SUGAR CREEK
WATER QUALITY DEMONSTRATION REPORT
PHASE I

ECOLOGICAL STUDIES SECTION - FIELD OPERATIONS DIVISION
MUNICIPAL BRANCH, WATER QUALITY BRANCH, INDUSTRIAL BRANCH - WATER DIVISION
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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Ecological Studies Section - Field Operations Division

Municipal Branch, Water Quality Branch, Industrial Branch - Water Divisio~

Alabama Department of Environmental Management

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INTRODUCTION

Sugar Creek, located in Tallapoosa County, is a tributary to Lake Martin (the Tallapoosa River). Sugar Creek originates in the southwestern part of Alexander City and flows in a southerly direction until it arrives at the Lake Martin backwaters, approximately 5 miles downstream. At the backwaters, the drainage area of Sugar Creek is 5.81 square miles. From its point of origin to its entrance into Lake Martin, Sugar Creek has a water-use classification of Agricultural & Industrial Water Supply (A&I). The Sugar Creek embayment area of Lake Martin is classified Swimming/Fish & Wildlife (S/F&W).

Alexander City currently has four municipal wastewater treatment plants (WWTP), largest of which is the Sugar Creek WWTP with a current design capacity of 8.5 million gallons per day (MGD). The WWTP discharges to Sugar Creek approximately 2.25 miles upstream of the Lake Martin backwaters. Russell Mills Corporation and Avondale Mills , Inc. are two significant indirect dischargers (SID) to the Sugar Creek facility, and presently operate under SID permits issued by the Alabama Department of Environmental Management (ADEM).

A water quality study of Sugar Creek was conducted by the ADEM from May 28 - June 1, 1990. The results were used to assist in determining new effluent limitations as a part of the permit renewal for the Sugar Creek WWTP.

An Administrative Order (AO) was issued on August 22, 1994 by the ADEM requiring Alexander City to take certain actions regarding violations of state and federal environmental laws and regulations. The AO also included a stipulation that the ADEM would conduct a water quality demonstration study of Sugar Creek and its embayment to assess physical, chemical, and biological conditions. The purpose of such studies is to focus on the conditions of receiving waters before and after all construction and regulatory actions have been taken to ascertain water quality improvement brought about by the expenditure of local, federal and state funds.

On December 9, 1993, Alexander City received a State Revolving Fund (SRF) loan in the amount of $16,500,000 for WWTP improvements. The SRF loan monies are made available through EPA capitalization grants to the State of Alabama. Of this amount, approximately $9.6 million has been targeted for construction activity at the Sugar Creek WWTP. Construction activity at these facilities to meet conventional pollutant permit limitations and sludge handling and disposal requirements are scheduled for completion by October 15, 1995.

The phase I water quality demonstration study (the "before" study) was conducted during August and September 1994. A phase II study will be scheduled after all construction and enforcement activity has been completed.

PHYSICAL DESCRIPTION WITH SAMPLING LOCATIONS

Lake Martin is located on the Tallapoosa River in the Tallapoosa River Basin. Impounded in 1926, Lake Martin has a surface area of approximately 39,000 acres and a drainage area of approximately 3,000 square miles (ADEM, 1992). Mean depth is 12.8 meters (42 feet) and maximum depth at the dam is 47.2 meters (155 feet). To meet hydropower and flood control requirements , annual water level fluctuation is about 3 meters (9.8 feet) each year. Average hydraulic retention time is 190 days (ADCNR, 1993).

Lake Martin lies entirely within the Piedmont Plateau Physiographic Province, where the surface rock is predominately ancient recrystallized granites, gneisses, schists, marbles and quartzes, which have been reformed by extreme heat and pressure. Major soils series are characteristic of the Piedmont and include Appling on the gentle slopes and Cecil on the upland slopes, both of which are erodable (EPD, 1984). Waters of these soils are relatively infertile, with total alkalinities the lowest in the State (Arce and Boyd, 1980)

Topographically, the Basin is characterized by rolling hills separated by wide valleys. Elevations in this area are in the range of 1000 feet above sea level. Stream valleys lie 100-150 feet below the surrounding area. The streams and rivers generally have small drainage areas which exhibit a rectangular drainage pattern and yield moderate amounts of water (EPD, 1984)

Watershed development is more evident in the Sugar and Elkahatchee embayment watersheds than in the Oakachoy and Manoy Creek embayment watersheds. Sugar and Elkahatchee Creek watersheds tend toward urban development with some forest and agricultural usage while the Oakachoy and Manoy embayments are predominately forested and/or agricultural. Embayment shoreline vegetation was dominated by mixed hardwoods with some pine at all locations. Single family housing was also evident , though Oakachoy embayment was not as developed as the others.

Bottom substrate dredge samples were taken from each of the four embayments studied. The observed composition of those samples is included in Table A-5 .

Locations of all stations appear in Table 1. Maps of all stations appear in Figures 1-3. Biological impact was determined in part by comparing the results of the biological assessment of the study waterbodies, Sugar Creek and Elkahatchee Creek, with the results of the biological assessments of two reference waterbodies in the area:

1) Oakachoy Creek, a physically similar creek in the area that does not receive any known point source discharges, and;
2) Manoy Creek, located on the opposite side of Lake Martin and that also does not receive any known point source discharges.

Though likely to be impacted by nonpoint source runoff from Alexander City, SUG-1, a station located upstream of the WWTP on Sugar Creek, was regarded as a reference station because of its position upstream of the WWTP. ELK-1, located upstream of the confluence of Sugar Creek with Elkahatchee Creek, was sampled to determine any biological impacts resulting from its proximity to Sugar Creek. Because of the natural differences in the water quality characterisitics of stream and embayment waters, only embayment stations were utilized for parts of the biological assessment and chemical/physical assessment.

Water quality measurements and water sample collections were conducted from boats positioned at the deepest point of the channel at each sampling site.

Table 1 Station Locations

Station No.	Station Description
SUG-1	Upstream of the discharge from the Sugar Creek WWTP
SUG-WWTP	Discharge from the Sugar Creek WWTP
S-1	Sugar Creek at the ADEM Ambient Monitoring station at the Alabama Highway 63 bridge south of Alexander City
SUG-2	Sugar Creek embayment, approximately 1/4 mile downstream of the beginning of the Lake Martin backwaters
SUG-3	Sugar Creek embayment, approximately 1/3 mile downstream of SUG-2
SUG-4	Sugar Creek embayment, approximately 1/2 mile downstream of SUG-3
ELK-1	Elkahatchee Creek embayment, approximately 1/5 mile downstream of Alabama Highway 63 bridge on Elkahatchee Creek.
ELK-2	Elkahatchee Creek embayment, approximately 1/2 mile downstream of the confluence of Elkahatchee and Sugar Creeks
OAK-1	Oakachoy Creek at Alabama Highway 259 bridge
OAK-2	Oakachoy Creek embayment, approximately 1/4 mile downstream of the beginning of the Lake Martin backwaters
OAK-3	Oakachoy Creek embayment, approximately 1/4 mile downstream of OAK-2
MAN-1	Manoy Creek embayment, approximately 1/2 mile downstream of beginning of Lake Martin backwaters.
MAN-2	Manoy Creek embayment, approximately 1 mile downstream of MAN-1.

Figure 1 - Sugar and Elkahatchee Creek Stations

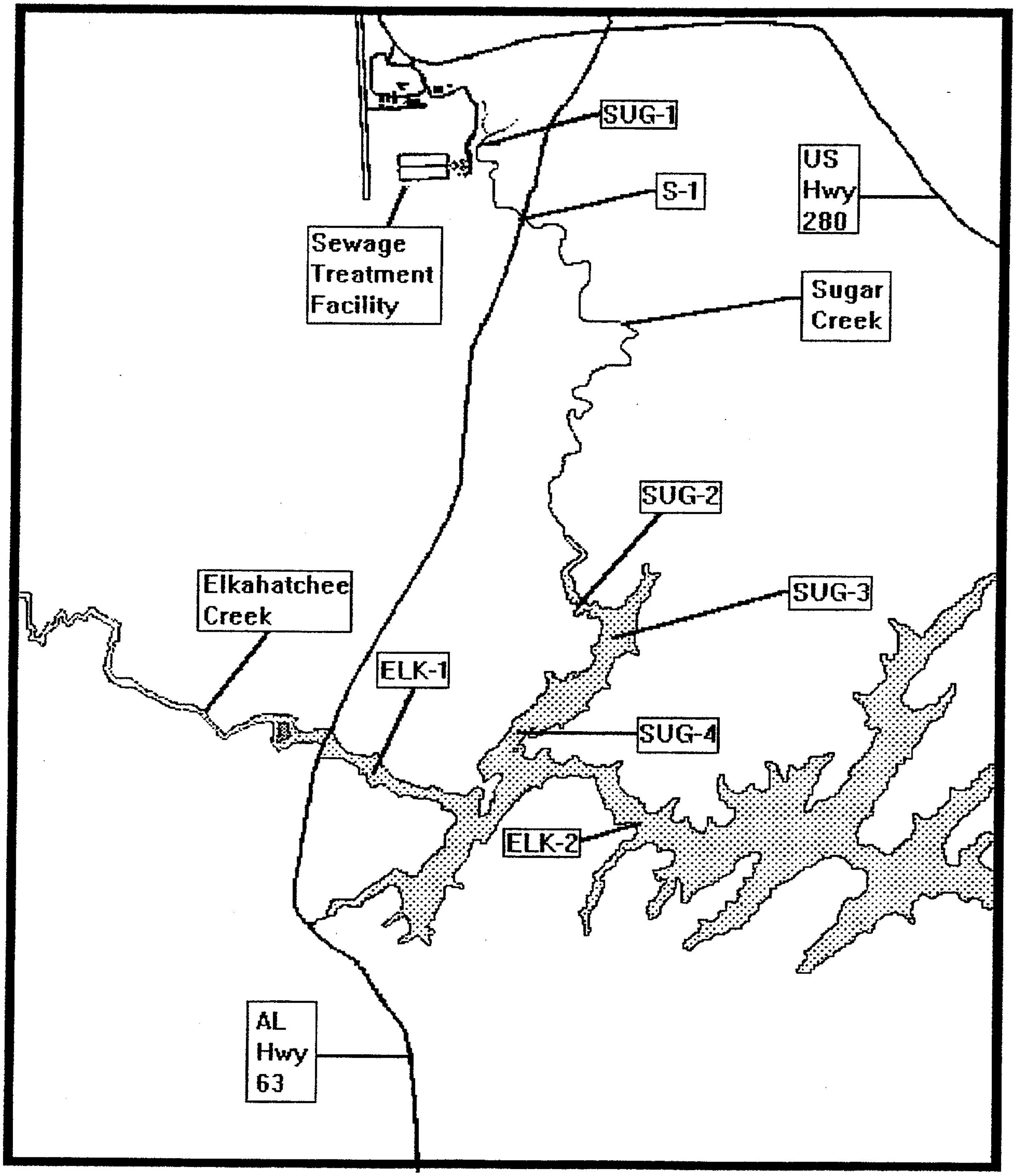


Figure 2 - Oakachoy Creek Stations

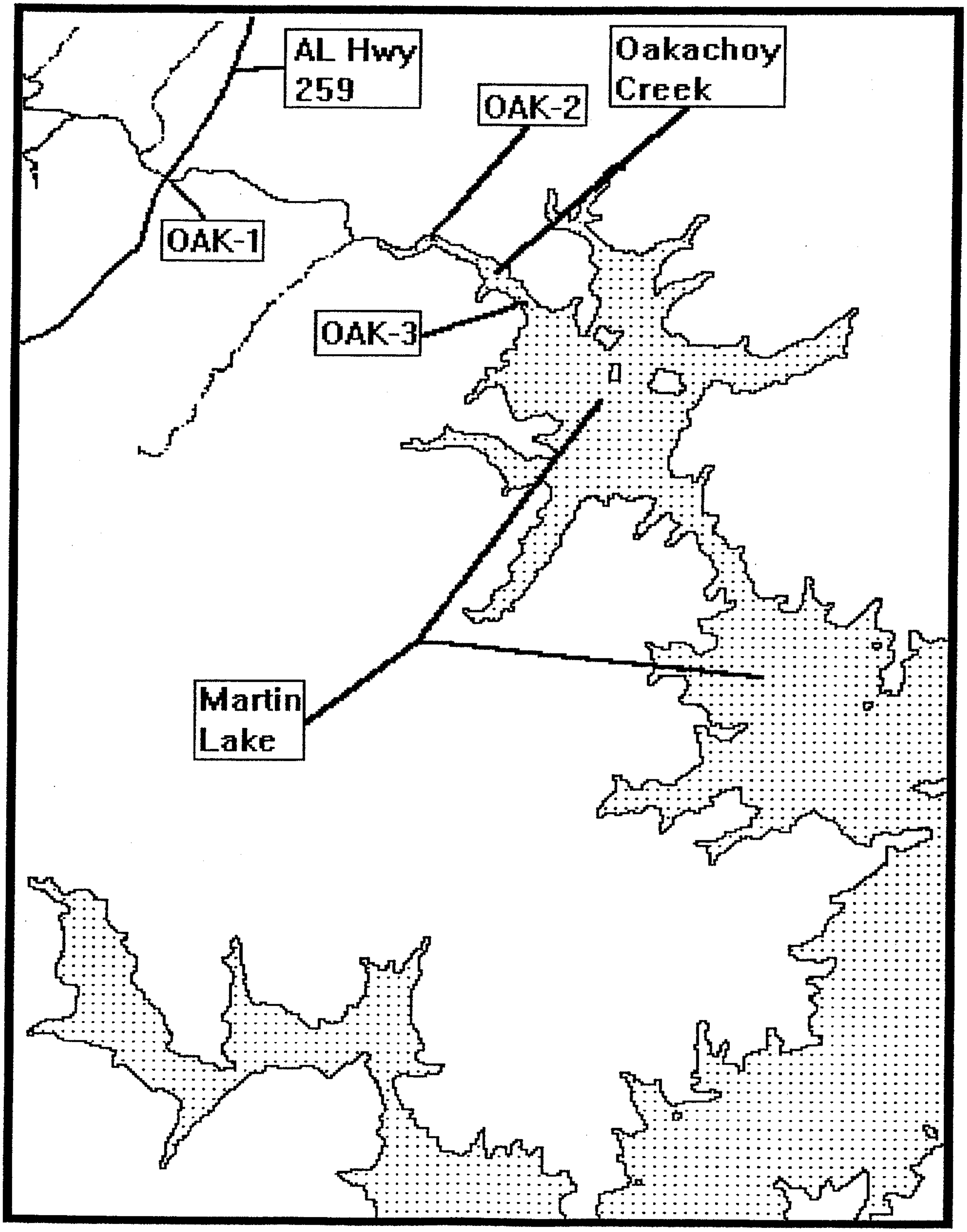
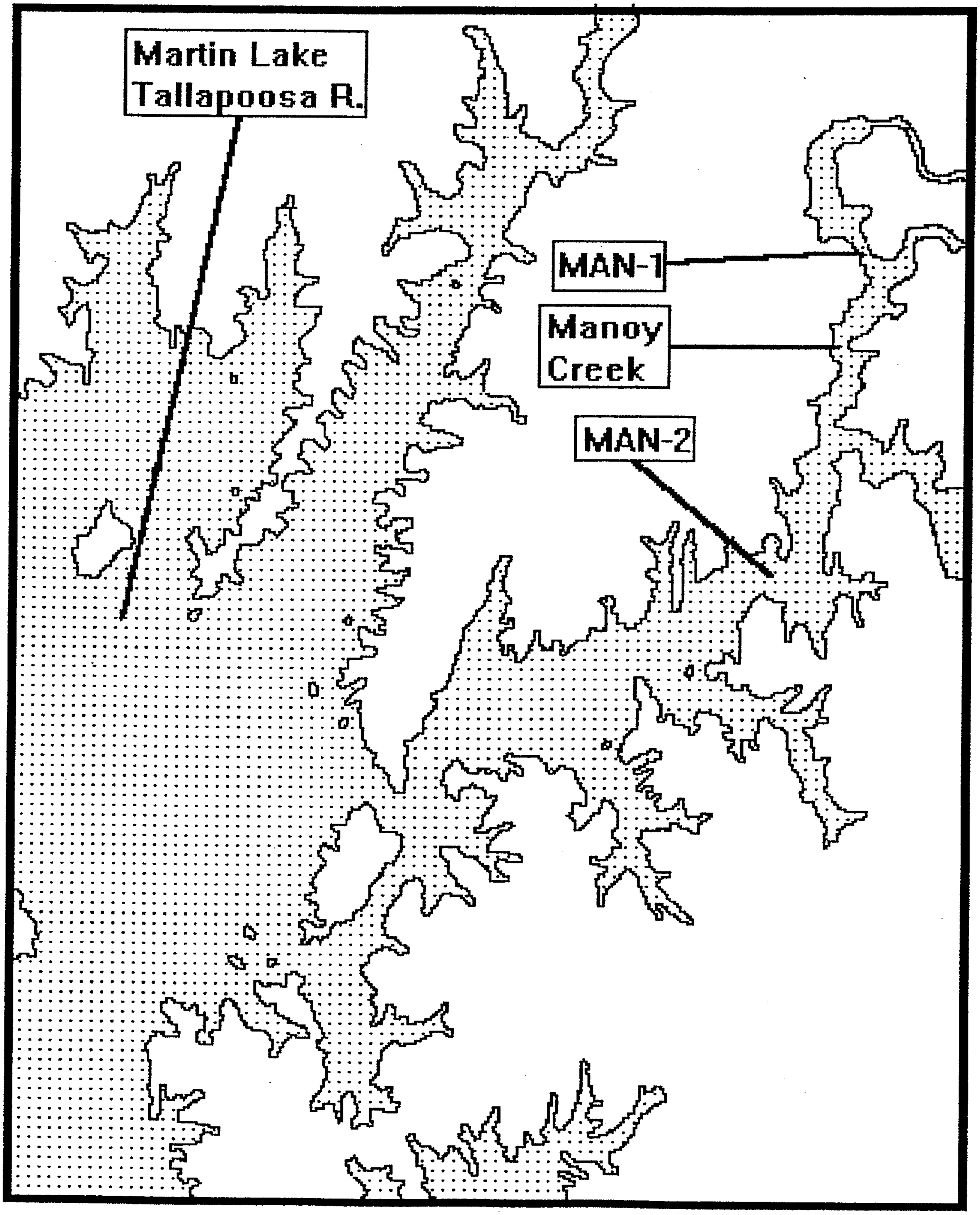


Figure 3 - Manoy Creek Stations



MATERIALS AND METHODS

I. PHYSICAL/CHEMICAL ASSESSMENT

A vertical profile of temperature, dissolved oxygen, specific conductance, and pH measurements were made at multiple depths in the water column at each embayment station using Hydrolab instruments. Measurements were made at mid-depth of shallow stream stations. At embayment stations, measurements were also taken at the regulatory depth of five feet for stations greater than or equal to ten feet in depth, or mid-depth for stations less than ten feet in depth.

A composited water sample was collected from the photic zone at each embayment sampling site. Photic zone depth determinations were made using an underwater photometer to measure the depth at which one percent of the surface illumination occurred. The water sample was collected by raising and lowering a plastic submersible pump-and-hose apparatus repeatedly through the photic zone while collecting the sample in a plastic container.

Water samples from stream stations were grab samples collected at mid-depth of the water column.

Photic zone or grab samples were collected in appropriate containers and properly preserved for analyses of the water quality variables listed in Table 2. Orthophosphate samples were collected by filtering 250 ml of the photic zone or grab sample through 0.45 micron membrane filters and collecting the filtrate in acid-washed Nalgene bottles. Dissolved metals samples were collected by filtering 250 ml of the photic zone or grab sample through 0.45 micron membrane filters and collecting the filtrate in a plastic container and preserving with nitric acid. All samples were analyzed as indicated in Table 2 .

For quality control/quality assurance purposes, field duplicates of each sample type were collected at a minimum of ten percent of the sampling sites. Measurements of temperature, dissolved oxygen, specific conductance, and pH were replicated at sampling sites where duplicate samples were collected.

All samples were preserved , stored, and transported according to the <u>ADEM Standard Operating Procedures and Quality Control Assurance Manual Volume I - Physical/Chemical (1992).</u>

Table 2. Chemical, physical and biological water quality variables measured during the Sugar Creek Study, July 1994

Variable	Method	Preservation/Container	Reference	Detection Limit
Physical				
Vertical illumination	Photometer, Secchi disk	—	Lind, 1979	—
Temperature	Thermistor	—	APHA et al. 1985	—
Turbidity	Nephelometer	—	APHA et al. 1985	—
Total dissolved solids	Filtration, drying	ice/plastic	EPA-600/4-79-020	1 mg/l
Specific conductance	Wheatstone bridge	—	APHA et al. 1985	—
Total suspended solids	Filtration, drying	ice/plastic	EPA-600/4-79-020	1 mg/l
Alkalinity	Potentiometric titration	ice/plastic	EPA-600/4-79-020	1 mg/l
Hardness	Titrametric, EDTA	ice/plastic	EPA-600/4-79-020	1 mg/l
ADMI Color#	SM2120E	ice/plastic	APHA et al. 1992	5 cu
Biological				
Fecal Coliform Analysis	Membrane filter	ice/sterile plastic	ADEM 1992a	—
Chlorophyll a Analysis	Spectrophotometric	filter/ice	APHA et al. 1992	—
Algal Growth Potential Tests	Printz algal assay test	ice	ADEM 1993b	—
Toxicity Testing	Short-term chronic	ice	ADEM 1993a	—
Macroinvertebrate Assessment	Multihabitat/HD/Dredge	90% ethanol	ADEM 1992b	—
Chemical				
Dissolved oxygen	Membrane electrode	—	APHA et al. 1985	—
pH	Glass electrode	—	APHA et al. 1985	—
Ammonia (low level)	Automated phenate	H2SO4/plastic	EPA-600/4-79-020	0.015 mg/l
Chlorides*	Argentometric	ice/plastic	APHA et al. 1992	0.5 mg/l
Nitrate + Nitrite (low level)	Cadmium reduction	H2SO4/plastic	EPA-600/4-79-020	0.003 mg/l
Total Kjeldahl Nitrogen (low level)	Automated colorimetric	H2SO4/plastic	EPA-600/4-79-020	0.15 mg/l
Orthophosphate (low level)	Automated single reagent	filter/ice/acid wash plastic	EPA-600/4-79-020	0.004 mg/l
Phosphorus, Total (low level)	Persulfate digestion	H2SO4/plastic	EPA-600/4-79-020	0.01 mg/l
Total organic carbon	Persulfate-ultraviolet	H2SO4/plastic	EPA-600/4-79-020	1 mg/l
Cyanide, Total @	EPA 335.2	NAOH+Ascorbic Acid	EPA-600/4-79-020	0.004 mg/l
Chlorine, Total Residual @	EPA 330.5	—	EPA-600/4-79-020	—
Biochemical Oxygen Demand, 5 day (BOD-5) @	EPA 405.1	ice/plastic	EPA-600/4-79-020	0.1 mg/l
Diazinon*	Gas chromatography	ice/amber glass	EPA-600/4-88/039	0.012 ug/l

Analysis on samples collected from all study stations and OAK-2

@ Analysis on samples collected from SUG-WWTP only

*Analysis on samples collected from SUG-1, SUG-WWTP and S-1 stations only

Table 2. Cont.

Variable	Method	Preservation/Container	Reference	Detection Limit
Chemical - Metals**				
Arsenic, Total (low level)	EPA 206.2	HNO3 /Plastic	EPA-600/4-79-020	0.01 mg/l
Arsenic, Dissolved (low level)	EPA 206.2	filter, HNO3/Plastic	EPA-600/4-79-020	0.01 mg/l
Cadmium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.02 mg/l
Cadmium, Dissolved	EPA 200.7	filter, HNO3/Plastic	EPA-600/4-79-020	0.02 mg/l
Chromium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.015 mg/l
Chromium, Dissolved	EPA 200.7	filter, HNO3/Plastic	EPA-600/4-79-020	0.015 mg/l
Chromium, Hexavalent	SM 312B	ice/Plastic	EPA-600/4-79-020	0.02 mg/l
Chromium, Trivalent (Total minus Hexavalent=est.)	—	—	—	—
Copper, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.02 mg/l
Copper, Dissolved	EPA 200.7	filter, HNO3/Plastic	EPA-600/4-79-020	0.02 mg/l
Lead, Total (low level)	EPA 239.2	HNO3 /Plastic	EPA-600/4-79-020	0.01 mg/l
Lead, Dissolved (Low level)	EPA 239.2	filter, HNO3/Plastic	EPA-600/4-79-020	0.01 mg/l
Mercury, Total	EPA 245.2	HNO3 /Plastic	EPA-600/4-79-020	0.0005 mg/l
Mercury, Dissolved	EPA 245.2	filter, HNO3/Plastic	EPA-600/4-79-020	0.0005 mg/l
Nickel, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.02 mg/l
Nickel, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.02 mg/l
Silver, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.015 mg/l
Zinc, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.03 mg/l
Thallium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.01 mg/l
Thallium, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.01 mg/l
Beryllium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.02 mg/l
Beryllium, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.02 mg/l
Antimony, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.1 mg/l
Antimony, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.1 mg/l
Selenium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.06 mg/l
Selenium, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.06 mg/l
Barium, Total	EPA 200.7	HNO3 /Plastic	EPA-600/4-79-020	0.015 mg/l
Barium, Dissolved	EPA 200.7	filter,HNO3/Plastic	EPA-600/4-79-020	0.015 mg/l

** Metals analysis on samples collected from SUG-1, Sug-WWTP, S-1, SUG-2, SUG-3, SUG-4, OAK-2

II. BIOLOGICAL ASSESSMENT

Macroinvertebrate Assessment

An assessment of the macroinvertebrate community was considered an essential part of the biological assessment because wastewater treatment plant effluent predictably alters the community by 1) increasing organism abundance and 2) reducing taxa richness (EPA 1973, EPA 1990). Macroinvertebrate communities that are severely impaired by organic pollution from WWTP's are typically dominated by a few pollution tolerant taxa (EPA 1990). Oligochaetes (aquatic earthworms) are often the only macroinvertebrate present in the areas most severely impaired by organic pollution (Wiederholm 1984). Mild organic pollution increases organism abundance, but may have no detectable effects on the number of taxa present (Wiederholm 1984), or may even increase taxa richness (Welch 1992).

Macroinvertebrate assessments were completed at six study stations on Sugar Creek and the Lake Martin embayment. For comparison, macroinvertebrate assessments were also completed at an upstream control station on Sugar Creek and at five physically similar reference stations. The three wadeable stations, SUG-1, S-1, and OAK-1, were assessed utilizing the Multihabitat Bioassessment Protocol as described in the <u>ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual Volume II - Freshwater Macroinvertebrate Biological Monitoring</u> (1992). At each nonwadeable station, macroinvertebrate assessments were conducted utilizing both artificial substrate samplers (Hester-Dendy samplers) and benthic dredge samples.

