WATER QUALITY DEMONSTRATION STUDY

TRIBUTARY TO- AND PATSLIGA CREEKS
LUVERNE, ALABAMA
1989 AND 1990

SPECIAL SERVICES SECTION
FIELD OPERATIONS DIVISION
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

WATER QUALITY DEMONSTRATION STUDY
TRIBUTARY TO- AND PATSALIGA CREEK AT LUVERNE, ALABAMA

INTRODUCTION

The City of Luverne, Alabama utilized a tributary to- and Patsaliga Creek as a receiving stream for the treated effluent from its municipal wastewater treatment plant (WWTP). During the period from May 1989 to September 1990, the City of Luverne WWTP underwent construction to upgrade the old disposal plant. Staff members of the Special Studies Section, Field Operations Division of the Alabama Department of Environmental Management (ADEM), at the request of the Municipal Branch of the Water Division of ADEM, conducted a water quality demonstration study to assess the effects of the new treatment facility on Patsaliga Creek.

EPA CONSTRUCTION GRANTS PROGRAM

Since 1972, approximately $545 million dollars in EPA grant funds have been expended toward construction of municipal wastewater treatment works in Alabama. The City of Luverne received an EPA Construction Grant for the improvements to the Luverne Wastewater Treatment Plant (WWTP).

The improvements to the Luverne WWTP consisted of the addition of a 3.3 acre water hyacinth system following the existing 10 acre single-cell lagoon. Additional construction included a 180 gallon per minute (gpm) sewage pumping station and 2170 L.F. of force main.

The total cost of construction and engineering was $808,450.00. An EPA grant for $561,053, including $136,375 in funding for Alternative Technology, was provided to help defray the cost of construction. On April 29, 1988, the City of Luverne entered into an engineering contract with the firm of Carter, Darnell and Grubbs of Andalusia, Alabama. On May 11, 1989, Development and Engineering Associates, Incorporated was awarded the construction contract for the hyacinth system.

Hyacinth systems can be designed for treatment of raw sewage or for any other treatment level, up to tertiary polishing of secondary effluent. As with other types of pond systems, the critical design parameter is organic loading. The degree of nutrient removal achieved with hyacinth systems is directly related to the frequency of harvesting the plants.

Hyacinth systems are only practical in locations where the plant can survive naturally. At present the State of Alabama has 9 treatment facilities that utilize hyacinths: Millry, New Brockton, Enterprise (2), Camp Hill, Citronelle, Luverne, Headland, and Cottonwood.

The partially treated effluent from Luverne's existing facultative lagoon passes through the flow measurement device and is transported to the water hyacinth pond via a 12 inch gravity sewer. The flow enters the pond at the front of three seperate parallel greenhouses which contain the hyacinths. The surface area of the pond is 4.0 acres at a 3 foot depth, and the retention time is 7.9 days at a flow rate of 0.45 million gallons per day (mgd). The wastewater is released through three tees placed in the line near the center of each greenhouse. It flows through the pond to three other parallel greenhouses where it is collected through baffles into an effluent trough and conveyed to Patsaliga Creek.

Operating problems which may arise in the water hyacinth pond will generally be related to the care and maintenance of the hyacinths. These plants will require care as other types of plants do. The plants perform best when young and actively growing. For this reason, they must be harvested on a regular basis. Plants need to be removed from the pond and allowed to dry. After drying, they can be hauled to a landfill for disposal.

Water hyacinths are sensitive to cold weather, and usually die when temperatures drop below freezing for an extended time. For this reason, greenhouses are provided to protect the plants during cold weather and to maintain a supply of plants during the winter to "seed" the hyacinth pond during the spring. When warmer weather arrives in the spring, the water level in the pond can be lowered, and the plants pushed out of the house into the pond. The plants multiply very rapidly and should cover the pond in a few weeks. Plants must occasionally be harvested from these greenhouses. This can be accomplished by lowering the water level in the pond and manually pushing the plants out of the house.

Seasonal NPDES permit limits for the 0.45 mgd treatment system are as follows:

	May-Oct	Nov-Apr
BOD_5	20 mg/L	30 mg/L
TSS	90 mg/L	90 mg/L
NH_3-N	8 mg/L	N/A
D.O.	6 mg/L	N/A

Average monthly performance by the treatment facility for the period from July 1990 to January 1991 is as follows:

Flow	0.247 mgd
BOD_5	13.3 mg/L
TSS	9.3 mg/L
NH_3-N	1.98 mg/L

FIELD OPERATIONS

During the period of May to September 1989, staff members of the Special Studies Section collected data to establish conditions and provide a comparative base of information on the tributary to- and Patsaliga Creek prior to construction and implementation of the new treatment plant. During August to September 1990, data were collected to demonstrate the improvement, if any, of water quality in the receiving stream attributable to the new plant.

SAMPLING LOCATIONS AND METHODOLOGY

Two sampling locations were selected and utilized for data collection prior to the upgrade of the WWTP. The station names and locations were as follows:

STATION	LOCATION:
PG-1 (control)	Unnamed tributary of Patsaliga Creek off South corner of WWTP. T9N, R18E, S32, SW1/4, SW1/4, SE1/4. Latitude: 33 42 18.4 Longitude: 086 16 45.5
PG-2	Unnamed tributary of Patsaliga Creek just upstream of confluence with Patsaliga Creek. T9N, R18E, S31, SE1/4, NW1/4, NE1/4.

Latitude: 33 42 33.2 Longitude: 086 17 18.2

After the upgrade, an additional two stations were selected and sampled, due to the effluent line being rerouted directly to Patsaliga Creek. These station names and locations were as follows:

STATION	LOCATION:
PG-3 (control)	Patsaliga Creek approximately 0.3 mile upstream of discharge of WWTP. T9N,R18E,S31,NE1/4,SE1/4,SW1/4. Latitude: 33 42 39.5 Longitude: 086 17 13.6
PG-4	Patsaliga Creek approximately 0.8 mile below WWTP discharge. T9N,R18E,S31,SW1/4,NE1/4,NE1/4. Latitude: 33 42 30.0 Longitude: 086 17 32.7

All physical data, chemical and biological sampling, sample handling techniques, and field parameter analyses utilized in the acquisition of data for this water quality demonstration study were as described in the Field Operations Standard Operating Procedures and Quality Control Assurance Manual (Field Operations Division, ADEM, Volumes 1 and 2), as amended. Chain- of-custody was maintained by locking the samples in a Departmental vehicle when not in sight of a Field Operations employee. The samples requiring laboratory analysis were transported to the ADEM Environmental Laboratory in Montgomery, Alabama. Analysis methodologies were as specified in the Federal Register, 40 CFR Part 136, October 1984, as amended. Analysis of the samples yielded the data which are reported in Tables 1 and 2.

