United States
Environmental Protection
Agency

Municipal Environmental Research
Laboratory
Cincinnati OH 45268

EPA-600/2-80-094
August 1980

Research and Development

EPA

Impact of Urban Storm Runoff on Stream Quality Near Atlanta, Georgia

RESEARCH REPORTING SERIES

Research reports of the Office of Research and Development, U.S. Environmental Protection Agency, have been grouped into nine series. These nine broad categories were established to facilitate further development and application of environmental technology. Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. The nine series are:

1. Environmental Health Effects Research
2. Environmental Protection Technology
3. Ecological Research
4. Environmental Monitoring
5. Socioeconomic Environmental Studies
6. Scientific and Technical Assessment Reports (STAR)
7. Interagency Energy-Environment Research and Development
8. "Special" Reports
9. Miscellaneous Reports

This report has been assigned to the ENVIRONMENTAL PROTECTION TECHNOLOGY series. This series describes research performed to develop and demonstrate instrumentation, equipment, and methodology to repair or prevent environmental degradation from point and non-point sources of pollution. This work provides the new or improved technology required for the control and treatment of pollution sources to meet environmental quality standards.

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

EPA-600/2-80-094
August 1980

IMPACT OF URBAN STORM RUNOFF ON STREAM QUALITY NEAR ATLANTA, GEORGIA

by

James B. McConnell
U.S. Geological Survey
Water Resources Division
Doraville, Georgia 30360

Interagency Agreement No. EPA-IAG-D6-0137

Project Officer

John N. English
Wastewater Research Division
Municipal Environmental Research Laboratory
Cincinnati, Ohio 45268

MUNICIPAL ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DISCLAIMER

This report has been reviewed by the Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay of its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communications link between the researcher and the user community.

This report describes water-quality impacts associated with wet-weather discharges into the Chattahoochee River at Atlanta, Georgia, and details the contribution of combined sewer overflows and other nonpoint discharges to the impact. Through this project, data are being obtained to determine in a rational way the degree of national wet-weather pollution control required.

Francis T. Mayo, Director
Municipal Environmental Research
Laboratory

ABSTRACT

The objective of this study was to assess the impact of stormwater runoff on the water quality of receiving streams in the Atlanta area. The scope included determining (1) the quality condition of discharges from 7 point sources (waste-treatment facilities) and 13 nonpoint sources (streams) in the study area of the Chattahoochee River basin during periods of stormwater runoff, and (2) the relative impact of point and nonpoint storm discharges on the quality of the Chattahoochee River downstream of the Atlanta Metropolitan Area. Emphasis was placed on the collection of water-quality data in the summer and autumn to determine the impact on streams from runoff produced by thunderstorms during the dry-weather seasons.

Compared to dry-weather flow, stormwater runoff significantly increased the average concentration of suspended sediment, BOD_5, total organic carbon, total ammonia nitrogen, total phosphorus, fecal coliform bacteria, and trace metals in most receiving streams in the Atlanta Metropolitan Area. Stormwater runoff increased the mean concentration of most constituents 2- to 5-fold. In most streams dissolved oxygen concentrations generally increased to near saturation during periods of stormwater runoff.

The combined sewer overflow channels had mean BOD concentrations that ranged from 23 to 37 milligrams per liter and fecal coliform concentrations that ranged from 250,000 to 550,000 colonies per 100 milliliters.

During low flow in the Chattahoochee River, thunderstorms that occur in the summer seem to have a much greater impact on river quality than storms at other times of the year. The dissolved-oxygen concentration in the Chattahoochee River near Fairburn reached a low of 1.5 milligrams per liter (a 4-milligram per liter decrease) as a result of runoff from a July thunderstorm. This compared to a low of about 6.0 milligrams per liter (a 1.0-milligram per liter decrease) for an October thunderstorm and 6.8 milligrams per liter (a 2.0-milligram per liter decrease) for a frontal-type storm in November 1976.

Low flow in the summer and autumn occurs only about 21 percent of the time due to river flow regulation by Buford and Morgan Falls Dams. The flushing and diluting effect of water released by these dams causes a significant improvement in Chattahoochee River quality most of the time.

This report was submitted in partial fulfillment of Interagency Agreement No. EPA-IAG-D6-0137 by the U.S. Geological Survey, Georgia District Office, under the sponsorship of the U.S. Environmental Protection Agency. The report covers the period of October 1975 to October 1977.

CONTENTS

FIGURES

TABLES

TABLES

CONVERSION FACTORS

For those readers who may prefer to use U.S. customary units rather than metric units, the conversion factors for the terms used in this report are listed below:

Multiply metric unit	By	To obtain U.S. customary unit
kilogram (kg)	2.205	pound (lb)
kilometer (km)	0.6214	mile (mi)
liter (L)	0.03531	cubic foot (ft^3)
millimeter (mm)	0.03937	inch (in.)
square kilometer (km^2)	0.3861	square mile (mi^2)

$°F = 9/5°C + 32$ or $°C = 5/9\ (°F - 32)$

LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

BOD_5	— 5 day biochemical oxygen demand
°C	— degrees Celsius
°F	— degrees Farenheit
CSO	— combined sewer overflow
col/100mL	— colonies per 100 milliliters
DO	— dissolved oxygen
ft^3/s	— cubic foot per second
kg	— kilogram
L	— liter
mg/L	— milligram per liter
mi^2	— square mile
µg/L	— microgram per liter
µmhos/cm	— micromhos per centimeter
WTF	— waste treatment facility

SYMBOLS

NH_3-N	— Ammonia nitrogen
NO_2+NO_3-N	— Nitrite plus nitrate nitrogen
O_2	— Oxygen
O-PO_4	— Orthophosphate
P	— Phosphorus
$<$	— Less than

ACKNOWLEDGMENTS

The author acknowledges the Chattahoochee River Project personnel for their assistance and advice on the project. Also, thanks go to the forecasters of the National Weather Service at Atlanta who provided information to aid the sampling effort.

SECTION 1

INTRODUCTION

The Federal Water Pollution Control Act Amendments of 1972 and 1977 (Public Law 95-217) provide strict controls to protect and maintain the quality of the Nation's waterways. With increasing urban development and more stringent water-quality standards for receiving streams, urban stormwater runoff is recognized as a significant source of pollution.

PREVIOUS STUDIES

Several studies in the Atlanta Metropolitan Area have been conducted to identify and assess the seriousness of problems associated with runoff from the urban areas. In 1970 an urban stormwater runoff study was conducted for EPA (U.S. Environmental Protection Agency) (13). The study included sampling CSO's (combined sewer overflows) and urban runoff from sites in the South River basin (tributary to the Ocmulgee River). The study defined and evaluated pollution sources in the upper South River basin. An urban storm-runoff sampling program conducted in 1973 for the city of Atlanta resulted in an analysis of the cost effectiveness of treatment for various storm sizes and a preliminary design of storage and treatment facilities (2). A study by Holbrook and others (8) utilized data from previous studies and a current sampling program to evaluate the impact of combined sewer overflows and stormwater runoff in the Atlanta area. The results indicated that on an annual basis, nonpoint sources (CSO's and urban runoff) contributed about 45 percent of the BOD (biochemical oxygen demand) load and about 95 percent of the suspended-solids load to Metropolitan Atlanta streams.

More recently a river-quality study of the upper Chattahoochee River basin was conducted by the U.S. Geological Survey (3). An assessment of the nature, magnitude, and effects of discharge of point and nonpoint sources of pollutants from the greater Atlanta area was included as part of this study. Average annual constituent loads and loads from one storm in March were used to assess the impact of point and nonpoint discharges to the Chattahoochee River. Results of the study showed that on an average annual basis and during one storm in March 1976, nonpoint-source loads of dissolved solids, total nitrogen, and total lead were larger than point-source loads at a station located about 64 river kilometers (40 river miles) downstream of Atlanta. However, dry-weather flow point discharges contributed the greatest percentage of the pollutant load.

OBJECTIVES AND SCOPE

Data collection for this study, conducted by the U.S. Geological Survey in agreement with the U.S. Environmental Protection Agency, was completed in October 1977. The objective of the project was to assess the impact of stormwater runoff on the water quality of receiving streams in the Atlanta area. The scope included determining (1) the quality condition of discharges from 7 point sources (waste-treatment facilities) and 13 nonpoint sources (streams) in the study area of the Chattahoochee River basin during periods of stormwater runoff, and (2) the relative impact of point and nonpoint storm discharges on the quality of the Chattahoochee River downstream of the Atlanta Metropolitan Area. Emphasis was placed on the collection of water-quality data in the summer and autumn to determine the impact to streams from runoff produced by thunderstorms during the dry-weather seasons.

SECTION 2

CONCLUSIONS

Variability of quality conditions in streams in the study area during both dry weather and wet weather was high. In general, the water quality of streams tributary to the Chattahoochee River was degraded during periods of stormwater runoff. In most receiving streams, significant increases occurred in the mean concentration of suspended sediment, BOD_5 (5-day biochemical oxygen demand), total organic carbon, total ammonia nitrogen, total nitrite plus nitrate nitrogen, total phosphorus, fecal coliform bacteria, and trace metals.

Peachtree, Proctor, Woodall, and Nickajack Creeks consistently showed the greatest impact from stormwater runoff. In addition to overland runoff from storms, the water quality of Peachtree and Proctor Creeks was also degraded by discharges from the CSO's. Woodall Creek is heavily impacted by runoff from a small, highly urbanized basin and Nickajack Creek may be impacted by discharges of untreated or partially treated sewage from a WTF (waste-treatment facility) during periods of heavy stormwater runoff. Dissolved oxygen (DO) concentrations remained high in streams during periods of stormwater runoff; therefore, no significant effects on DO can be related to urban runoff based on the number of measurements that were made during the study period. The concentrations of constituents from the CSO discharges were relatively high and comparable to the concentrations observed at the Proctor and Woodall Creek sites. The CSO sites had extremely poor sanitary quality, as indicated by fecal coliform concentrations which often exceeded 1 million col/100 mL (colonies per 100 milliliters). DO concentrations, however, were near the level of saturation even though the high BOD_5 values indicated a potential for creating low DO concentrations.

In general, the water quality of the Chattahoochee River during dry-weather flow was good at the Atlanta site and relatively poor at the Fairburn and Whitesburg sites. At the Fairburn and Whitesburg sites, the mean total ammonia and nitrite plus nitrate nitrogen concentrations were greater during dry-weather flow than during stormwater runoff. At the Fairburn site, the mean total phosphorus concentration was also less for wet-weather flow as indicated by a nearly 2-fold decrease in the mean concentration at dry-weather flow. Data indicate that stormwater rather than water released by Buford Dam was primarily responsible for dilution of these constituents at the Fairburn and Whitesburg sites.

Generally, concentrations of insecticides, industrial wastes, and toxic constituents in samples collected from point and nonpoint sources during times of stormwater runoff were low or less than the level of detection. Of the trace metals sampled, lead occurred in the highest concentration followed by zinc, copper, and chromium. The average concentration of lead in most streams sampled during periods of stormwater runoff exceeded the criterion of 50 ug/L recommended for domestic water-supply by the EPA (12).

Trace metals appear to be transported predominantly in the suspended phase. A high percentage of phosphorus is also transported as suspended phosphorus. Generally, higher percentages of organic carbon are transported as dissolved rather than as suspended organic carbon. Inorganic nitrogen is transported almost entirely in the dissolved phase.

An approximation of the mass balance of discharge volume and constituent loads during a storm period in November 1976 and October 1977 showed that Peachtree Creek (which receives discharges from two CSO's) contributed about 20 percent or less to the constituent loads (total nitrogen, total phosphorus, and total organic carbon) measured at the Fairburn site on the Chattahoochee River. Data indicated that the two CSO's in the basin contributed only small percentages of constituents to the Peachtree Creek and Fairburn loads. During these two storms, it was estimated that the seven waste-treatment facilities together contributed less than 10 percent of the discharge volume at the Fairburn site and between 12 and 72 percent of the constituent loads.

During the summer and autumn months, a substantial DO deficit (3 to 3.5 mg/L below saturation level) occurred at low flow in the Fairburn to Whitesburg reach of the Chattahoochee River when water was not being released from Buford Dam. The deficit was caused primarily by oxygen-demanding ammonia nitrogen and organic carbon discharged to the river by the seven waste-treatment facilities. River quality was greatly improved by dilution from water released at Buford Dam for power generation.

When runoff produced by a storm coincided with low flow in the river, the existing oxygen deficit increased. Some increase in the oxygen deficit was also noticeable when stormwater runoff occurred at higher flows, but the increase was most pronounced at low flow. The potential for the most severe degradation of water quality in the river from stormwater runoff appears to be during the summer. River temperatures and oxygen-demand rates are highest then, and intense short-duration thunderstorms produce relatively rapid runoff that carries high concentrations of constituents to the receiving streams. However summer regulation of the river normally provides low flows only on weekends. Thus only about 1.5 days out of 7, or 21 percent of the time, is the Chattahoochee River at a flow that could result in severe degradation of stream quality from storm runoff.

SECTION 3

DESCRIPTION OF STUDY AREA

The study area includes about 1,580 km^2 (980 mi^2) of the Chattahoochee River basin between the Atlanta and the Whitesburg sites. The city of Atlanta, which has a population of 1.5 million, is at the upstream end of the study area. Rainfall averages about 1,300 mm (50 in.) per year and the annual air temperature averages about 16°C (61°F). Figure 1 delineates the study area and shows the location of sample sites and Table 1 lists the corresponding reference numbers, site names, and site identification (U.S. Geological Survey) numbers.

TABLE 1.--MAP REFERENCE NUMBER, SITE NAME, AND SITE IDENTIFICATION NUMBER OF DATA COLLECTION SITES IN THE STUDY AREA

Map reference number	Site name	Site identification number
1	Chattahoochee River at Atlanta	02336000
2	Cobb Chattahoochee WTF near Atlanta	02336021
3	North Fork Peachtree Creek Tributary (Meadowcliff Drive near Chamblee)	02336090
4	North Fork Peachtree Creek at Buford Hwy. near Atlanta	02336090
5	South Fork Peachtree Creek at Atlanta	02336250
6	Clear Creek at Piedmont Park at Atlanta (CSO)	02336274
7	Tanyard Branch at 26th Street Extention at Atlanta (CSO)	02336290
8	Peachtree Creek at Atlanta	02336300
9	Woodall Creek at DeFoors Ferry Road at Atlanta	02336313
10	Nancy Creek Tributary near Chamblee	02336339
11	Nancy Creek at Randall Mill Road at Atlanta	02336380
12	R. M. Clayton WTF at Atlanta	02336450
13	Hollywood Road WTF at Atlanta	02336523
14	Proctor Creek at SR 280 at Atlanta	02336526
15	U.S. Air Force Plant 6 outfall near Smyrna	02336537
16	Nickajack Creek at Cooper Lake Drive near Mableton	02336610
17	South Cobb Chattahoochee WTF near Mableton	02336651
18	Utoy Creek WTF near Atlanta	02336653
19	North Fork Utoy Creek at Beecher Road at Atlanta (CSO)	02336654
20	Camp Creek WTF near Atlanta	02337073
21	Camp Creek at Enon Road near Atlanta	02337116
22	Chattahoochee River (SR 29) near Fairburn	02337170
23	Chattahoochee River (U.S. Alt. 27) near Whitesburg	02338000

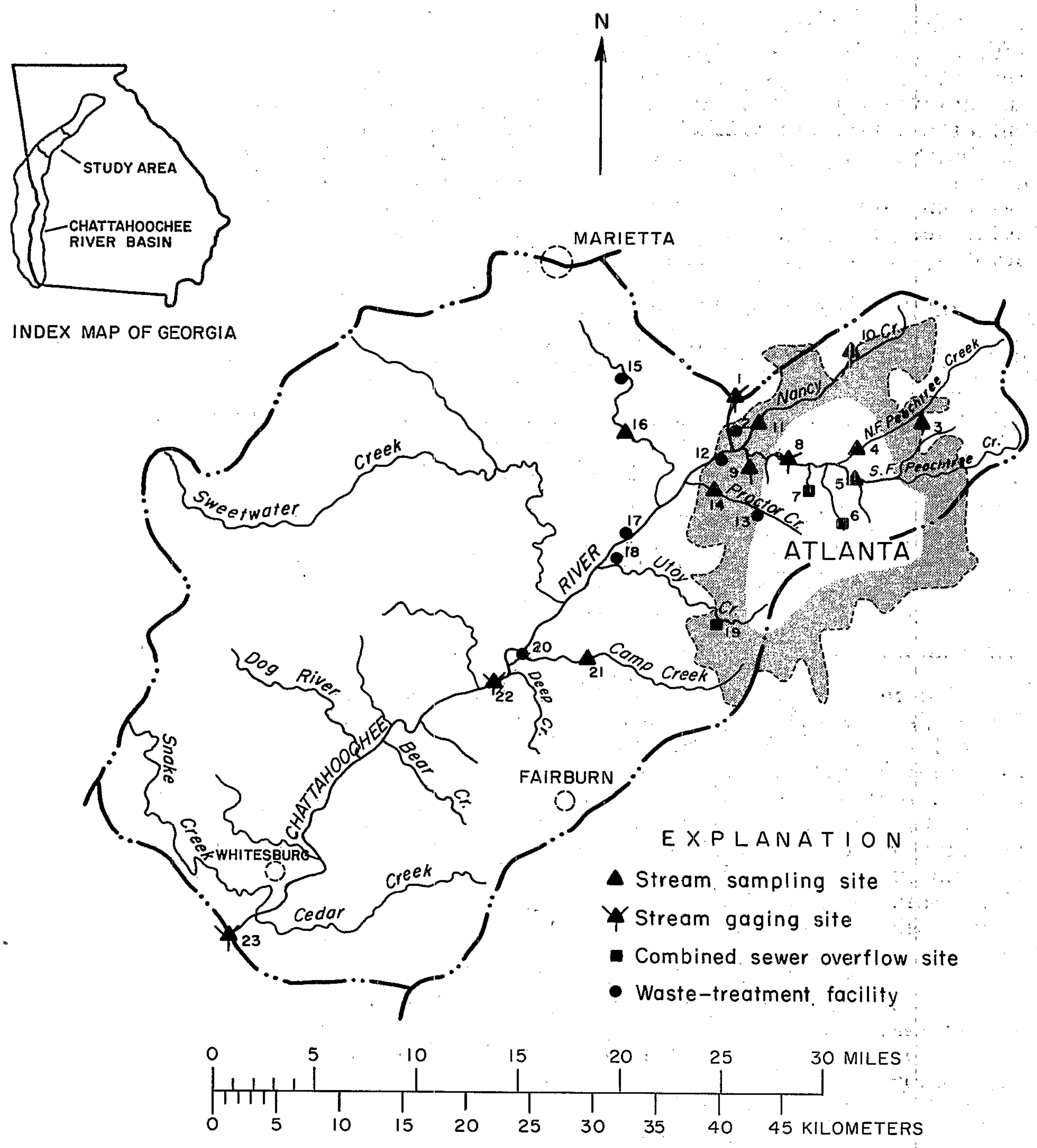

Figure 1.—Location of study area and sampling sites in the Chattahoochee River basin.