Hester-Dendy Artificial Substrate Samplers

Four modified Hester-Dendy artifical substrate samplers were deployed at each nonwadeable station using the method utilized by Auburn University (Bayne et al. 1987). Each sampler consisted of five tempered Masonite plates with a total surface area of approximately $0.05m^2$. Each sampler was tied between a small Styrofoam float and a brick anchor to suspend it in the water column, approximately five to six feet from the water surface and one foot above the bottom. To ensure that all samplers were suspended in a well-oxygenated area of the photic zone, the appropriate depth of the samplers was determined at the time of deployment utilizing a Hydrolab and an underwater photometer. Each sampler location was described in a bound study notebook and assigned an identification number that consisted of the station number followed by the letter "a", "b", "c", or "d".

The exposure time of the artificial substrate samplers was decreased from the six week period originally planned to a period of four weeks because of a weather-related delay in deployment and the approaching reservoir draw-down period. However, four weeks is the length of time routinely used by Auburn University in their macroinvertebrate studies (Bayne et al. 1986). The samplers were retrieved by slowly raising the sampler in the water column, submersing a wide mouth container and raising it around the sampler. The whole assembly was then carefully removed from the water. The samplers were put on ice for transport to the laboratory where they were processed and the resulting samples enumerated and identified using the methods described in the ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual Volume II - Freshwater Macroinvertebrate Biological Monitoring (1992).

Measurements of field parameters were collected at the approximate depth of each sampler to document exposure conditions at the time of deployment and retrieval.

Petite Ponar Dredge Samples

Benthic samples were collected from the left bank, midchannel, and right bank areas located along a transect perpendicular to the shore. A sample was collected from the mid-channel and each overbank to ensure that samples were obtained from areas continually inundated and from areas that might be exposed during draw-down of the reservoir level. Each of the three samples consisted of three petite Ponar grabs. The samples were elutriated using a stir and pour technique. The elutriate was poured through a #30 sieve and the remaining material was visually searched for any organisms. The resulting sample was then preserved in 90% ethanol and returned to the laboratory for processing, enumeration, and identification.

For each replicate, the approximate location, depth of collection, and observed composition of the bottom substrate were recorded in a bound study notebook.

Data Analysis

Comparisons were not made between collection methods because the results of the metrics calculated for each sample will naturally differ between multihabitat assessment samples, Hester-Dendy samples, and dredge samples. The results obtained at the study stations were compared to the results obtained at the physically similar reference stations in order to detect any differences in organism abundance and taxa richness.

The metrics used to interpret data differed slightly between the three collection methods. The diversity and equitability indices, which evaluate water quality based on macroinvertebrate samples, are used with quantitative samples and were therefore only calculated for the Hester-Dendy and dredge samples. No community similarity indices were calculated for the nonwadeable stations since there are no methods presently available for assessing habitat quality and evaluating similarity between study and reference stations.

The biometrics utilized in this study are discussed in more detail in ADEM Field Operations Standard Operating Procedures and Quality Control Assurance Manual Volume II Freshwater Macroinvertebrate Biological Monitoring (1992), as well as in Weber (1973), Hilsenhoff (1987), Shackleford (1988), and EPA (1989b).

Algal Growth Potential Tests

Algal Growth Potential Tests provide for the identification of possible water quality problems associated with nuisance algal blooms. These tests document the ability of a water body to promote a nuisance algal bloom and by the addition of regulated nutrients to the test flasks, aid in identifying the limiting nutrient status of a sample. Algal Growth Potential Tests also allow for the differentiation between the nutrients in a sample and the nutrient forms actually available for algal growth by chemical analyses.

Algal Growth Potential Tests (AGPT) were conducted on samples collected during August 1994 from five stations on Lake Martin selected for the Sugar Creek Study. Photic zone composite samples were collected from SUG-3, OAK-3, MAN-2, ELK-1, and ELK-2 on August 15, 1994 by ADEM personnel. Chemical analyses for low level nutrients were determined for each sample by the ADEM Central Laboratory.

Algal Growth Potential Tests using *Selenastrum capricornutum* were conducted according to methodology presented in the *Selenastrum capricornutum* Printz Algal Assay Bottle Test (EPA-600/9-78-018) and the ADEM Algal Growth Potential Test Standard Operating Procedure (Draft 1993). Regulated amounts of Nitrogen and Phosphorus were added to the processed samples to determine which was the limiting nutrient in each sample. A control of each sample was also tested to determine its algal growth potential. Algal cell counts were made on days 11-14 or until the maximum standing crop was obtained in each flask. For practical purposes, the maximum standing crop was defined as the day when the biomass growth was less than 5% of the biomass growth from the day before. Cell counts were determined using an electronic particle counter (Coulter Model ZM) and a mean cell volume (MCV) computer. All cell counts were then converted to equivalent dry weights using the following data reduction equation:

Cell counts (cells mg/L) X MCV (cubic micrometers) X

4.12×10^{-10} = mg dry weight *S. capricornutum*/L

The dry weight factor for this equation was developed by the Environmental Protection Agency, Ecological Support Branch, Athens, Georgia.

Chlorophyll a Analysis

Biomass determinations are probably the most useful measurement of the amount of algae with chlorophyll a the most frequently used biomass estimate. Chlorophyll a is a type of chlorophyll present in all types of algae, sometimes in direct proportion algal biomass. Mean summer chlorophyll concentrations are good indicators of the severity of algal problems in a lake (EPA 1990).

Chlorophyll a samples were collected by filtering 1000ml of the composited photic zone sample through glass fiber filters. Immediately after filtering, each filter was folded once and placed in a petri dish. Each petri dish was labeled, wrapped in aluminum foil, sealed in a ziploc bag, and placed on ice for transport to the ADEM Central Laboratory for analysis. Corrected chlorophyll a concentrations were determined according to procedures in the 18th edition of Standard Methods for the Examination of Water and Wastewater (APHA 1992).

Carlson Trophic State Index

Chlorophyll a data were used to calculate the Carlson Trophic State Index (TSI) for Sugar/Elkahatchee Creek and reference embayment stations. The index number can be calculated from any of several parameters, however Carlson recommends using chlorophyll a concentrations when using data collected during summer months. The Carlson Trophic State Index provides a single number that serves as an indicator of a lake's trophic status (Carlson 1977). The TSI incorporates most lakes in a scale of 0 to 100 with each major division (10, 20, 30, etc.) representative of a doubling in algal biomass. Lakes with a TSI of 70 or greater are generally considered hypereutrophic and in need of action appropriate for protection and restoration. A TSI of 50-70 indicates eutrophic conditions in a lake. Trophic state index values of 40-50 indicate mesotrophic conditions while oligotrophic conditions are indicated by TSI values less than 40.

Toxicity Testing

The purpose of toxicity testing is to assess the potential of an effluent to adversely affect the aquatic community in the waterbody receiving the effluent. These tests provide supplemental information on unknown compounds and/or synergistic effects which cannot be obtained through routine chemical-specific testing. Short-term chronic tests monitor for effects that are sub-lethal in nature and adversely impact aquatic organisms by interrupting one or more of their normal body functions.

In order to determine if the Alexander City - Sugar Creek WWTP effluent was adversely impacting Sugar Creek or its embayment area, chronic toxicity tests were conducted on samples collected from the WWTP, upstream of the WWTP and downstream in the Sugar Creek embayment area of Lake Martin. By conducting toxicity tests on upstream and downstream stations as well as the WWTP discharge, the toxic effects of an effluent discharge on a receiving water can be documented. In addition to photic zone samples, bottom samples were collected at the embayment stations to study the effects of a high conductivity layer which forms at the bottom of the channel (AT&E 1991).

Samples were collected by ADEM personnel on September 26, 28, and 30, 1994. Samples from the upstream station (SUG-1) were grab collection, while the samples from the WWTP were 24 hour composites collected in an automatic composite sampler. Separate samples were collected from the photic zone and the bottom of the water column of the embayment stations (SUG-2, SUG-3). Both were collected using a submersible pump.

Toxicity tests were conducted using two test species; *Ceriodaphnia dubia*, a microcrustacean typically found in the zooplankton, and the fathead minnow, *Pimephales promelas*. The measured endpoints for the *P. promelas* tests were survival and growth, while the measured endpoints for the *C. dubia* test were survival and reproduction. Toxicity was indicated if there was a significant reduction between the controls and the samples for any of the measured endpoints.

Procedures and methodology were as per EPA Test Method 1000.0 and 1002.0 of the manual, Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Second Edition (EPA/600/4-89/001) and ADEM Standard Operating Procedures and Quality Control Assurance Manual, Volume IV.

All relevant sampling, procedural, and quality control data are included in Appendix C.

Fecal Coliform Analysis

Subsurface grab samples were collected at each sampling site for fecal coliform analysis. Analysis of samples were conducted according to the ADEM Standard Operating Procedures and Quality Control Assurance Manual Volume I - Physical/Chemical (1992) .

DATA COLLECTION AND SUMMARY

I. PHYSICAL/CHEMICAL ASSESSMENT

Hydrologic Data

Rainfall during the Summer of 1994 was higher than normal in the Lake Martin and central Alabama area (Appendix Table E-1). A gage station on Hillabee Creek, a tributary to Lake Martin located upstream of Sugar Creek's confluence with Lake Martin, recorded flows that were higher than the long-term monthly mean for June - September 1994 (Appendix Figure E-1, Table E-2). Given the nature of the discharge to Sugar Creek, it is likely that the amount of rainfall effected a general improvement in the water quality of the Sugar Creek embayment by increasing dilution and decreasing residence time.

In-situ Measurements

Overall, temperature appeared to be slightly higher in the Sugar/Elkahatchee Creek embayment stations than at the reference stations and is likely due in part to the higher water temperatures of the WWTP discharge to Sugar Creek and to the absorbance of solar energy by the more turbid waters of the embayment. Temperatures measured at S-1 exceeded the standard for Agricultural and Industrial Water Supply classification by being 10° F (5.7° C) higher than ambient, which was measured upstream of the WWTP at SUG-1. Temperatures measured at the regulatory depth of five feet (1.5 m) or mid-depth for all embayment stations appear in Figure 4 and Appendix Table D-2.

Dissolved oxygen concentrations at the regulatory depth of five feet (1.5m) or mid-depth were above the dissolved oxygen standard of 5 mg/l at all stations (Figure 5). Only the deepest stations, ELK-2 and MAN-2, became essentially anoxic near the bottom.

Measurements of pH were generally higher at Sugar/Elkahatchee Creek stations than at reference stations (Figure 6). The pH values recorded at SUG-3, SUG-4, and ELK-2 exceeded the standard ($pH \geq 6 \leq 8.5$) for the Swimming/Fish and Wildlife use-classification of these waters. The higher pH values of the study stations may result in part from the removal of carbon dioxide (CO_2) from

Fig. 4. Temperature at 5 foot depth or mid-depth of channel.

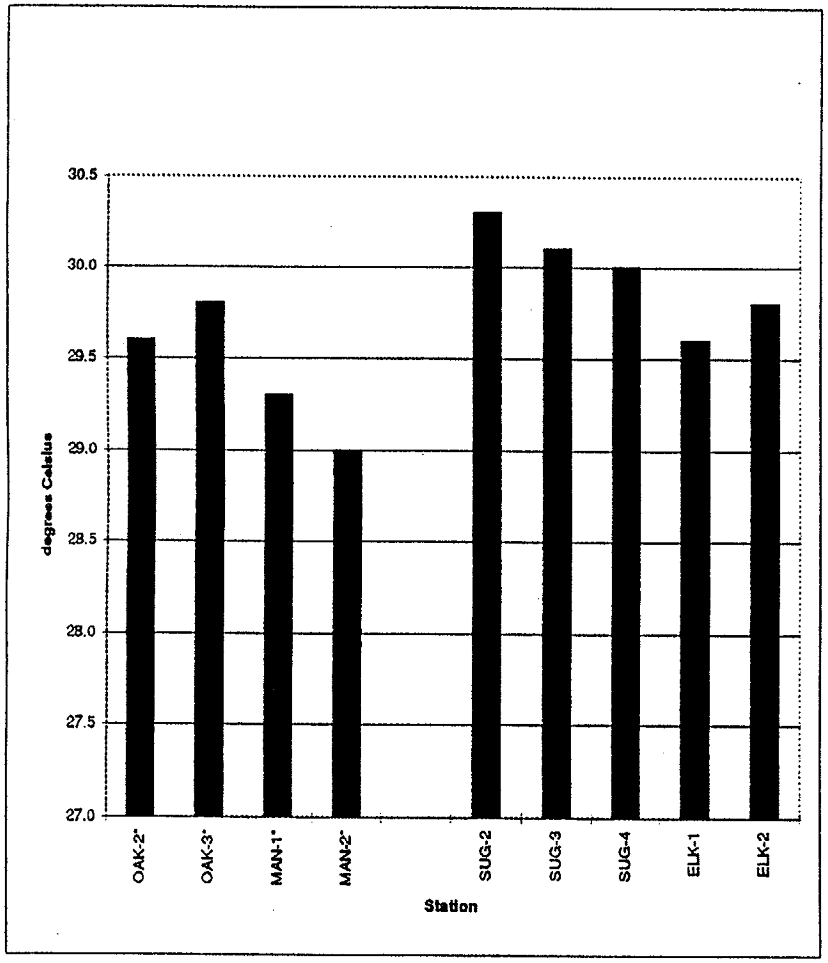
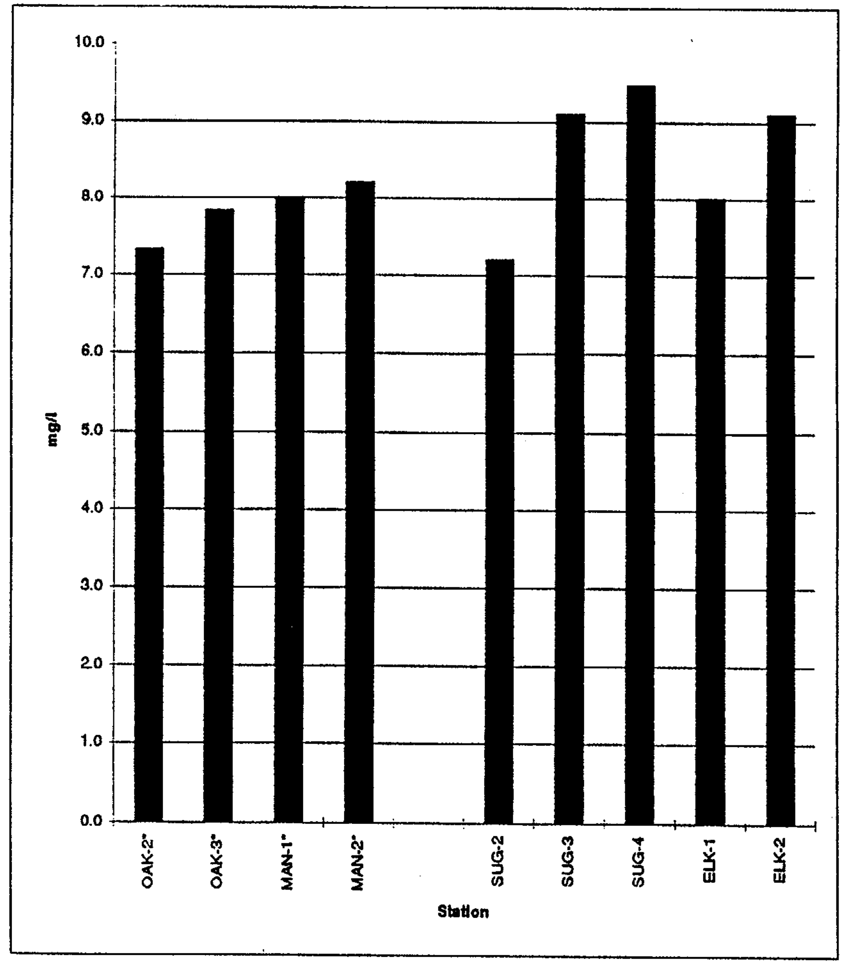
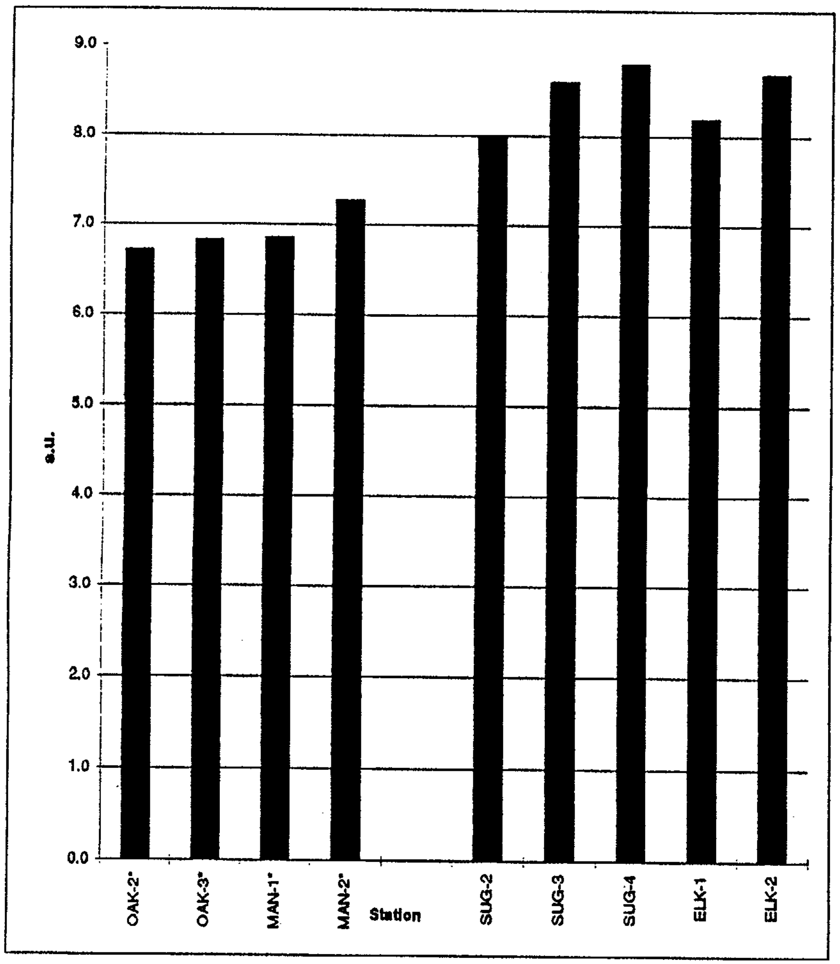


Fig. 5. Dissolved oxygen.



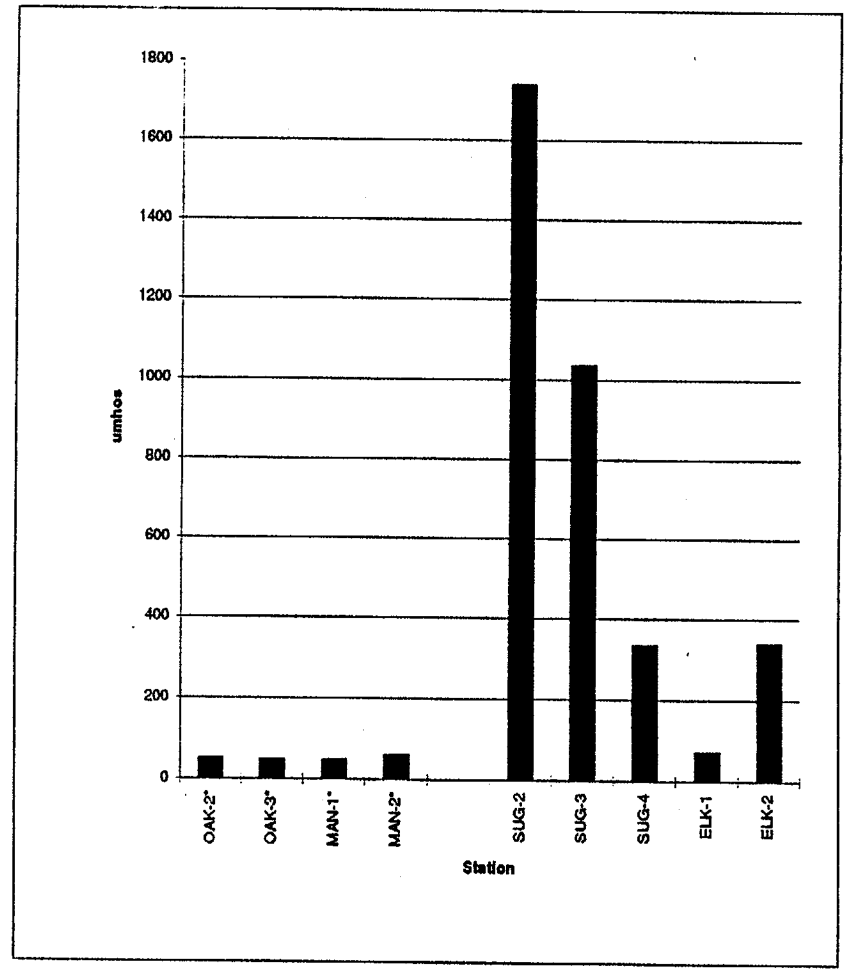
*Reference station

Fig. 6. pH measurements.



* Reference station

Fig. 7. Bottom conductivity.



the water column during photosynthetic activity of the dense algal populations present at the eutrophic Sugar/Elkahatchee Creek stations (see Biological Asessment - Carlson Trophic State Index). Low CO_2 and high pH conditions occur more frequently as waters become eutrophic, allowing the less desirable blue-green algal species to dominate (Welch 1992). The nuisance-forming species of blue-green algae require high total phosphorous concentrations, low CO_2 concentrations, and a high pH to produce a nuisance biomass. These conditions very well describe the conditions of the Sugar Creek/upper Elkahatchee Creek embayment areas and strongly indicate a potential for nuisance blue-green algal blooms in the waters of these embayments.

Specific conductance near the lake bottom was much higher at the Sugar/ Elkahatchee Creek embayment stations than at the reference stations (Figure 7). The specific conductance measured at ELK-1, located on Elkahatchee Creek upstream of its confluence with Sugar Creek, was similar to measurements at the reference stations.

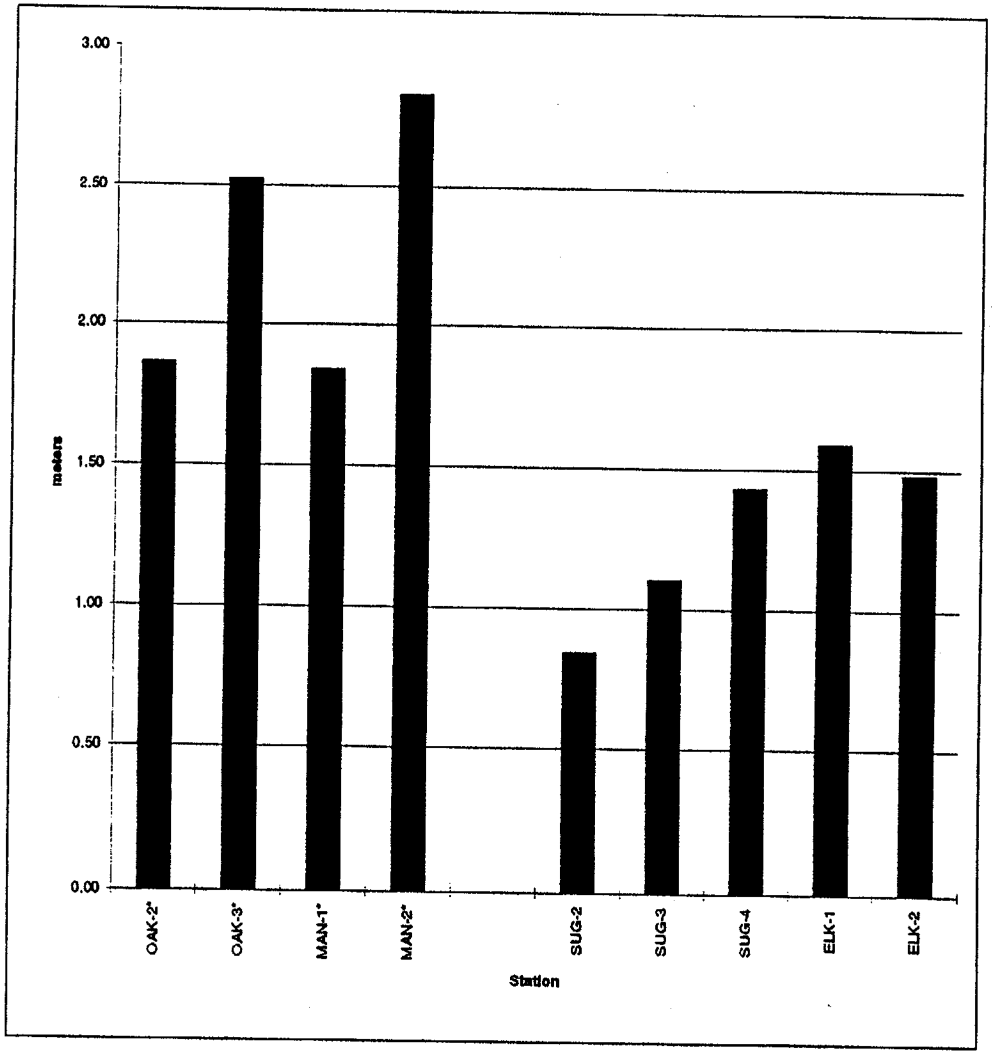
Vertical illumination appeared to be greater in reference embayment stations than at Sugar/Elkahatchee Creek stations. Vertical illumination as measured by Secchi disk visibility appears in Figure 8. Decreased Secchi disk visibility in the Sugar/Elkahatchee Creek embayment stations was likely due in part to high algal densities. Photic zone depth, as measured by photometer, appeared to be greater in reference stations also. However, the photic zone extended to the bottom at many shallow study and reference stations.

Numerical values for all measurements at each station appear in Appendix D, Table 2.

Analytical Parameters

There are four important constituents of domestic wastewater that are targeted for removal through treatment: total suspended solids (TSS), biochemical oxygen demand (BOD), nutrients (nitrogen and phosphorous), and pathogenic bacteria (Welch 1992). Because of laboratory workload constraints, BOD was assessed only in the sample collected from the WWTP effluent (Appendix D, Table 1).

Fig. 8. Secchi depth



*Reference station

Pathogenic bacteria concentrations are measured through fecal coliform analysis (see Biological Assessment - Fecal Coliform Analysis). Total suspended solids concentrations as well as results of nutrients, chlorides, metals, and pesticide analyses will be discussed in following paragraphs.

ADMI Color (Fig. 9), alkalinity/hardness (Fig. 10), and total dissolved solids (Fig. 11) were generally higher at Sugar/Elkahatchee Creek stations than at reference stations. No detectable amounts of cyanide were measured in samples collected from the WWTP effluent.