DISCUSSION AND RESULTS

A. PHYSICAL

The unnamed tributary to Patsaliga Creek, at PG-1 and PG-2, is a second order stream that, primarily, drains residential, commercial, and industrial lands. Patsaliga Creek, at PG-3 and PG-4, is a fifth order stream that drains residential, commercial, industrial, agricultural, and forested lands. These streams fall within the Southeastern Plains Ecoregion and lie within the Perdido/Escambia River drainage basin. The tributary was completely shaded by canopy, had shrubs and trees as the dominant streamside vegetations, and had moderately stable to unstable banks. Patsaliga Creek was partly shaded by canopy, had trees as the dominant streamside vegetation, and had moderately stable to unstable banks with high stream flow. At the tributary to Patsaliga Creek, bottom structure consisted largely of sand substrate. Flows averaged approximately 1.0 cubic feet per second (cfs) during low flow conditions, with the WWTP contributing 0.5 cfs. Due to the depth (greater than four feet) of the stream at Patsaliga Creek, bottom structure and flow are unknown. Although the streams were not evaluated for a Habitat Assessment, the tributary was judged to be habitat poor, while Patsaliga Creek was fair.

B. CHEMICAL

The Water Use Classification for Patsaliga Creek is Fish and Wildlife (F&W). F&W designates the waters to be suitable for fishing, propagation of fish, aquatic life, and wildlife, and any other usage except for swimming and water contact sports or as a source of water supply for drinking or food processing purposes.

As shown in Table 1, Table 2 and Figure 1, data collected prior to the upgrade of the treatment plant indicated that the waters in the tributary to Patsaliga Creek upstream (PG-1) were consistently meeting the dissolved oxygen (D.O.) standard for the F&W classification (5.0 mg/L). D.O.'s downstream, however, were well below the standard, indicating an adverse impact by the effluent. After the upgrade, D.O. concentrations were significantly improved. This was apparently due to the complete removal of the effluent from the tributary and routing it to Patsaliga Creek. Patsaliga Creek D.O. data collected during the after portion of the WQDS demonstrated no adverse impact to the stream attributable to the WWTP. Conductivity and pH data collected were well within the guidelines set out by the F&W classification.

Chemical analysis data (Figure 2) collected at the control station on the tributary indicated the possible presence of nutrient enrichment occurring upstream of the WWTP. Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Suspended Solids (TSS), Ammonia (NH_3), Phosphate (PO_4) and Kjeldahl Nitrogen (TKN) , were elevated before the upgrade, while COD, and Nitrate (NO_3) were elevated after the upgrade. At the downstream station of the tributary, (Figure 3) removal of the pollution source resulted in a signifcant decline in concentration of all parameters.

Patsaliga Creek, the present receiving stream for the treated effluent, does not appear to be adversely impacted from the addition of wastewater discharge. Chemical Analysis Data (Figure 5) indicates that, with the exception of TSS and PO_4, concentration levels of all parameters sampled are similar to the levels found in Patsaliga Creek upstream of the discharge. Chemical analysis of the effluent (Figure 4) showed that, after the upgrade, concentrations of most parameters were dramatically reduced.

C. BIOLOGICAL

An assessment of the tributary to- and Patsaliga Creeks water quality would be incomplete without considering impacts to the biological communities. The aquatic macroinvertebrate community was sampled using Hester-Dendy artifcial substrate samplers to substantiate the physical, and chemical data and to provide an aspect that reflects pollution response over time.

Biological metrics were used to analyze the raw macroinvertebrate data. Table 4 provides a simplified interpretation of these metrics and should be referred to in the following discussion.

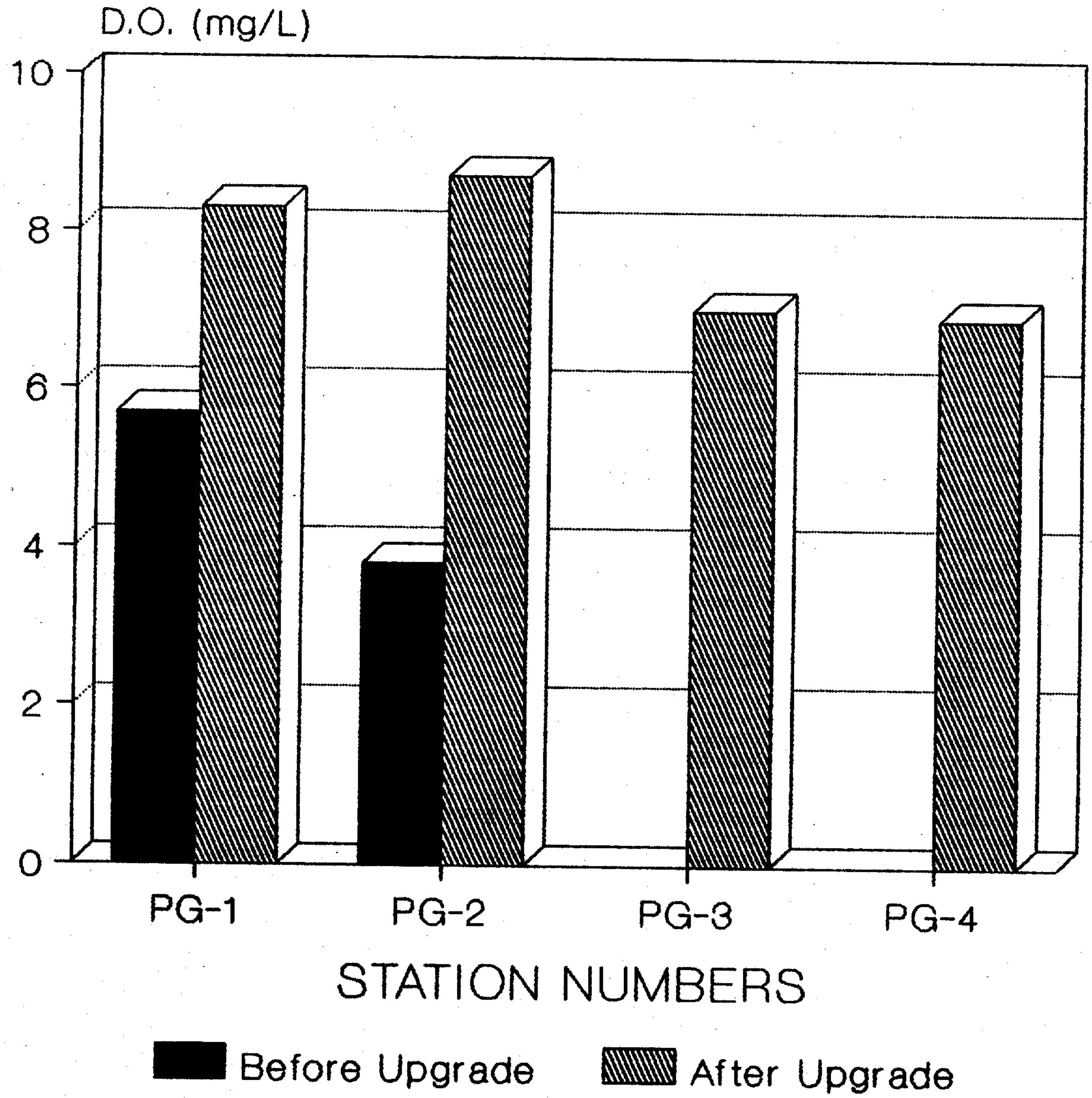
Due to the extremely shallow nature of the tributary to Patsaliga Creek upstream of the WWTP (4 to 6 feet wide by 0.1 to 0.2 feet deep), the biological assessment during the before portion of the WQDS was performed as a field observation. The following taxa were noted at PG-1: numerous Chironomidae (est. tolerance 8), some Trichoptera, one Megaloptera (est. tolerance 6), one Odonata, and numerous <u>Physella</u> (est. tolerance 8). Habitat was provided by fallen limbs and trees with entrapped leaf matter. As noted above, this data indicated that there may be some nutrient enrichment occurring upstream. Data collected upstream, after the upgrade, continued to support this conclusion (Table 3).