POINT AND NONPOINT SOURCES

Twenty-one sites were established in the study area at which samples were collected and flow measurements were made to determine the quality and quantity of point and nonpoint discharges from the Atlanta Metropolitan Area. An additional two sites on the Chattahoochee River near Fairburn and at Whitesburg were established to monitor the impact of these point and nonpoint discharges. The point sources are discharges from seven WTF's, which all discharge into the Chattahoochee River or its tributaries in the Atlanta-to-Fairburn reach. The design flow and mean daily flow (1976) for each of the point sources are given in Table 2. The R. M. Clayton WTF is the largest point source of treated sewage discharging to the Chattahoochee River.

TABLE 2.--FLOW DESIGN AND MEAN DAILY FLOW OF POINT SOURCES FOR 1976

Map reference number	Facility	Flow design (L/s)	Mean daily flow (L/s)
2	Cobb Chattahoochee WTF near Atlanta	450	424
12	R. M. Clayton WTF at Atlanta	5,270	3,340
13	Hollywood Road WTF at Atlanta	65	65
15	U.S. Air Force Plant 6 WTF near Smyrna	310	74
17	South Cobb Chattahoochee WTF near Mableton	340	368
18	Utoy Creek WTF near Atlanta	1,300	595
20	Camp Creek WTF near Atlanta	650	193

The combined mean daily flow from these facilities in 1976 was about 5,060 L/s (179 ft^3/s), or 4 percent of the mean daily river discharge of about 1.274×10^5 L/s (4,500 ft^3/s) at the Fairburn site. Nonpoint sources of discharge include all sources other than the seven WTF's. Nonpoint discharges were sampled at 11 stream sites and 3 CSO (combined sewer overflow) channels. The Atlanta site on the Chattahoochee River is considered as a nonpoint source. It is upstream of the major pollutant sources of the Atlanta urban area. Of the 11 stream sites, 7 are located in the Peachtree Creek basin. Most of the basin is within the Atlanta city limits, and Peachtree Creek conveys the major portion of the drainage from the Atlanta urban area.

Proctor Creek is a small stream adjacent to Peachtree Creek and this stream receives discharges from North Avenue and Greensferry CSO's during storms, and treated wastewater from the Hollywood Road WTF. The sample site on Proctor Creek is downstream of the inflows from the North Avenue and Greensferry CSO's and Hollywood Road WTF.

Nickajack Creek is located west of Atlanta. Its headwaters are in the residential area of Marietta. Upstream of the sampling site, U.S. Air Force Plant 6 outfall discharges treated wastewater to the stream.

Camp Creek lies southwest of Atlanta. Camp Creek WTF is located near the mouth of this stream. The sample site is upstream of the WTF.

Clear Creek and Tanyard Branch, located in the Peachtree Creek basin, and the North Fork of Utoy Creek, located in the Utoy Creek basin, were sampled when the CSO's overflowed. The sampling sites were located in concrete channels several hundred feet downstream from the point of overflow. Three other CSO's in the study area whose drainage are about 6.5 km^2 (2.5 mi^2), 3.1 km^2(1.2 mi^2), and 2.3 km^2 (0.9 mi^2) were not sampled. Manpower limitations and difficulty of access to these sites were reasons why they were not sampled. Constituent concentrations from these discharges are probably similar to the CSO's that were sampled; however, constituent loads may be less because of the smaller drainage areas.

During dry-weather periods, interceptors located in the combined sewers convey wastewater to nearby WTF's. During wet weather, wastewater plus the additional stormwater spills over the overflow regulator into the CSO channels which discharge into nearby Peachtree or Utoy Creeks.

LAND USE

Land use in the study area is primarily urban, agricultural, and forested. Land-use and drainage areas of the subbasins within the study area are listed in Table 3. Upstream of Metropolitan Atlanta at the Chattahoochee River at Atlanta site, runoff is mostly from forested land. Between the Atlanta and Fairburn sites (sites 1 and 22 in Figure 1) the drainage area increases by 1,580 km^2 (610 mi^2). In this reach the Chattahoochee River receives urban runoff from the Atlanta Metropolitan Area. Between Fairburn and Whitesburg (sites 22 and 23 in Figure 1), runoff originates from primarily forested land.

HYDROLOGY

The flow of the Chattahoochee River in the study area is dependent upon rainfall and on regulation by the Buford and Morgan Falls Dams. A hydrograph of the mean daily discharges at the Atlanta station for the 1977 water year is shown in Figure 2. The highest flows generally occur in the spring and the lowest flows in late autumn. Generally, the regulation schedule provides for peak hydroelectric power generation during the weekdays, which produces relatively high average daily flows. Curtailment of peak-power generation during weekends results in low flows in the river, provided there is no stormwater runoff.

WATER USE

The water of the Chattahoochee River is utilized for power generation, water supply, wastewater assimilation, and recreation.

Three fossil-fuel thermoelectric powerplants and two peak-power hydroelectric generating facilities (Buford and Morgan Falls Dams) are located upstream of the study area. Average daily municipal water-supply withdrawals of 3,790 L/s (134 ft^3/s) all occur between Atlanta and Fairburn and treated effluent from 7 waste-treatment facilities contribute an average of 5,060 L/s (179 ft^3/s) daily to the river in the Atlanta-to-Fairburn reach.

TABLE 3.--LAND USE FOR BASINS IN THE STUDY AREA

[Data from Land Information Analysis Office, Reston, Va. Percent values are land use in drainage basin upstream of sampling site.]

Sampling site	Drainage area (km^2)	Percent urban						Percent agriculture			Percent forested	Percent barren land	Percent water
		Residential	Commercial and services	Industrial	Transportation and Communication	Other urban	Total urban	Cropland and pasture	Other agriculture	Total agriculture			
Chattahoochee River at Atlanta, Ga. (02336000)	3,760	21.1	3.1	0.7	1.2	2.0	28.1	11.2	-	11.2	54.4	5.6	0.7
North Fork Peachtree Creek Trib. (Meadowcliff Dr. nr. Chamblee Ga. (02336090)	0.83	84	-	-	-	-	-	-	-	-	16	-	-
North Fork Peachtree Creek at Buford Hwy. nr. Atlanta, Ga. (02336120)	88.3	43.5	8.5	1.8	5.4	11.6	70.7	0.1	-	0.1	25.2	3.4	0.5
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	76.7	55.6	8.3	1.4	2.4	8.2	75.9	0.2	-	0.2	22.5	1.3	0.1
Clear Creek at Piedmont Park at Atlanta, Ga. (02336274)	9.6	39.3	43.3	-	3.5	13.9	100.0	-	-	-	-	-	-
Tanyard Branch at 26th St. Extension at Atlanta, Ga. (02336290)	9.1	26.3	44.9	7.1	8.3	12.6	99.2	-	-	-	0.8	-	-
Peachtree Creek at Atlanta, Ga. (02336300)	225	50.7	11.1	1.6	3.7	10.9	78.0	0.1	-	0.1	19.8	1.8	0.3
Woodall Creek at DeFoors Ferry Rd. at Atlanta, Ga. (02336313)	8.0	16.1	3.9	-	13.5	58.2	91.6	-	-	-	8.4	-	-
Nancy Creek Tributary (West Nancy Creek Dr.) nr. Atlanta, Ga. (02336339)	8.5	26.5	9.9	-	10.2	-	46.5	1.0	-	1.0	46.3	6.3	-
Nancy Creek at Randall Mill Rd. at Atlanta, Ga. (02336380)	90.1	57.6	7.0	1.0	1.6	9.0	76.2	0.8	-	0.8	20.5	1.5	1.0
Proctor Creek at State Route 280 at Atlanta, Ga. (02336526)	40.1	55.4	5.4	9.6	4.2	7.6	82.2	-	-	-	15.2	2.1	-
Nickajack Creek at Cooper Lake Dr. nr. Mableton, Ga. (02336610)	44.0	54.3	5.1	-	-	0.8	60.2	5.5	-	5.5	29.5	3.6	1.1
North Fork Utoy Creek at Beecher Rd. at Atlanta, Ga. (02336654)	-	65.0	3.0	-	-	32.0	100.0	-	-	-	-	-	-
Camp Creek at Enon Road nr. Atlanta, Ga. (02337116)	83.3	35.5	4.3	0.6	2.5	0.9	43.8	2.9	-	2.9	49.1	2.7	1.6
Chattahoochee River nr. Fairburn, Ga. (02337170)	5,340	29.3	3.4	0.6	2.3	4.1	39.7	5.3	-	5.4	51.5	2.9	0.4
Chattahoochee River nr. Whitesburg, Ga. (02338000)	6,290	3.5	0.5	-	-	0.1	4.1	16.8	-	16.8	75.4	3.0	0.6

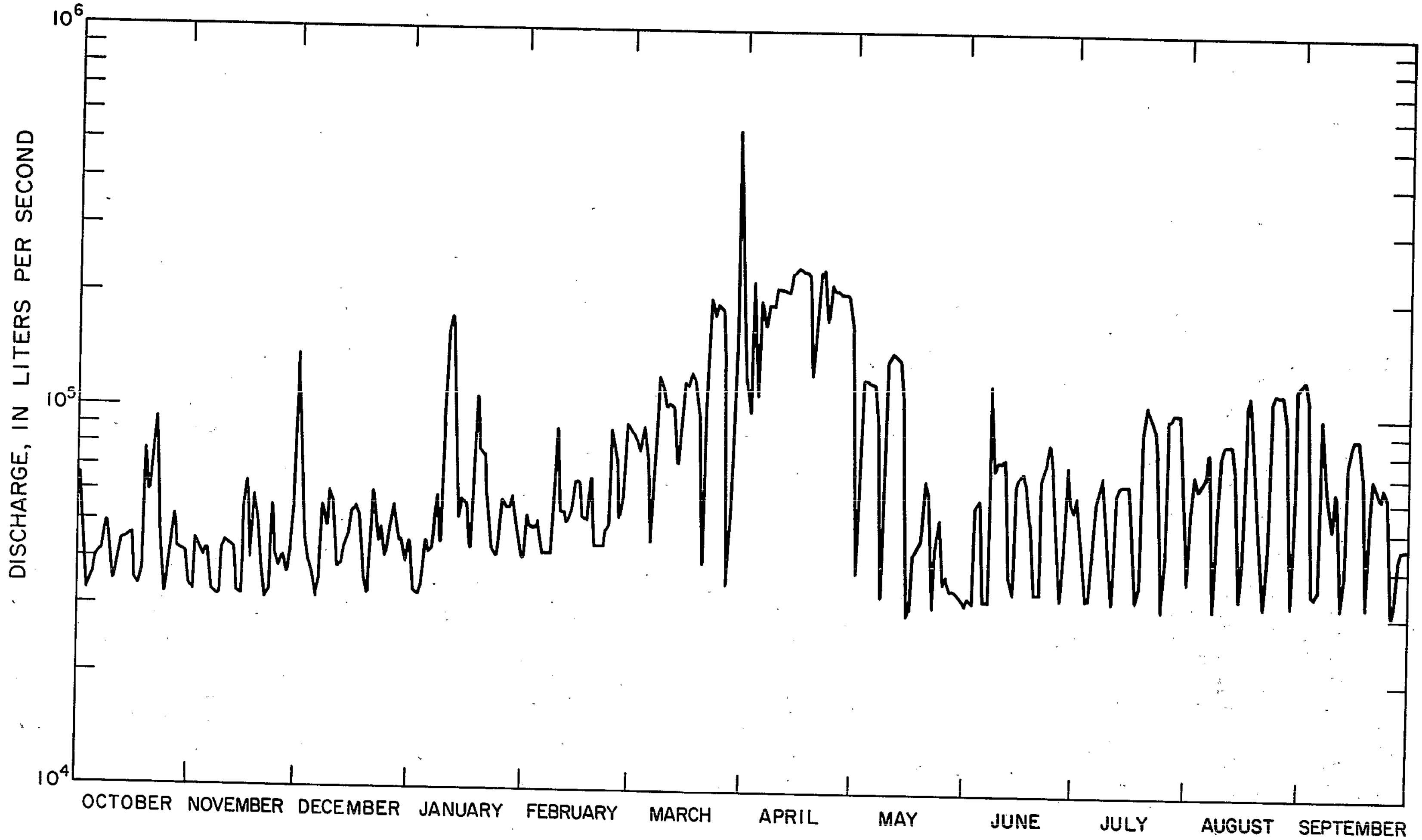

Figure 2.—Mean daily discharge for the Chattahoochee River at Atlanta site for 1977 water year.

The reach of the Chattahoochee River between the confluence of Peachtree Creek, about 4.0 km (2.5 mi) downstream of the Atlanta station, and Cedar Creek, 2.4 km (1.5 mi) upstream of the Whitesburg station, is classified as fishing water by the Georgia Department of Natural Resources, Environmental Protection Division. An average daily DO (dissolved-oxygen) concentration of 5.0 mg/L and no less than 4.0 mg/L is required at all times, when the river flow measured at a point immediately upstream from Peachtree Creek equals or exceeds 21.2×10^4 L/s (750 ft^3/s), unless violations occur due to uncontrolled urban stormwater runoff or discharges from CSO's to the river, or both (5).

SECTION 4

METHODS OF DATA COLLECTION AND ANALYSES

DATA COLLECTION

The data presented in this report were collected by the U.S. Geological Survey between September 1975 and November 1977. The collection of data, specifically as part of the EPA stormwater runoff study, began in November 1976 and was completed in October 1977. During this period, flow and water-quality measurements were made at 13 stream sites in the study area during stormwater runoff events. At some of these sites, samples were collected over the storm-runoff event to define stream-quality characteristics during various stages of stormwater runoff. The quality of effluent from wastewater treatment facilities that discharge into the Chattahoochee River was summarized from data collected by the U.S. Geological Survey and from available flow and water-quality data obtained from treatment plant monitoring records.

Parameters determined in this study include DO, specific conductance, temperature, ammonia, nitrite, nitrate and organic nitrogen, phosphorus, organic carbon, BOD_5, suspended inorganic sediments, trace metals, organochlorine pesticides, fecal coliform and fecal streptococci bacteria, and selected industrial pollutants (benzedine, trichlorethylene, chloroform, bromochloromethane, dibromochloromethane, bromoform, carbon tetrachloride, and 1,2-dichloroethane).

Stream constituent loads for the stormwater runoff periods of November 27-30, 1976, and July 25-27, October 8-10, and October 25-27, 1977, were determined by calculating the area under the transport rate (instantaneous load versus time) curve for the duration of the storm. The transport rate curve was developed by drawing a smooth curve through the instantaneous load values which were calculated by multiplying constituent concentration times the stream discharge at time of sample collection.

Point-source constituent loads for the November 1976 and October 1977 storms were computed by multiplying the product of the mean constituent concentration and the mean of the daily discharges for the storm-runoff period by the length of time it took the stormwater to pass the Fairburn site. The assumption was made that constituent concentrations and flows from the point sources were uniform during the storm period. Data indicate that this assumption was reasonable. If the WTF became hydraulically overloaded during a storm, the untreated water that bypassed the facility was considered a non-point source. These sources were not sampled.

The total point-source load to the river was computed by summing the loads from each of the treatment facilities. The point-source constituent concentrations were approximated by using the mean concentrations determined from spot samples collected by the U.S. Geological Survey in 1976-77. Plant discharges for the storm period were obtained from plant operator reports supplied to the Georgia Environmental Protection Division.

SAMPLE COLLECTION AND HANDLING

Stream samples were collected in accordance with techniques described by the U.S. Geological Survey (9). Depth-integrated samples were collected manually at several verticals in the stream cross section by use of a suspended-sediment sampler. Samples were then composited in glass gallon bottles that had been rinsed first with 10-percent hydrochloric acid and then with deionized water. The samples were preserved by chilling until processed in the laboratory. Several subsamples analyzed for various parameters were obtained from each composited sample by use of a churn-type splitter. Samples analyzed for industrial pollutants, bacteria, and insecticides were collected separately in the field and were not taken from the composited samples. BOD_5 and bacteria samples were analysed as soon as possible, usually within 12 hours after collection. The recommended 6-hour maximum holding time for bacteria was sometimes exceeded because of the length of time between sample collection and delivery of the sample to the laboratory.

DO and temperature were measured at the time of sample collection with an oxygen-temperature meter. At most sites, stream discharge at the time of sample collection was determined from stream stage and a predetermined stage-discharge relationship. At the CSO sites, discharge was measured continuously with a current meter during the storm event. Sample sites at Atlanta, Fairburn, and Whitesburg on the Chattahoochee River and Peachtree Creek at Atlanta (Figure 1) have stream-stage recorders from which discharge was determined. A water-quality monitor on the Chattahoochee River near Fairburn provided hourly DO, temperature, pH, and specific-conductance data.

ANALYTICAL METHODS

Methods described by Skougstad and Greeson and others were used to analyze the samples for physical, chemical, and bacterial quality except for BOD and special toxic materials (9) (7). BOD_5 was determined according to the unseeded sample methodology described in the American Public Health Association's methods book, and the selected industrial pollutants were analyzed for according to EPA procedures in the EPA laboratory in Cincinnati, Ohio (1) (11).

SECTION 5

RESULTS OF THE STUDY

The impact of stormwater runoff on the quality of a receiving stream depends on the season of the year, the type of storm (whether a convective thunderstorm or frontal storm), storm intensity, land use in the basin, topography, antecedent conditions, and for the Chattahoochee River, a highly regulated stream, the flow condition during stormwater runoff. As might be expected, these factors result in stream-quality conditions that are highly variable and difficult to predict.

QUALITY OF NONPOINT SOURCES

Table 4 summarizes the physical, chemical, and bacteriological data for tributaries to the Chattahoochee River collected during wet-weather and dry-weather flow conditions. Variability of stream quality during both flow conditions is very high, as indicated by the range of constituent concentrations. Generally, the chemical quality of most streams sampled is good during dry-weather flow. Exceptions are Woodall and Proctor Creeks, two highly polluted streams that have relatively high concentrations of chemical constituents. In contrast to the chemical quality, the sanitary quality of the streams is poor, as indicated by the high dry-weather fecal coliform bacteria concentrations. Dry-weather mean fecal coliform concentrations ranged from 300 col/100 mL for the Nancy Creek tributary site to 130,000 col/100 mL for the Woodall Creek site.

