WATER QUALITY DEMONSTRATION STUDY

MUD CREEK
HANCEVILLE, ALABAMA
1988 AND 1989

SPECIAL SERVICES SECTION
FIELD OPERATIONS DIVISION
ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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MUD CREEK AT HANCEVILLE, ALABAMA
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INTRODUCTION

The City of Hanceville, Alabama utilizes Mud Creek as a receiving stream for the treated effluent from its municipal wastewater treatment facility. During the period from April 1988 to October 1989, the City of Hanceville constructed a new wastewater treatment plant to replace the old disposal plant. Staff members of the 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 Mud Creek.

EPA CONSTRUCTION GRANTS PROGRAM

Since 1972, approximately $534 million in EPA Grant Funds have been expended for the construction of new, upgraded, and/or expanded wastewater collection and treatment works in Alabama. One recent recipient of grant funding from this program was Hanceville, Alabama, in Cullman county.

The City of Hanceville received an EPA Construction Grant in October 1987 to construct a new wastewater treatment plant (WWTP) to replace a 0.16 million-gallon-per-day (mgd) extended aeration WWTP constructed in 1965. The existing WWTP was overloaded and was not meeting its' NPDES effluent limitations. The new construction consisted of an influent pump station and interceptor main, screening and grit removal, aeration/clarification utilizing the Biolac-R process, post aeration, ultraviolet disinfection, cascade aeration, and other associated appurtenances. The total eligible construction cost of the improvements to the sewer system was approximately $1,215,000. Funding assistance on the project was provided by an EPA Construction Grant in the sum of $765,241. The project engineer was Larry E. Speaks and Associates, Inc. of Montgomery and the treatment plant contractor was B&G Construction Company.

The Hanceville WWTP consists of a 0.57 mgd extended aeration plant to provide the capability of advanced treatment with effluent discharge to Mud Creek, a tributary of Mulberry Fork of the Black Warrior River. Construction of the Hanceville WWTP began on May 16, 1988 and the plant began operation in March 1989. NPDES monthly permit limits for the facility are seasonal and are detailed below:

Parameter	Dec-Apr	May-Nov	
BOD_5	20	12	mg/L
TSS	30	30	mg/L
NH_3-N	6	1	mg/L
D.O.	6	6	mg/L
Fecal Coliform	1000	1000	org./100 mL

According to the self monitoring reports submitted by Hanceville, the average monthly performance of the plant from June 1989 to November 1989 is as follows:

Parameter	Jun-Nov	
Flow	0.481	mgd
BOD_5	8.5	mg/L
TSS	11.3	mg/L
NH_3 -N	0.6	mg/L
D.O.	8.1	mg/L
Fecal Coliform	351	org./100 mL

As can be seen by comparing the performance data with the permit limits, a high degree of treatment is apparently being maintained. An operation and maintenance inspection performed on January 12, 1990 by ADEM confirmed that the facility is being well operated and maintained.

FIELD OPERATIONS

During May to October 1988, staff members of the Field Operations Division collected data to establish conditions and provide a comparative base of information on Mud Creek prior to construction and implementation of the new treatment plant. During May to October 1989, data were collected to demonstrate the improvement, if any, of water quality in the receiving stream attributable to the new plant.

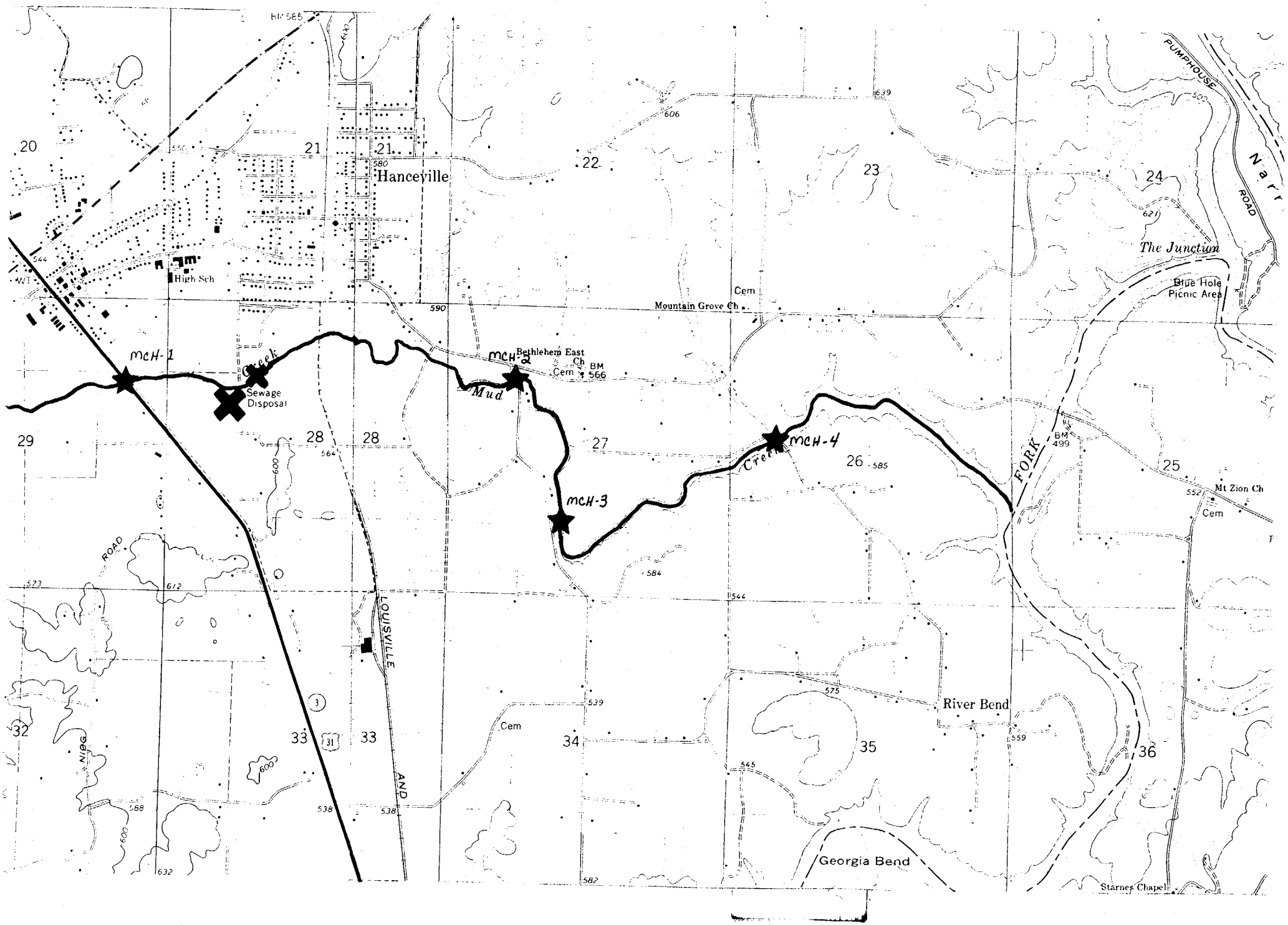
SAMPLING LOCATIONS AND METHODOLOGY

Four sampling locations were selected and utilized for data collection during the water quality demonstration study. The station names and locations were as follows:

STATION	LOCATION:
MCH-1	Mud Creek approximately 1/2 mile upstream of treatment plant at State Highway 31 crossing. T11S,R2W,S29,NE1/4,SE1/4,NW1/4
MCH-2	Mud Creek approximately 1 mile downstream of treatment plant at County Road 42 crossing. T11S,R2W,S28,NE1/4,NW1/4,SW1/4
MCH-3	Mud Creek approximately 1&1/4 miles downstream of treatment plant in back yard of private residence. T11S,R2W,S27,NW1/4, SW1/4,NE1/4
MCH-4	Mud Creek approximately 2&1/4 miles downstream of treatment plant at unnamed road crossing. T11S,R2W,S26,NW1/4,SW1/4, SE1/4

The following parameters were collected at each sampling location:

1). Date
2). Time
3). Air Temperature
4). Water Temperature
5). Conductivity


MCH-1
MCH-2
MCH-3
MCH-4
Sewage Disposal
Mud Creek
Hanceville
High Sch
Mountain Grove Ch
Cem
Bethlehem East Ch
Cem
BM 566
The Junction
Blue Hole Picnic Area
PUMPHOUSE ROAD
Mt Zion Ch
Cem
BM 499
River Bend
Georgia Bend
Starnes Chapel
LOUISVILLE AND NASHVILLE
ROAD
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

6). pH
7). Dissolved Oxygen (D.O.)
8). Biochemical Oxygen Demand (BOD_5)
9). Total Suspended Solids (TSS)
10). Nitrate (NO_3-N)
11). Ammonia (NH_3-N)
12). Total Kjeldahl Nitrogen (TKN)
13). Total Organic Nitrogen (TON)
14). Phosphate (PO_4-P)
15). Stream Flow
16). Fecal Coliform
17). Aquatic Macroinvertebrates

All 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, December 1986), 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 methodology 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.