Patsaliga Creek below the WWTP discharge (PG-4), showed little, if any, impact as a result of the addition of the effluent. When compared to data collected upstream (PG-3), Taxa Richness, and the generally intolerant EPT (Ephemeroptera, Plecoptera, Trichoptera families) taxa showed a minor decrease indicating a slight decline in water quality (Table 3). The Community Structure remained essentially the same, being dominated by Collector-Gatherers (Figure 6). The Biotic Index (Figure 7), also, remained the same. Species Diversity and Equitability (Figure 8) increased indicating an improvement in water quality. As compared to the upstream station (PG-3), the quantitative index of the relative abundance of taxa and of functional feeding groups (QSI-TAXA, QSI-FFG) present indicated that PG-3 and PG-4 are similar (Table 3). Among the Similarity Indices, the Indicator Assemblage Index, the Community Loss Index, and Sorenson's Community Similarity Index all indicated that communities found upstream and downstream are very similar.

CONCLUSIONS

Physical, chemical, and biological data collected before and after the upgrade of the Patsaliga Creek wastewater treatment plant indicate that, with the removal of the WWTP discharge, the tributary to Patsaliga Creek has experienced an improvement in its' water quality and appears to be meeting its' Fish and Wildlife Water Use Classification. Nutrient enrichment from upstream sources, however, continues to adversely affect the water quality of this stream. Patsaliga Creek water quality downstream of the WWTP discharge compares favorably with upstream water quality. Data indicates that Patsaliga Creek meets the Fish and Wildlife Water Use Classification.

FIGURE 1
TRIBUTARY TO- & PATSALIGA CREEK DISSOLVED OXYGEN DATA

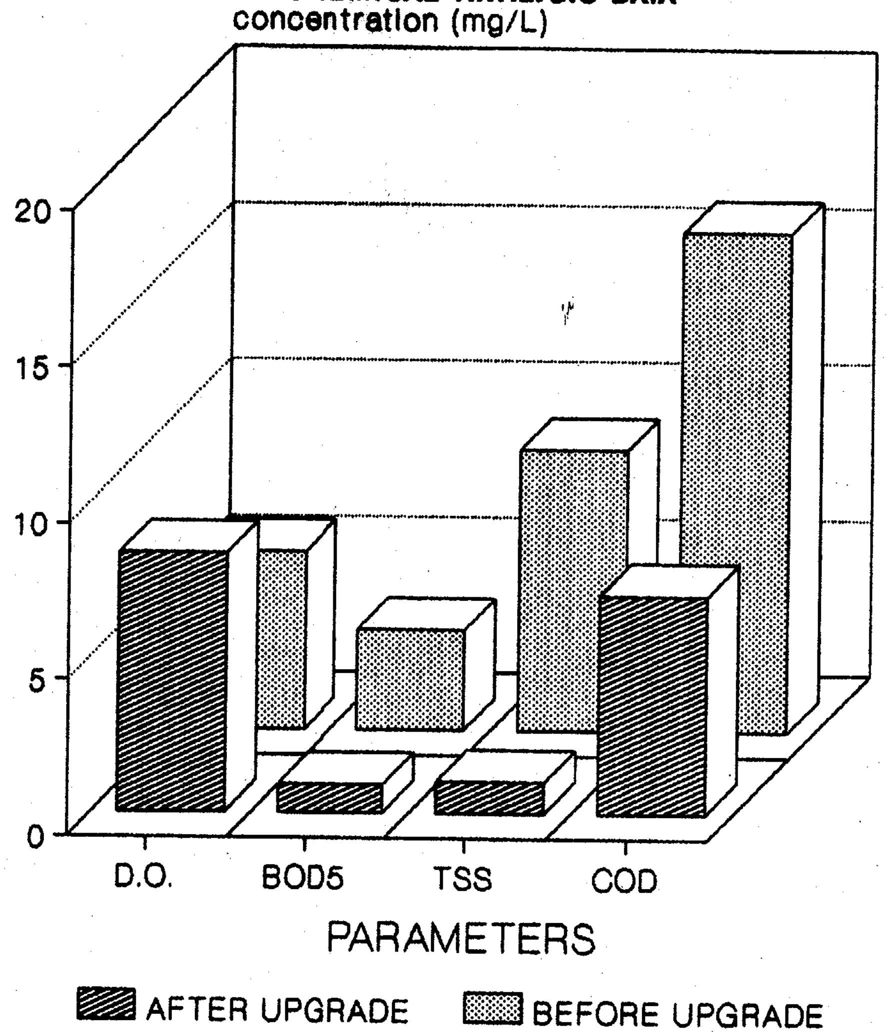


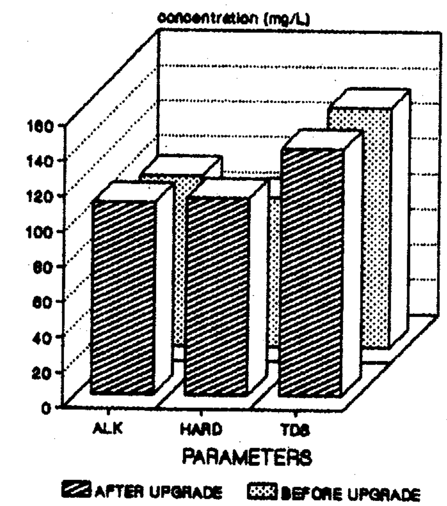
The above numbers are averages
representing multiple sampling events.

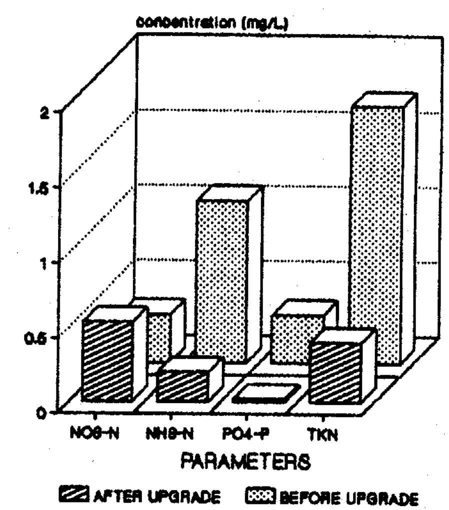
FIGURE 2

TRIBUTARY TO PATSALIGA CREEK (PG-1)