Based on the water-quality parameters listed in Table 4, stormwater runoff degrades the water quality of most streams that were sampled in the study area.

Generally, DO concentrations in streams at the time of sampling were higher during periods of stormwater runoff than at times of dry-weather flow. For this reason, the detrimental effects of stormwater runoff on receiving streams cannot necessarily be determined by DO measurements. Based on the number of measurements that were made during the study period, no significant detrimental effects on DO in the tributary streams to the Chattahoochee River could be related to urban runoff.

Parameters other than DO listed in Table 4 do, however, indicate that significant water-quality degredation occurs during periods of stormwater runoff. Mean concentrations of suspended sediment, BOD_5, total organic carbon, and trace metals are greater for periods of wet weather than dry weather for all streams listed in Table 4. The suspended-sediment concentrations

TABLE 4.--MEAN CONCENTRATIONS AND RANGES OF SELECTED WATER-QUALITY PARAMETERS FOR STREAMS IN STUDY AREA DURING PERIODS OF DRY-WEATHER FLOW AND STORMWATER RUNOFF, OCTOBER 1975-OCTOBER 1977

[DWF - Dry-weather flow; SWR - Stormwater runoff]

Sampling site	Flow conditions	Range of flow (L/s)	Dissolved O_2 (mg/L)				Suspended sediment (mg/L)				BOD_5 (mg/L)				Total organic carbon (mg/L)				Total NH_4 as N (mg/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
North Fork Peachtree Creek Trib. (Meadow-	DWF	5.7	3		7.3	6.3–8.8	5		38	6–100	4		6.2	0.5–11	4		4.8	0.8–9	4		0.07	0.01–0.16
cliff Dr.) nr. Chamblee Ga. (02336090)	SWR	85–900	–	–	–	–	3	3	450	130–780	3	3	9.6	5.9–14	3	3	12	9–12	3	3	0.17	0.09–0.25
North Fork Peachtree Creek at Buford Hwy.	DWF	140–1,100	3		7.2	6.9–7.4	5		18	11–38	4		2.6	2.0–4.0	5		6.3	1.8–11	5		0.28	0.07–1.1
nr. Atlanta, Ga. (02336120)	SWR	2,800–40,000	7	2	10.0	5.4–13.4	18	5	490	52–890	14	4	7.8	3.0–19	14	4	11	6.2–22	14	4	0.17	0.04–0.86
South Fork Peachtree Creek at Atlanta, Ga.	DWF	140–990	3		8.5	6.9–10.8	5		18	7–35	5		1.3	0.9–2.7	5		5.8	0.9–13	5		0.03	0.01–0.08
(02336250)	SWR	2,100–68,000	5	2	12.5	12.1–13.2	18	5	730	90–2,900	14	4	6.8	2.6–16	14	4	9.6	4.2–21	14	4	0.16	0.04–0.82
Peachtree Creek at Atlanta, Ga.	DWF	400–2,300	13		7.6	5.3–9.7	6		33	5–78	15		1.9	0.7–6.0	13		6.4	1.6–15	14		0.13	0.02–0.33
(02336300)	SWR	3,400–240,000	25	10	8.2	5.6–13.5	37	12	780	100–2,400	41	13	13	0.9–42	40	13	11	2.0–36	34	13	0.37	0.06–1.7
Woodall Creek at DeFoors Ferry Road	DWF	57–280	2		4.5	3.6–5.4	3		19	14–24	4		9.3	6.8–14	4		9	5.7–14	4		4.1	0.31–8.5
at Atlanta, Ga. (02336313)	SWR	1,100–8,500	5	2	6.5	5.5–8.0	13	5	570	60–2,400	11	5	32	5.5–73	11	5	19	9.6–45	11	5	0.21	0.04–0.71
Nancy Creek Tributary (West Nancy Creek Dr.)	DWF	42–99	1		8.7	–	3		26	9–39	2		2.0	1.8–2.1	2		1.1	1.0–1.2	2		0.03	0.00–0.06
near Atlanta, Ga. (02336339)	SWR	250–8,400	1	1	9.5	–	7	4	370	42–690	5	3	5.2	3.7–9.0	5	3	9.4	6.2–9.7	5	3	0.12	0.01–0.23
Nancy Creek at Randall Mill Road	DWF	85–990	6		7.7	6.9–8.8	5		36	16–93	9		2.8	1.1–7.0	7		4	1.2–7.6	8		0.05	0.01–0.66
at Atlanta, Ga. (02336380)	SWR	1,400–85,000	7	2	8.1	6.4–10.0	19	5	650	110–1,300	17	4	7.6	2.5–16	17	4	10	4.2–17	17	4	0.14	0.01–0.66
Proctor Creek at State Route 280	DWF	170–230	4		5.3	2.4–9.5	–		–	–	4		15	7.5–35	3		13	2.2–26	4		4.5	1.2–6.7
at Atlanta, Ga. (02336526)	SWR	1,800–16,000	7	2	8.3	7.4–9.4	9	3	1,700	170–6,300	9	3	32	9.2–77	9	3	45	7.6–70	9	3	1.7	0.35–6.8
Nickajack Creek at Cooper Lake Drive	DWF	280–700	8		8.2	7.0–9.1	4		38	14–64	8		1.9	0.20–4.0	7		5.7	2.2–8.9	8		0.03	0.00–0.08
near Mableton, Ga. (02336610)	SWR	1,300–6,500	3	1	7.2	7.0–7.3	3	2	1,100	920–2,200	4	2	8.8	5.1–14	4	2	18	5.2–50	4	2	0.15	0.08–0.19
Camp Creek at Enon Road near	DWF	280–570	5		7.4	6.6–8.2	–		–	–	5		1.2	0.9–7.8	4		3.2	2.2–6.0	5		0.07	0.01–0.12
Atlanta, Ga. (02337116)	SWR	1,400–20,000	5	1	11.6	10.7–12.0	7	2	700	140–1,500	7	2	4.4	2.0–8.8	7	2	13	4.2–48	7	2	0.15	0.05–0.22

(continued)

TABLE 4. (continued)

[DWF - Dry-weather flow; SWR - Stormwater runoff]

Sampling site	Flow conditions	Range of flow (L/s)	Total NO_2+ NO_3 as N (mg/L)				Total phosphorus as P (mg/L)				Dissolved O-PO_4 as P (mg/L)				Fecal coliform (col/100ml)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
North Fork Peachtree Creek Trib. (Meadowcliff Dr.) nr. Chamblee Ga. (02336090)	DWF	5.7	4		0.46	0.36-0.60	4		0.08	0.01-0.14	3		0.03	0.00-0.05	3		41,000	1,000-67,000
	SWR	85-900	3	3	0.43	0.33-0.50	3	3	0.41	0.33-0.52	3	3	0.10	0.01-0.16	3	3	49,000	17,000-74,000
North Fork Peachtree Creek at Buford Hwy. nr. Atlanta, Ga. (02336120)	DWF	140-1,100	5		0.49	0.35-0.60	5		0.09	0.04-0.22	4		0.02	0.00-0.09	4		2,800	1,500-4,900
	SWR	2,800-40,000	14	4	0.40	0.22-0.59	14	4	0.33	0.11-0.77	14	4	0.03	0.00-0.22	14	4	26,000	4,900-68,000
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	DWF	140-990	5		0.46	0.32-0.63	5		0.06	0.03-0.12	4		0.01	0.00-0.02	5		2,400	100-5,000
	SWR	2,100-68,000	13	4	0.47	0.24-0.86	14	4	0.39	0.15-0.73	14	4	0.02	0.00-0.05	14	4	27,000	1,200-70,000
Peachtree Creek at Atlanta, Ga. (02336300)	DWF	400-2,300	14		0.43	0.26-0.80	14		0.09	0.03-0.26	6		0.01	0.00-0.01	5		33,000	4,400-120,000
	SWR	3,400-240,000	35	13	0.44	0.16-0.70	35	13	0.50	0.07-1.0	31	12	0.02	0.00-0.08	30	12	140,000	4,000-800,000
Woodall Creek at DeFoors Ferry Road at Atlanta, Ga. (02336313)	DWF	57-280	4		0.49	0.04-0.95	4		2.0	0.30-4.7	3		0.56	0.01-1.2	4		130,000	25,000-340,000
	SWR	1,100-8,500	11	5	0.49	0.16-0.86	11	5	1.6	0.17-4.0	11	5	0.43	0.01-3.1	11	5	70,000	10,000-340,000
Nancy Creek Tributary (West Nancy Creek Dr.) near Atlanta, Ga. (02336339)	DWF	42-99	2		0.20	0.14-0.25	2		0.04	0.02-0.07	–		–	–	2		300	200-400
	SWR	250-8,400	5	3	0.19	0.09-0.28	5	3	0.20	0.13-0.28	5	3	0.02	0.00-0.05	4	3	4,500	900-6,300
Nancy Creek at Randall Mill Road at Atlanta, Ga. (02336380)	DWF	85-990	8		0.38	0.24-0.53	8		0.09	0.02-0.28	4		0.01	0.00-0.01	6		10,000	200-34,000
	SWR	1,400-85,000	17	4	0.34	0.13-0.59	17	4	0.33	0.09-0.56	17	4	0.03	0.00-0.07	17	4	41,000	3,300-190,000
Proctor Creek at State Route 280 at Atlanta, Ga. (02336526)	DWF	170-230	4		0.38	0.26-0.57	4		2.3	1.1-4.2	–		–	–	2		14,000	90-28,000
	SWR	1,800-16,000	9	3	0.52	0.30-0.69	9	3	1.1	0.72-1.6	9	3	0.10	0.01-0.32	9	3	260,000	110,000-560,000
Nickajack Creek at Cooper Lake Drive near Mableton, Ga. (02336610)	DWF	280-700	8		0.93	0.61-1.7	8		0.06	0.04-0.11	4		0.01	–	6		5,500	1,200-13,000
	SWR	1,300-6,500	4	2	0.63	0.29-0.90	4	2	0.58	0.41-0.92	4	2	0.00	–	4	2	170,000	80,000-280,000
Camp Creek at Enon Road, near Atlanta, Ga. (02337116)	DWF	280-570	5		0.52	0.31-0.70	5		0.12	0.05-0.19	1		0.05	–	3		1,200	600-2,200
	SWR	1,400-20,000	7	2	0.37	0.23-0.45	7	2	0.33	0.11-0.86	7	2	0.01	0.00-0.02	7	2	54,000	16,000-80,000

(continued)

TABLE 4. (continued)

[DWF - Dry-weather flow; SWR - Stormwater runoff]

Sampling site	Flow conditions	Range of flow (L/s)	Total lead (ug/L)				Total zinc (ug/L)				Total copper (ug/L)				Total chromium (ug/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
North Fork Peachtree Creek Trib. (Meadow-cliff Dr.) nr. Chamblee Ga. (02336090)	DWF	3-12	3		75	5-200	2		60	30-90	2		25	3-47	2		7	5-10
	SWR	85-900	3	3	120	44-250	3	3	110	70-210	3	3	19	10-34	3	3	18	5-20
North Fork Peachtree Creek at Buford Hwy. at Atlanta. Ga. (02336120)	DWF	140-1,100	3		25	8-35	3		17	10-20	4		12	4-26	4		12	10-20
	SWR	2,800-40,000	8	4	140	46-300	8	4	91	40-180	8	4	34	10-54	8	4	12	5-20
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	DWF	140-990	4		30	24-40	4		20	10-30	4		16	6-30	4		8	5-10
	SWR	2,100-68,000	8	4	240	88-440	8	4	180	60-400	8	4	56	18-100	8	4	31	5-80
Peachtree Creek at Atlanta, Ga. (02336300)	DWF	400-2,300	4		37	18-69	3		37	30-40	3		12	5-34	3		10	5-20
	SWR	3,400-240,000	24	7	360	17-400	24	7	230	30-630	24	7	67	11-160	24	7	36	5-100
Woodall Creek at DeFoors Ferry Rd. at Atlanta Ga. (02336313)	DWF	57-280	4		42	9-64	3		120	90-150	3		42	25-76	3		15	5-20
	SWR	1,100-8,500	8	3	300	76-900	8	3	460	160-1,800	8	3	310	22-2,000	8	3	60	5-340
Nancy Creek Trib. (West Nancy Creek Dr.) nr. Atlanta, Ga. (023363[illegible]9)	DWF	42-99	2		8	5-10	1		10	-	1		15	-	1		5	-
	SWR	250-8,400	4	3	140	48-320	4	3	58	20-90	4	3	22	11-37	4	3	10	5-20
Nancy Creek at Randall Mill Rd. at Atlanta, Ga. (02336380)	DWF	85-990	4		59	0-170	3		40	10-90	3		19	2-47	3		10	5-20
	SWR	1,400-85,000	10	3	140	42-390	10	3	100	40-200	10	3	42	10-150	10	3	14	5-30
Proctor Creek at State Route 280 at Atlanta, Ga. (02336526)	DWF	170-230	1		19	-	1		40	-	1		6	-	1		20	-
	SWR	1,800-16,000	2	2	1,700	250-3,200	2	2	640	90-1,200	2	2	85	30-140	2	2	72	5-140
Nickajack Creek at Cooper Lake Dr. nr. Mabelton, Ga. (02336610)	DWF	280-700	2		45	10-80	2		20	10-20	2		6	5-50	1		10	-
	SWR	1,300-6 500	1	1	72	-	1	1	120	-	1	1	50	-	1	1	0	-
Camp Creek at Enon Rd. nr. Atlanta, Ga. (02337116)	DWF	280-570	3		39	12-70	3		30	20-40	3		5	4-7	3		10	10
	SWR	1,400-20,000	3	2	93	60-140	3	2	83	10-180	3	2	30	9-56	3	2	25	5-50

(continued)

TABLE 4. (continued)

[DWF - Dry-weather flow; SWR - Stormwater runoff]

Sampling site	Flow conditions	Range of flow (L/s)	Total arsenic (ug/L)				Total mercury (ug/L)				Total cadmium (ug/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
North Fork Peachtree Creek Trib. (Meadow-cliff Dr.) nr. Chamblee Ga. (02336090)	DWF	3-12	3		<1	0-1	2		0.0	0.0-0.1	2		2	0-33
	SWR	85-900	3	3	4	2-6	1	1	0.1	-	1	1	1	-
North Fork Peachtree Creek at Buford Hwy. at Atlanta, Ga. (02336120)	DWF	140-1,100	4		0	0	3		0.0	0.0	3		1	0-2
	SWR	2,800-40,000	8	4	2	1-5	5	3	0.1	0.0-0.3	2	3	1	0-2
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	DWF	140-990	5		<1	0-2	3		0.0	0.0	2		2	0-4
	SWR	2,100-68,000	8	4	3	0-7	5	3	0.1	0.0-0.3	6	3	1	0-5
Peachtree Creek at Atlanta Ga. (02336300)	DWF	400-2,300	4		1	0-2	2		0.0	0.0	1		0	-
	SWR	3,400-240,000	24	7	4	0-18	17	6	0.3	0.0-0.9	18	5	2	0-3
Woodall Creek at DeFoors Ferry Rd. at Atlanta, Ga. (02336313)	DWF	57-280	4		5	2-10	1		0.0	-	2		0	-
	SWR	1,100-8,500	8	3	11	4-26	3	3	0.2	0.1-0.2	6	3	2	0-4
Nancy Creek Trib. (West Nancy Creek Dr.) nr. Atlanta, Ga. (02336339)	DWF	42-99	2		0	0	1		0.0	-	1		0.0	-
	SWR	250-8,400	4	3	2	1-3	3	2	0.0	0.1	3	2	1	0-2
Nancy Creek at Randall Mill Rd. at Atlanta, Ga. (02336380)	DWF	85-990	4		1	0-2	3		<0.1	0-0.1	3		1	0-4
	SWR	1,400-85,000	10	3	5	1-9	4	2	0.1	0.0-0.2	6	2	<1	0-1
Proctor Creek at State Route 280 at Atlanta, Ga. (02336526)	DWF	170-230	1		3	-	-		0.1	-	-		-	-
	SWR	1,800-16,000	2	-	26	6-45	-	-	-	-	-	-	-	-
Nickajack Creek at Cooper Lake Dr. nr. Mabelton, Ga. (02336610)	DWF	280-700	2		1	0-9	1		0.0	-	1		12	-
	SWR	1,300-6,500	1	1	9	-	-	-	-	-	-	-	-	-
Camp Creek at Enon Rd. nr. Atlanta Ga. (02337116)	DWF	280-570	3		1	0-1	-		-	-	-		-	-
	SWR	1,400-20,000	3	2	2	0-5	-	-	-	-	-	-	-	-

increase significantly during periods of stormwater runoff. The largest increases in the mean suspended-sediment concentrations are at the Peachtree, Nickajack, and Proctor Creek sites. Mean dry-weather suspended-sediment concentrations for the Peachtree and Nickajack Creek sites are 33 and 38 mg/L compared to mean wet-weather concentrations of 780 and 1,100 mg/L, Dry-weather suspended-sediment data are not available for the Proctor Creek site, but the mean wet-weather concentration is 1,700 mg/L.

The concentration of suspended sediment in streams is related to the concentration of many constituents. Increases in many constituent concentrations during periods of stormwater runoff are directly associated with increases in suspended-sediment concentration in the streams. Faye and others (4) demonstrated that, in general, suspended concentrations of phosphorus, nitrogen, organic carbon, lead, zinc, copper, chromium, and arsenic correlated well with concentrations of suspended silt plus clay-size particles.

The concentration of BOD_5 showed large increases during periods of stormwater runoff. The highest mean wet-weather BOD_5 concentrations were at the Peachtree, Woodall, and Proctor Creek sites where mean dry-weather concentrations of 1.9, 9.3, and 15 mg/L increased to mean wet-weather concentrations of 13, 32, and 32 mg/L, respectively. Mean wet-weather total organic carbon concentrations were relatively high at the Woodall and Proctor Creek sites. Mean dry-weather concentrations of 9 and 13 mg/L increased to mean wet-weather concentrations of 19 and 45 mg/L, respectively.