BIOLOGICAL METHODOLOGY

Aquatic macroinvertebrates, defined as organisms which are retained on a U.S. Standard No. 30 sieve (0.595 mm openings) (Weber, 1973), were collected by a staff biologist utilizing Hester-Dendy multiple plate artificial substrate samplers. A total of three samplers were deployed at each sampling location. Each sampler was placed in such a manner as to be suspended at a depth of 12 to 18 inches in the water column. The samplers were deployed for a period of approximately six weeks. At the end of the sampling period, the samplers were collected in wide-mouth jars, returned to the laboratory, cleaned over a No. 30 sieve, and the materials retained on the sieve preserved in 90% ethanol. The macroinvertebrate organisms were then sorted and identified to the lowest possible taxonomic level. The purpose of this sampling method is to provide a quantitative representation of the aquatic macroinvertebrate community at each station.

The macroinvertebrate data were analyzed using the following methods:

1). Relative Abundance- total number of organisms and total number of taxa were enumerated and compared station to station.
2). EPT Index- total number of distinct taxa within the orders Ephemeroptera, Plecoptera, and Trichoptera. This number, generally, increases with increasing water quality and summarizes taxa richness within the insect orders which are considered to be pollution sensitive (Plafkin, 1989).
3). Percent Contribution of Dominant Taxa- an indication of community balance at the lowest positive taxonomic level. A community dominated by relatively few taxa would indicate

environmental stress (Plafkin, 1989).
Percent= # of Most Abundant Taxa/ Total # of Organisms
As environmental stress increases, percentage increases.

4). Sorenson's Community Similarity as modified by Mathews (1978)- measures the degree of similarity in taxonomic composition between two stations in terms of presence or absence. Station of interest is compared to a reference station.
SCS= 2c/a+b
c= # of taxa common to both samples
a= total # of taxa at station 1.
b= total # of taxa at station 2.
Values range between 0 and 1. As value approaches 1.0, samples are considered more similar.

5). Dominants in Common- provides a measure of replacement or substitution, between the reference community and the downstream station, utilizing the dominant five taxa. Four or more dominant taxa in common indicates no impairment (Plafkin, 1989).

6). Indicator Assemblage Index- integrates the relative abundances of the EPT taxanomic groups and the relative abundances of chironomids and annelids (CA) upstream and downstream to evaluate impairment (Plafkin, 1989).
IAI=0.5* [(%EPT @ test station / %EPT @ control station)
+(%CA @ control station / %CA @ test station)]
As IAI approaches 1.0, value indicates good community balance.

7). Shannon-Weaver Species Diversity Index ($\bar{d}$)- a general representation of taxa richness and water quality. Values between 3 and 4 generally indicates unimpaired waters, whereas, in impacted waters, values are less than 1 (Weber, 1973).

$\bar{d} = [(C/N)* ((N \log_{10} N)-(n_i \log_{10} n_i))]$
C= 3.32928 (a constant)
N= total # of individuals
n_i= total # of individuals in the i^{th} species

8). Equitability (e)= s'/s -compares the number of taxa in a sample (s) with the number of taxa expected (s') from a community that conforms to the MacArthur's Broken Stick Model. Equitability has been found to be very sensitive to even slight levels of degradation due to oxygen demanding wastes. Generally, values greater than 0.5 indicate little stress, whereas, values less than 0.5 indicate that the communities are impacted (Weber, 1973).

9). Indicator organism analysis, using the Hilsenhoff Biotic Index (Plafkin,1989), and Weber's Tolerance Classification system (Weber,1973), was used to evaluate the composition and environmental requirements of the taxa. The Hilsenhoff Biotic Index is a whole number tolerance value ranging from 0 (least tolerant) to 10 (most tolerant). Weber's Tolerance Classification system rates an organism as T (tolerant, F (facultative), I (intolerant) or combinations of these based on the number of literary descriptions of the referenced organism.

DISCUSSION AND RESULTS

A. PHYSICAL

Mud Creek is a second order stream that is approximately five miles in length. It is a typical pool-riffle stream with varying bottom structure. At all stations, the bottom consists of primarily small rock, gravel, with occasional exposed bedrock. Under low flow conditions, the average flow is usually less than one cubic foot per second (Table 1, Figure 1). Portions along the length of this stream have been channelized to facilitate flow. Along these lengths, there is little riparian vegetation and very little habitat suitable for macroinvertebrate colonization. This is most notable at reference station MCH-1. Stations MCH-2, 3, and, 4 exhibit many varieties of habitat plus riparian vegetation. There has typically been beaver activity along the entire length of the stream. This could account for the predominance of pools in the stream and for the accumulation and retention of large quantities of organic silt. The Mulberry Fork of the Black Warrior River receives the flow from Mud Creek.

B. CHEMICAL

The Water Use Classification for Mud Creek is Fish and Wildlife (F&W) which 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 seen in Table 1 and Figure 2, data collected prior to the construction of the new treatment plant indicated that the waters below the discharge point were consistently in violation of the dissolved oxygen standard for the F&W classification (5.0 mg/L). The dissolved oxygen values at station MCH-2 ranged, during the summer of 1988, from a low of 0.0 mg/L to a high of 3.3 mg/L. Morning D.O.'s averaged 0.3 mg/L, while afternoon D.O.'s averaged 1.7 mg/L. At station MCH-3, the dissolved oxygen values ranged from a low of 0.0 mg/L to a high of 1.3 mg/L. Morning D.O.'s averaged 0.2 mg/L, while afternoon D.O.'s averaged 0.6 mg/L. At station MCH-4, the dissolved oxygen values ranged from a low of 0.6 mg/L to a high of 7.0 mg/L. Morning D.O's averaged 1.7 mg/L, while afternoon values averaged 5.0 mg/L. Although the dissolved oxygen values at MCH-1 are low, with morning D.O.'s averaging 3.4 mg/L and afternoon D.O.'s averaging 4.3 mg/L, an oxygen sag can still be observed in the D.O. values at stations MCH-2 and 3. Mud Creek shows a slight recovery by the time the water reaches station MCH-4. However, D.O.'s still do not exceed 5.0 mg/L.

As seen in Table 2 and Figure 2, data collected after the construction of the new treatment plant show a marked improvement. The dissolved oxygen values were frequently above the 5.0 mg/L F&W standard during the summer of 1989. Station MCH-2 had morning D.O. values averaging 5.0 mg/L and afternoon values averaging 5.8 mg/L. D.O. values at MCH-3 had morning values averaging 4.3 mg/L and afternoon values averaging 5.1 mg/L. Station MCH-4 had morning D.O. values averaging 6.8 mg/L and afternoon values averaging 7.7 mg/L.

In addition to improved dissolved oxygen content, other improve-

ments were evident. At all downstream stations, biochemical oxygen demand was significantly reduced, as was the amount of suspended solids below the discharge point. Ammonia, nitrates, and phosphates also experienced a dramatic decrease. The pH values , generally, remained in the 7.1 standard unit to 7.3 standard unit range. Conductance, however, showed a marked improvement. It should be noted, as seen in Figure 1, that, due to high precipitation events, stream flows during the 'after' portion of this study were increased. This makes a determination of improved stream conditions difficult due to the potential for greater dilution than what would normally be expected during low flow conditions.

C. BIOLOGICAL

Station MCH-1, upstream of the WWTP effluent, was sampled for aquatic macroinvertebrates before and after upgrade to use as a reference database (Table 3, Figure 4). The before sampling in 1988 revealed an aquatic community that, while not dominated by pollution sensitive organisms, were relatively well-balanced but showed an indication of impairment of the aquatic macroinvertebrate community. Species diversity and equitability values indicated a stressed aquatic community; however, this is probably attributable to low flow conditions during 1988, and a lack of adequate habitat due to stream channelization. Over 430 organisms were collected representing 26 taxa. Of the 26 taxa present, thirteen were classified as tolerant organisms, ten were moderately tolerant, two were intolerant, and two were undetermined. The EPT Index, while depressed at a value of 3, indicated the presence of pollution sensitive macroinvertebrates. However, all the EPT Index organisms are classified as tolerant to moderately tolerant with respect to organic pollution. The dominant taxa, Oligochaeta, while also being a generally pollution tolerant group, made up 38% of the total population. The number of organisms per square meter was calculated as 1093.