CHEMICAL ANALYSIS DATA

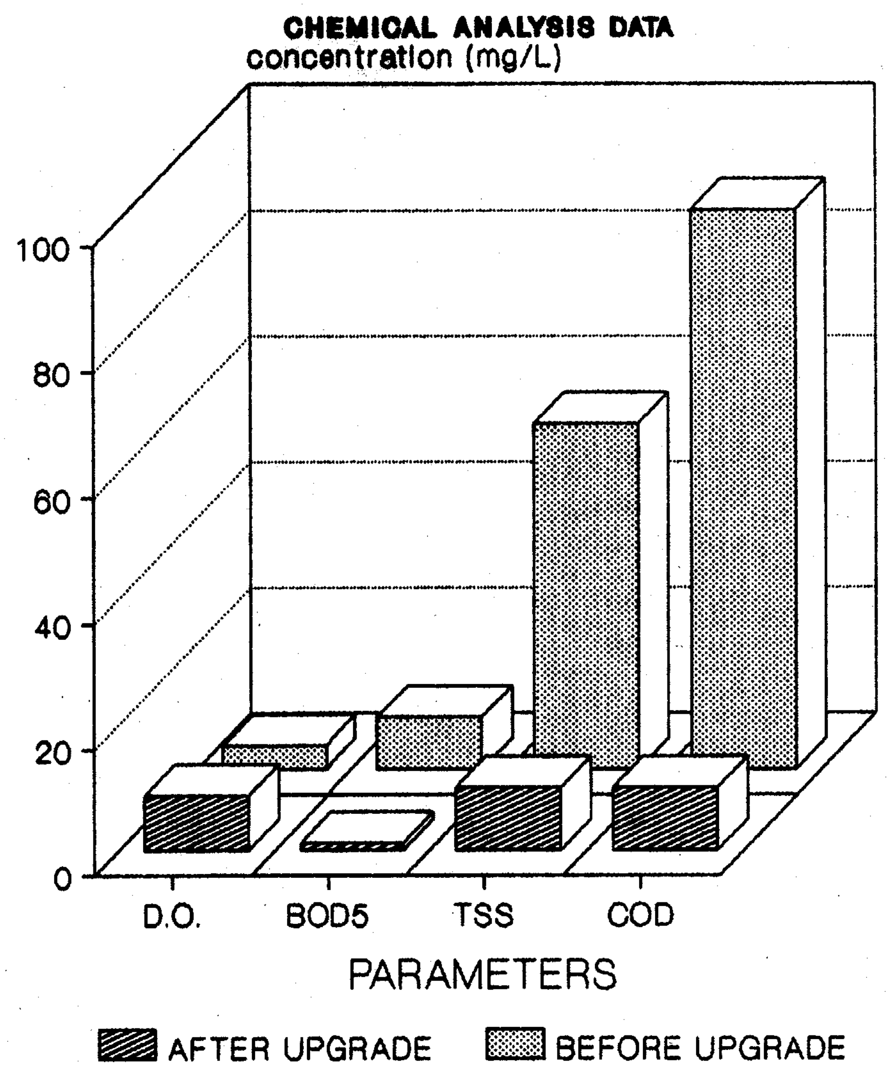


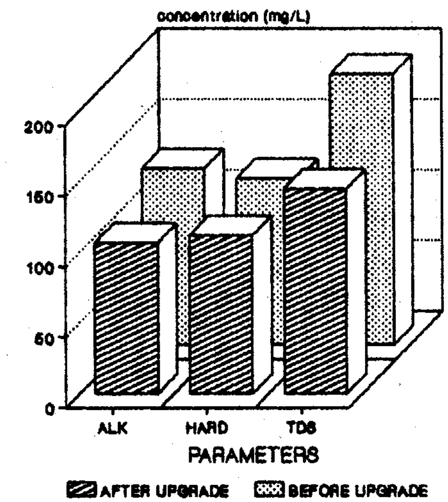


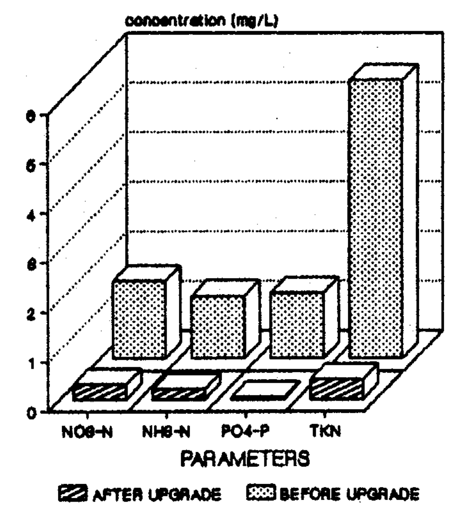


THE ABOVE NUMBERS ARE AVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

FIGURE 3
TRIBUTARY TO PATSALIGA CREEK (PG-2)