According to laboratory personnel, total phosphorous analysis results were not considered within quality assurance accuracy for reporting purposes because of an autoclave malfunction which prevented complete digestion of the samples during analysis. Total phosphorous analysis results are not included in this section because of equipment malfunctions which prevented compliance with quality assurance standards.

Numerical results of the laboratory analyses for each station appear in Appendix Table D-1.

Total Suspended Solids

Total suspended solids concentrations were much higher at Sugar Creek embayment stations than at reference stations (Fig. 12). The input of suspended solids from organic wastewater alters the bottom substratum to one that is more depositing than eroding with negative impacts to the macroinvertebrate community reflected by an increase in biomass and productivity accompanied by a reduction in species diversity (Welch 1992). These negative impacts were observed in the macroinvertebrate communities of the Sugar Creek embayment stations (see Biological Assessment - Macroinvertebrates).

Total Organic Carbon

Total organic carbon concentrations of all Sugar/Elkahatchee Creek embayment stations were higher than those of reference stations (Fig. 13). Total organic carbon is a convenient and direct expression of total organic content (APHA 1992) that further indicates the increased productivity of the Sugar/Elkahatchee Creek embayment area over the reference embayment areas.

Figure 9. ADMI color.

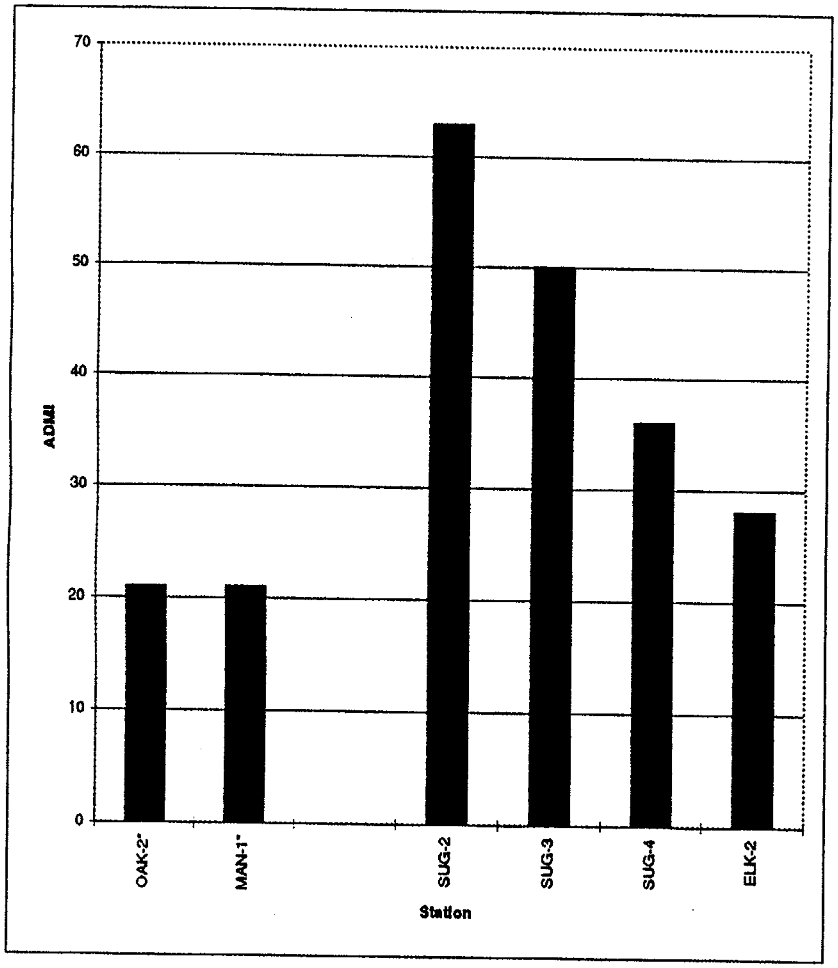
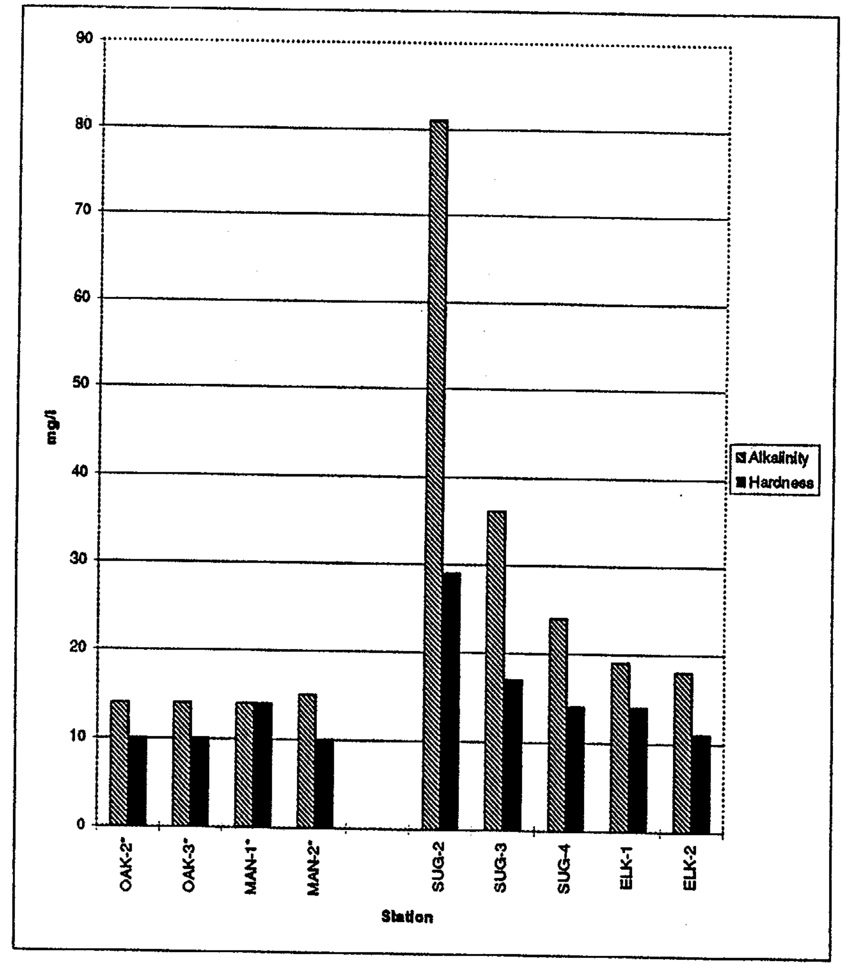


Figure 10. Alkalinity and hardness.



* Reference station

Figure 11. Total Dissolved Solids (TDS)

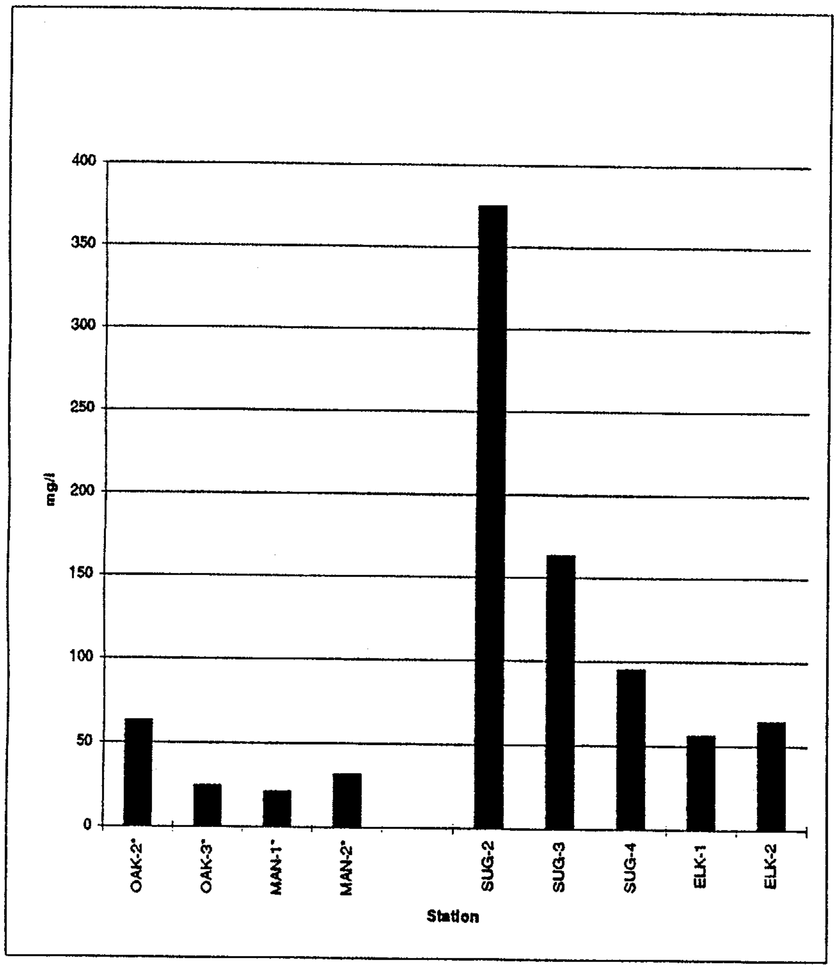
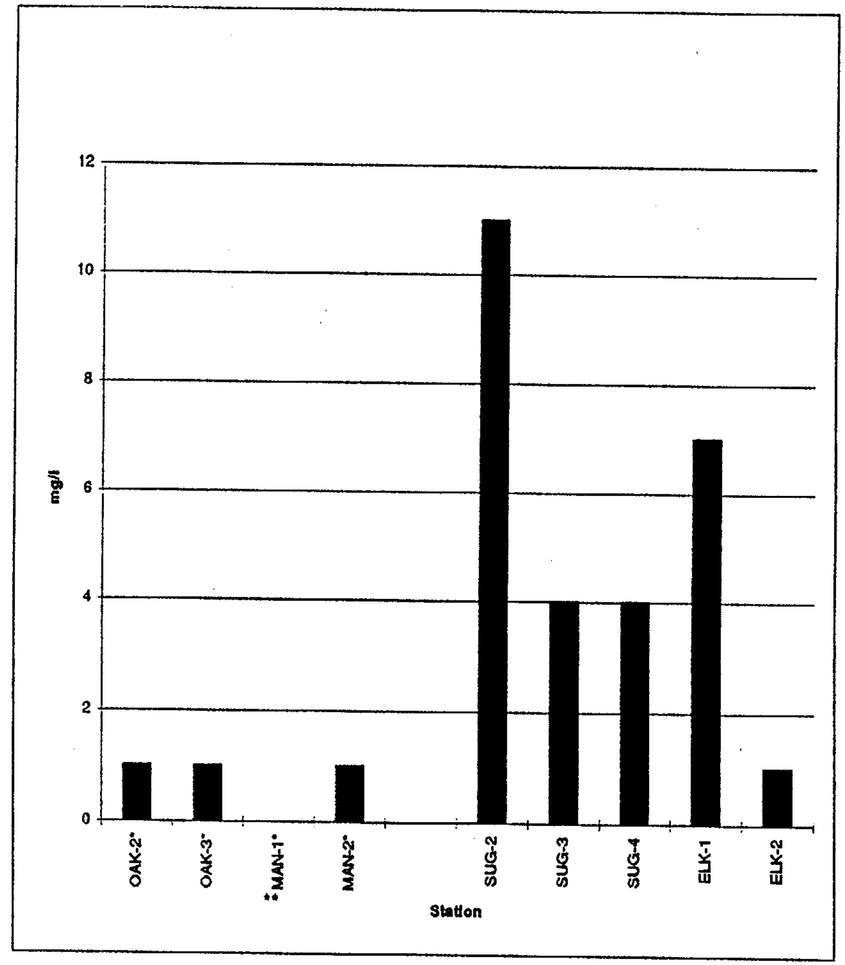


Figure 12. Total Suspended Solids (TSS)



* Reference station

** Value is less than detectable limit (<1)

Figure 13. Total Organic Carbon (TOC)

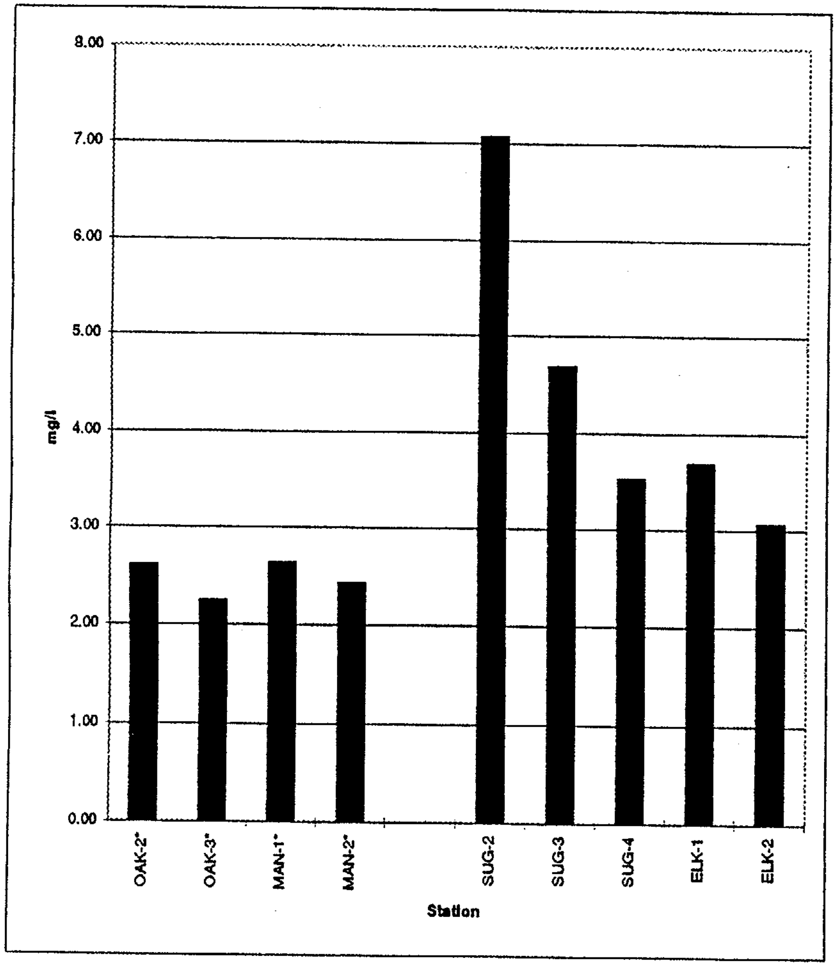
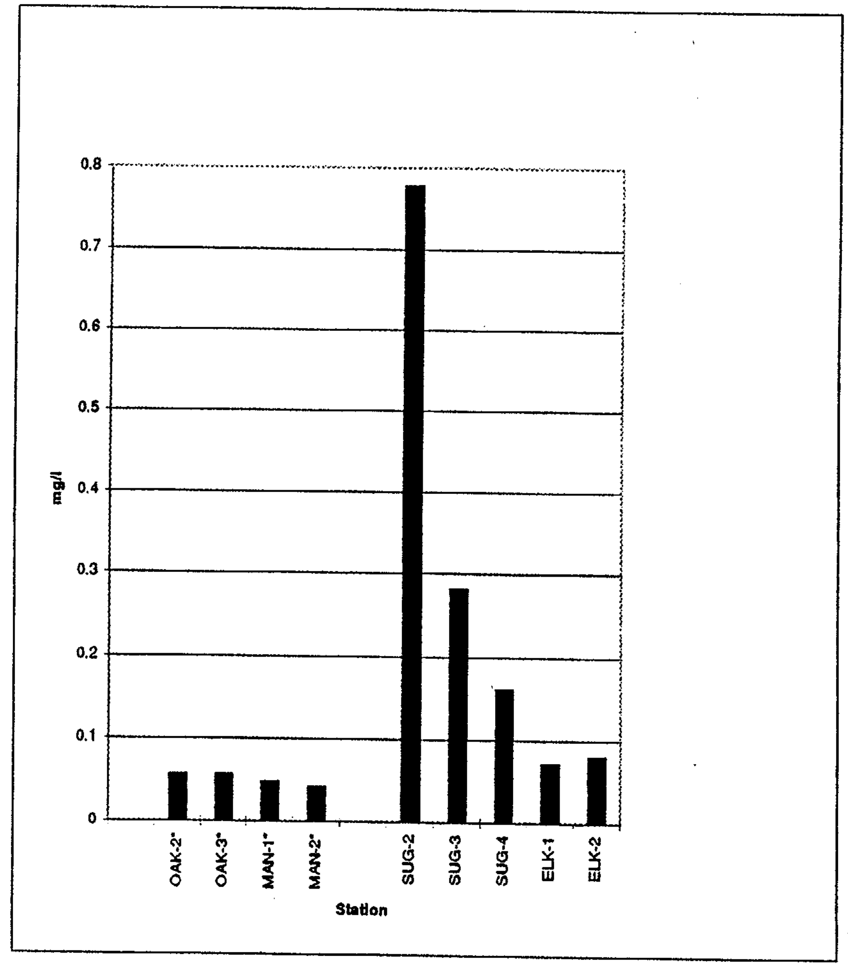


Figure 14. Orthophosphate (PO_4-P)



* Reference station

Nutrients

Orthophosphate and nitrogen concentrations were higher at Sugar/Elkahatchee Creek embayment stations than at reference stations (Figs. 14-17). Orthophosphate, ammonia nitrogen, and nitrate nitrogen are forms of the essential nutrients phosphorous and nitrogen that are available for uptake by algae and are therefore instrumental in the instigation of algal growth. In waters containing dense algal populations, as found in the Sugar/Elkahatchee Creek embayment area, orthophosphate concentrations are usually lowered as the readily available nutrient is rapidly taken up by the algal populations. However, the orthophosphate concentrations of SUG-2, SUG-3, and SUG-4 were high enough that uptake of orthophosphate by the relatively dense algal populations failed to reduce the orthophosphate concentration to that of the reference stations. Trophic state index values indicate the Sugar/Elkahatchee Creek embayment to be of an unusually advanced trophic state for the waters of Lake Martin (see Biological Assessment - Carlson Trophic State Index). However, with the surplus of orthophosphate available to algal populations and the identification of nitrogen as the limiting nutrient, it is likely that any increase in nitrogen in the waters of the Sugar/Elkahatchee Creek embayment would facilitate increased algal growth, further advancing the trophic state.

Chlorides

Chloride concentrations were measured at SUG-1, the WWTP, and S-1. Chloride concentrations from the WWTP and from S-1 exceeded the EPA Chronic Criteria for Chloride (Table 3) and may be involved in the toxicity detected in toxicity tests (see Biological Assessment - Toxicity Tests). Chloride concentrations of samples collected from the WWTP effluent and at S-1 may persist downstream to ELK-2 as indicated by the high conductivity values measured at this station.

Figure 15. Ammonia Nitrogen (NH_3-N)

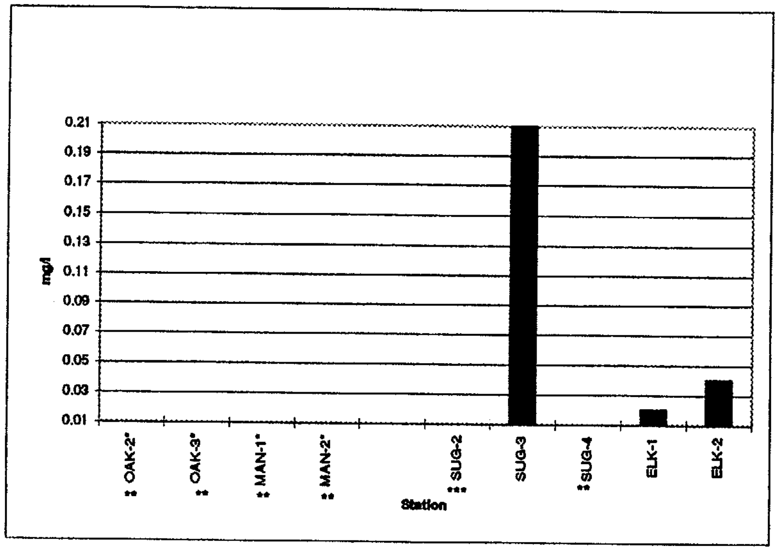


Figure 16. Nitrate-Nitrite (NO_2-NO_3-N)

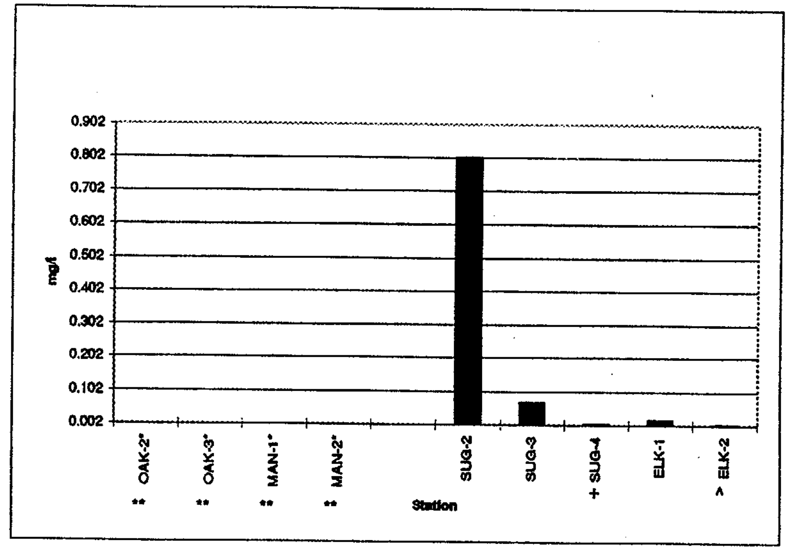
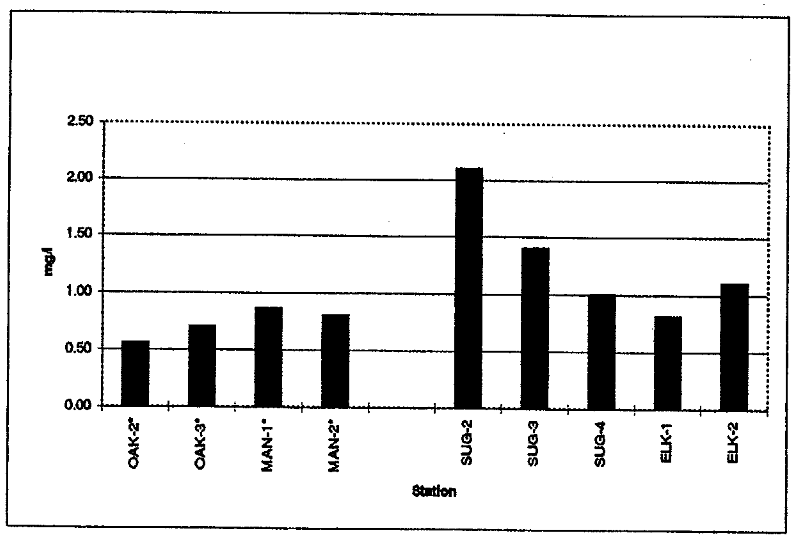


Figure 17. Total Kjeldahl Nitrogen (TKN).



* Reference station
** Value is less than detectable limit
*** Value is 0.01
\+ Value is 0.003
^ Value is 0.004

Metals

Copper concentrations measured in samples collected from the WWTP, S-1, and SUG-2 stations far exceeded the ADEM Toxic Pollutant Criteria for Copper (Table 3) and may be involved in toxicity detected in toxicity tests (see Biological Assessment - Toxicity Tests).

Detectable concentrations of barium and antimony were measured at all upper Sugar Creek stations (Appendix Table D-4). Concentrations of all other metals for which analyses were conducted were below detectable levels at all stations.

Pesticides

No detectable concentrations of the pesticides Diazinon, Ethion, Malathion, Methyl Parathion, and Phosdrin were measured in water samples collected from the WWTP effluent (Appendix Table D-3).

Table 3. Copper and chloride concentrations of chemical analyses samples from the Sugar Creek Study, August 15, 1994.

		Toxic Pollutant Acute Criteria		Toxic Pollutant Chronic Criteria		Measured Values		
Station	Hardness (mg/l)	Copper** (ug/l)	Chloride* (mg/l)	Copper** (ug/l)	Chloride* (mg/l)	Total Copper (ug/l)	Dissolved Copper ug/l	Chloride (mg/l)
SUG-1	97	17.22	860	11.52	230	<20***		26
WWTP	61	11.13	860	7.75	230	134	127	488
S-1	64	11.64	860	8.07	230	137	127	426
SUG-2 (Photic)	29	5.52	860	4.11	230	29	28	

*EPA Water Quality Criteria (1988)

**ADEM Water Quality Criteria (1990); EPA Water Quality Criteria (1986)
In accordance with EPA approved procedures, the criteria value for permitting purposes is assumed to be the dissolved fraction.
The total recoverable value is computed by dividing the dissolved fraction by 0.388.

***Less than detectable amount

II. BIOLOGICAL ASSESSMENT

Macroinvertebrate Assessment

The results of the Hester-Dendy and dredge samples indicate that negative impacts to the macroinvertebrate communities of the Sugar and Elkahatchee Creek embayments have been severe, although the impact appears to decrease gradually downstream. The results of the multihabitat bioassessments indicate that the macroinvertebrate community of Sugar Creek at S-1, immediately downstream of the WWTP discharge, has also been negatively impacted.

Macroinvertebrate communites of the reference waterbodies appear to be relatively unimpacted. Hester-Dendy samples from the MAN-2 reference station appeared to be atypical in comparison to all other stations. Samples from this station contained the highest number of total organisms collected at any station and unlike any other station, was dominated by cladocerans (89%), planktonic invertebrates common in lentic (nonflowing) conditions.

Interpretation as well as numerical values for the biometrics of each station appear in Appendix Tables A-1 through A-3. Measurements of field parameters collected at the approximate depth of each Hester-Dendy sampler that document exposure conditions at the time of deployment and retrieval appear in Appendix Table A-4. For each dredge replicate, the approximate location, depth of collection, and observed composition of the bottom substrate appear in Appendix Table A-5. A list of the taxa collected at each station appears in Appendix Table A-6.

Nonwadeable Stations

Hester-Dendy and dredge samples collected from nonwadeable embayment stations indicate that the macroinvertebrate communities of the Sugar Creek embayment stations have been negatively impacted as indicated by the following:

a) higher total number of organisms collected at the Sugar Creek stations than at reference stations (Fig. 18a, 18b);

b) greater percent contribution of the dominant taxon at the Sugar Creek stations than at reference stations (Fig. 19a, 19b);

c) higher biotic index values of the Sugar Creek stations (Fig. 20);

d) dominance of pollution-tolerant Chironomidae taxa at Sugar Creek stations (Fig.21);

e) lower taxa richness of the Sugar Creek stations (Figs. 22a, 22b);

f) equitability and diversity indices indication of moderate negative impacts to the macroinvertebrate communities of SUG-2 and SUG-3 (Figs.23a, 23b; 24a, 24b).