Similar conditions were found during 1989 macroinvertebrate sampling (Table 3, Figure 4). A total of 248 organisms were collected representing 27 taxa. Of the 27 taxa present, eighteen were classified as tolerant organisms, eight were moderately tolerant, one was intolerant, and one was undetermined. The EPT Index again showed a value of 3, indicating the presence of pollution sensitive organisms. All of the EPT Index organisms were, once again, classified as tolerant to moderately tolerant. The dominant taxa, again Oligochaeta, made up 27% of the total population. Species diversity and equitability values were improved, and, if considered alone, would be indicative of a healthy aquatic macroinvertebrate community. The number of organisms per square meter was calculated as being 827.

At station MCH-2, immediately downstream of the WWTP, the 1988 macroinvertebrate data documented severe impact to the aquatic community (Table 3, Figure 5). A total of 142 organisms were collected representing 7 taxa. Of the 7 taxa present, six were classified as tolerant organisms,and one was classified as moderately tolerant. Members of Diptera made up 92% of the total collection with Chironomous, typically pollution tolerant with a Hilsenhoff Biotic Index of 10, comprising 65% of the population. The EPT Index was 0 indicating an absence of pollution sensitive

organisms. Species diversity values indicated a stressed aquatic community. As compared to MCH-1, Sorenson's Community Similarity indicated that the two stations were very dissimilar. Only one dominant organism was common to both stations, Oligochaeta. The Indicator Assemblage Index value indicated the aquatic community at MCH-2 was very poorly balanced. Snails collected at MCH-1, and which are considered tolerant to organic pollution as a group, were notably missing at MCH-2. The number of organisms per square meter was calculated as 473.

In 1989, after upgrade, data indicated that, although there was some impairment, MCH-2 had undergone an improvement (Table 3, Figure 5). A total of 308 organisms were collected representing 21 taxa. Of the taxa present, thirteen were classified as tolerant organisms, eight were moderately tolerant, one was intolerant, and 2 were undetermined. Members of Ephemeroptera, a pollution sensitive group, made up 58% of the total population with Stenacron, a moderately intolerant organism with a Biotic Index of 4, comprising 53% of the collection. The EPT Index value was 3 indicating an increase in pollution sensitive organisms. However, all the EPT Index organisms were classified as moderately tolerant. Species Diversity and equitability values, while still showing a slight impairment, also indicates an improvement over 1988's data. As compared to MCH-1, Sorenson's Community Similarity indicated that the two stations were much more similar than in 1988. There were two dominant organisms common to both stations, Oligochaeta and Stenacron. The Indicator Assemblage Index indicated that MCH-2 was overbalanced in favor of the Ephemeroptera, Plecoptera, Trichoptera groups. The number of organisms per square meter was calculated as 1027.

Conditions further downstream at MCH-3 in 1988 also documented an adverse impact on the aquatic community (Table 3, Figure 6). A total of 15 organisms representing 7 taxa were collected. Of the taxa present, five were classified as tolerant organisms, and two were moderately tolerant. Members of the groups Oligochaeta and Diptera made up 86% of the population with the dominant taxa, Oligochaeta, comprising 33% of the collection. The EPT Index value was 1 indicating the presence of a moderately tolerant organism, Cloeon. The number of organisms per square meter was calculated as 50. Species diversity and equitability values increased from MCH-2 to MCH-3, but still indicated a moderate impact to the aquatic community. However, due to there being less than one hundred organisms collected, these values may be falsely representing the true condition of the stream. As compared to MCH-1, Sorenson's Community Similarity indicated that the two stations were very dissimilar. There was only one dominant organism common to both stations, Oligochaeta. The Indicator Assemblage Index value indicated that, as compared to MCH-1, MCH-3 possessed a very poorly balanced macroinvertebrate community.

The 1989 macroinvertebrate data documented that MCH-3 made an improvement (Table 3, Figure 6). A total of 122 organisms representing 22 taxa were found to be present during sampling. Of the taxa present, thirteen were classified as tolerant organisms, seven were moderately tolerant, two were intolerant, and one was undetermined. Members of the group Diptera comprised 36% of the collection with a pollution tolerant snail, Helisoma, being the dominant organism. The EPT Index value of 2 indicated an

improvement over 1988 in the number of pollution sensitive organisms present. Both EPT Index organisms were classified as moderately tolerant, however. There were approximately 610 organisms per square meter. Species diversity and equitability values indicated an improved aquatic community. As compared to MCH-1, Sorenson's Community Similarity indicated that MCH-3 was much more similar. Three dominant organisms were found to be common to both stations, Oligochaeta, Stenacron, and Chironomus. The Indicator Assemblage Index showed that MCH-3 was overbalanced in favor of the EPT group.

MCH-4, the station furthest downstream from the WWTP, was showing some recovery, according to the 1988 data (Table 3, Figure 7). A total of 313 organisms were collected representing 15 taxa. Of the taxa present, seven were classified as tolerant organisms, six were moderately tolerant, two were intolerant, and one was undetermined. The EPT Index was 3 with Caenis, a pollution tolerant Ephemeropteran, comprising 74% of the sample. The Ephemeroptera group comprised 81% of the sampled population. There were approximately 1043 organisms per square meter. Species diversity and equitability values indicated moderate impact on the aquatic community. When compared to MCH-1, Sorenson's Community Similarity suggested that, even two miles downstream of the effluent, MCH-4 was still very dissimilar. There were three dominant organisms common to both stations, Oligochaeta, Caenis, Physella, typically tolerant organisms. The Indicator Assemblage Index indicated that MCH-4 was overbalanced in favor of the EPT groups.

Data collected at MCH-4 after the upgrade again documented some improvement in community conditions (Table 3, Figure 7). A total of 245 organisms representing 23 taxa were collected in 1989. Of the taxa present, thirteen were classified as tolerant organisms, nine were moderately tolerant, one was intolerant, and one was undetermined. There were approximately 817 organisms per square meter. The EPT Index value was 5, showing an increase in pollution sensitive organisms since 1988. All of the EPT Index organisms were classified as tolerant to moderately tolerant. Members of the group Diptera comprised 68% of the sample, with Endochironomus/Tribelos being the dominant taxa comprising 18% of the collection. Species diversity and equitability values indicated no adverse impact to the macroinvertebrates. When compared to MCH-1, Sorenson's Community Similarity shows that MCH-4 has improved by being more similar. There was only one dominant organism in common to both stations, Stenacron. The Indicator Assemblage Index indicates that MCH-4 is very well balanced, as compared to MCH-1.