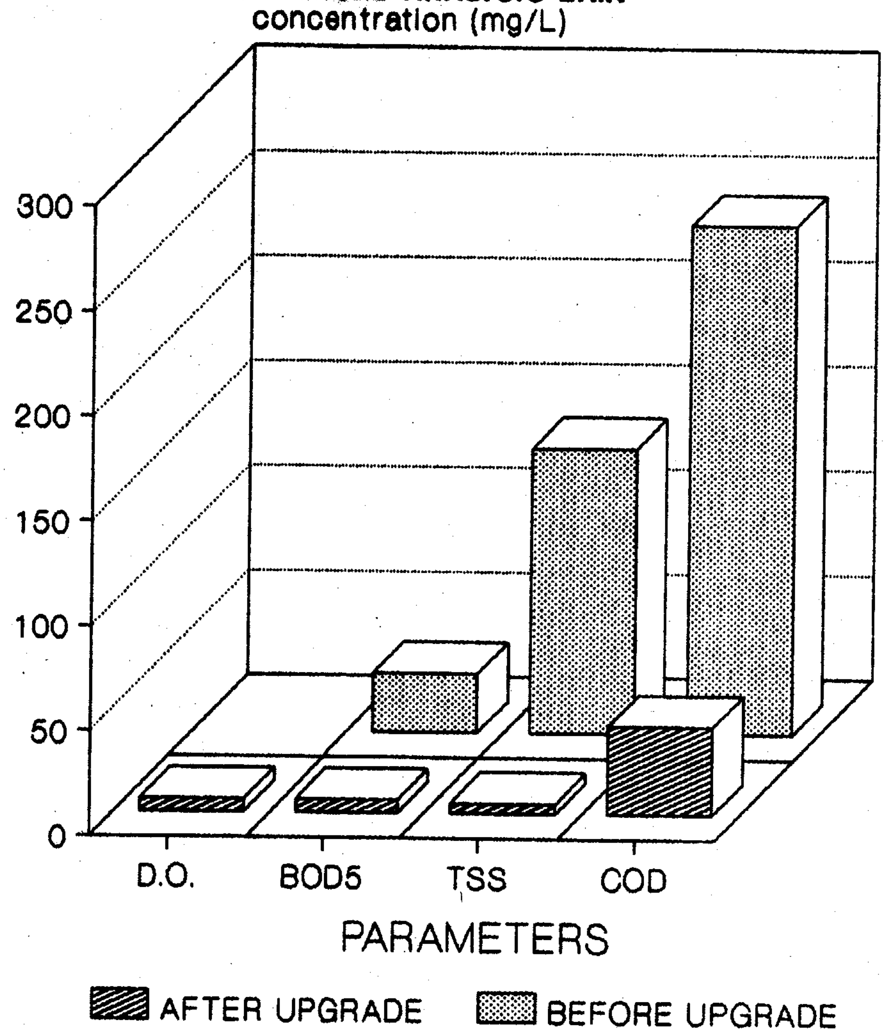


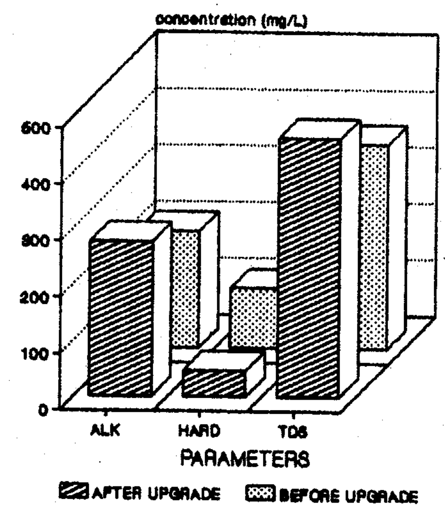


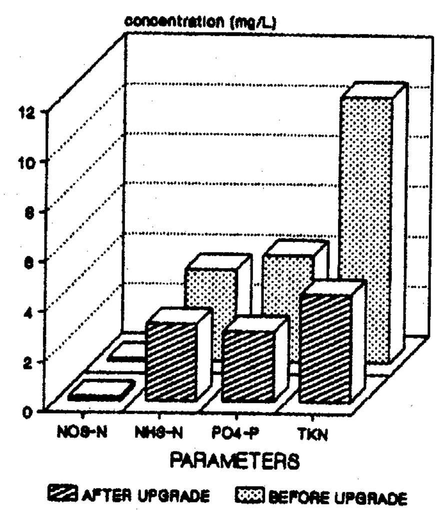
THE ABOVE NUMBERS ARE AVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

FIGURE 4
PATSALIGA CREEK WWTP (EFFLUENT)

CHEMICAL ANALYSIS DATA





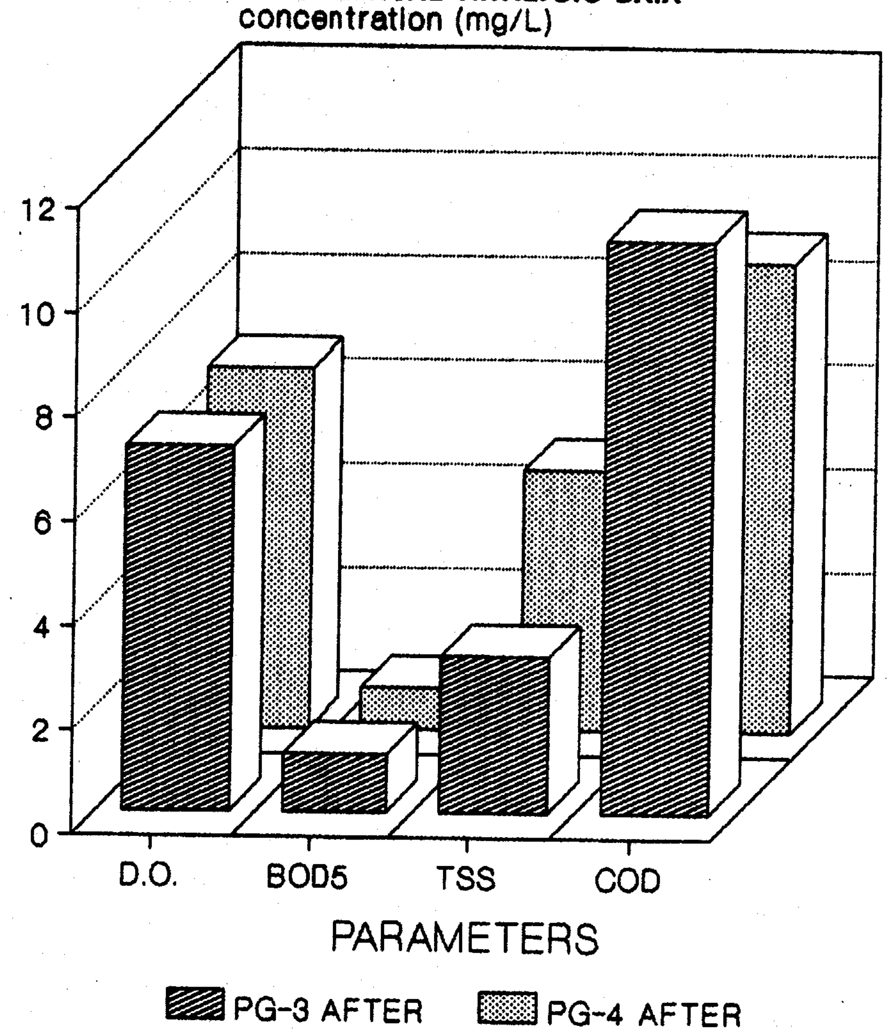


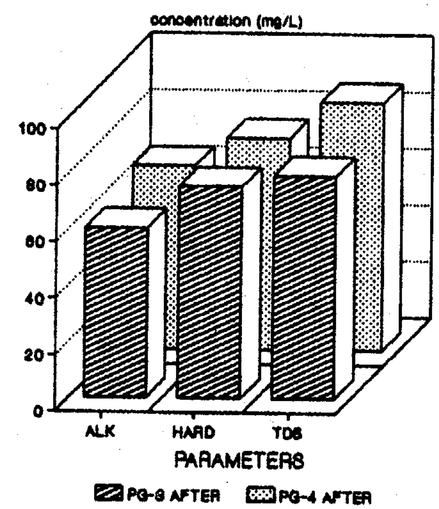
THE ABOVE NUMBERS ARE AVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

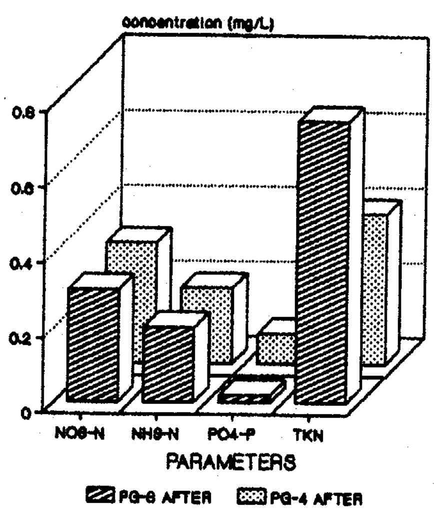
FIGURE 5

PATSALIGA CREEK (PG-3 & PG-4)

