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PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BLACK CREEK WATERSHED
BULLOCH COUNTY, GEORGIA

AUGUST 1977

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
SURVEILLANCE AND ANALYSIS DIVISION
ATHENS, GEORGIA

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BLACK CREEK WATERSHED
BULLOCH COUNTY, GEORGIA

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INTRODUCTION

The U. S. Department of Agriculture, Soil Conservation Service (SCS), plans to construct a multipurpose impoundment in southeastern Georgia near the city of Statesboro. At the request of and in support of SCS, water quality studies were performed in the drainage basin of the proposed impoundment by personnel of the U. S. Environmental Protection Agency, Region IV, Surveillance and Analysis Division (SAD). The studies were conducted under a cooperative, cost reimbursable agreement between SAD and SCS (see Appendix A).

PURPOSE AND AUTHORITY

These studies were conducted to:

(1) Determine and record preimpoundment water quality conditions within the drainage basin of the proposed impoundment;

(2) Provide a basis for predicting the quality of the impounded waters upon completion of the project;

(3) Provide data for the calibration and verification of the Hydrocomp Simulation Programming (HSP) model, which could possibly be used to predict future water quality in other proposed impoundments. (It was anticipated that these predictions could then be made with a minimal amount of additional data for model calibration and only for impoundments in areas with similar climate, soil type and land usage. Local variations however, proved too great to make this a reliable procedure.)

Authority for these studies is section 104(b)(6) of the Federal Water Pollution Control Act Amendments of 1972 (PL92-500).

SUMMARY

GENERAL

The proposed Little Black Creek Impoundment will be located in a primarily rural agricultural section of southeast Georgia. The multipurpose impoundment will have a normal pool area of 300 acres and a 9,895 acre drainage basin. Waste load input can be attributed to natural conditions, agricultural and animal husbandry practices, a small domestic waste source, and possibly polluted ground water.

Six routine water quality sampling stations were established on Little Black Creek and its tributaries. (See foldout map in Appendix E-1 for locations.) Daily samples for physical, chemical, and bacteriological analyses were collected for five days each during May and August, 1974 at all flowing stations. Diurnal studies were conducted at one station during November, 1974 and January, 1975.

A river stage recorder was installed at the farthest downstream station. From this data and also from a recording rain gauge, complete river discharge and precipitation plots were prepared for the entire study period.

A variety of recording climatological equipment was utilized during the study period. Data from this equipment, five years of historical climatological and hydrological data, and the chemical, physical, and bacteriological data resulting from this study were computer-coded for calibration of the HSP model.

STUDY FINDINGS

The following discussions of "Ranges of Data" and "High Values and Monthly Means" are based on comparisons between May and August, 1974. These two periods represent major differences in both the hydrologic and agricultural cycles, emphasizing data differences caused by variations in either cycle.

May was a relatively dry month. However, intensive rainfall fell on freshly tilled and fertilized fields the day before the sampling program started. Although rainfall during August was typically much higher than in May, it fell on "crusted over" fields which were covered by full grown plants or harvest residue.

Ranges* of Data

Chemical Parameters

Dissolved oxygen was generally low, although a few high values were measured occasionally. All data (from individual samples) ranged from 1.5 to 7.1 mg/l in May and 2.2 to 5.2 mg/l in August. Station means were noticeably higher in May. Station mean values ranged from 2.1 to 6.1 mg/l in May and from 2.4 to 4.5 mg/l in August.

All values for five-day biochemical oxygen demand ranged from 1.0 to 5.5 mg/l in May and 0.9 to 3.6 mg/l in August. Station means ranged from 1.6 to 3.5 mg/g in May and from 1.3 to 3.2 mg/l in August. Typical values for slow flowing swamp streams are 2.0 to 3.0 mg/l.

Nutrient concentrations (nitrogen and phosphorus species) varied during the May and August sampling periods. The following paragraphs examine the individual nutrient parameters on the basis of ranges of individual sample datum and ranges of station means. Except for a few isolated cases in May, all nitrate plus nitrite nitrogen concentrations were below detectable limits.

The ranges of all data and the ranges of station means remained fairly constant during both May and August for organic nitrogen (Org-N) and total Kjeldahl nitrogen (TKN). The following table shows these comparisons.

---

*Monthly data were compared on the basis of (1) monthly ranges of all data (from each individual sample) for the entire drainage basin and (2) monthly ranges of the station means for six stations. The monthly means are for all values at a given station.

Parameter	Range of All Data (mg/l)		Range of Station Means (mg/l)	
	May	August	May	August
Org-N	0.10-0.78	0.18-0.85	0.18-0.53	0.25-0.57
TKN	0.19-0.94	0.22-0.90	0.23-0.62	0.25-0.64

For ammonia nitrogen (NH_3-N) and total phosphorus (Total-P), the ranges of all data during August were nearly double those for May. The range of station means for NH_3-N was nearly the same for both months while the range of station means for Total-P was noticably higher in August. The following table shows these comparisons.

Parameter	Range of All Data (mg/l)		Range of Station Means (mg/l)	
	May	August	May	August
NH_3-N	0.01-0.28	0.01-0.47	0.03-0.14	0.04-0.13
Total-P	0.01-0.28	0.01-0.47	0.01-0.23	0.01-0.35

For total organic carbon, the range of all data during May was from 9 to 11 mg/l as compared to an August range of from 7 to 33 mg/l. Station means for May ranged from 9.6 to 16.5 mg/l while those for August ranged from 10.0 to 26.4 mg/l

Bacteriological Parameters

Ranges for fecal coliform densities were high and variable during both months. Some densities were slightly higher in August (110-7,600 fecal coliforms/100 ml compared to 10-8,400 fecal coliforms/100 ml). The range of station means was much higher in May (236-4,700 fecal coliforms/100 ml compared to 59-1,400 fecal coliforms/100 ml). No Salmonella bacteria were detected at either of the two stations sampled during May and no Salmonella determinations were performed in August.

Physical Parameters

Water temperature ranges reflected seasonal air temperature variations. Ranges of all data for May and August, respectively, were 18 to 22°C and 21 to 26°C.

Ranges of station means were 20.1 to 21.5°C and 21.8 to 24.0°C for May and August, respectively.

Dissolved solids values were variable during both comparison periods. All values ranged from 24 to 84 mg/l in May and from 8 to 307 mg/l in August. Station means ranged from 46 to 57 mg/l in May and from 59 to 152 mg/l in August.

Low suspended solids values indicate that very little sediment is washed from the flat sandy fields to the streams. All values for May ranged from 4 to 28 mg/l while the August range was from 3 to 22 mg/l. Station means during May ranged from 5.5 to 12.4 mg/l while the August range was from 6.3 to 11.5 mg/l.

Low pH values encountered during this study are typical for coastal plains streams in this part of the country. All values for May ranged from 5.3 to 6.2 units while those for August ranged from 4.1 to 5.9 units. Although mean pH is a questionable parameter, it is included here for comparison purposes. Station means ranged from 5.5 to 6.1 units in May and from 4.8 to 5.6 units in August.

High Values and Monthly Means

High May values for most pollutional parameters occurred at Station BC-2. August high values for BOD_5, Org-N, TKN, and Total-P occurred at Station BC-5. High values for other parameters (lows for D.O.) occurred at a variety of stations. The highest fecal coliform densities during both months occurred at Station BC-2.

Slightly higher monthly mean values for water temperature and Total-P occurred during August, and for S.S., pH, BOD_5, and NH_3-N during May. Monthly mean D.O. values were the same during both months. Much higher monthly mean values for D.S., Org-N, TKN, and TOC occurred in August, and for fecal coliform densities during May.

Much of this apparent data inconsistency is clarified through consideration of the hydrogeological characteristics of area, precipitation-hydrograph plots for the study period, local farming practices and possible nutrient sources and pathways.

Problem Areas

A combination of elevated nutrients, TOC and higher BOD_5 values resulted in lowered D.O. values. The major input of nutrients, TOC and BOD_5 for the entire drainage basin probably results from forest litter and fertilizer washout. Although it is not economically feasible to control the input from forest litter, the impact of fertilizer washout can be greatly reduced by good management practices. Minor but significant controllable sources were identified in the BC-6, BC-3, BC-2 and BC-1 sub-basin. Possible causes and solutions regarding these problems are offered in the body of this report.

Supplimental Oxygen Requirements

A possible but expensive solution to satisfaction of the oxygen deficit in the proposed impoundment would involve a diffuser system supplied with molecular oxygen. The minimum yearly cost for this would be $3,700 for oxygen, plus the capital cost of an oxygen storage and diffuser system in addition to operating and maintenance cost.

Hydrocomp Predictions

Postimpoundment water quality was predicted by the Hydrocomp Simulation Programming Model. The predicted water quality was compared to Georgia water quality standards. The model predicted that discharge waters from the impoundment would not meet state standards for dissolved oxygen.

Long Term BOD

During May, a long term BOD analysis was performed for Station BC-1 to determine rate coefficients for mathematical modeling efforts. This anlaysis yielded typical rate coefficients (see discussion of STUDY FINDINGS for values).

Time of Travel Studies

A dye tracer study was attempted during May. Extended time of travel caused by low flow conditions made this attempt unsuccessful. The study was repeated in August, under both high and medium flow conditions, with the following discharge averages and corresponding stream velocity averages: 25.6 cubic feet/sec. 0.16 mph; 4.8 cubic feet/sec. - 0.08 mph.

Diurnal Studies

These studies (November 1974 and January 1975) revealed no significant variations.

Assessment of Potential Non-Point Source Loads

A gross non-point source assessment (see Appendix C) established potential loads for typical conditions and evaluated the attenuation effects of control practices. Results of this assessment are too voluminous to present in summarized form.

CONCLUSIONS

(1) A dissolved oxygen deficiency will exist in the proposed impoundment.

(2) Supplemental aeration in the impoundment or other corrective action will be required to correct the oxygen deficiency.

(3) The dissolved oxygen deficiency will result from an oxygen demand exerted by the unoxidized nutrients (ammonia-N and organic-N).

(4) The major nutrient inputs into the proposed impoundment will result from forest and pasture litter and from fertilizer washout. Runoff from confined animal feeding operations, discharge from a small domestic oxidation pond and from polluted groundwater entering the upper end of the drainage basin will contribute to minor but still significant inputs.

(5) Most of the minor inputs can be partially eliminated by improved waste handling practices, thus reducing the supplemental aeration requirements.

(6) The degree of eutrophication experienced by this impoundment will depend on control of nutrient sources. This control includes the capacity of intermittant swampy areas upstream of the impoundment to assimilate nutrients. The quantitative aspects of such a capacity are not clearly understood. Qualitative aspects, however, are reflected by the data within this report.

(7) The high fecal coliform densities encountered represent stormwater runoff under free flowing stream conditions. After project completion, retention time in the impoundment should cause decreases in fecal coliform densities. These decreases should be sufficient to make the waters acceptable for body contact recreation. However, isolated shoreline areas which receive direct washoff from nearby animal waste sources still might not be acceptable for body contact recreation.

RECOMMENDATIONS

(1) Provide supplemental aeration in the proposed impoundment.

(2) Reduce nutrient inputs into the proposed impoundment by encouraging:

(a) Connection of all homes in the Statesboro, Georgia area to an expanding sewerage system (discharging into another drainage basin) which would eliminate septic tank usage upstream of the proposed impoundment;

(b) local farmers to contain and treat runoff from confined animal feeding operations;

(c) local farmers to avoid possible over application of chemical fertilizer, and

(d) upgrading of treatment at the mobile home park oxidation pond by the addition of mechanical aerators or complete elimination of the pond by connection with the Statesboro, Georgia municipal sewerage system.

(3) Initially, primary contact recreation in the impoundment, should be restricted, especially during heavy runoff periods. Further fecal coliform monitoring should be conducted after the impoundment has stabilized. The repeated absence of high fecal coliform densities would warrant a removal of this restriction.

STUDY METHODS

Six routine water quality sampling stations were established on Little Black Creek and its tributaries. The stations were located from the proposed dam site near the small community of Denmark, Georgia to its headwaters near Statesboro, Georgia. These locations are described in Appendix D and shown on the foldout map in Appendix E-1. The general location of the study area is shown on the map in Appendix E-2.

A stage recorder and staff gauge were installed and cross referenced at Station BC-1. Staff gauges were installed at all other stations except BC-2, where stream channel characteristics precluded stream gaugings. Initial stream gaugings were performed prior to initiation of the sampling program at each station except BC-2. Due to vandalism, it was impossible to maintain a staff gauge at BC-5. A wide crested, rectangular weir at a pond discharge immediately upstream of this station was utilized to approximate flow for this station.

All stations were sampled from bridges at one foot below the surface or less, as dictated by stream depth. Stream surface elevations, as indicated by staff gauge readings, (or depth of discharge over the weir at Station BC-5) were recorded each time a sample was collected. Daily samples for physical, chemical, and bacteriological analyses were collected for five days each during May and August, 1974 at all flowing stations. Some non-flowing stations were sampled during the first part of the May sampling period. All stations were not sampled during the November 1974 and January 1975 visits. (See Table 1 for a complete sampling schedule.)

Measurements and analyses of samples for the physical and chemical parameters were performed either immediately upon collection at the sampling site, within a few hours of collection at the SAD mobile laboratory in Claxton, Georgia, or at the SAD Regional Laboratory in Athens, Georgia. The parameter coverage and location of analysis are presented in Table 2.

TABLE 1

SAMPLING SCHEDULE

Station Number	Month and Day															
	May, 1974					August, 1974					November, 1974			January, 1975		
BC-1	13	14	15	16	17	7	8	15	29	30	18	20	21	13	14	25
BC-2	13	14	15	16	17	7	8	15	29	30	N/V	N/V	N/V	13	14	25
BC-2A	N/V	14	N/V	N/V	N/F	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V
BC-3	13	14	15	16	N/F	7	N/V	15	29	30	18	N/V	N/V	N/V	N/V	25
BC-3A	N/V	14	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V	N/V
BC-4	13	14	N/F	N/F	N/V	7	N/V	15	29	30	N/F	N/V	N/V	N/V	N/V	25
BC-5	N/V	14	N/F	N/F	N/V	N/V	8	15	29	30	N/V	N/V	N/V	N/V	14	N/V
BC-6	N/V	14	15	16	17	N/V	N/V	15	29	30	N/V	N/V	N/V	N/V	14	N/V

Key: # = Day of month
N/F = No flow, not sampled
N/V = Not visited
___ = Sampled under zero flow conditions

TABLE 2

LOCATION WHERE ANALYSES WERE CONDUCTED

A. On-Site

1. Dissolved oxygen
2. pH
3. Temperature (degrees centigrade)
4. Flow

B. Mobile Laboratory (SAD Laboratory, Athens, GA, after 8/30/74)

1. Biochemical oxygen demand (5 day)
2. Bacteriological-fecal coliform (MF Procedure)

C. SAD Laboratory, Athens, Georgia

1. Total phosphate
2. Total Kjeldahl nitrogen (TKN)
3. Ammonia nitrogen (NH_3-N)
4. Organic nitrogen (TKN minus NH_3-N)
5. Nitrate and nitrite nitrogen
6. Total dissolved solids
7. Suspended solids
8. Total organic carbon
9. Long term BOD

Bacteriological samples were also collected at a depth of approximately one foot or less, as dictated by stream depth using a grab technique. Samples were placed on ice and analyses were initiated within six hours after collection.

Fecal coliform densities were determined using the membrane filter technique as outlined in Standard Methods for the Examination of Water and Wastewater, 13th Edition.[1*]

Qualitative determinations for the presence of Salmonella bacteria were attempted at selected stations by filtering 200 ml of sample through a 0.45μ membrane filter. The filters were then placed in single strength Dulcitol Selenite Broth. The inoculated enrichment broth was incubated for 18 to 24 hours at 41.5°C according to Spino's procedure.[2]

After primary enrichment, an inoculum was streaked onto Taylor XLD Agar(XLD) and Hektoen Enteric Agar (HE) plates and incubated for 18-24 hours. Suspected Salmonella colonies were picked from the respective plates and identified by the scheme outlined in Table 3.

With the exception of the cytochrome oxidase and lysine decarboxylase methods, the methods and media outlined in Table 3 are described by Ewing.[3] Oxidase and decarboxylase activity was determined using Patho-Tec-CO and Patho-Tec-LD** reagent impregnated paper strips, respectively.

Serological identifications of suspected Salmonella isolates were made at the SAD-Athens laboratory using the standard serological procedures descrbied by Edwards and Ewing.[4]

During the May and August study periods, attempts were made at gauging stream discharges at a variety of different stream levels at all stations with staff

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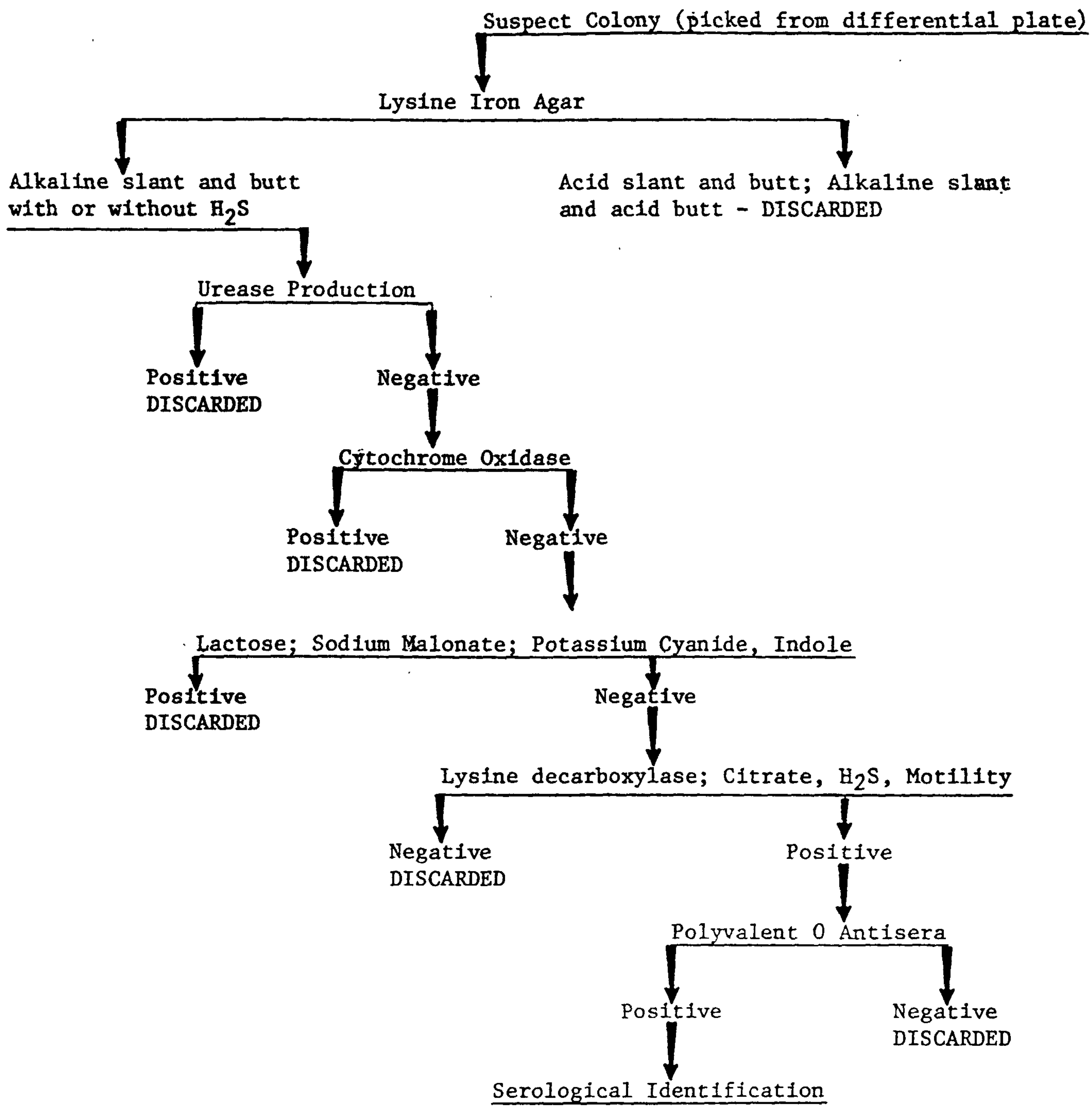
* References 1 through 29 appear on pages 73 and 74.

** Does not imply endorsement of this product by EPA.

TABLE 3

IDENTIFICATION SCHEME FOR SALMONELLA SUSPECTS



gauges. This was done in order to prepare stage-discharge curves for each station. From these curves and the individual staff gauge readings acquired during daily sampling visits, corresponding discharge data were obtained for most samples. For Station BC-5, rectangular weir tables were utilized.[5]

Recording climatological equipment, listed below with the indicated data collection function(s), was installed at the indicated locations in support of both the sampling program outlined in Table 1 and for calibration of the Hydrocomp Simulation Programming (HSP) model.

Equipment	Data Collection Function	Location*
Rain Gauge	Precipitation	Akin's Farm and Powell's house
Pyrheliograph	Incident solar radiation	Sapp's Farm**
Hygrothermograph	Air temperature and relative humidity	Sapp's Farm**
Evaporation Pan and Level Recorder	Rate of evaporation	Sapp's Farm**

Figure 1 is a graphical representation of the data obtained from the stage recorder at Station BC-1 and the rain gauge at the upper end of the drainage basin.

As additional support for calibration of the HSP model, five years of historical climatological[6] and hydrological[7] data were tabulated and computer coded for the indicated locations:

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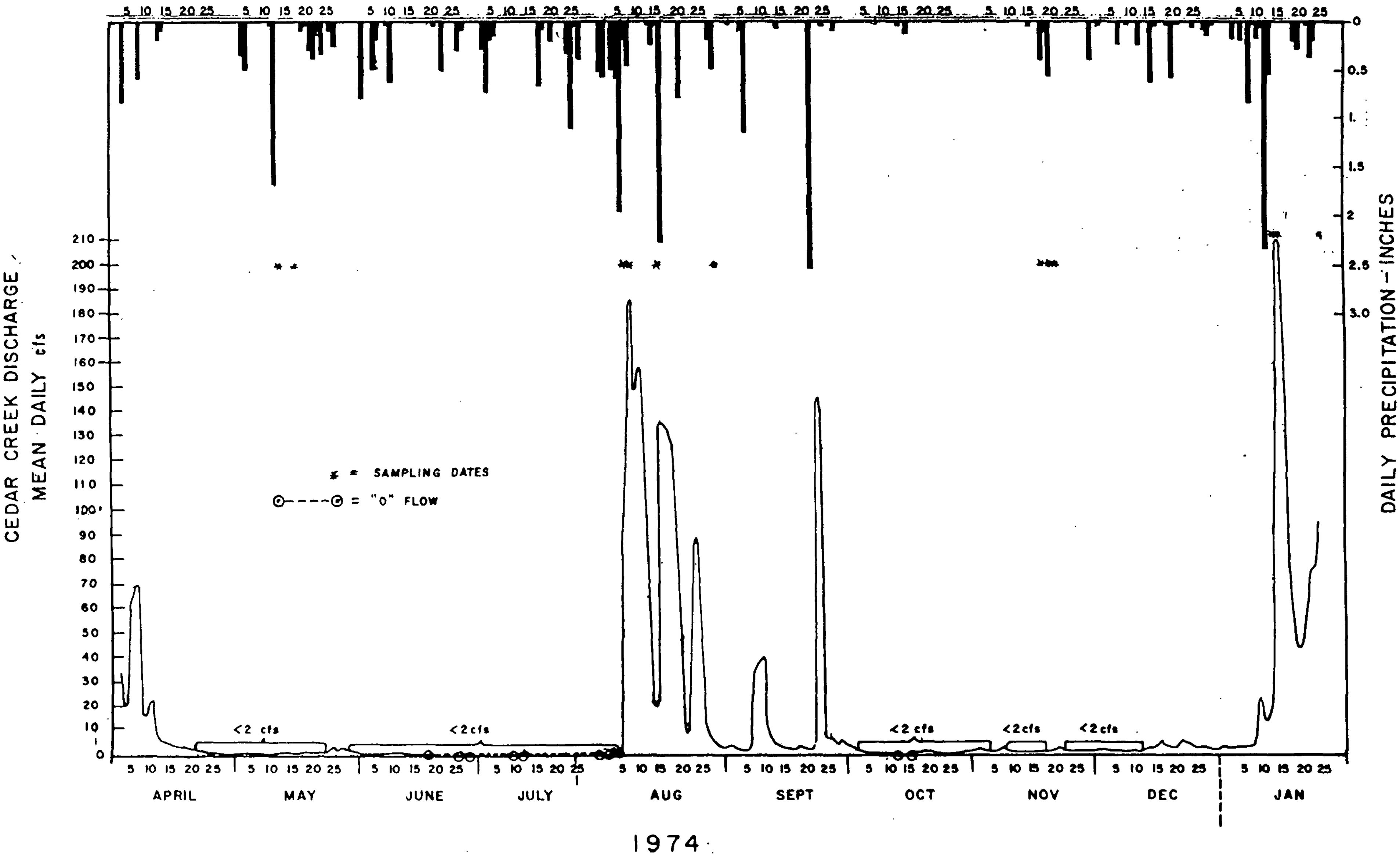
* Refer to Appendix E-1 for exact locations.

** Equipment installed at this site was utilized for two preimpoundment studies conducted concurrently. Refer to Appendix E-2 for exact location.

FIGURE 1
ANUAL PRECIPITATION
AND HYDROGRAPHS



Parameter	Location (Georgia)
Precipitation	Bellville Brooklet Metter Swainsboro
Maximum and Minimum Air Temperature	Metter Brooklet
Evaporation Rate	Ailey
Wind Speed	Savannah
Percent Cloud Cover	Augusta
Discharge (avg. daily cfs)	Canoochee River near Claxton

DESCRIPTION OF STUDY AREA

The heart of Black Creek Watershed project is the proposed impoundment on Little Black Creek. The Little Black Creek drainage basin is located on the gently rolling Pleistocene shoreline of the Altanama Upland Division of the coastal plain near Statesboro in southeast Georgia. Both the impoundment and it's 9,895 acre drainage basin are located entirely in Bulloch County. The impoundment will cover 300 acres at normal (irrigation) pool level. Of these 300 acres, 241 acres will be available for recreation usage. Maximum flood storage pool will be 485 acres.

