area (Table 1). Where ever possible, small drainage areas which represented a pure or single land use were chosen.

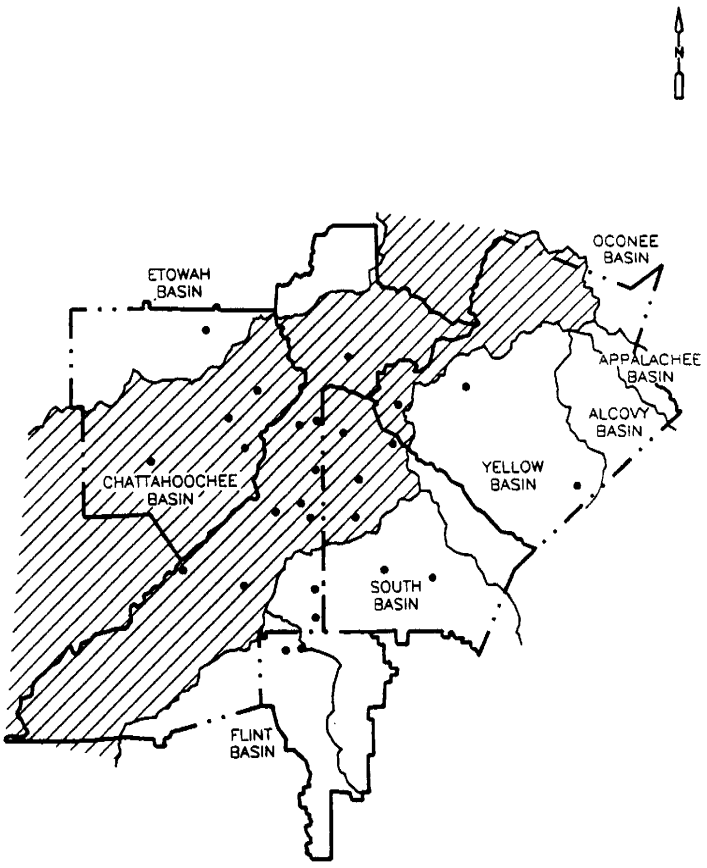

Figure 1. Location of the original storm water monitoring sites used by the Atlanta Region Storm Water. Management Task Force.

each site during the storm event, one crew can work two or three sites during a single event using automatic equipment rather than just one site if collecting samples manually. However, this is still a manpower intensive program and involves staff being on call at all times in order to be on site when the rain event occurs.

Sample Analysis

The EPA rules required that the storm water runoff samples be analyzed for a list of over 120 pollutants including metals and toxic organics. After the initial characterization work is concluded, this list of pollutants will be reduced for the long-term monitoring. Only those pollutants detected during the characterization study will be included on a routine basis. Sample collection, preservation and analysis techniques are performed according to approved EPA procedures, including preparing bacteria samples for analysis within six hours of collection. This will require that lab personnel be on call 24 hours a day and seven days a week in the event that an acceptable storm event occurs.

Consistency

The regional monitoring program includes up to 9 different governments and their contractors involved in collecting and analyzing storm water samples. It is important to maintain some consistency in methods so that the data is comparable and can be pooled to develop a regional data base. The regional consultant prepared a standard operating procedures manual which was distributed to all participants. The consultant also conducted a 1/2 day training session for local government staff before the sampling work began.

PRELIMINARY SAMPLING RESULTS

The preliminary sampling results have confirmed that storm water contains a variety of pollutants, however, only a few pollutants exceeded State water quality standards (Georgia DNR, 1989). These pollutants were fecal coliform bacteria, zinc, copper, lead, bis(2-ethylhexyl)-phthlate and chlordane (only found in one sample). Six other toxic organic pollutants were detected in the samples but were below state standards. Although there are no instream standards for nutrients and oxygen demanding pollutants, they also occurred in excessive amounts in some samples. Table 2 includes the average concentration of some pollutants measured by land use category and as a whole.

Different land uses appear to be characterized by different problem pollutants: bacteria suspended solids and copper from residential areas; nitrogen from commercial areas; and biochemical oxygen demand and zinc from industrial areas.

SUMMARY

The Georgia EPD's municipal storm water permitting strategy caught many smaller governments by surprise. Governments in the Atlanta area worked together through the Atlanta Region Storm Water Management Task Force to develop a consistent approach and to make efficient use of resources. By implementing a regional monitoring program, the resources required such as manpower, equipment and money were much less than if each government had worked independently. It has been shown that storm

TABLE 2. Average Pollutant Concentration in Storm Water Runoff

Pollutant	Units	Residential	Commercial	Industrial	All Samples
BOD*	(mg/l)	14.5	<13.3	<16.2	<14.7
TSS**	(mg/l)	744	97.4	96.8	293.3
Dissolved Phos.	(mg/l)	<0.1	<0.11	<0.27	<0.17
Ammonia	(mg/l)	<0.25	<0.55	<0.43	<0.42
Oil & Grease	(mg/l)	<4.91	<7.0	<6.7	<6.24
Copper	(μg/l)	<48.5	<22.4	<24.4	<30.3
Zinc	(μg/l)	135	139	205	162
F. Coli. Bacteria[aO]	(#/100ml)	15,762	2,557	3,631	5,028
Number of Samples		20	22	24	66

[aO]Geometric Average
*BOD = Biochemical Oxygen Demand
**TSS = Total Suspended Solids
Note: Values for parameters that were below the laboratory detection limit were assumed to be equal to the detection limit and a less than sign is placed with the average.

water characteristics are often dependent on land use and geographic conditions. Therefore, it is sensible for governments within a similar geographic area to coordinate monitoring efforts during the storm water characterization stage. By cooperating during the evaluation of structural controls and programs, these questions can also be answered much quicker.

Preliminary sampling results have illustrated that storm water quality in the Atlanta Region is somewhat degraded, however, the magnitude of the problem does not appear to be as great as anticipated. Certain pollutants can be targeted in particular land use areas and specific programs developed to control them.

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