CHEMICAL ANALYSIS DATA

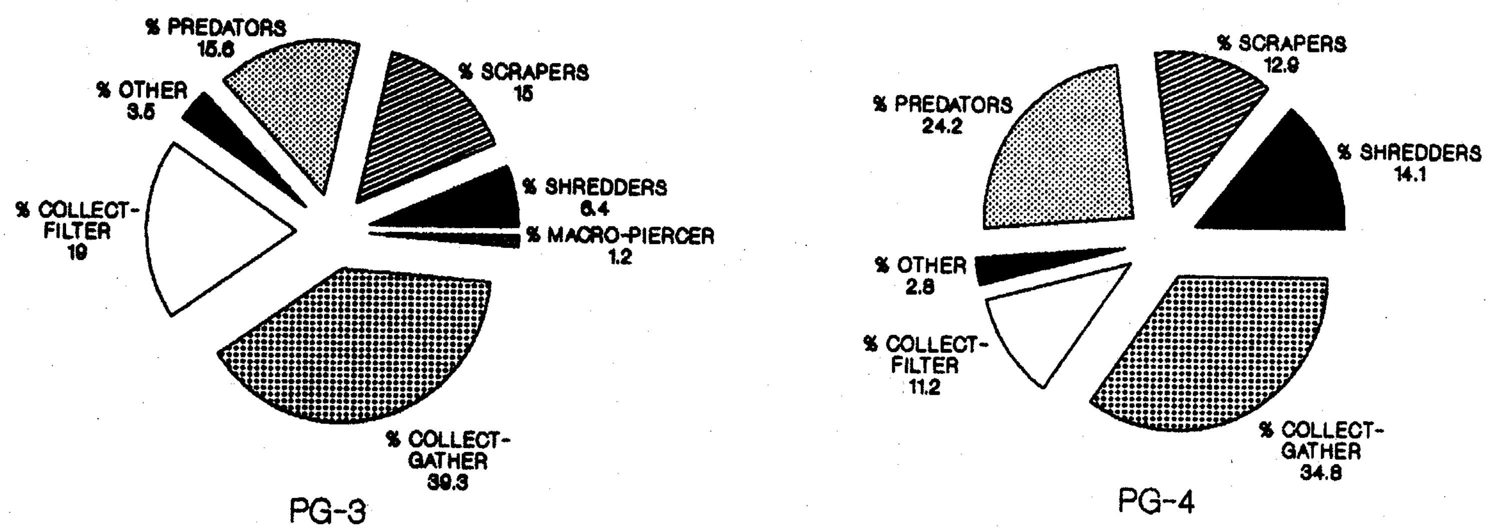






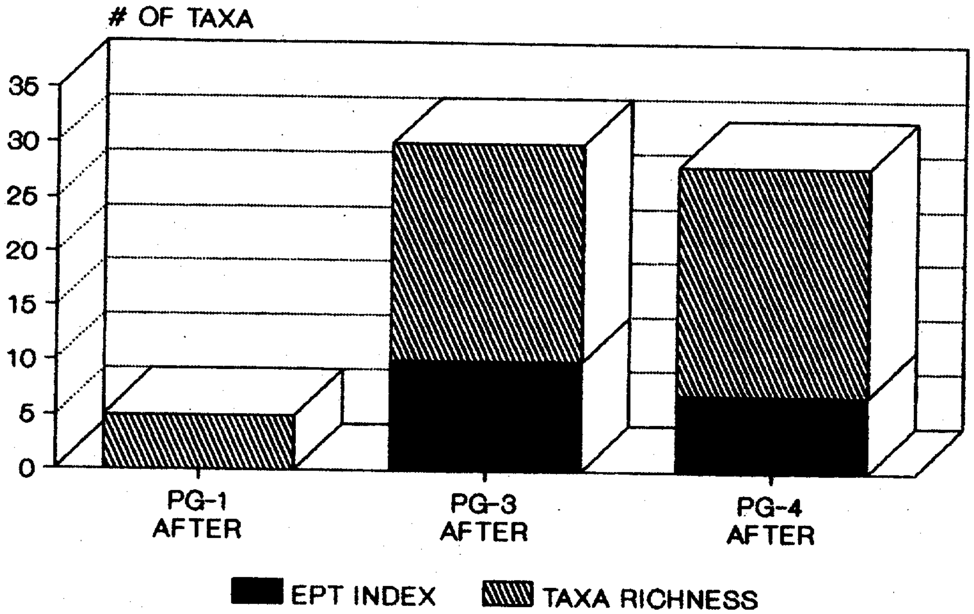
THE ABOVE NUMBERS ARE AVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

FIGURE 6
PATSALIGA CREEK
COMMUNITY STRUCTURE
AFTER UPGRADE OF WWTP



% OTHERS ARE ORGANISMS WHICH HAVE NO FUNCTIONAL FEEDING GROUP DESIGNATION.