Land usage is 32.5% cropland, 13.4% pasture, 47.7% forest, and 6.5% idle or miscellaneous. Only a few concentrated sources of pollution exist; these consist primarily of runoff from cattle pastures, swine feedlots, and layer hen operations. Natural conditions and agricultural practices create three possible non-point sources of pollution:

(1) Stormwater and possibly irrigation runoff from a land surface characterized by dendritic drainage patterns;

(2) Subsurface discharge into stream channels from both the shallow groundwater table and interflow, and

(3) Benthic decomposition of forest, pasture, and cropland litter deposited in the streams, and from both living and dead bottom-dwelling organisms.

Land elevation in the study area ranges from approximately 110 to 230 feet above mean sea level (MSL). Normal surface elevation of the impoundment will be 131 feet MSL and maximum surface elevation will be 142.7 feet MSL.

SCS classifies different areas as to soil associations,[9] which are landscapes with a distinctive proportional pattern of different soils. They normally consist of one or more major soils and at least one minor soil, and are classified according to the major soils.

The Little Black Creek drainage basin is located in a portion of Bulloch County which, according to the above classification scheme, is part of the Tifton-Fuquay-Pelham Association.[9] This association averages 35% Tifton, 25% Fuquay, 15% Pelham, and 25% minor sorts. Table 4 lists the characteristics of the different soil types.

The soil type percentages in the Little Black Creek drainage basin vary markedly from the overall association averages. When the drainage basin is divided into six areas (see foldout map in Appendix E-1), much more variability as to percentage soil type in a given area is apparent. The estimated percentages of soil types for each of the six areas are presented in the following table.

	Soil Type			
Area	Tifton	Fuquay	Pelham	Minor
BC-1	25	23	10	42
BC-2	35	15	15	35
BC-3	50	10	24	16
BC-4	50	3	15	32
BC-5	45	5	20	30
BC-6	69	3	15	13

According to the hydrographical analysis terminology of Thorn,[10] Figures 2, 3 and 4 are good examples of the three basic components of river flow which include: (1) base (groundwater) flow, (2) runoff (stormwater) flow, and (3) interflow.* All three figures show the rapidly changing runoff flow as temporary

*Interflow is that portion of precipitation which falls in the catchment basin and reaches the streams independently of either surface runoff or groundwater discharge. It percolates through the soil and moves laterally toward the stream without reaching the groundwater table. The rate of this movement is intermediate between surface runoff and groundwater discharge and is governed by the slope of the terrain and porosity of the soil.

TABLE 4

SOIL CHARACTERISTICS OF THE
LITTLE BLACK CREEK DRAINAGE BASIN

Soil Type	% of Drainage Basin	Water Table Depth	Water Table Time Span	Soil Description U.S.D.A. Texture	Soil Description Depth From Surface	pH Range
Tifton	44	>48"	--	Loamy Sand Sandy Clay Loam	0-14" 14-16"	4.5-5.5
Fuquay	10	>60"	--	Loamy Sand Sandy Clay Loam	0-30" 30-70"	4.5-5.0
Pelham	17	<15"	2 mos/yr*	Loamy Sand Sandy Clay Loam	0-21" 21-62"	4.5-5.0
Minor Soils	4	Approx. 30"	Prolonged Wet Periods	Sandy Loam Sandy Clay Loam	0-22" 22-65"	4.5-5.0
	10	15-30"	2-6 mos/yr	Sand & Loamy Sand Sandy Clay Loam Clay Loam	0-40" 10-62" 48-65"	4.5-5.0
	15	<15	>6 mos/yr*	Loamy Sand Sandy Clay Loam	0-21" 21-62"	4.5-5.0

* Water stands on surface 2 to 6 months per year.

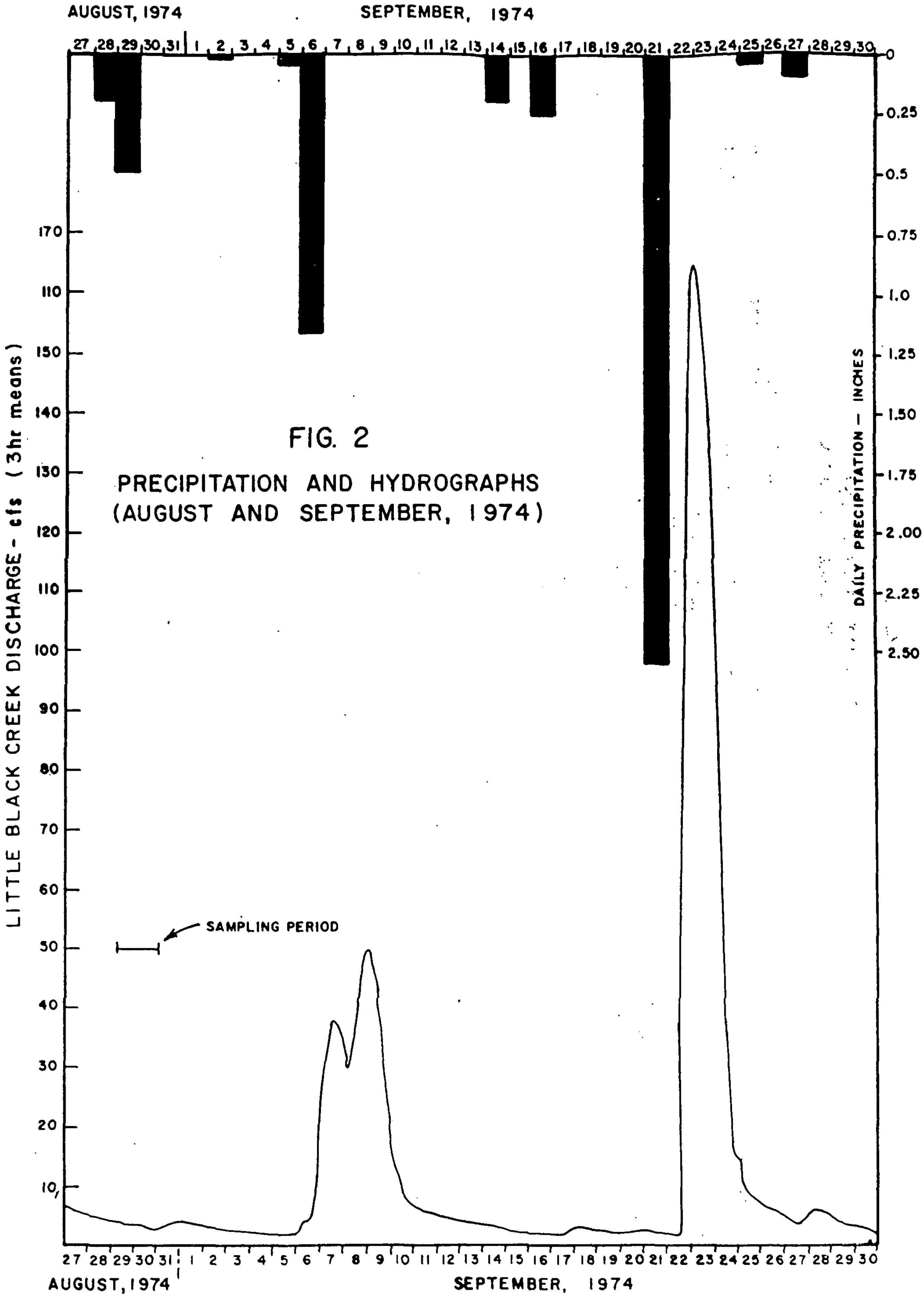


FIG. 2

PRECIPITATION AND HYDROGRAPHS (AUGUST AND SEPTEMBER, 1974)

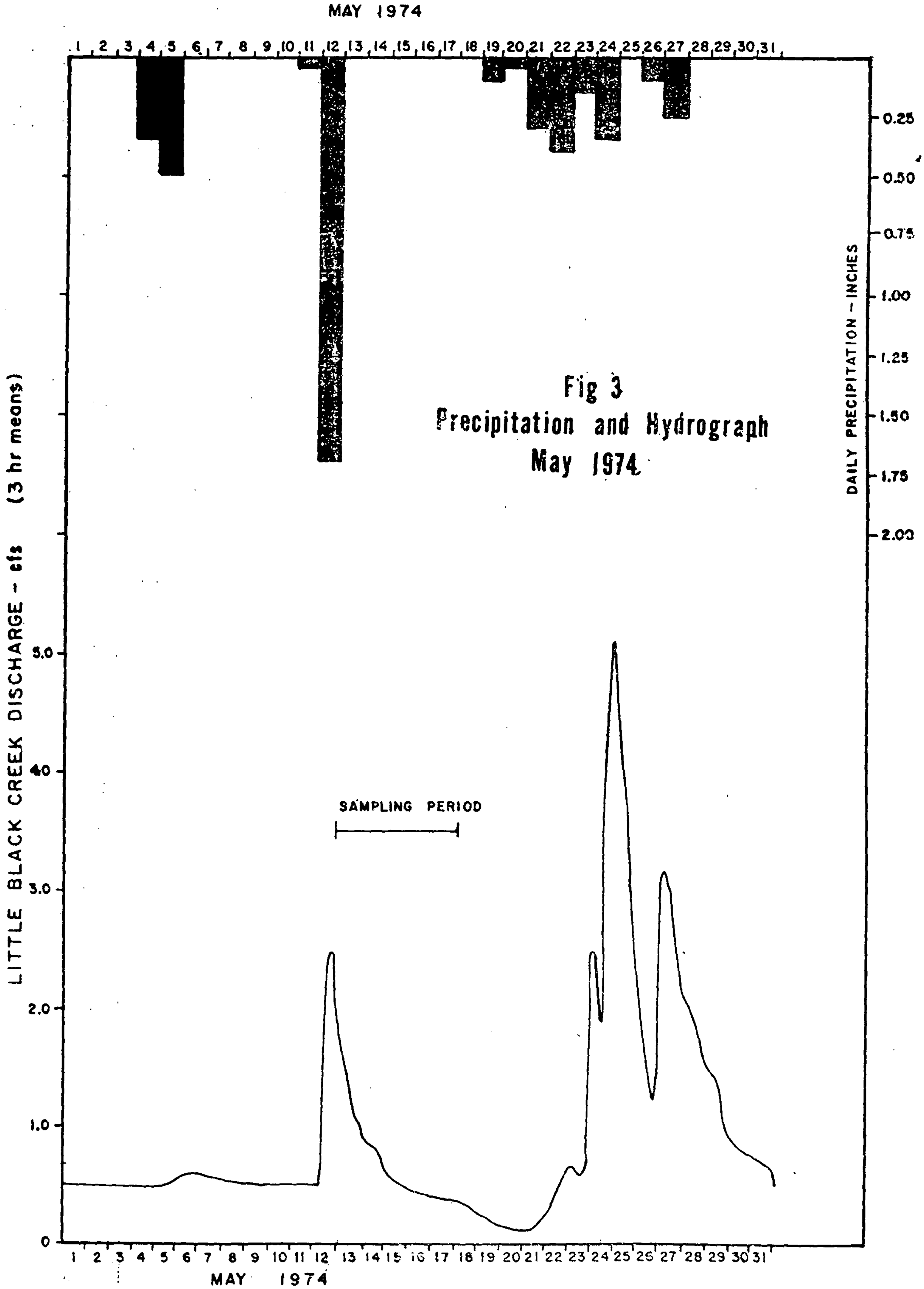


Fig 3
Precipitation and Hydrograph
May 1974

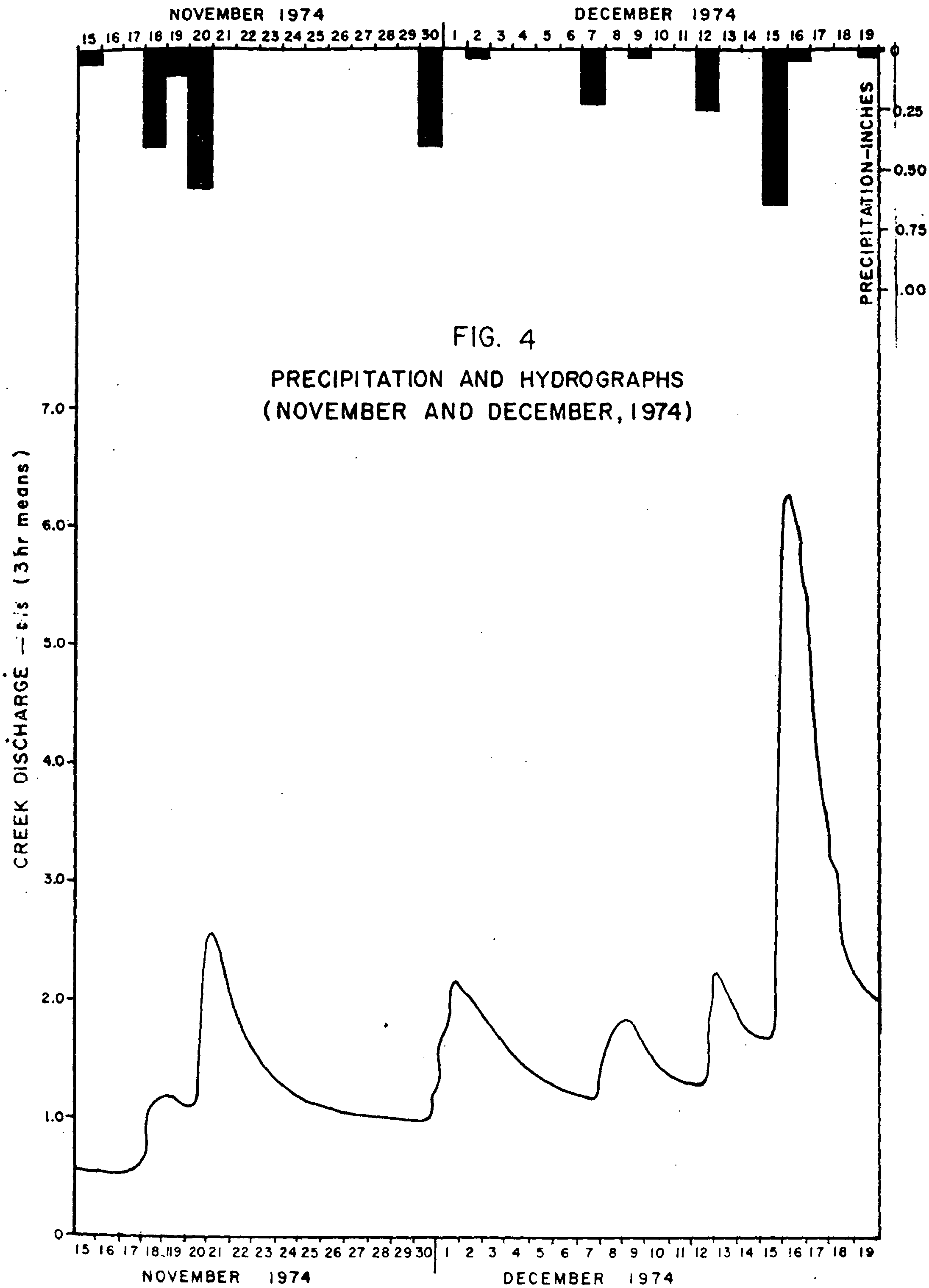


FIG. 4

PRECIPITATION AND HYDROGRAPHS
(NOVEMBER AND DECEMBER, 1974)

fluctuations of the more slowly changing base flow. Figures 3 and 4, due to their smaller scales, demonstrate the influence of interflow by the long trailing edges of each hydrographic maxima.

During wet portions of the year, the water table in this area is near the surface, causing soil moisture values to approach saturation. At these times, even small amounts of rainfall cause immediate runoff (either surface or subsurface) plus corresponding but slower increases in stream flow.

After extended dry periods, the water table is lowered sufficiently to cause the smaller tributaries to become dry. The sandy soil becomes very dry and capable of absorbing large quantities of rainfall without corresponding increases in runoff and stream flow.

As an example of wet period flow, a 1.28 inch rainfall on August 5-6 caused a stream flow increase of 48 cfs (Figure 2). During the dry periods of May 11-12 (Figure 3) and November 18-20 (Figure 4) rainfalls of 1.75 and 1.09 inches respectively, caused stream flow increases of approximately 2 cfs each. Figures 2, 3 and 4 are expansions of sections of Figure 1

Due to the small size of this drainage basin (9,895 acres), each stream flow increase is of a "flash flood" nature and appears to travel down the basin as a wave. The hydrographs on Figures 2, 3 and 4 are all examples of this phenomenon.

STUDY FINDINGS

RANGES OF DATA

General

Under low stream-flow conditions which prevailed during May, high values for most parameters (lows for dissolved oxygen) usually occurred at Station BC-2. During August under high flow conditions most extreme values occurred at Stations BC-4, BC-5 and BC-6. Analysis of the data (Table 5) included two modes of comparison; (1) ranges of all data for the drainage basin and (2) monthly ranges of station means for six stations. Only data for May and August, 1974 were included; data for samples which were collected under zero flow conditions were excluded. Data collected in November, 1974 and January, 1975 were only from a few selected stations. The following discussion is based on the analysis presented in Table 5 and the complete listing of analytical data presented in Appendix B.

Physical Parameters

Water temperature ranges reflect seasonal air temperatures. Exclusion of data from Station BC-5* lowers the maximum August value to 24°C and the high station mean for August to 22.8°C.

Dissolved solids were low during both the May and August periods of comparison. Station means ranged from 46 to 57 mg/l and from 59 to 152 mg/l, respectively. Suspended solids (S.S.) remained low throughout the year even after heavy areawide rains (5.5 to 12.4 mg/l and 6.3 to 11.5 mg/l for May and August, respectively).

---

*Station BC-5 is located immediately downstream of the discharge from a large, shallow pond. The normally slow flow through the pond combined with a surface overflow allows extensive solar heating before discharge. The very low flow usually encountered at this station negates any effect which the elevated temperatures would have on the waters of the proposed impoundment.

TABLE 5

COMPARISON OF RANGES

Parameter	All Stations			
	All Data*		Station Means**	
	May	August	May	August
Physical				
Temp. °C	18.0-22.0	21.0-26.0	20.1-21.5	21.8-24.0
Dissolved Solids - mg/l	24-84	8-307	46-57	59-152
Suspended Solids - mg/l	4-28	3-22	5.5-12.4	6.3-11.5
Chemical				
pH units	5.3-6.2	4.1-5.9	5.5-6.1	4.8-5.6
D.O. - mg/l	1.5-7.1	2.2-5.2	2.1-6.1	2.4-4.5
BOD_5 - mg/l	1.0-5.5	0.9-3.6	1.6-3.5	1.3-3.2
Org-N - mg/l	0.10-0.78	0.18-0.85	0.18-0.53	0.25-0.57
NH_3-N - mg/l	0.01-0.28	0.01-0.47	0.03-0.14	0.04-0.13
TKN - mg/l	0.19-0.94	0.22-0.90	0.23-0.62	0.25-0.64
NO_2 + NO_3-N - mg/l	Less than detectable limits in most cases.			
Total-P - mg/l	0.01-0.28	0.01-0.47	0.01-0.23	0.01-0.35
TOC - mg/l	9-11	7-33	9.6-16.5	10-26.4
Bacteriological				
Fecal Coliform - counts/100 ml	110-7,600	10-8,400	240-4,700	59-1,400

* No values for BC-4 and BC-5 during May ("0" flow conditions precluded sampling).

** Geometric mean for Fecal Coliform.

This indicates that very little sediment is transported from the relatively flat sandy fields to the streams.

Chemical Parameters

All pH values were on the acidic side of the pH scale, which is typical for black water streams in this area. These low values could be caused by the buildup of humates, tannins and other refractory organic acids from decaying plant matter. They could also originate from drainage of acid soils. According to Reid,[11] pH values in sluggish marshy streams of the southern United States may range as low as 4.0 units. Soils in the study area range from 4.5 to 5.5 pH units.[9]

Dissolved oxygen concentrations were variable. The decreasing May concentrations (Appendix B) demonstrate the effects of the decreasing flow conditions which prevailed during that period. Flows often fell to zero.

Some of the five day biochemical oxygen demand concentrations were relatively high when compared with typical values for free flowing upland streams of 1-2 mg/l and with slow flowing swamp streams of 2-3 mg/l.

Concentrations of all the nitrogen species studied plus the concentrations of total phosphorus varied widely, even within a given month.

Examination of the individual nitrogen parameters for May shows a relatively large contribution from organic nitrogen to the total Kjeldahl nitrogen (TKN) values and a smaller yet significant contribution from ammonia nitrogen (NH_3-N). Total phosphorus (Total-P) values ranged from 0.01 to 0.28 mg/l and nitrate-nitrite nitrogen values were less than detectable limits except in a few isolated cases.

Examination of the same parameters for August shows a nearly unchanged TKN, with a significantly higher contribution from NH_3-N. Total-P concentrations were approximately twice those for May. NO_3+NO_2-N concentrations were all less than detectable limits during August.

Total organic carbon values ranged from 9 to 11 mg/l in May and from 7 to 33 mg/l in August. These values are typical for coastal plain swampy areas.

Bacteriological Parameters

Fecal coliform densities were high and variable during both study periods with August having the highest value (8,400 fecal coliforms/100 ml) and May having the highest station mean (4,700 fecal coliforms/100 ml).

The high fecal coliform densities represent stormwater runoff under free flowing stream conditions. After project completion, retention time in the impoundment will result in greatly reduced fecal coliform densities. No water should be considered completely safe for body contact recreation, regardless of its fecal coliform density. Some health risks will be involved for the water user. However, these risks are greatly reduced in waters where such densities are low.

Qualitative determinations to detect *Salmonella* bacteria were made at two stations (BC-1 and BC-2) during May. *Salmonella* is a large serologically-related genus comprised of over 1,300 serotypes. *Salmonella* is probably the easiest enteric pathogen to isolate from water. All *Salmonella* are considered pathogenic to man and animals.

The presence of *Salmonella* is proof of fecal contamination from either man or animals, and establishes the potential of disease contraction resulting from water ingestion. It is important to note that the inverse of this statemment is not true. Failure to isolate *Salmonella* does not establish that the water is free of pathogenic organisms. No serotypes were isolated from either station. No *Salmonella* determinations were made during the August study.

ANIMAL POPULATION - DISTRIBUTION

During the week of May 13 through 17, 1974, animal population - distribution data were gathered by a combined team of SAD and SCS personnel by interviewing the major farmers in the area. The results are presented in Table 6. During January, 1970, a complete aerial mapping of the study area was performed by the U. S. Department of Agriculture, Agricultural Research Service. A complete waste source interpretation of the resulting photographs was performed by the U. S. Environmental Protection Agency, Environmental Photographic Interpretation Center (EPA-EPIC), Vint Hills Farm Station, Warrenton, Virginia. Results of the interpretation are shown on the map in Appendix E-1, along with the approximate locations of the animal populations listed on Table 6. It should be noted, that since the interpretations were made on 1970 photographs, some of the identified points may no longer exist. However, many of the smaller operations listed in the photographic interpretation would not have been listed in the SAD-SCS survey of major farmers during May of 1974.

HIGH VALUES AND MEANS

Discussion of Data

Table 7 shows that the high values (lows for D.O.) for most parameters, during May occurred at Station BC-2. The domestic animal population which most influenced* data for this report is located upstream of Stations BC-2 and BC-5. Seepage from the area upstream of Station BC-2 would strongly influence the May, low-flow values but would be greatly diluted by the much higher August flows. Waste from the animal population upstream of Station BC-5 was not reflected in the May data due to the zero flow conditions which prevailed at that station.

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* A single channel was assumed at Station BC-1 for all except flood conditions. A second channel was discovered toward the end of the study. This channel contains flow only under extremely high runoff conditions. Any runoff from the large hog feeding operation upstream of this station would occur only after heavy rains and would travel downstream via the second channel. Therefore, the data of this report does not reflect any effect of this waste source.

TABLE 6

ANIMAL POPULATION - DISTRIBUTION

Station Number	Cows	Swine	Miles Upstream of Station Stream	Miles Upstream of Station Tributary
BC-1		300*	1.5	
BC-2		165**	1.7	0.3
	100***		0.6	0.4
BC-5	60	165****	---	---

* Pens are located just above the swampy area which will be impounded (capacity of pens is much greater than 300 animals). Runoff caused by heavy rains would be directly into the proposed impoundment.

** These animals were located in woods adjacent to creek.

*** These animals were located on pastures which drain to a pond. Any runoff entering the creek would be through the pond.

**** Any runoff from these animal pens is to a self contained lagoon. Discharge from this lagoon is directly to a large lake located immediately upstream of Station BC-5.

COMPARISON OF HIGH VALUES AND MONTHLY MEANS
{Excluding high values (lows for D.O.) which occurred under "0" flow conditions}

Parameter	Basin Highs* {Sta. # (Value)} May	Basin Highs* {Sta. # (Value)} August	Means**(All data) May	Means**(All data) August	Monthly Comparative Means (August/May-ratio)
Physical					
Temp. °C	BC-2(22)	BC-5(26)	20.2	22.8	1.13
Dissolved Solids - mg/l	BC-6(84)	BC-2(307)	51.7	96.1	1.86
Suspended Solids - mg/l	BC-1(28)	BC-1(22)	10.2	8.8	0.86
Chemical					
pH - units	BC-1(6.2)	BC-4(5.9)	5.7	5.2	0.91
D.O. - mg/l	BC-2(1.5)	BC-6(2.2)	3.6	3.6	1.00
BOD_5 - mg/l	BC-2(5.5)	BC-5(3.6)	2.2	2.0	0.91
Org-N - mg/l	BC-2(0.78)	BC-5(0.85)	0.29	0.47	1.62
NH_3-N - mg/l	BC-2(0.28)	BC-1(0.47)	0.09	0.08	0.89
TKN - mg/l	BC-2(0.94)	BC-5(0.90)	0.37	0.52	1.41
NO_2+NO_3-N - mg/l	Less than detectable limits in most cases.				
Total P - mg/l	BC-1(0.28)	BC-5(0.47)	0.10	0.11	1.10
TOC - mg/l	BC-2(17)	BC-1(33)	12.2	20.3	1.66
Bacteriological					
Fecal Coliform - counts/100 ml	BC-2(7,600)	BC-2(8,400)	804	316	0.39

* Lows for D.O.
**Geometric mean for fecal coliform.