The mean concentrations of total ammonia nitrogen, total phosphorus, and fecal coliform bacteria were greater for wet-weather than dry-weather conditions for most but not all streams sampled. The highest mean wet-weather concentration of total ammonia nitrogen and total phosphorus was at the Peachtree Creek site where mean dry-weather concentrations of 0.13 and 0.09 mg/L increased to wet-weather concentrations of 0.37 and 0.50 mg/L, respectively. At the Woodall and Proctor Creek sites, stormwater runoff dilutes the dry-weather concentration of total ammonia nitrogen and total phosphorus. Mean dry-weather total ammonia nitrogen concentrations of 4.1 and 4.5 mg/L at the Woodall and Proctor Creek sites decreased to wet-weather concentrations of 0.21 and 1.7 mg/L, respectively. Dilution of total ammonia nitrogen also occurred during stormwater runoff periods at the North Fork Peachtree Creek site. Similarly, at the Woodall and Proctor Creek sites, the dry-weather mean total phosphorus concentrations of 2.0 and 2.3 mg/L were decreased slightly by stormwater runoff.

The highest mean wet-weather concentrations of fecal coliform bacteria were at the Peachtree, Proctor, and Nickajack Creek sites where mean dry-weather concentrations of 33,000, 14,000, and 5,500 col/100 mL increased to mean wet-weather concentrations of 140,000, 260,000, and 170,000 col/100 mL, respectively.

The mean total nitrite plus nitrate nitrogen concentration did not change significantly with the flow conditions for most streams. However, at the Proctor and Nickajack Creek sites mean concentrations did show considerable change. Compared to mean dry-weather concentrations, the wet-weather concentrations increased at the Proctor Creek site and decreased at the Nickajack Creek site.

The mean dissolved orthophosphate concentrations were 0.10 mg/L or less for all stream sites sampled except the Woodall Creek site. At this site the mean dry-weather concentration of 0.56 mg/L decreased to a mean wet-weather concentration of 0.43 mg/L.

Of the trace metals determined in samples, lead values were the highest for both dry-weather and wet-weather conditions followed by zinc, copper, and chromium. During dry-weather flow, the mean concentration of lead at most stream sites was below 50 ug/L. A criterion of 50 ug/L is the maximum level recommended by the EPA for domestic water supply (12). However, during wet-weather conditions the mean concentration of lead for most sites ranged from 72 to 1,700 ug/L, well above the 50 ug/L criterion. The highest mean concentration of 1,700 ug/L was at the Proctor Creek site. For all sampling sites except the Woodall Creek site, the mean dry-weather and wet-weather concentrations of zinc, copper, chromium, arsenic, and mercury did not exceed the EPA recommended criteria for domestic water supply of 5 mg/L, 1.0 mg/L, 50 ug/L, and 2.0 ug/L, respectively. The Woodall Creek site had a mean wet-weather chromium concentration of 60 ug/L, which is 10 ug/L larger than the EPA maximum recommended criterion for domestic water supply.

In summary, data presented in Table 4 indicate that streams undergo varying degrees of water-quality degradation during periods of stormwater runoff. Peachtree, Proctor, Woodall, and Nickajack Creeks consistently showed the greatest impact from stormwater runoff. In addition to stormwater runoff, both Peachtree and Proctor Creeks receive discharges from CSO's during storm periods that substantially contributes to the quality degradation of those streams. (See Peachtree Creek section.) Woodall Creek is heavily impacted by runoff from a small, highly urbanized (92-percent urban) basin. Nickajack Creek may be impacted by discharges of untreated or partially treated sewage during periods of heavy stormwater runoff; however, specific data are lacking to determine the source of pollution.

Table 5 summarizes the physical, chemical and bacteriological data for the CSO channel sites collected during wet-weather flow conditions. Mean concentrations of constituents in stormwater runoff from the three CSO channels (Clear Creek, Tanyard Branch, and North Fork Utoy Creek) were relatively high and comparable to the mean constituent concentrations at the Proctor Creek (which receives discharges from two CSO's) and Woodall Creek sites. Fecal coliform concentrations in the CSO channels are extremely high, often exceeding 1 million col/100 mL in Clear Creek and Tanyard Branch compared to counts of less than 400,000 col/100 mL in streams that do not receive CSO discharges. DO concentrations are near the level of saturation.

Table 6 summarizes the physical, chemical, and bacteriological data for sites on the Chattahoochee River for periods of dry-weather and wet-weather flow.

At the Atlanta site, which is upstream of the Atlanta Metropolitan Area, water quality is good. Mean constituent concentrations are low during

TABLE 5.--MEAN CONCENTRATIONS AND RANGES OF SELECTED WATER-QUALITY PARAMETERS FOR THE COMBINED SEWER OVERFLOW SITES DURING PERIODS OF STORMWATER RUNOFF, OCTOBER 1975-OCTOBER 1977

[DWF - Dry-weather flow: SWR - Stormwater runoff]

Sampling site	Flow conditions	Range of flow (L/s)	Dissolved O_2 (mg/L)				Suspended sediment (mg/L)				BOD_5 (mg/L)				Total organic carbon (mg/L)				Total NH_4 as N (mg/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Clear Creek at Piedmont Park at Atlanta, Ga. (02336274)	DWF	No flow																				
	SWR	2,100-33,000	3	1	8.2	8.0-8.3	13	4	360	79-950	14	5	37	4.2-150	14	5	25	6.4-130	13	4	0.60	0.13-2.6
Tanyard Branch at 26th Street Extension, at Atlanta, Ga. (02336290)	DWF	No flow																				
	SWR	85-110,000	7	1	7.9	6.9-8.4	16	4	370	13-1.600	16	4	23	6.0-42	18	4	11	2.6-28	18	4	2.0	0.18-8.3
North Fork Utoy Creek at Beecher Road at Atlanta, Ga. (02336654)	DWF	No flow																				
	SWR	2,000-5,700	3	1	10.2	9.1-12.2	3	1	380	220-640	3	1	29	26-36	3	1	23	12-29	3	1	0.28	0.11-0.50

Sampling Site	Flow conditions	Range of flow (L/s)	Total NO_2+NO_3 as N (mg/L)				Total phosphorus as P (mg/L)				Dissolved O-PO_4 as P (mg/L)				Fecal coliform (col/100ml)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Clear Creek at Piedmont Park at Atlanta Ga. (02336274)	DWF	No flow																
	SWR	2,100-33,000	13	4	0.39	0.20-0.84	13	4	0.80	0.3-2.0	13	4	0.21	0.05-0.58	14	4	550,000	80,000-$2.3x10^6$
Tanyard Branch at 26th Street Extension at Atlanta Ga. (02336290)	DWF	No flow																
	SWR	85-110,000	18	4	0.37	0.20-0.53	18	4	0.64	0.60-2.1	18	4	0.10	0.00-0.34	16	4	220,000	19,000-$1.5x10^6$
North Fork Utoy Creek at Beecher Road at Atlanta, Ga. (02336654)	DWF	No flow																
	SWR	2,000-5,700	3	1	0.34	0.24-0.39	3	1	0.50	0.28-0.62	3	1	0.10	0.00-0.18	3	1	250,000	230,000 260,000

(continued)

TABLE 5. (continued)

Sampling site	Flow conditions	Range of flow (L/s)	Total lead (ug/L)				Total zinc (ug/L)				Total copper (ug/L)				Total chromium (ug/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Clear Creek at Piedmont Park, at Atlanta, Ga. (02336274)	DWF	No flow																
	SWR	2,100-33,000	10	3	600	78-1,700	10	3	480	100-1,200	10	3	140	25-250	10	3	49	20-120
Tanyard Branch at 26th Street Extension, at Atlanta, Ga. (02336290)	DWF	No flow																
	SWR	85-110,000	8	4	660	400-1,100	7	4	430	260-520	7	4	51	34-74	7	4	22	5-50
North Fork Utoy Creek at Beecher Road, at Atlanta Ga. (02336654)	DWF	No flow																
	SWR	2,000-5,700	1	1	52	-	1	1	150	-	1	1	19	-	1	1	30	-

Sampling site	Flow conditions	Range of flow (L/s)	Total arsenic (ug/L)				Total mercury (ug/L)				Total cadmium (ug/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Clear Creek at Piedmont Park, at Atlanta, Ga. (02336274)	DWF	No flow												
	SWR	2,100-33,000	10	3	7	3-13	4	2	1.6	1.2-2.4	4	2	3	1-5
Tanyard Branch at 26th Street Extension, at Atlanta Ga. (02336290)	SWF	No flow												
	SWR	85-110,000	7	4	10	7-15	2	2	0.0	0.0	2	2	4	2-5
North Fork Utoy Creek at Beecher Road, at Atlanta, Ga. (02336654)	DWF	No flow												
	SWR	2,000 5,700	1	1	4	-	1	1	0.0	-	1	1	0	-

TABLE 6.--MEAN CONCENTRATIONS AND RANGES OF SELECTED WATER-QUALITY PARAMETERS FOR SITES ON THE CHATTAHOOCHEE RIVER DURING PERIODS OF DRY-WEATHER FLOW AND STORMWATER RUNOFF, OCTOBER 1975-OCTOBER 1977

[DWF - Dry-weather flow; SWR[1] - Stormwater runoff plus water released by Buford Dam]

Sampling site	Flow conditions	Range of flow (L/s)	Dissolved O_2 (mg/L)				Suspended sediment (mg/L)				BOD_5 (mg/L)				Total organic carbon (mg/L)				Total NH_4 as N (mg/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events samples	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events samples	Mean	Range	Number of samples	Storm events samples	Mean	Range
Chattahoochee River at Atlanta, Ga. (02336000)	DWF	1,150-1,250	36		9.3	7.7-11.2	19		11	3-29	27		1.5	0.6-4.5	29		3.0	0.6-6.8	31		0.02	0.00-0.06
	SWR[1]	1,300-18,000	17	11	10.5	7.2-12.2	21	7	560	48-2,600	20	5	2.7	1.3-6.0	28	12	6.4	1.4-17	29	12	0.06	0.00-0.15
Chattahoochee River near Fairburn, Ga. (02337170)	DWF	1,100-1,900	38		5.3	4.1-6.0	-		-	-	30		4.4	1.7-8.6	26		5.9	1.8-14	32		1.2	0.22-2.0
	SWR[1]	3,400-14,000	25	13	8.6	6.1-11.4	20	5	330	110-730	20	8	8.2	2.5-23	32	13	9.7	2.6-36	40	13	0.36	0.06-1.3
Chattahoochee River near Whitesburg, Ga. (02338000)	DWF	1,450-2,500	36		5.4	4.5-8.0	-		-	-	36		2.6	1.7-3.8	32		3.9	1.0-5.6	32		0.65	0.31-0.94
	SWR[1]	3,000-40,000	14	10	7.7	5.2-9.6	15	5	260	73-680	22	10	5.7	1.9-15	22	10	8.3	3.0-18	22	10	0.23	0.08-0.61

Sampling site	Flow conditions	Range of flow (L/s)	Total NO_2+NO_3 as N (mg/L)				Total phosphorus as P (mg/L)				Dissolved $O-PO_4$ as P (mg/L)				Fecal Coliform (col/100ml)			
			Number of samples	Storm events samples	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Chattahoochee River at Atlanta, Ga. (02336000)	DWF	1,150-1,250	31		0.29	0.21-0.37	31		0.03	0.01-0.06	2		0.01	0.00-0.01	7		600	57-2,200
	SWR[1]	1,300-18,000	30	12	0.26	0.14-0.41	29	12	0.15	0.01-0.55	22	6	0.01	0.00-0.03	20	9	4,400	500-26,000
Chattahoochee River near Fairburn, Ga. (02337170)	DWF	1,100-1,900	30		0.74	0.66-0.93	32		0.59	0.35-0.86	2		0.35	0.26-0.43	15		38,000	90-90,000
	SWR[1]	3,400-14,000	40	13	0.37	0.17-0.73	40	13	0.37	0.08-1.30	22	8	0.07	0.02-0.48	31	12	24,000	1,300-110,000
Chattahoochee River near Whitesburg, Ga. (02338000)	SWF	1,450-2,500	32		1.1	0.82-1.2	32		0.40	0.31-0.51	-		-	-	-		-	-
	SWR[1]	3,000-40,000	22	10	0.43	0.19-0.63	22	10	0.41	0.15-1.1	20	6	0.08	0.01-0.21	16	4	23,000	700-120,000

(continued)

TABLE 6. (continued)

[DWF - Dry-weather flow; SWR[1] - Stormwater runoff plus water released by Buford Dam]

Sampling site	Flow conditions	Range of Flow (L/s)	Total lead (ug/L)				Total zinc (ug/L)				Total copper (ug/L)				Total chromium (ug/L)				Total arsenic (ug/L)			
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Chattahoochee River at Atlanta, Ga. (02336000)	DWF	33,000-35,000	1		22	-	1		10	-	1		3	-	1		30	-	1		1	-
	SWR[1]	37,000-510,000	15	5	68	14-380	16	5	44	10-80	15	5	28	4-80	16	5	16	5-40	16	5	2	0-4
Chattahoochee River near Fairburn, Ga. (02337170)	SWF	31,000-54,000	6		23	6-40	6		53	20-80	3		12	7-15	5		27	5-40	4		1	1-2
	SWR[1]	96,000-400,000	24	6	97	16-300	24	7	78	20-200	22	7	28	6-100	23	7	15	5-40	21	6	2	0-6
Chattahoochee River near Whitesburg, Ga. (02338000)	DWF	41,000-71,000	1		14	-	1		50	-	1		8	-	1		20	-	1		2	-
	SWR[1]	85,000-1.1x10^3	10	4	99	27-300	10	4	88	30-200	13	4	36	19-56	13	4	18	5-40	13	4	3	1-5

Sampling site	Flow conditions	Range of flow (L/s)	Total mercury (ug/L)				Total cadmium (ug/L)							
			Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range	Number of samples	Storm events sampled	Mean	Range
Chattahoochee River at Atlanta, Ga. (02336000)	DWF	33,000-35,000	-		-	-	-		-	-				
	SWR[1]	37,000-510,000	15	5	0.1	0.1-0.2	11	4	1	0-1				
Chattahoochee River near Fairburn, Ga. (02337170)	DWF	31,000-54,000	3		0.2	0.0-0.3	3		1	0-2				
	SWR[1]	96,000-400,000	13	6	0.2	0.0-0.3	17	5	1	0-4				
Chattahoochee River near Whitesburg, Ga. (02338000)	DWF	41,000-71,000	-		-	-	-		-	-				
	SWR[1]	85,000-1.1x10^3	4	3	0.2	0.1-0.2	9	2	1	0-8				

dry-weather flow. As shown in Table 6, the greatest increases in mean wet-weather concentrations are for suspended sediment which increased about 50-fold, total phosphorus which increased 5-fold, and fecal coliform bacteria which increased about 7-fold.

At the Fairburn and Whitesburg sites, the mean total ammonia and total nitrite plus nitrate nitrogen concentrations were greater during dry-weather flow than for periods of stormwater runoff. The mean total ammonia nitrogen concentrations of 1.2 mg/L at the Fairburn site and 0.65 mg/L at the Whitesburg site for dry-weather flow decreased to 0.36 mg/L and 0.23 mg/L for wet-weather flow. Similarly, the total nitrite plus nitrate nitrogen concentration of 0.74 mg/L at the Fairburn site and 1.1 mg/L at the Whitesburg site for dry-weather flow decreased to 0.37 mg/L and 0.43 mg/L for wet-weather flow. At the Fairburn site, the mean total phosphorus concentration was also less for wet-weather flow, as indicated by a nearly 2-fold decrease in concentration from the dry-weather flow.

During dry-weather flow, concentrations of these constituents were higher at the Fairburn and Whitesburg sites because of high ammonia and nitrite plus nitrate nitrogen concentrations that are discharged from the WTF's to the reach of the river between the Atlanta and Fairburn sites. During wet weather, relatively lower concentrations of these constituents occurred in the river because of dilution by either stormwater or water released by Buford Dam, or both. Data indicate that stormwater is primarily responsible for the dilution because BOD_5 and total organic carbon concentrations increased during wet weather. If water released by Buford Dam (which has low constituent concentrations) were primarily responsible for the dilution, then all constituent concentrations would have decreased.

The concentrations of insecticides and industrial wastes in streams in the study area were low or below the level of detection (less than 0.01 ug/L) (Table 7). Unfiltered water samples were analyzed for aldrin, chlordane, endrin, lindane, heptachlor, heptachlor epoxide, DDD, DDE, DDT, and toxaphene (insecticides) and PCB and PCN (industrial wastes). Organochlorine insecticides were more commonly detected in Peachtree Creek and Tanyard Branch CSO's. A sample collected at low flow at the Woodall Creek site showed a PCB concentration of 9 ug/L. Woodall Creek drains a small highly industrialized land-use area (Table 3).

Selected toxic organic constituents sampled at selected sites in the study area are shown in Table 8. Generally, concentrations of these organics in nonpoint discharges were low and often below the level of detection. Trichloroethylene and chloroform were detected most frequently. Trichloroethylene occurred in the highest concentration. Concentrations of 15, 23, and 28 ug/L were detected in Clear Creek (CSO), Woodall Creek, and Tanyard Branch (CSO), respectively.