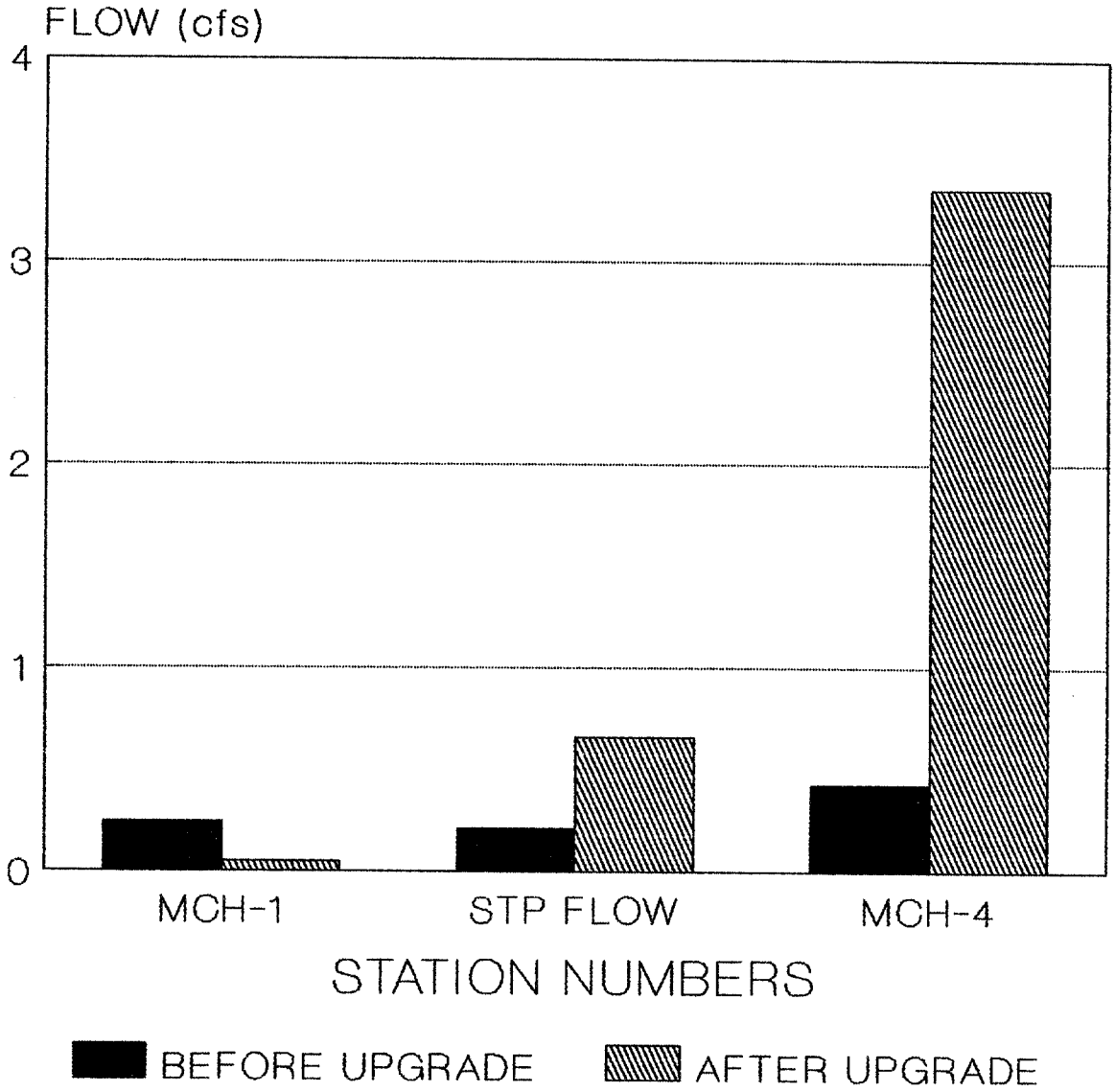
The aquatic macroinvertebrate data collected from Mud Creek during 1988 and 1989 clearly demonstrate the adverse impacts of the Hanceville WWTP before upgrade. Mud Creek was in very poor condition with recovery beginning to be noticeable two and one-quarter miles downstream. The 1989 data documents improvement at all downstream locations.

CONCLUSIONS

Physical, chemical, and biological data collected before and after the construction of the new Hanceville wastewater treatment plant indicate that Mud Creek has experienced an improvement in overall water quality. Mud Creek appears to be meeting its Water Use Classification of Fish and Wildlife. Stream channelization has

contributed to the degradation of the aquatic macroinvertebrate community due to the unavailability of some types of aquatic and streamside habitat and the physical alteration of the stream channel to an unnatural condition.

FIGURE 1
MUD CREEK-HANCEVILLE
STREAM FLOW DATA

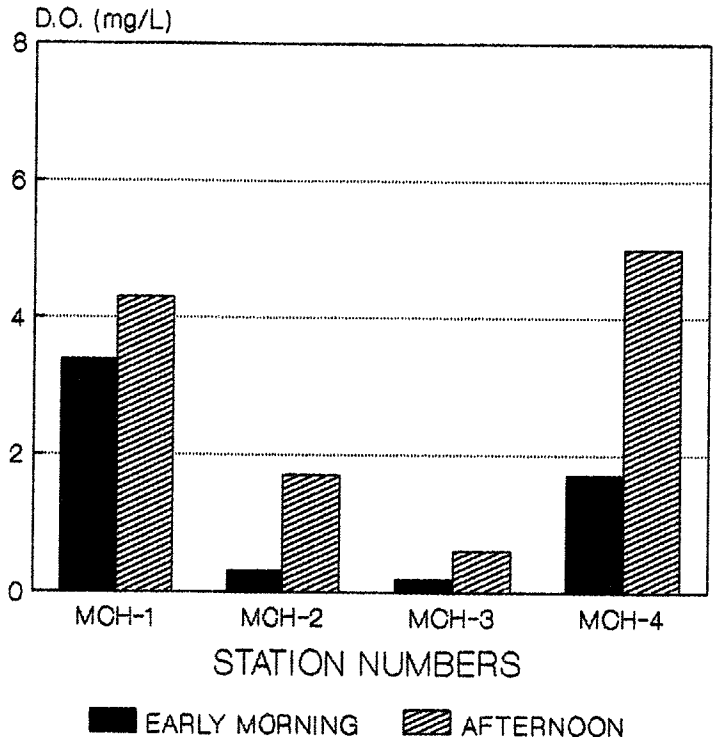


THE ABOVE NUMBERS AREAVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

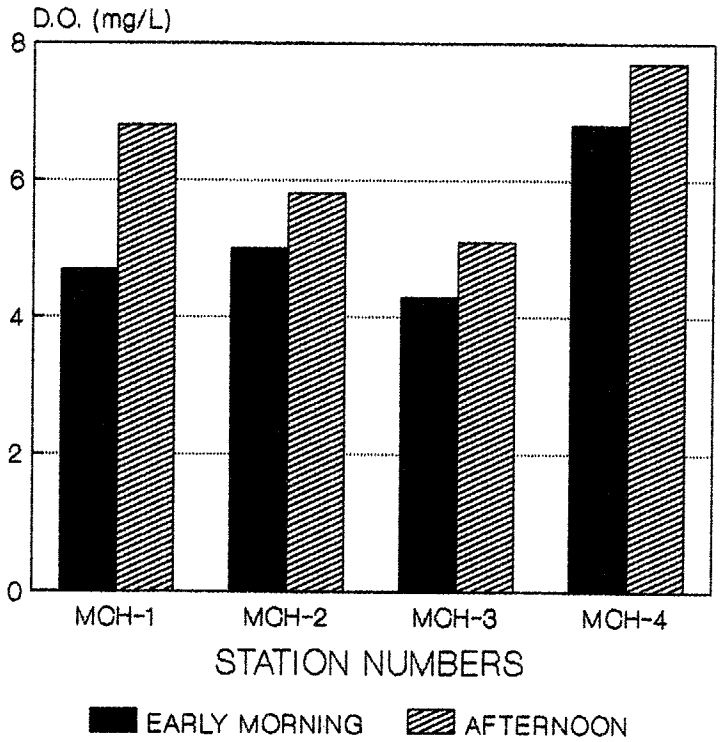
FIGURE 2

MUD CREEK-HANCEVILLE
DISSOLVED OXYGEN DATA

BEFORE STP UPGRADE



AFTER STP UPGRADE



THE ABOVE NUMBERS ARE AVERAGES REPRESENTING MULTIPLE SAMPLING EVENTS.

