

SECTION 305 (b) , PL-92-500 REPORT

SUMMARY

Prepared By

OHIO ENVIRONMENTAL PROTECTION AGENCY
AQUATIC BIOLOGICAL LABORATORY

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1974 FIELD BIOLOGICAL INVESTIGATIONS

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INTRODUCTION

Biological monitoring programs are conducted by the Ohio Environmental Protection Agency (OEPA) in partial fulfillment of the requirements of the 1972 Federal Water Pollution Control Act Amendments. Sections 106(e), 303 and 305 of the Act specifically call for the establishment of biological "base-line" data for the major river basins and the use of those data in pollution abatement planning procedures. Additionally, these data will support the NPDES permit issuance process and the NPDES permit compliance monitoring.

Section 502(15) of PL-92-500 defines biological monitoring as "the determination of the effects on aquatic life, including accumulation of pollutants in tissues, in receiving waters due to the discharge of pollutants". The biological monitoring programs of OEPA are in early stages of development and, to date, are generally limited to benthic aquatic community analyses and bioassay evaluations.

The data presented in this report are generally limited to these two monitoring components and are the initial products of a longer term monitoring program undertaken by the OEPA. This program will enable more efficient planning

and execution of pollution abatement efforts; and, perhaps more importantly, it is the biological monitoring programs that will register the ultimate success or failure of those programs.

The data reported in this document are accurate and reliable. However, at a number of investigation sites reported in this document the data base is not yet sufficient to support conclusive statements regarding biological effects of pollutant discharges. Biological monitoring must continue in the basins where it has been initiated and it must be increased in most of these basins and expanded to others.

METHODS

Sixteen specific areas were chosen for biological field investigations in 1974. The selection of sites near discharges were based on the existence of a recognized pollution problem and where, through the NPDES permit system, improvement in effluent quality had been requested. The entities selected consisted of seven municipal sewage treatment plants and nine industrial plants. Two additional sites were selected, one a non-point source discharge area, primarily acid mine drainage, and another where high water quality values were expected. These sixteen sites were located in eight different basins.

Sampling stations were located above and below the points of discharge of the entities. The specific location and description of each station is found in the Appendix. Five multiple plate artificial substrate samplers, of the modified Hester-Dendy type, were exposed for a six week period at each station. A concrete building block was used to anchor the samplers in place. The five artificial substrates were tied to the block and a float was attached to prevent the samplers from coming into contact with the natural substrate. The samplers were placed in runs rather than pools or riffles and an attempt was made to establish stations in as similar an ecological situation as possible. In some cases, where the stream was greater than forty feet wide, a set of five samplers were installed near both banks of the stream at these stations. The substrate was described following the categories for substrate characterization outlined in the USEPA publication Biological Field and Laboratory Methods (Weber, 1973). When the samplers were retrieved each was placed in a one quart plastic container while still submerged. The line was then cut and the plates removed from the stream. Formalin was added to each container to equal approximately a 10% solution and the samplers were returned to the laboratory for analyses. Qualitative samples of the natural substrate were collected at the time of retrieval of the multiple

plates. Dip net samples were taken in a stream segment approximately 20 yards long, in the area where the multiple plates were placed. The qualitative collecting continued until, by gross examination, no new taxa were being taken.

At one study site, biological samples were collected from the natural substrate above and below the discharge using a Surber square foot sampler. The material collected in the Surber sampler was placed in a white enamel pan and hand picked at the site. Five Surber samples were taken at each of these stations.

The multiple plates were dismantled in the laboratory and the material washed through a US Standard Testing Sieve number 40 (425 μ m openings). The larger organisms were hand picked from the screens and the smaller material washed into a jar containing 70% alcohol. Where the number of organisms collected was so large that the identification of each individual was impractical, a Folsom sample splitter was used to obtain a subsample. Identifications and counts were made using dissecting and compound microscopes. Dipterans of the family Chironomidae were prepared following the methods described by Mason (1973). Identifications were made using the following taxonomic keys: Beck and Beck (1966), Brown (1972), Johannsen (1969), Harden and Mickel (1952), Harman and Berg (1971), Hilsenhoff (1970), Hobbs (1972), Holsinger (1972), Klemm (1972), Mason (1973), Needham, Traver, and Hsu (1935), Pennak (1953), Peterson (1951), Roback (1957), Ross (1944), Usinger (1956), Walker (1958), Ward and Whipple (1959), and Williams (1972).

After the benthic organisms had been identified and counted, species diversity indices (\bar{d}) were calculated using the expression $\bar{d} = -\sum \left(\frac{n_i}{n}\right) \log_2 \left(\frac{n_i}{n}\right)$. This formula is a function of the number of species (n_i), total number of individuals (n), and the distribution of the individuals within the number of species. Equitability (e) values were determined from all diversity indices using the

expression $e = \frac{s'}{s}$, where s equals the number of taxa, and s' the tabulated value provided in the USEPA Methods Manual (Weber, 1973). The equitability value is a comparison of \bar{d} to MacArthur's broken stick model which is based on a community structure frequently found in nature and theoretically increases the sensitivity of \bar{d} . At several of our stations, apparent discrepancies between \bar{d} and e were found.

In these biological evaluations, little emphasis was placed on the concept of specific organisms as indicators of the environmental condition. Unfortunately, most of the dominant organisms have a questionable classification as to their tolerance for stress.

Fish collections were taken above and below one entity using a 10 x 4 foot straight minnow seine of 1/4 inch mesh. A 100 foot stream segment at each station was marked off and 40 seine hauls were made covering all of the area within the 100 foot segment. The stream segments were selected for their similarity in available stream habitat types giving consideration to the number of pools, riffles, and runs, as well as type of bottom, logs and other debris furnishing fish habitats. The fish were preserved in 10% formalin and identified in the laboratory using the taxonomic key by Trautman (1957).

The bioassay methods generally parallel those described in "Standard Methods" (APHA, 1971), for acute, static tests. Laboratory-reared fathead minnows (Pimephales promelas) were used for all of the bioassays, and one or more of the following invertebrates were used in many of the texts; Daphnia magna, Daphnia pulex, Gammarus fasciatus and Chironomus riparius.

In most instances, bioassays were conducted on the actual effluent of the entities in question, with dilutant coming from the receiving body of water.

However, in some cases, effluents were simulated when the use of actual effluents would prove impossible or impractical.

In some instances where the effluent was highly variable with respect to time, it was desirable to employ in situ fish bioassays. Collapsible nylon fish live-bags held ten temperature-acclimated fathead minnows, and were placed in appropriate areas of the receiving water for in situ studies. Usually one live-bag was placed directly in the effluent plume, as near the source of discharge as feasible, while another was placed above the point of entry of the discharge, and at least one other below the mixing zone, in an effort to estimate the toxicological impact of the effluent after natural dilution.

BIOLOGICAL FIELD EVALUATIONS

SCIOTO RIVER BASIN

The aquatic biological monitoring program in the Scioto River Basin was comprised of two elements during 1973 and 1974. One program element was a basin-wide benthic monitoring program initiated in 1973 and continued through 1974. In this program nineteen stations were established for biological sampling in the mainstem and in the mouths of major tributaries of the Scioto River. Ten artificial substrate samplers of the modified Hester-Dendy type were exposed at each mainstem station and five at each of the tributary stations during each sampling period. Qualitative samples from the natural substrate were also collected at each station. Collections were made during summer and fall of 1973 and summer of 1974. Approximately 450 biological samples were collected and two thirds of these have been analyzed. Completion of the analyses and the preparation of the summary report is anticipated during the latter part of 1975.

The second element in the Scioto River Basin biological program consisted of monitoring benthic communities around specific discharges. The results of the 1974 effort on this program in Scippo Creek, the Little Scioto River and in Paw Paw Creek are presented in the following three sections of this report.

SCIOTO RIVER BASIN

Little Scioto River
Marion Sewage Treatment Plant

The Little Scioto River, located in Crawford and Marion Counties, drains 110 square miles and joins the Scioto River below Greencamp, Ohio. The Marion Sewage Treatment Plant is located 6.4 miles from the mouth of the Little Scioto and contributes 7.99 million gallons of effluent per day to the river. This is the largest point source pollutant load to this stream. The present average daily load of the Marion plant is 2104 pounds of BOD (biological oxygen demand), 2416 pounds of dissolved solids, 1668 pounds of Kjeldahl nitrogen, and 5508 pounds of COD (chemical oxygen demand). The UOD (ultimate oxygen demand) was calculated to be 9820 pounds (OEPA, 1974d).

A static bioassay analysis using the fathead minnows, Pimephales promelas, was conducted on this effluent in July of 1974. The effluent was toxic (lethal) to 50% of the test organisms during the 96 hour test period at a concentration of 20%.

At critical low flow the Little Scioto River is considered a dry stream at a point about 1.5 miles above the sewage treatment plant. Violations of stream water quality standards for dissolved oxygen, fecal coliforms, and total dissolved solids occur in the stream segment extending 3.5 miles upstream from the Marion plant to Rocky Fork Creek. Concentrations of these parameters, chromium and ammonia violate water quality standards downstream from the Marion Sewage Treatment Plant to the river's confluence with the Scioto River. Above Marion the average observed concentration (at an estimated flow rate of .5 cfs) for dissolved oxygen ranged from 4.9 to 6.2 mg/l, total dissolved solids 534 mg/l, and fecal coliforms numbered 490/100 ml. There were no measurable amounts of ammonia and chromium. Below Marion (at a flow rate of 11 to 12 cfs) dissolved

oxygen concentrations ranged from 1.3 to 4.2 mg/l, dissolved solids 538 to 630 mg/l, ammonia 0.8 to 9.7 mg/l, and chromium 0.1 to 0.6 micrograms/l. Fecal coliforms numbered 630/100 ml (OEPA, 1974d).

Three stations for biological sampling were established in the Little Scioto River for the sampling period of July 8 to August 19, 1974. Station I was located approximately one mile above the sewage treatment plant upstream from the potable water treatment plant intake and south of Route 30-S. Station II was two miles downstream from the Marion Sewage Treatment Plant near the Keener Pike Bridge, and station III was 4.5 miles below the sewage treatment plant site near Route 203 and approximately 1.5 miles above Greencamp (see Appendix). The general locations of these stations are shown in Figure 1. The results of the biological sampling are shown in Table 1.

The upstream station (I) was characterized by a relatively low diversity index (2.17) and a low equitability calculation (0.44) indicating that the water quality at this station was imposing a stress on the benthic macroinvertebrate community. Most of the organisms collected at this site have been classified as facultative or tolerant to pollution. Organisms from the orders Ephemeroptera (Mayflies) and/or Trichoptera (Caddisflies) were not collected from any of the study sites. Many organisms from these two groups are considered highly sensitive to pollution, a great number are considered facultative, and few have been classified as tolerant.

Data from stations II and III clearly demonstrate further degradation of the water quality downstream from the Marion Sewage Treatment Plant. The number of taxa, the diversity indices, and the equitability values at station II were 4, 0.08, and 0.10 respectively while at station III these values were 7, 0.35,



Figure 1
 SCIOTO RIVER BASIN
 1974 Biological
 Sampling Stations

Table 1
 Organisms Collected on Artificial Substrate Samplers
 from the Little Scioto River, July 8 to August 19, 1974 (a)

Taxa		Station		
		I	II	III
Coelenterata:	<u>Hydra</u> sp	6		
Bryozoa:	<u>Plumatella repens</u>	+		
Annelida:	<u>Oligochaeta</u>	73	376+	5052+
Amphipoda:	<u>Hyalella azteca</u>	4+		
Decapoda:	<u>Orconectes</u> sp	1		
Odonata:	<u>Nasiaeschna</u> sp	+		
	<u>Argia</u> sp	4		
Hemiptera:	<u>Corixidae</u>	+		+
Coleoptera:	<u>Peltodytes</u> sp			+
	<u>Macronychus glabratus</u>	+		
	<u>Ancyronyx variegata</u>	+		
	<u>Dubiraphia</u> sp	+		
	<u>Cyphon</u> sp	+		
	<u>Helophorus</u> sp	+		
	<u>Dytiscidae</u>			+
Diptera:	<u>Chironomus</u> sp	142+	+	244+
	<u>Psectrotanypus</u> sp		+	32+
	<u>Glyptotendipes</u> sp	548+		
	<u>Endochironomus</u> sp	+		
	<u>Polypedilum</u> sp	+		
	<u>Harnischia abortiva</u>	20+		
	<u>Einfeldia</u> sp	265		
	<u>Ablabesmyia</u> sp	20		
	<u>Kiefferulus</u> sp	62		
	<u>Tanytarsus</u> sp		4	
	<u>Tipula</u> sp	+		
	<u>Culicoides(?)</u> sp	1		
Gastropoda:	<u>Physa</u> sp			17+
	Number of organisms/Sq. Ft. (b)	229	76	1069
	Total number of taxa	23	4	7
	\bar{d} (b)	2.17	0.08	0.35
	e (b)	0.49	0.10	0.22

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

and 0.22. These values were dramatically lower than those calculated for station I and they indicate very poor water quality. Only two taxa were collected on the artificial substrate samplers at station II and the diversity index (0.08) is one of the lowest encountered in 1974 by the OEPA staff. Disturbance of the sediments at station II released a black material with an oily appearance into the water. This condition was not observed at station I. While there was a great reduction in taxa from station I to station III, the oligochaetes, organisms that may appear in great numbers in organically polluted water, increased from 73 individuals at station I to 5,052 at station III. The increase in diversity and equitability values at station III over those for station II is not considered significant in terms of identifying the station III area as a recovery zone.

SCIOTO RIVER BASIN

Scippo Creek
PPG Industries

Scippo Creek, located in Pickaway County, drains 52.8 square miles and joins the Scioto River approximately ten miles below Circleville, Ohio. The PPG Industries effluent, about three million gallons per day, enters Scippo Creek 4.3 miles from the mouth. The present average daily load to Scippo Creek is 200 pounds of BOD, 11,400 pounds of total dissolved solids, and 700 pounds of COD (OEPA, 1974d).

Scippo Creek is in violation of stream water quality standards for fecal coliforms from above the PPG outfall to the mouth. Upstream from the PPG outfall the average observed concentration of dissolved oxygen was 9.2 mg/l, total dissolved solids 390 mg/l, COD 14.4 mg/l and fecal coliforms numbered 290/100 ml. The average observed flow rate at this station was 9.6 cfs. At the mouth, where the flow rate was 14.3 cfs, these values were as follows: dissolved oxygen 8.0 mg/l, total dissolved solids 403 mg/l, fecal coliforms 220/100 ml, and COD 14.4 mg/l (OEPA, 1974d).