The results of Hester-Dendy and dredge samples analyses are typical of macroinvertebrate communities severely impaired by organic pollution (Wiederholm 1984, Welch 1992). Macroinvertebrate communities exposed to severe organic pollution are characterized by low taxa richness and diversity because of the elimination of taxa sensitive to low dissolved oxygen concentrations and siltation (EPA 1973, Wiederholm 1984, Welch 1992). The abundance of the relatively few pollution tolerant taxa rises, increasing the percent contribution of the dominant taxon and the biotic index scores (EPA 1990). Oligochaetes were the dominant taxon at SUG-2 comprising 82% of the organisms collected at this station. Station SUG-2 was not deoxygenated at the time of sampling (Appendix Table D-2), however dominance of the macroinvertebrate community by Oligochaetes is indicative of waters that are often deoxygenated (Wiederholm 1984). Though present at all other stations, the pollution-sensitive EPT taxa were absent at SUG-2 and SUG-3, with the generally pollution-tolerant Chironomidae family comprising a greater proportion of the total taxa. Equitability values of SUG-2 and SUG-3 indicate moderately impaired waters.

Hester-Dendy and dredge samples indicate that the impairment to the macroinvertebrate communities decreases gradually downstream. Though still more impaired than reference stations, macroinvertebrate communities of SUG-4 and ELK-2 appeared to be less impacted than those of the

Fig. 18a. Total Number of Organisms**
Hester-Dendy samples

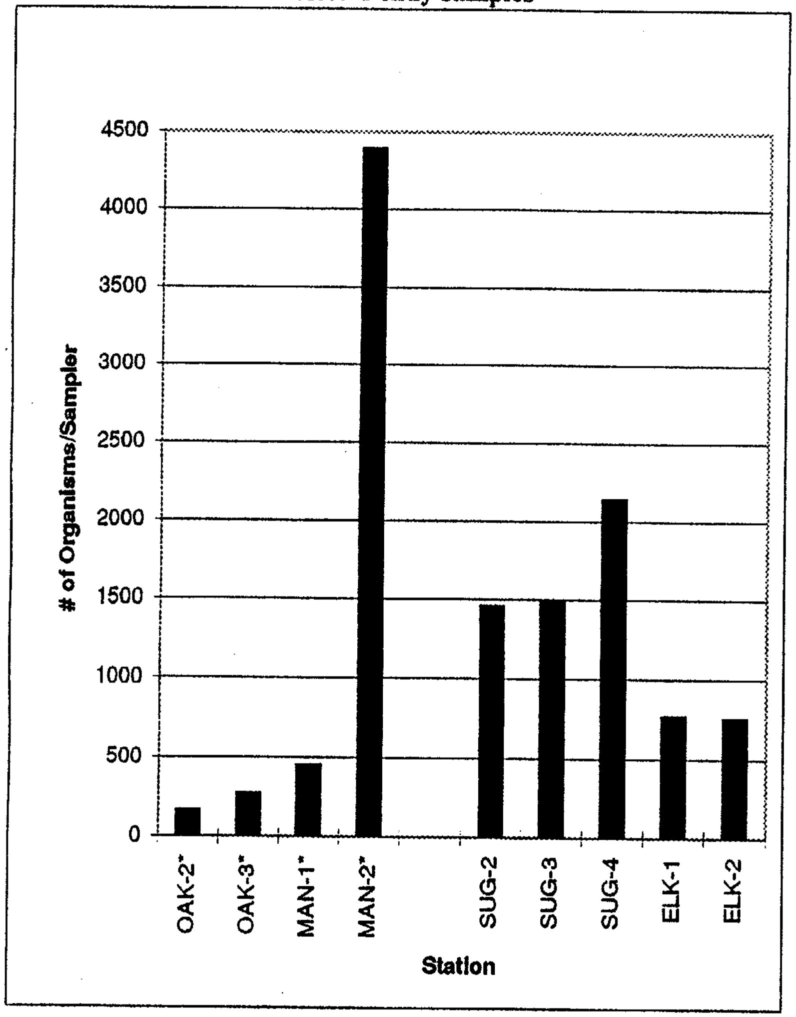
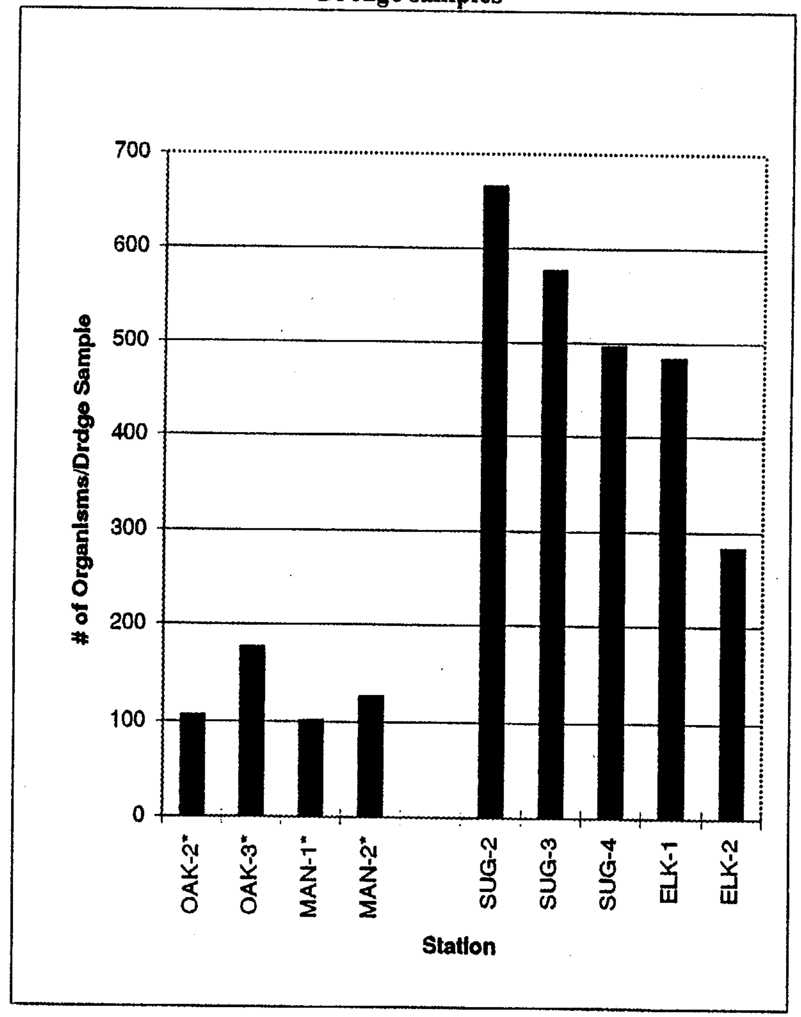


Fig. 18b. Total Number of Organisms**
Dredge samples



**Total number of organisms collected: Generally decreases with increasing water quality.
*Reference station

Fig. 19a. Percent Contribution of the Dominant Taxon**: Hester-Dendy samples

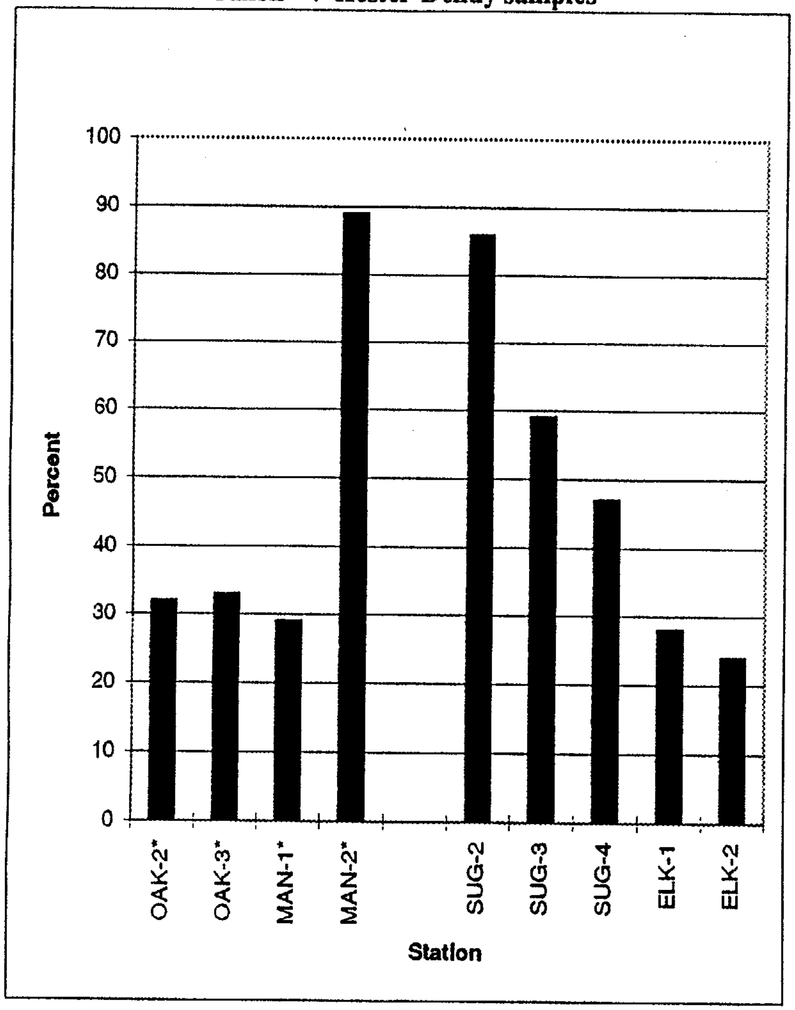
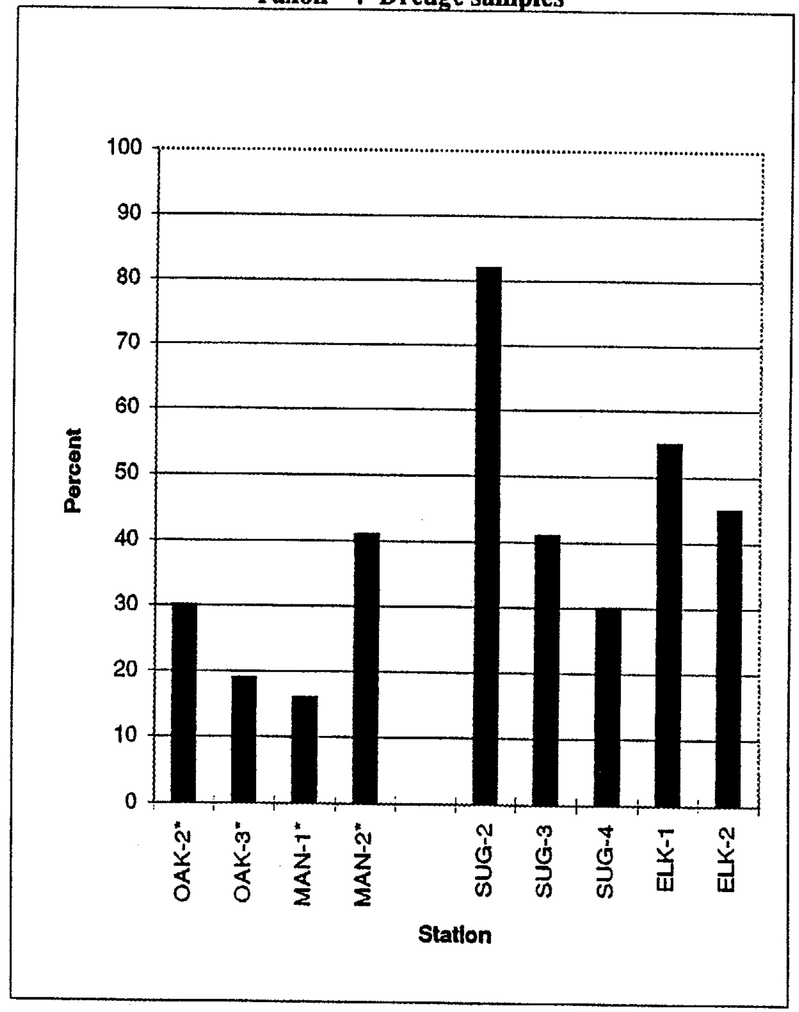
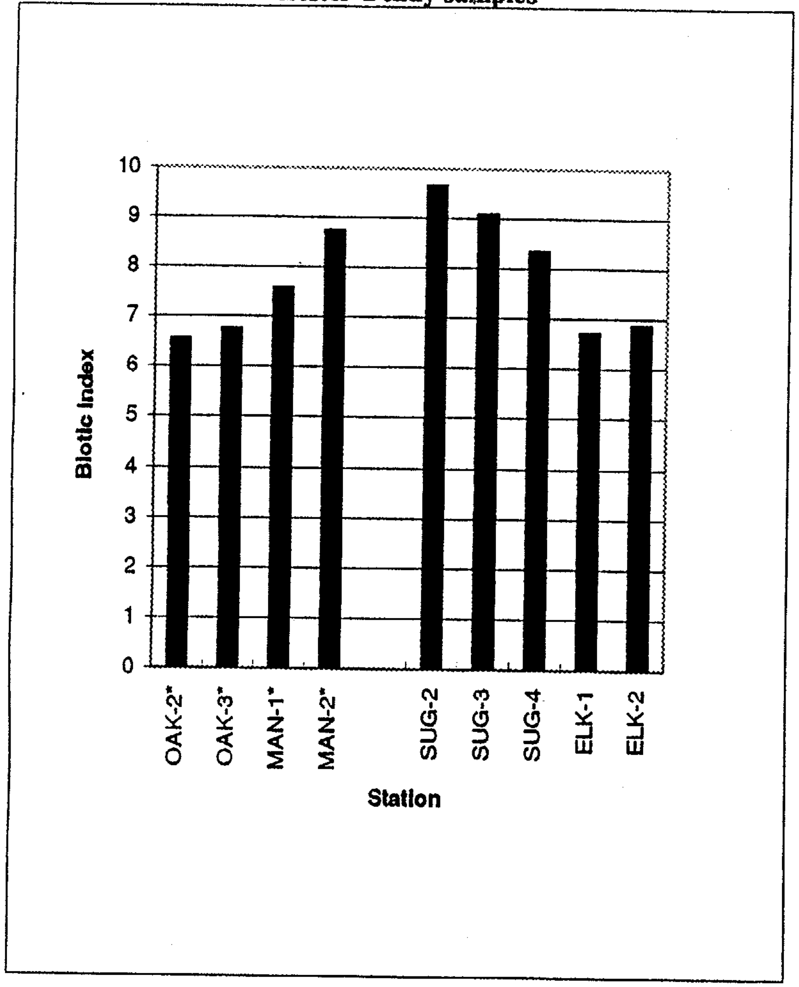


Fig. 19b. Percent Contribution of the Dominant Taxon**: Dredge samples



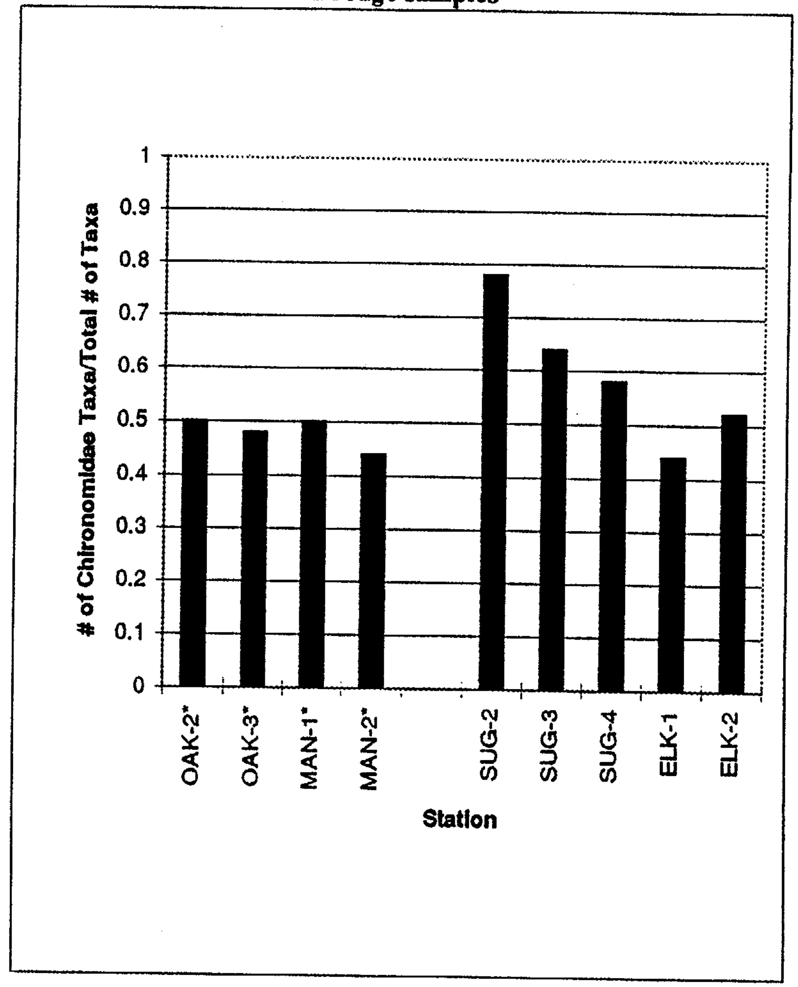
**Proportion of total sample comprised of dominant taxon. Generally decreases with increasing water quality.
*Reference station.

Fig. 20. Biotic Index values**
Hester-Dendy samples



**Biotic Index values generally decrease with increasing water quality.
*Reference station.

Fig. 21. Number of ChironomidaeTaxa /Total Number of Taxa***
Dredge samples



*** Proportion of total sample comprised of pollution-tolerant Chironomidae taxa. Generally increases with decreasing water quality.

Fig. 22a. Taxa Richness values**
Hester-Dendy samples

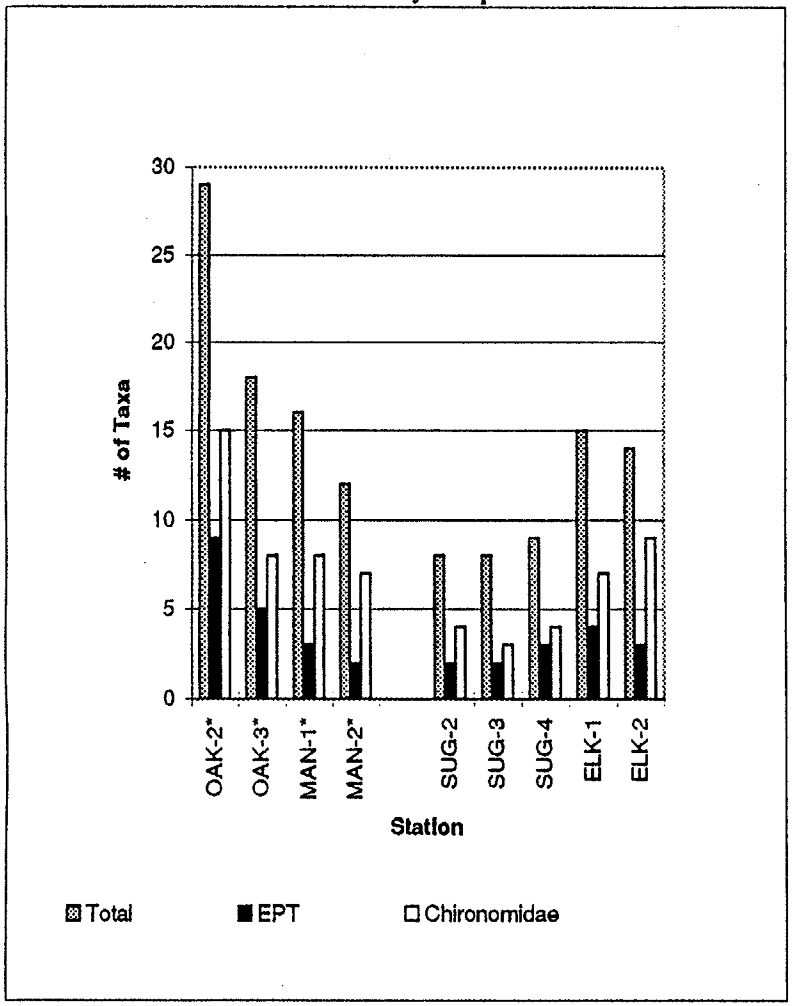
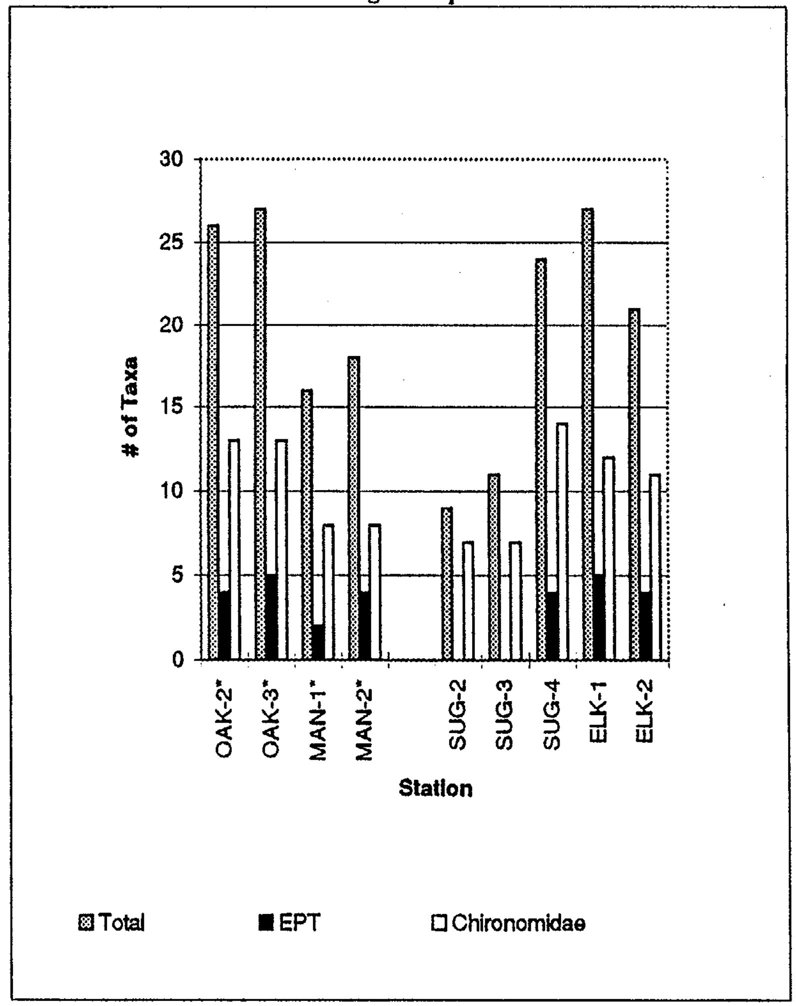


Fig. 22b. Taxa Richness values**
Dredge samples



**Taxa richness: Number of taxa collected at each station. Generally increases with increasing water quality.
*Reference station

Fig. 23a. Equitability Index values**
Hester-Dendy samples

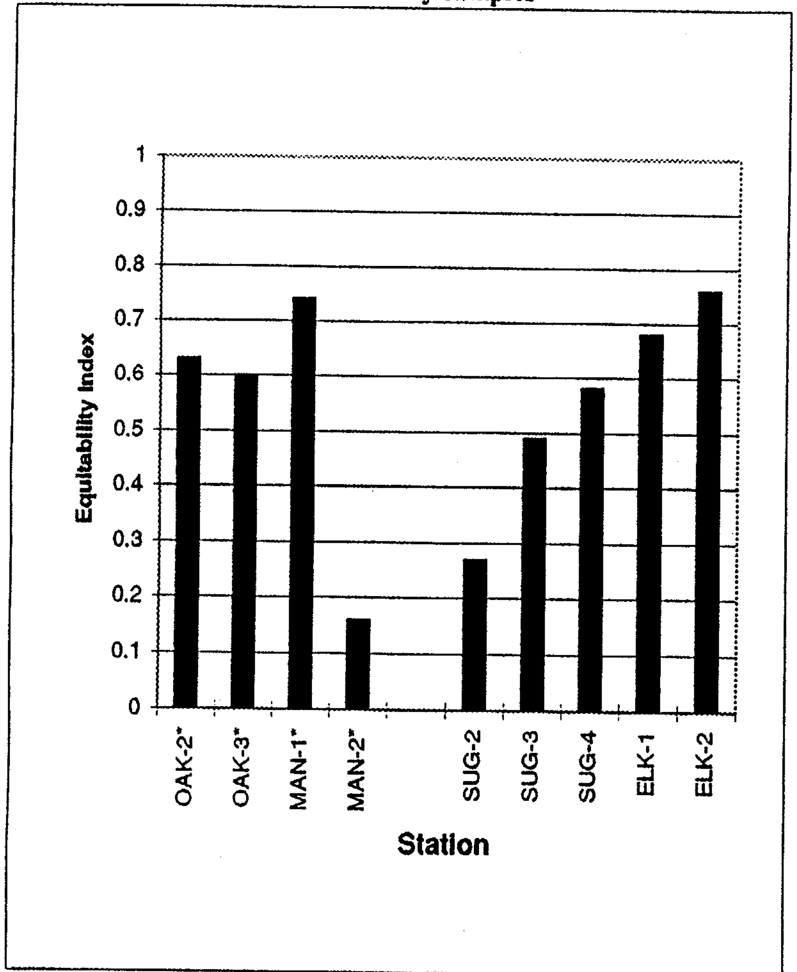
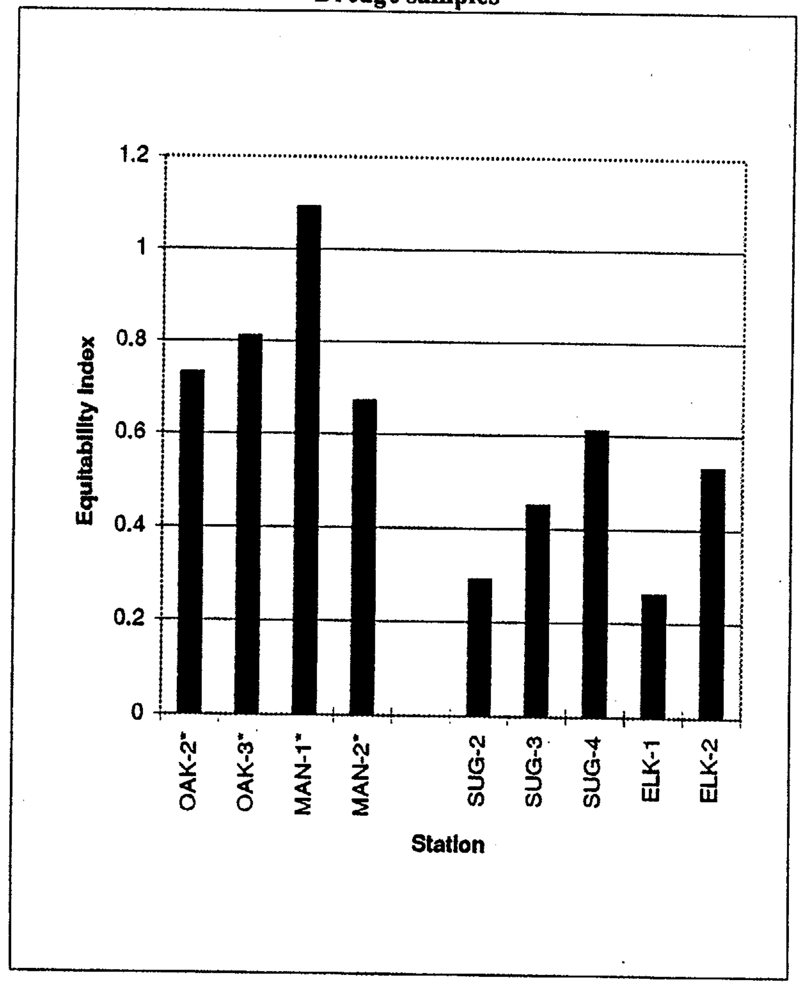


Fig. 23b. Equitability Index values**
Dredge samples



**Equitability index: values of <0.5 indicate an impact.

*Reference station.