TABLE 1

WATER QUALITY DEMONSTRATION STUDY
MUD CREEK AT HANCEVILLE, ALABAMA
DATA COLLECTED PRIOR TO UPGRADE OF WWTP

DATE	LOCATION	TIME	AIR TEMP	WATER TEMP	D. O. a.m.	D. O. p.m.	pH	SPEC COND	BOD 5	TSS	NO -N 2	NO -N 3	NH -N 3	TKN	TON	PO -P 4	FLOW	BACT
05/27/88	MCH-1	07:30	11.7	17.8	6		7.6	160	2.2	7	-----	0.08	<0.1	1.3	1.3	0.11	*	
06/28/88		10:20	33	24		1.1	7.2	340	3	7	-----	<0.04	0.2	2	1.8	0.05	<0.1	
06/29/88		06:20	20	25	2.4		7.2	410	2.6	7	-----	0.04	0.2	2.5	2.3	0.04	<0.1	620
07/26/88		10:20	32	26		0.9	7.2	180	1.6	35	-----	<0.02	0.2	0.9	0.7	0.03	<0.1	
07/27/88		09:15	27	25	1.6		7.2	180	2.6	26	0.05	0.04	0.2	1.2	1	0.8	<0.1	23
09/07/88		10:55	23	20		3.8	7.4	210	1	5	-----	0.04	<0.2	1.4	1.4	0.25	<0.1	
09/08/88		09:25	21	19	3.4		7.5	210	1	<1	<0.02	0.07	<0.2	1	1	0.14	<0.1	48
10/19/88		10:45	15.6	16.7		7.3	7.2	130	5.8	7	-----	0.09	<0.2	0.4	0.4	0.46	1.1	
10/20/88		10:45	16.1	14.4		8.2	7.3	150	1.5	22	<0.02	0.08	<0.2	0.5	0.5	0.13		77
AVERAGE			22.2	20.9	3.4	4.3	7.3	219	2.4	--	----	----	----	1.2	1.2	0.22	----	192
05/27/88	MCH-2	07:50	11.7	16.7	0.01		7.1	200	11.8	11	-----	0.08	3.4	9.1	5.7	1.27	*	
06/28/88		10:40	29	23		3.3	7.6	700	30.0	56	-----	<0.04	12.7	19.8	7.1	7	<0.1	
06/29/88		06:45	20	22	0		7.7	600	20.0	27	-----	0.06	12.2	16.2	4	5.9		333
07/26/88		11:05	27	25		3.1	7.1	390	>13.6	41	0.07	0.05	3.5	7.2	3.7	2.5	0.19	
07/27/88		08:35	25	24	0.8		7.1	370	15.6	37	0.04	0.02	3.9	6	2.1	1.6		>600
09/07/88		11:05	23	19		2	7	285	10.0	22	-----	<0.04	4.5	5.4	0.9	2.6	0.32	
09/08/88		09:05	18.5	19	0.3		7.4	310	12.0	20	<0.02	<0.04	5.5	8	2.5	3.5		>600
10/19/88		11:00	17.2	17.2		0	7.3	250	20	21	-----	<0.04	5	5.2	0.2	3.4	0.22	
10/20/88		10:20	15.6	14.4		0	7.1	240	25.2	26	<0.02	0.15	5.6	7.2	1.6	0.34		>600
AVERAGE			20.8	20.0	0.3	1.7	7.3	372	----	29	----	----	6.3	9.3	3.1	3.12	----	----
05/27/88	MCH-3	08:05	12.8	15	0.01		7	240	20	23	-----	0.06	4.5	8.9	4.4	2.15	*	
06/28/88		10:50	29	23		0	7.1	700	24	72	-----	<0.04	11.2	18.1	6.9	6.8	<0.1	
06/29/88		06:55	21	21	0		7.4	550	18	32	-----	<0.04	11.1	13.2	2.1	5.3	<0.1	540
07/26/88		11:35	27	24		1.1	6.9	275	13.2	26	0.12	0.22	1.7	4.3	2.6	0.96	<0.1	
07/27/88		08:45	25	24	0.7		6.9	280	13.2	51	0.32	0.33	2	4.4	2.4	1.14	<0.1	410
09/07/88		11:15	22	19		0	7.1	345	23	41	-----	<0.04	7.8	11.2	3.4	5.75	<0.1	
09/08/88		08:50	19	18	0		7.3	310	18	23	<0.02	<0.04	6.1	8.1	2	4.3	<0.1	>600
10/19/88		11:05	16.7	16.1		1.3	7.3	215	10	17	-----	0.12	3.9	4.91	1	1.56		
10/20/88		10:25	15.6	20		0.5	7.1	230	16	22	<0.02	0.24	4.5	6	1.5	1.92		>600
AVERAGE			20.9	20.0	0.2	0.6	7.1	349	17.3	34	----	----	5.9	8.8	2.9	3.32	----	----
			C	C	mg/L	mg/L	SU	umho	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfs	org/ 100 mL

TABLE 1

WATER QUALITY DEMONSTRATION STUDY
MUD CREEK AT HANCEVILLE, ALABAMA
DATA COLLECTED PRIOR TO UPGRADE OF WWTP

DATE	LOCATION	TIME	AIR TEMP	WATER TEMP	D. O. a.m.	D. O. p.m.	pH	SPEC COND	BOD 5	TSS	NO -N 2	NO -N 3	NH -N 3	TKN	TON	PO -P 4	FLOW	BACT
05/27/88	MCH-4	08:25	15.6	15	2.2		7	300	3.6	1	-----	0.52	4.5	8.8	4.3	2.02	0.50	
06/28/88		11:10	30	23		3.8	7.2	400	2.6	24	-----	0.61	1.7	4.1	2.4	0.8	<0.1	
06/29/88		07:05	21	22	0.6		7.5	370	11.2	125	-----	0.72	1.6	4.3	2.7	0.81	<0.1	33
07/26/88		11:55	27.5	25		4.5	6.9	260	>14.6	73	0.19	0.56	3.4	4.6	1.2	1.83	1.11	
07/27/88		08:55	25	23	2.6		7.3	250	10.4	114	0.19	0.42	3.1	10.3	7.2	2	<0.1	273
09/07/88		11:30	25	19		3.7	7.4	460	7.8	22	-----	0.14	11.9	14.8	2.9	5.4	<0.1	
09/08/88		08:30	18	18	1.3		7.1	455	5.2	47	0.02	0.07	10.7	13	2.3	4.85	<0.1	90
10/19/88		11:20	18.3	16.1		7	7.4	175	5	4	-----	2.14	0.8	1	0.2	0.74	1.3	
10/20/88		10:05	15.6	13.3		5.8	7	175	5.2	6	0.24	3.29	1.3	2.3	1	0.86		>700
AVERAGE			21.8	19.4	1.7	5.0	7.2	316	----	46	0.13	0.94	4.3	7.0	2.7	2.15	----	----
			C	C	mg/L	mg/L	SU	umho	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfs	org/ 100 mL

* - No flow attempted due to upstream obstruction of stream.

TABLE 2

WATER QUALITY DEMONSTRATION STUDY
MUD CREEK AT HANCEVILLE, ALABAMA
DATA COLLECTED AFTER UPGRADE OF WWTP

DATE	LOCATION	TIME	AIR TEMP	WATER TEMP	D. O. a.m.	D. O. p.m.	pH	SPEC COND	BOD 5	TSS	NO -N 3	NH -N 3	TKN	TON	PO -P 4	FLOW	BACT
05/09/89	MCH-1	09:45	24.4	19.4	7.7		7	90	1.2	10	0.4	0.2	1.2	1	0.02		120
06/07/89		10:00	22.7	21.7		6.6	7	95									
07/25/89		10:25	30.6	25.6		7.3	6.9	125	1.2	8	0.13	<0.2	<0.4	<0.2	0.04		
07/26/89		10:10	29.4	26.7		6.9	6.9	115	0.9	4	0.13	<0.2	<0.4	<0.2	0.1		17
08/22/89		09:35	30	26.7	3.4		7.6	290	5.2	20	<0.04	<0.2	0.64	0.44	0.27	0.05	
08/23/89		09:55	28.9	26.7	2.9		7.5	320	4.1	15	<0.04	<0.2	0.64	0.44	0.6		83.7
09/28/89		16:30	13	17		6.3	7.3	170	4.5	37	0.1	<0.2	<0.4	<0.2	0.23		
AVERAGE			25.6	23.4	4.7	6.8	7.2	172	2.9	16	----	----	----	----	0.21	----	73.6
05/09/89	MCH-2	10:00	23.9	19.4		6.4	7.1	120	3.5	14	0.72	0.8	1.6	0.8	0.2	0.69	17
06/07/89		10:10	22.8	21.7		5.6	7.1	120								0.71	
07/25/89		10:05	28.3	24.4		6.1	6.9	140	1	6	0.66	<0.2	<0.4	<0.2	0.19	0.71	
07/26/89		09:45	27.8	25.6	6.1		6.9	150	0.9	4	0.76	<0.2	<0.4	<0.2	0.26		93
08/22/89		10:00	30	25.6		3.6	7.3	395	3.6	7	4.34	<0.2	1.06	0.86	2.13	0.52	
08/23/89		09:15	26.7	26.1	3.8		7.4	240	3.2	14	2.34	<0.2	0.85	0.65	1.58		180
09/28/89		15:15	13	17		7.2	7.4	230	2.1	8	1.2	<0.2	<0.4	<0.2	0.62	0.65	
AVERAGE			24.6	22.8	5.0	5.8	7.2	199	2.4	9	1.67	----	----	----	0.83	0.66	96.7
05/09/89	MCH-3	10:10	22.8	19.4		5.4	7.2	120	3.2	8	1.22	0.6	1.6	1	0.22		187
06/07/89		10:20	23.9	21.7		5.5	7.1	125									
07/25/89		10:15	28.3	25		6.2	6.9	155	1.4	3	1.02	<0.2	<0.4	<0.2	0.23		
07/26/89		09:55	28.3	25.6	5.6		7	140	0.7	5	0.91	<0.2	<0.4	<0.2	0.24		5
08/22/89		10:20	30	23.9		2.5	7	295	1.8	28	2.27	<0.2	0.64	0.44	1.02		
08/23/89		09:20	27.8	25.6	2.9		7.1	280	1.7	8	2.8	<0.2	<0.4	<0.2	1.46		250
09/28/89		16:09	13	16		5.8	7.25	250	1.2	5	4.02	<0.2	<0.4	<0.2	1.79		
AVERAGE			24.9	22.5	4.3	5.1	7.1	195	1.7	10	2.04	----	----	----	0.83	----	147.3
05/09/89	MCH-4	10:55	22.2	18.9		7.4	7.3	120	2.2	5	1.2	0.2	1.6	1.4	0.2	5.31	12
06/07/89		11:10	25.6	22.8		7.4	7.2	138								5.15	
07/25/89		09:55	28.3	24.4	6.9		7.1	140	0.75	1.5	1.1	<0.2	<0.4	<0.2	0.2	5.38	
07/26/89		09:30	28.3	25	6.9		7	130	0.4	1	0.7	<0.2	<0.4	<0.2	0.16		2
08/22/89		10:30	29.4	25.6		8.3	7.6	220	1.6	20	0.79	<0.2	<0.4	<0.2	0.45	0.57	
08/23/89		09:40	27.8	25.6	6.7		7.4	210	1	3	1.14	<0.2	0.64	0.44	0.47		23.2
09/28/89		14:38	13	16		7.8	7.5	210	0.8	2	3.28	<0.2	<0.4	<0.2	1.46	0.41	
AVERAGE			24.9	22.6	6.8	7.7	7.3	167	1.1	5	1.37	----	----	----	0.49	3.36	12.4
			C	C	mg/L	mg/L	SU	umho	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	cfs	org/ 100 mL