On September 24, 1973, water was collected for bioassay purposes from the PPG discharge pipe. A rust colored flocculent material covered the stream bottom below the outfall on this date. This precipitate was also present in smaller amounts approximately two miles below the discharge point but it was not observed upstream from the discharge. Approximately 30 to 40 dead or dying fish (primarily Campostoma anomalum and Pimephales notatus) were observed in an 80 yard stream segment below the outfall. No distressed fish were seen in a 200 yard segment upstream from the discharge. The effluent collected on this date was toxic to 50% of the test fish in 96 hours at a concentration of 56%. No significant toxicity was observed in subsequent static bioassays conducted in April, July,

and September, 1974, nor in 24 hour in situ bioassays conducted upstream from the discharge, in the effluent, and downstream from the outfall on September 19, 1974.

Three stations were established in Scippo Creek for biological sampling. Station I was located approximately 125 yards upstream from the PPG outfall and station II 450 yards downstream. Station II was two miles downstream from the outfall and approximately 100 yards downstream from Route 23 (see the Appendix). The general locations of these stations are shown in Figure 1. These stations were sampled with artificial substrates during the period August 20 to October 1, 1974. Surber samples were collected at the first riffle below each of these sites on October 11th. On the same date, fish collections were taken from physically comparable 100 foot stream segments at each station. Qualitative dip net samples were taken above and below the outfall in August and again in September. The results of the biological sampling are shown in Tables 2, 3, 4, and 5.

Data from the artificial substrate samplers (Table 2) at station II (downstream) show a substantial reduction in the number of taxa present and a reduction in the diversity index. The diversity indices are relatively high at all stations, however. Little difference between stations was indicated by the equitability values. The number of taxa from the orders Ephemeroptera and Trichoptera was reduced from eight at station I to one at station II.

No substantial differences in the total number of taxa, diversity indices, or equitability values were found from Surber samples (Table 3) taken from natural substrates at stations I and II. The numbers of taxa from the orders Ephemeroptera and Trichoptera were essentially the same at these stations. The number of individuals within these orders ranged from 462 at station I to 130 at station II. The number of oligochaetes increased at station II.

Table 2
Organisms Collected on Artificial Substrate Samplers
from Scippo Creek, August 20 to October 1, 1974

Taxa		Station		
		I	II	III
Turbellaria:	<u>Planariidae</u>	5		1
Annelida:	<u>Oligochaeta</u>	30	22	44
	<u>Helobdella</u> sp			3
	<u>Erpobdella</u> (?) sp			1
Ephemeroptera:	<u>Tricorythodes</u> sp	4	3	8
	<u>Caenis</u> sp	1		3
	<u>Stenonema interpunctatum</u> group	2		1
	<u>Stenonema pulchellum</u> group	8		2
	<u>Baetis</u> (?) sp	1		
Odonata:	<u>Agrion</u> sp	1		
	<u>Coenagrionidae</u>	21	7	20
Trichoptera:	<u>Cheumatopsyche</u> sp	2		13
	<u>Cecetis</u> sp	6		
	<u>Hydroptilidae</u>	1		1
Coleoptera:	<u>Berosus</u> sp	19	7	60
	<u>Dubiraphia</u> sp	3	3	2
	<u>Macronychus glabratus</u>	6	11	7
	<u>Helichus</u> sp	2		
	<u>Stenelmis</u> sp	5		1
	<u>Ancyronyx variegata</u>		3	
Diptera:	<u>Tanytarsus</u> sp	14		
	<u>Cricotopus</u> sp	49		
	<u>Polypedilum fallax</u> (?)		80	16
	<u>Polypedilum</u> sp	11	106	16
	<u>Pseudochironomus</u> sp	3		
	<u>Chironomus</u> sp	5	27	3
	<u>Pentaneura</u> sp	11	40	9
	<u>Glyptotendipes</u> sp	3		3
	<u>Ablabesmyia</u> sp	5	13	
	<u>Tribelos</u> sp		13	
	<u>Phaenopsectra</u> sp			19
	<u>Trichocladius</u> sp			6
	<u>Psectrocladius</u> sp			6
	<u>Tipula</u> (?) sp			2
	<u>Ceratopogonidae</u>	1	2	
	Unidentified		66	3
Gastropoda:	<u>Physa</u> sp	88	95	142
	<u>Ferrissia</u> sp	3	1	
	Number of organisms/Sq. Ft.	63	125	78
	Total number of taxa	28	17	26
	\bar{d}	3.73	3.19	3.29
	e	0.66	0.68	0.54

Table 3
Organisms Collected from Natural Substrates
in Scippo Creek, October 11, 1974 (a)

Taxa		Station			
		I	II	III	
Annelida:	<u>Oligochaeta</u>	16	573	31	
Ephemeroptera:	<u>Tricorythodes</u> sp	16	18		
	<u>Baetis</u> (?) sp	29	25	108	
	<u>Stenonema</u> tripunctatum group	9		3	
	<u>Stenonema</u> pulchellum group		1		
Trichoptera:	<u>Hydropsyche</u> bifida group	108	19	35	
	<u>Hydropsyche</u> sp	14	12	4	
	<u>Cheumatopsyche</u> sp	266	55	165	
	<u>Chimarra</u> sp	20		4	
Coleoptera:	<u>Psephenus</u> sp	8		38	
	<u>Berosus</u> sp	24	6	54	
	<u>Ancyronyx</u> variegata	8	1		
	<u>Dubiraphia</u> sp	1			
	<u>Macronychus</u> glabratus	11	18	36	
	<u>Helichus</u> sp	1			
	<u>Stenelmis</u> sp		2		
	<u>Cricotopus</u> sp	541	430	120	
Diptera:	<u>Pentaneura</u> sp	42	71	3	
	<u>Polypedilum</u> fallax(?)	150	566	21	
	<u>Polypedilum</u> sp		189	3	
	<u>Simulium</u> sp	13	24	143	
	<u>Tipula</u> (?) sp	5	2	5	
	<u>Ceratopogonidae</u>		4		
	<u>Empididae</u>		12		
	Unidentified		259	9	
	Gastropoda:	<u>Physa</u> sp			42
		<u>Ferrissia</u> sp	8		
	Number of organisms/Sq. Ft.	244	457	165	
	Total number of taxa	20	20	18	
	\bar{d}	2.73	2.84	3.35	
	e	0.43	0.50	0.78	

(a) Five Surber samples collected at each site.

Table 4
 Composite Samples of Organisms Collected (a) Above and Below
 the PPG Outfall in Scippo Creek, August 16 and September 24, 1974

Taxa		Above	Below
Ephemeroptera:	<u>Stenonema pulchellum</u> group	X	
	<u>Stenonema interpunctatum</u> group	X	
	<u>Baetis</u> sp	X	
	<u>Tricorythodes</u> sp		X
Odonata:	<u>Enallagma(?)</u> sp	X	
	<u>Aeshna</u> sp		X
Trichoptera:	<u>Hydropsyche</u> sp	X	
	<u>Cheumatopsyche</u> sp	X	
	<u>Chimarra</u> sp	X	
Coleoptera:	<u>Macronynus glabratus</u>	X	
	<u>Helichus</u> sp	X	X
	<u>Hydrochus</u> sp	X	
	<u>Tropisternus</u> sp		X
	<u>Dineutus</u> sp		X
	<u>Iaccophilus</u> sp		X
	<u>Haliphus</u> sp		X
	<u>Polypedilum</u> sp	X	
Diptera:	<u>Chironomus</u> sp		X
	<u>Pentaneura</u> sp		X
	<u>Cricotopus</u> sp		X
	<u>Procladius</u> sp		X
	<u>Tribelos</u> sp		X
	<u>Hexatoma(?)</u> sp	X	
	Simuliidae	X	
Gastropoda:	<u>Physa</u> sp		X
	Number of taxa	13	13

(a) Collected with dip nets from similar habitats.

Table 5
Fish Species Collected in Scippo Creek,
October 11, 1974 (a)

Species	Station		
	I	II	III
Catostomidae:	<u>Hypentelium nigricans</u>	2	
	<u>Catostomus commersoni</u>	1	9
Centrarchidae:	<u>Ambloplites rupestris</u>	5	
	<u>Micropterus salmoides</u>	1	
	<u>Micropterus dolomieu</u>	1	
	<u>Lepomis megalotis</u>	42	3
Percidae:	<u>Etheostoma flabellare</u>	2	2
	<u>Etheostoma nigrum</u>	6	
	<u>Etheostoma zonale</u>	5	1
	<u>Etheostoma caeruleum</u>	32	8
	<u>Etheostoma blennioides</u>		1
Cyprinidae:	<u>Semotilus atromaculatus</u>	4	1
	<u>Phenacobius mirabilis</u>	8	1
	<u>Pimephales notatus</u>	103	
	<u>Ericymba bucatta</u>	35	5
	<u>Notropis cornutus</u>	5	
	<u>Notropis deliciosus</u>	196	6
	<u>Notropis volucellus</u>	35	
	<u>Campostoma anomalum</u>		1
	Number of individuals	483	6
	Number of species	17	4
			43
			9

(a) Forty seine (10' x 4') hauls made in each one hundred foot segment.

Qualitative dip net samples (Table 4) taken above and below the discharge point produced an identical number of taxa but a totally different collection of organisms. Only one organism (Coleoptera: Helichus sp) was found in both areas. The upstream samples were characterized by mayflies and caddisflies while downstream samples were predominantly beetles and dipterans. The types of organisms found upstream are representative of high water quality areas.

The fish collections from station I and station II (Table 5) were markedly different. Four hundred and eighty-three fish representing 17 taxa were collected at station I and only six fish representing four taxa were found at station II.

Diversity indices and most of the equitability values were relatively high for macrobenthic invertebrate samples collected upstream and downstream from the PPG discharge into Scippo Creek. Fewer number of taxa of benthic organisms were collected from the station downstream from the discharge than were collected from the upstream station. A much greater number of fish species were present at the upstream station than were collected from the downstream station. Toxicity to test fish was recorded in one of four bioassays conducted on the effluent.

SCIOTO RIVER BASIN

Paw Paw Creek
Crown Zellerbach Corporation

Paw Paw Creek, located in Fairfield County, drains 16.6 square miles and joins Walnut Creek about 0.8 mile below Baltimore. Walnut Creek enters the Scioto River below Ashville in Pickaway County, Ohio. The Crown Zellerbach Corporation is located on a small unnamed tributary which flows into Paw Paw Creek within the village of Baltimore, Ohio and discharges into this tributary at a flow rate of 0.489 million gallons/day. The present average daily loading to the tributary from Crown Zellerbach is 308 pounds BOD, 7124 pounds total dissolved solids, 269 pounds total suspended solids, and 462 UOD (OEPA, 1974d).

A static bioassay analysis using the fathead minnow, Pimephales promelas, was conducted on this effluent in July of 1974. The effluent was toxic (lethal) to 50% of the test organisms during the 96 hour test period at a concentration of 75%.

At the mouth of Paw Paw Creek the average observed concentration of dissolved oxygen was 6.6 mg/l, BOD 12.0 mg/l, total dissolved solids 447 mg/l, and total suspended solids 45 mg/l. The average observed flow rate at this station was 5.91 cfs. At critical low flow (0.76 cfs) total dissolved solids concentrations violate water quality standards (OEPA, 1974d).

Three biological sampling stations were established in Paw Paw Creek for the sampling period of July 2 to August 13, 1974. Samplers from one station located upstream from the village of Baltimore were lost. Station I of the two productive stations was located in Paw Paw Creek approximately 100 yards upstream from the unnamed tributary receiving the Crown

Zellerbach effluent and was within the village of Baltimore. Station II was located approximately 0.7 mile below the unnamed tributary and about 100 yards upstream from the confluence of Paw Paw and Walnut Creeks (see the Appendix). The general locations of these stations are shown in Figure 1. The results are shown in Table 6.

The upstream station (I) was characterized by a relatively high equitability value (0.63) and a high diversity index (3.11) which indicate that a high water quality condition existed at this station. A total of 29 taxa were collected at station I and nine taxa of mayflies and caddisflies were taken.

Station II (downstream) had diversity and equitability values of 2.04 and 0.29 respectively indicating a moderate to poor water quality existed at this station. There were fewer types and numbers of caddisflies and mayflies than were collected at station I. While there was a reduction in total numbers of taxa, the oligochaetes increased from seven at station I to 1065 at station II.

These data indicate a substantial reduction in water quality in Paw Paw Creek downstream from the village of Baltimore as reflected by the benthic biota. It is questionable whether this effect would be demonstratable in Walnut Creek.

Table 6
Organisms Collected on Artificial Substrate Samplers
from Paw Paw Creek, July 2 to August 13, 1974^(a)

Taxa	Station	
	I	II
Coelenterata:	<u>Hydra</u> sp	8
Turbellaria:	<u>Dugesia</u> (?) sp	4
Nematoda:	Unidentified	1
Annelida:	<u>Oligochaeta</u>	7+
Isopoda:	<u>Asellus</u> sp	+
Amphipoda:	<u>Hyalella azteca</u>	1+
	<u>Crangonyx</u> (?) sp	+
Decapoda:	<u>Orconectes</u> sp	1+
Ephemeroptera:	<u>Stenonema tripunctatum</u> group	5+
	<u>Stenonema interpunctatum</u> group	12+
	<u>Stenonema pulchellum</u> group	2+
	<u>Caenis</u> sp	5
	<u>Neocloeon</u> (?) sp	2
	<u>Hexagenia</u> sp	+
Odonata:	<u>Agrion</u> (?) sp	+
	<u>Perithemis</u> sp	+
	<u>Boyeria vinosa</u>	+
Megaloptera:	<u>Sialis</u> sp	2
Trichoptera:	<u>Hydropsyche bifida</u> group	3
	<u>Cheumatopsyche</u> sp	12
Coleoptera:	<u>Stenelmis</u> sp	2+
	<u>Helichus</u> sp	+
	<u>Dubiraphia</u> sp	8
	<u>Psephenus</u> sp	+
Diptera:	<u>Tanytarsus</u> sp	73+
	<u>Einfeldia</u> sp	7
	<u>Ablabesmyia</u> sp	7
	<u>Pentaneura</u> sp	19
	<u>Microtendipes</u> sp	87
	<u>Polypedilum fallax</u> (?)	80
	<u>Psectrocladius</u> sp	
	<u>Chironomus</u> sp	
	<u>Cricotopus</u> sp	
	Simuliidae	+
	Unidentified	87
Gastropoda:	<u>Physa</u> sp	70+
	<u>Ferrissia</u> sp	4+
	<u>Lymnaea</u> sp	+
	Number of organisms/Sq. Ft. (b)	84
	Total number of taxa	29
	\bar{d} (b)	3.11
	e (b)	0.63

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

HOCKING RIVER BASIN

Hocking River Lancaster Sewage Treatment Plant

The Hocking River drains 1200 square miles and enters the Ohio River below Coolville, Ohio. The Lancaster Sewage Treatment Plant is located in the head waters of the Hocking River in Fairfield County and discharges 5.7 million gallons of effluent per day to the river. The present average daily load of the Lancaster plant is 1798 pounds of BOD, 762 pounds of total dissolved solids, 381 pounds Kjeldahl nitrogen, 333 pounds ammonia, and 333 pounds chromium (personal communication with OEPA, Central District Office, 1975). No significant toxicity was found in the effluent as determined by static bioassays in July, 1974.