QUALITY OF POINT SOURCES

The quality of effluent from seven WTF's is listed in Table 9. The mean concentrations of constituents in the treated waste discharges from all WTF's except the U.S. Air Force Plant 6 and Camp Creek treatment facilities were

TABLE 7.--RANGE OF CONCENTRATIONS OF SELECTED ORGANOCHLORINE INSECTICIDES AND INDUSTRIAL WASTES FOR STREAMS IN THE STUDY AREA, 1976-1978

[Concentrations in micrograms per liter]

Sampling site	Aldrin		Chlordane		DDD		DDE		DDT		Dieldrin		Endrin		Heptachlor		Heptachlor epoxide		Lindane		Toxaphene		PCB		PCN	
	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range
Chattahoochee River at Atlanta, Ga. (02336000)	3	0.00	3	0.0	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0	3	0.0	3	0.0
North Fork Peachtree Creek Trib. (Meadowcliff Dr. nr. Chamblee, Ga. (02336090)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Fork Peachtree Creek at Buford Hwy, nr. Atlanta, Ga. (02336120)	2	0.00	2	0.2-0.5	2	0.00	2	0.00	2	0.00-0.01	2	0.00	2	0.00	2	0.00-0.05	2	0.00	2	0.00-0.01	2	0	2	0.0	2	0.0
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0	2	0.0-0.7	2	0.0
Clear Creek at Piedmont Park at Atlanta, Ga. (02336274)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanyard Branch at 26th St. Extension at Atlanta, Ga. (02336290)	3	0.0-0.02	3	0.1-0.8	3	0.00-0.01	3	0.00	3	0.00-0.02	3	0.00-0.05	3	0.00	3	0.00-0.03	3	0.00	3	0.00-0.12	3	0	3	0.0	3	0.0
Peachtree Creek at Atlanta, Ga. (02336300)	5	0.00	5	0.0-0.8	5	0.00	5	0.00	5	0.00	5	0.00	5	0.00	5	0.00-0.07	5	0.00	5	0.00-0.03	5	0	5	0.0	5	0.0
Woodall Creek at DeFoors Ferry Rd. at Atlanta, Ga. (02336313)	1	0.00	1	0.0	1	0.40	1	0.00	1	0.12	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0	1	9.0	1	0.0

(continued)

TABLE 7. (continued)

[Concentration in micrograms per liter]

Sampling site	Aldrin		Chlordane		DDD		DDE		DDT		Dieldrin		Endrin		Heptachlor		Heptachlor epoxide		Lindane		Toxaphene		PCB		PCN	
	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range
Nancy Creek Tributary (West Nancy Creek Dr.) nr. Atlanta, Ga. (02336339)	1	0.00	1	0.0	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0	1	0.0	1	0.0
Nancy Creek at Randall Mill Rd. at Atlanta, Ga. (02336380)	1	0.00	1	<0.1	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0	1	0.0	1	0.0
Proctor Creek at State Route 280 at Atlanta, Ga. (02336526)	2	0.00	2	0.0	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0	2	0.0	2	0.0
Nickajack Creek at Cooper Lake Dr. nr. Mableton, Ga. (02336610)	1	0.00	1	0.0	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0.00	1	0	1	0.0	1	0.0
North Fork Utoy Creek at Beecher Rd., at Atlanta, Ga. (02336654)	1	0.00	1	0.0	1	0.00	1	0.00	1	0.05	1	0.04	1	0.00	1	0.04	1	0.04	1	0.00	1	0	1	0.0	1	0.0
Camp Creek at Enon Rd., nr. Atlanta, Ga. (02337116)	3	0.00	3	0.0	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0.00	3	0	3	0.0	3	0.0
Chattahoochee River nr. Fairburn, Ga. (02337170)	6	0.00	6	0.0-0.1	6	0.00	6	0.00	6	0.00	6	0.00	6	0.00	6	0.00	6	0.00	6	0.00	6	0	6	0.0-0.3	6	0.0
Chattahoochee River nr. Whitesburg, Ga. (02338000)	2	0.00	2	0.0-0.1	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0.00	2	0	2	0.0	2	0.0

TABLE 8.—RANGE OF CONCENTRATIONS OF SELECTED TOXIC ORGANIC CONSTITUENTS FOR STREAMS IN THE STUDY AREA, 1976-1977

[ND - none detected; concentration in micrograms per liter]

Sampling site	Benzidene		Trichloro-ethylene		Chloroform		Bromo-dichloro-methane		Dibromo-chloro-methane		Bromoform		Carbon tetra-chloride		1,2-di-chloro-ethane		Vinyl chloride		Benzene	
	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range	Number of samples	Range
Chattahoochee River at Atlanta, Ga, (02336000)	2	ND	2	ND	2	0.1-0.2	2	ND	2	ND	2	ND	2	ND	2	ND	1	1.5	2	<1
North Fork Peachtree Creek at Buford Hwy., near Atlanta, Ga. (02336120)	1	ND	1	3.1	1	0.1	1	ND	1	ND	1	ND	1	ND	1	ND	1	0.7	1	0.6
South Fork Peachtree Creek at Atlanta, Ga. (02336250)	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	0.1	1	0.5
Clear Creek at Piedmont Park, at Atlanta, Ga. (02336274)	1	ND	1	15	1	1.5	1	ND	1	ND	1	ND	1	0.1	1	0.1	1	ND	1	<1
Tanyard Branch at 26th St. Ext., at Atlanta, Ga. (02336290)	1	ND	1	28	1	4.1	1	0.8	1	ND	1	ND	1	0.9	1	ND	1	ND	1	<1
Peachtree Creek at Atlanta, Ga. (02336300)	4	ND	4	ND-2.8	4	ND-0.1	4	ND-0.06	4	ND	4	ND	4	ND-0.3	4	ND-0.4	4	ND-0.5	4	<1
Woodall Creek at DeFoors Ferry Rd., at Atlanta, Ga. (02336313)	1	ND	1	23	1	0.3	1	ND	1	ND	1	0.2	1	ND	1	0.4	1	<0.5	1	<1
Nancy Creek at Randall Mill Rd., at Atlanta, Ga. (02336380)	1	ND	1	2.8	1	0.1	1	ND	1	ND	1	ND	1	ND	1	0.3	1	0.5	1	<1
North Fork Utoy Creek at Beecher Rd., at Atlanta, Ga. (02336654)	1	ND	1	3.2	1	1.9	1	ND	1	ND	1	ND	1	0.5	1	ND	1	1.5	1	<1
Camp Creek at Enon Rd., near Atlanta, Ga. (02337116)	1	ND	-	-	1	ND	1	ND	1	ND	1	ND	1	ND	1	ND	1	0.3	1	0.2
Chattahoochee River near Fairburn, Ga. (02337170)	8	ND	8	ND-2.2	8	ND-10	8	ND	8	ND	8	ND-0.7	8	ND-0.4	8	ND-3.6	8	ND-1.5	-	ND-0.7
Chattahoochee River at Whitesburg, Ga. (02338000)	2	ND	2	ND-8.2	2	ND-4.1	2	ND	2	ND	2	ND-1.3	2	ND	1	ND	1	ND	1	ND

TABLE 9.—MEAN CONCENTRATIONS AND RANGES OF SELECTED WATER-QUALITY PARAMETERS FOR EFFLUENT FROM WASTE-TREATMENT FACILITIES IN THE STUDY AREA, MARCH 1976-OCTOBER 1977

[WTF - Waste-treatment facility]

Sampling site	Range of flow (L/s)	Dissolved O_2 (mg/L)			BOD 5 (mg/L)			Total organic carbon (mg/L)			Total NH_4 as N (mg/L)			Total NO_2+NO_3 as N (mg/L)			Total phosphorus as P (mg/L)			Dissolved $O-PO_4$ as P (mg/L)		
		Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range
Cobb Chattahoochee WTF near Atlanta, Ga. (02336021)	280-820	18	0.8	0.1-2.7	24	35	2.8-175	24	25	5.0-88	24	10	3.6-15	24	0.50	0.01-2.9	24	7.6	1.1-4.2	8	1.7	0.01-4.4
R.M. Clayton WTF at Atlanta, Ga. (02336450)	1,800-6,500	20	1.6	0.5-5.5	26	35	0.2-220	26	32	11-120	26	13	4.4-18	26	0.11	0.00-1.2	26	4.0	0.89-11	9	1.5	0.61-2.5
Hollywood Road WTF at Atlanta, Ga. (02336523)	57-85	-	-	-	9	45	7.8-87	10	24	5.0-44	10	14	10-20	10	0.12	0.01-0.39	10	4.4	1.6-9.9	9	2.6	1.3-4.0
U.S. Air Force Plant 6 outfall near Smyrna, Ga. (02336537)	57-310	6	5.4	1.5-9.8	8	3	0.2-18	10	3.4	1.8-11	10	0.08	0.00-0.41	10	4.0	2.9-5.0	10	0.31	0.20-0.50	9	0.24	0.17-0.38
South Cobb Chattahoochee WTF near Mableton, Ga. (02336651)	110-570	19	1.9	0.2-9.5	24	36	2.0-110	24	22	6.1-48	24	12	1.2-16	24	0.56	0.00-4.8	24	7.2	1.4-11	9	3.8	1.7-5.2
Utoy Creek WTF near Atlanta, Ga. (02336653)	400-790	19	3.2	2.3-6.3	22	17	4.3-37	23	20	6.6-80	23	11	2.0-16	23	0.14	0.00-1.7	23	3.6	0.91-5.9	9	1.8	0.24-3.1
Camp Creek WTF near Atlanta, Ga. (02337073)	110-1,100	19	4.0	3.1-7.0	25	7.1	1.7-45	24	8.1	4.7-18	24	3.9	0.01-9.6	24	4.9	0.24-13	24	5.3	0.99-7.1	9	3.2	2.0-5.1

Sampling site	Range of flow (L/s)	Total lead (ug/L)			Total zinc (ug/L)			Total copper (ug/L)			Total chromium (ug/L)			Total arsenic (ug/L)			Total mercury (ug/L)			Total cadmium (ug/L)		
		Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range	Number of samples	Mean	Range
Cobb Chattahoochee WTF near Atlanta, Ga. (02336021)	280-820	8	37	2-94	8	94	20-490	8	20	3-99	7	28	5-60	4	1	0-2	2	1.0	0.1-1.9	1	0	-
R.M. Clayton WTF at Atlanta, Ga. (02336450)	1,800-6,500	10	160	35-550	10	460	100-1,600	10	69	12-200	10	120	10-400	4	5	3-6	2	1.9	1.7-2.1	2	2	0-5
Hollywood Road WTF at Atlanta, Ga. (02336523)	57-85	10	33	7-100	10	43	20-100	10	20	7-84	10	19	5-50	4	1	1	2	0.6	0.0-1.1	2	1	0-1
U.S. Air Force Plant 6 outfall near Smyrna, Ga. (02336537)	57-310	10	17	7-50	10	29	0-120	10	8	4-16	10	41	5-210	4	<1	0-1	2	0.2	0.1-0.3	2	1	0-2
South Cobb Chattahoochee WTF near Mableton, Ga. (02336651)	110-570	10	47	14-100	10	84	30-170	10	17	6-41	9	21	10-40	3	1	0-2	1	0.2	-	2	0	-
Utoy Creek WTF near Atlanta, Ga. (02336653)	400-790	10	57	36-110	10	72	40-130	10	15	9-28	10	26	10-60	4	1	0-2	2	0.1	0.0-0.2	2	0	-
Camp Creek WTF near Atlanta, Ga. (02337073)	110-1,100	10	17	2-49	10	41	20-100	10	11	4-18	10	18	5-50	4	1	1	2	0.1	0.1-0.2	2	0	0

high. The ranges of the mean concentrations of some constituents listed in Table 9 (excluding the relatively low concentrations of U.S. Air Force Plant 6 and Camp Creek WTF's) were 17 to 45 mg/L BOD_5, 20 to 32 mg/L total organic carbon, 10 to 14 mg/L total ammonia nitrogen, and 3.6 to 7.6 mg/L total phosphorus.

Except for the R. M. Clayton WTF, the mean concentrations of trace metals in the waste effluents were, in general, less than the mean wet-weather concentrations of trace metals in the streams (<100 ug/L). As shown in Table 9, the mean concentrations of trace metals in the effluent from the R. M. Clayton WTF are 2 to 10 times greater than the other WTF's.

Point-source discharges were sampled one time during a storm event for organochlorine insecticides and selected organic constituents. Insecticide concentrations in all samples were below the level of detection, or occurred only in trace amounts. Organic constituents were low (Table 10). Trichloroethylene and chloroform were detected most frequently. Concentrations of trichloroethylene ranged from less than the level of detection to 15 ug/L and chloroform from less than the level of detection to 11 ug/L.

TRANSPORT OF POLLUTANTS IN URBAN STREAMS

Chemical pollutants that are transported by urban streams during storm-water runoff have characteristic transport modes. They may be transported in the soluble or particulate (suspended) phase, or both. The suspended pollutants may occur as particulate organic material or be adsorbed onto the inorganic sediment particles. The mode of transport of pollutants has significant implication for allocation of resources for pollution abatement. For example, the constituents closely associated with suspended sediments, as opposed to the dissolved constituents, may be more effectively reduced in urban streams by land use practices that control erosion, by street sweeping, and perhaps by pollution abatement measures such as retention ponds that collect sediment. Table 11 lists the mean percentage concentration of selected parameters in the dissolved and suspended phase for six sites in the study area.

Organic carbon, as indicated by the mean percentages, occurs more commonly in the dissolved than in the suspended phase. The dissolved organic carbon ranged from 46 to 65 percent. Exceptions are the Clear Creek CSO site and the R. M. Clayton WTF. Samples from both of these sites had slightly larger mean percentages of suspended organic carbon of 52 and 54 percent, respectively. Inorganic nitrogen (nitrite plus nitrate and ammonia nitrogen) occurs mostly in the dissolved phase. Mean percentages ranged from 93 to 98 percent. Conversely, phosphorus and the selected trace metals occur primarily in the suspended phase. The mean percentage of suspended phosphorus ranged from 45 to 98 percent. The overall mean percentage of suspended lead, zinc, and copper ranged from 69 to 96 percent.

In summary, the trace metals appear to be transported predominantly in the suspended phase. A high percentage of phosphorus is also transported as suspended phosphorus. Generally, higher percentages of organic carbon are

TABLE 10.--CONCENTRATIONS OF SELECTED ORGANIC CONSTITUENTS IN THE EFFLUENT OF WASTE-TREATMENT FACILITIES DURING A STORM PERIOD IN NOVEMBER 1976

[WTF - Waste-treatment facility; ND - None detected; concentration in micrograms per liter]

Sampling site	Benzidene		Tri-chloro-ethylene		Chloro-form		Bromo-dichloro-methane		Dibrom-chloro-methane		Bromo-form		Carbon tetra-chloride		1,2-di-chloro-ethane		Vinyl chloride		Benzene	
	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration	Number of samples	Concentration
Cobb Chattahoochee WTF near Atlanta, Ga. (02336021)	1	ND	1	ND	1	2.0	1	ND	1	ND	1	ND	1	ND	1	1.0	1	0.8	1	<1
R.M. Clayton WTF at Atlanta, Ga. (02336450)	1	ND	1	15	1	5.6	1	0.8	1	ND	1	0.3	1	8.0	1	ND	-	ND	1	<1
Hollywood Road WTF at Atlanta, Ga. (02336523)	1	ND	1	4.5	1	4.6	1	ND	1	ND	1	ND	1	ND	1	ND	1	0.8	1	<1
U.S. Air Force Plant 6 outfall near Smyrna, Ga. (02336537)	1	ND	1	8.4	1	11	1	ND	1	ND	1	ND	1	ND	1	ND	1	0.8	1	<1
South Cobb Chattahoochee WTF near Mableton, Ga. (02336651)	1	ND	1	6.6	1	6.0	1	ND	1	ND	1	ND	1	ND	1	ND	1	<0.5	1	<1
Utoy Creek WTF near Atlanta, Ga. (02336653)	1	ND	1	2.7	1	5.3	1	0.1	1	ND	1	ND	1	1.1	1	ND	1	<0.5	1	<1
Camp Creek WTF near Atlanta, Ga. (02337073)	1	ND	1	ND	1	3.9	1	0.1	1	ND	1	ND	1	ND	1	ND	1	<0.5	1	<1

TABLE 11.—COMPARISON OF DISSOLVED AND SUSPENDED CONCENTRATIONS OF PARAMETERS EXPRESSED AS PERCENTAGE OF TOTAL CONCENTRATION FOR SELECTED SITES IN STUDY AREA

[Sample collection period: January 1976 - October 1977. WTF - Waste-treatment facility]

Sampling site	Organic carbon				Inorganic nitrogen as N				Phosphorus as P				Lead				Zinc				Copper			
	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended	Number of samples	Mean percent in dissolved phase	Mean percent in suspended phase	Standard deviation of percent mean suspended
Chattahoochee River at Atlanta, Ga. (02336000)	36	64	36	20	24	94	6	7	21	34	66	43	12	6	94	12	12	19	81	25	12	13	87	18
Clear Creek at Piedmont Park, at Atlanta, Ga. (02336274)	13	48	52	28	13	93	7	7	13	37	63	18	10	6	94	7	10	10	90	9	11	13	87	11
Tanyard Branch at 26th St. Extn., at Atlanta, Ga. (02336290)	18	63	37	24	17	96	4	5	18	24	76	16	7	4	96	3	6	21	79	13	6	19	81	14
Peachtree Creek at Atlanta, Ga. (02336300)	41	61	39	18	37	96	4	5	38	11	89	8	27	12	88	19	25	14	86	16	26	13	87	12
R.M. Clayton WTF at Atlanta, Ga. (02336450)	25	46	54	17	9	98	2	4	9	55	45	22	9	6	94	6	9	31	69	27	9	24	76	21
Chattahoochee River near Fairburn, Ga. (02337170)	23	65	35	23	22	96	4	5	23	30	70	18	16	9	91	10	15	9	91	12	15	21	79	21

transported as dissolved rather than as suspended organic carbon. Inorganic nitrogen is transported almost entirely in the dissolved phase.

IMPACT OF STORMWATER RUNOFF ON STREAM QUALITY

The Chattahoochee River downstream of the Atlanta site receives significant pollutant loads from the highly urbanized (78-percent urban) Peachtree Creek basin. Data from Peachtree Creek and the CSO's (Clear Creek and Tanyard Branch) indicate the quality characteristics of these discharges and their impact on the quality of the receiving streams.

Clear Creek and Tanyard Branch Combined Sewer Overflows

Data collected from Clear Creek and Tanyard Branch characterize the quality of water in the CSO channels. The time distribution of constituent concentrations is shown in Table 12. For two storms occurring on March 12-15, 1976, and September 16, 1977, constituent concentrations generally were highest during the rise of discharges and generally decreased by about one-half during peak discharges. Most constituent concentrations increase slightly during the last stages of the recession.

Because of the CSO's immediate flow response to rainfall, discharges from Clear Creek and Tanyard Branch are received primarily during the rising stage of the Peachtree Creek storm hydrograph. The impact of the CSO's on Peachtree Creek and the Chattahoochee River will be discussed later in the report.

Peachtree Creek

The nature of storms and perhaps antecedent conditions have a significant effect on the quality of stormwater runoff and its impact on the receiving waters. Stormwater runoff data collected during four different storm conditions describe the nature and magnitude of constituent discharges in Peachtree Creek. Storm characteristics and antecedent conditions for the four storms are listed in Table 13.

The hourly rainfall amounts, time distribution of discharge, constituent concentrations, and transport rates at the Peachtree Creek at Atlanta site are shown in Figures 3, 4, 5, and 6. The November storm resulted from the passage of a cold front which produced relatively continuous rainfall and sustained runoff. The other 3 events resulted from thunderstorms with most of the rainfall occurring during a 3- to 8-hour period. The resulting runoff from the July and October storms was rapid and produced high peak flows.