FIGURE 3
MUD CREEK-HANCEVILLE MACROINVERTEBRATE DATA

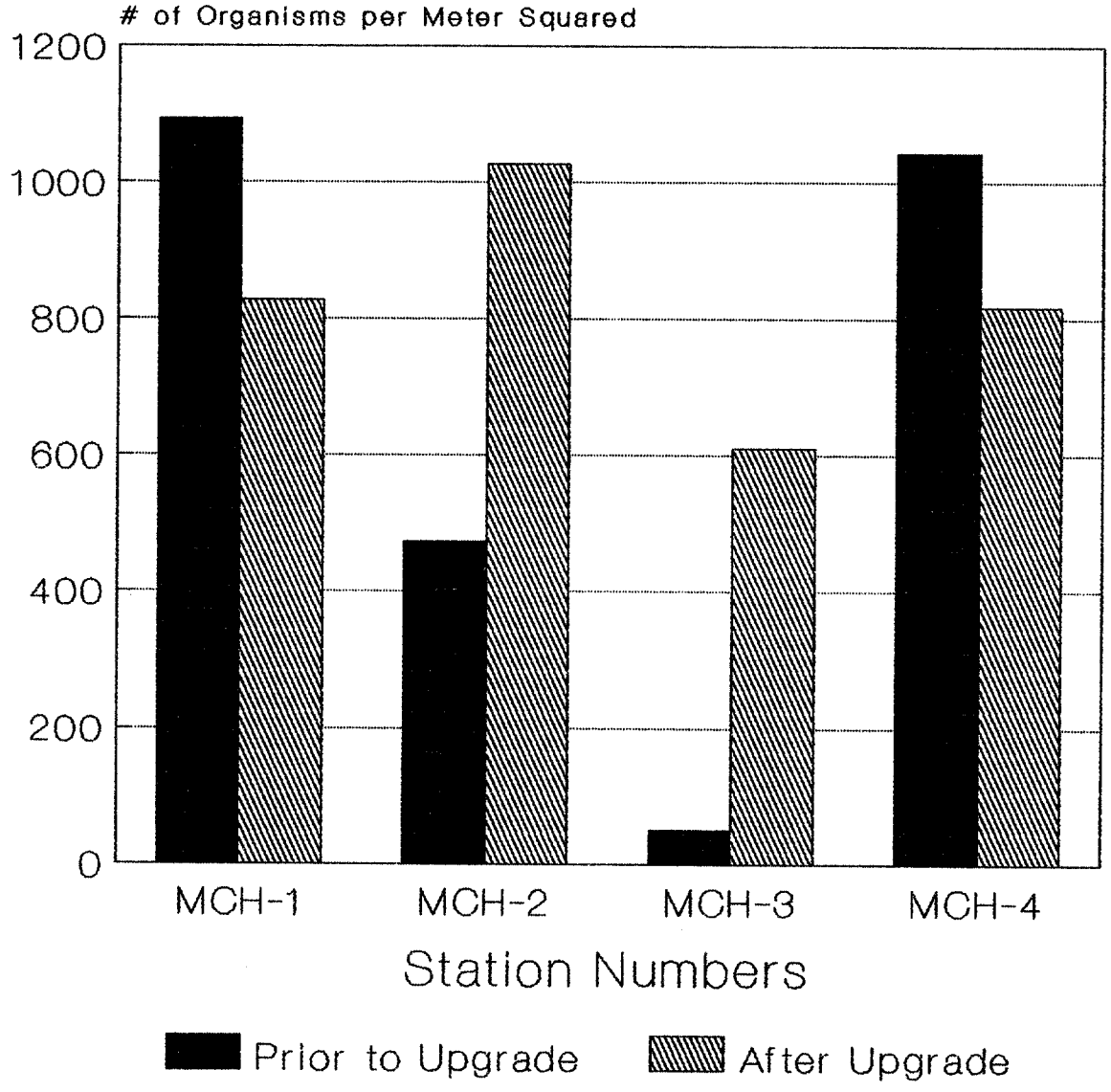
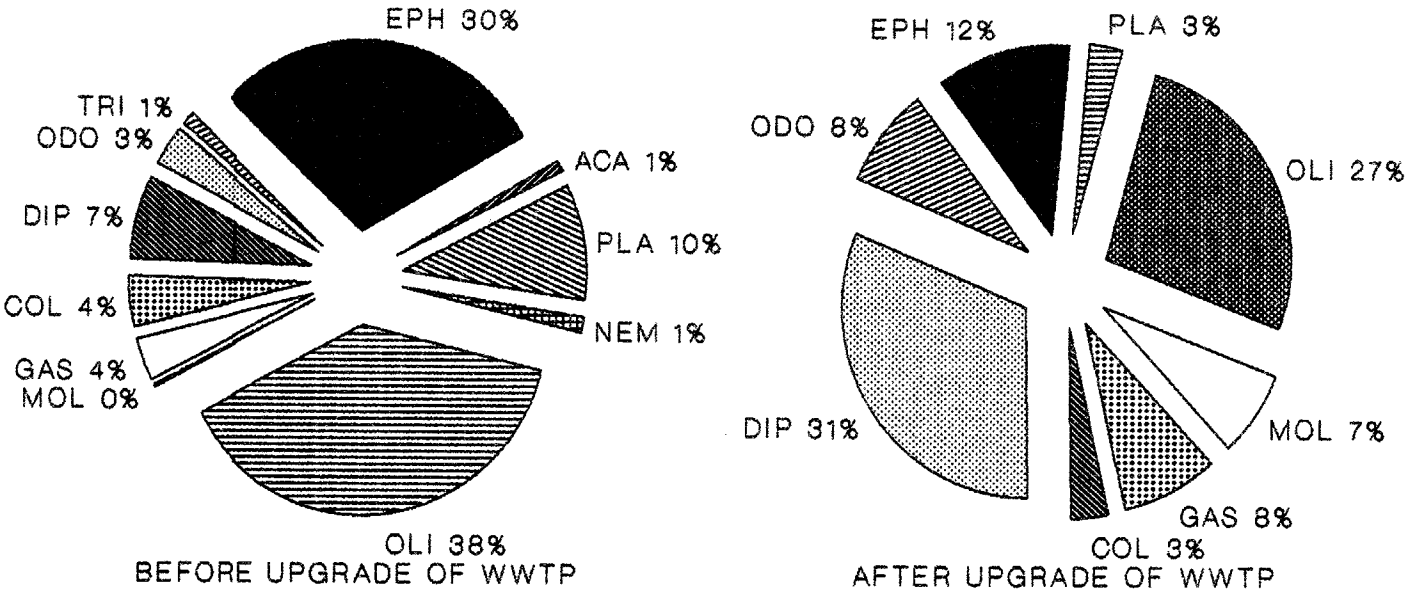