The August data in Table 7, however, does reflect the influence of the waste sources upstream of Station BC-5. August basin highs for BOD_5, Org-N, TKN, and Total-P all occurred at this station. Basin high fecal coliform densities occurred at Station BC-2 during both months.

The monthly comparative means column on Table 7 is a comparison of the mean values of all data for a given parameter. The water temperatures were slightly higher in August. Suspended solids, pH, BOD_5, and NH_3-N were all slightly higher in May. Mean D.O. values were the same during both months. Mean values for dissolved solids, Org-N, TKN and TOC were all much higher in August. Most of the May values and all of the August values for NO_3+NO_2-N were less than detectable limits. Geometric mean fecal coliform densities were all much higher in May.

Much of this apparently inconsistent data may be clarified by considering some of the many factors which can affect the data (e.g. hydrogeological characteristics of the area, precipitation-hydrographs for the study period, local farming practices and possible nutrient sources and pathways).

Factors Affecting Data

Nutrients can enter the soil from many sources. The two major sources in the study area are through applied fertilizer and organic detritus. A third source which is not fully understood but may be of major importance is the ammonia produced by leguminous crops. Except for the discharge from a small oxidation pond serving a mobile home court downstream of Station BC-6, there are no municipal or industrial point sources of pollution in the study area.

Fertilizers applied to the croplands and pastures, cow manure dropped on pastures and in feedlots, swine droppings in feedlots, leaf litter in the extensive forests and swampy areas, and possible ammonia liberated by leguminous crops would all decompose or otherwise be transformed. Table 8[13] is a listing of possible sources of nitrogen and phosphorus (excluding municipal and industrial point sources) on

TABLE 8

SOURCES OF NITROGEN AND PHOSPHORUS ON A NATIONAL AND A WATERSHED SCALE

Source	National				Wisconsin watersheds			
	Nitrogen		Phosphorus		Nitrogen		Phosphorus	
	Million Tons	Percent	Million Tons	Percent	lbs/acre	Percent	lbs/acre	Percent
Fertilizer	6.8	45.9	2.2	76	10	8.5	8	32
Fixation	3.0	20.3	0	0	12	10.3	0	0
Manure	1.0	6.8	0.4	14	42	35.9	12	48
Plant residues	2.5	16.9	0.3	10	45	38.5	5	20
Precipitation	1.5	10.1	0.01	0	8	6.8	0	0
Total	14.8		2.9		117		25	

both a national and a watershed scale. Except for manure, values for the Little Black Creek drainage basin should be close to those for the Wisconsin watersheds. Manure values in Table 8 are for manure incorporated into the soil as a fertilizer. In the Little Black Creek drainage basin, no manure is applied to the cropland.[14] Any nutrients entering the streams from manure would come from seepage and runoff from pastures and feedlots. The number of these type operations in the study area is small. Only 13.4 percent of the entire drainage basin is pasture land and 6.5 percent is classified as idle or miscellaneous.[8]

Of the 32.5 percent of the basin utilized as cropland, 12.4 percent contains corn, 9.4 percent peanuts, and 9.4 percent soybeans. Local farmers till the soil approximately five to six inches deep in early spring (March 1-15) and apply approximately 500 lbs/acre of 5-10-5 fertilizer. During late April and early May, approximately 100 lbs/acre of nitrogen fertilizer is added to the soil for the growing corn crops. Fifty percent of this fertilizer is injected directly into the soil as anhydrous ammonia. The remainder is broadcast as ammonium nitrate and plowed into the soil. No nitrogen fertilizers are applied to the peanut or soybean crops, since both are leguminous crops.[14]

The flat fields and pastures in the study area are composed of a very permeable, sandy soil with a shallow groundwater table below (see description of study area). According to Davis and DeWeist[15] and Thorn,[10] surface water runoff does not begin until the rainfall exceeds the soils infiltration capacity. A portion of the infiltrating water flows slowly and laterally above the groundwater table to nearby streams (interflow).The remainder will reach the watertable and also flow slowly toward the streams (groundwater flow).

The rate of infiltration and resulting interflow and groundwater flow, will depend on the grade of the terrain. Additional factors affecting this rate include soil permeability as well as the slope and gradient of the groundwater table.

Nitrate from applied fertilizers can follow two pathways through the soil. It can be leached through the soil or immobilized in the soil organic matter. Small amounts of rainfall and a low groundwater table present conditions favorable for immobilization.[13]

Nitrate which is immobilized can undergo ammonification (conversion of organic nitrogen into the ammonium ion).[13] The rate of this process is proportional to the pool of ammoniziable nitrogen. Two mechanisms by which ammonification take place are: (1) bacterial decomposition of soluable organic nitrogen, and (2) direct autolysis after both microbial and plant cell death.[16]

Large amounts of rainfall and a high groundwater table are favorable conditions for nitrate leaching. Relatively nonreactive solutes such as nitrates can move through the soil with approximately the same velocity as does the soil water. Before peak leachate nutrient concentrations can appear in sub-surface drainage water, infiltrating rain or irrigation water must flow through the surface soil and displace the nutrient rich solution through the soil profile.[17]

Nitrates which do leach through the soil can undergo denitrification before reaching sub-surface drainage water. The nitrate is used by anaerobic soil organisms as a source of oxygen and in the process is converted to nitrogen gas. A few bacteria can carry this reaction all the way to ammonia.[13] The denitrification process requires both an adequate supply of carbon as an energy source[18] and anaerobic soil conditions.[13] Anaerobic conditions usually occur in water saturated soil. However, they can also occur in anaerobic micro-environments in an otherwise well drained soil. If added water is sufficient to cause continuous movement of nitrate through the soil, the residence time required for denitrification to occur in any significant amounts might not be met.[13]

The ammonium ion can enter the soil from three additional sources; (1) the ammonium portion of the ammonium nitrate fertilizer, (2) injected anhydrous ammonia, and (3) ammonia liberated by leguminous crops. Anhydrous ammonia which is injected into the soil is converted almost immediately to the ammonium ion by the most minute quantities of soil moisture.

Leguminous crops (soybeans and peanuts), which cover approximately nineteen percent of the total area of the Little Black Creek drainage basin,[14] biologically fix nitrogen from the atmosphere. In this process, the bacterium Rhizobium enters the root hairs of the legume root. The cell wall of the root hair invaginates to form an infection thread. A few of the threads grow back to the base of the hair and enter the root. The ends of the infection threads rupture and release the bacteria into the root cells. The infected cells grow into nodules in which the bacteria produce ammonia.

This ammonia is immediately utilized by the plant. However, most of the infective thread growths abort through rupture and subsequent death before reaching the root.[19] The ammonia which is produced during the abortive growth is liberated into the surrounding soil and converted to the ammonium ion. This hypothesis is supported by observations of farmers concerning weed growth in soybean rows. When certain weeds are physically pulled up, their root masses are asymetrical. The side near the soybean plants are very thick and well developed. The other side is usually very sparse and underdeveloped. This shows that the weed is gaining nutrients from the area of the legume roots.

Reactive solutes such as the phosphate and ammonium ions and organic carbon are firmly, yet not absolutely secured by the soil matrix. Consequently, they will move through the soil profile, but at a much slower rate than the percolating water. The rate of their movement is governed by soil type, microbiological transformations and syntheses, precipitation, adsorption-desorption, and other physical-chemical reactions with the matrix.[13] Sandy soils exhibit a much smaller affinity for reactive solutes than do clayey soils.[17]

Both the availability of phosphate for plant use and its freedom of movement through the soil column decreases exponentially with time after application. Recent research work indicates that chemical reactions immobilize more than fifty percent of added soluable phosphate in a few hours after application and an additional ten percent in approximately one month or so. However, the phosphate conversion rate again depends on the soil type or chemical reactivity of the soil. The amount of biological immobilization which occurs simultaneously with the chemical reactions depends upon the amount of biological activity.[13]

Some small amounts of material will reach the streams by surface water runoff after intensive rains. The rate and volume of runoff from the cultivated fields will be reduced drastically by the flat terrain, the soil permeability, and the forests which border the streams in the study area. Any surface water runoff from shallow tilled sandy soils carries only negligible amounts of nitrate and phosphate.[13]

Organic detritus, the other major nutrient source in the study area, results primarily from forest litter in the extensive forests and swampy areas. Nearly fifty percent of the entire drainage basin is forest. Leaves significantly affect water quality in small streams.[20] According to Ruttner[21] and Reid[11] nitrogen, in the form of ammonia and ammonium compounds, is released into streams mainly through the decomposition of organic debris. The work of many researchers[22] indicates that the phosphorus load from pastures, orchards and forests are higher than from cropland. Both the nitrogen and phosphorus present in agricultural runoff was estimated by sampling small streams which did not receive any municipal or industrial discharges. The sampling program of these researchers indicated that higher nutrient values usually occurred in streams which drained forests and slightly marshy type areas.

Another source of phosphorus to be considered is atmospheric input from dust and precipitation. These inputs may be more significant than those from detergent, industrial or agricultural runoff, especially in low population areas.[16] There are no incorporated towns within the Little Black Creek drainage basin.[8]

The above discussions plus a 10-hour rain period totaling 1.75 inches the day before commencement of May sampling suggest very plausible explanations for the apparently inconsistent data.

Intensive rainfall in May, within two weeks after fresh tillage of approximately six percent of the entire drainage basin, led to the slight elevatic in suspended solids. In August, heavier rains fell on plowed fields on which crust had formed and which were covered by either full grown plants or harvest residue.

The low groundwater table and lack of precipitation which occurred in early May would have been conducive to immobilization and ammonification of the nitrate portion of the freshly applied ammonium nitrate fertilizer. These ammonium ions would join with those from the same fertilizer, those from the injected anhydrous ammonia, and possibly those liberated by the leguminous crops. A large, drainage basin pool of ammonium ions would then be formed, in the dry, sandy soil column. Intensive rains could then rapidly move them toward the streams via interflow.

Aerobic bacteria in the stream would oxadize the ammonium ion to nitrates and nitrites. This would explain the few occurrances of nitrates and nitrites above detectable limits during May. This conversion would exert an increased oxygen demand and explain the slightly elevated BOD_5 values for May. The "flash flood" nature of the May 12-15 hydrograph on Figure 3 and the consequently reduced reaction time explains why an even greater oxygen demand did not occur.

Increased washout of the woods and increased swampy areas, and increased atmospheric contributions resulted in higher total phosphorus during August.

The extended low flow conditions which existed during June and July (Figure 1) immediately preceeding the August high flow sampling period caused many stagnant pools of water which were rich in detritus. This would have allowed ample opportunity and time for decay of forest litter, and concentration of dissolved solids, organic carbon, and organic nitrogen before flushing by the high August flows. These flows, in addition to the resulting decrease in wasteload time, explain why an elevated oxygen demand was not measured in August.

Fecal coliforms reach the streams mainly by surface water runoff. Both increases and maxima for this parameter usually lag behind hydrographic increases and maxima.[23] The high mean fecal coliform densities encountered in May and the steady five day decrease in mean daily values (1,670; 1,350; 1,050; 625 and 500) should, according to this argument, represent the declining slope of a hydrograph. Reference to the May sampling period on Figure 3 shows this to indeed be the case. Figure 1 shows that all August sampling was performed either during hydrographic maxima or during low flows following hydrographic maxima. This should and does indicate lower fecal coliform densities than occurred immediately after the peak discharge.

LONG TERM BOD

Long term BOD (1,4,5,7,10,12,14,16,18 and 20 day) analyses were performed on a single sample collected from Station BC-1 on May 17, 1974. A least squares analysis[24] of this data produced the following results:

La = Ultimate Carbonaceous Demand = 2.33 mg/1

k_1 = Carbonaceous Rate Coefficient* = 0.20/day

Na = Ultimate Nitrogenous Oxygen Demand = 3.2 mg/1

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* Both rate coefficients are to the base e at $20^{o}C$.

k_3 = Nitrogenous Rate Coefficient* = 0.035/day

tn = Lag time to initiation of nitrogenous (2nd stage) oxygen demand = 11.5 days

Figure 5 is a plot of both the observed values and those predicted by the following equations:

$$Y = La(1.0 - e^{-k_1 t}) \text{ when } t < n \text{ and}$$

$$Y = La(1.0 - e^{-k_1 t}) + Na(1.0 - e^{(-k_3)(t-tn)}) \text{ when } t \geq tn$$

Y = oxygen demand at time t

These values are typical and are included for use in any future modeling efforts with this data.

TIME OF TRAVEL STUDIES

Throughout the week of May 13-17, time of travel studies were performed by the use of dye tracer techniques. Because of the low flow conditions, no dye was detected at any of the downstream sampling stations. These studies were repeated during August under the indicated flow conditions.

Station Number	Date	Flow Conditions
BC-2A	August 7	High
BC-3	August 13	High
BC-2	August 13	High
BC-2A	August 28	Medium
BC-3A	August 28	Medium

Results of these studies are presented in Table 9 and in Figures 6-10.

DIURNAL STUDIES

Diurnal studies were performed at Station BC-1 under ultra-low flow conditions during November, 1974 and under peaking flood conditions during January, 1975

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* Both rate coefficients are to the base e at 20^{o}C.

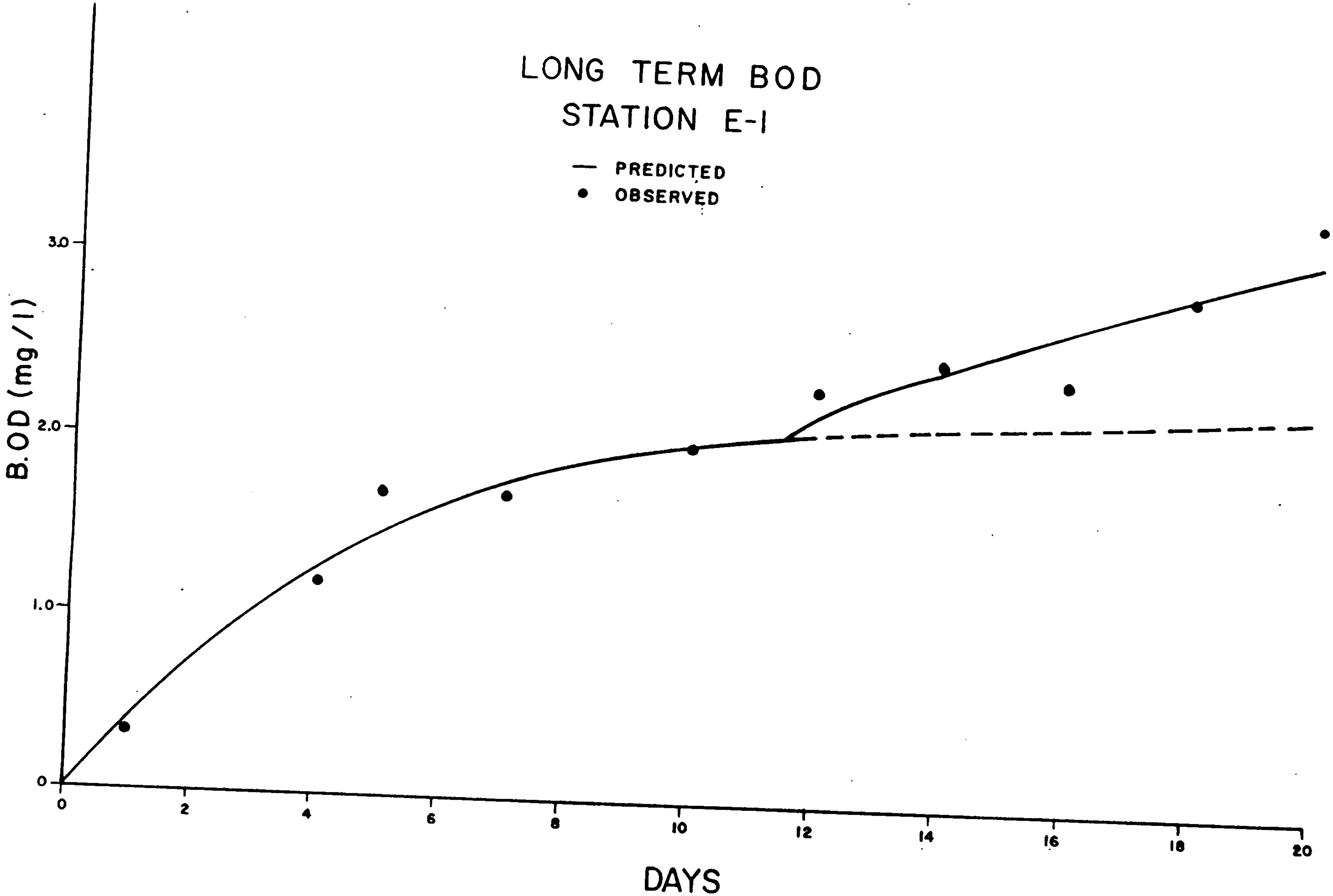

LONG TERM BOD
STATION E-1
PREDICTED
OBSERVED
B.OD (mg/l)
3.0
2.0
1.0
0
0
2
4
6
8
10
12
14
16
18
20
DAYS

TABLE 9

TIME OF TRAVEL DATA

"FROM" STA. #	"TO" STA. #	DATE/TIME OF DYE DUMP	DATE/TIME OF PEAK ARRIVAL	LENGTH OF REACH MILES	VELOCITY IN REACH MILES/HR	AVG. DISCHARGE (CFS) FROM DUMP TIME TO PEAK ARRIVAL TIME
BC-2A	BC-2	8/7/74 1740	8/7/74 2030	0.556	0.196	50.4
BC-3	BC-2	8/13/74 1300	8/14/74 0700	2.208	0.123	12.1
BC-2	BC-1	8/13/74 1330	8/14/74 0300	2.000	0.148	14.3
BC-3A	BC-3	8/28/74 0740	8/29/74 0500	1.556	0.073	4.5
BC-2A	BC-2	8/28/74 0815	8/28/74 1400	0.556	0.097	5.1