Averages of data for 1974 from a monthly sampling station located 7.5 miles above Lancaster were dissolved oxygen 11.2 mg/l, total suspended solids 1.0 mg/l, BOD 1.4 mg/l, ammonia 0.34 mg/l and sulfates 52 mg/l. Dissolved oxygen concentrations violate water quality standards downstream from the sewage treatment plant for at least 1.7 miles. The data from dissolved oxygen analyses at a point 1.7 miles downstream from the discharge ranged from 0.8 to 10.4 mg/l during 1974. Averages of data for other parameters analyzed in 1974 from this downstream station were total suspended solids 9.0 mg/l, BOD 4.8 mg/l, ammonia 1.39 mg/l and sulfates 75 mg/l (personal communication with OEPA, Central District Office, 1975).

Two stations for biological sampling were established in the Hocking River. Station I was located approximately 0.5 mile above the Lancaster Sewage Treatment Plant and immediately downstream from the Maple Street bridge within the City of Lancaster. Station II was located approximately 1.7 miles below the sewage treatment plant site and was between Route 33 and the C&O Railway

bridge (see the Appendix). All samplers were lost from an additional downstream station. The general locations of these stations are shown in Figure 2. The results from stations I and II are shown in Table 7.

The upstream station (I) is characterized by a low diversity index (2.07) and a low equitability value (0.38) indicating a moderate to poor water quality situation. No caddisflies and only one genus of mayfly were collected from station I.

Data from station II (downstream) clearly demonstrate a further reduction in water quality below the Lancaster Sewage Treatment Plant when compared with station I data. The diversity and equitability values at station II were 0.73 and 0.14 respectively indicating very low water quality. There was no significant difference in number of taxa collected from the two stations. The oligochaetes increased from 956 at station I to 5312 at station II.

Although the water quality in the Hocking River, as reflected by the benthic biota, was poor at the upstream study site, it undergoes further degradation downstream from the Lancaster Sewage Treatment Plant discharge.

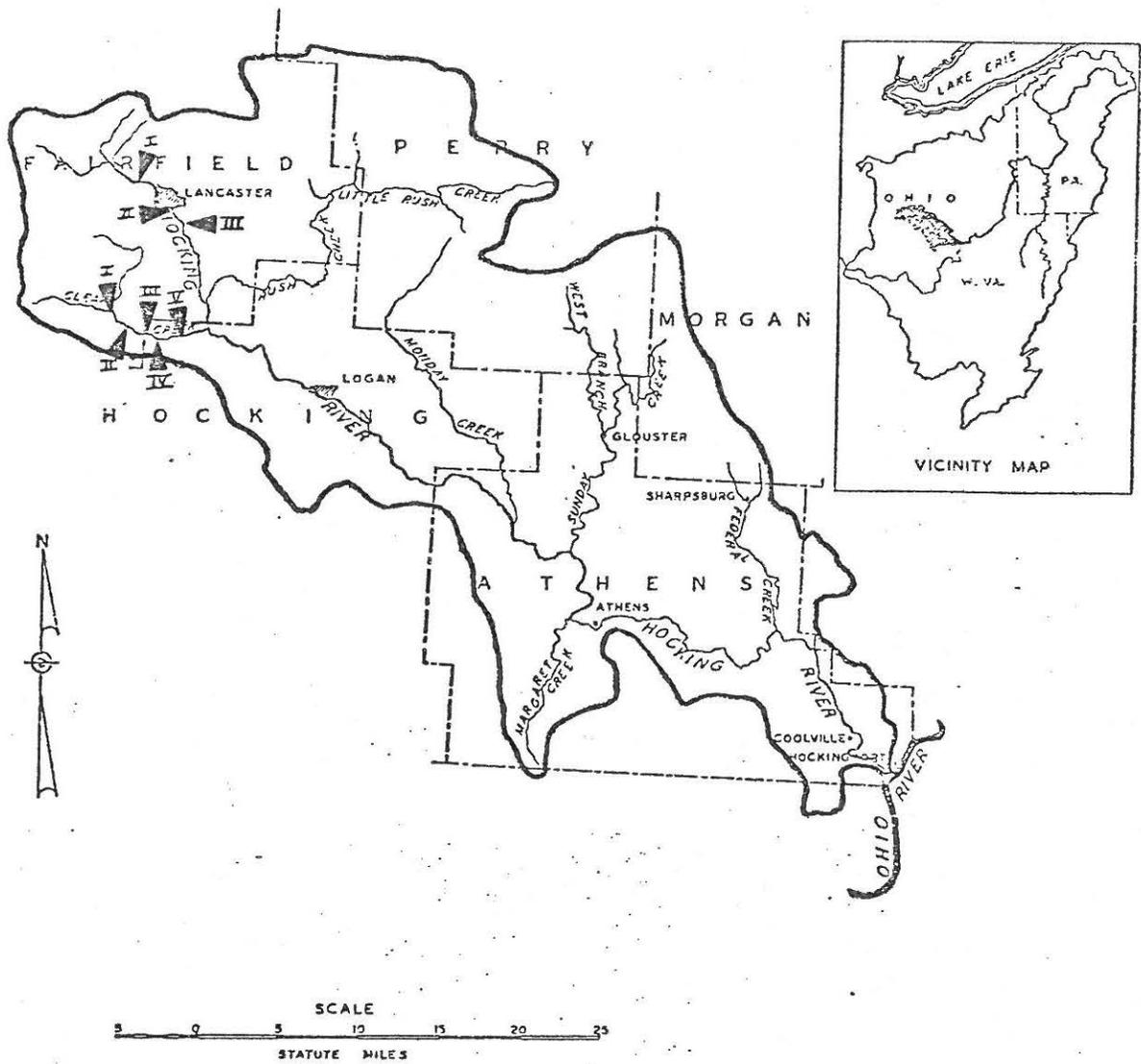


Figure 2
 HOCKING RIVER BASIN
 1974 Biological Sampling Stations

Table 7
Organisms Collected on Artificial Substrate Samplers
from the Hocking River, July 3 to August 14, 1974 (a)

Taxa		Station		
		I	II	
Coelenterata:	<u>Hydra</u> sp	110		
Turbellaria:	<u>Dugesia</u> (?) sp	8	117+	
Annelida:	<u>Oligochaeta</u>	956+	5312+	
	<u>Helobdella</u> sp	32	38	
	<u>Erpobdella</u> (?) sp	9+	5+	
	<u>Placobdella parasitica</u>		+	
	<u>Hyalella</u> azteca		+	
Amphipoda:	<u>Orconectes</u> sp	1+	2+	
Decapoda:	<u>Boyeria</u> vinosa	1+		
	<u>Cordulia</u> (?) sp		1	
Odonata:	<u>Enallagma</u> (?) sp	+	+	
	Coenagrionidae		16	
	<u>Argia</u> (?) sp	1+		
	Diptera:	<u>Cricotopus</u> sp	268+	144+
		<u>Pentaneura</u> sp	16	96+
Ceratopogonidae		27	1	
Unidentified		63	120	
Coleoptera:	<u>Dubiraphia</u> sp	12	16	
	<u>Helichus</u> sp	+		
	<u>Peltodytes</u> sp		+	
Gastropoda:	<u>Physa</u> sp	83+	24+	
	<u>Ferrissia</u> sp	8		
	<u>Helisoma</u> sp		+	
	Number of organisms/Sq. Ft. (b)	403	1178	
	Total number of taxa	17	18	
	d (b)	2.07	0.73	
	e (b)	0.38	0.14	

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

HOCKING RIVER BASIN

Clear Creek

Biological stations were established in Clear Creek to collect baseline data on diversity and equitability values of a benthic aquatic community in a stream with consistently high water quality. Clear Creek has a minimal number of sources of pollutants, and relatively high values for the diversity index and equitability were anticipated from these stations. Clear Creek is located in Fairfield and Hocking Counties and drains 91.3 square miles, most of which is heavily forested hills of sandstone, shale, and limestone. The upper reaches of the stream receive run off from agricultural operations. The village of Amanda (population 788) discharges water from storm sewers into Clear Creek. Some of these storm sewers carry effluent from residential septic tanks. The Midwest Fabricating Company, within the village of Amanda, also discharges an estimated 100 gallons of waste water daily containing 2.6 pounds of BOD, 0.1 pounds of total dissolved solids, and 0.1 pounds of total iron (personal communication with OEPA, Central District Office, 1975).

Five stations for biological sampling were established in Clear Creek for the period July 12 to August 23, 1974. Station I was located approximately ten miles downstream from the village of Amanda and immediately upstream from the bridge at the intersection of Revenge and Snortin Hollow Roads. Each additional station was located, moving downstream, approximately one mile apart. The last station (V) was located immediately upstream from the USGS gaging station at Wyandot bridge (see the Appendix). The general locations of these stations are shown in Figure 2. Data from the gaging station show an average flow during the sampling period of 24.7 cfs. The results of the biological sampling are shown in Table 8.

Table 8
Organisms Collected on Artificial Substrate Samplers
from Clear Creek, July 12 to August 23, 1974^(a)

Taxa		Station				
		I	II	III	IV	V
Coelenterata:	<u>Hydra</u> sp	2	66	4	27	5
Nematoda:	Unidentified			1	2	
Bryozoa:	Unidentified	1	1	1	1	
Annelida:	<u>Oligochaeta</u>	117	77+	127+	31+	9
Amphipoda:	<u>Hyalella azteca</u>		+			
Decapoda:	<u>Orconectes</u> sp	+	3+		2+	+
Hydracarina:	Unidentified		1			
Ephemeroptera:	<u>Stenonema interpunctatum</u>	13	20	37+	45+	8+
	group					
	<u>Stenonema tripunctatum</u>			4	1	
	group					
	<u>Stenonema pulchellum</u>	88+	5+	90+	16+	3+
	group					
	<u>Ephemera simulans</u>		2	4	2	
	<u>Tricorythodes</u> sp	1	8	2		
	<u>Baetis</u> sp					1
	<u>Caenis</u> sp					+
	<u>Centroptilum(?)</u> sp					+
	<u>Cinygmula</u> sp			4		
	<u>Isonychia</u> sp		+	+		+
Odonata:	<u>Boyeria vinosa</u>	+	+	+	1+	4+
	<u>Gomphus</u> sp			+	+	
	Gomphidae	+				
	<u>Argia</u> sp			1		
	<u>Agrion</u> sp		1	3		+
	<u>Enallagma(?)</u> sp			+		
Hemiptera:	Corixidae			+	+	+
Megaloptera:	<u>Corydalus</u> sp		+	+		
Trichoptera:	<u>Hydropsyche bifida</u> group	14+	+	1+	1+	+
	<u>Cheumatopsyche</u> sp	13+	+	10+	+	+
	Hydroptilidae	1+				
Coleoptera:	<u>Dubiraphia</u> sp			1		
	<u>Macronychus glabratus</u>	1		11	11	1
	<u>Helichus</u> sp		+			+
	<u>Ancyronyx variegata</u>				+	+
	<u>Hydrochus</u> sp				+	
Diptera:	<u>Polypedilum</u> sp				42	4
	<u>Polypedilum fallax(?)</u>	254	184+	231+	277+	51
	<u>Glyptotendipes</u> sp					4
	<u>Chironomus</u> sp	28		133+	+	19+
	<u>Tanytarsus</u> sp	422	198+	63		
	<u>Tribelos</u> sp	112				11
	<u>Einfeldia</u> sp	84		7		

Organisms Collected on Artificial Substrate Samplers
from Clear Creek, July 12 to August 23, 1974 (a)
(Cont'd)

Taxa	I	II	Station III	IV	V
Diptera: (Cont'd)					
<u>Cricotopus</u> sp	84	14	7		
<u>Pentaneura</u> sp	112	170+	21+	69+	18+
<u>Cryptochironomus</u> sp			7	14	2
<u>Microtendipes</u> sp		14			
<u>Dictrotendipes</u> sp		127	14	29	21
<u>Ceratopogonidae</u>					3
<u>Tabanidae</u>			+	+	
<u>Empididae</u>	11		3		
<u>Simuliidae</u>	+	+		+	
Unidentified	169	111	119	28	44
Gastropoda:					
<u>Physa</u> sp	1+	5+	9	13+	7+
<u>Ferrissia</u> sp	8	3+	58+	53+	8+
Pelecypoda:					
<u>Sphaerium</u> sp		+			
Number of organisms/ Sq. Ft. (b)	307	202	195	133	45
Total number of taxa	25	28	35	28	29
\bar{d} (b)	3.23	3.11	3.44	3.04	3.50
e(b)	0.65	0.67	0.57	0.59	0.88

(a) Qualitative samples were also collected from the natural substrates and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

At the time of retrieval of the artificial substrates and collection of the qualitative samples, water was collected for chemical analyses at stations I and V. The results are shown in Table 9. Other than the high BOD reading at station I, chemical parameters measured do not suggest a degraded water quality condition existed in this stream segment. A pesticide scan of water samples from stations I and V showed no measurable amounts of pesticides present.

The diversity indices from station I to V were 3.23, 3.11, 3.44, 3.04, and 3.50 respectively, and these values are indicative of high water quality throughout this five mile segment. Equitability values ranged from a moderate value (0.57) at station III to a high value (0.88) at station V. The number of organisms per square foot decreased downstream from station I where there were 307 organisms collected, to station V where 45 organisms were collected. The total number of taxa averaged 28.2 per station and ranged from 26 at station I to 34 at station III. The total number of taxa collected throughout the five mile segment was 53.

Fourteen taxa from the orders Trichoptera, Ephemeroptera, and Megaloptera were collected, although most in relatively small numbers. Most of these taxa are considered residents of high water quality areas. Dipterans of the family Chironomidae were the dominant organisms at all stations. The genus Tanytarsus was the dominant organism at stations I and II and has been classified as facultative/tolerant with regard to its sensitivity to pollution. Polypedilum fallax was the dominant species at stations III, IV, and V and has been classified as intolerant/facultative.