The Peachtree Creek hydrograph is characterized by a minor peak in discharge near the beginning for both the November and October storms. The bimodal hydrograph can be attributed to the rainfall distribution and discharges from the CSO's, which respond more quickly to rainfall than other tributaries to Peachtree Creek. A similar peak is unnoticeable in the July storm hydrograph, probably because of the short rainfall period.

TABLE 12.--TIME DISTRIBUTION OF SELECTED CONSTITUENT CONCENTRATIONS AT CLEAR CREEK AND TANYARD BRANCH COMBINED SEWER OVERFLOWS FOR A STORM ON MARCH 12-15, 1976, AND SEPTEMBER 19, 1977

[Concentration expressed in milligrams per liter except where noted.]

	BOD_5	Total ammonia as N	Total nitrogen as N	Total phosphorus as P	Total lead	Fecal coliform (col/100 ml)
Clear Creek (Storm period, Mar. 12-15, 1976)						
-Rise- Initial discharge	52	2.6	9.0	1.8	0.92	1,400,000
-Peak- 25 minutes after initial discharge	38	0.44	4.8	0.99	1.3	270,000
-Recession- 50 minutes after initial discharge	18	0.82	3.8	0.84	0.42	200,000
-Recession- 65 minutes after initial discharge	28	1.2	4.2	0.84	0.24	220,000
Tanyard Branch (Storm period, Sept. 19, 1977)						
-Rise- Initial discharge	23	0.42	5.3	0.22	0.70	56,000
-Midpoint of rise- 20 minutes after initial discharge	61	1.8	7.3	2.1	-	1,500,000
-Near peak- 30 minutes after initial discharge	28	1.5	2.6	1.3	-	540,000
-Midpoint of recession- 50 minutes after initial discharge	24	1.5	3.8	0.65	-	260,000
-Recession- 90 minutes after initial discharge	-	8.3	9.1	0.79	-	100,000

TABLE 13.--CHARACTERISTICS OF STORMS AND ANTECEDENT CONDITIONS FOR THE PEACHTREE CREEK BASIN

Storm date	Duration of rainfall (hrs)	Total rainfall (mm)	Antecedent conditions in Peachtree Creek basin	
			Days since last rainfall	Approximate amount of last rainfall (mm)
November 27, 1976	35	48	5	2
July 25, 1977	8	27	2	15
October 8, 1977	22	83	7	1
October 25, 1977	17	65	15	53

Generally, constituent concentrations were greater during the rising limb of the hydrograph and smaller on the receding limb for the July and October storms. This characteristic was not apparent during the November storm, during which the rainfall duration was long, initial runoff was slower, and constituent concentrations were much more dilute.

The apparent effect of discharges from the Clear Creek and Tanyard Branch CSO's on the flow and constituent concentrations in Peachtree Creek is indicated by the relatively high concentrations of constituents that coincide with the minor peak in discharge that occurred at the Peachtree Creek site during the October 1977 storms. As shown in figures 3, 4, 5, and 6, the maximum rates of transport coincided with maximum discharges, even though the highest constituent concentrations often occurred prior to the maximum discharges. Constituent concentrations, which were considerably higher during the July and October storms compared to the November storm, resulted in constituent storm loads that were very much larger per unit volume than the November storm loads. For example, the November storm volume was about four times larger than the July storm volume, yet the November BOD_5 and phosphorus storm loads were only about twice as large as the July storm loads. Also, the July ammonia nitrogen storm load was greater than the November ammonia nitrogen storm load. Similarly, the October storm volume was roughly twice the November storm volume, but storm loads in October ranged from 1 to about 6 times greater than the November storm loads. The higher constituent concentrations observed during the July and October storms can probably be attributed to the rapid runoff, which had a greater capability to suspend and wash material from the land surface than the less rapid runoff of the November storm.

Chattahoochee River

Point- and Nonpoint-Source Pollutant Loads--
The impact of stormwater runoff from the Peachtree Creek basin and the WTF's on the Chattahoochee River was evaluated by an approximation of the mass balance of discharge volume and constituent loads during storm periods that occurred on November 27-30, 1976, and October 8-10, 1977. A similar analysis could not be done for the storm on July 25, 1977, because chemical-quality data were not collected at the Chattahoochee River near Fairburn site. Discharge volumes, constituent loads, and the percentage contribution of the constituents to the Chattahoochee River near Fairburn are shown in Tables 14 and 15. Losses due to deposition were not accounted for.

Many nonpoint sources to the Chattahoochee River were not measured during these two storms. These nonpoint sources are primarily streams tributary to the Chattahoochee River. (See Figure 1.) Unmeasured (residual) flow and constituent loads in the Atlanta-to-Fairburn reach were computed as the difference between volumes measured at the Fairburn site and at sites upstream of the Fairburn site, and as the difference between loads calculated for the Fairburn site and for sites upstream of the Fairburn site. For example, as shown in Table 14, the sum of the discharge volumes and constituent loads from the Atlanta, Peachtree Creek, Nancy Creek, and unmeasured sites and the WTF's equals the discharge volume and load at the Fairburn site. Clear Creek

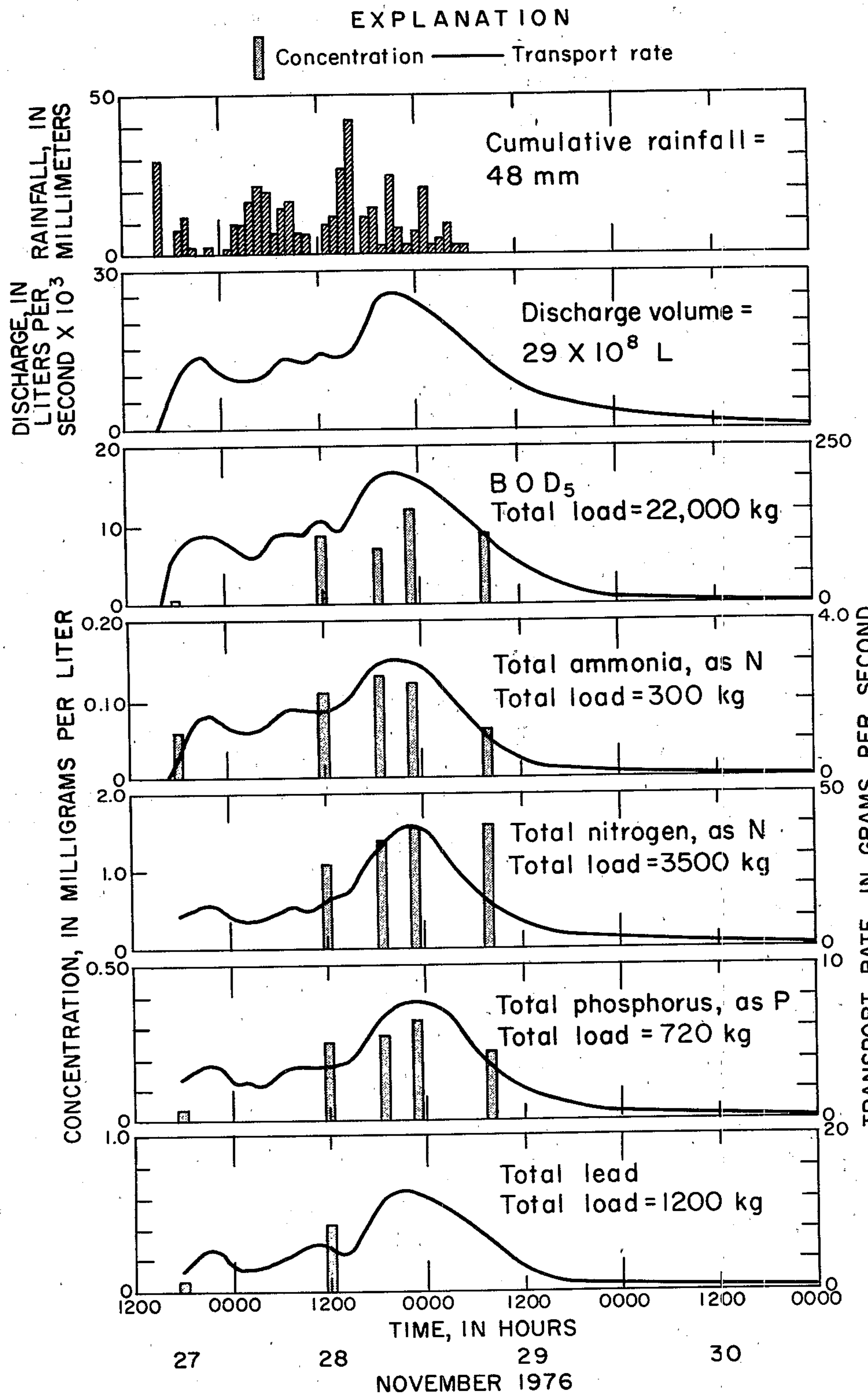

Figure 3.—Concentrations and transport rates of constituents for Peachtree Creek at Atlanta for a storm occurring on November 27–28, 1976.

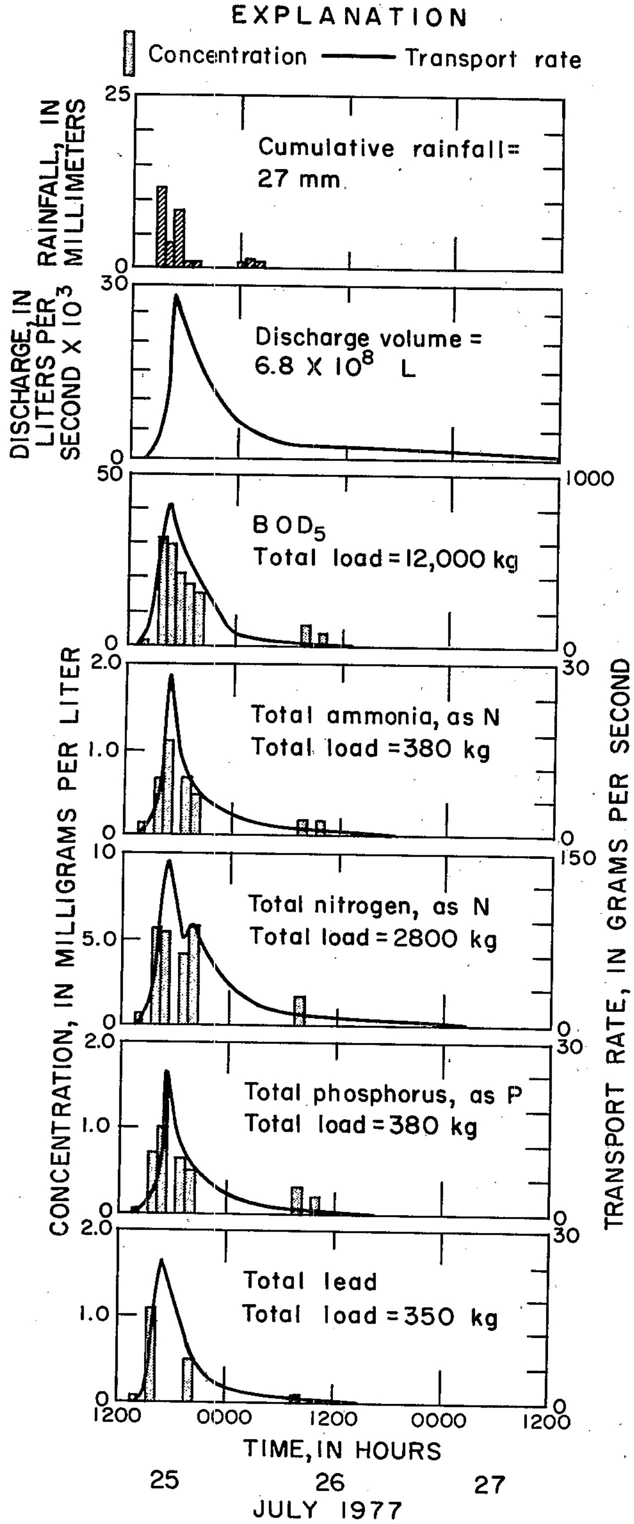

Figure 4.—Concentrations and transport rates of constituents for Peachtree Creek at Atlanta for a storm occurring on July 25, 1977.

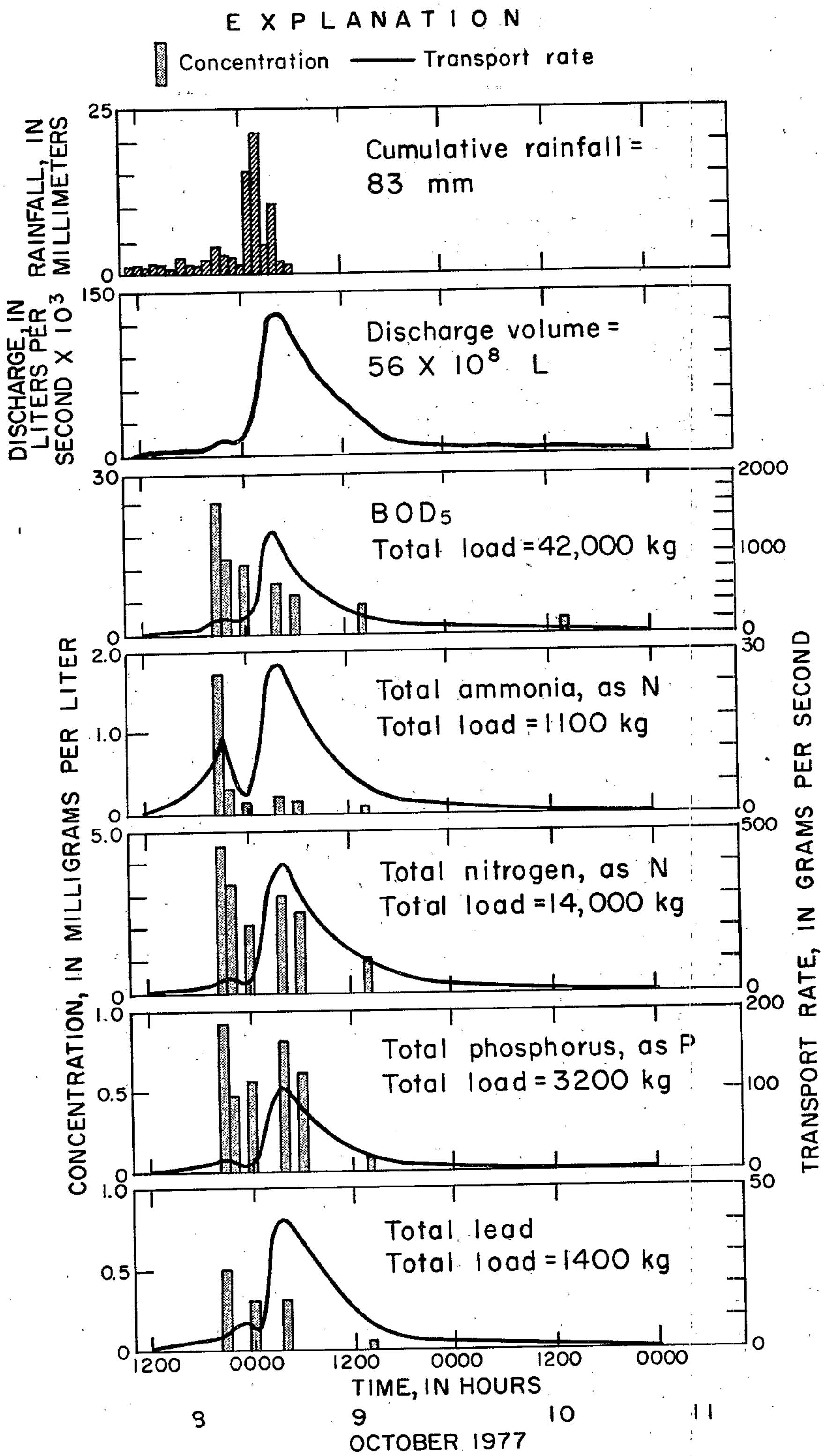

Figure 5—Concentrations and transport rates of constituents for Peachtree Creek at Atlanta for a storm occurring on October 8–9, 1977.

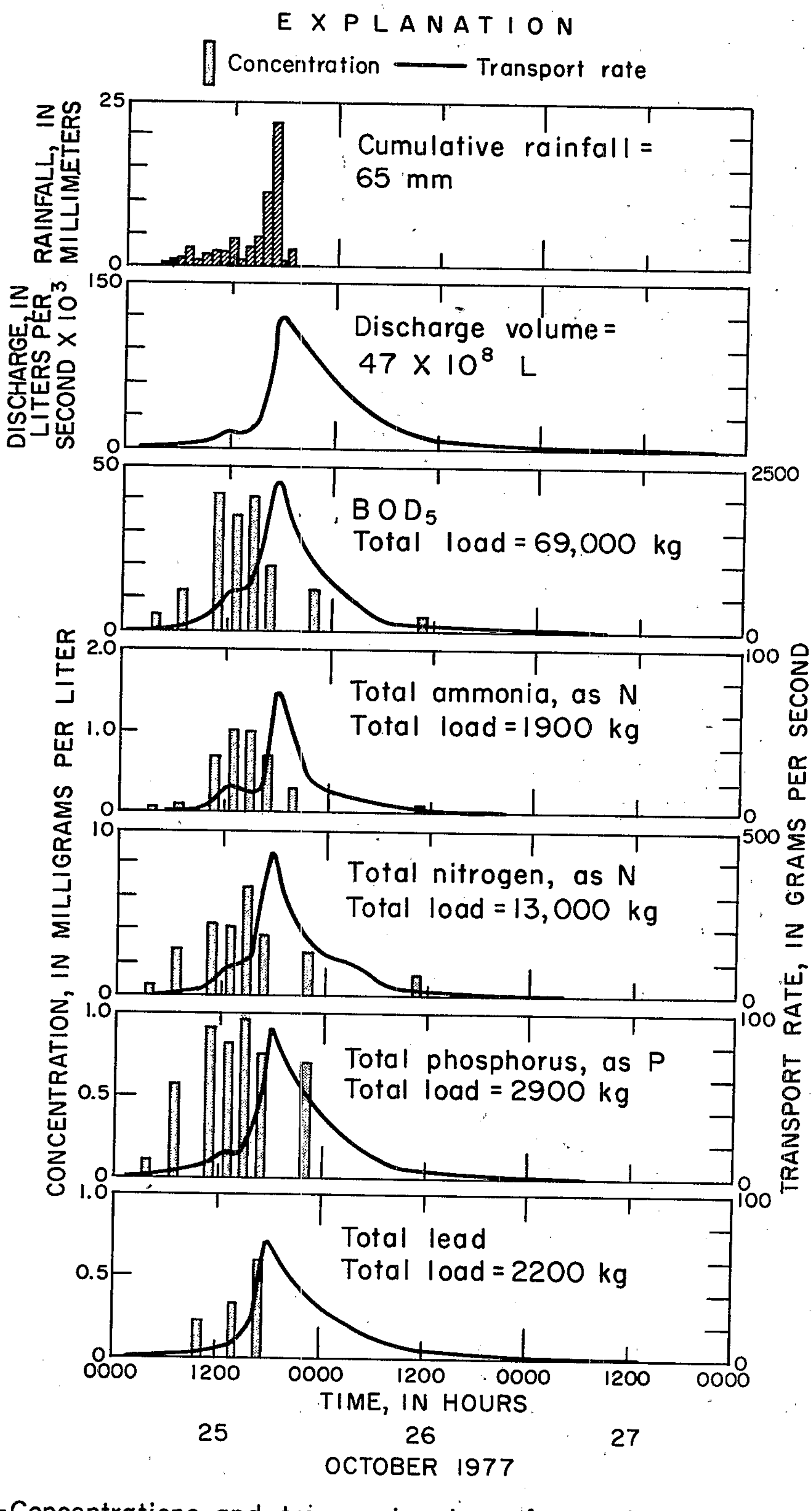

Figure 6.—Concentrations and transport rates of constituents for Peachtree Creek at Atlanta for a storm occurring on October 25, 1977.

and Tanyard Branch, tributaries to Peachtree Creek upstream of the sampling site, were not included in the sum (except as part of the load calculated for the Peachtree Creek site). Nancy Creek was included because it is downstream of the Peachtree Creek sampling site.