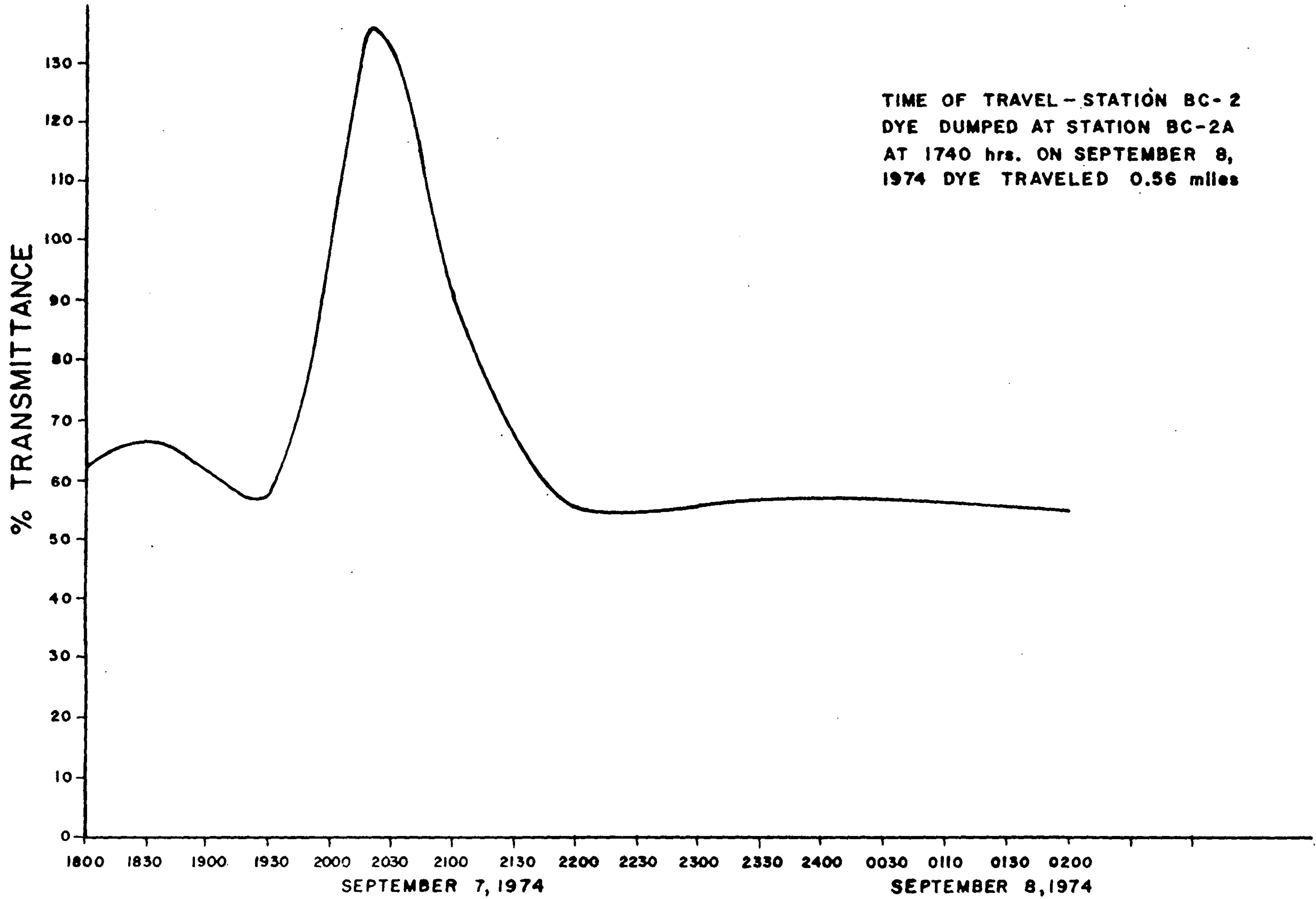
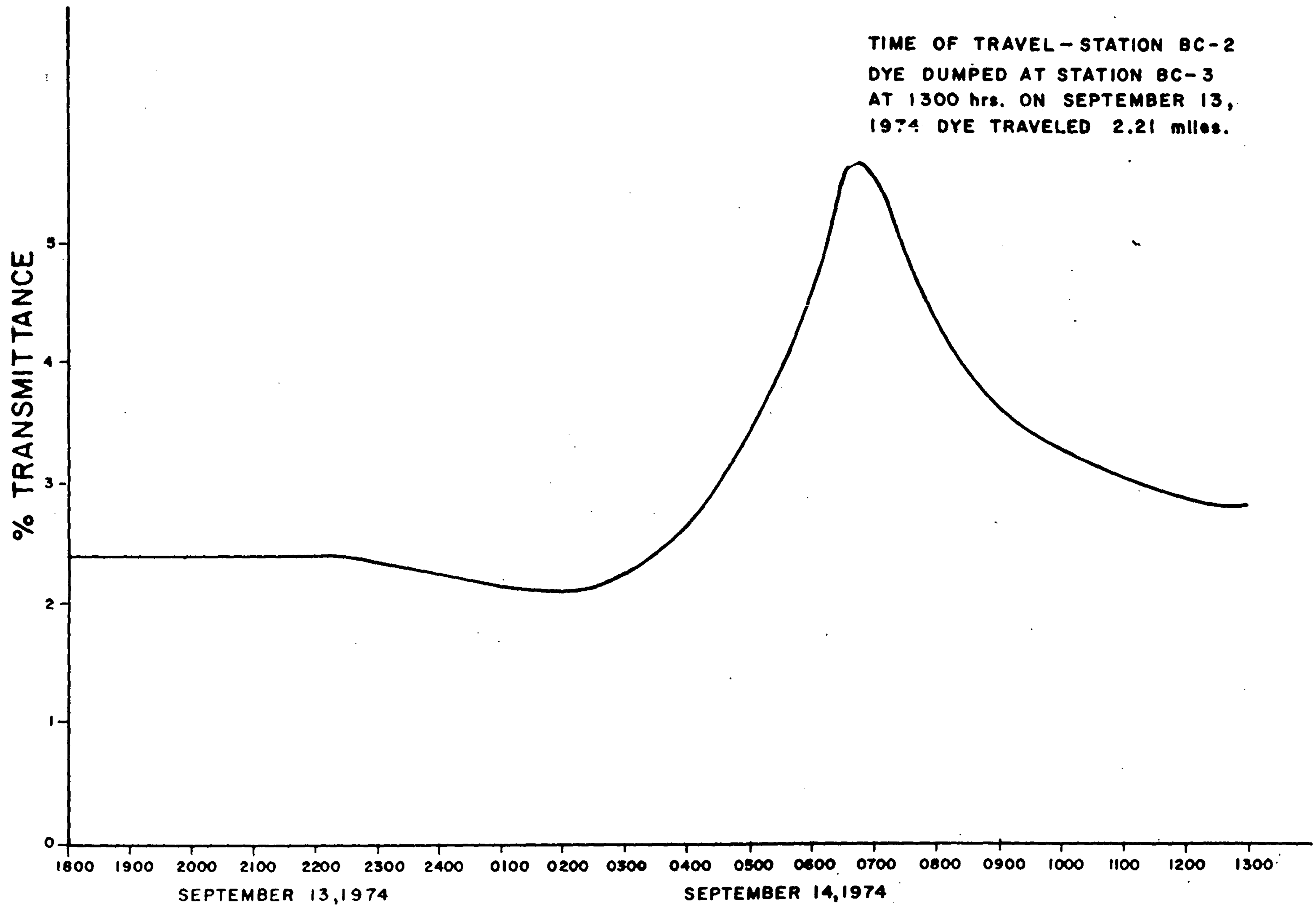
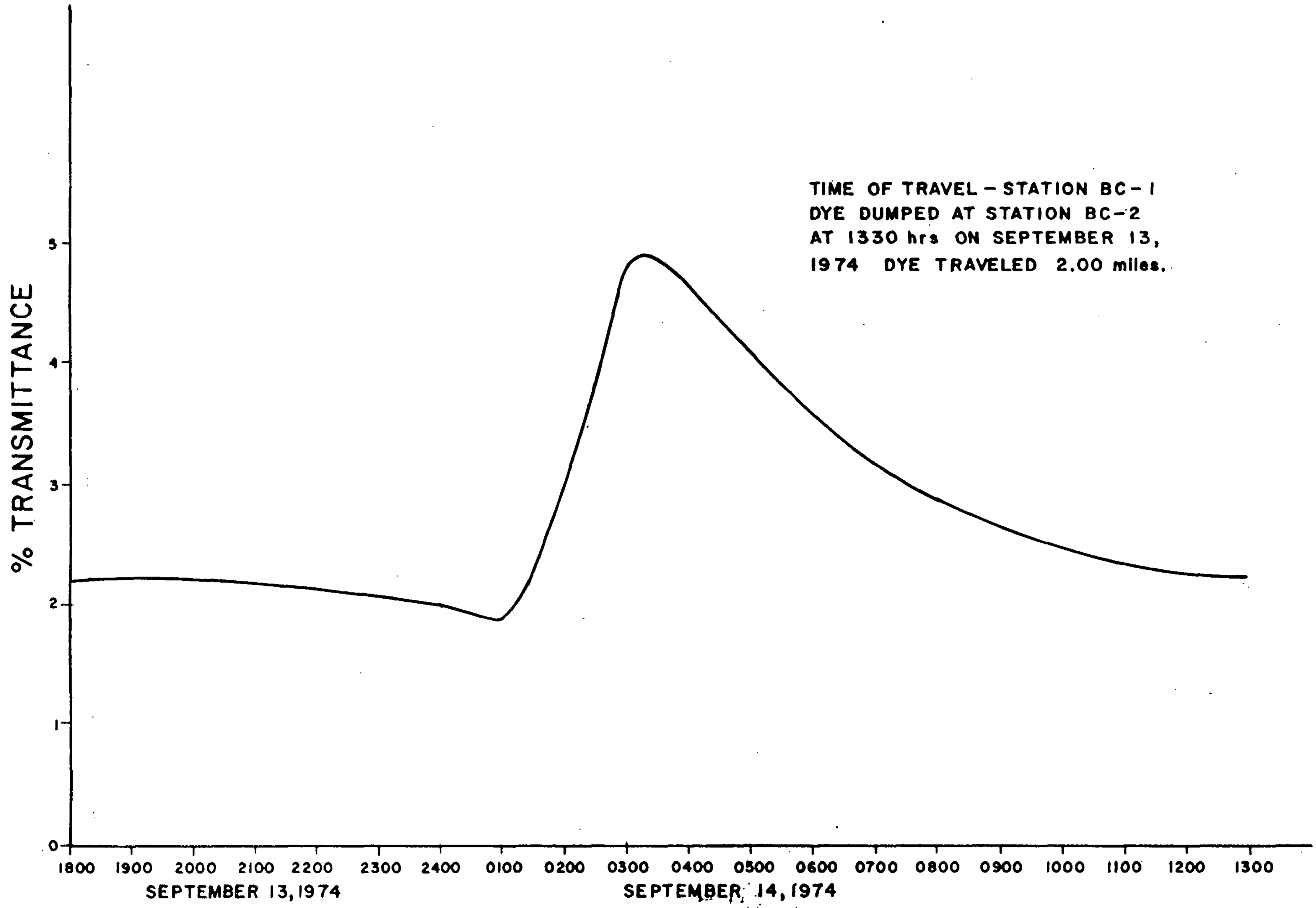
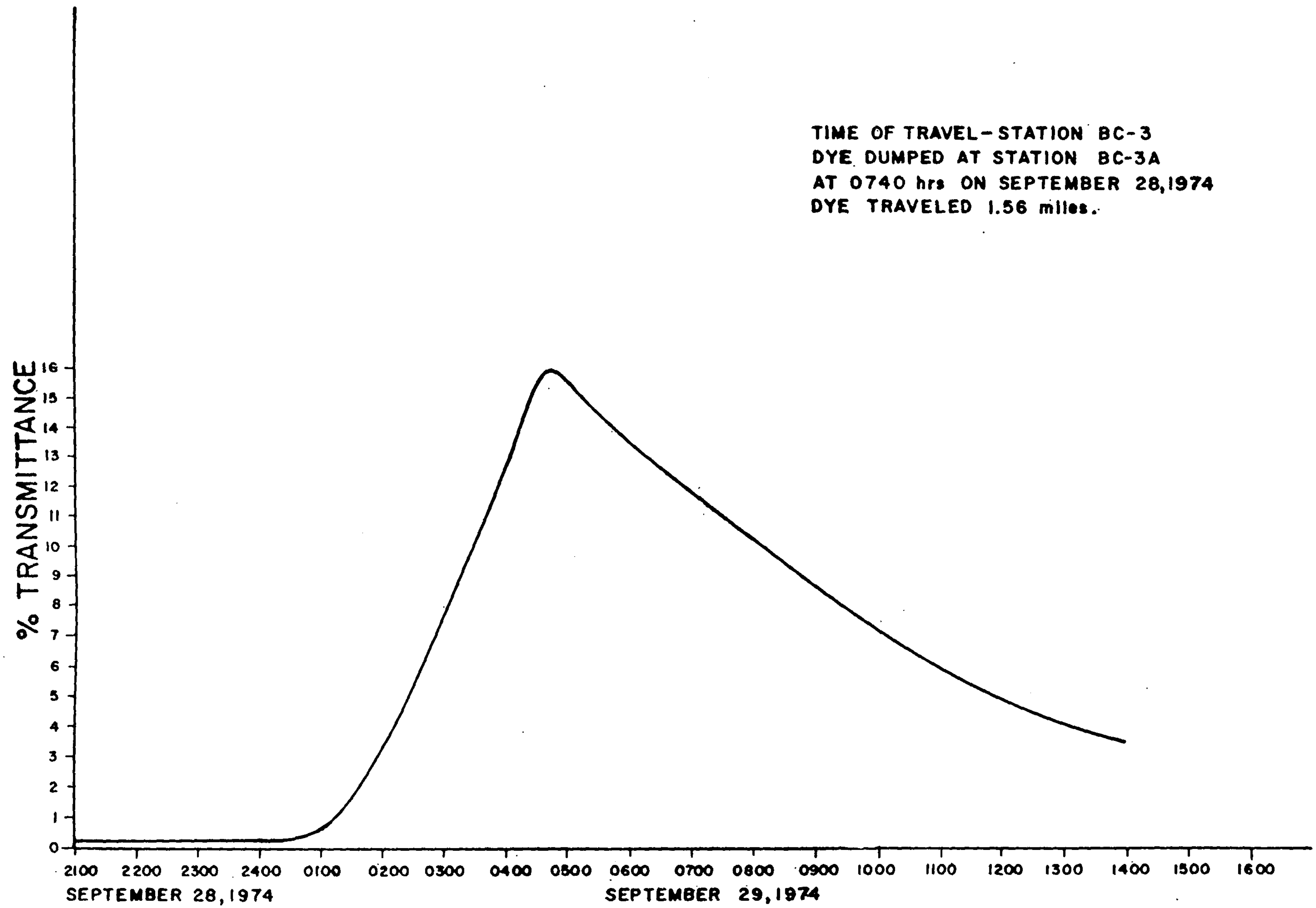

TIME OF TRAVEL - STATION BC-2
DYE DUMPED AT STATION BC-2A
AT 1740 hrs. ON SEPTEMBER 8,
1974 DYE TRAVELED 0.56 miles
% TRANSMITTANCE
0
10
20
30
40
50
60
70
80
90
100
110
120
130
1800
1830
1900
1930
2000
2030
2100
2130
2200
2230
2300
2330
2400
0030
0110
0130
0200
SEPTEMBER 7, 1974
SEPTEMBER 8, 1974

FIG. 7



TIME OF TRAVEL – STATION BC-2
DYE DUMPED AT STATION BC-3
AT 1300 hrs. ON SEPTEMBER 13,
1974 DYE TRAVELED 2.21 miles.
% TRANSMITTANCE
0
1
2
3
4
5
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
SEPTEMBER 13, 1974
SEPTEMBER 14, 1974


TIME OF TRAVEL – STATION BC-1
DYE DUMPED AT STATION BC-2
AT 1330 hrs ON SEPTEMBER 13,
1974 DYE TRAVELED 2.00 miles.
% TRANSMITTANCE
0
1
2
3
4
5
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
0500
0600
0700
0800
0900
1000
1100
1200
1300
SEPTEMBER 13, 1974
SEPTEMBER 14, 1974


TIME OF TRAVEL-STATION BC-3
DYE DUMPED AT STATION BC-3A
AT 0740 hrs ON SEPTEMBER 28,1974
DYE TRAVELED 1.56 miles.
% TRANSMITTANCE
0
1
2
3
4
5
6
7
8
9
10
11
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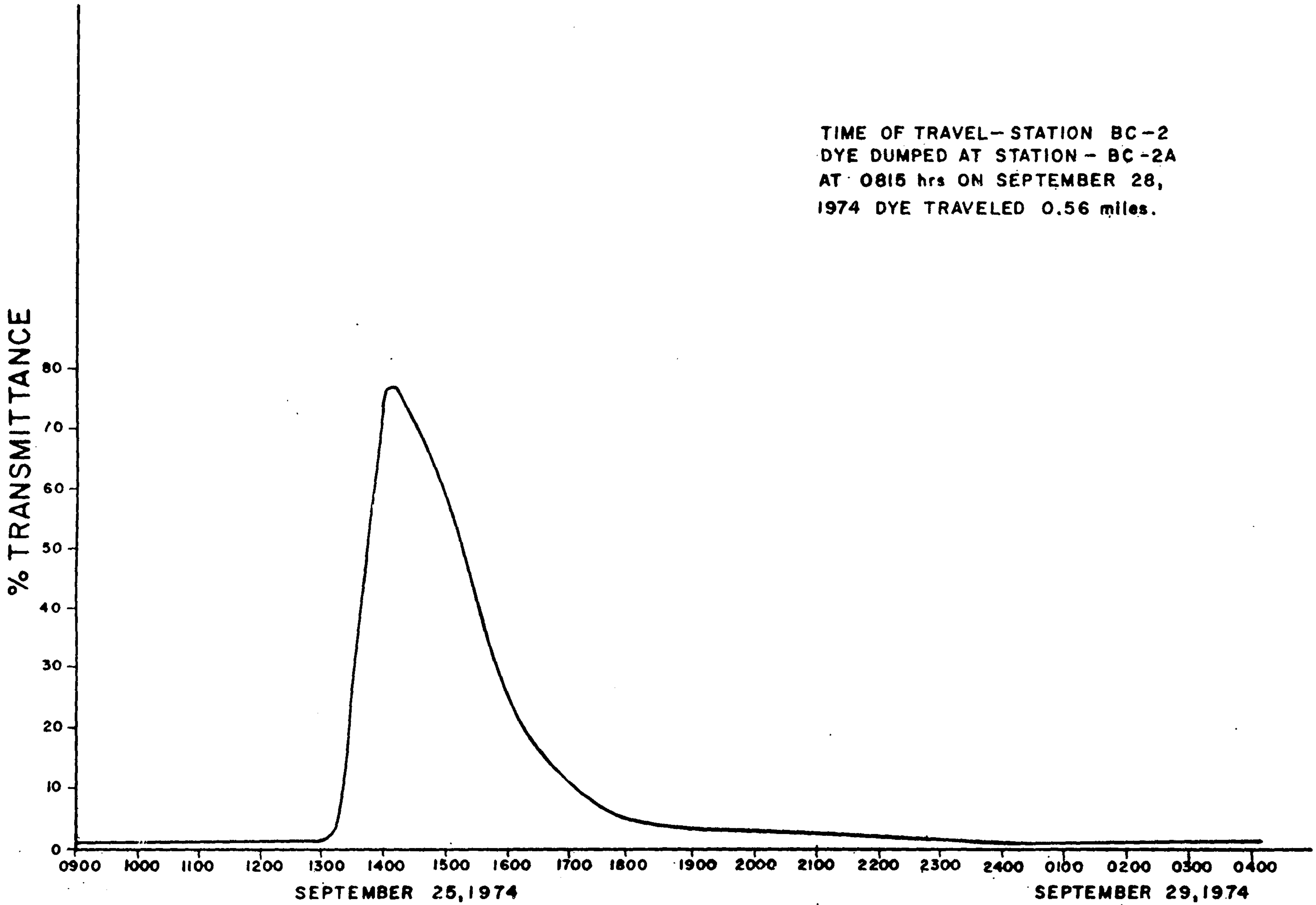
1500
1600
SEPTEMBER 28,1974
SEPTEMBER 29,1974


TIME OF TRAVEL— STATION BC-2
DYE DUMPED AT STATION - BC-2A
AT 0815 hrs ON SEPTEMBER 28,
1974 DYE TRAVELED 0.56 miles.
% TRANSMITTANCE
80
70
60
50
40
30
20
10
0
0900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
0300
0400
SEPTEMBER 25,1974
SEPTEMBER 29,1974

(Figure 1). Results of these studies are presented in Appendix B. No significant diurnal variations were noted during either period.

ASSESSMENT OF POTENTIAL NON-POINT SOURCE RUNOFF LOADS

The gross assessment performed in this watershed was accomplished by applying loading factors to six drainages which were fully described according to land use, soil type, topographic features, livestock/poultry counts and historic climatic conditions. A detailed report is given in Appendix C with applicable loading factors stated. A brief summary of the results on an annual basis, a seasonal wet period (June to August) basis and for selected storms follows:

- The Little Black Creek drainage basin contains 9,985 acres and is broken into 6 drainages ranging in size from 954 to 2,355 acres.
- It undergoes an annual erosion of 17,672 tons and a wet period erosion (June-August) of 7,952 tons.
- It has an annual sediment delivery of 1,633 tons and a wet period sediment delivery of 735 tons.
- A one inch per hour rain storm produces seven percent of the average annual sediment load.*
- A two inch per hour rain storm produces thirty-two percent of the average annual sediment load.*
- Livestock and poultry produce about five percent of the N, six percent of the P, and fifteen percent of the BOD.
- Forest and pasture litter provides about thirty-one percent of the N, seven percent of the P, and eighty-five percent of the BOD.
- Sediment produces about sixty-four percent of the N, eighty-seven percent of the P, plus negligible BOD. This includes dissolved N and P.

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* Under average soil moisture antecedant conditions.

The analysis was performed to establish potential loads for typical conditions according to relationships stated on page "c" of the report. Attenuation effect of control practices can be determined using these calculations; however, it is unlikely that a valid comparison can be made between stream loads based on sampling and these gross assessment loads.

HYDROCOMP WATER QUALITY PREDICTIONS

General

The postimpoundment water quality of the Little Black Creek drainage basin was simulated using the combined hydrologic and water quality models known as the Hydrocomp Simulation Programming (HSP) model. The models were calibrated (or adapted) to local conditions using observed hydrometeorologic and water quality data collected by the Environmental Protection Agency. In calibrating the model, it was assumed that the animal population of a hog farm upstream from Station BC-1 was reflected in the water quality data at BC-1. Later it was determined that this was not the case. Flow at BC-1 was multi-channel rather than single channel as originally assumed and the hog farm waste was being carried by a channel which was not sampled. Inclusion of the hog population would have increased the BOD_5, NH_3-N and organic N loadings, and the fecal coliform densities at Station BC-1 above those used for model calibration. The net effect of this error would be to increase rate coefficients above BC-1 since in calibrating the model, this would force the waste to degrade before reading BC-1.

Water quality in the basin was simulated for a five year period, both with and without the proposed impoundment. The resulting time series of water quality constituents were analyzed to determine the percentage of time that various concentration levels would be exceeded both with and without the impoundment. The result of these analyses were compared with Georgia Water Quality Standards.

Temperature

The HSP model predicts that the impoundment will dampen out extreme temperatures, both on an annual and on a seasonal basis. Predicted peak temperatures with the impoundment were less than 28°C at all times, well below the Georgia water quality standard of 32.2°C. Without the impoundment, predicted peak temperatures exceeded 30°C and may exceed the state standard a small percentage of the time in the summer.

Dissolved Oxygen

The HSP model predicts that on an annual basis instantaneous minimum standard of 4.0 mg/l D.O. would be violated 12 percent of the time without the impoundment and 40 percent of the time with the impoundment. During July and August the predictions indicate that the instantaneous standard would be violated 100 percent of the time with the impoundment and 14 percent of the time without the impoundment. Predictions also indicated that the daily average D.O. standard of 5.0 mg/l would be violated 100 percent of the time with the impoundment and 28 percent of the time without the impoundment for the period June through September.

Hydrocomp used a very high, possibly unrealistic, NH_3 nitrification rate coefficient of 0.1 per hour, rather than a more typical value such as 0.0185 per hour. Consequently, the simulated D.O. concentrations represent the worst likely conditions; and actual D.O. concentrations may be considerably higher than simulated.

Fecal Coliform

The last Georgia water quality standard of concern was the fecal coliform standard for body contact recreation*. It is difficult to compare the HSP model

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* Measured values not to exceed 200 fecal coliforms/100 ml based on a geometric mean of four or more samples taken at least 24 hours apart.

predictions with the standards since the predicted data do not fit the criteria of discrete samples collected at least 24 hours apart. However, the probability of violations with and without the impoundment can be addressed in relative terms. The predictions on an annual basis indicated that fecal coliform counts greater than 200/100 ml would occur 2 percent of the time with the impoundment and 83 percent of the time without the impoundment thus indicating a much higher probability of standards violations without the impoundment. Results on a seasonal basis (June-September) were similar (3% > 200/100 ml with the impoundment and 87% > 200/100 ml without the impoundment).

Five Day Biochemical Oxygen Demand (BOD_5)

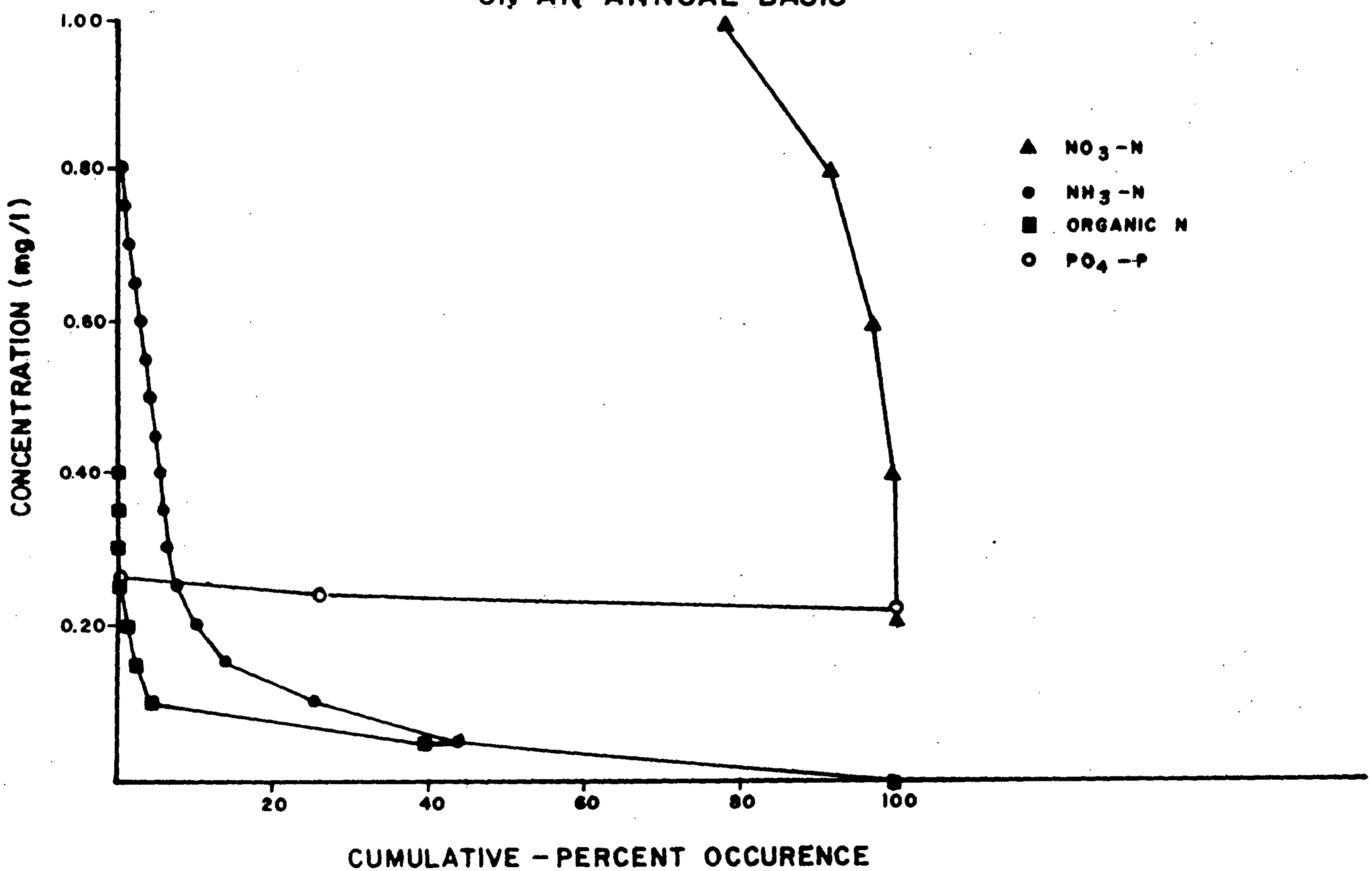
The HSP predictions of BOD_5 concentrations indicate that the impoundment will have a dampening effect. Predicted concentrations on an annual basis indicated that the BOD_5 would be less than 3.0 mg/1 99 percent of the time with the impoundment but only 53 percent of the time without the impoundment. Seasonal predictions indicate that the highest BOD_5 concentrations would occur during the high flow period from December through March with the impoundment since the high flows would reduce the dampening effect. Without the impoundment consistently high BOD_5's occur throughout the spring and summer (i.e., BOD_5 concentration grater than 3.0 mg/1 69 percent of the time from April through September). The maximum predicted BOD_5 concentration with the impoundment was 7.0 mg/1 while concentrations in excess of 15.0 mg/1 were predicted without the impoundment.

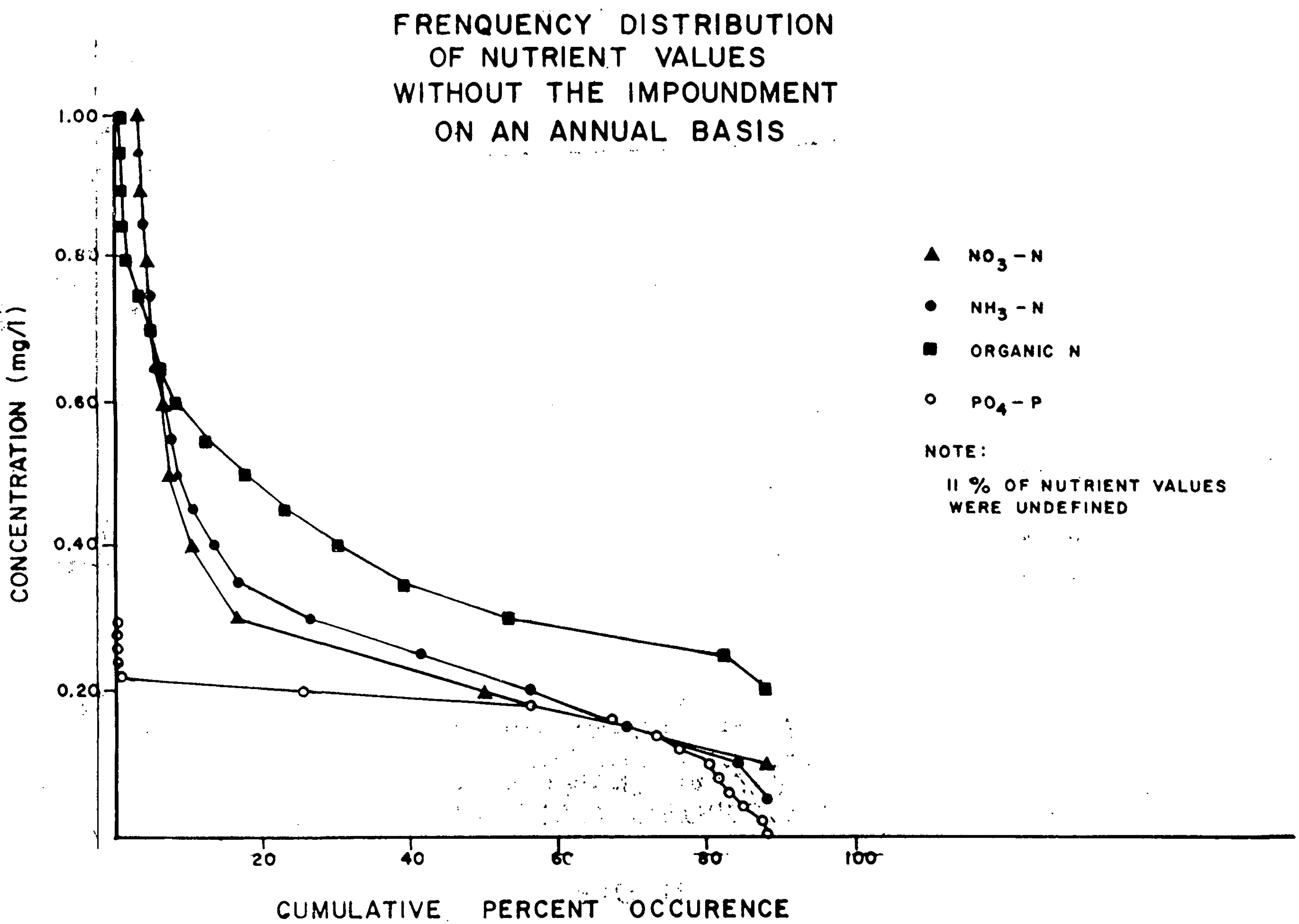
Nitrogen and Phosphorus Species

Predicted concentration frequencies for the various species are presented on Figures 11 and 12. HSP made no predictions as to the eutrophication potential which would exist at the various nutrient concentrations.