Based on the diversity and equitability values and the number of taxa collected at all stations, it is apparent that waste water originating in or near Amanda had an insignificant effect on the stream biota in this segment during the sampling period.

Table 9
Water Quality Data Collected from
Clear Creek, August 23, 1974

Parameter	Station	
	I	V
Temperature, field, °C	22.0	19.0
Dissolved oxygen, field, mg/l	11.8	7.8
Conductivity, micromhos	240	355
pH, standard units	8.7	8.3
BOD, mg/l	8.4	1.9
Nitrogen Ammonia, mg/l	0	0.04
Aluminum, ug/l	300	700
Barium, ug/l	300	300
Beryllium, ug/l	0	0
Cadmium, ug/l	0	0
Chromium, ug/l	0	0
Copper, ug/l	0	0
Iron, total, ug/l	400	800
Lead, total, ug/l	0	0
Manganese, ug/l	400	90
Nickel, ug/l	0	0
Selenium, ug/l	0	0
Silver, ug/l	0	0
Tin, ug/l	0	0
Zinc, ug/l	0	0
TKN, mg/l	0	1.0

GREAT MIAMI RIVER BASIN

Great Miami River Sidney Sewage Treatment Plant, Sidney Water Treatment Plant

The Great Miami River Basin has a drainage area of 5,385 square miles which includes portions of twelve counties. This biological investigation was conducted in Shelby County near Sidney, Ohio in a segment of the river approximately 123 miles upstream from the mouth. Two major point sources discharge into this segment of the river. The Sidney Water Works discharges 0.095 million gallons per day with a present average daily load of 47,240 pounds of dissolved solids and 8,000 pounds of suspended solids. The Sidney Sewage Treatment Plant contributes 3.1 million gallons per day to the Great Miami River with a present average daily load of 362 pounds of BOD, 3129 pounds of suspended solids, 582 pounds of total phosphorus, and 1810 pounds of ammonia (OEPA, 1974b). A 96 hour static bioassay conducted on the effluent of the Sidney Sewage Treatment Plant in October, 1974 indicated no significant acute toxicity on the test fish, Pimephales promelas.

The ammonia concentration approximately one mile upstream from the sewage treatment plant was 0.4 mg/l and at approximately 2.5 miles downstream from the plant the concentration was 1.2 mg/l. During low flow conditions (21.2 cfs) the river violates stream water quality standards with concentrations of ammonia at 6.5 mg/l and dissolved oxygen at 4.5 mg/l (OEPA, 1974b).

Four biological stations were established in the Great Miami River for the sampling period August 27 to October 8, 1974. The general locations of these stations are shown in Figure 3. Station I was located about 1.5 miles upstream from the sewage treatment plant and was about 300 yards upstream from the discharge of the Sidney water works. The results are shown in Table 10.

Table 10
 Organisms Collected on Artificial Substrate Samplers
 from the Great Miami River, August 27 to October 8, 1974 (a)

Taxa		Station			
		I	II	III	IV
Coelenterata:	<u>Hydra</u> sp	2			
Turbellaria:	Unidentified			4	
Nematoda:	Unidentified			4	
Bryozoa:	Unidentified	1			+
Annelida:	<u>Oligochaeta</u>	171	78+	258	125
	<u>Hirudinea</u>		4		
Isopoda:	<u>Lirceus fontinales</u>	2	1+		
Amphipoda:	<u>Hyalella azteca</u>	+			
Decapoda:	<u>Oroonectes</u> sp		+		
	<u>Astacidae</u>		1		
Plecoptera:	<u>Acroneuria lycorias</u>		1		
	<u>Phasganophora capitata</u>				1
Ephemeroptera:	<u>Stenonema interpunctatum</u> group	156+	63+	186	252+
	<u>Stenonema pulchellum</u> group	56	49+		390+
	<u>Stenonema tripunctatum</u> group				+
	<u>Baetis</u> sp	2+	9+		56
	<u>Caenis</u> sp	18	17	9	
	<u>Tricorythodes</u> sp	2	4		19
	<u>Ephemera simulans</u>		+		
	<u>Potamanthus</u> sp				+
Odonata:	<u>Argia sedula</u>		2		
	<u>Argia</u> sp			4	+
	<u>Hyponeura</u> (?) sp				4
	<u>Agrion aequabile</u>				2
Hemiptera:	<u>Corixidae</u>	+			
Megaloptera:	<u>Corydalus</u> sp		1		
Trichoptera:	<u>Hydropsyche bifida</u> group	4	23+		47
	<u>Hydropsyche simulans</u> (?)				52
	<u>Cheumatopsyche</u> sp	112	131+	2	603+
	<u>Neureclipsis</u> sp	16+	4	18	3+
	<u>Psychomyiid</u> Genus A			6	
	<u>Limnephilus</u> (?) sp	+			
Coleoptera:	<u>Dubiraphia</u> sp	+	4		+
	<u>Macronychus glabratus</u>	4	4	1	9
	<u>Stenelmis</u> sp		10+		1
	<u>Peltodytes</u> sp	+			
	<u>Psephenus</u> sp	+			
Diptera:	<u>Tanytarsus</u> sp A	115	33	79	252+
	<u>Tanytarsus</u> sp B	29	11	10	18
	<u>Tanytarsus</u> sp C	29			
	<u>Pentaneura</u> sp	128	17	1	111
	<u>Ablabesmyia</u> sp			16	
	<u>Cricotopus</u> sp	94	25	4	67
	<u>Corynoneura</u> sp	18	8	39	24

Organisms Collected on Artificial Substrate Samplers
from the Great Miami River, August 27 to October 8, 1974 (a)
(Cont'd)

Taxa	Station			
	I	II	III	IV
Diptera: (Cont'd)				
<u>Psectrocladius</u> sp		4	1	23
<u>Microtendipes</u> sp	80+	8	16	
<u>Glyptotendipes senilis</u>	224	16	67	15
<u>Glyptotendipes</u> sp	96+	4	307	
<u>Chironomus</u> sp			16	
<u>Cryptochironomus</u> sp				15
<u>Polypedilum fallax</u>	64	12	32	8
<u>Polypedilum</u> sp	72	24	1	69
<u>Tribelos</u> sp		4	32	
<u>Palpomyia</u> (?) sp	2			
<u>Culicoides</u> (?) sp	2		4	
Empididae	4			2
Gastropoda:				
<u>Ferrissia</u> sp	6+	7+	23	5
<u>Physa</u> sp	+			
<u>Goniobasis</u> (?) sp		5+		
Number of organisms/Sq. Ft. (b)	302	117	228	435
Total number of taxa	35	34	26	31
\bar{d} (b)	3.89	3.97	3.20	3.33
e (b)	0.78	0.72	0.50	0.57

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

The diversity index and equitability values were 3.89 and 0.78 respectively, an indication of very high water quality. Representatives of the orders Ephemeroptera and Trichoptera were collected at this station.

Station II was located approximately 300 yards downstream from the discharge of the Sidney water works under the North Street Bridge and above the sewage treatment plant approximately 1.15 miles. The substrate was covered with a lime sludge during the sampling period which turned the water milky white when the bottom was disturbed. The diversity index calculated at this site was 3.97, one of the highest determined by the OEPA Biological Laboratory staff during 1974. A number of caddisflies and mayflies were collected here as well as one species of stonefly. Numerous crayfish were also present in the area. Apparently the lime sludge of the Sidney water works was not adversely effecting the biota which colonized the artificial substrate samplers during the sampling period.

Station III was located just off Van Denmark Road approximately one mile below the discharge point of the Sidney Sewage Treatment Plant. The diversity index of 3.20 calculated at this station was slightly decreased when compared to upstream stations but indicated very good water quality. The equitability value was reduced to 0.50. While the diversity index was high, there is evidence that the discharge from the Sidney plant may have a deleterious effect on the substrate. No organisms were collected in the qualitative sample suggesting that while the water flowing above the substrate may have been suitable for aquatic life, as indicated by the colonization of the multiple plate samplers, the substrate may have been less suitable. The number of taxa collected also decreased from 34 at station II to 26 at station III.

Station IV was located 2.5 miles below the sewage treatment plant discharge. The diversity index at this station was 3.33 and the equitability calculation was

0.57. Unlike station III organisms were taken in the qualitative samples at this site. Members of the orders Plecoptera, Trichoptera, and Ephemeroptera were also collected. This indicated a recovery during the collecting period from the probable deleterious effects mentioned at the previous upstream site.

This investigation indicates that the Sidney Sewage Treatment Plant and the Sidney water works had no significant effect on the biota of the Great Miami River during August 27 to October 8, 1974 as determined by the use of artificial substrate samplers. The deleterious effect on the substrate indicated below the sewage treatment plant may be a minor one involving a relatively small area of the stream.

GREAT MIAMI RIVER BASIN

Dick's Creek
Armco Steel Corporation

Dick's Creek, located in Butler and Warren Counties, drains 47.6 square miles and enters the Great Miami River below Middletown, Ohio. The major discharger to this stream is Armco Steel Corporation with five separate outfalls, one of which is located in the North Branch of Dick's Creek. Five private treatment facilities discharge into Dick's Creek upstream from the Armco outfalls. The effluent from one municipal plant, the Monroe sewage treatment facility, also enters Dick's Creek between the North Branch and Armco outfall 005 by way of Shaker Creek, a distance of 1.6 miles from the Armco plant.

Three stations for biological sampling were established in Dick's Creek for the period July 8 to August 19, 1974. The general locations of these stations are shown in Figure 3. Figure 4 shows the location of the biological sampling stations relative to the outfalls. Station I was located approximately 400 feet upstream from Armco outfall 003 off Oxford State Road about 1.5 miles west of Cincinnati-Dayton Road. The total of all loadings into Dick's Creek above this point was slightly in excess of six million gallons per day of which 5.6 million gallons originate from Armco outfalls 004 and 005. Table 11 characterizes the loadings from private and industrial dischargers upstream from station I (OEPA, 1974b).

Station II was located approximately 1.5 miles below outfall 003 and just west of Yankee Road. Table 12 lists the Armco outfalls and characterizes the effluent of each between stations I and II (OEPA, 1974b). Station III was located 1.5 miles downstream from station II and near the Main Street bridge (see the Appendix). The results of the biological sampling are shown in Table 13.

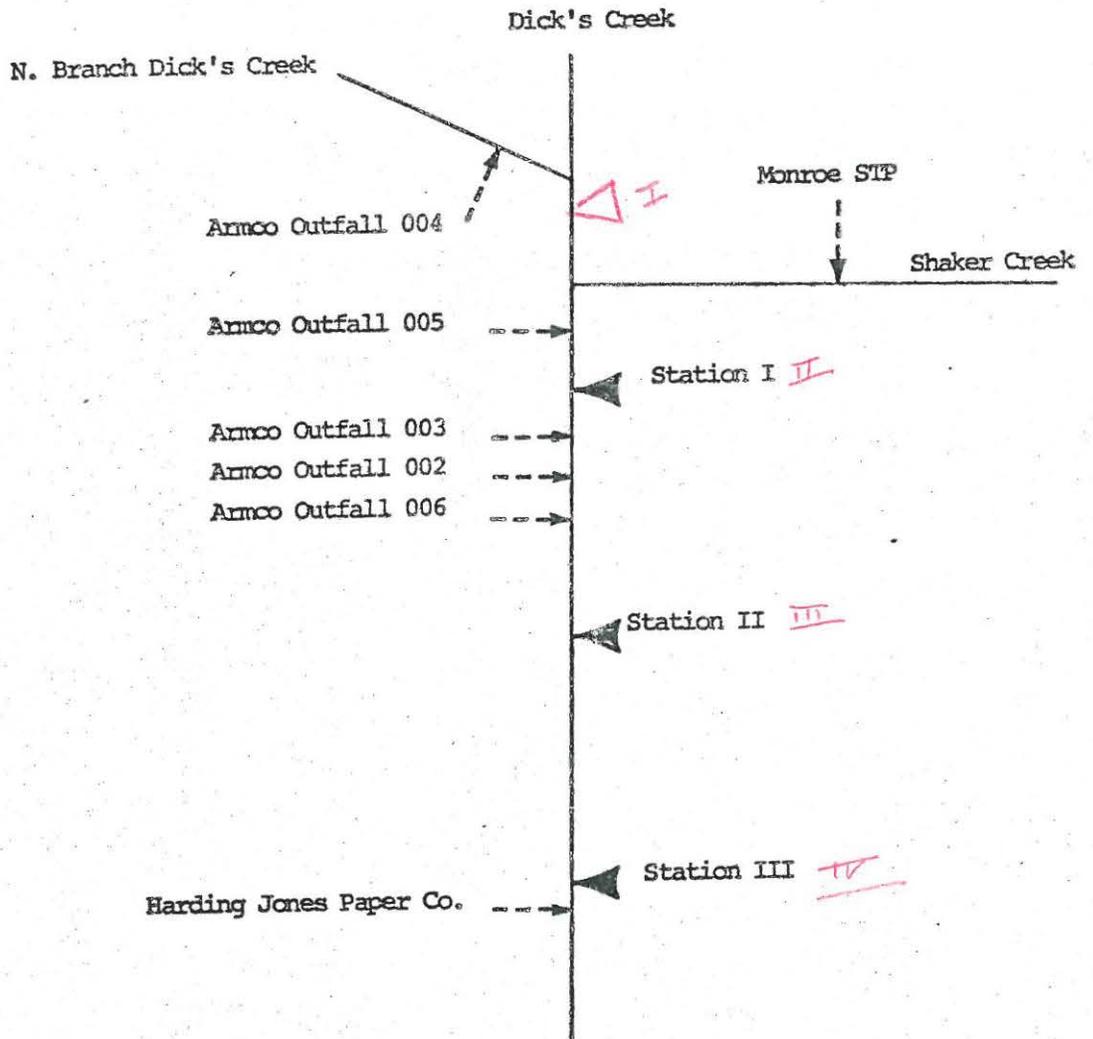


Figure 4
 Location of Biological Sampling
 Stations in Dick's Creek Relative to
 Industrial and Municipal Outfalls