Fig. 24a. Shannon-Weaver Diversity Index values**
Hester-Dendy samples

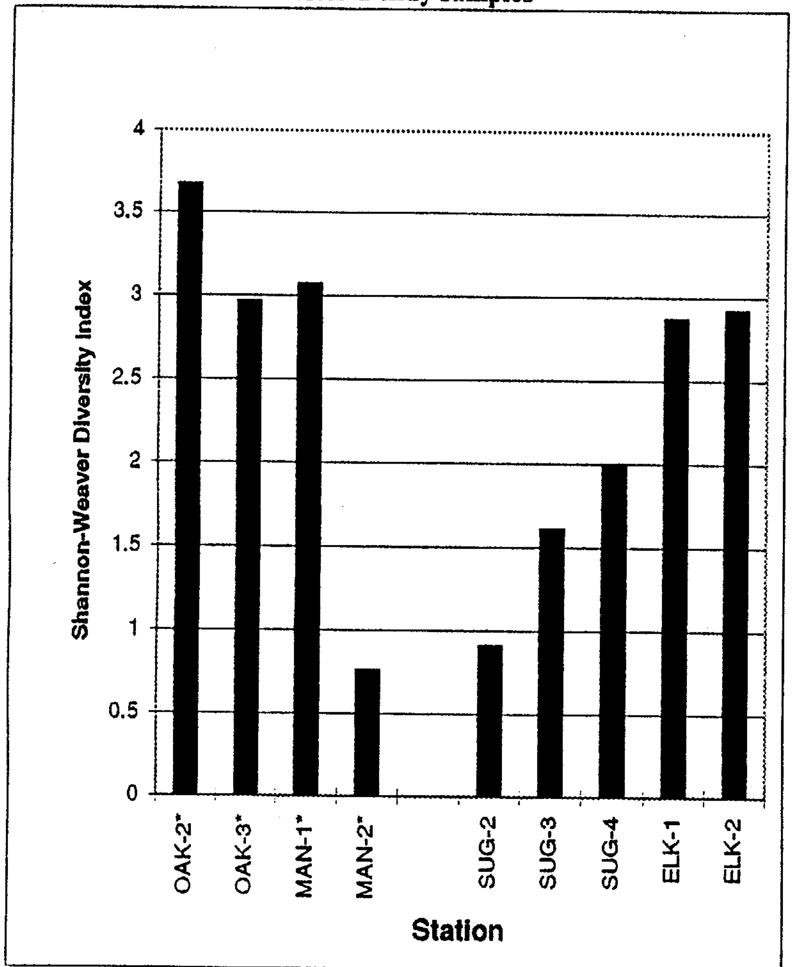
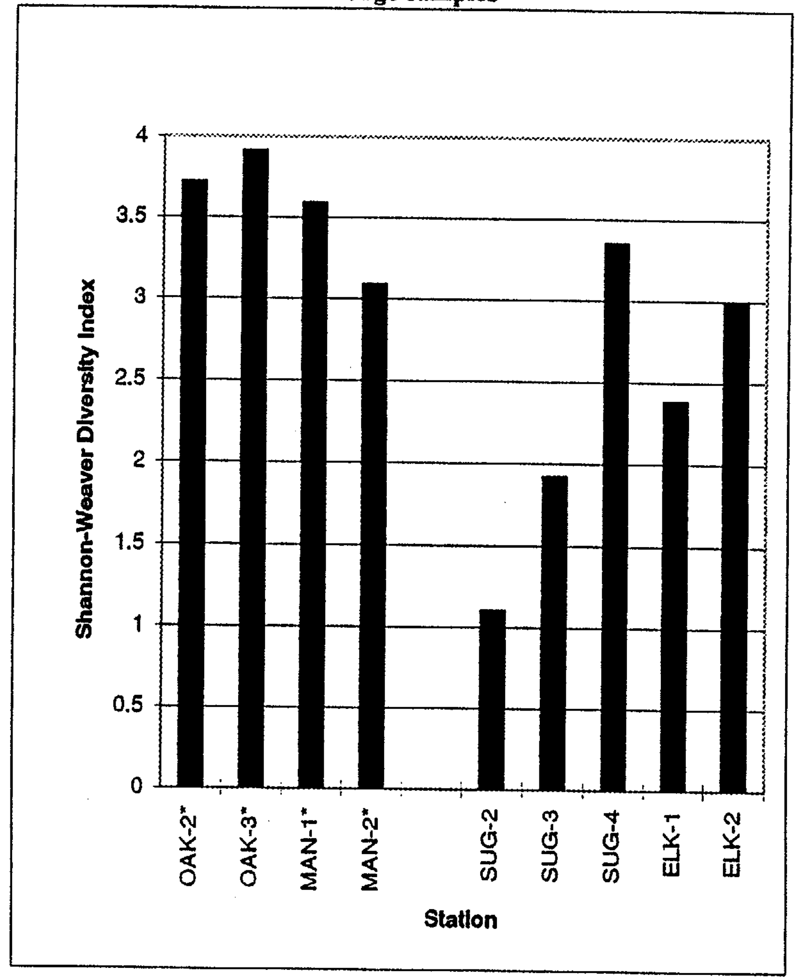


Fig. 24b. Shannon-Weaver Diversity Index values**
Dredge samples



**Diversity index: Values<1.0 indicate severely impaired waters.

*Reference station

upstream Sugar Creek embayment stations. Taxa richness increased and the percent contribution of the dominant taxon decreased, indicating an improvement in water quality by the presence of pollution-sensitive organisms not found at upstream stations SUG-2 and SUG-3. The lower biotic index values at downstream embayment stations also indicate the presence of pollution sensitive taxa, further indicating improvement in water quality. Diversity and equitability values of the most downstream stations, SUG-4 and ELK-2, indicate slight to no impairment.

Hester-Dendy and dredge samples from ELK-1, located above the confluence of Sugar Creek and Elkahatchee Creek, indicate that the macroinvertebrate community of ELK-1 has been negatively impacted. Samples from ELK-1 contained a greater total number of organisms and lower diversity and equitability index values than the reference stations.

Wadeable Stations

The results of the multihabitat bioassessments of wadeable stream stations indicate that the macroinvertebrate communities of Sugar Creek have been negatively impacted at S-1, immediately downstream of the WWTP discharge, as indicated by the following:

a) lower total number of organisms at S-1 than at SUG-1 and OAK-1 (Fig. 25);

b) higher percent contribution of dominant taxon at S-1 than at reference station OAK-1 (Fig. 26);

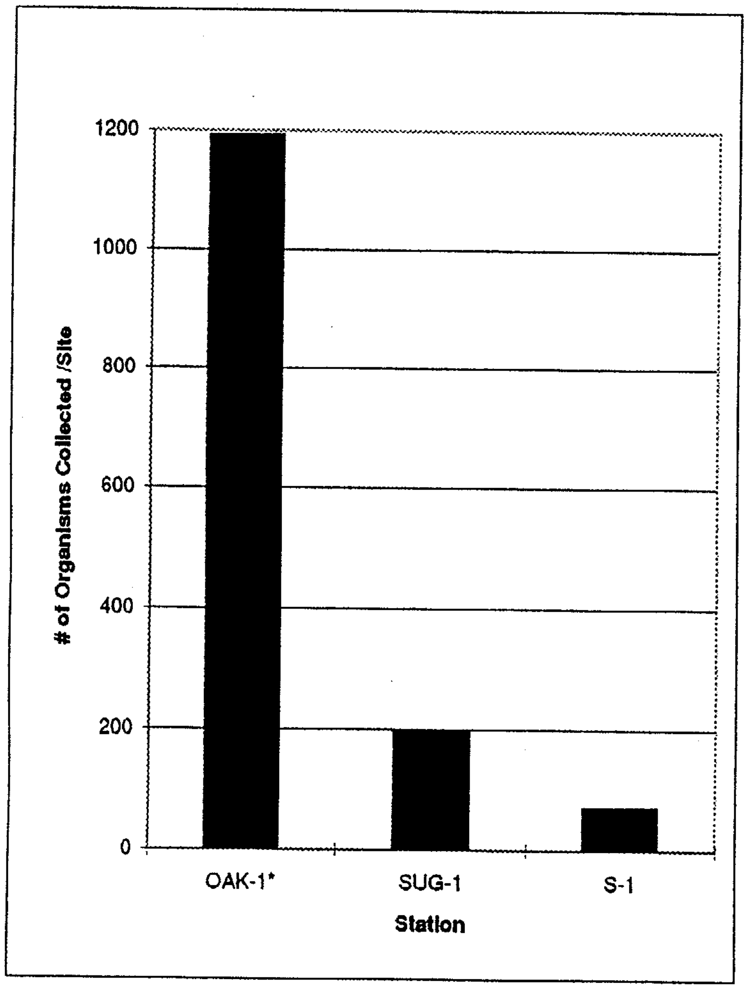
c) lower taxa richness at S-1 (Fig. 27);

d) pollution-intolerant EPT taxa, present at SUG-1and OAK-1, were entirely absent at S-1 (Fig. 27);

e) the higher biotic index at S-1 than at OAK-1 (Fig. 28); and,

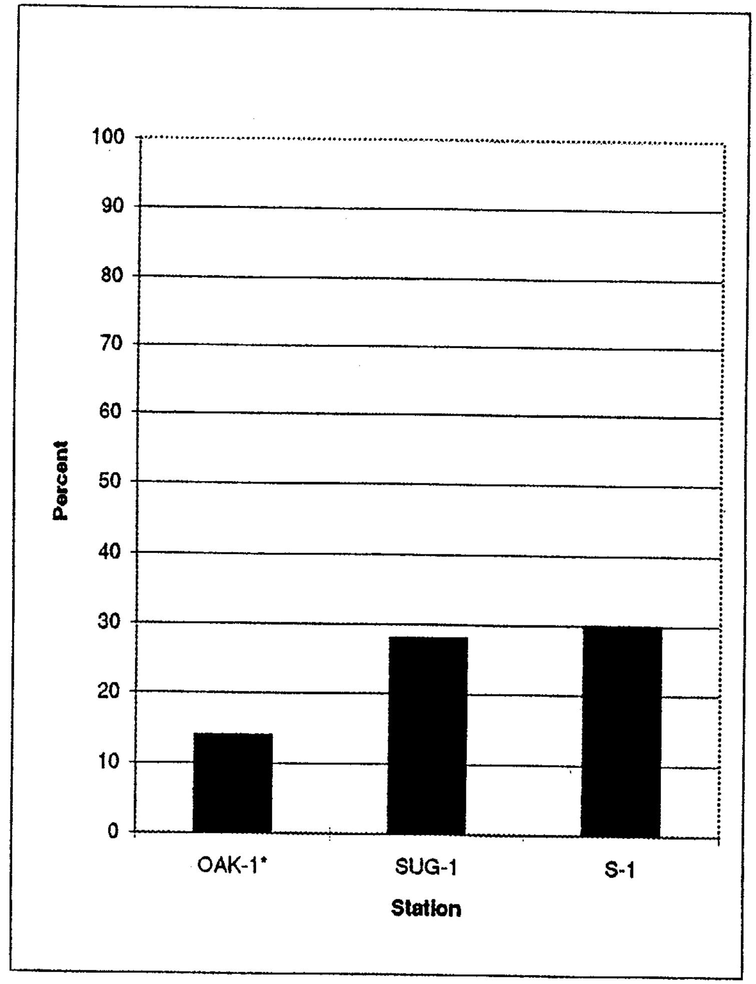
f) the Indicator Assemblage Index and Jaccard Coefficient of Community indication of a more impaired macroinvertebrate community at S-1.

Fig. 25. Total Number of Organisms**



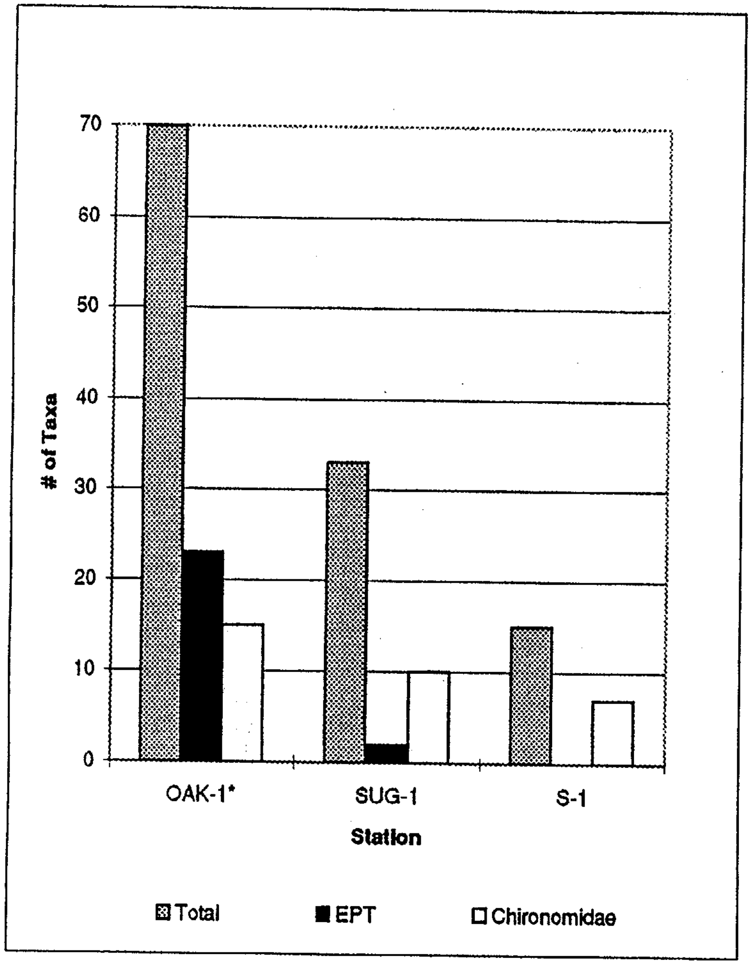
**Total number of organisms: Generally increases wtih decreasing water quality. Severely decreased in severely degraded waters.
*Reference station.

Fig. 26. Percent Contribution of the Dominant Taxon***



***Percent contribution of dominant taxon: generally higher in degraded waters.

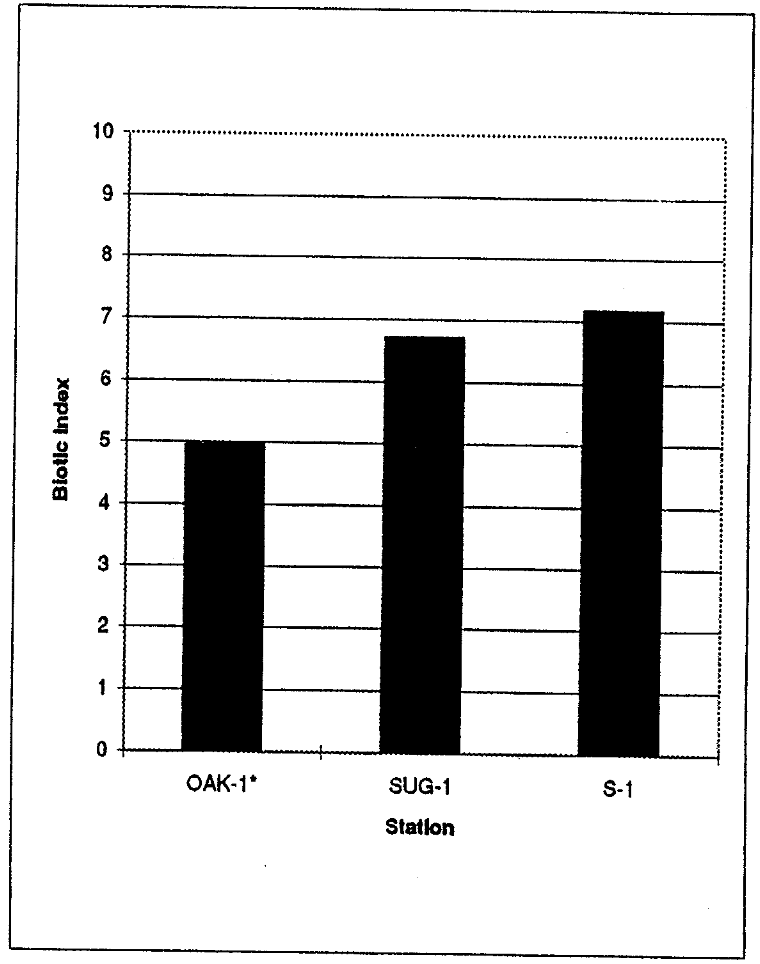
Fig. 27 Taxa Richness values**



**Total number of taxa collected at each station. Generally increases with improving water quality.

*Reference station.

Fig. 28. Biotic Index values***



***Biotic index values generally increase with decreasing water quality.

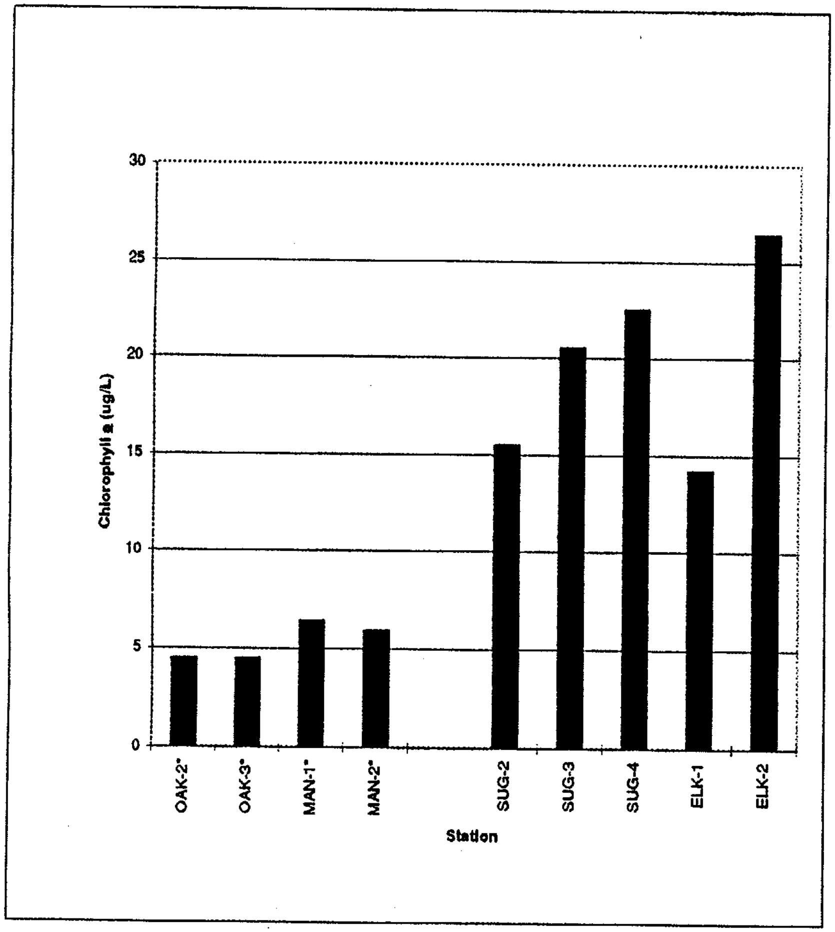
The indicator assemblage index and the Jaccard Coefficient of Community evaluate water quality at a study station by directly comparing the macroinvertebrate community of a study station, S-1, to the community present at a physically similiar reference station, SUG-1. The indicator assemblage index and the Jaccard Coefficient of Community indicate a more impaired macroinvertebrate community at S-1 because of a loss of taxa at this station. The slightly higher biotic index at this station indicates a shift to more pollution tolerant taxa at S-1.

Differences in the macroinvertebrate communities between OAK-1 and the two Sugar Creek stations, SUG-1 and S-1, are to some degree attributable to loss of habitat at the Sugar Creek stations by sand deposition from nonpoint sources. OAK-1 received a habitat assessment score of 104, which is indicative of excellent habitat quality and much higher than the habitat assessment scores of SUG-1 (69) and S-1 (73). The presence of multiple stresses at SUG-1 and S-1 is indicated by the very low total number of organisms collected at both stations and the high percent contribution of dominant taxon. In comparison to the two Sugar Creek stations, reference station OAK-1 supported higher taxa richness, a lower percent contribution of the dominant taxon, and a lower biotic index score, indicating relatively unimpaired water quality.

Chlorophyll a Analysis

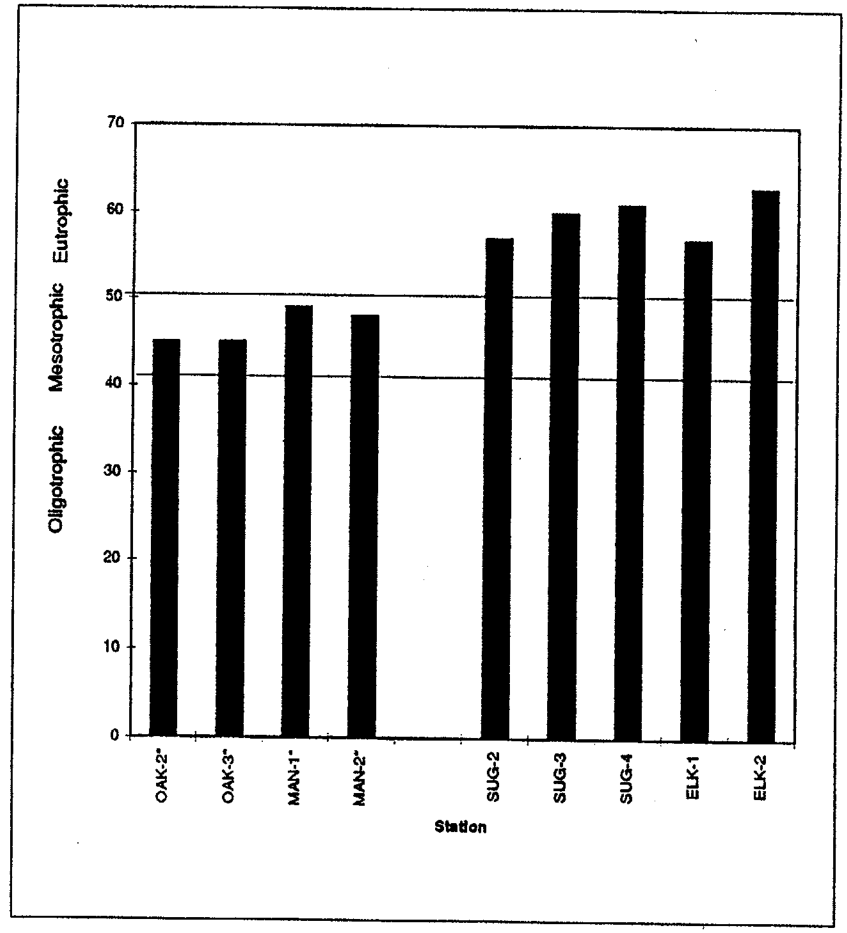
Chlorophyll a concentrations of the Sugar/Elkahatchee Creek embayment stations were much higher than those of the reference embayment stations (Figure 29). Chlorophyll a concentrations of Sugar/Elkahatchee Creek embayment stations were indicative of highly productive, eutrophic waters while concentrations of the reference embayment stations were indicative of mesotrophic waters that are much less productive and more characteristic of Lake Martin (ADEM 1994). In addition, chlorophyll a

Fig. 29. Chlorophyll a



* Reference station

Figure 30. Trophic State Index (TSI)



concentrations measured in other areas of Lake Martin during August 1994 for the ADEM Reservoir Monitoring Program were similar to those of reference stations and indicative of mesotrophic waters.

The highest chlorophyll a concentration measured was at the most downstream study station, ELK-2, perhaps indicative of the effect of the combination of increased light availability and substantial phosphorous concentrations. The chlorophyll a concentration at ELK-2 also illustrates the effect of the WWTP discharges at a point approximately 4.2 miles downstream of the discharge point and approximately 1.8 miles downstream of the beginning of the Sugar Creek embayment area.

Numerical values for chlorophyll a concentrations of all stations appears in Appendix D, Table 1.

Carlson Trophic State Index

Trophic State Index (TSI) values for all Sugar and Elkahatchee Creek embayment stations fell within the eutrophic range of 50-70 while TSI values for reference stations in the Oakachoy and Manoy Creek embayments fell within the mesotrophic range of 40-50 (Fig. 30). The TSI values for the lower Sugar Creek embayment stations (SUG-3, SUG-4) and the lower Elkahatchee station (ELK-2) were within the upper half of the eutrophic range and are considered highly eutrophic. The highly eutrophic TSI values of the Sugar and Elkahatchee Creek embayments represent a doubling of the algal biomass in comparison to the mesotrophic TSI values of the reference embayments and appear to be very uncharacteristic of Lake Martin. In addition, mesotrophic TSI values of the reference embayments were consistent with mesotrophic TSI values calculated for other areas of Lake Martin over a five-year period (ADEM 1994).

Based on the mesotrophic status of other areas of Lake Martin, it is reasonable to assume that the effects of WWTP discharges and nonpoint sources have led to an unnatural advance in the trophic status of Sugar and Elkahatchee Creeks from mesotrophic to eutrophic conditions, commonly referred to as cultural eutrophication. Cultural eutrophication occurs when nutrient, soil, and/or organic matter loads to a lake are dramatically increased by wastewater treatment plant discharges, agricultural/silvicultural activities, and/or residential development (EPA 1990a). Cultural eutrophication within an embayment can result in a short-term increase in fish production. However, continued or increased additions of nutrients, soil, and/or organic matter could lead to a further advance in the trophic state of Sugar and Elkahatchee Creeks from eutrophic to hypereutrophic conditions, characterized by a TSI value of 70 or greater and by a general deterioration of water quality that further degrades biological communities.

Numerical TSI values for all stations appears in Appendix D, Table 1.