FIG. II

FRENQUENCY DISTRIBUTION OF NUTRIENT VALUES WITH THE IMPOUNDMENT ON AN ANNUAL BASIS





FRENQUENCY DISTRIBUTION
OF NUTRIENT VALUES
WITHOUT THE IMPOUNDMENT
ON AN ANNUAL BASIS
1.00
0.80
0.60
0.40
0.20
CONCENTRATION (mg/l)
20
40
60
80
100
CUMULATIVE PERCENT OCCURENCE
NO3 - N
NH3 - N
ORGANIC N
PO4 - P
NOTE:
11 % OF NUTRIENT VALUES
WERE UNDEFINED

This representation appears to be oversimplified especially with regard to the conversion of organic-N and NH_3-N to NO_3. The high nitrification rate coefficient referenced to earlier in the section on dissolved oxygen would account for this high conversion, but the basis for the problem appears to be the assumption of a one-way conversion for a naturally cyclic process.

Total Dissolved Solids (TDS)

Hydrocomp predicted that the impoundment would increase the TDS concentrations slightly above those of the uncontrolled stream (greater than 50 mg/l 100 percent of the time with the impoundment and 89 percent of the time without the impoundment). However, peak concentrations would occur in the free flowing environment (greater than 90 mg/l one percent of the time without the impoundment and never exceeding 70 mg/l with the impoundment).

PROBLEM AREAS

General

Both the Hydrocomp Simulation Programming (HSP) Model[25] and the data of this report point out problems with the discharge waters of the proposed impoundment meeting the Georgia Water Quality Standards for dissolved oxygen (D.O). The D.O. of waters in rural streams can be depressed by both carbonaceous and nitrogenous oxygen demands. Water entering streams from springs, subterranean channels, or groundwater seepage is typically low in D.O.[11]

In an attempt to better define problem areas, loadings comparisons were made on both a lbs/acre/day and a lbs/day basis. These comparisons were made between the different sub-basins in the overall Little Black Creek drainage basin (see foldout map in Appendix E-1). For purposes of these comparisons, a sub-basin is defined as the drainage area upstream of a given station, but not included in an upstream sub-basin.

These modes of comparison require both analytical and discharge data. During the entire study period, these two pieces of data were available concurrently for most stations during only two days (August 29 and 30). Since no discharge determinations were performed at Station BC-2, discussion of problems in the BC-2 sub-basin will be based on concentrations only. Flows during these two days were medium to low (Figures 1 and 2).

Table 10 is a comparison of the mean loadings for these two days. It is apparent that the BC-6 sub-basin is the major contributor on a lbs/acre/day basis and one of the major contributors on a lbs/day basis. Table 11 gives the relative magnitude of the BC-6 sub-basin contribution when compared to other sub-basins. The following sub-basin size comparison emphasizes the magnitude of the BC-6 sub-basin contribution under medium to low flow conditions.

Sub-basin	Upstream Drainage Area (acres)	Fractional Size Comparison with BC-6
BC-1	1210	1.27
BC-2	2355	2.47
BC-3	2099	2.20
BC-4	1536	1.61
BC-5	1741	1.82
BC-6	954	____

Figures 13 through 18 point out major nutrient contributions between Stations BC-6 and BC-3. This includes the BC-3 and BC-5 sub-basins.

As pointed out earlier in the discussion of high values and means, the highest fecal coliform densities in May or August occurred at Station BC-2. This indicates a major bacteriological input between stations BC-2 and BC-3 (includes BC-2 and BC-4 sub-basin).

TABLE 10

SUB-BASIN LOADINGS COMPARISONS

Sub-basin	Mean Loadings (August 29-30)-Lbs/acre/day x 10^{-4}*					
	TOC	BOD_5	Tot.-P	Org-N	NH_3-N	Fecal Coliform
BC-1	430	32	2.3	8	0.9	13.2
BC-3	710	79	5.4	18	2.2	311
BC-4	225	18	0.2	5	0.6	1.9
BC-5	130	22	2.0	4	0.4	0.3
BC-6	2,510	387	11.2	52	11.1	1,100
	Mean Loadings (August 29-30)-Lbs/day**					
BC-1	423	32	2.3	7.9	0.9	1,300
BC-3	341	38	2.6	8.7	1.1	14,900
BC-4	34	2.7	0.03	0.81	0.10	29
BC-5	23	3.8	0.35	0.62	0.06	6
BC-6	239	37	1.1	5.0	1.1	10,500

* Fecal coliform loadings are geometric mean F.C./acre/day x 10^5

** Fecal coliform loadings are geometric mean F.C./day x 10^7

TABLE 11

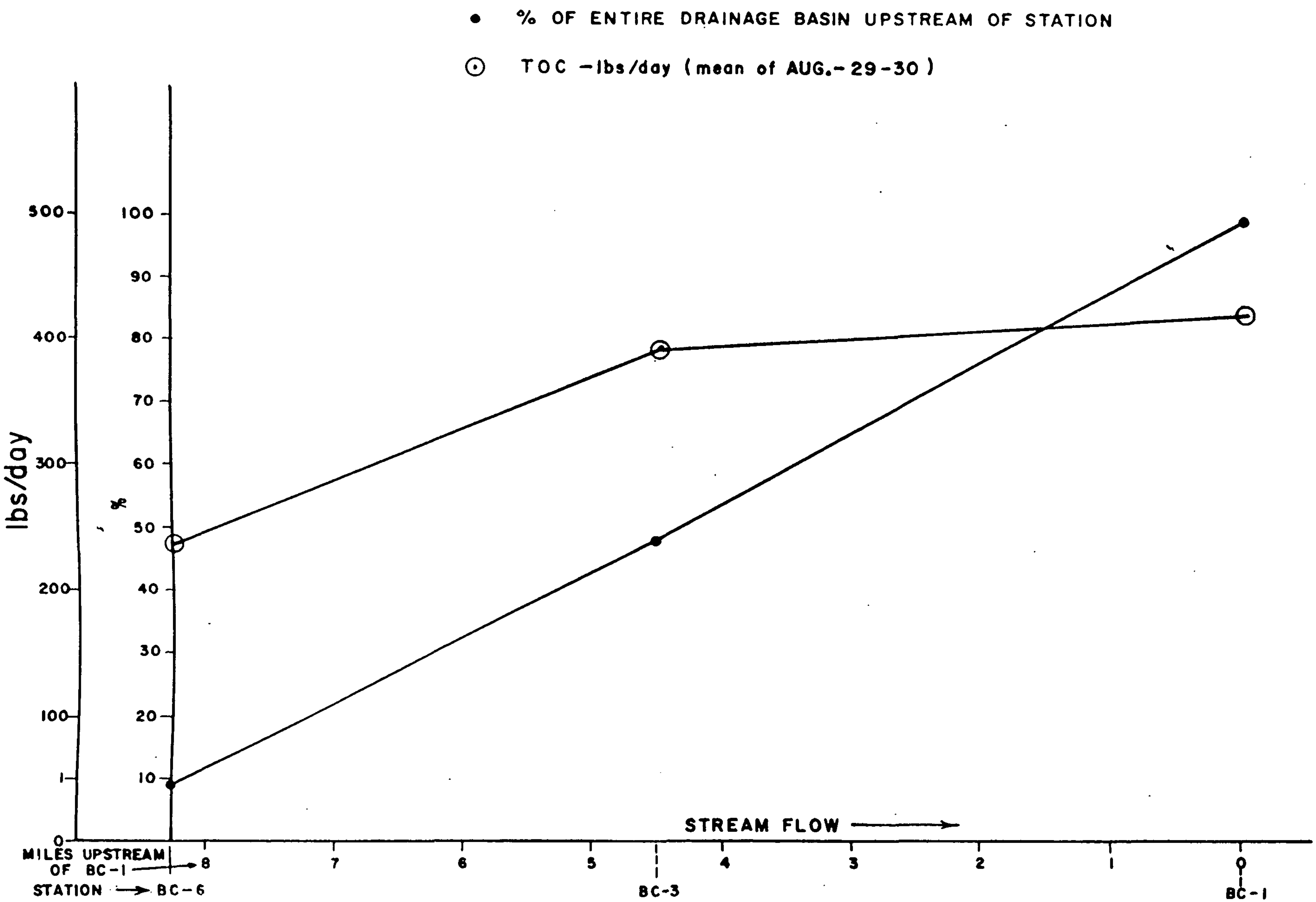
FRACTIONAL COMPARISON OF BC-6 SUB-BASIN LOADINGS
VALUES WITH OTHER SUB-BASINS (ratio of BC-6 values to comparing sub-basin)

Comparing Sub-basin	TOC	BOD_5	Tot-P	Org-N	NH_3-N	Fecal Coliform
			lbs/acre/day Basis*			
BC-1	5.8	12.1	4.9	6.5	12.3	83.6
BC-3	3.5	4.9	2.1	2.9	5.0	3.6
BC-4	11.2	21.5	56	10.4	18.3	578
BC-5	19.3	17.6	516	13.0	27.8	3,247
			lbs/day Basis**			
BC-1	0.55	1.16	0.47	0.63	1.18	8.1
BC-3	0.70	0.97	0.41	0.57	0.96	0.71
BC-4	7.03	13.70	35.7	6.17	10.60	359
BC-5	10.60	9.70	3.06	8.06	17.70	1,757

* Fecal coliform ratios are based on geometric mean F.C./acre/day x 10^5

** Fecal coliform ratios are based on geometric mean F.C./day x 10^7

FIG. 13
TOC PROFILE



BOD_5 PROFILE

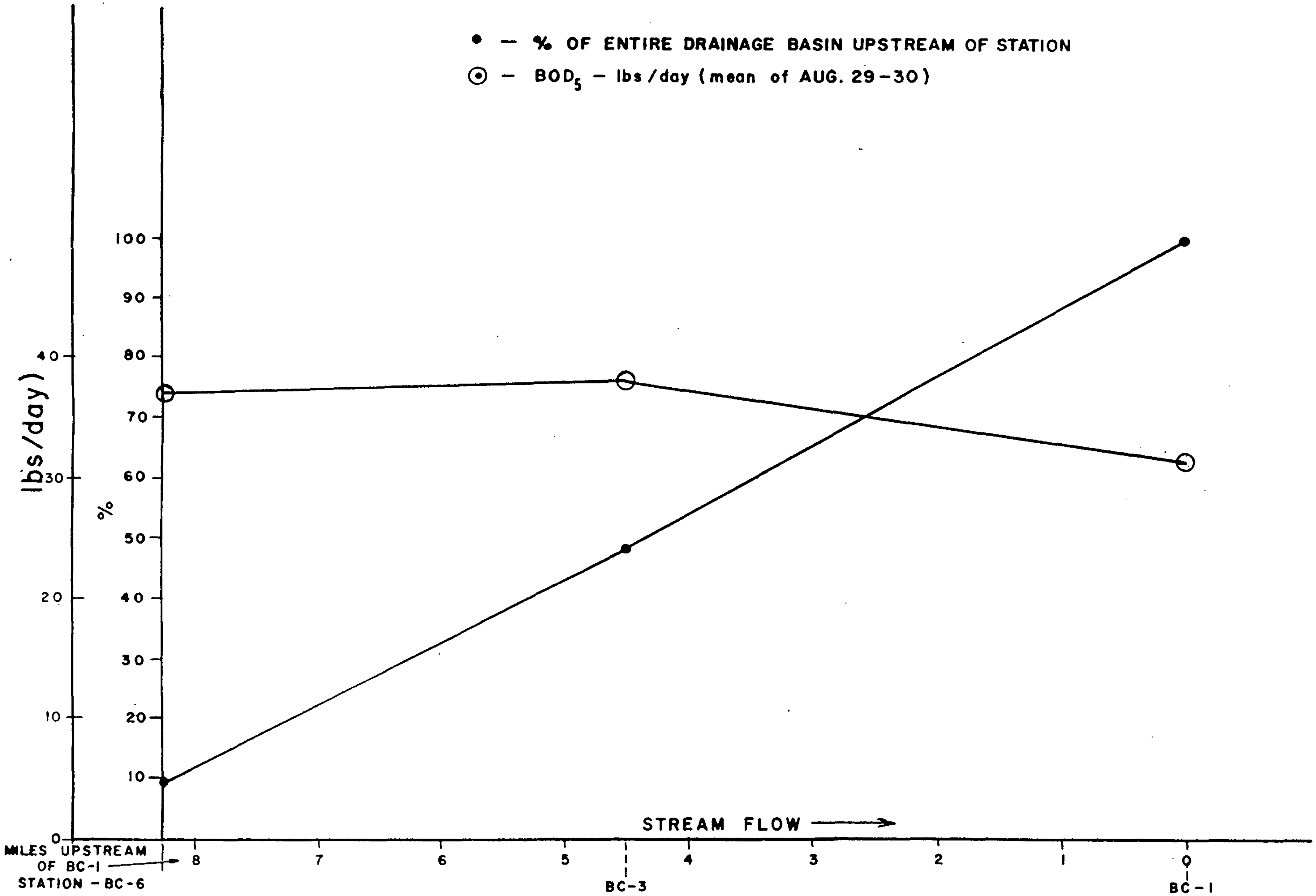


FIG. 15

Tot-P PROFILE

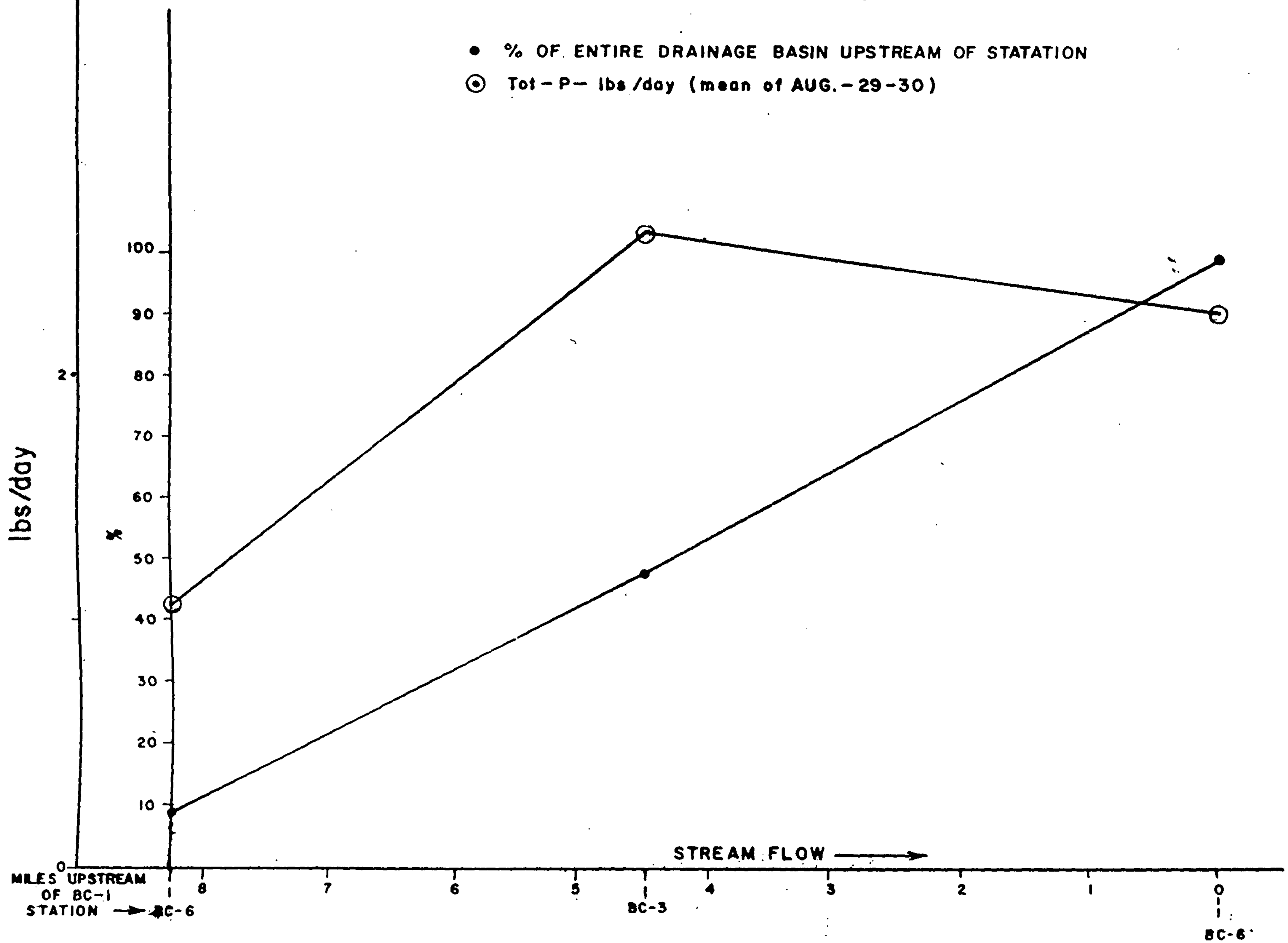


FIG. 16
Org-N PROFILE

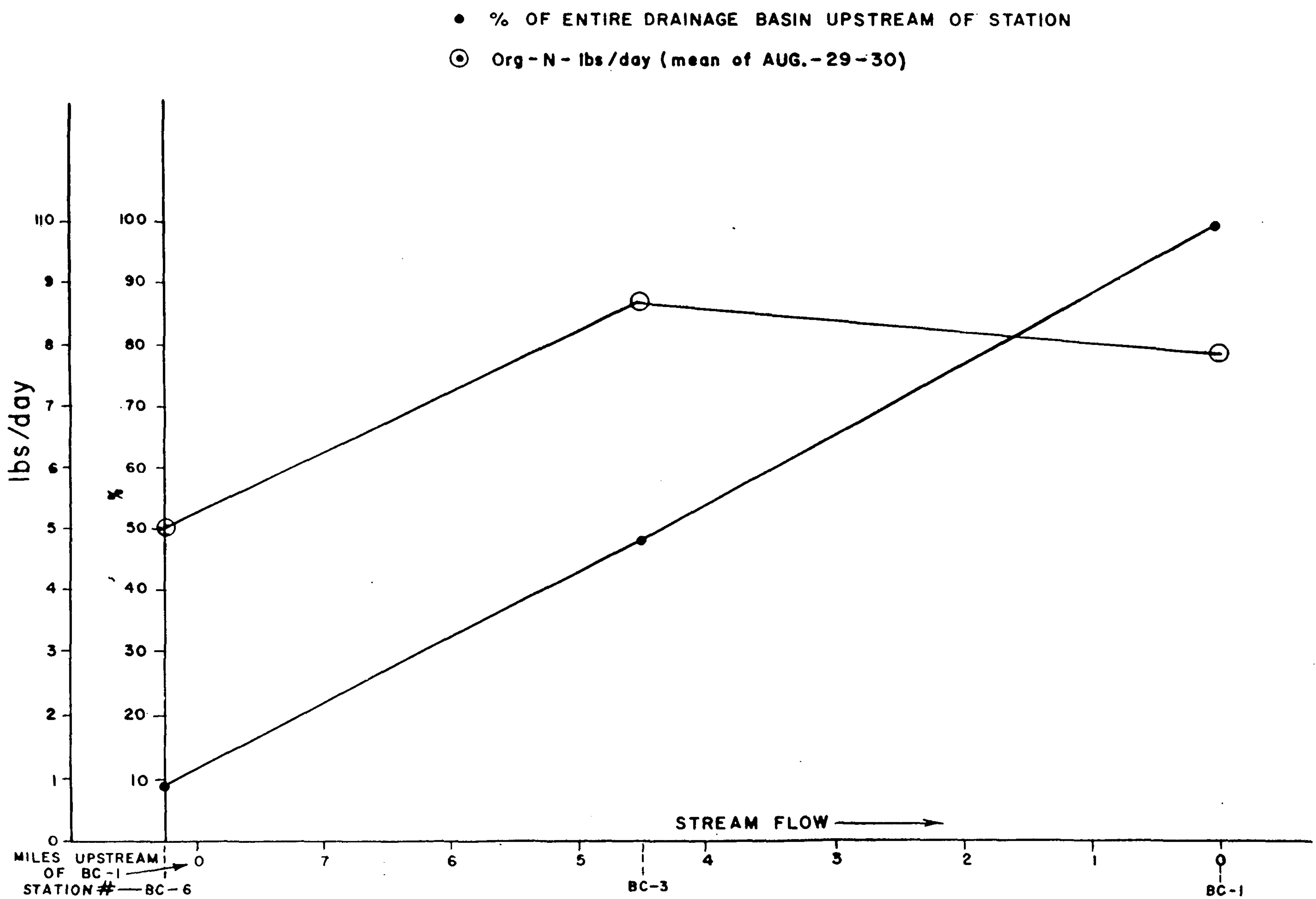
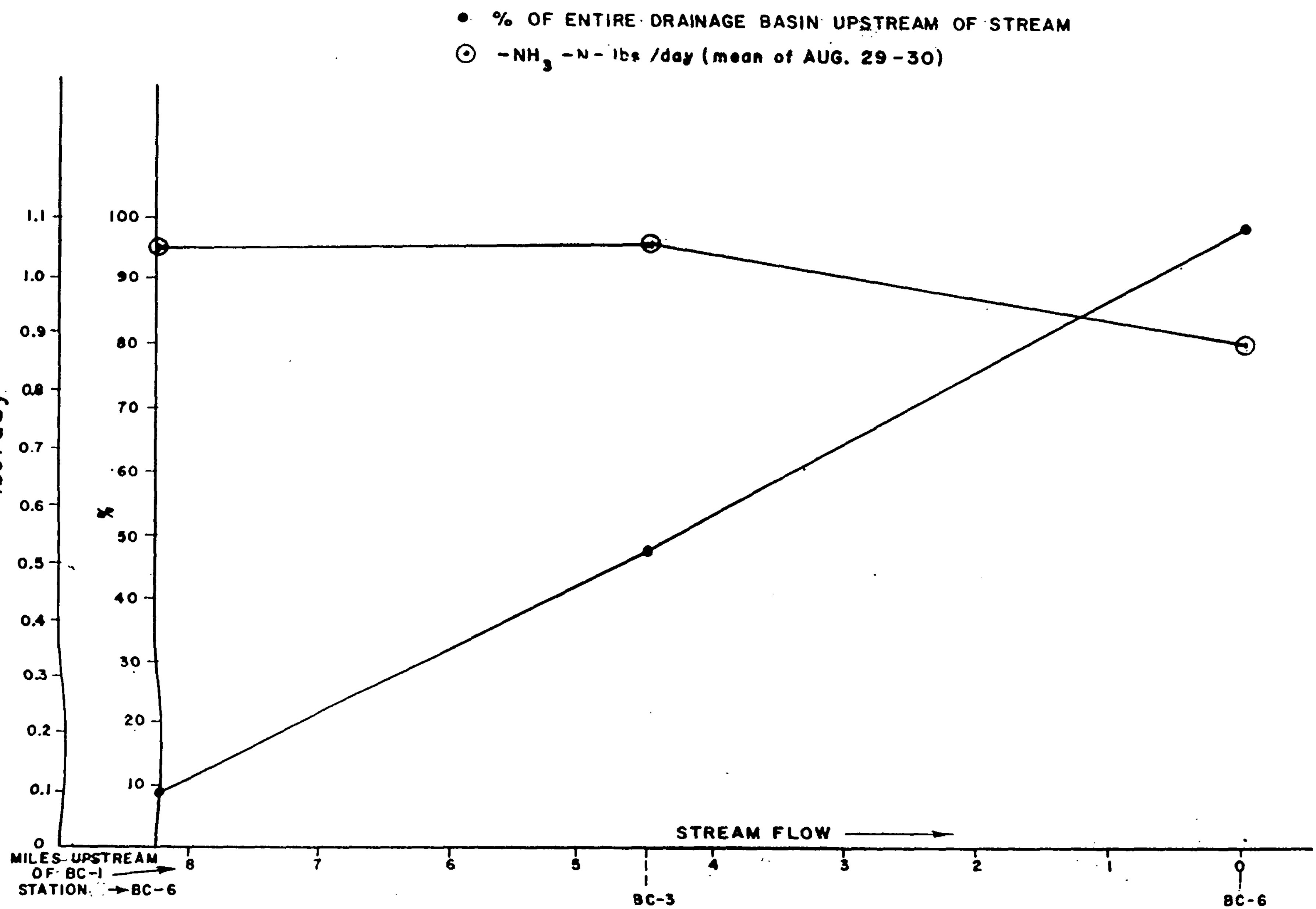
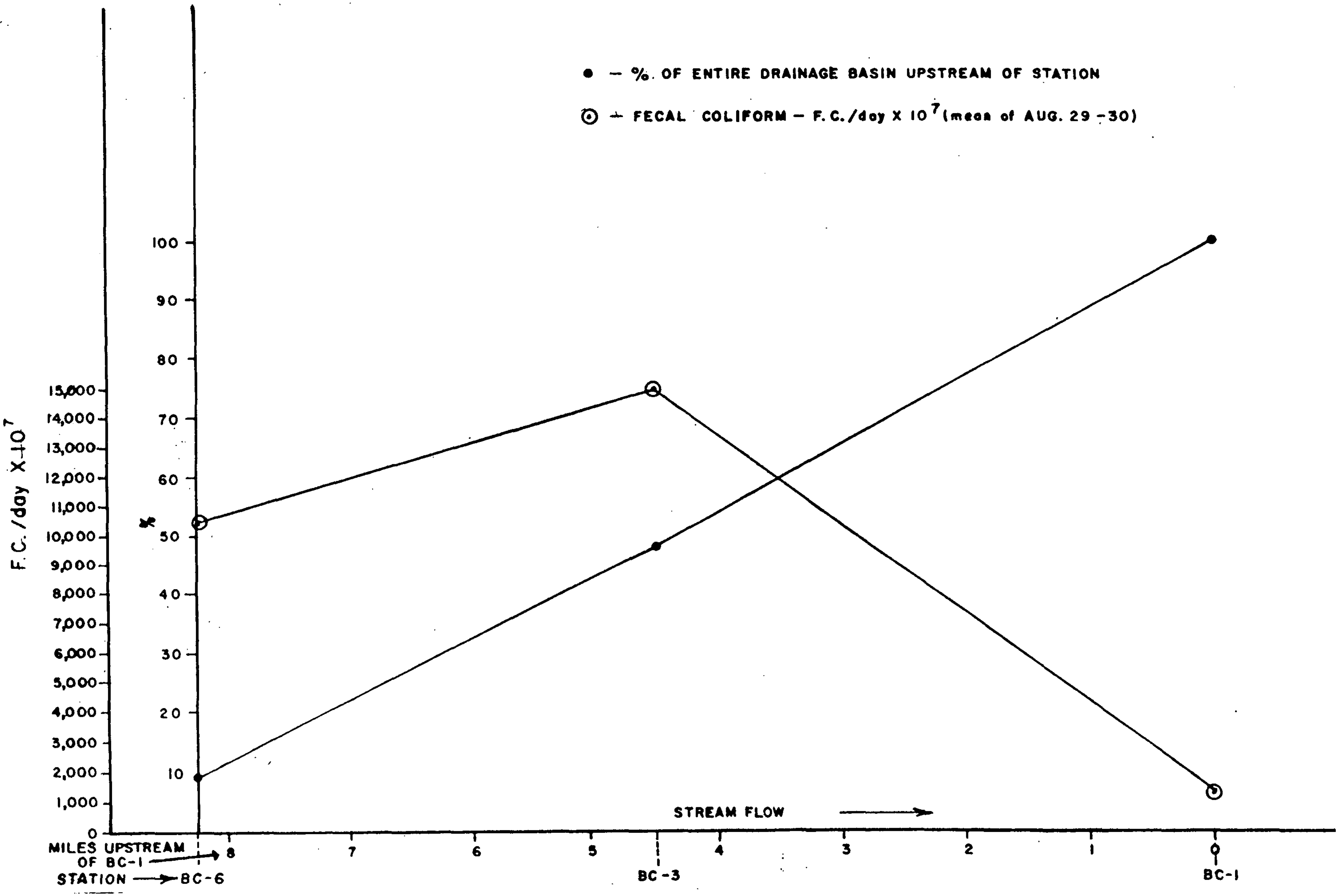