I-IV = 1975

Table 11
LOADINGS FROM PRIVATE AND INDUSTRIAL DISCHARGERS
ON DICK'S CREEK, UPSTREAM FROM STATION I

	Knollbrook Meadows STP	Midtown Investment Co.	Armco Steel Outfall 004	Otterbein Home STP	Lebanon Correctional Invst. STP	Congress Inn	Armco Steel Outfall 005	Total	
Flow	0.035	0.030	1.7	0.05	0.289	0.025	3.9	6.029	mgd
BOD ₅	8.8	7.5	36.0	12.5	32.1	6.3	32.0	135.2	lbs/day
TSS	8.8	7.5	53.8	12.5	36.2	6.3	1432.0	1557.1	lbs/day
Tot P	2.0	1.8	UK	2.9	7.78	1.5	UK	15.98	lbs/day
NH ₃	2.9	2.5	0.2	4.2	24.1	2.1	2.0	38.0	lbs/day
pH	UK	UK	7.9	UK	UK	UK	8.1		S.U.
TDS	UK	UK	38,000	UK	UK	UK	23,000	61,000	lbs/day
NO ₂ -NO ₃	UK	UK	38.0	UK	UK	UK	77.0	115.0	lbs/day
COD	UK	UK	820	UK	UK	UK	550	1370.0	lbs/day
Fe	UK	UK	5.67	UK	UK	UK	10.0	15.67	lbs/day
F	UK	UK	15.0	UK	UK	UK	26.0	41.0	lbs/day
Zn	UK	UK	UK	UK	UK	UK	0.3	0.3	lbs/day

Table 12
LOADINGS FROM DISCHARGERS
BETWEEN STATIONS I AND II

	Armco Outfall 003	Armco Outfall 006	Armco Outfall 002	Total
Flow	1.4	0.45	1.7	3.55 mgd
pH	9.4	UK	7.8	--- S.U.
BOD ₅	25.0	7.0	71.0	103. lbs/day
TDS	11,000	2,200	9,180	23,380 lbs/day
TSS	280.0	32	58.0	370 lbs/day
NO ₂ -NO ₃	34.0	8	55.0	97 lbs/day
NH ₃	3.0	1.0	5.0	9.0 lbs/day
Fe	22.0	0.14	184.0	206.14 lbs/day
Zn	5.0	UK	UK	5 lbs/day
COD	75.0	57.0	610	742 lbs/day
F	75.0	8.0	10	93.0 lbs/day
Phenols	UK	UK	0.067	0.067

Table 13
Organisms Collected on Artificial Substrate Samplers
from Dicks Creek, July 8 to August 19, 1974 (a)

Taxa	Station			
	I	II	III	
Turbellaria:	Unidentified	1	8	
Bryozoa:	<u>Plumatella repens</u>	2		
	<u>Urnatella gracilis</u>	2		
	Unidentified	1		
Annelida:	<u>Oligochaeta</u>	221+	282	
Decapoda:	<u>Orconectes</u> sp	+		
Odonata:	<u>Argia(?)</u> sp	2		
	<u>Anomalagrion(?)</u> sp	+		
	<u>Ishnura</u> sp	+		
Coleoptera:	<u>Dubiraphia</u> sp	2		
Diptera:	<u>Cricotopus</u> sp	15+	4	
	<u>Corynoneura</u> sp	5		
	<u>Procladius</u> sp	2		1
	<u>Ablabesmyia</u> sp	25		
	<u>Pentaneura</u> sp A	17		2
	<u>Pentaneura</u> sp B	4		
	<u>Cryptochironomus</u> sp	1		
	<u>Psectrocladius</u> sp	1	2	1
	<u>Chironomus</u> sp	1		
	<u>Polypedilum fallax</u>	4		
	<u>Glyptotendipes</u> sp	10		
	<u>Tanytarsus</u> sp		1	
	<u>Dasyhelea(?)</u> sp			1
	<u>Culicoides(?)</u> sp	14		1
	Gastropoda:	<u>Physa</u> sp	2+	
	Number of organisms/Sq. Ft. (b)	65	3	59
	Total number of taxa	20	6	7
	\bar{d} (b)	1.94	(c)	0.37
	e (b)	0.29	(c)	0.08

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

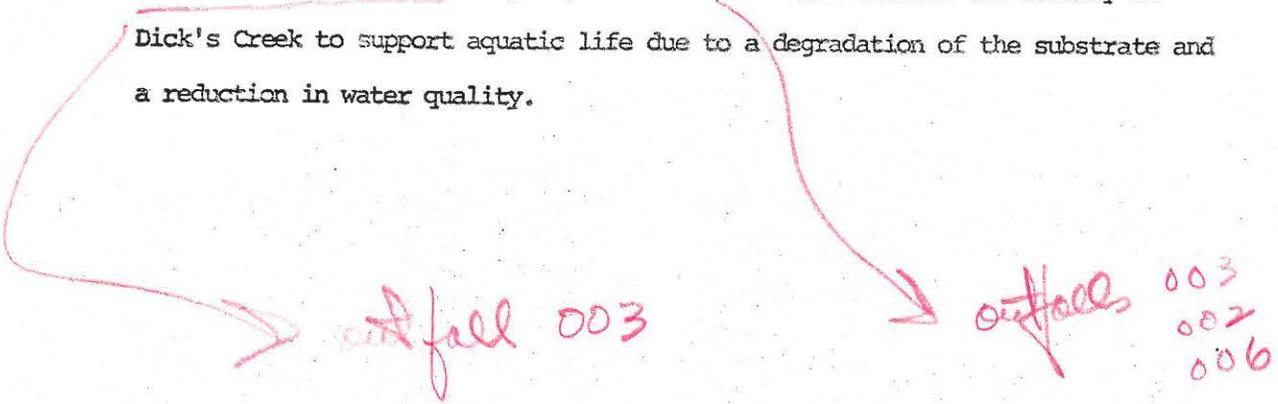
(c) Inadequate number of individuals to calculate \bar{d} .

Upstream from station I above all major dischargers Dick's Creek violates stream water quality standards for fecal coliforms at critical low flow (0.2 cfs) and at the average observed condition (15 cfs). Between stations II and III at critical low flow (28 cfs) the stream violates standards for dissolved oxygen and phenols. At the average observed condition (65 cfs) the stream is in violation of standards only for phenols (OEPA, 1974b). A diversity index of 1.94 and an equitability value of 0.29 were determined at station I indicating that a poor water quality condition existed at this station.

At the time of retrieval of the artificial substrates at station II a 2.5 foot thick deposit of a light brown flocculent material was observed over the stream substrate that had not been present six weeks previously. In addition, the float which was intended to prevent the samplers from laying on the substrate contained water, suggesting that the samplers may have been in contact with the stream bottom. This development would invalidate a diversity index calculated from this site. In any case, only 12 individuals from six taxa were collected on the samplers and no organisms were collected from the natural substrate. While no index was calculated here, it was apparent that the quality of the water as well as the substrate was significantly degraded.

At station III, the total number of organisms increased, due primarily to oligochaetes, but the number of taxa increased by only one over the previous station. An index of 0.37 and an equitability value of 0.08 were calculated for this site indicating a very poor water quality condition. The substrate at this site had a deposit of the light brown flocculent noted at station II, but not nearly as thick. A thin layer of the material coated the substrate at this station. The decreased amount of flocculent material may have allowed the oligochaetes, a burrowing type organism, to inhabit the area -- a situation not possible at station II because of the depth of the material.

This investigation indicates that though the water quality above the Armco Steel Corporation is poor, the Armco effluent reduces the ability of Dick's Creek to support aquatic life due to a degradation of the substrate and a reduction in water quality.



GREAT MIAMI RIVER BASIN

Bluejacket Creek
Bellefontaine Sewage Treatment Plant

Bluejacket Creek located in Logan County drains 16 square miles. The Bellefontaine Sewage Treatment Plant, located on Opossum Run 0.5 mile upstream from its confluence with Bluejacket Creek, discharges 3.15 million gallons of effluent per day to the stream. The average daily load of the Bellefontaine plant is 315.3 pounds of BOD, 577.9 pounds of total suspended solids, 184 pounds of total phosphorus, and 262.7 pounds of ammonia (CEPA, 1974b). A 96 hour static bioassay analysis conducted on the effluent in July, 1974, demonstrated no significant acute toxicity.

Bluejacket Creek violates water quality standards downstream from the confluence of Opossum Run at critical low flow (2.0 cfs). Examples of violations at a sampling station 2.2 miles downstream from the Opossum Run inflow include fecal coliforms 3,000/100 ml, ammonia 6.0 mg/l, and dissolved oxygen below detectable concentrations. At a flow of 20.5 cfs at this station violations of fecal coliform (2,000/100 ml) and ammonia (2.0 mg/l) were reported (CEPA, 1974b).

Five stations for biological sampling were located in Bluejacket Creek for the period July 15 to August 26, 1974 (see the Appendix). The general locations of these stations are shown in Figure 3. The results are shown in Table 14.

Station I was located in Bluejacket Creek about one mile above the confluence with Opossum Run. A diversity index of 1.35 and an equitability value of 0.28 were calculated for this station. Station II was located in Bluejacket Creek 0.25 mile below its confluence with Opossum Run. This site was 0.75 mile downstream from the discharge of the Bellefontaine Sewage Treatment Plant. The diversity index was 2.04 and equitability value 0.47.

Table 14
 Organisms Collected on Artificial Substrate Samplers
 from Bluejacket Creek, July 15 to August 26, 1974 (a)

Taxa		I	II	Station		
				III	IV	V
Turbellaria:	Unidentified	+	1			
Nematoda:	Unidentified	7	24	48	50	12
Annelida:	Oligochaeta	134+	97+	870+	336+	161+
Isopoda:	Lirceus sp	3+				
Decapoda:	Astacidae	+				
Ephemeroptera:	Baetis sp					29+
Odonata:	Coenagrionidae	+		2		
	Ishmura sp		3+	+	6+	4+
	Argia sedula	+				4
	Enallagma sp		+		+	
	Argia sp					+
	Aeshna sp	+		+		
	Anax amazili				+	+
	Boyeria vinosa				+	3+
	Agrion aequabile					5+
	Hetaerina sp					1+
	Archilestes grandis	+				
Hemiptera:	Corixidae				+	+
Trichoptera:	Agraylea sp					9+
	Hydropsyche bifida group					+
	Hydropsyche sp					17
Coleoptera:	Peltodytes sp			+	+	+
	Eretes sp					+
	Laccophilus sp					+
	Enochrus sp			+		
	Berosus sp					3+
	Tropisternus sp			+		
	Dubiraphia sp	2				
	Dubiraphia bivittata					+
	Stenelmis sp	1				
Diptera:	Anthomyiidae	1				
	Empididae		1			23+
	Ephydriidae					+
	Simuliidae				+	1+
	Simulium sp			+		
	Limonia(?) sp		2+			
	Palpomyia(?) sp		1+		5	
	Culicoides(?) sp	1	1		1	3
	Limnophora aequifrons		+			
	Pseudolimnophila(?) sp					2
	Chironomus sp			4		+
	Cricotopus sp		128+	12+	8+	469+
	Pentaneura sp	1	164+	60+	300+	855+
	Psectrocladius sp			5		
	Procladius sp	1+		4	16+	32+

Organisms Collected on Artificial Substrate Samplers
from Bluejacket Creek, July 15 to August 26, 1974 (a)
(Cont'd)

Taxa	I	II	Station III	IV	V
Diptera: (Cont'd)					
<u>Ablabesmyia</u> sp			1		
<u>Corynoneura</u> sp		2		4	2
<u>Dictrotendipes</u> sp		4			
<u>Polypedilum fallax</u>				8	48
<u>Polypedilum</u> sp					32
<u>Cryptochironomus</u> sp					16+
<u>Tanypus</u> sp					+
<u>Tanytarsus</u> sp	3				
<u>Glyptotendipes senilis</u>				16	
<u>Psectrotanypus</u> sp				+	
Gastropoda:					
<u>Basommatophora</u>					1
<u>Lymnaea</u> sp				+	
<u>Physa</u> sp	1+				
Number of organisms/ Sq. Ft. (b)	35	86	252	188	346
Total number of taxa	17	14	15	19	35
\bar{d} (b)	1.35	2.04	0.83	1.84	2.24
e (b)	0.28	0.47	0.23	0.40	0.29

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

Station III was located one mile further downstream and beyond the dissolved oxygen sag point during the sampling period. The diversity index was 0.83 and the equitability value was 0.23. The number of oligochaetes at this station increased dramatically, comprising 86% of the total number of organisms found. At station III the water was clouded with black organic matter and an odor of sewage became very obvious when the substrate was disturbed.

The lower diversity and equitability values at station III compared to those at station II located closer to the discharge of the effluent may be explained in the following manner. If the stress originating from a sewage treatment plant is confined to the biochemical oxygen demand, i.e., there is no toxicity associated with chlorine, heavy metals, or some other parameter, than that point where the stress will first be measurable may not be before the dissolved oxygen sag point. During this sampling period the location of the sag point was estimated to be 1.1 miles below the Bellefontaine Sewage Treatment Plant (personal communication with OEPA, Technical Advisory Group, 1975) and therefore 0.35 miles below station II.

Station IV was located one mile downstream from station III, and station V, three miles downstream from station III. Both stations IV and V indicated recovery with diversity indices of 1.84 and 2.24 respectively. The number of taxa increased at these stations with 20 taxa at station IV and 35 taxa at station V. Both mayflies and caddisflies were present at the latter site, a good indication of water quality improvement. The black organic matter and sewage odor encountered at station III were not present at stations IV and V. While the equitability value increased to 0.40 at station IV, it decreased to 0.29 at station V.

Stress factors originating from non-point source discharges, such as the railroad yards or oil storage facility located upstream from station I, may account for the low diversity and equitability values at this station. The discharge from the Bellefontaine Sewage Treatment Plant reduces this effect through dilution above the dissolved oxygen sag point at station II. The diversity value at station III reflects the degraded conditions brought about by the sewage effluent below the dissolved oxygen sag point. Values at station IV indicate some improvement and are similar to station I. Further improvement is indicated at station V.

GREAT MIAMI RIVER BASIN

Mad River, Dugan's Run
ITE Imperial, Howard Paper, W.B. Marvin Company
Chicago Vitreous

Dugan's Run drains 27.6 square miles of Champaign County before it joins the Mad River near Urbana, Ohio. The effluents of ITE Imperial, Howard Paper, W.B. Marvin Manufacturing Company, and Chicago Vitreous discharge into the stream. The average daily loadings of each are listed in Table 15 (OEPA, 1974b).

At a sampling point in Dugan's Run located downstream from the ITE Imperial outfall and upstream from the discharges of Howard Paper, W.B. Marvin Manufacturing Company, and Chicago Vitreous, the following concentrations of selected parameters were reported (OEPA, 1974b) at a flow of 8 cfs: dissolved oxygen 7.1 mg/l, total phosphorous 0.1 mg/l, ammonia 0.2 mg/l, and COD 40 mg/l.