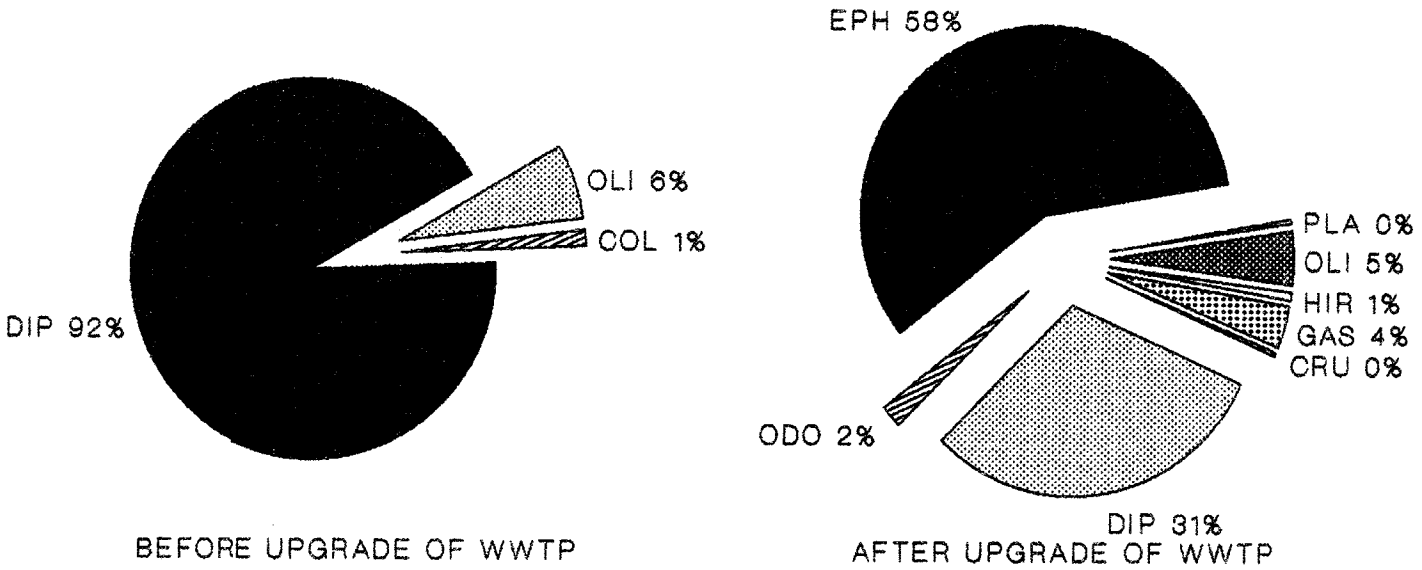
FIGURE 4
% TOTAL POPULATION OF TAXA PRESENT AT STATION MCH-1 (MUD CREEK)



LEGEND

EPH-EPHEMEROPTERA	**DIP-DIPTERA**	**MOL-MOLLUSCA**	**PLA-PLANARIA**
TRI-TRICHOPTERA	**COL-COLEOPTERA**	**OLI-OLIGOCHAETA**	**ACA-ACARI**
ODO-ODONATA	**GAS-GASTROPODA**	**NEM-NEMATODA**	

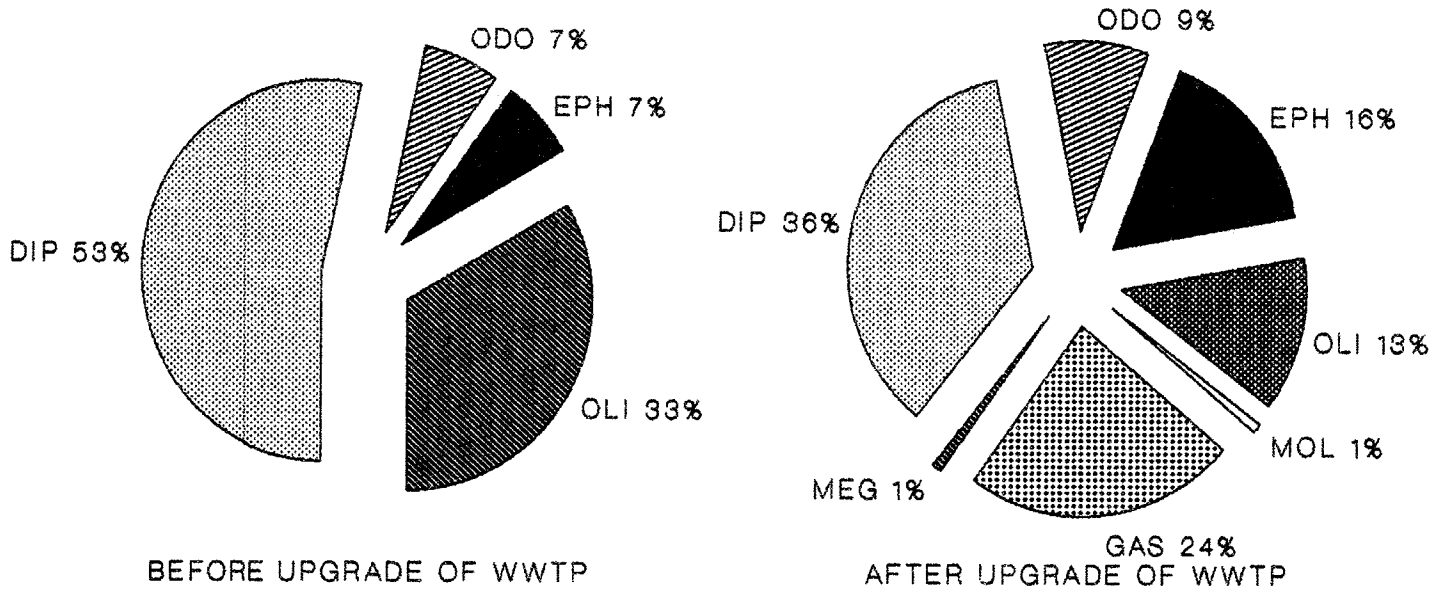
FIGURE 5
% TOTAL POPULATION OF TAXA PRESENT AT STATION MCH-2 (MUD CREEK)



LEGEND

EPH-EPHEMEROPTERA	**DIP-DIPTERA**	**MOL-MOLLUSCA**	**PLA-PLANARIA**
TRI-TRICHOPTERA	**COL-COLEOPTERA**	**OLI-OLIGOCHAETA**	**CRU-CRUSTACEA**
ODO-ODONATA	**GAS-GASTROPODA**	**NEM-NEMATODA**	**HIR-HIRUDINEA**

FIGURE 6
% TOTAL POPULATION OF TAXA PRESENT AT STATION MCH-3 (MUD CREEK)



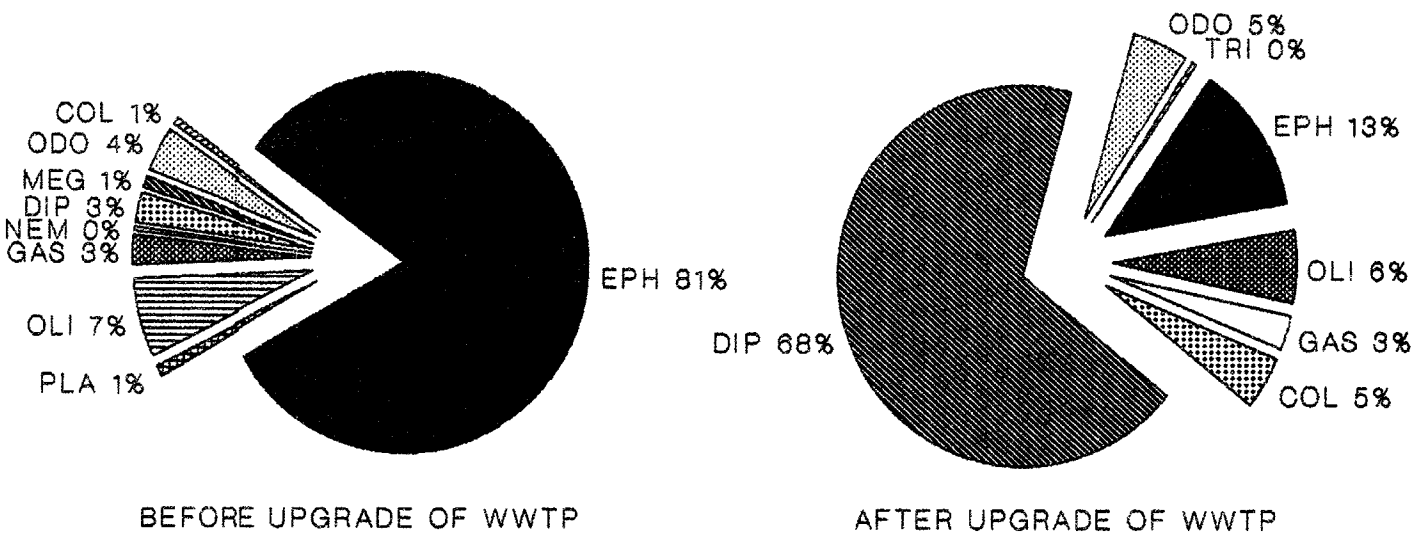
BEFORE UPGRADE OF WWTP

AFTER UPGRADE OF WWTP

LEGEND

EPH-EPHEMEROPTERA	**DIP-DIPTERA**	**MOL-MOLLUSCA**	**PLA-PLANARIA**
TRI-TRICHOPTERA	**COL-COLEOPTERA**	**OLI-OLIGOCHAETA**	**CRU-CRUSTACEA**
ODO-ODONATA	**GAS-GASTROPODA**	**NEM-NEMATODA**	**MEG-MEGALOPTERA**