FIG. 17
NH_3-N PROFILE



FECAL COLIFORM PROFILE



If all of the nutrient inputs in the overall drainage basin were from decaying vegatative matter (forest and pasture litter), the carbon to nitrogen ratio (C:N) in the stream would be very high. The mean C:N for trees indigenous to the study area is 59:1.[26] Since the soluble carbon in streams should remain fairly constant for a given rural area, the C:N should be lowered mainly by the introduction of extraneous nitrogen. In rural areas, this is accomplished by the introduction of nutrients from decaying vegetative matter, fertilizer, animal manure, and domestic sewage. The mean C:N for domestic animals in the study area is 12:1[27] and for domestic sewage is 5:1.[28]

It would not be practical to remove all forest and pasture litter or to have farmers stop the application of fertilizers. However, good farming management practices can reduce nutrient inputs from fertilizer. The elimination of nutrient inputs from animal manure and domestic sewage is the most practical means of elevating the C:N ratio (indicative of reduction in nitrogen inputs).

The following sections examine each of the above mentioned problem areas in detail. Possible reasons for and solutions to the problems from the viewpoint of animal and domestic waste reduction are given. Also discussed is a potential problem in the BC-1 sub-basin which was mentioned earlier in the footnote on page

BC-6 Sub-basin

On only one day was it possible to compare the BC-6 Sub-basin with the entire drainage basin (Station BC-1) under high runoff conditions. Under these conditions, the loadings at Station BC-1 were much greater than at Station BC-6. Since it is easy to see from Figure 1 that medium and low flow conditions prevail during the major portion of the year, the continued medium and low flow contribution from this sub-basin will have a significant impact on the proposed impoundment.

The many possible sources for these inordinately high loadings include: (1) agricultural runoff; (2) forest runoff; (3) runoff from confined animal feeding operations; (4) cross drainage from adjoining drainage basins, and (5) polluted water from springs or groundwater seepage.

The following points invalidate the first four causes as major contributors.

(1) As discussed earlier, agricultural runoff in the study area is negligible except under intensive rainfall-runoff conditions. The medium to low flow conditions during the period under discussion represent low runoff conditions.

(2) Low runoff conditions and the fact that the sub-basin has only 25 percent forest cover indicates that very little forest runoff would have occurred during the period under discussion.

(3) As far as could be determined by either the SAD-SCS animal population survey or the EPA-EPIC waste source inventory, no point sources of pollution (confined animal feeding operations) exist in this sub-basin.

(4) On-site inspections by SCS personnel revealed no cross-drainage from adjoining drainage basins.[14]

Based on the above arguments, the most likely origin of high loadings appears to be an underground source. This thesis is supported by both the chemical and discharge data of this study, plus the hydrogeological characteristics of the study area.

The consistantly low D.O. values for this sub-basin are indicative of groundwater seepage.[11]

The BC-6 Sub-basin is only 0.62 and 0.55 times as large as the BC-4 and BC-5 Sub-basins respectively. The following discharge data, however, indicate that the BC-6 Sub-basin should have a much larger drainage basin than either of the other two.

Date	Flow-cfs BC-4	BC-5	BC-6
May (all visits)	0	0	Flow
August 29	0.3	0.3	6.0
August 30	0.4	0.1	1.9

This apparent discrepancy in flow can be explained with a map showing flow characteristics of the area surrounding the BC-6 sub-basin (Figure 19). Groundwater flow in this area roughly parallels the flow of Little Black Creek. This contention is supported by the flow direction of the major rivers in the study area (Appendix E-2). Figure 19 shows that shallow groundwater flow should reach the BC-6 sub-basin without significant interference. Shallow groundwater flow toward the BC-5 and BC-4 sub-basins should, however, be intercepted by Little Lotts Creek and Upper Black Creek respectively. This would reduce the groundwater induced base flow in the two latter sub-basins.

Although Statesboro, Georgia is served by a sewage treatment plant, many of the recently annexed outlying areas are serviced by septic tanks.[14] Since groundwater flow is apparently from Statesboro into the BC-6 Sub-basin (Figure 19 and Appendix E-2), septic tank drainage could possibly pollute the groundwater entering the sub-basin.

If future groundwater sampling in the upper end of the BC-6 Sub-basin indicates that this is the case, the only economically feasible solution to the problem would be the elimination of all upgradient septic tanks.

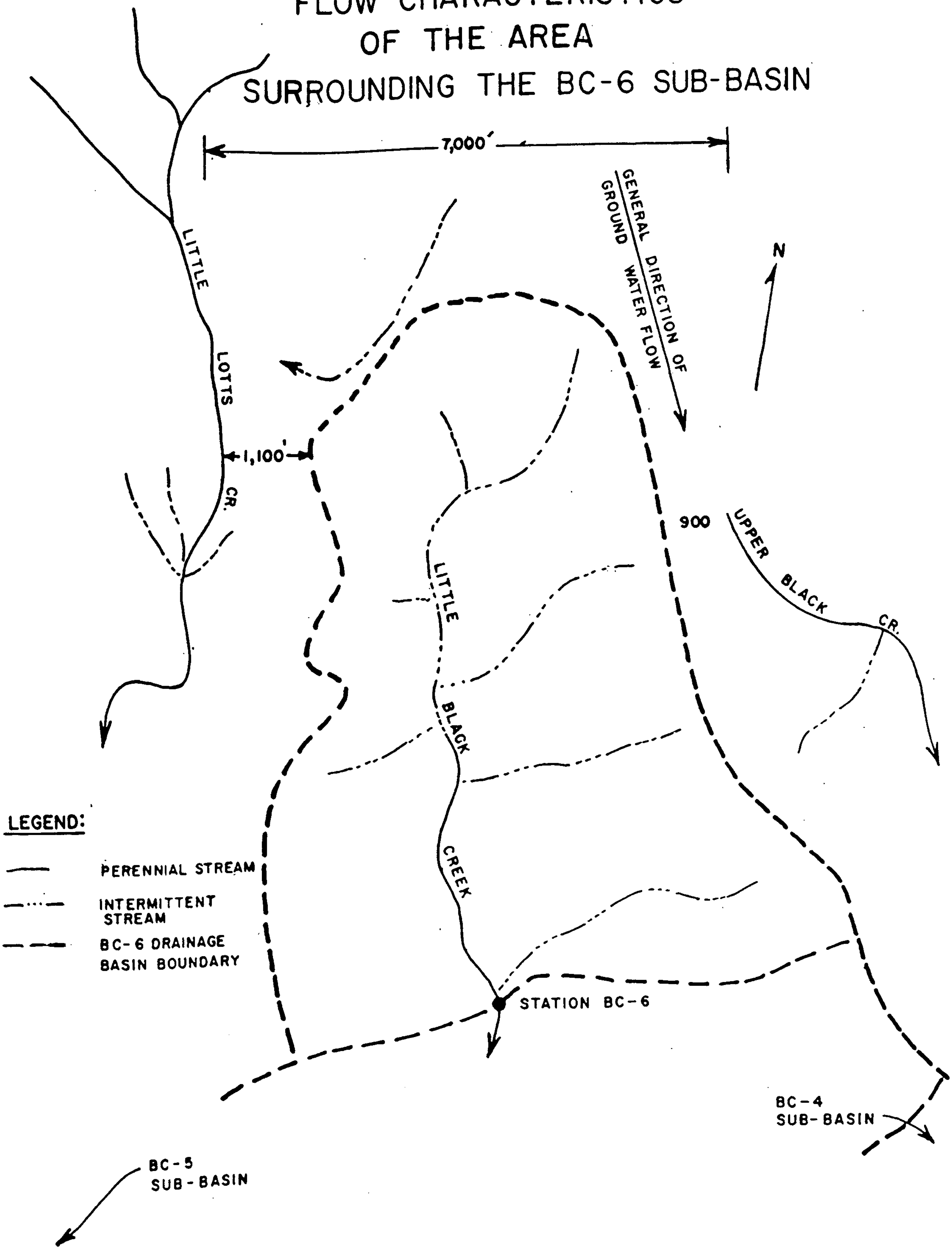
BC-3 Sub-basin

As mentioned earlier and illustrated in Figures 13 through 18, there is a major pollutional input in this sub-basin somewhere between Stations BC-3 and BC-6. Contributions from the BC-5 Sub-basin can be disregarded as shown by its insignificant lbs/day input depicted in Table 10.

Three possible sources are the two hog feeding and one poultry feeding operations identified by EPA-EPIC and shown on the map in Appendix E-1. The status of these

FIG. 19

FLOW CHARACTERISTICS OF THE AREA SURROUNDING THE BC-6 SUB-BASIN



operations as to size or existance during the study period are unknown.

The other source is the mobile home court identified by EPA-EPIC and shown on the map in Appendix E-1. This source was also identified by field sampling personnel during the study. The court contains thirteen mobile homes which house thirty-five to forty people. All sanitary waste from the court is treated in a 1.5 acre oxidation pond having a normal flow of 0.6 cubic feet per second (CFS). Maximum flow from the pond before overflow through an emergency sluceway is 1.0 c.f.s.[14]

Possible solutions to waste source problems in this area include: (1) containment and treatment of all runoff from any animal feeding operations, and (2) upgrading of the court's waste treatment system or connection with the Statesboro municipal system.

BC-2 Sub-basin

The absence of discharge data for Station BC-2 precluded comparisons of its sub-basin with the other sub-basins on a loadings basis. However, this station is of major importance in the identification of problem areas. It exhibited the highest concentrations for most parameters during the May sampling period. Negligible runoff conditions and resultant low stream flow existed over the entire drainage basin during this time. The major identifiable sources of pollution in this area are animal feeding operations. A possible solution to this problem would be the containment and treatment of any seepage or runoff from these operations.

BC-1 Sub-basin

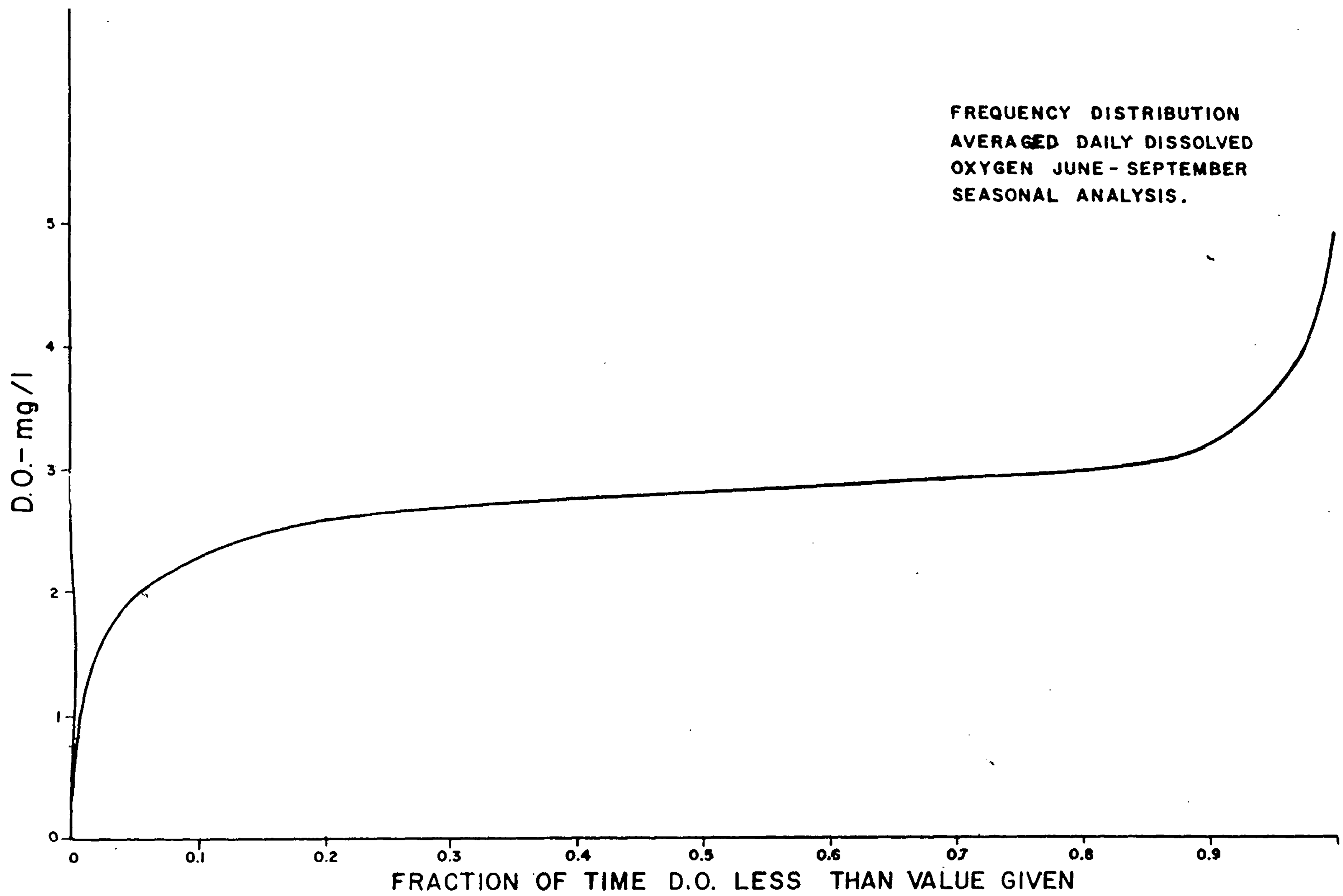
The major characteristic of this sub-basin appears to be its reduction in most cases of the pollutional loading contributed by the BC-3 Sub-basin (Table 10) and reduction of the high concentrations exhibited by Station BC-2 (Appendix B). This capacity is explained by the soil types described in the description of the study area. The forty-two percent minor soils and ten percent Pelham soils are all subject to complete inundation for extended portions of the year. This gives rise to an intermittent swampy environment. The capacity of swamps to effectively remove nutrients from water is not fully understood. However, the work of many researchers indicates that swamps are effective "treatment" systems. Some investigators estimate that swamps can remove up to fifty percent and thirty percent of the nitrogen and phosphorus, respectively, from waters flowing through.[29]

A major ,otential problem not reflected by the data of this report is runoff from a large hog feeding operation in the BC-1 Sub-basin. During the study, this operation contained 300 hogs in a wooded area just above the swampy area which will become the upper end of the impoundment. The capacity of these hog pens was much greater than 300 animals. Although the hog pens were dry during the May visit by the SAD-SCS team, heavy rains would wash pollution directly into the swamp. During the study, a single channel was assumed at Station BC-1 for all except flood conditions. A second, high flow only, channel was discovered toward the end of the study. Any runoff from the hog feeding operation would enter Little Black Creek via the second channel. The load from this source could possibly be greater than the assimilative capacity of the downstream swampy area. This waste flow directly into the proposed impoundment would accelerate any eutrophication process already underway.

If the impoundment is constructed, this waste source would definitely have to be eliminated or its waste contained and adequately treated.

SUPPLEMENTAL OXYGEN REQUIREMENTS

Based on the HSP report,[25] it is difficult to determine the amount of supplemental oxygen that would be required to maintain Georgia Water Quality Standards for dissolved oxygen (D.O.) in the proposed Little Black Creek Impoundment. However, a minimum value can be determined from the information given in Table 8.5 of the HSP report and plotted here as Figure 20.


FREQUENCY DISTRIBUTION
AVERAGED DAILY DISSOLVED
OXYGEN JUNE - SEPTEMBER
SEASONAL ANALYSIS.
D.O. - mg/l
0
1
2
3
4
5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
FRACTION OF TIME D.O. LESS THAN VALUE GIVEN

This figure shows that the average daily D.O. will be greater than 1.0 mg/l 99.5 percent of the time in the summer season. The summer season, as defined in the HSP report, is June through September (122 days). It can be inferred from the above statistic that D.O. concentrations of less than 1.0 mg/l will not be a yearly occurrance, but should occur perhaps every other year.

It can be estimated, therefore, that, at least once during the year, the difference in D.O. between 5.0 mg/l and 1.0 mg/l will have to be made up. Since the lake will typically be operating near the level of the primary spillway, its' volume will be approximately 2,000 acre feet (2.5 x 10^9 liters). Satisfaction of the 4.0 mg/l D.O. deficit in the lake would require 22,026 pounds $\{(4.0 \text{ mg/l}) (2.5 \times 10^9 \text{ liters}) (\frac{\text{gram}}{10^3 \text{ mg}}) (\frac{\text{pounds}}{454 \text{ gram}})\}$ of molecular oxygen.

This amount of oxygen is an estimate of the minimum required if the impoundment were to begin the summer season at 5.0 mg/l of D.O. and gradually decline to a 1.0 mg/l level at the end of the season. This situation probably will not occur. The gradual decline will be interrupted by periods of high flow. These high flows will replace the oxygen deficient water in the lake with oxygen rich water. Despite this, the actual oxygen requirement is likely to be greater, possibly several times that of the estimated amounts. An estimate of the actual amount of supplemental oxygen required could be made by having Hydrocomp re-run their model with these features included.

Dissolving enough oxygen in the lake may present a problem. Mechanical surface aerators are a possibility, but their use would not be wise. These units are very inefficient when operated at high levels of dissolved oxygen. In addition, they require maintenance and constant care, present a danger to the public, and are subject to vandalism. Because of the areal extent of the lake, many such units would be required to aerate the entire body of water.

The most reasonable possibility would involve the use of molecular oxygen (either gaseous or liquid) and a system of diffusers. Such a system is being investigated by the U. S. Army Corps of Engineers for use in Clarke Hill Reservoir on the Georgia-South Carolina border.

In a 15 foot deep lake, a diffuser might typically achieve absorption efficiencies of twenty to forty percent. Based on thirty percent efficiency, about 73,000 pounds or thirty-seven tons of oxygen would be required as a minimum over the summer season to satisfy the 4.0 mg/l D.O. deficit. Since molecular oxygen is generally available for about $100/ton, the minimum yearly requirement for oxygen would be $3,700. Additional expenses would include the capital cost of an oxygen storage and diffuser system plus operation and maintenance cost. However, this estimate is only a minimum cost. The actual cost could be several times higher.

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APPENDIX A

Contract No. AG-13-scs-00223

COOPERATIVE AGREEMENT
between the
ENVIRONMENTAL PROTECTION AGENCY
and the
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

RELATIVE TO: Preimpoundment Water Quality Studies

THIS AGREEMENT, made and entered into this 1st day of May, 1974, by and between the Environmental Protection Agency (EPA) Region IV (referred to as the EPA) and the Soil Conservation Service, United States Department of Agriculture (referred to as the Service).

AUTHORITY: (1) Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 820) 33 U.S.C. 1254 (b)(6)

(2) Section 601 of the Economy Act of June 30, 1932, as amended (31 U.S.C. 686)

WITNESSETH

WHEREAS, the Soil Conservation Service in administering and carrying out an effective watershed protection program under provisions of Public Law 566 - 83rd Congress, as amended, 16 U.S.C. 1003, has a need for preimpoundment studies of water quality conditions within the drainage basins of proposed impoundments in Black Creek Watershed, Bulloch County, Georgia and Evans County Watershed, Evans, Tattnall and Candler Counties, Georgia. In order to determine existing stream water quality and to predict the quality of water in the reservoirs after impoundment, the Soil Conservation Service is desirous of entering into a financial arrangement with the Environmental Protection Agency for a preimpoundment study.

WHEREAS, the Environmental Protection Agency has the personnel, facilities and technical knowledge to make the desired studies and are willing to enter into a cooperative arrangement.

NOW, THEREFORE, for and in consideration of the promises and mutual covenants herein contained, the parties hereto do agree with each other as follows:

I. THE EPA AGREES:

A. To commence a comprehensive study in the current fiscal year to achieve the below listed objectives leading towards completion in the following fiscal year.

B. To conduct two studies of about one week duration each to determine the physical and chemical quality and the degree of bacteriological contamination of: (a) tributaries which will serve as influent water sources after the lakes are filled, (b) some main channel points on both Cedar and Little Black Creeks within the boundaries of the impoundments and (c) main channel points at or immediately downstream of both dam sites. Work will be performed in accordance with a prepared detailed study plan (Attachment A).

C. To predict the quality of the impounded waters following project completion; especially the expected fecal coliform concentrations in designated recreational areas of the impoundments.

D. To provide data for the confirmation of a mathematical model which can be used in the future, with a minimal amount of additional data, to predict water quality in other impoundments in the same general type of area (same soil type and land usage).

E. To furnish SCS with a complete report giving results of studies conducted under A, B, C and D above within nine (9) months after effective date of this agreement.

F. To periodically furnish the Service itemized billings for work accomplished in accordance with study plan (Attachment A).

II. THE SERVICE AGREES:

A. To assist EPA by changing charts on recording instruments at specific locations within the watersheds.

B. To furnish maps of the study areas and design data for the proposed impoundments.

C. To assist EPA in gathering land use data within the impoundment drainage areas.

D. To reimburse EPA for the preimpoundment studies in an amount not to exceed $15,000 during fiscal year 1974. Payments will be made upon receipt of itemized billings for work accomplished.

III. IT IS MUTUALLY AGREED:

A. This agreement shall be effective for the period May 1, 1974 through June 30, 1974 and may be supplemented, amended or renewed for continued work during subsequent fiscal year.

B. It is the intent of the EPA and Service to continue this agreement during fiscal year 1975 for completion of work in the study plan. Renewal will be contingent upon availability of appropriated funds.

C. This agreement shall be terminated upon completion of the work as mutually determined by the parties thereto.

IN WITNESS WHEREOF, the parties have executed this agreement on the day, month and year first above written.

ENVIRONMENTAL PROTECTION AGENCY

John C. White

for Jack E. Ravan

Title: Regional Administrator
Region IV

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Charles W. Bartlett

Charles W. Bartlett

Title: State Conservationist

ATTACHMENT A

For copies of or details concerning the study plan, contact:

Dr. David W. Hill

or

Hugh C. Vick

Environmental Protection Agency
Region IV
Surveillance and Analysis Division
College Station Road
Athens, GA 30601

EPA-IAG-R5-0604

Contract No. AG-13-scs-00226

COOPERATIVE AGREEMENT
between the
ENVIRONMENTAL PROTECTION AGENCY
and the
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

RELATIVE TO: Preimpoundment Water Quality Studies

THIS AGREEMENT, made and entered into this 1st day of July , 1974, by and between the Environmental Protection Agency (EPA) Region IV (referred to as the EPA) and the Soil Conservation Service, United States Department of Agriculture (referred to as the Service).

AUTHORITY: (1) Federal Water Pollution Control Act Amendments of 1972 (86 Stat. 820) 33 U.S.C. 1254 (b)(6)

(2) Section 601 of the Economy Act of June 30, 1932, as amended (31 U.S.C. 686)

WITNESSETH

WHEREAS, the Soil Conservation Service in administering and carrying out an effective watershed protection program under provisions of Public Law 566 - 83rd Congress, as amended, 16 U.S.C. 1003, has a need for preimpoundment studies of water quality conditions within the drainage basins of proposed impoundments in Black Creek Watershed, Bulloch County, Georgia and Evans County Watershed, Evans, Tattnall and Candler Counties, Georgia. In order to determine existing stream water quality and to predict the quality of water in the reservoirs after impoundment, the Soil Conservation Service is desirous of entering into a financial arrangement with the Environmental Protection Agency for a preimpoundment study.