Two additional entities discharge into the Mad River downstream from the confluence of Dugan's Run and between Mad River mile points 39.0 and 36.2. Approximately 500 feet downstream from Dugan's Run, the Urbana Sewage Treatment Plant discharges 1.64 million gallons per day of effluent to the river with an average daily load of 780 pounds of BOD and 385 pounds of total dissolved solids. According to estimates based on the type of treatment at the plant, 99.3 pounds of total phosphorus and 142 pounds of ammonia enter the river from the plant. About one mile below Dugan's Run, American Aggregates discharges 4.03 million gallons per day of clear non-toxic effluent to the stream (OEPA, 1974b). No other data were available on the loadings from this source.

Table 15
Average Daily Loadings into Dugan's Run

	IIE Imperial	Howard Paper	W.B. Marvin Mfg. Co.	Chicago Vitreous	
Flow	0.439	UK	0.01	0.15	MGD
pH	8.4	UK	NA	NA	SU
TSS	149	UK	2.58	NA	pounds/day
TCu	2.3	UK	UK	NA	pounds/day
TCr	0.168	UK	1.3	NA	pounds/day
Zn	1.20	UK	1.59	NA	pounds/day

In the Mad River about 0.5 mile upstream of Dugan's Run the average concentrations of selected parameters were reported as follows: 1.5 mg/l BOD, 0.2 mg/l total phosphorus, 0.05 mg/l ammonia, and 14.0 mg/l of chlorine. About one mile downstream from the Urbana Sewage Treatment Plant and about 50 feet below the American Aggregate's outfall the average concentrations of the same parameters were reported as follows: 3.7 mg/l BOD, 0.1 mg/l total phosphorus, 0.2 mg/l ammonia, and 17 mg/l chlorine (OEPA, 1974b).

In September, 1974 a static bioassay analysis using the fathead minnow, Pimephales promelas, was conducted on the ITE Imperial effluent. The effluent was toxic (lethal) to 50% of the test organisms during the 96 hour test period at a concentration of 24%. On September 11, 1974 fish live bags, each containing 10 fathead minnows, were placed at the following locations: in Dugan's Run about 3.2 miles downstream from ITE Imperial; in Dugan's Run about 16 miles downstream from ITE Imperial; and in the Mad River about 50 feet upstream from its confluence with Dugan's Run. All of the fish in the live bag nearest the ITE Imperial discharge died following a 24 hour exposure, but all of the fish survived in the other two live bags. However, there was a severe rainstorm during the exposure period, which may have diluted toxic materials in Dugan's Run reducing the possible impact on the caged fish further downstream.

The general locations of the biological sampling stations are shown in Figure 3. Four stations for biological sampling were located in Dugan's Run and the Mad River for the period July 9 to August 20, 1974. The results of the sampling are shown in Table 16. The specific locations of these stations may be found in the Appendix and a diagram showing their locations relative to the industrial and municipal outfalls is found in Figure 5.

Table 16
Organisms Collected on Artificial Substrate Samplers
from the Mad River and Dugans Run, July 9 to August 20, 1974 (a)

Taxa		Station			
		Dugans Run I	II	Mad River III	IV
Turbellaria:	Unidentified		219+	260+	45+
Nematoda:	Unidentified	2		1	
Annelida:	Oligochaeta	46+	127+	80	50+
	<u>Helobdella stagnalis</u>				+
	<u>Erpobdella punctata</u>				+
Isopoda:	<u>Lirceus fontinalis</u>		6+		2
Amphipoda:	<u>Hyalella azteca</u>				+
Decapoda:	<u>Orconectes</u> sp		+		
Hydracarina:	Unidentified	2		1	
Ephemeroptera:	<u>Stenonema interpunctatum</u> group		140+		25+
	<u>Stenonema pulchellum</u> group		14		
	<u>Baetis</u> sp		6+	1	17
	<u>Tricorythodes</u> sp		4		
Odonata:	<u>Argia sedula</u>		+		
Trichoptera:	<u>Hydropsyche bifida</u> group		25+	2+	88+
	<u>Hydropsyche</u> sp				36+
	<u>Cheumatopsyche</u> sp		21		+
	Psychomyiid Genus A		1		1
	<u>Agraylea</u> sp		13+	3	3+
Coleoptera:	<u>Dubiraphia bivittata</u>		1+		
	<u>Dubiraphia</u> sp		8	1	
	<u>Stenelmis</u> sp		2+		
	<u>Ootioservus</u> sp		13+	1	1
	<u>Microcylløopus</u> sp		1		
Diptera:	<u>Tipula</u> sp			1	
	<u>Limonia</u> sp			+	
	<u>Simulium vittatum</u>		+		
	<u>Tanytarsus</u> sp A		179	1	10
	<u>Tanytarsus</u> sp B		30		
	<u>Pentaneura</u> sp		124	59	199+
	<u>Ablabesmyia</u> sp		10	5	
	<u>Clinotanyvus</u> sp			5	
	<u>Chironomus</u> sp		+		
	<u>Cryptochironomus</u> sp		19+		
	<u>Endochironomus</u> sp		18+	+	
	<u>Microtendipes</u> sp		281+		
	<u>Polypedilum fallax</u>		37	14	9
	<u>Polypedilum</u> sp		143+		
	<u>Tribelos</u> sp		1		
	<u>Phaenopsectra</u> sp				+
	<u>Procladius</u> sp		+		
	<u>Cardiocladius</u> sp		+		
	<u>Psectrocladius</u> sp			1	

Organisms Collected on Artificial Substrate Samplers
from the Mad River and Dugans Run, July 9 to August 20, 1974 (a)
(Cont'd)

Taxa		Station			
		Dugans Run I	II	Mad River III	IV
Diptera: (Cont'd)	<u>Trichocladus</u> sp				42
	<u>Cricotopus</u> sp			+	18+
	<u>Corynoneura</u> sp		48		
	<u>Metriocnemus</u> (?) sp				13
	<u>Brillia</u> sp				9
	<u>Psilodiamesa</u> (?) sp				1
	Unidentified		5		9
Gastropoda:	<u>Palpomyia</u> (?) sp	1			
	<u>Physa</u> sp		2+		1+
	<u>Ferrissia</u> sp		1		
Pelecypoda:	<u>Goniobosis</u> (?) sp				+
	<u>Pisidium</u> sp		+		
	Number of organisms/ Sq. Ft. (b)	10	300	87	116
	Total number of taxa	4	37	19	26
	\bar{d} (b)	(c)	3.65	1.82	3.18
	e (b)	(c)	0.60	0.29	0.65

- (a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.
- (b) Artificial substrate sample only.
- (c) Inadequate number of individuals to calculate \bar{d} .

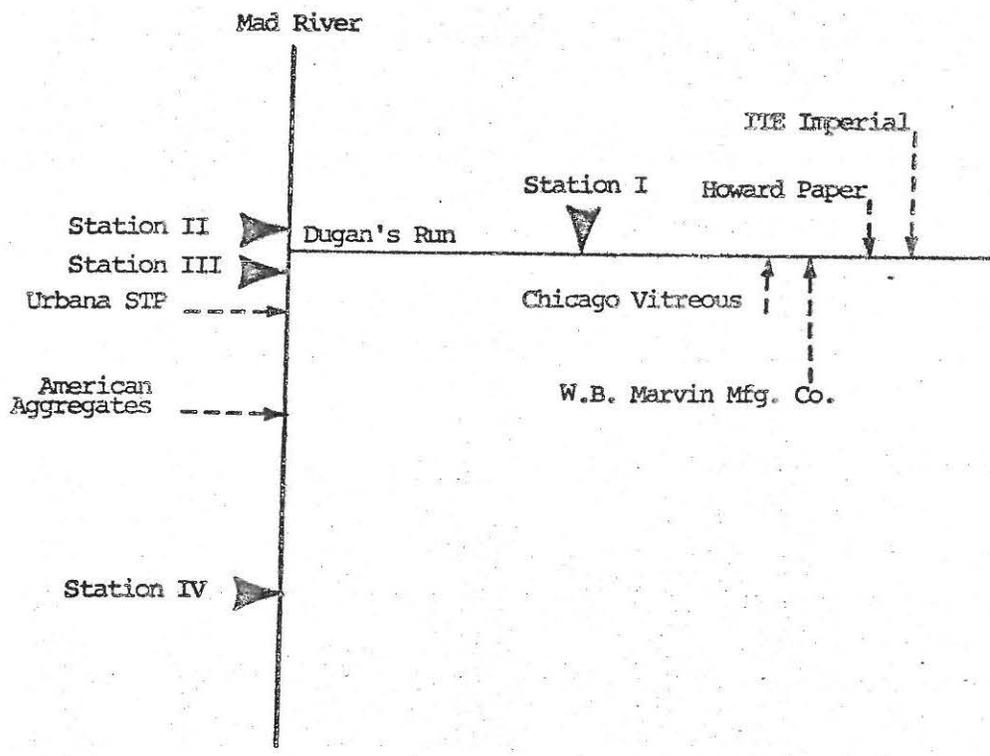


Figure 5

Location of Biological Sampling Stations
 in Dugan's Run and the Mad River
 Relative to Industrial and Municipal Outfalls

Station I was located in Dugan's Run about two miles downstream from the ITE Imperial discharge. The quantitative sampling produced only four taxa and a density of ten organisms per square foot, composed mostly of oligochaetes, which is too few to determine a diversity index or equitability value. Algae on the rocks and debris present in the stream was noticeably absent and some parts of the substrate was blue tinted in color. The small number of organisms collected, the lack of algae, and the blue tint present on the substrate may be attributable to the 2.3 pounds of copper discharged daily to Dugan's Run by the ITE Imperial effluent. This effluent combined with the effluents of Howard Paper, W.B. Marvin Manufacturing Company, and Chicago Vitreous produce very poor water quality in this section of Dugan's Run.

Station II was located in the Mad River about 50 feet above the confluence with Dugan's Run. This station yielded a very high diversity index of 3.65 and an equitability value of 0.60. The number of taxa collected was also high (37) and included numerous mayflies and caddisflies all representative of good water quality.

Station III was located in the Mad River about 50 feet below Dugan's Run. The diversity index computed here was 1.82 and the equitability calculation 0.29. The number of taxa collected dropped from 37 to 19 when compared to station II. There was also a drastic reduction in mayflies and caddisflies, a fact indicative of degraded water quality. While Dugan's Run does degrade the water quality of the Mad River, the degradation may not be to the degree indicated by this index. The location of the artificial substrate samplers may have been too close to the Dugan's Run confluence, to allow sufficient mixing of the two streams.

Station IV was located about 2.1 miles below the Dugan's Run confluence which was about two miles below the Urbana Sewage Treatment Plant discharge, and

about one mile below the American Aggregates discharge. The diversity index computed here was 3.18 and the equitability calculation 0.65. The number of taxa collected increased from 19 at station III to 26 and both mayflies and caddisflies were abundant. These factors suggest that the water quality at station IV has recovered even though the sampling station was located below a municipal sewage treatment plant and an industrial discharge.

This study has demonstrated that the industries discharging into Dugan's Run significantly degrade the water quality, and that this degraded water does have a deleterious effect on the water quality of the Mad River although perhaps not to the degree indicated by the diversity index. The water quality about two miles below the Dugan's Run confluence indicates recovery as shown by the benthic biota.

GREAT MIAMI RIVER BASIN

Mud Creek
Park Layne Sewage Treatment Plant

Mud Creek, located in Clark, Miami and Green Counties, drains 27.5 square miles before it joins the Mad River near Crystal Lakes, Ohio. The Park Layne Sewage Treatment Plant discharges 0.6 million gallons per day of effluent to the stream with an average daily load of 315 pounds of BOD, 415 pounds of total suspended solids, 10 pounds of total phosphorus, and 30 pounds of ammonia. The Fairway Terrace Mobile Home Park Sewage Treatment Plant discharges 0.053 million gallons per day of effluent to the stream with an average daily load of 5.3 pounds of BOD, 12.4 pounds of total suspended solids, and 0.4 pounds of ammonia (OEPA, 1974b).

Water quality standards violations have been reported in Mud Creek during critical low flow of 1.0 cfs (OEPA, 1974b). Violations for dissolved oxygen (3.0 mg/l) and ammonia (2.5 mg/l) were reported from a station 0.6 mile upstream from the confluence with the Mad River. No water quality data were available for Mud Creek upstream from this station. Where all three biological stations were located.

The approximate locations by river mile of the pertinent sites in this study are as follows: Station I, 3.75; Park Layne Sewage Treatment Plant, 3.0; Station II, 2.25; Fairway Terrace Mobile Home Park Sewage Treatment Plant, 1.1; Station III, 1.0; and the water quality station, 0.6. The general locations of biological stations are shown in Figure 3.