Algal Growth Potential Tests

In the AGPT, the Maximum Standing Crop (MSC) of the alga in the control (untreated flasks) for each station determines the potential for algal growth and/or possible nuisance algal blooms at each station at the time the samples were collected. An MSC of ≤ 5 mg/l dry weight in the control flasks is a concentration that will reasonably assure protection from nuisance algal blooms and fish-kills in southeastern lakes (Miller et al. 1974; Raschke and Schultz 1987; Vollenweider, 1971). The MSC of SUG-3 was 15.07 mg/l, over three times the 5.0 mg/l limit that indicates the potential for a nuisance algal bloom, while the MSC of ELK-1 was also over the limit at 6.76 mg/l (Table 4). The MSC of study station ELK-2 was near the limit at 4.30 mg/l. Maximum Standing Crop dry weights of the two reference stations were well below the 5.0 mg/L limit.

The AGPT determined that nitrogen was the limiting nutrient to algal growth in samples collected from all Sugar/Elkahatchee Creek and reference embayment stations . However, results of the chemical analyses of the AGPT samples (Table 4) indicated that phosphorous concentrations at the Sugar/Elkahatchee Creek embayment stations were much higher than those of reference stations.

The addition of nitrogen to the flasks of the Sugar/Elkahatchee Creek embayment stations increased the mean MSC from 311-990% over the mean MSC of the control while adding nitrogen to the flasks of reference stations increased the mean MSC from 52-89% over the mean MSC of the control. The magnitude of the mean MSC increase in samples from the Sugar/Elkahatchee Creek embayment stations illustrates the potential for algal growth in the embayment should nitrogen concentrations in the waters of the embayment increase.

Table 4. Sugar Creek Study Algal Growth Potential Tests.

Stations	Limiting Nutrient	Mean MSC (mg/l)		Percent Increase	Chemical Analyses (mg/l)						
					NH3-N	NO2-NO3-N	TSIN-N	TKN	Organic N	Total N	Total P
SUG-3	Nitrogen	Control (C)	15.07		*0.015	0.130	0.130	0.852	0.852	0.982	0.400
		C + Nitrogen	**66.58**	342%							
		C + Phosphorous	14.63	-3%							
ELK-2	Nitrogen	Control (C)	4.30		*0.015	0.005	0.005	*0.150	*0.150	*0.150	0.140
		C + Nitrogen	**46.87**	990%							
		C + Phosphorous	4.14	-4%							
ELK-1	Nitrogen	Control (C)	6.76		*0.015	0.020	0.020	0.340	0.340	0.360	0.120
		C + Nitrogen	**27.76**	311%							
		C + Phosphorous	7.29	8%							
OAK-3	Nitrogen	Control (C)	2.10		*0.015	0.030	0.030	*0.150	*0.150	*0.150	0.009
		C + Nitrogen	**3.20**	52%							
		C + Phosphorous	2.36	12%							
MAN-2	Nitrogen	Control (C)	1.57		*0.015	*0.003	*0.015	*0.150	*0.150	*0.150	0.009
		C + Nitrogen	**2.97**	89%							
		C + Phosphorous	1.93	23%							

Maximum Standing Crop (MSC)
Values significantly different from control in bold print.
TSIN-N = (NH3-N) + (NO2-NO3-N)
Organic N = TKN - (NH3-N)
Total N = TKN + (NO2-NO3-N)
* Less than detectable

Final results of the AGPT are listed in Table 4 and in Table 1 of Appendix B and are expressed as mean Maximum Standing Crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L.

Toxicity Testing

Chronic toxicity was indicated in a 100% concentration of the WWTP effluent and the SUG-2 bottom samples by the significant reduction in reproduction of the microcrustacean, *Ceriodaphnia dubia*.

Copper (Cu) concentrations in the samples may bear at least partial responsibility for the toxicity. Highest Cu concentrations were measured in the WWTP and SUG-2 bottom samples (Table 5). Copper concentrations in samples from the WWTP, SUG-2, and SUG-3 far exceeded the Toxic Pollutant Criteria for copper in the ADEM Water Quality Criteria (1990) and the EPA Water Quality Criteria (WQC 1986).

Chloride content of the samples may also be involved in the toxicity. The Ambient Water Quality Criteria for Chloride - 1988 (WQC 1988) suggests a chloride instream concentration of 230 mg/l to protect all species from chronic toxicity effects. The ADEM typically uses this criterion in developing permit limits. Mean chloride concentrations for the SUG-WWTP sample and the SUG-2 bottom sample were well above these values (Table 5). The mean chloride concentration of the SUG-3 bottom sample was 383 mg/l, indicating a potential for toxic effects at this station also. No significant difference to *C. dubia* survival or reproduction was indicated by samples from any other stations.

There was no significant difference to survival or growth of the fathead minnow, *Pimephales promelas*, when tested at a 100% concentration of the sample from each station. However, the potential for toxicity to the fathead minnow is present in the WWTP samples and the SUG-2 bottom samples. The chloride chronic toxicity value for the fathead minnow is 433.1 mg/l, while the mean chloride concentration of the WWTP sample was 575 mg/l and for the SUG-2 bottom sample, 442 mg/l.

Specific numeric results and statistical analyses appear in Appendix C.

Table 5. Mean copper and chloride concentrations of toxicity test samples from the Sugar Creek Study, Sept. 26-30, 1994.

		Toxic Pollutant Chronic Criteria		Measured Values	
Station	Hardness (mg/l)	Copper** (ug/l)	Chloride* (mg/l)	Total Copper (ug/l)	Chloride (mg/l)
SUG-1	104	12.23	230	<20***	44
WWTP	53	6.87	230	147	575
SUG-2 (Bottom)	55	7.09	230	94	442
SUG-3 (Bottom)	49	6.43	230	81	383

*EPA Water Quality Criteria (1988)

**ADEM Water Quality Criteria (1990); EPA Water Quality Criteria (1986)
In accordance with EPA approved procedures, the criteria value for permitting purposes is assumed to be the dissolved fraction.
The total recoverable value is computed by dividing the dissolved fraction by 0.388.

***Less than detectable amount

Fish Tissue Collection

Largemouth bass and channel catfish were collected from the Sugar Creek embayment and in the Elkahatchee Creek embayment, downstream of its confluence with Sugar Creek, during September 1994 in association with the ADEM Fish Tissue Monitoring Program. Samples were analyzed in accordance with the ADEM Standard Operating Procedures For Fish Sampling and Tissue Preparation For Bioaccumulative Contaminants (ADEM 1991) utilizing the routine list of analytical parameters with the inclusion of chromium and copper.

In largemouth collected from the Sugar Creek embayment, concentrations of all analytical parameters were below the minimum amount detectable, with the exception of mercury (Table 6). Mercury concentrations in the largemouth bass were well below the FDA action level of 1.0 ug/g, however. Concentrations of all parameters were below the minimum amount detectable In channel catfish collected from the Sugar Creek embayment.

In largemouth bass collected from the Elkahatchee Creek embayment, concentrations of all analytical parameters were below the minimum amount detectable, with the exception of mercury. Mercury concentrations in the largemouth bass were well below the FDA action level of 1.0 ug/g, however. In channel catfish collected from the Elkahatchee Creek embayment, concentrations of all parameters were below the minimum amount detectable.

All data for fish species collected at each station appears in Appendix F.

Fecal Coliform Analysis

Fecal coliform concentrations did not appear unusually high at any study or reference stations with the exception of SUG-1. However, the sample from SUG-1 was collected during a period of rainfall, the runoff from which was most likely responsible for the high concentration. Fecal coliform concentrations for all stations appear in Appendix Table D-2.

Table 6. Results of tissue analysis of fish collected from Sugar/Elkahatchee Creek embayments, September 1994.

Parameters (ug/g)	FDA Levels (ug/g)	Martin Station 3 (Elkahatchee Creek)		Martin Station 4 (Sugar Creek)	
		Largemouth bass	Channel catfish	Largemouth bass	Channel catfish
Chromium	----	1.5*	1.5*	1.5*	1.5*
Copper	----	2.0*	2.0*	2.0*	2.0*
Mercury	1.0	0.14	0.10*	0.11	0.10*
PCB	2.0	0.05*	0.05*	0.05*	0.05*
Chlordane	0.3	0.02*	0.02*	0.02*	0.02*
DDT	5.0	0.01*	0.01*	0.01*	0.01*
4,4-DDD	5.0	0.01*	0.01*	0.01*	0.01*
4,4-DDE	5.0	0.01*	0.01*	0.01*	0.01*
Dieldrin	0.3	0.01*	0.01*	0.01*	0.01*
Dursban	----	0.01*	0.01*	0.01*	0.01*
Endrin	0.3	0.01*	0.01*	0.01*	0.01*
Heptachlor	0.3	0.01*	0.01*	0.01*	0.01*
Heptachlor epoxide	----	0.01*	0.01*	0.01*	0.01*
Mirex	0.1	0.01*	0.01*	0.01*	0.01*
Toxaphene	5.0	0.05*	0.05*	0.05*	0.05*
Percent Lipids	----	2.19	1.30	0.93	2.92

* results less than the instrument detection limit.

PRELIMINARY ASSESSMENT OF PHASE I STUDY

A preliminary assessment of the phase I Water Quality Demonstration Study (WQDS) indicates that, as expected, Sugar Creek and its embayment was impacted by toxicity to the reproduction of *Ceriodaphnia dubia* (water flea) which may be the result of relatively high concentrations of chlorides and/or copper in the point source discharge from the Sugar Creek WWTP. Also, when compared to the reference waterbodies, the Sugar Creek macroinvertebrate populations appear to be adversely impacted by the point and nonpoint discharges to the Sugar Creek embayment. The AO which has been imposed on the City of Alexander City should address the concerns associated with effluent toxicity once the Toxicity Reduction Evaluation (TRE) and engineering report investigating the various options, estimated costs, and estimated impact of complying with more stringent Fish and Wildlife (F&W) criteria are finalized in October of 1995.

Although pH was found to be slightly greater than the water quality standard of 8.5 at several of the stations in the embayment, no direct correlation to the pH rise could be made with the WWTP discharge, and therefore, the rise in pH was considered to be a result of algal photosynthesis processes occurring in the Lake Martin backwaters. In this regard, algal growth potential tests conducted during the study indicated that nitrogen is the limiting nutrient for algal proliferation in the water body. If bottom sediments were disturbed by sediment removal activities, a release of nitrogen to the water column could lead to severe algal blooms which could temporarily advance the trophic state of the water body, thereby, increasing the opportunity for fish-kills due to oxygen deficiencies brought on by the respiration of algae during nighttime hours and cloudy days. As noted in the Department's AO (Findings of Fact), a release of ammonia nitrogen from the bottom sediments to the water column could also cause acute and/or chronic toxicity effects to the aquatic life in the area of such removal activities. If operated within NPDES limitations, the likelihood of the Sugar Creek WWTP causing an increase in nitrogen levels appears remote based on review of the available data and the fact that the relatively high chlorination levels for color removal is no doubt assisting in removal of nitrogen through breakpoint chlorination.

Dissolved oxygen levels, one of the primary standards for establishment of organic limitations in the NPDES permit, measured during the study, were well above the 5 mg/l requirement for survival and propagation of fish.

The fish tissue study also revealed that there were no bioaccumulative contaminants above FDA actions levels.

Color levels were found to be below the maximum permit limit of 300 ADMI units in the discharge and below the 80 ADMI units goal for the embayment area.

Fecal coliform concentrations were below applicable water quality standards at all points, which is an indication of the effectiveness of the disinfection processes at the treatment plant. Although the study was not performed under 7Q10 flow conditions, these findings were a positive indication that efforts made thus far toward improving and maintaining water quality in Sugar Creek and Lake Martin have been effective. The data collected on the Sugar Creek WWTP effluent indicated that, except for toxicity to the reproduction of the water flea, the facility was in compliance with National Pollutant Discharge Elimination (NPDES) permit. A review of the permit conditions, discharge monitoring report (DMR), and study results are summarized as follows:

	NPDES limits*	DMR data (average)*	WQDS
FLOW(mgd)	8.5	6.67	5.96
BOD5(mg/l)	23	6.3	2.5**
TSS(mg/l)	30	10.3	3
NH3-N(mg/l)	1.3	0.16	.28
D.O.(mg/l)min	5	6.7	-
pH(S.U.)	6-8.5	6.4-7.48	7.9
TRC(mg/l)min	0.5	9.25	-
TRC (DeCl2-mg/l)max	.01	0	.05-.1***
COLOR(ADMI)max	300	272	147

*APRIL - NOVEMBER, 1994 **CBOD5 *** below detection level for field testing.

This situation will be reassessed in Phase II of the Water Quality Demonstration Study which will be conducted after all improvements are completed at the Sugar Creek WWTP and requirements of the AO have been implemented based on the findings of the TRE and the engineering report concerning the possible upgrade of Sugar Creek to F&W.

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APPENDIX A

MACROINVERTEBRATE ASSESSMENT DATA

Table A-1. Interpretation of biometrics and results of Hester-Dendy samples.

			Reference Stations				Study Stations				
Structure Metrics	**Range**	**Interpretation**	**OAK-2**	**OAK-3**	**MAN-1**	**MAN-2**	**SUG-2**	**SUG-3**	**SUG-4**	**ELK-1**	**ELK-2**
Total # Organisms	Total number of organisms collected at each station.	Generally increases with organic enrichment; multiple stresses may reduce the number of organisms.	164	272	451	4392	1457	1486	2145	771	760
Taxa Richness	Total number of distinct taxa.	Generally increases with increasing water quality.	29	18	16	12	8	8	9	15	14
EPT Index	Total number of generally pollution-sensitive insect taxa in orders: Ephemeroptera, Plecoptera, and Trichoptera.	Generally increases with increasing water quality.	9	5	3	2	2	2	3	4	3
Chironomidae Taxa Richness	Total number of distinct Chironomidae taxa.	Generally decreases with increasing water quality.	15	8	8	7	4	3	4	7	9
Community Balance Metrics	**Range**	**Interpretation**									
Biotic Index	0-10	Generally decreases with increasing water quality.	6.6	6.8	7.6	8.7	9.7	9.1	8.4	6.7	6.9
% Contribution Dominant Taxon	0-100%	Generally decreases with increasing water quality.	32	33	29	89	86	59	47	28	24
Equitability*	0-1	Values >0.5 indicate little stress; values <0.5 indicate an impact	0.63	0.60	0.74	0.16	0.27	0.49	0.58	0.68	0.76
Shannon-Weaver Diversity Index*	0-4	Values between 3-4 indicate little stress; values <1indicate severely impacted waters.	3.67	2.96	3.07	0.76	0.91	1.61	2.00	2.87	2.92

* For use with quantitative samples

Table A-2. Interpretation of biometrics and results of dredge samples.

			Reference Stations				Study Stations					
Structure Metrics	**Range**	**Interpretation**	**OAK-2**	**OAK-3**	**MAN-1**	**MAN-2**	**SUG-2**	**SUG-3**	**SUG-4**	**ELK-1**	**ELK-2**	**DUP (SUG-3)**
Total # Organisms	Total number of organisms collected at each station.	Generally increases with organic enrichment; multiple stresses may reduce the number of organisms.	106	176	101	125	665	577	496	483	283	988
Taxa Richness	Total number of distinct taxa.	Generally increases with increasing water quality.	26	27	16	18	9	11	24	27	21	8
EPT Index	Total number of generally pollution-sensitive insect taxa in orders: Ephemeroptera, Plecoptera, and Trichoptera.	Generally increases with increasing water quality.	4	5	2	4	0	0	4	5	4	0
Chironomidae Taxa Richness	Total number of distinct Chironomidae taxa.	Generally decreases with increasing water quality.	13	13	8	8	7	7	14	12	11	5
Community Balance Metrics	**Range**	**Interpretation**										
% Contribution Dominant Taxon	0-100%	Generally decreases with increasing water quality.	30	19	16	41	82	41	30	55	45	37
#Chironomidae Taxa/#Total Taxa	0-1	Generally increases with decreasing water quality.	0.5	0.5	0.5	0.4	0.8	0.6	0.6	0.4	0.5	0.6
Equitability*	0-1	Values >0.5 indicate little stress; values <0.5 indicate an impact.	0.73	0.81	1.09	0.67	0.29	0.45	0.61	0.26	0.53	0.56
Shannon-Weaver Diversity Index*	0-4	Values between 3-4 indicate little stress; values <1indicate severely impacted waters.	3.72	3.91	3.59	3.09	1.10	1.92	3.35	2.38	2.99	1.79

* For use with quantitative samples

Table A-3. Interpretation of biometrics and results of the multihabitat bioassessments.

			Reference Stations		Study Station
Structure Metrics	**Range**	**Interpretation**	**OAK-1**	**SUG-1**	**S-1**
Total # Organisms	Total number of organisms collected at each station.	Generally increases with organic enrichment; multiple stresses may reduce the number of organisms.	1192	197	70
Taxa Richness	Total number of distinct taxa.	Generally increases with increasing water quality.	70	33	15
EPT Index	Total number of generally pollution-sensitive insect taxa in orders: Ephemeroptera, Plecoptera, and Trichoptera.	Generally increases with increasing water quality.	23	2	0
Chironomidae Taxa Richness	Total number of distinct Chironomidae taxa.	Generally decreases with increasing water quality	15	10	7
Community Balance Metrics	**Range**	**Interpretation**			
Biotic Index	0-10	Generally decreases with increasing water quality.	5.0	6.7	7.2
% Contribution Dominant Taxon	0-100%	Generally decreases with increasing water quality.	14	28	30
#Chironomidae Taxa/#Total Taxa	0-1	Generally increases with decreasing water quality.	0.2	0.3	0.5
Community Similarity Indices**	**Range**	**Interpretation**			
Indicator Assemblage Index**	0-1	Increases with increasing water quality. Values <0.5 indicate excessive impairment.	–	–	0.4
Jaccard Coefficient of Community**	0-1	Increases with increasing similarity to reference station.	–	–	0.32

* For use with quantitative samples

**For use with samples collected using Multihabitat Bioassessment methods. These indices evaluate community similarity between a control (SUG-1) and a study station (S-1).

Table A-4. Hester-Dendy Deployment and Retrieval Parameters

At deployment							
Station No.	H.D. Depth (approx.ft)	Photic Zone Depth (m)	Hydrolab Depth (m)	Water Temp. c	pH s.u.	D.O. mg/l	Cond. umhos
MAN-1	6	4.2	1.5	28.6	6.8	8.8	41
MAN-2	6	6.7	1.5	28.7	6.7	8.5	39
SUG-2	5	1.5	1.5	27.5	7.7	7.7	1311
SUG-3	6	2.1	1.5	28.1	7.7	8.3	278
SUG-4	6	2.6	1.5	28.5	8.5	9.9	137
ELK-1	6	3.3	1.5	28.6	7.5	7.5	118
ELK-2	6	3.9	1.5	28.6	7.9	8.5	97
OAK-2	6	3.2	1.5	28.9	6.9	8.9	40
OAK-3	6	4.6	1.5	29.0	7.2	8.1	41

At Retrieval						
Station No.	Hydrolab Depth (m)	Water Temp. c	pH s.u.	D.O. mg/l	Cond. umhos	No. plates retrieved
MAN-1	1.5	29.4	6.3	7.7	42	4
MAN-2	1.5	29.3	6.2	7.9	41	4
SUG-2	1.5	28.7	7.5	6.7	1550	4
SUG-3	1.5	29.7	8.1	8.4	230	4
SUG-4	1.5	29.6	8.5	10.0	100	3
ELK-1	3.0	—	—	7.1*	—	4
ELK-2	1.5	29.5	8.7	10.3	70	3
OAK-2	2.0	—	—	6.0*	—	4
OAK-3	2.0	—	—	7.7*	—	4

Note: Plate D at SUG-4 appeared to have had the line cut. The sampler was reset in deeper water at approximately 2 weeks (of the 4 week exposure).

* Measurement taken at bottom.

Table A-5. Observed composition of bottom substrate composition and depth of dredge samples.

Station	Sample No.*	Rep No.	Depth (ft)	Color	Odor	Texture/Particle size
MAN-1	E	1	10	Gray/Brown	Earthy	muck/sand
		2	10	Gray/Brown	Earthy	muck/sand
		3	10	Gray/Brown	Earthy	muck/sand
MAN-1	F	1	12	Gray/Brown	Earthy	Fine Muck
		2	12	Gray/Brown	Earthy	Fine Muck
		3	12	Gray/Brown	Earthy	Fine Muck
MAN-1	G	1	6	Brown	Earthy	Sand/Muck
		2	6	Brown	Earthy	Sand/Muck
		3	6	Brown	Earthy	Sand/Muck
MAN-2	E	1	10	Brown	Earthy	sand/clay
		2	12	Brown	Earthy	sand/clay
		3	12	Clay red/Brown	Earthy	sand/clay
MAN-2	F	1	25	Gray/Brown	Earthy	sand/muck
		2	30	Gray/Brown	Earthy	sand/muck
		3	35	Gray/Brown	Earthy	sand/muck
MAN-2	G	1	3	—	Earthy	sand/clay/organic debris
		2	3	—	Earthy	sand/clay/organic debris
		3	5	—	Earthy	sand/clay/organic debris
OAK-2	E	1	3	Gray Brown	—	sand/muck
		2	3	Gray Brown	—	sand/muck
		3	3	Gray Brown	—	sand/muck
OAK-2	F	1	10	Gray Brown	—	sand/muck
		2	10	Gray Brown	—	sand/muck
		3	10	Gray Brown	—	sand/muck
OAK-2	G	1	4	Gray Brown	—	sand/fine muck/organic debris
		2	2	Gray Brown	—	sand/fine muck/organic debris
		3	2	Gray Brown	—	sand/fine muck/organic debris
OAK-3	E	1	6	Gray Brown	Earthy	muck/sand/organic debris
		2	8	Gray Brown	Earthy	muck/sand/organic debris
		3	6	Gray Brown	Earthy	muck/sand/organic debris
OAK-3	F	1	10	Gray Brown	Earthy	muck/organic debris
		2	10	Gray Brown	Earthy	sand/muck/organic debris
		3	10	Gray Brown	Earthy	sand/muck/organic debris
OAK-3	G	1	8	—	—	fine sediment/organic debris
		2	5	—	—	organic debris/fine sediment
		3	5	—	—	organic debris/fine sediment
ELK-1	E	1	6	Gray Brown	Earthy	sand/muck
		2	6	Gray Brown	Earthy	sand/muck
		3	6	Gray Brown	Earthy	sand/muck

*E= Left Bank: F= Midchannel: G= Right Bank

Table A-5, cont.

Station	Sample No.*	Rep No.	Depth (ft)	Color	Odor	Texture/Particle size
ELK-1	F	1	16	Gray Brown	Earthy	muck/sand/organic debris
		2	16	Gray Brown	Earthy	muck/sand/organic debris
		3	16	Gray Brown	Earthy	muck/sand/organic debris
ELK-1	G	1	4	red/brown	Earthy	sand/clay
		2	4	red/brown	Earthy	sand/clay
		3	4	red/brown	Earthy	sand/clay
ELK-2	E	1	6	Red/Brown	Earthy	Sand/Clay
		2	4	Red/Brown	Earthy	Sand/Clay
		3	4	Red/Brown	Earthy	Sand/Clay
ELK-2	F	1	28	Black/Gray	Earthy	Muck
		2	28	Black/Gray	Earthy	Muck
		3	28	Black/Gray	Earthy	Muck
ELK-2	G	1	3	Gray Brown	Earthy	Sand/Muck/Organic debris
		2	4	Gray/Brown	Earthy	Sand/Muck/Organic debris
		3	4	Gray/Brown	Earthy	Sand/Muck/Organic debris
SUG-4	E	1	6	Red/Brown	Earthy	Sand/Clay
		2	6	Red/Brown	Earthy	Sand/Clay
		3	4	Red/Brown	Earthy	Sand/Clay
SUG-4	F	1	10	Black/Gray	Earthy	Fine Muck
		2	10	Black/Gray	Earthy/Sulfur	Fine Muck
		3	10	Black/Gray	Earthy/Sulfur	Fine Muck
SUG-4	G	1	4	Brown	Earthy	Organic debris/Sand
		2	4	Brown	Earthy	Organic debris/Sand
		3	4	Brown	Earthy	Organic debris/Sand
SUG-3	E	1	6	Brown/Gray	Earthy	Fine muck
		2	6	Brown/Gray	Earthy	Fine muck
		3	6	Brown/Gray	Earthy	Fine muck
SUG-3	F	1	7	Brown/Gray	Earthy	Fine muck
		2	7	Brown/Gray	Earthy	Fine muck
		3	7	Brown/Gray	Earthy	Fine muck
SUG-3	G	1	5	Black/Gray	Earthy	Fine muck
		2	5	Black/Gray	Earthy	Fine muck
		3	5	Black/Gray	Earthy	Fine muck
Duplicate (SUG-3)	E	1	6	Brown/Gray	Earthy	Fine muck
		2	6	Brown/Gray	Earthy	Fine muck
		3	6	Brown/Gray	Earthy	Fine muck
Duplicate (SUG-3)	F	1	8	Brown/Gray	Earthy	Fine muck
		2	8	Brown/Gray	Earthy	Fine muck
		3	8	Brown/Gray	Earthy	Fine muck
Duplicate (SUG-3)	G	1	5	Black/Gray	Earthy	Fine muck
		2	5	Black/Gray	Earthy	Fine muck
		3	5	Black/Gray	Earthy	Fine muck

*E= Left Bank; F= Mid-channel; G=Rt. Bank

Table A-5, cont.