WHEREAS, the Environmental Protection Agency has the personnel, facilities and technical knowledge to make the desired studies and is willing to enter into a cooperative arrangement.

NOW, THEREFORE, for and in consideration of the promises and mutual covenants herein contained, the parties hereto do agree with each other as follows:

I. THE EPA AGREES:

A. To carryout a comprehensive study in the current fiscal year to achieve the below listed objectives.

B. To conduct two studies of about one week duration each to determine the physical and chemical quality and the degree of bacteriological contamination of: (a) tributaries which will serve as influent water sources after the lakes are filled, (b) some main channel points on both Cedar and Little Black Creeks within the boundaries of the impoundments and (c) main channel points at or immediately downstream of both dam sites. Work will be performed in accordance with a prepared detailed study plan (Attachment A).

C. To predict the quality of the impounded waters following project completion; especially the expected fecal coliform concentrations in designated recreational areas of the impoundments.

D. To provide data for the confirmation of a mathematical model which can be used in the future, with a minimal amount of additional data, to predict water quality in other impoundments in the same general type of area (same soil type and land usage).

E. To furnish SCS with a complete report giving results of studies conducted under A, B, C and D above within seven (7) months after effective date of this agreement.

F. To periodically furnish the Service itemized billings for work accomplished in accordance with study plan (Attachment A).

II. THE SERVICE AGREES:

A. To assist EPA by changing charts on recording instruments at specific locations within the watersheds.

B. To furnish maps of the study areas and design data for the proposed impoundments.

C. To assist EPA in gathering land use data within the impoundment drainage areas.

D. To reimburse EPA for the preimpoundment studies in an amount not to exceed $23,469 during fiscal year 1975. Payments will be made upon receipt of itemized billings for work accomplished.

III. IT IS MUTUALLY AGREED:

A. This agreement shall be effective for the period July 1, 1974 through January 31, 1975 and may be supplemented, amended or renewed for continued work during subsequent fiscal year.

B. This agreement shall be terminated upon completion of the work as mutually determined by the parties thereto.

IN WITNESS WHEREOF, the parties have executed this agreement on the day, month and year first above written.

ENVIRONMENTAL PROTECTION AGENCY	SOIL CONSERVATION SERVICE UNITED STATES DEPARTMENT OF AGRICULTURE
Jack E. Ravan	Charles W. Bartlett
Title: Regional Administrator Region IV	Title: State Conservationist

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region IV, Surveillance & Analysis Division
College Station Road, Athens, GA 30601

SUBJECT: Request for Extension of Cooperative Agreement with the Soil Conservation Service (SCS) DATE: May 20, 1975

FROM: 4ASI:David W. Hill
Chief, Special Studies

TO: 4A:Jack E. Ravan
Administrator, Region IV, EPA

THRU: 4AS:John A. Little
Director, S&A Division

JAL

SUMMARY

The attached amendment to our current Cooperative Agreement with SCS is intended to extend the agreement through the next fiscal year. This will be adequate time to complete and terminate the project and will allow us to take advantage of unused funds (more than $11,000) committed to the project.

Approximately May 1, 1975, the SCS finalized a contract with Hydrocomp, a private computer firm specializing in hydrology and water quality, which will analyze and make detailed (hour-by-hour) water quality projections from our field data. This is to be a six-month contract, and, consequently, Hydrocomp will not finish its work until around November 1, 1975, after which time we will need to use its findings and report as the major components of a report from EPA to SCS.

We are currently using the reimbursable funds available through this cooperative agreement primarily to hire students on the "Stay-in-School" program to process data. (All field work has been completed.) An extension of this agreement will allow us to continue to use the funds remaining in the contract for student salaries and other project-related costs. This use of these funds will not hinder other work in progress or assigned and will also provide Region IV with some very useful water quality data and projection techniques that will be valuable in connection with similar projects which we review for SCS through the EIS process.

ACTION

Please sign the attached amendment to allow us to continue to use SCS-designated funds during the next fiscal year. Please sign the original and all four copies of the amendment and return them to me.

EPA Form 1320-6 (Rev. 6-72)

BACKGROUND

Cooperative Agreement No. AG-13-scs-00226 (EPA-IAG-R5-0604) and cover letter dated May 15, 1975, from the State Conservationist, Athens, GA.

David W. Hill

David W. Hill
Chief, Special Studies

Enclosures

cc - Bill McBride

Contract No. AG-13-scs-00226
EPA-IAG-R5-0604

AMENDMENT
to
COOPERATIVE AGREEMENT
between the
ENVIRONMENTAL PROTECTION AGENCY
and the
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

RELATIVE TO: Preimpoundment Water Quality Studies

Section III.A. and Amendment are hereby modified as follows:

> This agreement shall be effective for the period July 1, 1975 through June 30, 1976 and may be supplemented, amended or renewed for continued work during subsequent fiscal year.

ENVIRONMENTAL PROTECTION AGENCY	SOIL CONSERVATION SERVICE UNITED STATES DEPARTMENT OF AGRICULTURE
Jack E. Ravan	Charles W. Bartlett
Title: Regional Administrator Region IV	Title: acting State Conservationist

APPENDIX B

****

WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-01 L BLACK CR AT DAMSITE N DENMARK OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L	00605 ORG N N MG/L
		740513	1840	20.0	0.9	5.2	1.5	5.9	34	4	0.200
		740514	1215	18.5	0.8	4.8	2.1	6.0	57	5	0.210
		740515	1220	21.5	0.6	4.6	1.6	6.1	56	18	0.170
		740516	1125	20.5	0.6	4.1	1.7	6.2	54	28	0.200
		740517	0840	20.0	0.6	4.1	1.0	6.2	29	9	0.250
		740517	0845				1.7				
		740806	1945	23.0	127.0	5.2		4.8			
		740807	1120	23.0	131.0		2.1	4.4	131	7	0.180
		740808	1115	24.0	175.0		2.4	4.5			0.670
		740815	1030		155.0		1.3		89	11	0.600
		740829	0920	22.0	3.5	4.2	1.8	5.3	138	6	0.400
		740830	0755	21.0	3.2	4.0	1.7	5.3	102	22	0.480
		741118	1020	15.0	1.2		1.5		18	24	0.100
		741118	1410	16.0	1.2		1.1		41	3	0.230
		741120	1500	17.0	1.9		2.6		54	8	0.160
		741120	1530	17.0	1.9		2.2		34	14	0.070
		741120	1600	17.0	2.0		2.1		43	13	0.130
		741120	1630	17.0	2.1		2.5		45	9	0.190
		741120	1700	16.5	2.1		2.0		38	13	0.170
		741120	1800	16.5	2.2		1.5		47	11	0.100
		741120	1900	16.5	2.3		1.7		21	7	0.160
		741121	1325	15.0	2.4		3.2		74	12	0.760
		750113	1730	12.0	190.0		2.6		134	9	0.480
		750113	1830	12.0	190.0		1.8		159	5	0.490
		750114	0925		212.0		0.9		111	10	0.460
		750125	1000	12.0	100.0		1.4		63	3	0.290

DATE	TIME	DATE	TIME	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML	00303 BOD 1 DAY MG/L	00306 BOD 4 DAY MG/L
		740513	1840	0.07	0.27	0.06	0.18	9.0	400		
		740514	1215	0.06	0.27	0.10	0.20	9.0	170		
		740515	1220	0.10	0.27	0.10	0.25	11.0	520		
		740516	1125	0.10	0.30	0.10	0.25	10.0	110		
		740517	0840	0.08	0.33	0.10	0.28	9.0	190		
		740517	0845							0.300	1.2
		740807	1120	0.47	0.65	0.05K	0.06	33.0	850		
		740808	1115	0.01	0.68	0.05K	0.06	27.0	180		
		740815	1030	0.05	0.65	0.05K	0.11	25.0	5800		
		740829	0920	0.05K	0.40	0.05K	0.13	22.0	110		
		740830	0755	0.05K	0.48	0.05K	0.13	25.0	230		
		741118	1020	0.10	0.20	0.10	0.20	4.0	870		
		741118	1410	0.01	0.24	0.01K	0.18	4.0	830		

APPENDIX B
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WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-01 L BLACK CR AT DAMSITE N DENMARK OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML	00303 BOD 1 DAY MG/L	00306 BOD 4 DAY MG/L
		741120	1500	0.10	0.26	0.10	0.20	6.0	1320		
		741120	1530	0.17	0.24	0.10	0.19	6.0	1600		
		741120	1600	0.07	0.20	0.01K	0.31	7.0	1550		
		741120	1630	0.01	0.20	0.01K	0.19	10.0	1530		
		741120	1700	0.03	0.20	0.01K	0.19	7.0	1300		
		741120	1800	0.10	0.20	0.01K	0.22	13.0	1180		
		741120	1900	0.10	0.26	0.01K	0.20	9.0	1350		
		741121	1325	0.07	0.83	0.02	0.05	12.0	425		
		750113	1730	0.04	0.52	0.01K	0.10	22.0	17600		
		750113	1830	0.07	0.56	0.01	0.10	26.0	13200		
		750114	0925	0.06	0.52	0.01	0.06	27.0	12000		
		750125	1000	0.01	0.30	0.01	0.03	13.0	260		

DATE	TIME	DATE	TIME	00315 BOD 7 DAY MG/L	00322 BOD 10 DAY MG/L	00328 BOD 12 DAY MG/L	00350 BOD 14 DAY MG/L	00331 BOD 16 DAY MG/L	00333 BOD 18 DAY MG/L	00324 BOD 20 DAY MG/L
		740517	0845	1.7	2.0	2.3	2.5	2.4	2.9	3.3

APPENDIX B

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WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-02A L BLACK CR NO EAST OF EMIT OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
		740514	0950	20.0	0.0	0.5	6.6	6.1	98	28

DATE	TIME	DATE	TIME	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740514	0950	0.240	0.86	1.10	0.01	0.52	25.0	300

APPENDIX B
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WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-03 L BLACK CR SW OF BROOKLET OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
		740513	1555	24.0	0.0	1.7	9.6	6.5	84	20
		740514	1015	18.0	2.8	7.1	1.3	5.7	68	8
		740515	1100	20.0	0.9	6.4	2.4	5.9	54	10
		740516	1210	20.0	0.1	4.7	1.6	5.5	50	4
		740814		23.0	6.6			5.8		
		740815	1100				1.5		76	14
		740829	0805	21.5	3.0	3.3	2.4	5.4	128	4
		740830	0700	21.5	4.3	3.5	1.6	5.3	27	15
		741118	1445	14.0	0.0		2.8		68	12
		750125	0910				1.3		49	3

DATE	TIME	DATE	TIME	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740513	1555	2.000	2.50	4.50	0.01	0.18	26.0	260
		740514	1015	0.230	0.04	0.27	0.01K	0.01	10.0	9000
		740515	1100	0.250	0.01K	0.25	0.01K	0.01	11.0	5600
		740516	1210	0.220	0.05	0.27	0.01K	0.03	9.0	2100
		740807	1230							510
		740815	1100	0.460	0.06	0.52	0.05K	0.12	20.0	2600
		740829	0805	0.500	0.05	0.55	0.05K	0.18	25.0	760
		740830	0700	0.400	0.05	0.45	0.05K	0.10	12.0	3800
		741118	1445	0.590	0.03	0.62	0.01K	0.09	13.0	10
		750125	0910	0.290	0.01	0.30	0.03	0.03	9.0	180

APPENDIX B
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WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-03A L BLACK CR WEST OF BROOKLET OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L	00605 ORG N N MG/L
		740514	1045	19.5	6.8	1.2	5.6	58	4	0.170

DATE	TIME	DATE	TIME	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740514	1045	0.10	0.27	0.01K	0.01K	10.0	2700

APPENDIX B

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WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-04 L BLACK CR UNNMD TRIB W BROOKLET OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
		740513	1620	23.0	0.0	0.5	3.2	5.5	58	74
		740514	1025	20.0	0.0	0.5	5.0	5.8	110	24
		740814		22.0	0.7			4.9		
		740829	0750	22.5	0.3	3.5	1.5	5.9	125	3
		740830	0650	21.0	0.4	3.1	1.4	5.2	8	10
		750125	0820		11.4		0.7		46	2

DATE	TIME	DATE	TIME	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740513	1620	0.720	0.68	1.40	0.10	0.19	17.0	360
		740514	1025	0.630	0.77	1.40	0.06	0.09	17.0	40
		740807	1235							290
		740829	0750	0.400	0.05K	0.40	0.05K	0.01	17.0	60
		740830	0650	0.450	0.05K	0.45	0.05K	0.02	19.0	20
		750125	0820	0.200	0.02	0.22	0.11	0.02	9.0	50

WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-05 L BLACK CR UNNMD TRIB GA HWY 67 OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
		740514	1115	22.5	0.0	1.0	3.1	5.9	59	15
		740808	1215	25.0			3.1	5.5		
		740814		26.0				5.5		
		740815	1105				3.1		63	11
		740829	0830	23.5	0.3	3.8	3.6	5.8	130	4
		740830	0715	24.0	0.1	3.4	3.1	5.7	94	4
		750114	0845				1.4		82	10

DATE	TIME	DATE	TIME	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740514	1115	0.650	0.45	1.10	0.05	0.21	14.0	40
		740808	1215	0.850	0.05	0.90	0.05K	0.47	15.0	190
		740815	1105	0.230	0.25	0.48	0.05K	0.32	15.0	320
		740829	0830	0.550	0.05K	0.55	0.05K	0.33	20.0	20
		740830	0715	0.650	0.05K	0.65	0.05K	0.29	24.0	10
		750114	0845	0.390	0.10	0.49	0.08	0.14	19.0	7800

APPENDIX B
****

WATER QUALITY DATA PREIMPOUNDMENT STUDY
LITTLE BLACK CREEK DRAINAGE BASIN
BULLOCH COUNTY, GEORGIA

STATION - BC-06 L BLACK CR FAS RD1844 W PRETORIA OGEECHEE R. BASIN BLACK CREEK WATERSHED

DATE	TIME	DATE	TIME	00010 WATER TEMP CENT	00060 STREAM FLOW CFS	00300 DO MG/L	00310 BOD 5 DAY MG/L	00400 PH SU	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
		740514	1100	19.5		2.6	1.2	5.3	39	5
		740515	0925	19.5		2.1	1.3	5.6	49	5
		740516	1250	20.5		1.7	1.6	5.5	24	8
		740517	1000	21.0		1.7	2.5	5.5	84	4
		740815	1115		1.2		1.1		46	6
		740829	0730	22.0	6.0	2.5	2.0	5.2	115	3
		740830	0630	21.0	1.9	2.2	0.9	5.1	17	10
		750114	0750		6.3		1.5		86	4

DATE	TIME	DATE	TIME	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00650 T PO4 PO4 MG/L	00680 T ORG C C MG/L	31616 FEC COLI MFM-FCBR /100ML
		740514	1100	0.140	0.05	0.19	0.01K	0.01K	11.0	870
		740515	0925	0.250	0.01K	0.25	0.01K	0.01K	13.0	930
		740516	1250	0.240	0.06	0.30	0.01K	0.01K	12.0	870
		740517	1000	0.100	0.23	0.33	0.01	0.01	15.0	730
		740815	1115	0.220	0.01K	0.22	0.05K	0.03	7.0	160
		740829	0730	0.200	0.05K	0.20	0.05K	0.01	11.0	2200
		740830	0630	0.340	0.05K	0.34	0.05K	0.01	12.0	740
		750114	0750	0.540	0.11	0.65	0.02	0.35	19.0	810

APPENDIX C

A GROSS ASSESSMENT OF THE LITTLE BLACK CREEK, GA, WATERSHED RURAL RUNOFF ANNUALLY, WET SEASON AND UNDER SELECTED STORM CONDITIONS.

The watershed has been subdivided into six areas (See Map - Page B) to allow reasonably detailed information to be used on a geographic basis. This watershed can best be represented this way while other watersheds often can be divided into areas based on Land Use or areas of approximately equal Slope percentages. The locally developed process EPARRB, "Erosion, Sedimentation and Rural Runoff," is flexible enough to handle any of these area representations. The descriptive information for each area is stated on Page C. The summarization of total area results for five periods or conditions can be found on Page D with detailed reports numbered 1 through 5 cross-referenced in the summary.

A cropland is Tifton (K = .24); other upland is Fuquay (K = .20) and the lowland soils such as Bladen and Rains were assigned a K value of .15 which is at the low end of the SCS series. The upper part of the watershed contained higher Slope percentages (up to 5%) and shorter Slope Lengths (average 300') while the lower part of the watershed had lower Slope percentages (<3%) and longer Slope Lengths (average 400').

Sediment Delivery throughout the watershed was considered low with approximately 10% in the upper portion and 5% in the swampy lower part. The Litterfall* for Forests was considered to be relatively light with an average of 2,900 pounds per acre annually and ultimate delivery to waterbodies approximating 1% as floatables or dissolved nutrients after decay. A minimal population of livestock exists in the area. Standard Cropping Factors (C) were used, and no Control Practices (P) were assumed.

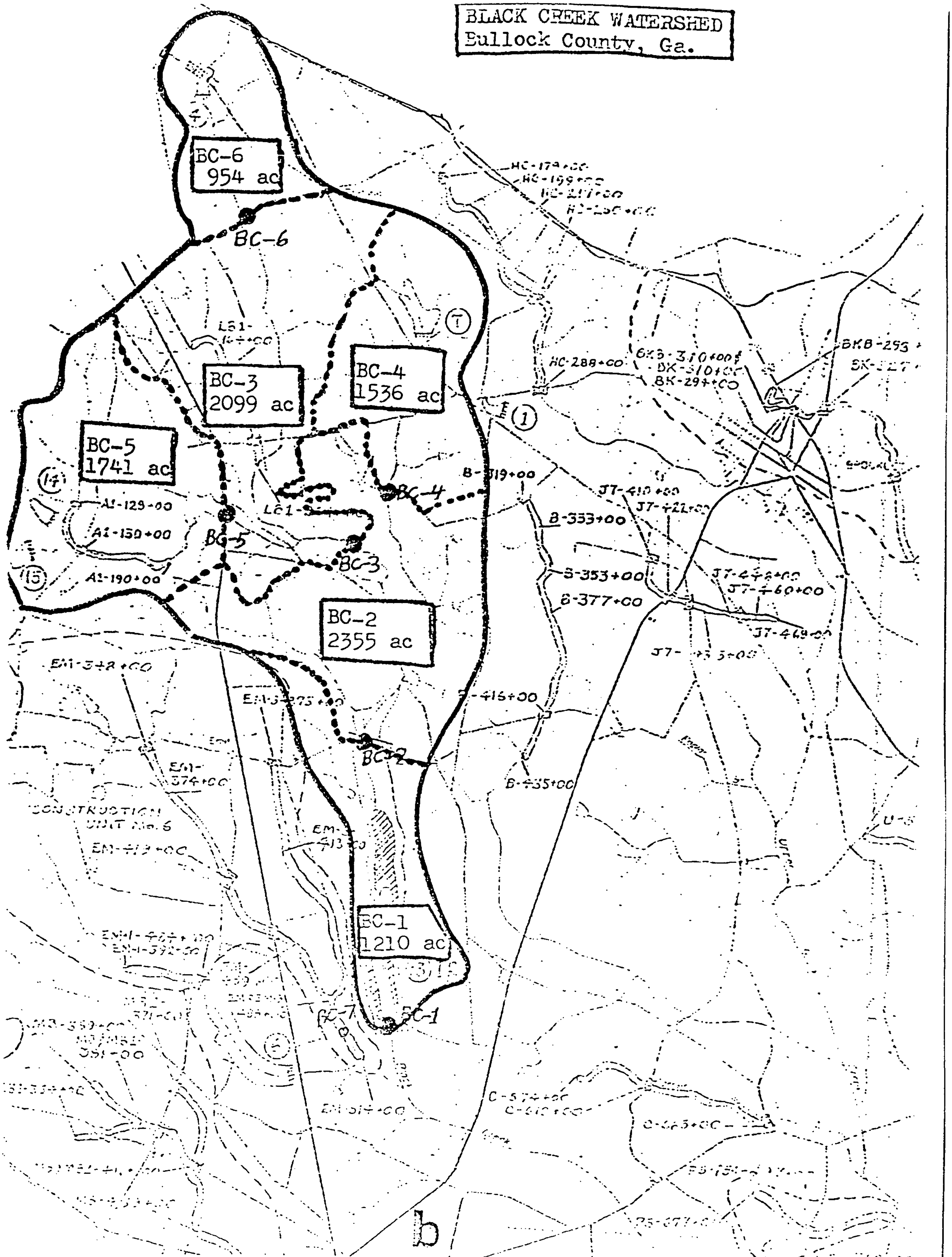
The calculating process for erosion is the "Universal Soil Loss Equation," and specific values for Slope %, Slope Length, R, K, C, & P can be input to the system to give specific answers: however, Slope % and Slope Length can be input as ranges or as means and R, K, C, and P can be input as values of percentage composition based on Land Use and this results in a variety of evaluations combining randomly selected components to more accurately represent the variable nature of actual areas.

The results given on Page D represent the best assessment obtainable with the knowledge available to the author; the Soil Conservation Service was very helpful in supplying localized information for this final assessment.

Howard A. True
Ambient Monitoring Section
Water Surveillance Branch
Surveillance and Analysis Division
EPA, Region IV, ERLA
Athens, GA 12/8/76

* Personal communication - data transmitted through telephone conversation, October 14, 1976, with Dr. W. Nutter, School of Forestry, University of Georgia, Athens, Georgia.

a



BLACK CREEK WATERSHED
Bullock County, Ga.
BC-6
954 ac
BC-3
2099 ac
BC-4
1536 ac
BC-5
1741 ac
BC-2
2355 ac
BC-1
1210 ac
B-353+00
B-377+00
B-435+00
HC-288+00
A1-129+00
A1-150+00
A1-190+00

LITTLE BLACK CREEK (GA) WATERSHED ANALYSIS
DATA USED FOR FINAL GROSS ASSESSMENT USING "EPARRB" PLANNING MODEL

Items	Areas						
	BC-1	BC-2	BC-3	BC-4	BC-5	BC-6	Totals
Area acres	1210	2355	2099	1536	1741	954	9895
Area sq. mi.	1.89	3.68	3.28	2.40	2.72	1.49	15.48
Blowup acres (plot size)1/	10	5	3	6	10	3	
Land Use %:							
(1) Cropland	25	25	31	31	43	47	
(2) Pasture	10	10	13	13	18	19	
(3) Forest	60	60	50	50	30	25	
(5) Other	5	5	6	6	9	9	
Slope % range	0-3	0-3	0-5	0-5	0-5	0-5	
Slope lng. range	400	400	300	300	300	300	
K, C, P, values & %							
K	.24-25 .15-75	.20-15 .24-25 .15-60	.20-69 .24-31	.20-69 .24-31	.20-69 .24-43	.20-53 .24-47	
C	.26-25 .012-75	.26-25 .012-75	.26-31 .012-69	.26-31 .012-69	.26-43 .012-57	.26-47 .012-53	
P	1.0-100	1.0-100	1.0-100	1.0-100	1.0-100	1.0-100	
Sed. Del. % range	5±0	5±0	10±0	10±0	10±0	10±0	
Nutrient % of Sed.:							
N	.1	.1	.1	.1	.1	.1	
P	.08	.08	.08	.08	.08	.08	
K	1.25	1.25	1.25	1.25	1.25	1.25	
Animal/Fowl counts:2/							
Total Cows		100			60		160
Dairy Cows		100			60		160
Swine	300	165			165		630
Poultry							
Forest/Pasture Litter:3/							
Lbs/ac/yr.	2900	2900	2900	2900	2900	2900	
Delivery %	1	1	1	1	1	1	
Composition %:							
N	.9	.9	.9	.9	.9	.9	
P	.12	.12	.12	.12	.12	.12	
K	.18	.18	.18	.18	.18	.18	
BOD	10.0	10.0	10.0	10.0	10.0	10.0	
TOC	50.2	50.2	50.2	50.2	50.2	50.2	

1/ Each evaluation of the "Universal Soil Loss Equation", using randomly selected values from 100 value tables for land use, slope %, slope length, K, C and P, is multiplied by the blowup acres for accumulation of report quantities. (Note BC-1 1210 acres with blowup factor of 10 acres = 121 evaluations).

2/ Animal/Fowl counts not used in single storm event evaluations.

3/ Forest/Pasture Litter was not used in single storm event evaluations since primary objective was to obtain erosion and sediment.