FIGURE 7
% TOTAL POPULATION OF TAXA PRESENT AT STATION MCH-4 (MUD CREEK)



BEFORE UPGRADE OF WWTP

AFTER UPGRADE OF WWTP

LEGEND

EPH-EPHEMEROPTERA	**DIP-DIPTERA**	**MOL-MOLLUSCA**	**PLA-PLANARIA**
TRI-TRICHOPTERA	**COL-COLEOPTERA**	**OLI-OLIGOCHAETA**	**CRU-CRUSTACEA**
ODO-ODONATA	**GAS-GASTROPODA**	**NEM-NEMATODA**	**MEG-MEGALOPTERA**

TABLE 3

MUD CREEK AT HANCEVILLE, ALABAMA
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	HILSENHOFF BIOTIC INDEX	Data Collected Prior To Upgrade of WWTP				Data Collected After Upgrade of WWTP			
		MCH-1	MCH-2	MCH-3	MCH-4	MCH-1	MCH-2	MCH-3	MCH-4
INSECTA									
EPHEMEROPTERA									
Baetidae	4								
Baetis		0	0	0	0	0	2	0	3
Cloeon		1	0	1	0	0	0	0	0
Heptageniidae	4				1				
Stenacron		0	0	0	24	20	163	16	15
Stenonema		0	0	0	0	4	13	2	3
Caenidae	7								
Caenis		128	0	0	230	5	0	2	10
PLECOPTERA		0	0	0	0	0	0	0	0
TRICHOPTERA									
Hydroptilidae	4								
Hydroptila		0	0	0	0	0	0	0	1
Orthotrichia		5	0	0	0	0	0	0	0
ODONATA									
Aeshnidae	3								
Basiaeschna		0	0	0	2	0	0	0	0
Coenagrionidae	9								
Argia		0	0	0	0	14	2	6	7
Amphiagrion		0	0	0	0	3	3	1	0
Chromagrion		1	0	0	3	3	1	3	3
Enallagma		2	0	0	0	0	0	0	0
Corduliidae									
Epicordulia		0	0	0	0	1	0	0	0
Neurocordulia		0	0	0	0	0	0	1	2
Lestidae	9								
Lestes		0	0	0	0	0	0	0	0
Libellulidae	9								
Libellula		0	0	0	0	0	0	0	0
Pachydiplax		0	0	1	6	0	0	0	0
Macromiidae	3								
Didymops		12	0	0	1	0	0	0	0
Macromia		0	0	0	0	0	0	0	0

TABLE 3

MUD CREEK AT HANCEVILLE, ALABAMA
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	HILSENHOFF BIOTIC INDEX	Data Collected Prior To Upgrade of WWTP				Data Collected After Upgrade of WWTP			
		MCH-1	MCH-2	MCH-3	MCH-4	MCH-1	MCH-2	MCH-3	MCH-4
DIPTERA									
Ceratopogonidae									
Bezzia	6	8	1	1	0	1	0	0	0
Chironomidae		1				7	9	1	13
Ablabesmyia	8	0	0	0	1	12	9	3	35
Chironomus	10	0	92	3	0	22	11	9	1
Cricotopus	7	3	0	0	0	0	0	0	0
Cryptochironomus	8	1	0	0	0	1	0	0	0
Dicrotendipes	8	13	0	0	5	11	13	23	19
Endochironomus/Tribelos	5-10	1	0	0	0	6	10	1	45
Glyptotendipes	10	1	1	0	0	0	0	0	0
Goeldichironomus	?	0	21	2	0	0	0	0	0
Kiefferulus	10	1	16	2	0	2	3	0	0
Labrundinia	7	0	0	0	0	1	2	3	2
Larsia	6	0	0	0	2	0	0	0	0
Microtendipes	6	1	0	0	0	0	0	0	0
Nilothauma	2	0	0	0	0	0	3	0	0
Phaenopsectra	?	0	0	0	0	0	0	1	5
Polypedilum	6	0	0	0	0	0	0	1	4
Procladius	9	0	0	0	0	5	0	0	0
Stenochironomus	5	0	0	0	0	0	0	0	0
Tanytarsus	6	1	0	0	0	5	32	1	29
Thienemannimyia Group	6	0	0	0	0	5	3	1	15
NEUROPTERA	?	0	0	0	0	0	0	0	0
MEGALOPTERA									
Sialidae									
Sialis	4	0	0	0	3	0	0	1	0
HEMIPTERA	?	0	0	0	0	0	0	0	0
COLEOPTERA									
Elmidae									
Ancyronyx	6	4	0	0	0	0	0	0	2
Dubiraphia	6	4	0	0	0	0	0	0	0
Macronychus	4	0	0	0	0	5	0	0	0
Stenelmis	5	3	0	0	0	0	0	0	0
Haliplidae	?								

TABLE 3

MUD CREEK AT HANCEVILLE, ALABAMA
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	HILSENHOFF BIOTIC INDEX	Data Collected Prior To Upgrade of WWTP				Data Collected After Upgrade of WWTP			
		MCH-1	MCH-2	MCH-3	MCH-4	MCH-1	MCH-2	MCH-3	MCH-4
Peltodytes		0	0	0	2	0	0	0	0
Hydrophilidae	?								
Berosus		8	2	0	0	3	0	0	9
MALACOSTRACA									
DECAPODA	?								
Astacidae		0	0	0	0	0	0	0	0
Cambaridae		0	0	0	0	0	1	0	0
GASTROPODA	?								
LIMNOPHILIA									
Ancylidae									
Ferrissia		0	0	0	0	3	0	1	3
Laevapex		0	0	0	0	1	0	0	0
Physidae									
Physella		15	0	0	8	16	9	3	2
Planorbidae									
Helisoma		0	0	0	0	1	2	25	2
Planorbula		1	0	0	0	0	0	0	0
BIVALVIA	?								
Fresh Water Mussel		1	0	0	0	0	0	0	0
Corbiculidae									
Corbicula		0	0	0	0	18	0	1	0
ANNELIDA	?								
OLIGOCHAETA		168	9	5	21	66	14	16	15
HIRUDINEA									
Glossiphoniidae									
Helobdella		0	0	0	0	0	2	0	0
PLANARIA	?	43	0	0	3	7	1	0	0
NEMATODA	?	6	0	0	1	0	0	0	0
ACARI	?	4	0	0	0	0	0	0	0

TABLE 3

MUD CREEK AT HANCEVILLE, ALABAMA
MACROINVERTEBRATE DATA

MACROINVERTEBRATE	HILSENHOFF BIOTIC INDEX	Data Collected Prior To Upgrade of WWTP				Data Collected After Upgrade of WWTP			
		MCH-1	MCH-2	MCH-3	MCH-4	MCH-1	MCH-2	MCH-3	MCH-4
Total # Organisms		437	142	15	313	248	308	122	245
Total # Taxa		26	7	7	15	27	21	22	23
# H-D Plates/ Sample		4	3	3	3	3	3	2	3
Organisms/ Square meter		1093	473	50	1043	827	1027	610	817
EPT Index		3	0	1	2	3	3	3	5
% Contribution of Dominant Taxa		38.4	64.8	33.3	73.4	26.6	52.9	20.5	18.4
Species Diversity ($\bar{d}$)		2.73	1.61	2.55	1.62	3.85	2.64	3.49	3.75
Equitability (e)		0.35	0.55	1.14	0.26	0.78	0.41	0.73	0.85
Sorenson's Community Similarity (as compared to reference station MCH-1)		----	0.15	0.12	0.2	----	0.39	0.35	0.36
# of Dominant Organisms in Common (as compared to reference station MCH-1)		----	1	1	3	----	2	3	1
Indicator Assemblage Index (as compared to reference station MCH-1)		----	0.22	0.38	3.68	----	3.3	1.29	0.95

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