Station	Sample No.*	Rep No.	Depth (ft)	Color	Odor	Texture/Particle size
SUG-2	E	1	3	Brown/Gray	Earthy	Fine muck
		2	3	Brown/Gray	Earthy	Fine muck
		3	3	Brown/Gray	Earthy	Fine muck
SUG-2	F	1	9	Brown/Gray	Earthy	Sand/Muck
		2	9	Brown/Gray	Earthy	Sand/Muck
		3	9	Brown/Gray	Earthy	Sand/Muck
SUG-2	G	1	2	Black/Brown/Gray	Earthy	Fine muck
		2	3	Black/Brown/Gray	Earthy	Fine muck
		3	3	Black/Brown/Gray	Earthy	Fine muck

*E= Left Bank; F= Midchannel; G= Right Bank

Table A-6

Taxa Lists of Each Station

94/10/03 14:24:03
PROGRAM ID: PRTHESDN

TABLE 5
TAXA LIST
Hester-Dendy Samplers
MACROINVERTEBRATE DATA

PAGE 1

MACROINVERTEBRATE	OAK 2 94-08-31	OAK 3 94-08-31	MAN 1 94-08-31	MAN 2 94-08-31	ELK 1 94-08-31	ELK 2 94-08-31	SUG 2 94-08-31
ANNELIDA							
OLIGOCHAETA	3	91	112	54	8	16	2
ARTHROPODA							
OSTRACODA		7	3	6	2		
CRUSTACEA							
CLADOCERA		22	27	3894			
INSECTA							
COLEOPTERA							
Elmidae							
Macronychus	2						
Gyrinidae							
Dineutus					1		
DIPTERA							
Ceratopogonidae							
Bezzia	10	71	35		5		
CHIRONOMIDAE							
Chironominae							
Chironomini							
Cryptochironomus					5		
Cryptotendipes	1						
Dicrotendipes	3	10	20	60	105	175	69
Endochironomus	1	4					
Glyptotendipes	1	16	133	282	51	47	1247
Harnischia	3						
Nilothauma			3			17	
Pagastiella	5						
Parachironomus				6		31	
Paralauterborniella	4						
Asheum			19	12			
Phaenopsectra	1						
Polypedilum	2						30
Stenochironomus		9	11				

TABLE 5
TAXA LIST
Hester-Dendy Samplers
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-31	OAK 3 94-08-31	MAN 1 94-08-31	MAN 2 94-08-31	ELK 1 94-08-31	ELK 2 94-08-31	SUG 2 94-08-31
Tribelos	1						
Pseudochironomini Pseudochironomus		1		6	141	169	
Tanytarsini Stempellinella	1						
Tanytarsus	8	4					
Orthocladinae Cricotopus/Orthocladius					5	8	
Nanocladius			8	6	45	25	
Orthocladinae UNID		1					
Tanypodinae Ablabesmyia	27	16	17	6	217	41	45
Labrundinia	5	5	5			8	
Procladius	3						
Tanypodinae UNID					3		
CHIRONOMIDAE UNID	1						
EPHEMEROPTERA Baetidae Baetis	3	1			3		
Caenidae Caenis	1	1					
Ephemeridae Hexagenia	52						
Heptageniidae Stenacron	3		1		3	1	
Stenonema	1						
Tricorythidae Tricorythodes	1						
MEGALOPTERA Corydalidae Chauliodes							

TABLE 5
TAXA LIST
Hester-Dendy Samplers
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-31	OAK 3 94-08-31	MAN 1 94-08-31	MAN 2 94-08-31	ELK 1 94-08-31	ELK 2 94-08-31	SUG 2 94-08-31
ODONATA							
Coenagrionidae							
Argia	2	2	7			1	7
Coenagrionidae UNID							
Corduliidae							
Epicordulia							
Gomphidae							
Gomphus	1						
TRICHOPTERA							
Hydroptilidae							
Orthotrichia	1	6	11	18	65	40	1
Leptoceridae							
Oecetis		1					
Polycentropodidae							
Cernotina	9						
Cyrnellus	8	4	39	42	112	181	56
Polycentropodidae UNID							

TABLE 1
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-16	OAK 3 94-08-16	MAN 1 94-08-15	MAN 2 94-08-15	ELK 1 94-08-16	ELK 2 94-08-16	SUG 2 94-08-17
ANNELIDA							
OLIGOCHAETA	32	27	13	9	48	32	545
ANNELIDA UNID dif		7		1			
ANNELIDA UNID					10		
ARTHROPODA							
CRUSTACEA							
ISOPODA							
Asellidae							
Asellus		1					
INSECTA							
COLEOPTERA							
Elmidae							
Dubiraphia	2	4	1		1		
Macronychus	1						
DIPTERA							
Ceratopogonidae							
Alluaudomyia		4					
Bezzia	2	4	2	8	4	5	
CHIRONOMIDAE							
Chironominae							
Chironomini							
Chironomus		14	6		1		3
Cladopelma	1	5	2		1		
Cryptochironomus	3		6	6	13	3	26
Cryptotendipes	3			2			1
Dicrotendipes				1			
Glyptotendipes		2		4	17	3	
Harnischia	1						
Nilothauma						6	
Pagastiella	4	3					
Phaenopsectra		1					
Polypedilum	1	14	6	2	1		6

TABLE 1
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-16	OAK 3 94-08-16	MAN 1 94-08-15	MAN 2 94-08-15	ELK 1 94-08-16	ELK 2 94-08-16	SUG 2 94-08-17
Stenochironomus		1					
Stictochironomus	5	2		4			1
Chironomini UNID	1		1				
Pseudochironomini Pseudochironomus					2	128	
Tanytarsini Cladotanytarsus						3	
Tanytarsus		5					
Zavreliella					1		
Orthocladinae Krenosmittia	1						
Nanocladius					1	9	
Orthocladinae UNID dif					1		
Tanypodinae Ablabesmyia	2	27	1	12	3	9	
Coelotanyhpus	1	7	13		19	11	33
Labrundinia	1	4				3	
Procladius	4	14	11	13	7	6	14
Tanypus	1		2			12	
CHIRONOMIDAE UNID		1					
Chaoboridae Chaoborus	6	8	16	51	266	32	36
EPHEMEROPTERA Baetidae Centroptilum						1	
Caenidae Caenis		1			2		
Ephemeridae Hexagenia	15	12	3		5		

TABLE 1
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-16	OAK 3 94-08-16	MAN 1 94-08-15	MAN 2 94-08-15	ELK 1 94-08-16	ELK 2 94-08-16	SUG 2 94-08-17
MEGALOPTERA							
Sialidae							
Sialis			5		1		
ODONATA							
Coenagrionidae							
Argia				1			
Corduliidae							
Tetragoneuria	1						
Gomphidae							
Erpetogomphus						4	
Gomphidae UNID		1					
Macromiidae							
Didymops					1		
Macromia	2				1	3	
TRICHOPTERA							
Hydroptilidae							
Oxyethira						1	
Leptoceridae							
Mystacides	1			2			
Oecetis	1			3	1	3	
Molannidae							
Molanna	1	1					
Polycentropodidae							
Cernotina		2	3	3	1		
Cyrnellus				1	1	7	
Phylocentropus		1					
MOLLUSCA							
GASTROPODA							
LIMNOPHILA							
Physidae							
Physella		1					
MESOGASTROPODA							
Pleuroceridae							

TABLE 1
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 2 94-08-16	OAK 3 94-08-16	MAN 1 94-08-15	MAN 2 94-08-15	ELK 1 94-08-16	ELK 2 94-08-16	SUG 2 94-08-17
Elimia	8	1			69		
Viviparidae *							
Campeloma				1			
PELECYPODA							
HETERODONTA							
Corbiculidae							
Corbicula	5	1	10	1	4	1	
Unionidae							
Unionidae UNID dif					1		
HETERODONTA UNID						1	

TABLE 6
TAXA LIST
Hester-Dendy Samplers
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	SUG 3 94-08-31	SUG 4 94-08-31
ARTHROPODA		
CRUSTACEA		
CLADOCERA		6
INSECTA		
COLEOPTERA		
COLEOPTERA UNID dif		30
DIPTERA		
CHIRONOMIDAE		
Chironominae		
Chironomini		
Dicrotendipes	356	479
Glyptotendipes	882	1011
Orthocladinae		
Cricotopus/Orthocladius		5
Tanypodinae		
Ablabesmyia	81	28
MEGALOPTERA		
Corydalidae		
Chauliodes	1	
ODONATA		
Coenagrionidae		
Argia	4	
Coenagrionidae UNID	1	
Corduliidae		
Epicordulia	1	
TRICHOPTERA		
Hydroptilidae		
Orthotrichia	23	212
Leptoceridae		
Oecetis		6
Polycentropodidae		
Cyrnellus	135	364
Polycentropodidae UNID	2	4

TABLE 2
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	SUG 3 94-08-17	SUG 3 Q 94-08-17	SUG 4 94-08-16
ANNELIDA			
OLIGOCHAETA	78	367	44
ARTHROPODA			
INSECTA			
COLEOPTERA			
Elmidae			
Dubiraphia	1		
DIPTERA			
Ceratopogonidae			
Bezzia	1	1	5
CHIRONOMIDAE			
Chironominae			
Chironomini			
Chironomus	14	7	4
Cryptochironomus	2	3	43
Cryptotendipes			3
Dicrotendipes			3
Glyptotendipes	2		23
Nilothauma			3
Polypedilum	6		3
Tanytarsini			
Cladotanytarsus			35
Tanytarsus			8
Tanypodinae			
Ablabesmyia			8
Coelotanypus	238	284	90
Labrundinia			3
Procladius	8	7	24
Tanypus	9	13	24
Tanypodinae UNID			1
CHIRONOMIDAE UNID	1		1

TABLE 2
TAXA LIST
Dredge Samples
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	SUG 3 94-08-17	SUG 3 Q 94-08-17	SUG 4 94-08-16
Chaoboridae			
Chaoborus	217	306	148
EPHEMEROPTERA			
Caenidae			
Caenis			3
ODONATA			
Macromiidae			
Macromia			3
TRICHOPTERA			
Hydroptilidae			
Ochrotrichia			2
Leptoceridae			
Oecetis			8
Polycentropodidae			
Cyrnellus			3
MOLLUSCA			
GASTROPODA			
LIMNOPHILA			
Ancylidae			
Ferrissia			1
MESOGASTROPODA			
Viviparidae *			
Campeloma			3

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
ANNELIDA			
HIRUDINEA			
Pharyngobdellida			
Erpobdellidae			
Erpobdellidae UNID dif	4		1
OLIGOCHAETA	18	7	6
ARTHROPODA			
INSECTA			
COLEOPTERA			
Curculionidae			
Stenopelmus		1	
Dryopidae			
Helichus			2
Dytiscidae			
Derovatellus			1
Elmidae			
Ancyronyx	2		
Dubiraphia	5		
Macronychus	8		
Microcylloepus	8		
Optioservus	24		
Oulimnius	1		
Stenelmis	85		1
Elmidae UNID	1		
Eubriidae			
Ectopria	2		
Psephenidae			
Psephenus	6		
Ptilodactylidae			
Anchytarsus	15		1
DIPTERA			
Ceratopogonidae			
Bezzia	2		

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
CHIRONOMIDAE			
Chironominae			
Chironomini			
Chironomus		11	10
Cryptochironomus	2	1	2
Dicrotendipes			1
Goeldichironomus		3	14
Polypedilum	15	21	55
Robackia	2		
Stenochironomus	7		2
Stictochironomus	56		
Chironomini UNID			1
Tanytarsini			
Cladotanytarsus	2		
Rheotanytarsus	18		
Tanytarsus	7		
Orthocladinae			
Cricotopus	1		21
Lopescladius	3		
Orthocladius	1		
Pseudosmittia			1
Rheocricotopus	2		
Tanypodinae			
Ablabesmyia		3	3
Clinotanypus	2		
Natarsia	1	1	
Thienemannimyia Grp	1	10	12

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
Empididae			
Hemerdromia	3		2
Simulidae			
Simulium			3
Simulidae UNID	154		
Tabanidae			
Chrysops	1		
Tabanus	1		
Tipulidae			
Hexatoma	4		
Limonia			1
Tipula			1
EPHEMEROPTERA			
Baetidae			
Baetis	8		
Centroptilum	1		
Heterocloeon	7		
Baetidae UNID	4		
Caenidae			
Brachycercus	1		
Ephemerellidae			
Serratella	49		
Ephemeridae			
Hexagenia	1		
Heptageniidae			
Heptagenia	3		
Leucrocuta	2		
Stenacron	5		
Stenonema	87		

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
Oligoneuridae			
Isonychia	24		
Tricorythidae			
Tricorythodes	1		
HEMIPTERA			
Gerridae			
Trepobates			1
Veliidae			
Microvelia	2		
Rhagovelia			1
MEGALOPTERA			
Corydalidae			
Corydalus	29	3	1
Nigronia	7		
Sialidae			
Sialis	1		
ODONATA			
Aeshnidae			
Boyeria	5		2
Calopterygidae			
Calopteryx		1	2
Hetaerina			1
Coenagrionidae			
Argia	2	5	30
Coenagrionidae UNID dif			1
Gomphidae			
Dromogomphus	10		
Progomphus	15	1	2
Macromiidae			
Macromia	8		
PLECOPTERA			
Perlidae			

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
Acroneuria	4		
Neoperla	2		
TRICHOPTERA			
Brachycentridae			
Micrasema	19		
Helicopsychidae			
Helicopsyche	3		
Hydropsychidae			
Cheumatopsyche	109		10
Hydropsyche	31		
Hydropsychidae UNID	9		
Leptoceridae			
Ceraclea	4		
Oecetis	2		
Triaenodes	2		
Philopotamidae			
Chimarra	40		1
Polycentropodidae			
Cernotina	2		
MOLLUSCA			
GASTROPODA			
LIMNOPHILA			
Ancylidae			
Laevapex	2		
Physidae			
Physella	1		
Planorbidae			
Planorbella	1		
Planorbula			2
MESOGASTROPODA			
Hydrobiidae			
Amnicola		1	2

TABLE 9
TAXA LIST
RBP-Multihabitat
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	OAK 1 94-08-17	S 1 94-08-17	SUG 1 94-08-17
Pleuroceridae			
Elimia	172		
PELECYPODA			
HETERODONTA			
Corbiculidae			
Corbicula	53		
MISCELLANEOUS			
Collembola		1	

APPENDIX B

ALGAL GROWTH POTENTIAL DATA

Table B-1. Sugar Creek Study Algal Growth Potential Testing Maximum Standing Crop Data@.

Station	Treatment*	REP 1	REP 2	REP 3	Mean	Range
SUG-3	C	15.34	15.11	14.76	15.07	0.58
	C+N	66.87	66.59	66.28	**66.58**	0.59
	C+P	14.69	14.43	14.79	14.63	0.36
OAK-3	C	1.95	2.16	2.20	2.10	0.25
	C+N	3.08	3.41	3.12	**3.20**	0.33
	C+P	2.24	2.29	2.54	2.36	0.30
MAN-2	C	1.50	1.43	1.78	1.57	0.34
	C+N	2.95	2.51	3.46	**2.97**	0.95
	C+P	1.84	1.98	1.97	1.93	0.14
ELK-1	C	7.16	6.44	6.67	6.67	0.72
	C+N	28.55	26.62	28.11	**27.76**	1.93
	C+P	7.09	7.45	7.33	7.29	0.36
ELK-2	C	4.24	4.30	4.37	4.30	0.12
	C+N	48.41	44.64	47.57	**46.87**	3.77
	C+P	4.08	4.07	4.27	4.14	0.20

The results in bold print represent values which are significantly different from control.

@ Algal Growth Potential Test Results (Maximum Standing Crop dry weights (mg/L))

* C = Control; C+N = Control + Nitrogen; C+P = Control+ Phosphorous

APPENDIX C

TOXICITY TEST DATA

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
FIELD OPERATIONS DIVISION
SPECIAL STUDIES
TOXICS UNIT
TOXICITY TEST REPORT

1. GENERAL:
NPDES PERMIT NO.: AL0048861 DSN: 001 COUNTY: Tallapoosa
Facility Name: Alexander City Sugar Creek WWTP and Sugar Creek Special Study
Receiving Water: Sugar Creek Design Flow: 8.5 (MGD
Total 24-Hour Flow: (1) 3.25 MGD (2) 7.73 MGD (3) 6.90 MGD
Test Type: Short-term Chronic Screening
Test Id. #: 940926

Station Locations:
SUG-1 - upstream of the discharge from the Sugar Creek WWTP
SUG-WWTP - discharge from the Sugar Creek WWTP
SUG-2 - Sugar Creek embayment, approximately 1/4 mile downstream of the beginning of the Lake Martin backwaters
SUG-3 - Sugar Creek embayment, approximately 1/3 mile downstream of SUG-2
PHOTIC - the sample was collected from the photic zone water column using a submersible pump
BOTTOM - the sample was collected from the bottom of the water column using a submersible pump

Test Organism	Date/Time Started YYMMDD	HHMM	Date/Time Ended YYMMDD	HHMM	Control Acceptable	Validity Unacceptable
C.d.	940927	1420	941003	1355	X	----
P.p.	940927	1445	941004	1345	X	----

2A. SUMMARY OF RESULTS FOR SCREENING TEST:

Test Org.	Eff. Conc	SUG-WWTP Mort	SUG-WWTP Repr	SUG-WWTP Grow	SUG-1 Mort	SUG-1 Repr	SUG-1 Grow	SUG-2 PHOTIC Mort	SUG-2 PHOTIC Repr	SUG-2 PHOTIC Grow	SUG-2 BOTTOM Mort	SUG-2 BOTTOM Repr	SUG-2 BOTTOM Grow
C.d.	100	PASS	FAIL	---	PASS	PASS	---	PASS	PASS	---	PASS	FAIL	---
P.p.	100	PASS	---	PASS	PASS	---	PASS	PASS	---	PASS	PASS	---	PASS

Continued SUMMARY OF RESULTS FOR SCREENING TEST:

Test Org.	Eff. Conc	SUG-3 PHOTIC Mort	SUG-3 PHOTIC Repr	SUG-3 PHOTIC Grow	SUG-3 BOTTOM Mort	SUG-3 BOTTOM Repr	SUG-3 BOTTOM Grow	(3) Mort	(3) Repr	(3) Grow	(4) Mort	(4) Repr	(4) Grow
C.d.	100	PASS	PASS	---	PASS	PASS	---						
P.p.	100	PASS	---	PASS	PASS	---	PASS						

3. LABORATORY ANALYSES OF UNDILUTED SAMPLE(S):

SUG-WWTP

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-02	7.5	253	53	2490 @ 25.8	0.05	600.0	0.164	523.
940928-02	7.9	253	55	2480 @ 23.0	0.10	580.0	0.135	570.
940930-02	7.6	261	52	2380 @ 22.1	0.10	545.0	0.142	545.

Continued LABORATORY ANALYSES OF UNDILUTED SAMPLE(S):

SUG-1

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-01	7.8	99	107	334 @ 25.8	-----	36.5	0.020*	32.7
940928-01	8.1	97	108	337 @ 22.6	-----	39.0	0.020*	43.9
940930-01	8.0	92	96	371 @ 22.5	-----	58.0	0.020*	50.0

SUG-2 PHOTIC

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-03	8.2	83	30	730 @ 25.5	-----	150.0	0.032	151.0
940928-03	8.3	91	25	825 @ 22.9	-----	185.0	0.033	184.0
940930-03	8.1	123	35	1082 @ 22.4	-----	240.0	0.051	243.0

SUG-2 BOTTOM

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-04	8.2	206	60	1883 @ 25.7	-----	405.0	0.094	417.0
940928-04	8.3	230	50	2080 @ 23.0	-----	440.0	0.101	516.0
940930-04	8.2	239	54	2070 @ 22.7	-----	480.0	0.086	473.0

SUG-3 PHOTIC

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-05	8.4	45	20	345 @ 25.8	-----	67.0	0.020*	72.3
940928-05	8.1	47	31	384 @ 23.5	-----	77.0	0.020*	79.5
940930-05	8.0	76	29	676 @ 22.7	-----	485.0	0.027	145.0

SUG-3 BOTTOM

SAMPLE Id.	pH su	Alk mg/L	Hard mg/L	Conductivity umhos/cm @ °C.	TRC mg/L	** Cl mg/L	** Cu mg/L	**Na mg/L
940926-06	8.2	177	48	1584 @ 25.5	-----	370.0	0.075	351.0
940928-06	8.3	193	49	2040 @ 23.6	-----	395.0	0.086	457.0
940930-06	8.0	192	49	1750 @ 23.1	-----	385.0	0.081	417.0

* denotes results less than the instrument detection limit
** tests conducted by ADEM Central Laboratory

4. SAMPLE COLLECTION:

Split Samples: N/A

Samples Collected As Specified in NPDES Permit (Location and/or Type): Yes

SUG-WWTP

Sample Id.	Sample(s) Collected YYMMDD HHMM to YYMMDD HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD to YYMMDD
940926-02	940925 0916 to 940926 0901	1	940927 to 940928
940928-02	940927 0915 to 940928 0900	2	940929 to 940930
940930-02	940929 0915 to 940930 0900	2	941001 to 941003

continued SAMPLE COLLECTION

SUG-1

Sample Id.	Sample(s) Collected YYMMDD	HHMM	to	YYMMDD	HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD	to	YYMMDD
940926-01	940926	1050	to	N/A		1	940927	to	940928
940928-01	940928	1110	to	N/A		2	940929	to	940930
940930-01	940930	1045	to	N/A		2	941001	to	941003

SUG-2 PHOTIC

Sample Id.	Sample(s) Collected YYMMDD	HHMM	to	YYMMDD	HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD	to	YYMMDD
940926-03	940926	0925	to	N/A		1	940927	to	940928
940928-03	940928	0915	to	N/A		2	940929	to	940930
940930-03	940930	0915	to	N/A		2	941001	to	941003

SUG-2 BOTTOM

Sample Id.	Sample(s) Collected YYMMDD	HHMM	to	YYMMDD	HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD	to	YYMMDD
940926-04	940926	0933	to	N/A		1	940927	to	940928
940928-04	940928	0930	to	N/A		2	940929	to	940930
940930-04	940930	0935	to	N/A		2	941001	to	941003

SUG-3 PHOTIC

Sample Id.	Sample(s) Collected YYMMDD	HHMM	to	YYMMDD	HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD	to	YYMMDD
940926-05	940926	0950	to	N/A		1	940927	to	940928
940928-05	940928	0950	to	N/A		2	940929	to	940930
940930-05	940930	0945	to	N/A		2	941001	to	941003

SUG-3 BOTTOM

Sample Id.	Sample(s) Collected YYMMDD	HHMM	to	YYMMDD	HHMM	Arrival Temp.(°C.)	Used in Test(s) YYMMDD	to	YYMMDD
940926-06	940926	1000	to	N/A		1	940927	to	940928
940928-06	940928	1010	to	N/A		2	940929	to	940930
940930-06	940930	0955	to	N/A		2	941001	to	941003

5. CONTROL/DILUTION WATER:

Carboy #	Prep. YYMMDD	Begin Use YYMMDD	Initial Water Chemistries pH	Alkalinity	Hardness	Conductivity @ °C.
C-3	940923	940927	8.0	59	89	141 @ 23.6
C-4	940928	941001	8.2	61	95	148 @ 23.9

6. TOXICITY TEST INFORMATION:

Test Organism	Organism Age	Organism Source	Org./Test Vessel	Replicates Per Conc.
C.d.	<24 h old	ADEM In-House Cultures	1	10
P.p.	<24 h old	TAI, EPA in Cinn. OH	15	3

Test Organism	Temp. Range (°C.)	D.O. Range (mg/L)	pH Range (su)	Light Intensity Average (ft.-c.)
C.d.	23.5 - 26.0	6.1 - 9.8	7.4 - 8.8	67.2
P.p.	22.5 - 26.3	5.6 - 9.8	7.2 - 9.1	66.2

7. FEEDING: Fed Irregularly (Explained in Comments Below)

Brine Shrimp: Fed 0.15 mL Suspension of Newly Hatched Larvae 2 Times Daily.
YCT: Fed 0.10 mL Suspension Containing 1800 mg/L TSS Daily.
Algae: Fed 0.10 mL Suspension Containing 3.0 to 3.1 X 10 7 Cells/mL Daily.

COMMENTS: The P. promelas were not fed at Day 6 (941003) AM time due to clog aeration and a poor brine shrimp hatch. This does not appear to have advers affected the test results.

8. REFERENCE TOXICANT TESTS:

TOXICANT: Sodium Chloride (NaCl) SOURCE: EM Science, EM Industries CAS#:7647-14-

Test Organism	Test Date YYMMDD	Results LC50 (mg/L)	95% Confidence Interval (mg/L)
C.d.	940921	2036.91	1681.13/2467.99
P.p.	940907	6251.27	5909.15/6613.19

9. TEST CONDITION VARIABILITY:

A. Deviations From Standard Test Conditions:

Feeding of the P. promelas was irregular, see comments in feeding section.

A few P. promelas larvae were injured during handling and transfer. These organisms were treated as dead in the statistical calculations and results. This did not adversely affect the test results.

Replicates #6 and #9 of the C. dubia test were removed from the data prior to statistical calculations and results. These replicates contained some probable males and were not consistent throughout the test solutions. This adjustment t the standard methodology did not affect the outcome of any of the tests.

The test temperatures were out of range on a few occasions for both species tested. The D.O. and pH levels were slightly outside the suggested ranges a fe times during testing. These deviations do not appear to have adversely affecte the test results.

B. Test Solution Manipulations or Test Modifications: none

11. CHRONIC SCREENING TOXICITY TESTS RESULTS:

TEST ORGANISM: Ceriodaphnia dubia

Test Validity:
Percent (%) Survival in the CONTROL: 100
Average Neonates/Surviving Female in the CONTROL: 24.8
Did 60% of the CONTROL Females Produce Their Third Brood? YES

SUG-WWTP

MORTALITY **CHRONIC TOXICITY INDICATED: YES** --- **NO** X
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 12.5 48h 12.5 7day 12.5
Fishers Exact Test: A = 8, B = 8, a = 8, b = 7, table value = 4

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES** X **NO** ---
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 0.5
Normally Distributed: No
Test Statistic: 0.822 Critical Value: 0.844 (Parametric)
Equal Variance N/A
F Statistic: --- Critical F: ---
Significant Difference Indicated: YES
t Test Statistic: --- t Test Critical Value: ---
Sample Rank Sum: 36.0 #Reps.: 8 Critical Rank Sum: 51.0 (Non-Parametric)

SUG-1

MORTALITY **CHRONIC TOXICITY INDICATED: YES** --- **NO** X
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES** --- **NO** X
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 24.5
Normally Distributed: No
Test Statistic: 0.707 Critical Value: 0.844 (Parametric)
Equal Variance N/A
F Statistic: --- Critical F: ---
Significant Difference Indicated: NO
t Test Statistic: --- t Test Critical Value: ---
Sample Rank Sum: 80.0 #Reps.: 8 Critical Rank Sum: 51.0 (Non-Parametric)

SUG-2 PHOTIC

MORTALITY **CHRONIC TOXICITY INDICATED: YES** --- **NO** X
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES** --- **NO** X
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 25.1
NO REPRODUCTION STATISTICAL ANALYSIS NECESSARY: X

SUG-2 BOTTOM

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES X NO ___**
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 19.9
Normally Distributed? YES
Test Statistic: 0.976 Critical Value: 0.844 (Parametric)
Equal Variance? YES
F Statistic: 1.995 Critical F: 8.89
Significant Difference Indicated? YES
t Test Statistic: 4.174 *t* Test Critical Value: 1.76
Sample Rank Sum: ___ #Reps.: - Critical Rank Sum: ___ (Non-Parametric)

SUG-3 PHOTIC

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 23.9
Normally Distributed? YES
Test Statistic: 0.901 Critical Value: 0.844 (Parametric)
Equal Variance? NO
F Statistic: 11.799 Critical F: 8.89
Significant Difference Indicated? NO
t Test Statistic: ___ *t* Test Critical Value: ___
Sample Rank Sum: 71.5 #Reps.: 8 Critical Rank Sum: 51.0 (Non-Parametric)

SUG-3 BOTTOM

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 0 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

REPRODUCTION **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(avg. neonates/female): 24.8 EFFLUENT(avg. neonates/female): 22.6
Normally Distributed? YES
Test Statistic: 0.878 Critical Value: 0.844 (Parametric)
Equal Variance? YES
F Statistic: 3.132 Critical F: 8.89
Significant Difference Indicated? NO
t Test Statistic: 1.549 *t* Test Critical Value: 1.76
Sample Rank Sum: ___ #Reps.: - Critical Rank Sum: ___ (Non-Parametric)

COMMENTS: These tests indicated a significant difference in the reproduction of t organisms exposed to the SUG-WWTP and the SUG-2 BOTTOM samples. No significa difference to survival or reproduction was indicated by any of the other samples.

continued CHRONIC SCREENING TOXICITY TESTS RESULTS:

TEST ORGANISM: Pimephales promelas

Test Validity:
Percent (%) Survival in the CONTROL: 95.6
Mean Dry Weight (mg) of CONTROL replicates: 0.29

SUG-WWTP

MORTALITY **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 0 7day 4.4
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

GROWTH **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.37
NO GROWTH STATISTICAL ANALYSIS NECESSARY: X

SUG-1

MORTALITY **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 2.2 7day 13.3
Normally Distributed? YES
Test Statistic: 0.962 Critical Value: 0.788 (Parametric)
Equal Variance? YES
F Statistic: 10.213 Critical F: 199.0
Significant Difference Indicated? NO
t Test Statistic: 1.059 t Test Critical Value: 76.15
Sample Rank Sum: ___ #Reps.: - Critical Rank Sum: ___ (Non-Parametric)

GROWTH **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.26
Normally Distributed? YES
Test Statistic: 0.951 Critical Value: 0.788 (Parametric)
Equal Variance? YES
F Statistic: 2.154 Critical F: 199.0
Significant Difference Indicated? NO
t Test Statistic: 1.718 t Test Critical Value: 76.15
Sample Rank Sum: ___ #Reps.: - Critical Rank Sum: ___ (Non-Parametric)

SUG-2 PHOTIC

MORTALITY **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 2.2 7day 2.2
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

GROWTH **CHRONIC TOXICITY INDICATED: YES** ___ **NO** X
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.31
NO GROWTH STATISTICAL ANALYSIS NECESSARY: X

continued *P. promelas* CHRONIC SCREENING TOXICITY TESTS RESULTS:

SUG-2 BOTTOM

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

GROWTH **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.30
NO GROWTH STATISTICAL ANALYSIS NECESSARY: X

SUG-3 PHOTIC

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 0 7day 2.2
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

GROWTH **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.29
NO GROWTH STATISTICAL ANALYSIS NECESSARY: X

SUG-3 BOTTOM

MORTALITY **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL(%) 24h 0 48h 0 7day 4.4 EFFLUENT(%): 24h 0 48h 0 7day 0
NO MORTALITY STATISTICAL ANALYSIS NECESSARY: X

GROWTH **CHRONIC TOXICITY INDICATED: YES ___ NO X**
CONTROL mean dry weight (mg): 0.29 EFFLUENT mean dry weight (mg): 0.33
NO GROWTH STATISTICAL ANALYSIS NECESSARY: X

COMMENTS: There was no significant difference to survival or growth of the promelas when tested at a 100% concentration of each sample.