C

LITTLE BLACK CREEK WATERSHED RURAL RUNOFF GROSS QUANTITIES

Period/Type	EI	Erosion Tons	Sediment Tons	Forest Litter Tons Del.	N Lbs.	P Lbs.	K Lbs.	BOD Lbs.	TOC Lbs.	Report Number
Annual Totals	275	17,672	1,633	87	5,102	3,003	41,144	20,425	90,674	1(a)
Daily Average (365 Days)		48.4	4.5	.24	14	8	113	56	248	1(b)
Wet Period Totals (June-August)	124	7,952	735	39	2,243	1,315	18,515	8,592	40,167	2(a)
Daily Average (92 days)		86.4	8.0	.4	24	14	201	93	437	2(b)
Single Storm (1" per hour) Sed. Del. = 5-10%	19	1,221.0	112.8	--	--	--	--	--	--	3
Single Storm (2" per hour) Sed. Del. - 5-10%	88	5,655.0	522.7	--	--	--	--	--	--	4
Single Storm (2" per hour) Sed. Del. - 23-28% (Based on drainage area)	88	5,655.0	1,419.7	--	--	--	--	--	--	5

Note: Only erosion and sediment delivery was reported for single storm events.
Data information for all reports has been stated on the data sheet; however, report #5 is a special report with sediment delivery percentages calculated from drainage area sizes (See Pg. 22 "Control of Water Pollution from Cropland"), see S.D. percentages on top of report 5.
A 1" per hour storm event would be expected to occur 2 times in July each year and 1 time in June and August every 5 years.
A 2" per hour storm event would be expected to occur 1 time in each month of June, July and August every 5 years.
(Period of analysis 1970-1974 at Bellvile, GA)

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** PERIOD MONTHS 1 - 12

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	TO WATER BODIES							
			SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (10.0)	1210.00	1137.57	56.88	12.28	335.	120.	1466.	2456.	12330.	0.
LIVESTOCK/FOWL					49.	27.	0.	843.	854.	
UNIT TOTALS	1210.00	1137.57	56.88	12.28	384.	148.	1466.	3299.	13184.	0.
PER ACRE LOADS FOR PERIOD		0.94	0.05	0.01	0.32	0.12	1.21	2.73	10.90	0.0
2 LAND (5.0)	2355.00	1540.47	77.02	23.90	584.	181.	2012.	4781.	23997.	0.
LIVESTOCK/FOWL					89.	64.	0.	810.	889.	
UNIT TOTALS	2355.00	1540.47	77.02	23.90	673.	245.	2012.	5591.	24887.	0.
PER ACRE LOADS FOR PERIOD		0.65	0.03	0.01	0.29	0.10	0.85	2.37	10.57	0.0
3 LAND (3.0)	2099.00	4390.57	439.04	19.00	1220.	748.	11044.	3801.	19078.	0.
PER ACRE LOADS FOR PERIOD		2.09	0.21	0.01	0.58	0.36	5.26	1.81	9.09	0.0
4 LAND (6.0)	1536.00	3174.45	317.44	13.92	885.	541.	7986.	2784.	13975.	0.
PER ACRE LOADS FOR PERIOD		2.07	0.21	0.01	0.58	0.35	5.20	1.81	9.10	0.0
5 LAND (10.0)	1741.00	4695.24	469.52	11.98	1155.	780.	11781.	2397.	12032.	0.
LIVESTOCK/FOWL					129.	89.	0.	1343.	1443.	
UNIT TOTALS	1741.00	4695.24	469.52	11.98	1283.	869.	11781.	3740.	13475.	0.
PER ACRE LOADS FOR PERIOD		2.70	0.27	0.01	0.74	0.50	6.77	2.15	7.74	0.0
6 LAND (3.0)	954.00	2733.67	273.37	6.05	656.	452.	6855.	1210.	6076.	0.
PER ACRE LOADS FOR PERIOD		2.87	0.29	0.01	0.69	0.47	7.19	1.27	6.37	0.0
STATE GROUP LAND	9895.00	17671.95	1633.27	87.14	4835.	2822.	41144.	17429.	87489.	0.
LIVESTOCK/FOWL					267.	181.	0.	2996.	3186.	
GEORGIA	9895.00	17671.95	1633.27	87.14	5102.	3003.	41144.	20425.	90674.	0.
AREA LAND	9895.00	17671.95	1633.27	87.14	4835.	2822.	41144.	17429.	87489.	0.
LIVESTOCK/FOWL					267.	181.	0.	2996.	3186.	
GRAND TOTALS	9895.00	17671.95	1633.27	87.14	5102.	3003.	41144.	20425.	90674.	0.

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** PERIOD MONTHS 1 - 12

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	DAILY LOADINGS TO WATER BODIES SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(10.0)	1210.00	3.12	0.16	0.03	1.	0.	4.	7.	34.	0.
LIVESTOCK/FOWL						0.	0.	0.	2.	2.	
UNIT TOTALS		1210.00	3.12	0.16	0.03	1.	0.	4.	9.	36.	0.
2 LAND	(5.0)	2355.00	4.22	0.21	0.07	2.	0.	6.	13.	66.	0.
LIVESTOCK/FOWL						0.	0.	0.	2.	2.	
UNIT TOTALS		2355.00	4.22	0.21	0.07	2.	1.	6.	15.	68.	0.
3 LAND	(3.0)	2099.00	12.03	1.20	0.05	3.	2.	30.	10.	52.	0.
4 LAND	(6.0)	1536.00	8.70	0.87	0.04	2.	1.	22.	8.	38.	0.
5 LAND	(10.0)	1741.00	12.86	1.29	0.03	3.	2.	32.	7.	33.	0.
LIVESTOCK/FOWL						0.	0.	0.	4.	4.	
UNIT TOTALS		1741.00	12.86	1.29	0.03	4.	2.	32.	10.	37.	0.
6 LAND	(3.0)	954.00	7.49	0.75	0.02	2.	1.	19.	3.	17.	0.
STATE GROUP LAND		9895.00	48.42	4.48	0.24	13.	8.	113.	48.	240.	0.
LIVESTOCK/FOWL						1.	0.	0.	8.	9.	
GEORGIA		9895.00	48.42	4.48	0.24	14.	8.	113.	56.	248.	0.
AREA LAND		9895.00	48.42	4.48	0.24	13.	8.	113.	48.	240.	0.
LIVESTOCK/FOWL						1.	0.	0.	8.	9.	
GRAND TOTALS		9895.00	48.42	4.48	0.24	14.	8.	113.	56.	248.	0.

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

EROSION & SD FOR SUMMER (WET) MONTHS JUN JUL & AUG.
LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** PERIOD MONTHS 6 - 8

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	TO WATER BODIES							
			SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (10.0)	1210.00	511.90	25.60	5.53	151.	54.	660.	1105.	5549.	0.
LIVESTOCK/FOWL					12.	7.	0.	211.	213.	
UNIT TOTALS	1210.00	511.90	25.60	5.53	163.	61.	660.	1316.	5762.	0.
PER ACRE LOADS FOR PERIOD		0.42	0.02	0.00	0.13	0.05	0.55	1.09	4.76	0.0
2 LAND (5.0)	2355.00	693.20	34.66	10.76	263.	81.	905.	2151.	10799.	0.
LIVESTOCK/FOWL					22.	16.	0.	203.	222.	
UNIT TOTALS	2355.00	693.20	34.66	10.76	285.	97.	905.	2354.	11021.	0.
PER ACRE LOADS FOR PERIOD		0.29	0.01	0.00	0.12	0.04	0.38	1.00	4.68	0.0
3 LAND (3.0)	2099.00	1975.75	197.58	8.55	549.	337.	4970.	1710.	8585.	0.
PER ACRE LOADS FOR PERIOD		0.94	0.09	0.00	0.26	0.16	2.37	0.81	4.09	0.0
4 LAND (6.0)	1536.00	1428.49	142.85	6.26	398.	244.	3594.	1253.	6289.	0.
PER ACRE LOADS FOR PERIOD		0.93	0.09	0.00	0.26	0.16	2.34	0.82	4.09	0.0
5 LAND (10.0)	1741.00	2112.87	211.29	5.39	520.	351.	5301.	1079.	5414.	0.
LIVESTOCK/FOWL					32.	22.	0.	336.	361.	
UNIT TOTALS	1741.00	2112.87	211.29	5.39	552.	373.	5301.	1414.	5775.	0.
PER ACRE LOADS FOR PERIOD		1.21	0.12	0.00	0.32	0.21	3.05	0.81	3.32	0.0
6 LAND (3.0)	954.00	1230.13	123.01	2.72	295.	203.	3085.	545.	2734.	0.
PER ACRE LOADS FOR PERIOD		1.29	0.13	0.00	0.31	0.21	3.23	0.57	2.87	0.0
STATE GROUP LAND	9895.00	7952.34	734.99	39.21	2176.	1270.	18515.	7843.	39370.	0.
LIVESTOCK/FOWL					67.	45.	0.	749.	796.	
GEORGIA	9895.00	7952.34	734.99	39.21	2243.	1315.	18515.	8592.	40167.	0.
AREA LAND	9895.00	7952.34	734.99	39.21	2176.	1270.	18515.	7843.	39370.	0.
LIVESTOCK/FOWL					67.	45.	0.	749.	796.	
GRAND TOTALS	9895.00	7952.34	734.99	39.21	2243.	1315.	18515.	8592.	40167.	0.

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

EROSION & SD FOR SUMMER (WET) MONTHS JUN JUL & AUG.
LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** PERIOD MONTHS 6 - 8

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	DAILY LOADINGS TO WATER BODIES							
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(10.0)	1210.00	5.56	0.28	0.06	2.	1.	7.	12.	60.	0.
LIVESTOCK/FOWL						0.	0.	0.	2.	2.	
UNIT TOTALS		1210.00	5.56	0.28	0.06	2.	1.	7.	14.	63.	0.
2 LAND	(5.0)	2355.00	7.54	0.38	0.12	3.	1.	10.	23.	117.	0.
LIVESTOCK/FOWL						0.	0.	0.	2.	2.	
UNIT TOTALS		2355.00	7.54	0.38	0.12	3.	1.	10.	26.	120.	0.
3 LAND	(3.0)	2099.00	21.48	2.15	0.09	6.	4.	54.	19.	93.	0.
4 LAND	(6.0)	1536.00	15.53	1.55	0.07	4.	3.	39.	14.	68.	0.
5 LAND	(10.0)	1741.00	22.97	2.30	0.06	6.	4.	58.	12.	59.	0.
LIVESTOCK/FOWL						0.	0.	0.	4.	4.	
UNIT TOTALS		1741.00	22.97	2.30	0.06	6.	4.	58.	15.	63.	0.
6 LAND	(3.0)	954.00	13.37	1.34	0.03	3.	2.	34.	6.	30.	0.
STATE GROUP LAND		9895.00	86.44	7.99	0.43	24.	14.	201.	85.	428.	0.
LIVESTOCK/FOWL						1.	0.	0.	8.	9.	
GEORGIA		9895.00	86.44	7.99	0.43	24.	14.	201.	93.	437.	0.
AREA LAND		9895.00	86.44	7.99	0.43	24.	14.	201.	85.	428.	0.
LIVESTOCK/FOWL						1.	0.	0.	8.	9.	
GRAND TOTALS		9895.00	86.44	7.99	0.43	24.	14.	201.	93.	437.	0.

NO LIVESTOCK - NO LITTER

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

EROSION & SD FOR 1" PER HR STORM - 2 JULY EVENTS/YR - 1 JUN & AUG EVENT/5 YRS.
LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** SINGLE STORM WITH EI= 19.

UNIT/TYPE	(PLOT AC.)	ACRES	S.L. TONS	TO WATER BODIES							
				SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND	(10.0)	1210.00	78.60	3.93	0.0	8.	6.	98.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.06	0.00	0.0	0.01	0.01	0.08	0.0	0.0	0.0
2 LAND	(5.0)	2355.00	106.43	5.32	0.0	11.	9.	133.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.05	0.00	0.0	0.00	0.00	0.06	0.0	0.0	0.0
3 LAND	(3.0)	2099.00	303.34	30.33	0.0	61.	49.	758.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.14	0.01	0.0	0.03	0.02	0.36	0.0	0.0	0.0
4 LAND	(6.0)	1536.00	219.33	21.93	0.0	44.	35.	548.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.14	0.01	0.0	0.03	0.02	0.36	0.0	0.0	0.0
5 LAND	(10.0)	1741.00	324.40	32.44	0.0	65.	52.	811.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.19	0.02	0.0	0.04	0.03	0.47	0.0	0.0	0.0
6 LAND	(3.0)	954.00	188.87	18.89	0.0	38.	30.	472.	0.	0.	0.
PER ACRE LOADS FOR PERIOD			0.20	0.02	0.0	0.04	0.03	0.49	0.0	0.0	0.0
GEORGIA		9895.00	1220.97	112.84	0.0	226.	181.	2821.	0.	0.	0.
GRAND TOTALS		9895.00	1220.97	112.84	0.0	226.	181.	2821.	0.	0.	0.

NO LIVESTOCK - NO LITTER

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

EROSION & SD FOR 2" PER HR STORM - 1 EVENT/5 YRS. FOR EACH MON JUN JUL & AUG.
LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** SINGLE STORM WITH EI= 88.

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	******** TO WATER BODIES ******** SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (10.0)	1210.00	364.02	18.20	0.0	36.	29.	455.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.30	0.02	0.0	0.03	0.02	0.38	0.0	0.0	0.0
2 LAND (5.0)	2355.00	492.94	24.65	0.0	49.	39.	616.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.21	0.01	0.0	0.02	0.02	0.26	0.0	0.0	0.0
3 LAND (3.0)	2099.00	1404.97	140.50	0.0	281.	225.	3512.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.67	0.07	0.0	0.13	0.11	1.67	0.0	0.0	0.0
4 LAND (6.0)	1536.00	1015.81	101.58	0.0	203.	163.	2540.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.66	0.07	0.0	0.13	0.11	1.65	0.0	0.0	0.0
5 LAND (10.0)	1741.00	1502.48	150.25	0.0	300.	240.	3756.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.86	0.09	0.0	0.17	0.14	2.16	0.0	0.0	0.0
6 LAND (3.0)	954.00	874.76	87.48	0.0	175.	140.	2187.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.92	0.09	0.0	0.18	0.15	2.29	0.0	0.0	0.0
GEORGIA	9895.00	5654.98	522.65	0.0	1045.	836.	13066.	0.	0.	0.
GRAND TOTALS	9895.00	5654.98	522.65	0.0	1045.	836.	13066.	0.	0.	0.

NO LIVESTOCK - NO LITTER

LITTLE BLACK CREEK WATERSHED
BULLOCK COUNTY, GA.

S.D. #1(26%)#2(23%)#3(24%)
#4(25%)#5(25%)#6(28%)

EROSION & SD FOR 2" PER HR STORM - 1 EVENT/5 YRS. FOR EACH MON JUN JUL & AUG.
LAND UNITS 1-6 ARE DRAINAGE AREAS FOR SAMPLING POINTS BC-1 TO BC-6.
**** SINGLE STORM WITH EI= 88.

UNIT/TYPE (PLOT AC.)	ACRES	S.L. TONS	TO WATER BODIES SED. TONS	LITTER TONS	NIT.LBS	PHOS.LBS	<K> LBS	BOD LBS	TOC LBS	ACID LBS
1 LAND (10.0)	1210.00	364.02	94.65	0.0	189.	151.	2366.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.30	0.08	0.0	0.16	0.13	1.96	0.0	0.0	0.0
2 LAND (5.0)	2355.00	492.94	113.38	0.0	227.	181.	2834.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.21	0.05	0.0	0.10	0.08	1.20	0.0	0.0	0.0
3 LAND (3.0)	2099.00	1404.97	337.18	0.0	674.	539.	8429.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.67	0.16	0.0	0.32	0.26	4.02	0.0	0.0	0.0
4 LAND (6.0)	1536.00	1015.81	253.96	0.0	508.	406.	6349.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.66	0.17	0.0	0.33	0.26	4.13	0.0	0.0	0.0
5 LAND (10.0)	1741.00	1502.48	375.62	0.0	751.	601.	9390.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.86	0.22	0.0	0.43	0.35	5.39	0.0	0.0	0.0
6 LAND (3.0)	954.00	874.76	244.94	0.0	490.	392.	6123.	0.	0.	0.
PER ACRE LOADS FOR PERIOD		0.92	0.26	0.0	0.51	0.41	6.42	0.0	0.0	0.0
GEORGIA	9895.00	5654.98	1419.72	0.0	2839.	2272.	35493.	0.	0.	0.
GRAND TOTALS	9895.00	5654.98	1419.72	0.0	2839.	2272.	35493.	0.	0.	0.

APPENDIX D

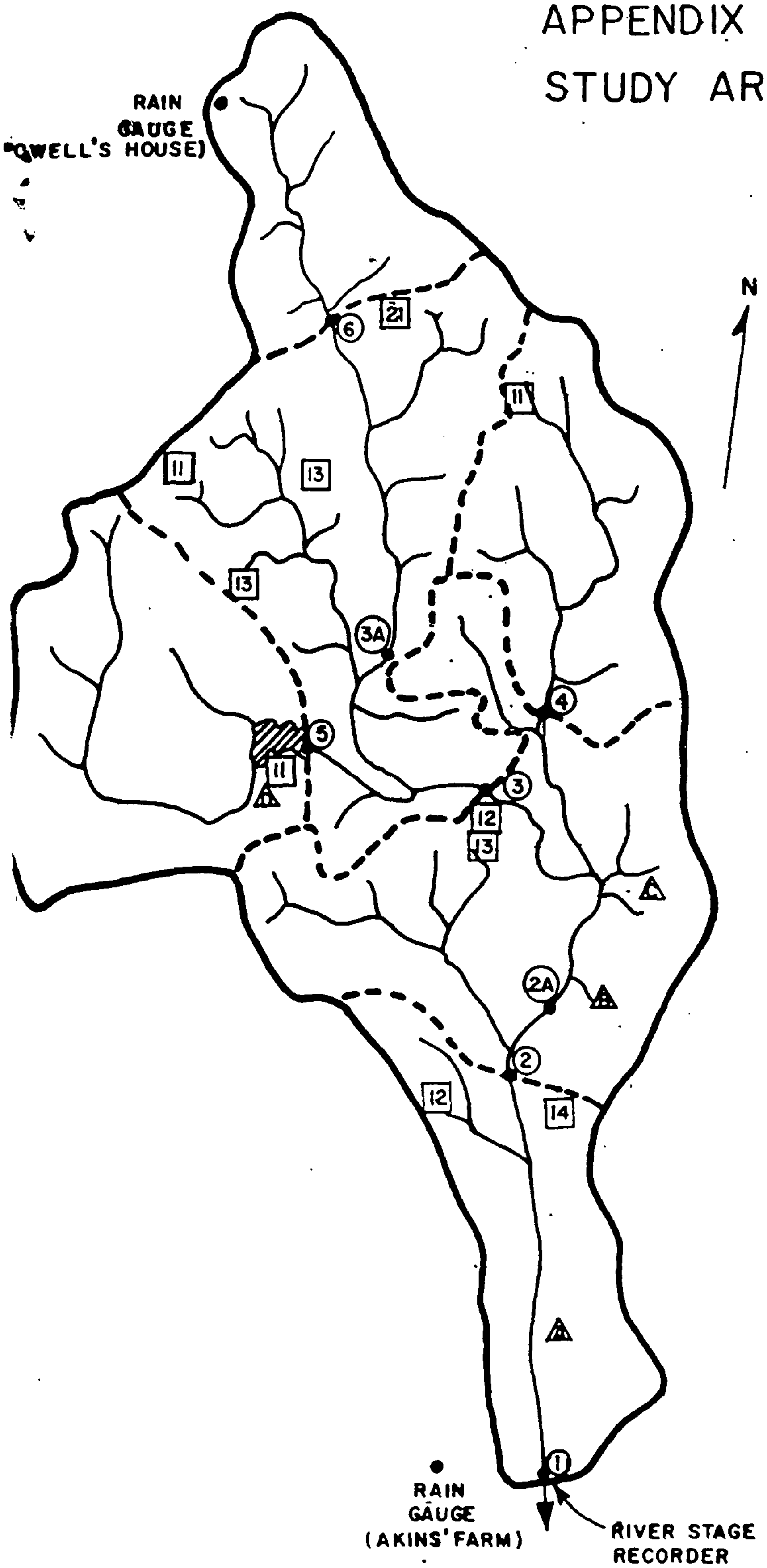
SAMPLING STATION LOCATIONS

Little Black Creek Impoundment - Black Creek Watershed

Station Number	Description
BC-1	Little Black Creek at proposed dam site* - Bulloch County.
BC-2	Little Black Creek at unnumbered county road* - Bulloch County.
BC-2A	Little Black Creek at unnumbered county road* - Bulloch County.
BC-3	Little Black Creek at unnumbered county road* - Bulloch County.
BC-3A	Little Black Creek at unnumbered county road* - Bulloch County.
BC-4	Unnamed creek at unnumbered county road* - Bulloch County.
BC-5	Unnamed creek at Georgia Highway 67* - Bulloch County.
BC-6	Little Black Creek at FAS Route S1844 - Bulloch County.

* For exact location, refer to maps in Appendices E-1 and E-2.

APPENDIX E-1
STUDY AREA MAP

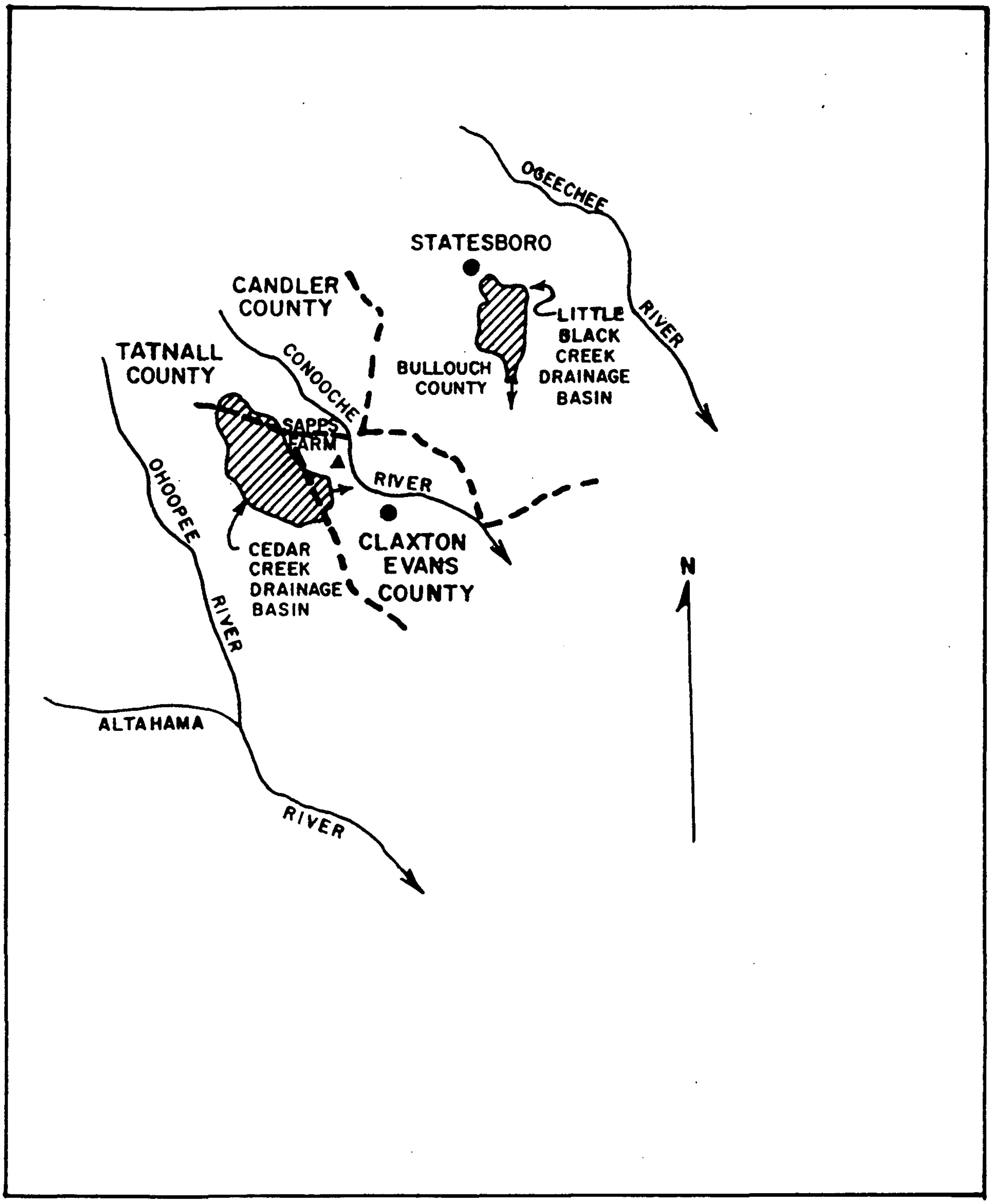


LEGEND:

———	DRAINAGE BASIN BOUANDARY
- - - -	SUB-BASIN BOUNDARY
~	STREAM
(#) •	BC-STATION NUMBERS
[#]	WASTE SOURCES IDENTIFIED BY E.P.A.-EPIC
11	CONFINED POULTRY FEEDING
12	CONFINED BEEF FEEDING
13	CONFINED HOG FEEDING
14	NON-IDENTIFIABLE
21	MOBILE HOME COURT
Δ	WASTE SOURCES IDENTIFIED BY SAD AND SCS
A	300 HOGS
B	100 COWS
C	165 HOGS
D	60 COWS
	165 HOGS

APPENDIX E-2

LOCATION MAP



PROJECT PERSONNEL

FIELD AND MOBILE LAB CREWS

Cindy Adams	Typist
Richard L. Baird	Engineer
Larry Brannen	Co-op
Tom Cavinder	Engineer
Mike Chronic	Co-op
Ralph E. Gentry	Microbiologist
Margaret Hale	Computer Technician
David W. Hill	Engineer
W. F. Holsomback	Computer Specialist
Ray Lassiter	Stay-in-school-student
Raymond Lawless	Chemist
George Leverett	Co-op
Eddie Minchew	Co-op
Eddie Shollenberger	Engineering Technician
Karen Smart	Peripheral Equipment Operator
T. L. Vaughn	Engineering Technician
H. C. Vick	Environmentalist
Roy Weimert	Engineering Technician
Bob Woodward	Co-op

GATHERING AND TABULATION OF HISTORICAL METEOROLOGICAL AND HYDROLOGICAL DATA

Bryan Green	Stay-in-school-student
Elizabeth Korhonen	Clerk typist
Ray Lynch	Stay-in-school-student
Debora Talkington	Stay-in-school-student
H. C. Vick	Environmentalist

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- for the invaluable servicing of meteorological equipment installed on his land.

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- for his follow-up in gathering data on fertilizer application and other local farming practices and possible cross drainage from another drainage basin after completion of the study.

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