Because the residual loads are calculated by mass balance rather than from measured values, they need to be evaluated to determine if they are realistic. An evaluation was done by determining the average residual concentrations (residual loads divided by residual volume) of the constituents in Tables 14 and 15 and comparing them to the mean wet-weather concentrations of similar constituents for streams in the study area. Residual mean constituent concentrations were 0.52 mg/L total nitrogen, 0.25 mg/L total phosphorus, and 2.2 mg/L total organic carbon for the November storm and 1.7 mg/L total nitrogen, 0.28 mg/L total phosphorus, and 6.9 mg/L total organic carbon for the October storm. The concentrations appear to be realistic. In general, they were 2 to 3 times lower than the mean wet-weather concentration of similar constituents for the Peachtree Creek site.

The data in Table 14 indicate that for the November storm, point-source total nitrogen and total phosphorus loads were significantly greater than the nonpoint-source loads. The point-source total organic carbon load was less than the nonpoint-source load. At the Fairburn site, point discharges contributed only about 8.7 percent of the total discharge volume, but 72 percent of the total nitrogen load, 67 percent of the total phosphorus, and 40 percent of the total organic carbon. Nonpoint discharges contributed roughly 91 percent of the total discharge at the Fairburn site, but only 28 percent of the total nitrogen load, 33 percent of the total phosphorus, and 60 percent of the total organic carbon. The combined percentage contribution of loads at the Fairburn site from the measured CSO's was 0.9 percent for total nitrogen, 1.1 percent for total phosphorus, and 2.3 percent for total organic carbon. The approximate percentage contribution of loads at the Fairburn site from the Peachtree Creek basin (Peachtree Creek at Atlanta, plus Nancy Creek at Randall Mill Road) was 5.9 percent for total nitrogen, 5.0 percent for total phosphorus, and 17 percent for total organic carbon.

The data in Table 15 indicate that for the October storm, nonpoint-source loads were greater than point-source loads. Point-source loads, however, were high. Nonpoint discharges contributed roughly 96 percent of the total discharge at the Fairburn site, 68 percent of the total nitrogen load, 61 percent of the total phosphorus load, and 88 percent of the total organic carbon load. Point discharges contributed about 4 percent of the discharge volume, 32 percent of the total nitrogen, 39 percent of the total phosphorus, and 12 percent of the total organic carbon loads. For this storm period, the Peachtree Creek at Atlanta site was the only tributary sampled in the Peachtree Creek basin. The percentage contributions of total nitrogen, total phosphorus, and total organic carbon loads from Peachtree Creek (at Atlanta site) to the Chattahoochee River near Fairburn site were 17, 19, and 13 percent, respectively.

Impact of Stormwater Runoff on Dissolved-Oxygen Concentration--

The impact of flow regulation and stormwater runoff on the DO and dissolved-solids concentrations in the Chattahoochee River is detected by an

TABLE 14.—COMPUTED CONSTITUENT LOADS AND PERCENTAGES OF LOADS CONTRIBUTED BY TRIBUTARIES TO THE CHATTAHOOCHEE RIVER FOR A STORM ON NOVEMBER 27-29, 1976

[CSO, Combined sewer overflow]

Sampling site	Drainage area (Km^2)	Discharge volume during storm (L)	Percent of discharge at Fairburn	Total nitrogen load (Kg)	Percent of nitrogen load at Fairburn	Total phos-phorus load (Kg)	Percent of phos-phorus load at Fairburn	Total organic carbon load (Kg)	Percent of organic carbon load at Fairburn
Chattahoochee River at Atlanta, Ga. (02336000)	3,760	$68x10^8$	25	4,900	8.6	600	4.0	37,000	23
Clear Creek at Piedmont Park CSO, at Atlanta, Ga. (02336274)	9.6	$1.2x10^8$	0.4	180	0.3	100	0.7	2,700	1.7
Tanyard Branch at 26th Street Extn. CSO, at Atlanta, Ga. (02336290)	9.1	$1.2x10^8$	0.4	340	0.6	52	0.4	940	0.6
Peachtree Creek at Atlanta, Ga. (02336300)	225	$29x10^8$	11	3,000	5.3	640	4.3	24,000	15
Nancy Creek at Randall Mill Rd., at Atlanta, Ga. (02336380)	90.1	$3.1x10^8$	1.1	370	0.6	99	0.7	3,100	1.9
Unmeasured flow and constituent sources in the Atlanta-Fairburn reach	1,360	$147x10^8$	54	7,700	14	3,700	25	32,000	20
Measured point sources, total of 7 sites	-	$23x10^8$	8.7	41,000	72	10,000	67	64,000	40
Chattahoochee River near Fairburn, Ga. (02337170)	5,340	$270x10^8$	100	57,000	100	15,000	100	160,000	100

TABLE 15.—COMPUTED CONSTITUENT LOADS AND PERCENTAGES OF LOADS CONTRIBUTED BY TRIBUTARIES TO THE CHATTAHOOCHEE RIVER FOR A STORM ON OCTOBER 8-9, 1977

Sampling site	Drainage area (Km^2)	Discharge volume during storm (L)	Percent of discharge at Fairburn	Total nitrogen load (Kg)	Percent of nitrogen load at Fairburn	Total phos-phorus load (Kg)	Percent of phos-phorus load at Fairburn	Total organic carbon load (Kg)	Percent of organic carbon load at Fairburn
Chattahoochee River at Atlanta, Ga. (02336000)	3,760	$180x10^8$	47	17,000	22	3,000	19	150,000	47
Peachtree Creek at Atlanta, Ga. (02336300)	225	$56x10^8$	15	13,000	17	3,100	19	41,000	13
Unmeasured flow and constituent sources in the Atlanta-Fairburn reach	1,360	$130x10^8$	34	22,000	29	3,600	23	90,000	28
Measured point sources, total of 7 sites	-	$14x10^8$	4	25,000	32	6,300	39	39,000	12
Chattahoochee River near Fairburn, Ga. (02337170)	5,340	$380x10^8$	100	77,000	100	16,000	100	320,000	100

automatic water-quality monitor located at the Fairburn site. (See Figure 1.) Near this site the DO concentration reaches a point of minimum DO produced by oxygen-consuming constituent loads to the river. Figure 7 shows that during low flow (about 3.4×10^4L/s (1,200 ft^3/s) at Atlanta), minimum DO occurs about 18 km (11 mi) downstream of the Fairburn site and is only slightly less that at Fairburn. At higher flows the minimum DO concentration is displaced downstream. At a streamflow of about 5.1×10^4L/s (1,800 ft^3/s) the minimum DO occurs about 43 km (27 mi) downstream of the Fairburn site (10).

The flow pattern and DO concentrations that occur at the Chattahoochee River near Fairburn site as a result of flow regulation by Buford Dam and stormwater runoff are shown in Figure 8. Daily rainfall measured at one site in the Peachtree Creek basin and mean daily discharge at the Peachtree Creek at Atlanta site are included in the illustration. The 6-month time period includes mainly the summer and fall seasons. The shaded columns which extend over 2-day periods indicate the days when river flows at the Fairburn site were not influenced by water released by Buford Dam for power generation. Typically, these times of low flow occurred at the Fairburn site every Sunday and Monday from June through September. After September, the storms rather than flow regulation were primarily responsible for the variations in discharge and DO at the Fairburn site. The lowest daily minimum DO concentrations during June through September were concurrent with the Sunday and Monday daily mean low flows. At higher flows produced by water released during the other days of the week by Buford Dam, daily minimum DO concentrations were much higher.

The impact of stormwater runoff on DO concentrations appears to be most severe during the summer at times when the river is at low flow. However, data are scarce because the occurrence of stormwater runoff at times of low flow in the river is infrequent. For example, Figure 8 shows that during the summer of 1977 stormwater runoff occurred at low flow only once (July 26). In the fall, stormwater runoff occurred when the river was at low flow only on September 26 and October 1, 8, and 25. On September 26 and October 1 the DO concentration reached a minimum of 3.8 mg/L, which was about 1 mg/L lower than occurred during dry-weather low flow the first 3 weeks in September. Runoff produced by heavy thunderstorms on October 8 and 25 caused some decrease in the minimum DO at the Fairburn site, but the change was not as marked as that during the July 26 summer storm or the September 26 and October 1 fall storms.

The hourly variations of discharge, DO, and specific conductance that occurred at the Fairburn site during the July 26 and October 8, 1977 and November 27, 1976 storms are shown in Figures 9, 10, and 11. The specific conductance and discharge at the Fairburn site were similar prior to each storm, which indicates the presence of similar dissolved-solids loads. River temperature was highest during the July storm and was a major factor causing the lowest prestorm DO concentrations at the Fairburn site.

The effect of runoff from each storm was an increase in specific conductance and a decrease in DO as the pollutant load passed the Fairburn site. An improvement in river quality followed when the hydropulse water (released water from Buford Dam) passed the monitor site. Figure 9 shows that the

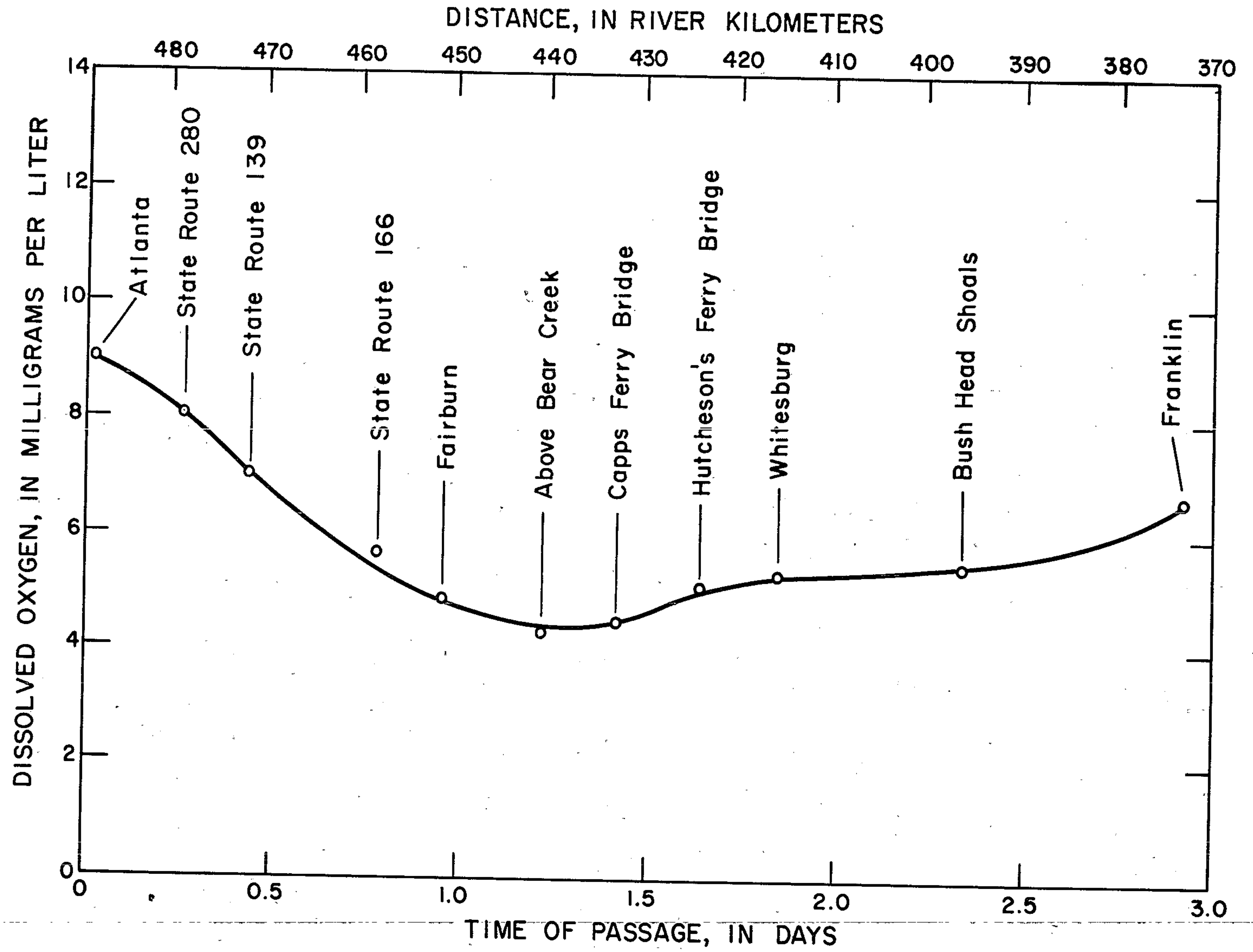

Figure 7.—Dissolved-oxygen concentrations in the Atlanta-to-Franklin reach of Chattahoochee River during low-flow period June 1–2, 1977.

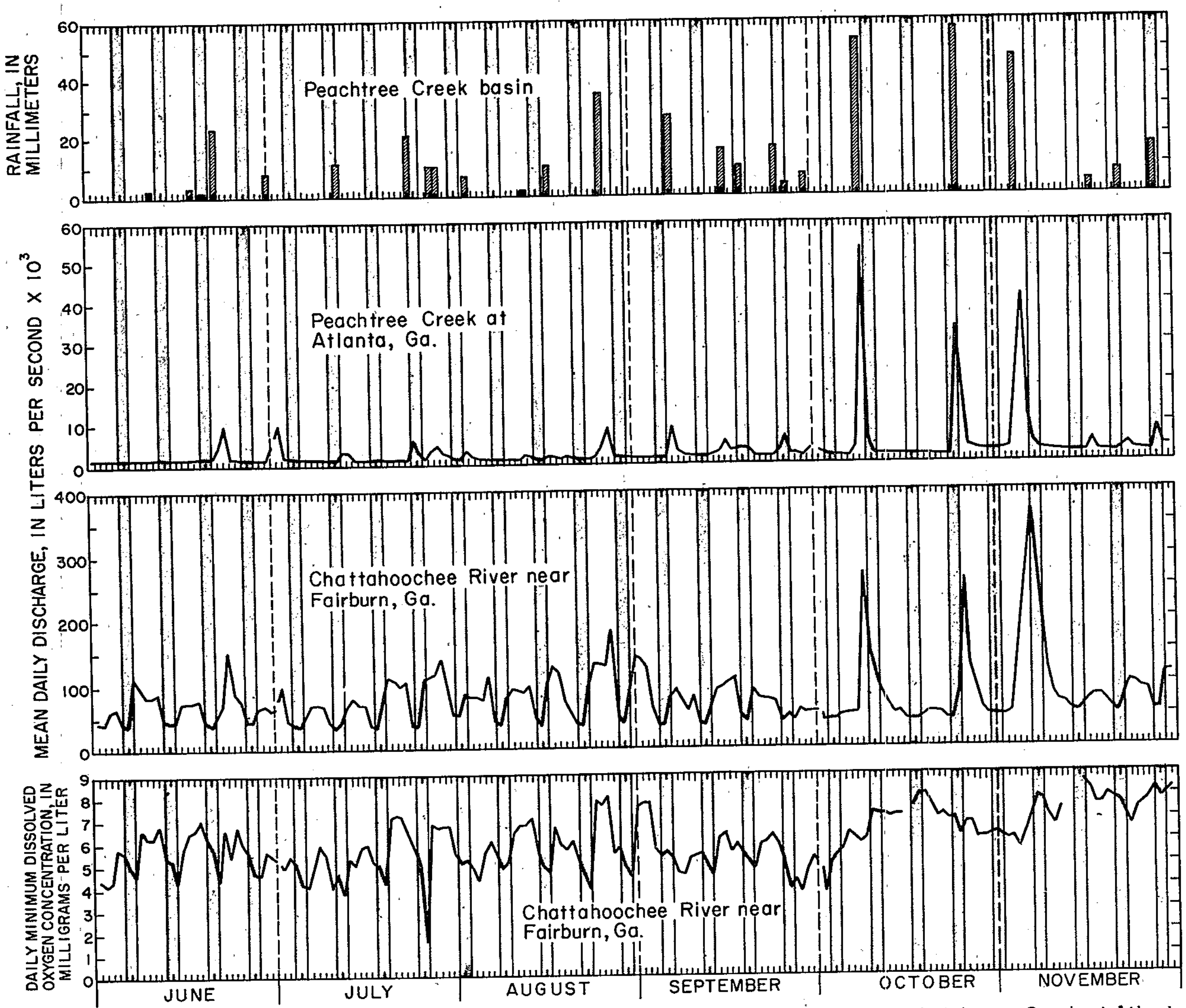

Figure 8.—Daily rainfall in Peachtree Creek basin, mean daily discharge at Peachtree Creek at Atlanta, and mean daily discharge and daily minimum dissolved-oxygen concentration at Chattahoochee River near Fairburn, 1977.