FIGURE 7



BIOMETRIC INDICES
TRIBUTARY TO- AND PATSALIGA CREEK

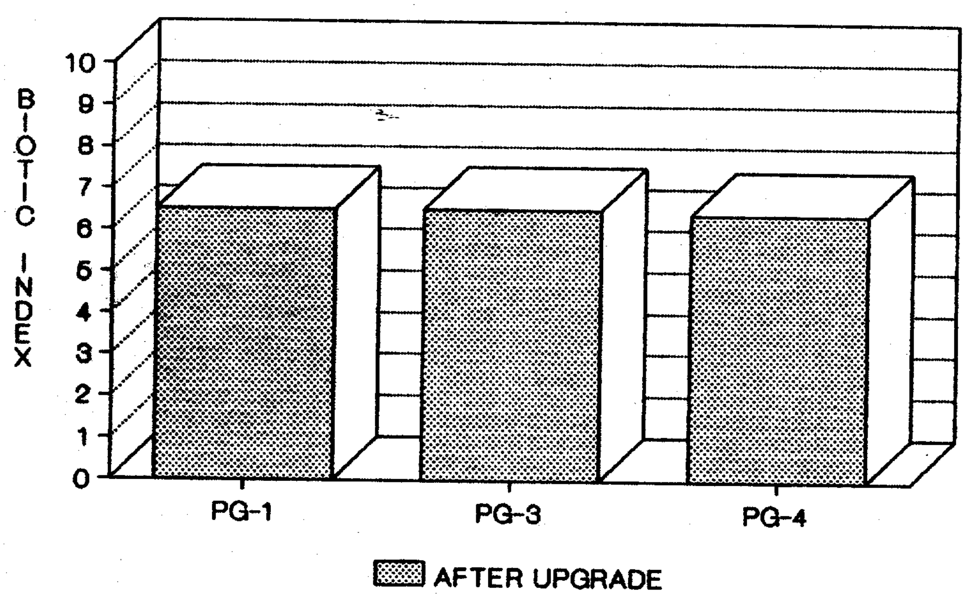


FIGURE 8
TRIBUTARY TO- AND PATSALIGA CREEK

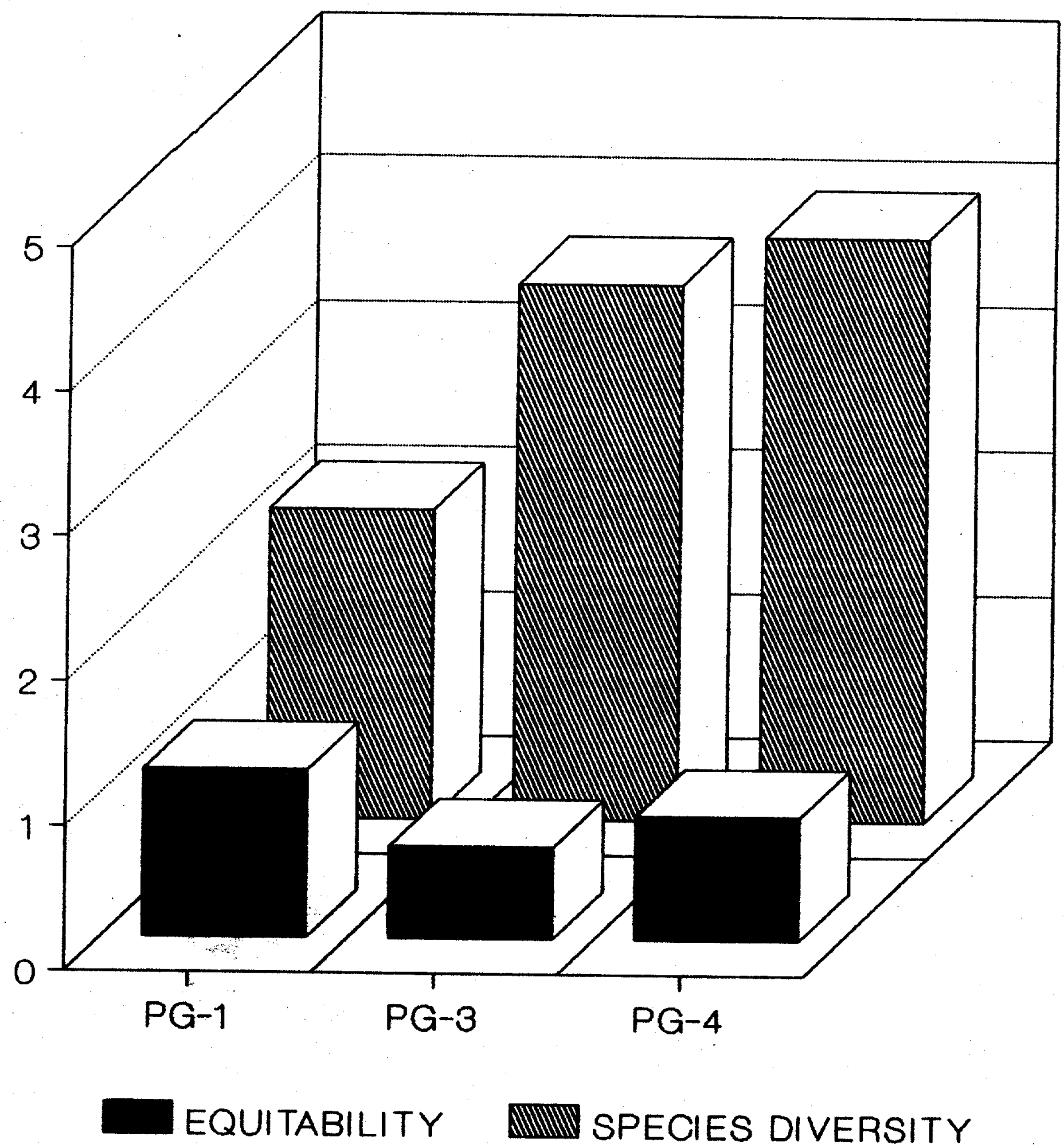


TABLE 1

WATER QUALITY DEMONSTRATION STUDY
TRIBUTARY TO- AND PATSALIGA CREEK AT LUVERNE, ALABAMA
DATA COLLECTED PRIOR TO UPGRADE OF WWTP

DATE	LOCATION	TIME	AIR TEMP	WATER TEMP	D.O.	pH	SPECIFIC COND	TURB	ALK	BOD_5	HARD	TSS	TDS	COD	NO_3-N	NH_3-N	TKN	PHOS TOT	FLOW	BACTERIA
05/26/89	STP	11:50	30	28	---	7.6	505	>100	240	66	250	212	420	340	<0.04	6.8	6.8	4.6	0.54	---
07/15/89	EFF	11:52	26	27	---	8.7	380		140	12.5	33	97	226	200	0.19	<0.2	10.2	2.72		---
09/12/89		11:00	29	30	---	9	800	>100	240	6.1	37	99	443	190	0.1	4.1	14.88	5.48		---
AVERAGE			28.3	28.3	---	8.4	562	---	207	28.2	107	136	363	243	---	---	10.63	4.27	0.54	---
05/26/89	PG-1	12:30	31	24	6.1	7	250	14	102	1.6	98	11	154	15	0.18	1.4	2	0.6	0.74	>600
07/15/89		12:15	24	24	6.2	7.2	200	20	75	3.8	66	10	108	22	0.54	0.36	1.22	0.14	3.34	140
09/12/89		10:00	28	23	4.9	7.5	280	10	113	4.1	90	7	146	10	0.23	1.47	1.91	0.23	0.48	>400
AVERAGE			27.7	23.7	5.7	7.2	243	15	97	3.2	85	9	136	16	0.32	1.08	1.71	0.32	1.52	---
05/26/89	PG-2	11:20	30	24	4.3	7.7	295	46	160	3	250	110	256	190	0.12	3.2	8.8	1.9	1.27	>2833
07/15/89		12:40	24	24	5.2	7.1	80	56	40	0.8	38	27	64	28	1.39	<0.2	0.82	0.14		>600
09/12/89		11:15	30	25	2	7.7	450	38	176	21	67	28	257	49	0.1	3.47	7.23	1.92		>100
AVERAGE			28.0	24.3	3.8	7.5	275	47	125	8.3	118	55	192	89	0.54	---	5.62	1.32	1.27	---
			C	C	mg/L	SU	umho/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfs	org/100ml

TABLE 2

WATER QUALITY DEMONSTRATION STUDY
TRIBUTARY TO- AND PATSALIGA CREEK AT LUVERNE, ALABAMA
DATA COLLECTED AFTER UPGRADE OF WWTP