Station I was located near Dilly Road and approximately 0.75 miles above the Park Layne Sewage Treatment Plant. The results of the biological sampling are shown in Table 17. Five genera of mayflies and 6 genera of caddisflies

Table 17
Organisms Collected on Artificial Substrate Samplers
from Mud Creek, July 8 to August 19, 1974 (a)

Taxa		Station		
		I	II	III
Turbellaria:	Unidentified	43+	8+	4+
Nematoda:	Unidentified		16	4
Bryozoa:	Unidentified		1	+
Annelida:	Oligochaeta	55	3392	1800+
	<u>Helobdella stagnalis</u>	+	+	+
	<u>Dina lateralis</u>		1+	
	<u>Dina</u> sp		1	+
	Hirudinea			12
Isopoda:	<u>Lirceus fontinalis</u>	1749+	164+	20+
Decapoda:	<u>Orconectes</u> sp		+	1
Hydracarina:	Unidentified	+		
Ephemeroptera:	<u>Stenonema interpunctatum</u> group	20	12	12+
	<u>Stenonema tripunctatum</u> group	14		
	<u>Habrophlebiodes</u> sp	1		
	<u>Callibaetis</u> sp	+		
	<u>Baetis</u> sp	+	20+	48+
	<u>Caenis</u> sp		36+	8
Odonata:	<u>Ishnura</u> sp	+		
	<u>Ehallagma</u> (?) sp			+
Hemiptera:	<u>Hesperocorixa</u> sp	+		+
Trichoptera:	<u>Hydropsyche bifida</u> group		8+	+
	<u>Hydropsyche betteni</u>		+	
	<u>Hydropsyche</u> sp		+	
	<u>Cheumatopsyche</u> sp	+	40+	16+
	<u>Polycentropus</u> sp	1		
	<u>Neureclipsis</u> sp	2		
	<u>Agraylea</u> sp	8+		
	<u>Oecetis</u> sp	+		
	Unidentified	1		
Coleoptera:	<u>Dubiraphia bivittata</u>	1		
	<u>Dubiraphia</u> sp	+	4+	8
	<u>Peltodytes simplex</u>	+		
Diptera:	Tipulidae	1		
	<u>Dixa</u> sp	+		
	<u>Ancopheles</u> sp	+		
	Simuliidae	+		
	<u>Tanytarsus</u> sp A	377+	428+	901
	<u>Tanytarsus</u> sp B		499	721
	<u>Tanytarsus</u> sp C			360
	<u>Tanypus</u> sp			+
	<u>Ablebesmyia</u> sp	8		
	<u>Pentaneura</u> sp	21+	238	36
	<u>Procladius</u> sp	+		+
	<u>Psectrocladius</u> sp	+	58	65
	<u>Heterotrissociadius</u> sp		4	
	<u>Cricotopus</u> sp	52+	95+	36
	<u>Corynoneura</u> sp	6	12	8
	<u>Thienemanniella</u> sp	9		32

Organisms Collected on Artificial Substrate Samplers
from Mud Creek, July 8 to August 19, 1974 (a)
(Cont'd)

Taxa	Station			
	I	II	III	
Diptera: (cont'd)	<u>Microtendipes</u> sp	13+		
	<u>Paratendipes</u> sp		38	
	<u>Glyptotendipes senilis</u>	81+	185	32
	<u>Glyptotendipes</u> sp		53	
	<u>Parachironomus</u> sp	2		
	<u>Stictochironomus</u> sp	+		
	<u>Cryptochironomus</u> sp	+		
	<u>Chironomus</u> sp	+	73	
	<u>Harnischia(?)</u> sp	1	8	
	<u>Tribelos</u> sp	1		
	<u>Phaenopsectra</u> sp	4		
	<u>Polypedilum fallax</u>		88	96
	<u>Polypedilum</u> sp	+	18	
	Unidentified	9		
	<u>Culicoides(?)</u> sp	1	12	
	<u>Chrysops</u> sp	+		
<u>Empididae</u>			24	
Gastropoda:				
<u>Limnophora aequifrons</u>	1			
<u>Ferrissia</u> sp		72+	4+	
<u>Physa</u> sp	2+			
Pelecypoda:				
<u>Pisidium</u> sp		+		
Number of organisms/Sq. Ft. (b)	497	1117	850	
Total number of taxa	48	34	31	
\bar{d} (b)	1.68	2.37	2.49	
e(b)	0.14	0.24	0.32	

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

were collected at this site. The total number of taxa was 48. While these two factors would suggest good water quality, the calculated diversity index (1.68) and equitability value (0.14) were not consistent with this assumption. Reexamination of the samples provided an explanation of this matter. The isopod (Lirceus fontinalis) had recently completed the reproductive portion of its life cycle resulting in the collection of a very large number of newly hatched young, some still occupying the female marsupium. By recalculating the index, discounting the very small early instars, the diversity index was 2.48 at station I.

Station II was located 0.75 miles below the Park Layne Sewage Treatment Plant just south of Gerlough Road. The recalculated diversity index at this site, excluding newly hatched isopods is 2.33. This decrease from station II indicates some minor degradation of the stream below the plant discharge as does the dramatic increase in the number of oligochaetes and the drop from 48 to 34 taxa collected. These types of changes are typical of organic pollution. When the substrate was disturbed at this station, the water clouded with black organic matter and an odor of sewage became prevalent.

Station III was located about 1.25 miles below station II near Lower Valley Pike Road. This site was inadvertently placed about 500 feet below the Fairway Terrace Mobile Home Park Sewage Treatment Plant. The data indicate that the water quality at this site is similar to that at the previous site. Any recovery of the stream from Park Layne's effluent was not demonstrated because of the location of this site below the outfall of the Fairway Terrace plant. The increase of the diversity index to 2.46 and the decrease in oligochaetes may indicate a minor improvement in water quality.

LITTLE BEAVER CREEK BASIN

Little Beaver Creek

Little Beaver Creek, located in the Ohio counties of Columbiana and Mahoning, and Pennsylvania counties of Lawrence and Beaver, drains approximately 510 square miles (102 in Pa.) and joins the Ohio River near East Liverpool, Ohio. Little Beaver Creek was selected because portions of the stream have been designated a "Wild River" by the Ohio Department of Natural Resources. The study area, though free of point source discharges, receives drainage from coal strip mines, run-off from grazing dairy and beef cattle, and pit-privies are evident in the upstream portion of the study area.

The stream segment throughout the study area was in violation of stream water quality standards for fecal coliforms. Average conditions for the upstream segment of the study area (station I) at a flow rate of 140 cfs were conductivity 675 umhos, dissolved oxygen 9.4 mg/l, BOD 2.45 mg/l, COD 17 mg/l, sulfates 225 mg/l, total solids 500 mg/l, suspended solids 13 mg/l, total iron 1129 ug/l, and fecal coliforms 7790/100 ml. Average conditions for the downstream segment of the study area (station IV) were conductivity 605 umhos, dissolved oxygen 9.9 mg/l, BOD 1.68 mg/l, COD 18.5 mg/l, sulfates 220 mg/l, total solids 434 mg/l, suspended solids 6 mg/l, total iron 574 ug/l, and fecal coliforms 440/100 ml, (OEPA, 1974a).

Four biological sampling stations were established in Little Beaver Creek in 1974. The general locations of these stations are shown on Figure 6. The six week sampling period was August 29th to October 9th. Station I was located in the West Fork of Little Beaver Creek about 0.5 miles upstream from the confluence with the Middle Fork at Route 7 bridge. Stations II, III, and IV

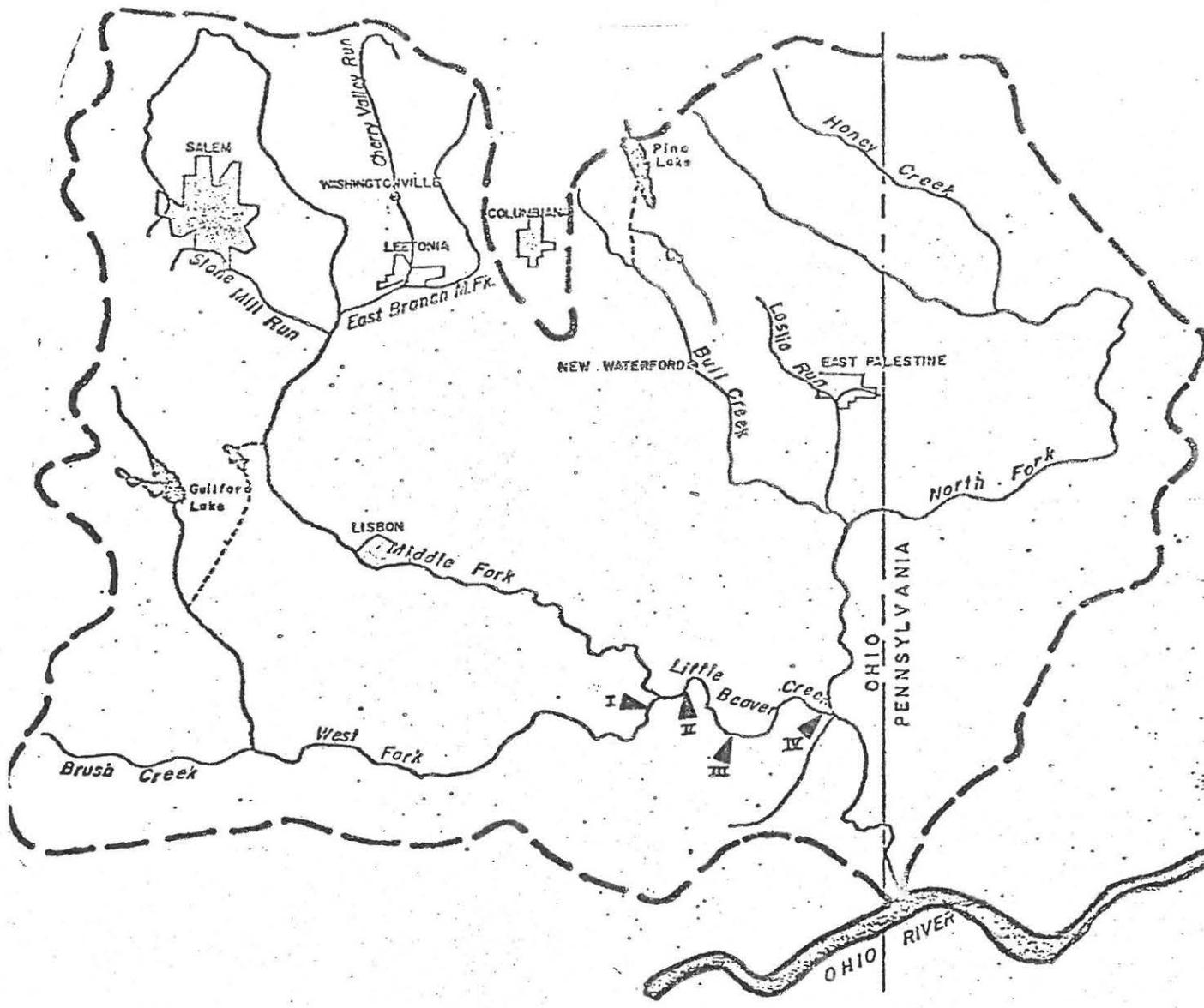


Figure 6
 LITTLE BEAVER CREEK BASIN
 1974 Biological Sampling Stations

were located in the main stem. Station II was approximately one mile downstream from the confluence of the Middle and West Fork. Station III was about four miles downstream from the confluence, and station IV was about 0.3 mile upstream from the confluence of the North Fork (see the Appendix). The results are shown in Table 18.

The diversity indices indicate an increase in water quality moving downstream from station I to station IV. Stations I and II had diversity indices of 2.74 and 2.84 which reflect moderate to good water quality while stations III and IV had diversity indices of 3.12 and 3.35 indicating high water quality. This trend is also evident in the number and type of taxa collected. The number of taxa increased from 20 at station I to 34 at station IV. Stations III and IV have a greater number of taxa in the groups Ephemeroptera, Trichoptera, and Plecoptera than stations I and II possibly indicating a stress situation in these upstream stations. The equitability values indicated a moderate (0.51 - 0.59) to poor (0.37) water quality throughout the stream segment.

The lower diversity indices attained at stations I and II may be attributed to various non-point sources discharges located in this area. The high iron and sulfate readings at station I indicate the presence of coal, strip mine drainage, and the high fecal coliform count reflected the presence of pasture run-off. In September of 1973 the West Fork at station I had a flow reading of 2.0 cfs. Since the samplers were in the river during the month of September, the low flow in addition to the problems previously mentioned may account for these diversity values.

There are a few point source discharges approximately eight to ten miles upstream from the study area on the Middle Fork. There was no significant effect of these dischargers indicated by the benthic organisms in the study area.

Table 18
Organisms Collected on Artificial Substrate Samplers
from Little Beaver Creek, August 29 to October 9, 1974 (a)

Taxa	Station			
	I	II	III	IV
Coelenterata:	<u>Hydra</u> sp	8		
Nematoda:	Unidentified	10		1
Bryozoa:	<u>Plumatella repens</u>		1	1
Annelida:	<u>Oligochaeta</u>	1438	710	706
Amphipoda:	<u>Hyalella azteca</u>		1+	+
Decapoda:	<u>Orconectes rusticus</u>	+		
	<u>Orconectes</u> sp			+
Plecoptera:	<u>Pteronarcys</u> sp		2	
	Unidentified			1
Ephemeroptera:	<u>Stenonema interpunctatum</u> group		22	43+
	<u>Stenonema pulchellum</u> group	14+	2+	113
	<u>Baetis</u> sp			2+
	<u>Caenis</u> sp	8+	130+	58+
	<u>Tricorythodes</u> sp			6
	<u>Isonychia christina</u> (?)	44+	1+	4
	<u>Ephemera simulans</u>		2+	
Odonata:	<u>Hexagenia</u> sp		+	+
	<u>Enallagma</u> sp		2+	+
	<u>Agrion aquabile</u>		2	
	<u>Hetaerina</u> sp			2
	<u>Boyeria vinosa</u>		+	
	<u>Dromogomphus</u> sp		+	+
	<u>Macromia</u> sp			+
Hemiptera:	<u>Corixidae</u>			+
Trichoptera:	<u>Hydropsyche bifida</u> group	27+		12
	<u>Hydropsyche</u> sp A	364+		2
	<u>Cheumatopsyche</u> sp	337+	14+	186
	<u>Neureclipsis</u> sp		3	
	<u>Ptilostomis</u> sp			+
	<u>Hydroptilidae</u>			2
Coleoptera:	<u>Dubiraphia</u> sp		3	+
	<u>Macronychus glabratus</u>		1	1
	<u>Stenelmis</u> sp		+	1
	<u>Tropisternus</u> sp		+	
	<u>Berosus</u> sp			2
	<u>Psephenus</u> sp	+		
Diptera:	<u>Antocha saxicola</u>	4		1
	<u>Eriocera cinera</u>			+
	<u>Simulium meridionale</u>	86+		
	<u>Chironomus</u> sp		25	+
	<u>Glyptotendipes senilis</u>	28	428	222
	<u>Polypedilum fallax</u>			33
	<u>Polypedilum</u> sp		25	343+
	<u>Tribelos</u> sp			12
	<u>Cricotopus</u> sp	422	101+	99

Organisms Collected on Artificial Substrate Samplers
from Little Beaver Creek, August 29 to October 9, 1974 (a)
(Cont'd)

Taxa	Station			
	I	II	III	IV
Diptera: (Cont'd)				
<u>Eukiefferiella</u> sp.	141			
<u>Thienemanniella</u> sp.		25	33	79
<u>Procladius</u> sp.			+	
<u>Pentaneura</u> sp.		76	12	
<u>Ablabesmyia</u> sp.				40
<u>Rheotanytarsus</u> group	479	50	99	715
<u>Micropsectra</u> group		125		431
<u>Calopsectra</u> group A		25	56	
<u>Culicoides</u> (?) sp.	6	1		
<u>Chrysops</u> sp.			+	
<u>Empididae</u>	166		8	2
Gastropoda:				
<u>Ferrissia</u> sp.	4+	5+	8	+
<u>Goniobasis</u> sp.	4+			
<u>Physa</u> sp.	+	8+	+	+
Number of organisms/Sq. Ft. (b)	714	361	412	743
Total number of taxa	20	29	35	34
d (b)	2.74	2.84	3.12	3.35
e (b)	0.51	0.37	0.53	0.59

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

MUSKINGUM RIVER BASIN

Black Fork of the Mohican River Ohio Steel Tube

The Black Fork of the Mohican River, located in Richland and Ashland Counties, drains 350.9 square miles and joins the Mohican River below Loudonville, Ohio. The Ohio Steel Tube Corporation, located in Shelby, Ohio, discharges its effluent into an unnamed tributary of the Black Fork approximately 0.3 mile upstream from the confluence of the tributary with Black Fork. Four stations for biological sampling were established in the Black Fork for the period of July 1 to August 15, 1974. Station I was located in the Black Fork about 150 yards upstream from the unnamed tributary. Station II was located 100 yards upstream in the unnamed tributary which carries the effluent from Ohio Steel Tube. Stations III and IV were both in the Black Fork, station III being 50 yards downstream from the confluence with the unnamed tributary and station IV approximately one mile downstream (see the Appendix). The general locations of these stations are shown on Figure 7. The results are shown in Table 19.