SIGNATURE: Janet Olens DATE: 10-18-94

APPENDIX D

CHEMICAL/PHYSICAL ASSESSMENT DATA

Sugar Creek Special Study August 15, 1994

Table D-1. Results of Chemical Analyses.

Station Number	Chlorophyll *a* (mg/m^3)	Trophic State Index (TSI)	CBOD5 (mg/l)	Total Dissolved Solids (TDS) (mg/l)	Total Suspended Solids (TSS) (mg/l)	Alkalinity (mg/l)	Hardness (mg/l)	Total Organic Carbon (mg/l)	Total Phosphorous (mg/l)	Ortho-Phosphate (mg/l)	Ammonia Nitrogen (mg/l)	NO2+NO3 (mg/l)	Total Kjeldahl Nitrogen (mg/l)	ADMI Color (ADMI)	Chloride (mg/l)	Total Cyanide (mg/l)
SUG-1	—	—	—	178	13	92	97	4.80	0.059	0.125	0.13	0.040	0.94	41	26	—
WWTP	—	—	2.5	1430	3	240	61	19.60	3.14	2.62	0.28	3.81	4.1	147	488	<0.004
S-1	—	—	—	1250	3	180	64	20.00	3.38	2.70	0.20	3.00	4.9	154	426	—
SUG-2	15.5	57	—	375	11	81	29	7.07	0.627	0.778	0.01	0.803	2.1	63	—	—
SUG-3	20.5	60	—	163	4	36	17	4.68	0.261	0.281	0.21	0.068	1.4	50	—	—
SUG-4	22.5	61	—	95	4	24	14	3.52	0.135	0.161	<0.01	0.003	1.0	36	—	—
ELK-1	14.2	57	—	56	7	19	14	3.68	0.034	0.072	0.02	0.016	0.81	999*	—	—
ELK-2	26.4	63	—	64	1	18	11	3.06	0.053	0.080	0.04	0.004	1.1	28	—	—
MAN-1	6.4	49	—	63	1	22	14	2.63	0.026	0.048	0.04	0.051	0.81	21	—	—
MAN-2	5.9	48	—	63	1	14	10	2.42	<0.005	0.042	<0.01	<0.002	0.55	—	—	—
OAK-1	—	—	—	24	1	14	10	4.06	<0.005	0.116	<0.01	<0.002	0.70	—	—	—
OAK-2	4.5	45	—	21	<1	14	14	2.60	0.014	0.057	<0.01	<0.002	0.86	21	—	—
OAK-3	4.5	45	—	31	1	15	10	2.24	<0.005	0.057	<0.01	<0.002	0.80	—	—	—
DUP-1 (SUG-2)	lab error	—	—	368	10	75	23	6.80	0.577	0.690	0.11	0.688	2.1	70	—	—
DUP-2 (OAK-3)	4.5	—	—	34	6	14	9	2.39	<0.005	0.052	<0.01	<0.002	0.36	—	—	—

Sugar Creek Special Study   August 1994
Table D-2. Profile data.

Station	Date	Secchi m	Photic-Zone m	Depth m	Temperature C	pH s.u.	Specific Conductivity umhos	Dissolved Oxygen mg/l	Turbidity ntu	Fecal Coliform per 100 ml
SUG-2	8/15/94	0.84	1.9	0.0	30.6	8.5	193	8.8	6.9	<10
				0.5	30.3	8.5	218	8.5		
				1.0	28.1	8.0	812	7.3		
				1.5	27.3	7.9	1740	7.0		
DUP-1 (SUG-2)	8/15/94	0.88	1.9	0.0	30.6	8.6	193	9.1	6.4	<1
				0.5	29.6	8.3	340	8.1		
				1.0	28.2	8.0	886	7.2		
				1.5	27.4	7.9	1431	6.9		
SUG-3	8/15/94	1.10	2.3	0.0	30.1	8.6	172	9.3	5.6	5*
				0.5	30.1	8.6	175	9.3		
				1.0	30.1	8.6	176	9.1		
				1.5	29.4	8.2	354	7.6		
				1.8	27.6	7.8	1035	6.3		
SUG-4	8/15/94	1.43	3.1	0.0	30.1	8.7	130	9.7	3.6	<3
				0.5	30.1	8.8	130	9.7		
				1.0	30.0	8.8	128	9.6		
				1.5	30.0	8.8	121	9.5		
				2.0	29.9	8.7	118	9.2		
				2.5	29.6	7.9	294	5.4		
				2.7	29.3	7.6	332	3.4		

* estimated
^ Data collected during rain event.

Sugar Creek Special Study August 1994
Table D-2, cont.

Station	Date	Secchi m	Photic-Zone m	Depth m	Temperature C	pH s.u.	Specific Conductivity umhos	Dissolved Oxygen mg/l	Turbidity ntu	Fecal Coliform per 100 ml
ELK-1	8/15/94	1.59	3.6	0.0	29.8	7.9	89	8.2	3.0	7*
				1.0	29.6	8.1	89	8.1		
				1.5	29.6	8.2	89	8.0		
				2.0	29.7	8.2	88	7.7		
				3.0	29.5	8.0	84	7.3		
				4.0	28.9	7.5	74	6.7		
				4.3	28.5	7.3	71	6.6		
ELK-2	8/15/94	1.48	4.3	0.0	29.8	8.6	83	9.4	2.5	<3
				1.0	29.8	8.7	83	9.2		
				1.5	29.8	8.7	81	9.1		
				2.0	29.8	8.7	82	9.1		
				3.0	29.6	7.9	121	7.0		
				4.0	29.4	7.4	172	5.6		
				5.0	29.0	7.1	319	2.7		
				6.0	28.2	6.9	350	0.5		
				7.0	27.3	6.8	356	0.4		
				8.0	26.7	6.8	273	0.4		
				8.5	26.7	6.8	337	0.4		
SUG-1	8/15/94	---	---	---	25.4	7.3	252	7.5	16	>2420^
WWTP	8/15/94	---	---	---	---	---	---	6.6	3.0	---
S-1	8/15/94	---	---	---	31.1	6.7	1910	5.6	2.9	90*

* estimated

^ Data collected during rain event.

Sugar Creek Special Study August 1994
Table D-2, cont.

Station	Date	Secchi m	Photic-Zone m	Depth m	Temperature C	pH s.u.	Specific Conductivity umhos	Dissolved Oxygen mg/l	Turbidity ntu	Fecal Coliform per 100 ml
OAK-1	8/15/94	---	---	0.1	24.6	6.1	53	8.2	8.7	30*
OAK-2	8/15/94	1.86	3.0	0.0	29.7	6.5	42	7.5	3.4	2*
				0.5	29.7	6.6	42	7.5		
				1.0	29.7	6.6	41	7.5		
				1.5	29.6	6.7	41	7.3		
				2.0	29.2	6.7	43	7.0		
				2.5	26.7	6.6	46	6.9		
				2.7	26.5	6.7	50	6.9		
OAK-3	8/15/94	2.52	3.8	0.0	29.8	6.3	41	7.8	2.3	6*
				0.5	29.9	6.6	40	7.8		
				1.0	29.8	6.7	40	7.8		
				1.5	29.8	6.8	42	7.8		
				2.0	29.8	6.9	40	7.8		
				2.5	29.8	6.9	39	7.8		
				3.0	29.6	6.8	41	7.2		
				3.5	28.0	6.6	48	6.0		
DUP-2 (OAK-3)	8/15/94	2.53	3.8	0.0	29.9	6.9	41	7.7	2.4	<1
				0.5	29.9	7.0	39	7.8		
				1.0	29.9	7.0	39	7.8		
				1.5	29.8	7.0	41	7.8		
				2.0	29.8	7.0	40	7.8		
				2.5	29.8	7.0	39	7.7		
				3.0	29.6	6.7	44	6.5		
				3.5	27.8	6.6	49	6.0		

* estimated
^ Data collected during rain event.

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Table D-2, cont.

Station	Date	Secchi m	Photic-Zone m	Depth m	Temperature C	pH s.u.	Specific Conductivity umhos	Dissolved Oxygen mg/l	Turbidity ntu	Fecal Coliform per 100 ml
MAN-1	8/15/94	1.84	4.3	0.0	29.9	6.5	44	8.6	3.5	6*
				0.5	29.9	6.7	44	8.4		
				1.0	29.5	6.8	43	8.1		
				1.5	29.3	6.9	42	8.0		
				2.0	29.2	6.9	45	7.9		
				2.5	28.9	6.8	41	7.3		
				3.0	28.6	6.7	39	6.5		
				3.5	28.4	6.5	46	5.4		
				4.0	27.8	6.4	48	4.4		
MAN-2	8/15/94	2.83	6.5	0.0	30.0	7.0	43	8.1	1.8	<1
				1.0	29.7	7.1	44	8.1		
				1.5	29.0	7.3	44	8.2		
				2.0	29.0	7.3	40	8.1		
				3.0	28.8	7.2	43	7.7		
				4.0	28.3	6.9	38	6.8		
				5.0	28.1	6.5	48	4.1		
				6.0	27.5	6.3	47	2.0		
				7.0	26.9	6.1	50	0.8		
				8.0	26.2	6.1	45	0.1		
				9.0	25.9	5.9	38	0.1		
				10.0	25.6	5.9	42	0.1		
				11.0	25.3	5.9	38	0.1		
				12.0	25.1	6.0	57	0.1		
				12.9	24.7	6.1	59	0.1		

* estimated
^ Data collected during rain event.

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Table D-3. Pesticide Data.

Station Number	Time (24 hrs)	Diazinon (mg/l)	Ethion (mg/l)	Malathion (mg/l)	Methyl Parathion (mg/l)	Parathion (mg/l)	Phosdrin (mg/l)
SUG-1	1515	<0.0100	<0.0100	<0.0300	<0.0120	<0.0150	<0.0500
WWTP	1500	<0.0100	<0.0100	<0.0300	<0.0120	<0.0150	<0.0500
S-1	1430	<0.0100	<0.0100	<0.0300	<0.0120	<0.0150	<0.0500

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Table D-4. Results of Metals Analyses.

Station Number	Time (24 hrs)	Total Silver (mg/l)	Total Arsenic (mg/l)	Dissolved Arsenic (mg/l)	Total Barium (mg/l)	Dissolved Barium (mg/l)	Total Cadmium (mg/l)	Dissolved Cadmium (mg/l)	Total Chromium (mg/l)	Dissolved Chromium (mg/l)	Total Hexavalent Chromium (mg/l)
SUG-1	1515	<0.015	<0.010	<0.010	**0.058**	**0.052**	<0.003	<0.003	<0.015	<0.015	<0.02
WWTP	1500	<0.015	<0.010	<0.010	**0.052**	**0.047**	<0.003	<0.003	<0.015	<0.015	<0.02
S-1	1430	<0.015	<0.010	<0.010	**0.053**	**0.050**	<0.003	<0.003	<0.015	<0.015	<0.02
SUG-2	1250	<0.015	<0.010	<0.010	**0.022**	0.019	<0.003	<0.003	<0.015	<0.015	<0.02
SUG-3	1205	<0.015	<0.010	<0.010	<0.015	<0.015	<0.003	<0.003	<0.015	<0.015	<0.02
SUG-4	1130	<0.015	<0.010	<0.010	<0.015	<0.015	<0.003	<0.003	<0.015	<0.015	<0.02
ELK-1	1015	---	---	---	---	---	---	---	---	---	---
ELK-2	1050	---	---	---	---	---	---	---	---	---	---
MAN-1	1431	<0.015	<0.010	<0.010	<0.015	<0.015	<0.003	<0.003	<0.015	<0.015	<0.02
MAN-2	1510	---	---	---	---	---	---	---	---	---	---
OAK-1	1315	---	---	---	---	---	---	---	---	---	---
OAK-2	1029	<0.015	<0.010	<0.010	<0.015	<0.015	<0.003	<0.003	<0.015	<0.015	<0.02
OAK-3	1130	---	---	---	---	---	---	---	---	---	---
DUP-1 (SUG-2)	1310	<0.015	<0.010	<0.010	0.020	0.018	<0.003	<0.003	<0.015	<0.015	<0.02
DUP-2 (OAK-3)	1145	---	---	---	---	---	---	---	---	---	---

* Values in bold are above detection limit.

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Table D-4, cont.

Station Number	Dissolved Hexavalent Chromium (mg/l)	Total Copper (mg/l)	Dissolved Copper (mg/l)	Total Mercury (mg/l)	Dissolved Mercury (mg/l)	Total Beryllium (mg/l)	Dissolved Beryllium (mg/l)	Total Thallium (mg/l)	Dissolved Thallium (mg/l)	Total Nickel (mg/l)	Dissolved Nickel (mg/l)
SUG-1	<0.02	<0.020	<0.020	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
WWTP	<0.02	**0.134**	**0.127**	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
S-1	<0.02	**0.137**	**0.127**	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
SUG-2	<0.02	**0.029**	**0.028**	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
SUG-3	<0.02	<0.020	<0.020	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
SUG-4	<0.02	<0.020	<0.020	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
ELK-1	---	---	---	---	---	---	---	---	---	---	---
ELK-2	---	---	---	---	---	---	---	---	---	---	---
MAN-1	<0.02	<0.020	<0.020	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
MAN-2	---	---	---	---	---	---	---	---	---	---	---
OAK-1	---	---	---	---	---	---	---	---	---	---	---
OAK-2	<0.02	<0.020	<0.020	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
OAK-3	---	---	---	---	---	---	---	---	---	---	---
DUP-1 (SUG-2)	<0.02	**0.029**	**0.029**	<0.0005	<0.0005	<0.003	<0.003	<0.0011	<0.0011	<0.020	<0.020
DUP-2 (OAK-3)	---	---	---	---	---	---	---	---	---	---	---

* Values in bold are a* Values in bold are above detection limit.

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Table D-4 cont.

Station Number	Total Lead (mg/l)	Dissolved Lead (mg/l)	Total Antimony (mg/l)	Dissolved Antimony (mg/l)	Total Selenium (mg/l)	Dissolved Selenium (mg/l)	Total Zinc (mg/l)
SUG-1	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
WWTP	<0.010	<0.010	**0.147**	**0.107**	<0.010	<0.010	<0.030
S-1	<0.010	<0.010	**0.114**	**0.106**	<0.010	<0.010	<0.030
SUG-2	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
SUG-3	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
SUG-4	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
ELK-1	---	---	---	---	---	---	---
ELK-2	---	---	---	---	---	---	---
MAN-1	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
MAN-2	---	---	---	---	---	---	---
OAK-1	---	---	---	---	---	---	---
OAK-2	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
OAK-3	---	---	---	---	---	---	---
DUP-1 (SUG-2)	<0.010	<0.010	<0.100	<0.100	<0.010	<0.010	<0.030
DUP-2 (OAK-3)	---	---	---	---	---	---	---

* Values in bold are a* Values in bold are above detection limit.

APPENDIX E

HYDROLOGIC DATA

Table E-1. Rainfall data for Hillabee Creek near Hackneyville, AL, 1994. Longterm rainfall data recorded from 1986-1990 are provided for comparison.

	1994 VALUES			LONG TERM DATA			
MONTH	MONTHLY MEAN	DAILY MAX	DAILY MIN	MONTHLY MEAN	MAX. MONTH	MIN. MONTH	YEAR OF OCCURANCE
May	276	898	142	316	725	124	1988
June	246	778	116	212	655	38.6	1988
July	324	1320	136	169	592	44.4	1986
August	204	633	120	116	262	29.8	1988
September	139	616	94	119	720	15.3	1990

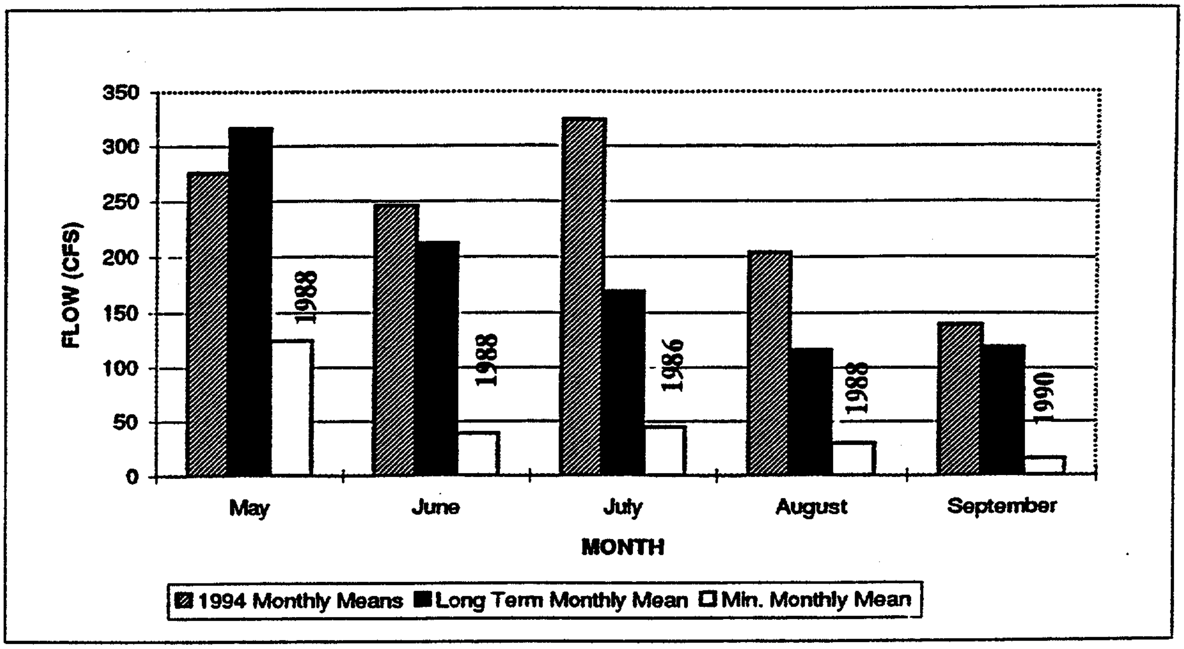
D.A. = 190 MI^2

Table E-2. Rainfall data for Montgomery, AL, 1994*.

MONTH	TOTAL PRECIPITATION (INCHES)	DEPARTURE FROM NORMAL (INCHES)
January	3.83	-0.85
February	6.28	+0.80
March	5.73	-0.53
April	3.22	-1.27
May	1.76	-2.16
June	6.61	+2.71
July	8.47	+3.28
August	4.46	+0.77
September	4.60	+0.51

*Personal Communication: J. Owen, ADEM

Fig. E-1. Hydrologic data for Hillabee Creek near Hackneyville.



APPENDIX F

FISH TISSUE MONITORING PROGRAM DATA

LABORATORY REPORT- COMPOSITE PARAMETERS

Generated March 29, 1995 at 10:42 AM

Station Code: MAR3 Water Body: LAKE MARTIN/ELKAHATCHEE RESERVOIR
Latitude: 32 52 40.9 N Longitude: 085 56 38.5 W
BASIN: Major: SOUTHEAST Minor: TALLAPOOSA RIVER
HUC Code: 03150109 Reach Code: 015 Precision Code: 1
Mile: 5.200 COUNTY: 1: TALLAPOOSA 2:
LOCATION: Near City: ALEXANDER CITY
OFF ELKAHATCHEE CREEK EMBAYMENT APPROXIMATELY 1.6 MILES DOWNSTREAM OF STATE ROUTE 63 BRIDGE. VICINITY OF RAINTREE SUBDIVISION.

Episode Number: 95 08 Date Collected: 09/27/94 Method: EF
Collecting Agency: 001 ADEM-MONTGOMERY
Collector 1: DAVIES 2: HOUSTON 3: SHOEMAKER

001 A LARGEMOUTH BASS MICROPTERUS SALMOIDES
Sample Type: CLF Size: 6 Avg Weight: 891.6 gm Avg Length: 378 mm
Lab Code: 001 Name: ADEM MONTGOMERY LABORATORY

Chemical Name	Units	Parm	Value
Chlordane	PPM	<	0.02
Chromium	PPM	<	1.50
Copper	PPM	<	2.00
DDD	PPM	<	0.01
DDE	PPM	<	0.01
DDT	PPM	<	0.01
Dieldrin	PPM	<	0.01
Dursban	PPM	<	0.01
Endrin	PPM	<	0.01
Heptachlor	PPM	<	0.01
Heptachlor-epoxide	PPM	<	0.01
Lipid	%		2.19
Mercury	PPM		0.14
Mirex	PPM	<	0.01
PCB	PPM	<	0.05
Toxaphene	PPM	<	0.05

007 A CHANNEL CATFISH ICTALURUS PUNCTATUS
Sample Type: CLF Size: 6 Avg Weight: 1,121.6 gm Avg Length: 473 mm
Lab Code: 001 Name: ADEM MONTGOMERY LABORATORY

Chemical Name	Units	Parm	Value
Chlordane	PPM	<	0.02
Chromium	PPM	<	1.50
Copper	PPM	<	2.00
DDD	PPM	<	0.01

LABORATORY REPORT- COMPOSITE PARAMETERS

DDE	PPM	<	0.01
DDT	PPM	<	0.01
Dieldrin	PPM	<	0.01
Dursban	PPM	<	0.01
Endrin	PPM	<	0.01
Heptachlor	PPM	<	0.01
Heptachlor-epoxide	PPM	<	0.01
Lipid	%		1.30
Mercury	PPM	<	0.10
Mirex	PPM	<	0.01
PCB	PPM	<	0.05
Toxaphene	PPM	<	0.05

LABORATORY REPORT- COMPOSITE PARAMETERS

Station Code: MAR4 Water Body: LAKE MARTIN/SUGAR CREEK RESERVOIR
Latitude: 32 53 7.5 N Longitude: 085 57 6.1 W
BASIN: Major: SOUTHEAST Minor: TALLAPOOSA RIVER
HUC Code: 03150109 Reach Code: 015 Precision Code: 1
Mile: 5.200 COUNTY: 1: TALLAPOOSA 2:
LOCATION: Near City: ALEXANDER CITY
OFF SUGAR CREEK EMBAYMENT FROM ITS CONFLUENCE WITH ELKAHATCHEE CREEK TO A POINT APPROXIMATELY 0.8 MILES UPSTREAM.

Episode Number: 95 07 Date Collected: 09/27/94 Method: EF
Collecting Agency: 001 ADEM-MONTGOMERY
Collector 1: SHOEMAKER 2: DAVIES 3: HOUSTON

001 A LARGEMOUTH BASS MICROPTERUS SALMOIDES
Sample Type: CLF Size: 6 Avg Weight: 978.3 gm Avg Length: 391 mm
Lab Code: 001 Name: ADEM MONTGOMERY LABORATORY

Chemical Name	Units	Parm	Value
Chlordane	PPM	<	0.02
Chromium	PPM	<	1.50
Copper	PPM	<	2.00
DDD	PPM	<	0.01
DDE	PPM	<	0.01
DDT	PPM	<	0.01
Dieldrin	PPM	<	0.01
Dursban	PPM	<	0.01
Endrin	PPM	<	0.01
Heptachlor	PPM	<	0.01
Heptachlor-epoxide	PPM	<	0.01
Lipid	%		0.93
Mercury	PPM		0.11
Mirex	PPM	<	0.01
PCB	PPM	<	0.05
Toxaphene	PPM	<	0.05

007 A CHANNEL CATFISH ICTALURUS PUNCTATUS
Sample Type: CLF Size: 6 Avg Weight: 702.5 gm Avg Length: 415 mm
Lab Code: 001 Name: ADEM MONTGOMERY LABORATORY

Chemical Name	Units	Parm	Value
Chlordane	PPM	<	0.02
Chromium	PPM	<	1.50
Copper	PPM	<	2.00
DDD	PPM	<	0.01
DDE	PPM	<	0.01

LABORATORY REPORT- COMPOSITE PARAMETERS

DDT	PPM	<	0.01
Dieldrin	PPM	<	0.01
Dursban	PPM	<	0.01
Endrin	PPM	<	0.01
Heptachlor	PPM	<	0.01
Heptachlor-epoxide	PPM	<	0.01
Lipid	%		2.92
Mercury	PPM	<	0.10
Mirex	PPM	<	0.01
PCB	PPM	<	0.05
Toxaphene	PPM	<	0.05

--- End of Report ---