DATE	LOCATION	TIME	AIR TEMP	WATER TEMP	D.O.	pH	SPECIFIC COND	TURB	ALK	BOD_5	HARD	TSS	TDS	COD	NO_3-N	NH_3-N	TKN	PHOS TOT	FLOW	BACTERIA
08/14/90	STP	11:29	31	26	4.9	7.4	850	10	266	7	45	1	449	46	<0.04	5.2	6.1	2.6	0.35	---
09/25/90	EFF	10:49	19	16	8	7.8	750	4	284	5	47	8	469	38	0.3	1	2.5	3		---
AVERAGE			25.0	21.0	6.5	7.6	800	7	275	6.0	46	5	459	42	---	3.1	4.3	2.8	0.35	---
08/14/90	PG-1	09:40	28	24	7.2	7.8	280	6	104	0.8	109	<1.0	141	4	0.45	<0.2	<0.4	<0.02	0.28	44
09/25/90		11:24	20	16	9.3	7.7	225	3.7	113	0.9	114	1	139	10	0.61	<0.2	<0.4	<0.02		220
AVERAGE			24.0	20.0	8.3	7.8	253	5	109	0.9	112	---	140	7	0.53	---	---	---	0.28	132
08/14/90	PG-2	10:24	30	24	9.3	8.2	280	7	103	1.1	109	<1.0	141	7	0.3	<0.2	<0.4	<0.02	0.28	29
09/25/90		09:52	19	16	8	7.6	250	30	111	1.2	114	19	149	12	0.3	<0.2	<0.4	0.05		198
AVERAGE			24.5	20.0	8.7	7.9	265	19	107	1.2	112	---	145	10	0.30	---	---	---	0.28	114
08/14/90	PG-3	10:37	30	26	6.5	7.5	150	10	55	1.4	72	3	80	10	0.25	<0.2	1.1	<0.02	---	36
09/25/90		10:40	19	18	7.5	7.6	130	5.8	65	0.8	78	2	77	12	0.34	<0.2	<0.4	<0.02	---	70
AVERAGE			24.5	22.0	7.0	7.6	140	8	60	1.1	75	3	79	11	0.30	---	---	---	---	53
08/14/90	PG-4	11:21	31	25	6.5	7.5	160	10	60	0.6	72	4	92	10	0.32	<0.2	<0.4	0.05	---	51
09/25/90		10:19	19	18	7.3	7.6	145	7.3	69	1	77	5	84	7	0.32	<0.2	<0.4	0.1	---	69
AVERAGE			25.0	21.5	6.9	7.6	153	9	65	0.8	75	5	88	9	0.32	---	---	0.08	---	60
			C	C	mg/L	SU	umho/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfs	org/100mL

TABLE 3
MACROINVERTEBRATE
DATA SUMMARY SHEET

Waterbody Name: Tributary to- and Patsaliga Creek Aq. Ecoregion: 65
Location/ City: Luverne County: Crenshaw State: AL
Investigators: Bauer, Cooner Date: 08-14-90, 09-25-90

Habitat Assess.	---	---	---
Station Number	PG-1	PG-3	PG-4
Total No. Org.	11	173	178
Taxa Richness	5	30	28
EPT Index	0	10	7
Biotic Index	6.5	6.5	6.4
% Dom. Taxa	36.4%	26.6%	13.5%
Dominant Taxa	Calopteryx	Dicrotendipes	Polypedilum
Tolerance Value of Dominant Taxa	5	8	6
% Shredders	8.3%	6.4%	14.1%
% Scrapers	0%	15.0%	12.9%
% Predators	66.7%	15.6%	24.2%
% Collect-Gath.	25.0%	39.3%	34.8%
% Collect-Fil.	0%	19.0%	11.2%
% Macro-Piercer	0%	1.2%	0%
% Other	0%	3.5%	2.8%
Scrap/Scrap+C-F	0	0.44	0.54
Shredder/Total	0.09	0.06	0.14
EPT/EPT+Chiro.	0	0.26	0.19
Hydrop/Trichop	0	0.67	0
S.W. Diversity	2.13	3.70	4.03
Equitability	1.16	0.63	0.85

	PG-3 vs PG-4
IAI	0.84
DIC (>5%)	3
QSI-Taxa	65.3%
QSI-FFG	83.8%
Comm. Loss Index	0.43
Jaccard Comm. Sim.	0.45
Sorenson's CSI	0.62

TABLE 4
BIOMETRIC INTERPRETATION

METRIC	RANGE	INTERPRETATION
HABITAT ASSESSMENT	104-135 71-103 35-70 0-34	EXCELLENT GOOD FAIR POOR
a). TAXA RICHNESS b). EPT INDEX c). SHANNON-WEAVER SPECIES DIVERSITY d). EQUITABILITY		GENERALLY INCREASES WITH INCREASING WATER QUALITY.
a). BIOTIC INDEX b). % DOMINANT TAXA c). TOLERANCE VALUE OF DOM TAXA		GENERALLY INCREASES WITH DECREASING WATER QUALITY.
a). % SHREDDERS b). % SCRAPERS c). % PREDATORS d). % COLLECTOR-GATHERERS e). % COLLECTOR-FILTERERS f). % MACROPHYTE PIERCERS g). % OTHERS		PERCENTAGES AND COMPOSITION SHOULD BE SIMILAR TO BACKGROUND STATION FOR SIMILAR STREAM SIZES AND HABITAT COMPOSITION.
a). SCRAPERS/SCRAPERS+C-F b). SHREDDERS/TOTAL c). HYDROPTILIDAE/TRICHOPTERA		NO SIGNIFICANT CHANGE AS COMPARED TO BACKGROUND.
a). EPT/EPT+CHIRONOMIDAE		GENERALLY INCREASING WATER QUALITY AS APPROACHES 1.0.
SIMILARITY INDICES		
a). INDICATOR ASSEMBLAGE INDEX (IAI) b). JACCARD COMMUNITY SIMILARITY c). SORENSON'S CSI		INCREASING SIMILARITY AS APPROACHES 1.0.
a). DOMINANTS IN COMMON b). QUANTITATIVE SIMILARITY INDEX (QSI)-TAXA c). QSI-FUNCTIONAL FEEDING GROUP (FFG)		GENERALLY INCREASING WITH INCREASING SIMILARITY.
a). COMMUNITY LOSS INDEX		GENERALLY INCREASING WITH INCREASING DISSIMILARITY.

TAXA LIST

TRIBUTARY TO- AND PATSALIGA CREEK
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	PG-1 AFTER	PG-3 AFTER	PG-4 AFTER
ANNELIDA			
OLIGOCHAETA		3	3
INSECTA			
COLEOPTERA			
Ancyronyx		1	1
Macronychus		1	1
Stenelmis		1	
DIPTERA			
Bezzia		2	1
Palpomyia			1
CHIRONOMIDAE			
Ablabesmyia		12	13
Cladotanytarsus		2	2
Dicrotendipes		46	14
Labrundinia			2
Nilothauma		2	
Orthocladius		1	2
Phaenopsectra			14
Polypedilum	1	10	24
Procladius		1	2
Rheocricotopus	3		
Stelechomyia		1	
Stempellinella		1	
Stenochironomus		1	13
Tanytarsus		30	17
Thienemannimyia Grp	3		
Tribelos		4	18
CHIRONOMIDAE UNID			1
ORTHOCLADINAE UNID DIF			1
EPHEMEROPTERA			
Brachycercus		1	1
Cloeon		1	2
Hexagenia		3	10
Stenacron		19	8
Stenonema		1	1
Tricorythodes		7	
BAETIDAE UNID DIF		3	
ODONATA			
Argia		7	15
Calopteryx	4		
Chromagrion		4	
Enallagma	1		
Perithemis			1
CORDULIDAE UNID DIF			1
COENAGRIONIDAE UNID			1
TRICHOPTERA			
Cyrnellus			6

TAXA LIST

TRIBUTARY TO- AND PATSALIGA CREEK
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	PG-1 AFTER	PG-3 AFTER	PG-4 AFTER
Hydroptila		1	
Nectopsyche			1
Oxyethira		1	
Polycentropus		1	
MOLLUSCA			
GASTROPODA			
Laevapex		5	
PELECYPODA			
Corbicula			1