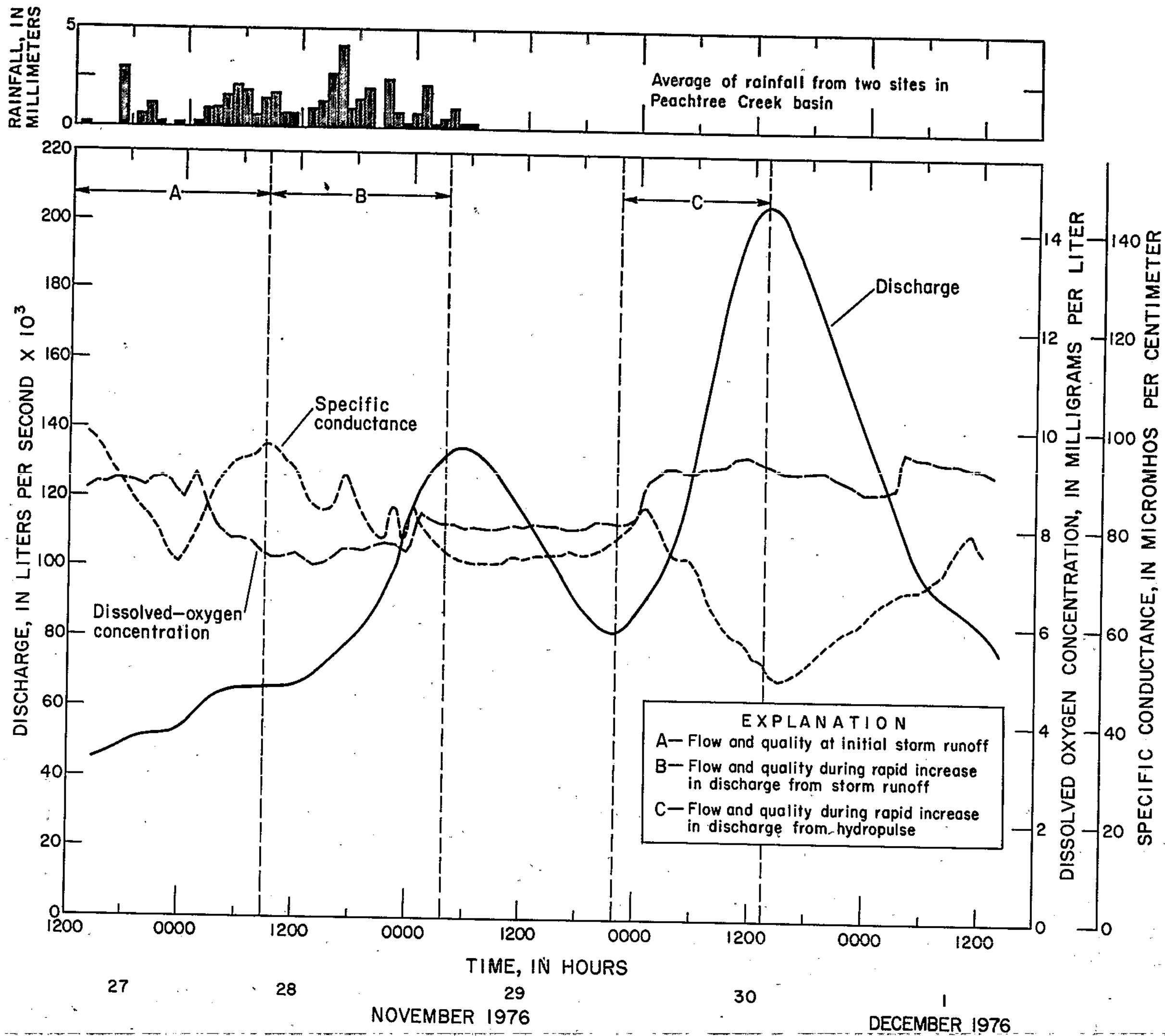

Figure 9.—Impact of stormwater runoff and hydropulse water on specific conductance and dissolved-oxygen concentration at Chattahoochee River near Fairburn, November 27—December 1, 1976.

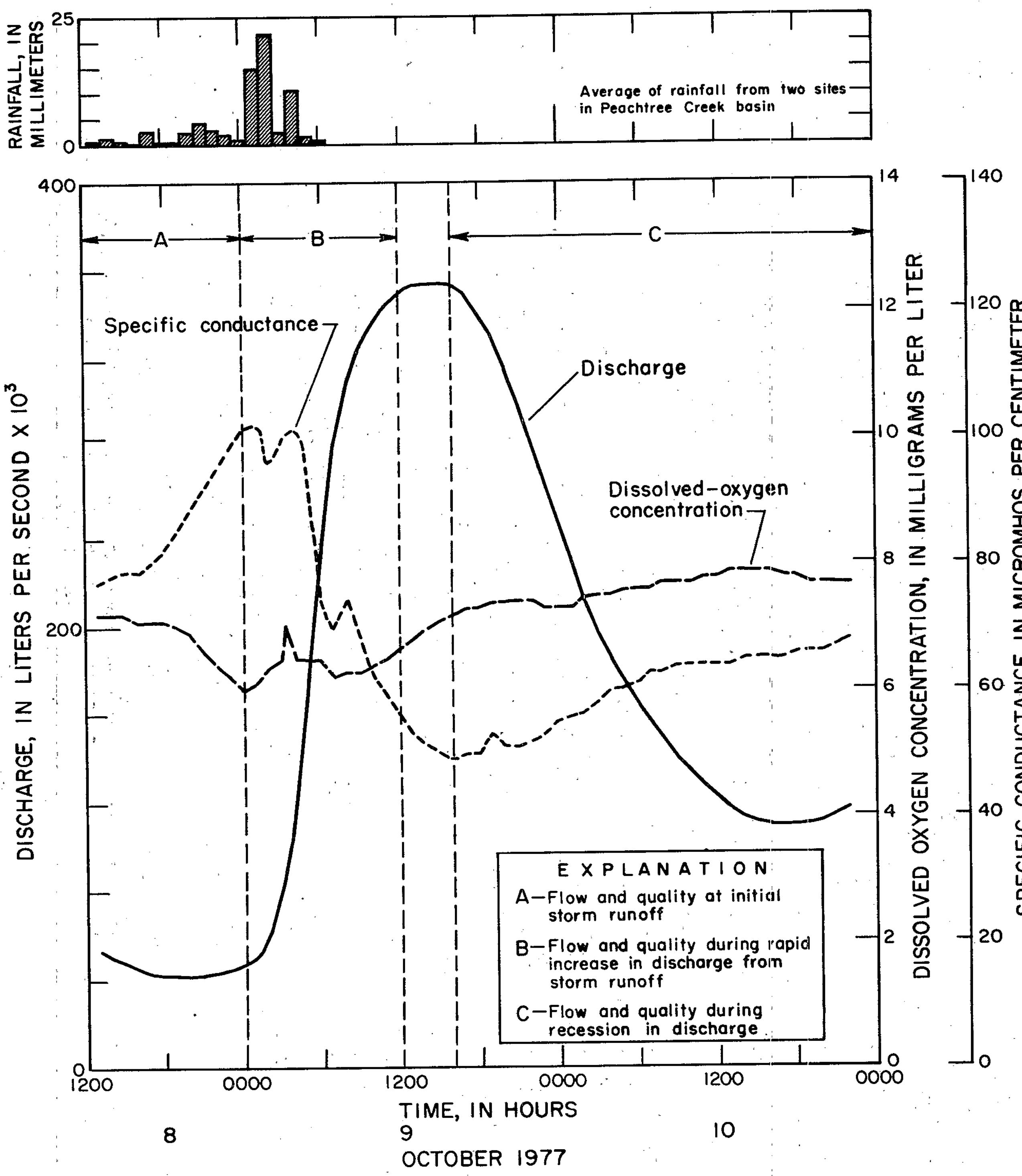

Figure 10.—Impact of stormwater runoff on specific conductance and dissolved-oxygen concentration at Chattahoochee River near Fairburn, October 8—10, 1977.

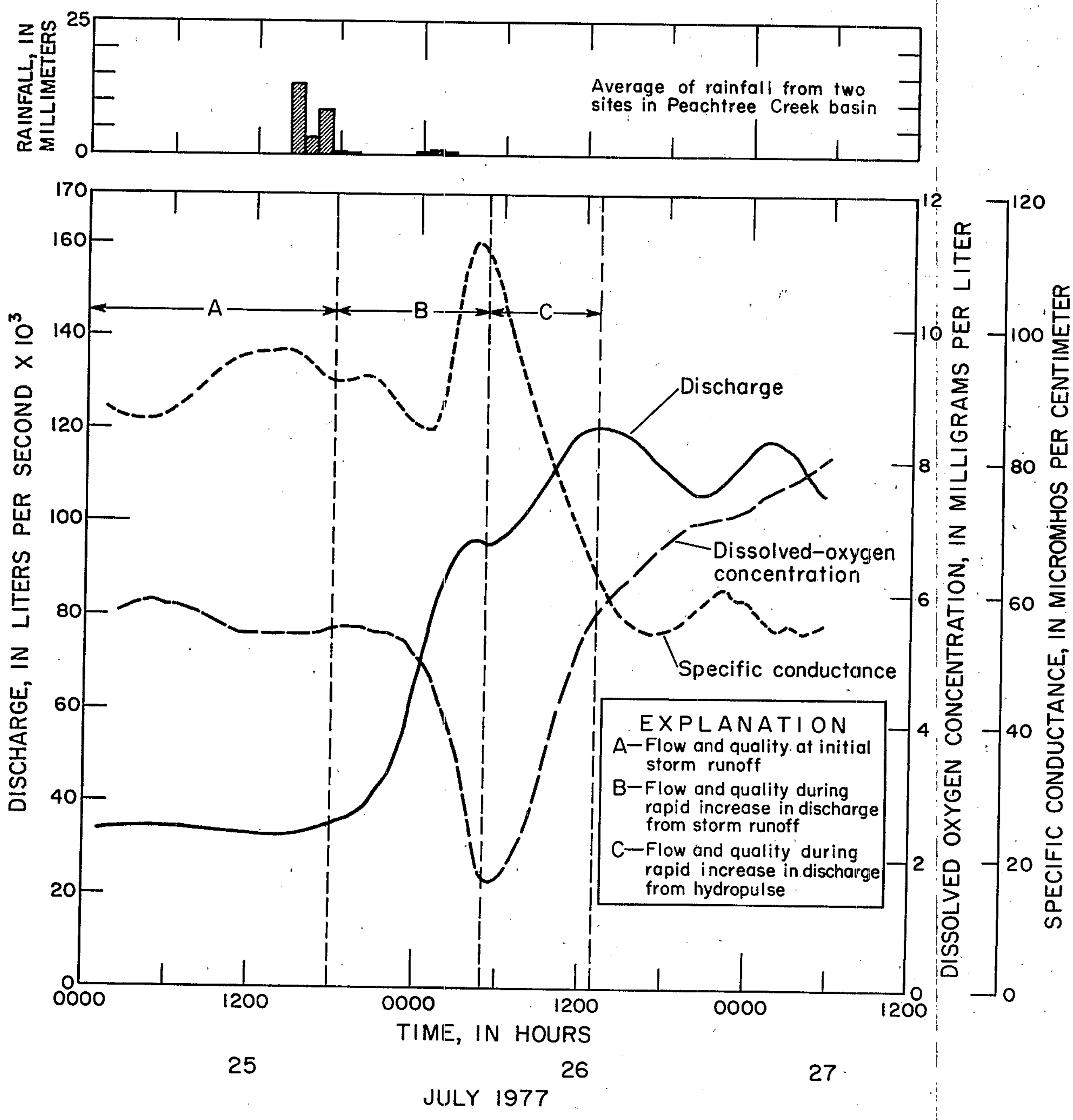

Figure 11.—Impact of stormwater runoff and hydropulse water on specific conductance and dissolved-oxygen concentration at Chattahoochee River near Fairburn, July 25–27, 1977.

pollutant load from the November storm resulted in an initial increase in specific conductance, and about a 1-mg/L decrease in DO as the initial runoff passed the Fairburn site (section A). After the initial runoff, river quality improved somewhat, as indicated by a general decrease in specific conductance and an increase in DO (section B). Once the hydropulse reached Fairburn, the river quality showed further improvement (section C).

Figure 10 shows that the constituent load from the October 8-10, 1977, storm resulted in an initial increase in specific conductance and about a 1-mg/L decrease in DO as the initial runoff passed the monitor site (section A). After the initial runoff, river quality improved, as indicated by a general decrease in specific conductance and an increase in DO (section B). A hydropulse did not occur during the storm-runoff period, but river quality continued to improve during the recession in discharge (section C).

The most substantial changes in quality conditions occurred during the July storm. Figure 11, section A, indicates that the prestorm stream conditions at the Fairburn site were relatively stable. As the pollutant load from Peachtree Creek and other basins passed the Fairburn site, the DO declined about 4 mg/L to a minimum of about 1.6 mg/L (section B). Correspondingly, the specific conductance increased about 30 umhos/cm to a maximum of 114 umhos/cm. In section C the effects of the hydropulse water become apparent, as indicated by a marked increase in DO and a decrease in specific conductance.

At the Fairburn site on the Chattahoochee River, the major effect of pollutant loads from stormwater runoff occurred on the rising limb of the discharge hydrograph, as indicated by a maximum specific conductance and a minimum dissolved-oxygen concentration at this time. River quality improved during the period of discharge recession after peak flow or when hydropulse water reached the Fairburn site.

Data indicate that runoff from thunderstorms that occur in the summer has a much greater impact on dissolved oxygen and specific conductance than runoff from storms in the fall or winter season. Summer storms could produce severe quality conditions in the Chattahoochee River downstream of Atlanta, if the river is at low flow. However, summer regulation of the river normally provides low flows only on weekends. Thus, only about 1.5 days out of 7, or 21 percent of the time, is the Chattahoochee River at a flow that could result in severe degradation of stream quality from stormwater runoff.

REFERENCES

1. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, 1975, Standard Methods for the examination of water and wastewater: (14th ed.), American Public Health Association, Washington, D. C., 1193 p.

2. Black, Crow, and Eidsness, Inc., April 1974, Three river water quality management plan: A report to the city of Atlanta, 360 p.

3. Cherry, R. N., Faye, R. E., Stamer, J. K., and Kleckner, R. L., 1978, Summary report of the intensive river-quality assessment, upper Chattahoochee River basin: U.S. Geological Survey Circular ___ [in press].

4. Fay, R. E., Carey, W. P., Stamer, J. K., and Kleckner, R. L., 1978, Erosion, sediment discharge, and channel morphology in the upper Chattahoochee River Basin, Georgia: U.S. Geological Survey, Open-File Report 78-576, 133 p.

5. Federal water pollution control act amendments of 1972, Public Law 92-500, 92d Congress, S. 2770, October 18, 1972, 89 p.

6. Georgia Department of Natural Resources, Environmental Protection Division, June 28, 1977, Water-use classifications (including trout stream designations) and water quality standards for the surface waters of the State of Georgia, 22 p.

7. Greeson, P. E., Ehlke, T. A., Irwin, G. A., Lium, B. W., and Slack, K. V., 1977, Methods for collection and analysis of aquatic biological and microbiological samples: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A4, 332 p.

8. Holbrook, R. F., Perez, A. I., Turner, B. G., and Miller, H. I., December 1976, Stormwater studies and alternatives in Atlanta: Journal of Environmental Engineering Division, p. 1261-1277.

9. Skougstad, M. W., 1978, Methods for the analysis of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, p. 916-921.

10. Stamer, J. K., Cherry, R. N., Faye, R. E., and Klechner, R. L., 1978, Magnitudes, nature, and effects of point and nonpoint discharges in the Chattahoochee River basin, Atlanta to West Point Dam, Georgia: U.S. Geological Survey Open-File Report 78-577, 105 p.

REFERENCES (continued)

11. U.S. Environmental Protection Agency, April 1977, Sampling and analysis procedures for screening of industrial effluents for priority pollutants: Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 69 p.

12. U.S. Environmental Protection Agency, July 1976, Quality criteria for water: Washington, D. C., 256 p.

13. 1971, Water Quality Office, Storm and combined sewer pollution sources and abatement, Atlanta, Georgia: Black, Crow and Eidsness, Inc., U.S. Environmental Protection Agency Report No. 11024 ELB, 173 p.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/2-80-094	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE IMPACT OF URBAN STORM RUNOFF ON STREAM QUALITY NEAR ATLANTA, GEORGIA		5. REPORT DATE August 1980 (Issuing Date) 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) James B. McConnell		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Geological Survey Water Resources Division Suite B, 6481 Peachtree Industrial Boulevard Doraville, Georgia 30360		10. PROGRAM ELEMENT NO. 35B1C,AP#C611A,SOS#1,TASK 62 11. IAG NO. EPA-IAG-D6-0137
12. SPONSORING AGENCY NAME AND ADDRESS Municipal Environmental Research Laboratory--Cin.,OH Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED Final 10/75 to 10/77 14. SPONSORING AGENCY CODE EPA/600/14
15. SUPPLEMENTARY NOTES Project Officer: John N. English (513) 684-7613		

16. ABSTRACT

The objective of this study was to assess the impact of stormwater runoff from point and nonpoint sources on the water quality of receiving streams in the Atlanta area. Emphasis was placed on the collection of water-quality data in the summer and autumn to determine the impact on streams from runoff produced by thunderstorms during the dry-weather seasons.

Compared to dry-weather flow, stormwater runoff significantly increased the average concentration of suspended sediment, BOD_5, total organic carbon, total ammonia nitrogen, total phosphorus, fecal coliform bacteria, and trace metals in most receiving streams in the Atlanta Metropolitan Area. Stormwater runoff increased the mean concentration of most constituents 2- to 5-fold. In most streams, the dissolved-oxygen concentrations generally increased to near saturation during periods of stormwater runoff.

The dissolved-oxygen concentration in the Chattahoochee River near Fairburn during a period of low flow reached a low of 1.5 milligrams per liter (a 4-milligram per liter decrease) as a result of runoff from a July thunderstorm. However, low flow during the summer and autumn occurs only about 21 percent of the time due to flow regulation of the river. The flushing and dilution effect of water released for power generation caused a significant improvement in Chattahoochee River quality most of the time.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
*Dissolved oxygen Surface-water runoff Combined sewers Water pollution Nutrients *Water quality Pesticides	Rainfall Urban runoff Trace organics Trihalomethanes	13 B

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release to public	Unclassified	64
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980--657-165/0129

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Postage and
Fees Paid
Environmental
Protection
Agency
EPA-335

Official Business
Penalty for Private Use, $300

Special Fourth-Class Rate
Book

Please make all necessary changes on the above label, detach or copy, and return to the address in the upper left-hand corner.

If you do not wish to receive these reports CHECK HERE □; detach, or copy this cover, and return to the address in the upper left-hand corner.

EPA-600/2-80-094