Station I, upstream from the effluent, exhibited a high diversity index (3.55) and a high equitability calculation (0.81) indicating a high water quality condition existed at this station. This was the only site where organisms from the order Ephemeroptera were collected. Station II, located in the unnamed tributary, had a low diversity index (0.51) and a low equitability calculation (0.21) indicating very poor water quality. A number of rattail maggots (Eristalis bastardi), an organism considered to be very tolerant to pollution, were collected in the qualitative sample at this station.

Though the data from stations III and IV indicate a higher water quality than station II, located in the tributary, there is a marked reduction in



Figure 7
 MUSKINGUM RIVER BASIN
 1974 Biological Sampling Stations

Table 19
 Organisms Collected on Artificial Substrate Samplers
 from the Black Fork of the Mohican River, July 1 to August 15, 1974 (a)

Taxa	Station			
	I	II	III	IV
Coelenterata:				
			1	5
Turbellaria:				
	10		19	2
Nematoda:				
		16		1
Bryozoa:			1	
Plumatella repens				
Annelida:				
Oligochaeta	49+	661+	273	150+
Amphipoda:				
Hyaella azteca	+			
Decapoda:				
Orconectes sp	+		2	+
Cambarus bartonii	+			
Ephemeroptera:				
Callibaetis sp				+
Caenis sp	7+			
Stenonema interpunctatum group	10			
Stenonema tripunctatum group	2			
Odonata:				
Enallagma sp	+		8+	
Pachydiplax longipennis			+	
Argia sp	+			
Coenagrionidae	2			1+
Trichocoryxa sp	+			
Megaloptera:				
Sialis sp	1			
Coleoptera:				
Pelodytes sp	+		+	+
Dubiraphia sp	+			
Ancyronyx variegata	+			
Stenelmis sp	+			1
Tropisternus sp	+		+	
Diptera:				
Eristalis bastardii		+		
Cricotopus sp		3	11	2
Pentaneura sp	13	1	25	9+
Psectrotanytus sp			2+	+
Procladius sp	13+		10+	16+
Ablabesmyia sp	6		13	39
Glyptotendipes senilis sp	13		14	
Glyptotendipes sp	14			
Einfeldia sp	93		4	77
Dictroterdipes sp			4	
Tanytarsus sp	13		2	
Phaenopsectra sp	6		2	
Psectrocladius sp			2	
Polypedilum fallax			2	
Lasioidanesa(?) sp				+
Chironomus sp	71			8
Paratendipes sp	13			
Cryptochironomus(?) sp	1			
Culicoides(?) sp	3			

Organisms Collected on Artificial Substrate Samplers
from the Black Fork of the Mohican River, July 1 to August 15, 1974 (a)
(Cont'd)

Taxa	Station				
	I	II	III	IV	
Gastropoda:	<u>Physa</u> sp	30+	36+	275+	112+
	<u>Ferrissia</u> sp	25		3	13
	<u>Helisoma trivolvis</u>			1	
	<u>Lymnaea humilis</u>		1		
Pelecypoda:	<u>Sphaerium</u> sp				+
	Number of organisms/Sq. Ft. (b)	79	143	134	87
	Total number of taxa	32	7	25	19
	\bar{d} (b)	3.55	0.51	2.16	2.52
	e (b)	0.81	0.21	0.28	0.57

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

water quality from station I located in the Black Fork. The diversity index and equitability calculation dropped from 3.55 and 0.81 at station I to 2.16 and 0.28 at station III, and 2.52 and 0.57 at station IV.

From these data it is apparent that the effluent of Ohio Steel Tube has a deleterious effect upon the water quality of the Black Fork of the Mohican River.

MUSKINGUM RIVER BASIN

Rocky Fork of the Mohican River Empire Detroit Steel Corporation

The Rocky Fork of the Mohican River, located in Richland County, drains 76.7 square miles and joins the Black Fork of the Mohican River near Lucas, Ohio. The Empire Detroit Steel Corporation, located in the city of Mansfield, is a major point source discharger to this stream contributing effluent from four separate outfalls located in a stream segment approximately one mile long.

The stream above Empire Detroit's first outfall violates water quality standards for fecal coliforms. The average condition at 2.03 cfs for dissolved oxygen was 8.9 mg/l, total dissolved solids 403 mg/l, total suspended solids 8 mg/l, chloride 14.5 mg/l, BOD 0.7 mg/l, oil and grease 0.3 mg/l, total zinc 0.89 mg/l, and fecal coliforms 250/100 ml. Below Empire Detroit's last outfall dissolved oxygen was 7.2 mg/l, total dissolved solids 447 mg/l, total suspended solids 18.8 mg/l, chloride 34 mg/l, BOD 2.8 mg/l, oil and grease 1.5 mg/l, and total zinc 0.17 mg/l (personal communication with OEPA, Southeast District Office, 1975).

Three stations for biological sampling were established in the Rocky Fork of the Mohican River in 1974. The six week sampling period was from July 1 to August 16. Two stations were located on Empire Detroit's property. Station I was located approximately 50 yards upstream from the first outfall, while station II was located approximately 50 yards downstream from the last outfall. All samplers from an additional downstream station were lost. The general locations of these stations are shown on Figure 7. The results are shown in Table 20.

Table 20
Organisms Collected on Artificial Substrate Samplers
from Rocky Fork of the Mohican River, July 1 to August 16, 1974 (a)

Taxa		Station	
		I	II
Coelenterata:	<u>Hydra</u> sp	1	
Turbellaria:	Unidentified	235+	
Nematoda:	Unidentified		28
Annelida:	<u>Oligochaeta</u>	186+	3788
	<u>Erpobdella punctata</u>		+
Odonata:	<u>Enallagma</u> (?) sp	20+	
	<u>Aeshna</u> sp	1	
	<u>Enallagma</u> sp		+
	<u>Plathemis</u> sp	+	
	<u>Archilestes</u> sp	+	
Megaloptera:	<u>Chauliodes</u> sp	+	
Coleoptera:	<u>Iaccophilus</u> sp		+
	<u>Peltodytes</u> sp	+	
Diptera:	<u>Psectrotanypus</u> sp	1+	
	<u>Procladius</u> sp	13+	
	<u>Chironomus</u> sp	10	
	<u>Pentaneura</u> sp	6	162
	<u>Einfeldia</u> sp	16	
	<u>Glyptotendipes</u> sp	7	
	<u>Cricotopus</u> sp	1	5
	<u>Paratendipes</u> sp	1	
	<u>Polypedilum</u> sp	1	5
	<u>Palpomyia</u> (?) sp	2	
Gastropoda:	<u>Physa</u> sp	53+	72
	<u>Lymnaea</u> sp		8
	Number of organisms/Sq. Ft. (b)	111	814
	Total number of taxa	20	10
	\bar{d} (b)	2.21	0.48
	e (b)	0.38	0.16

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

Station I (upstream) had a low diversity index (2.21) and equitability value (0.38) indicating a moderate to poor water quality situation. There were no organisms collected from the orders Ephemeroptera and, or Trichoptera at either station. The data from station II reflected very poor water quality with the diversity index and equitability values being 0.48 and 0.16. Though the number of taxa dropped significantly at station II, the number of oligochaetes, increased from 186 at station I to 3788 at station II.

Though the water quality from station I was poor, the dramatic decline in the diversity index at station II indicates further degradation in water quality downstream from the Empire Detroit outfalls.

MUSKINGUM RIVER BASIN

Leatherwood Creek
Oxford Tile Company

Five stations for biological sampling were established in Leatherwood Creek located in Guernsey County above and below the Oxford Tile Company. Samplers from all of these stations were lost.

PORTAGE RIVER BASIN

Portage River Brush Wellman

The Portage River, located in the northwestern part of Ohio drains 601.8 square miles and flows into the Western Basin of Lake Erie. Brush Wellman located about 0.3 mile downstream from Rt. 590 bridge in Ottawa County, discharges 0.149 million gallons of effluent per day to the Portage River with an average daily load of 15.8 pounds of BOD, 2265 pounds of dissolved solids, 73.3 pounds of suspended solids, 0.285 pounds of copper, 0.155 pounds of zinc, and 0.631 pounds of chromium (personal communication with OEPA, Northwest District Office, 1975). A 96 hour static bioassay conducted on the effluent in August, 1974 demonstrated no significant acute toxicity.

Above Brush Wellman, at Rt. 590 bridge, the average conditions for dissolved oxygen was 10.3 mg/l, fecal coliforms 60/100 ml, total dissolved solids 476 mg/l, suspended solids 134 mg/l, BOD 5.6 mg/l, and no detectable phenols. About one mile below Brush Wellman dissolved oxygen was 9.8 mg/l, fecal coliforms 100/100 ml, total dissolved solids 543 mg/l, suspended solids 82 mg/l, BOD 4.8 mg/l, phenols 13 ug/l, and beryllium 40 mg/l (personal communication with OEPA, Northwest District Office, 1975).

Two biological sampling stations were established in the Portage River for the sampling period July 2 to August 13, 1974. The general locations of these stations are shown on Figure 8. Station I was located approximately 0.75 mile upstream from Brush Wellman's discharge. Samplers were placed at both the east and west bank of the river at station II, which was located about one mile downstream from Brush Wellman's discharge. The results are shown in Table 21.

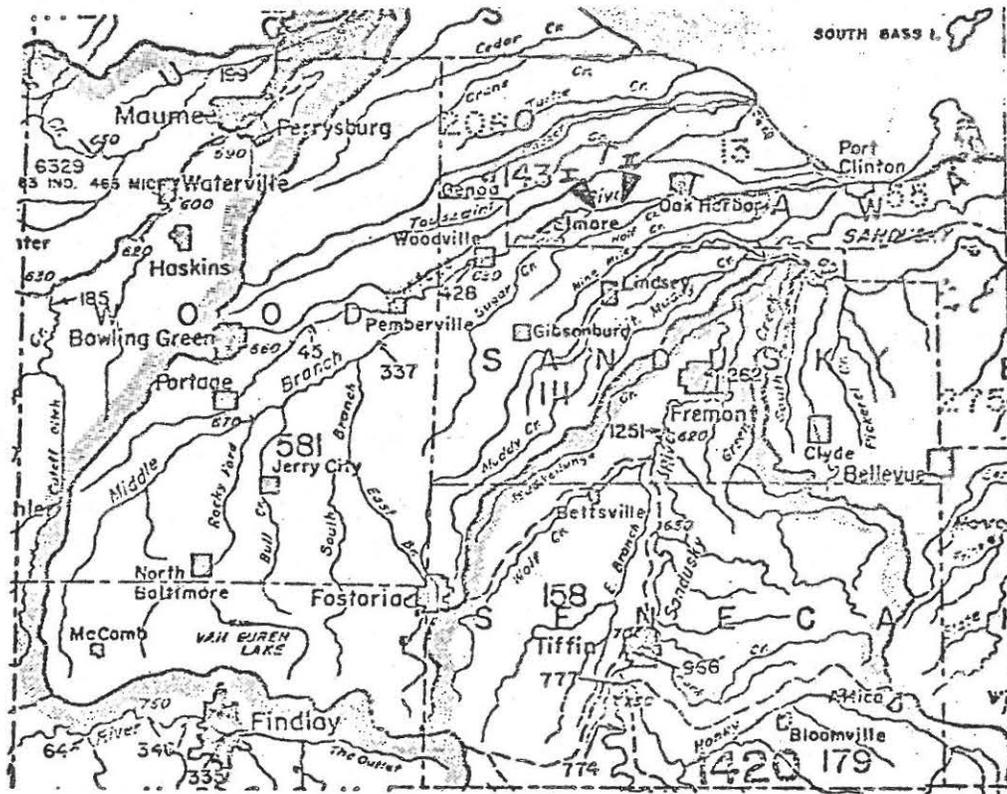


Figure 8
 PORTAGE RIVER BASIN
 1974 Biological Sampling Stations

Table 21
Organisms Collected on Artificial Substrate Samplers
from the Portage River, July 2 to August 13, 1974 (a)

Taxa		I	Station IIE(b)	IIW(b)
Coelenterata:	<u>Hydra</u> sp	22	1,000	216
Turbellaria:	Unidentified	155	256	
Bryozoa:	<u>Plumatella repens</u>	+		
Annelida:	<u>Oligochaeta</u>	12	24+	528
Amphipoda:	<u>Gammarus fasciatus</u>	+	+	
Decapoda:	<u>Orconectes</u> sp	+		
Ephemeroptera:	<u>Caenis</u> sp	27+	+	64+
	<u>Tricorythodes</u> sp	84+		64
	<u>Potamanthus</u> sp	2+		
	<u>Stenonema interpunctatum</u> group	30+	+	
	<u>Stenonema pulchellum</u> group	+		
Odonata:	<u>Argia</u> sp	16+		
	<u>Enallagma</u> sp	+		
	Coenagrionidae	6		
	<u>Hetaerina</u> sp	+		
Hemiptera:	<u>Trichocorixa</u> sp	+		
Megaloptera:	<u>Sialis</u> sp	+	+	
Trichoptera:	Psychomyiid Genus A	51+		480
	<u>Cheumatopsyche</u> sp	+		+
	<u>Hydropsyche</u> sp	+		
	<u>Hydropsyche bifida</u> group	+		
	<u>Oecetis</u> sp	2+		
	<u>Leptocella diarina</u>	+		
Lepidoptera:	<u>Paragyraetis</u> sp	+		
Coleoptera:	<u>Stenelmis</u> sp	+		
	<u>Macronychus glabratus</u>	+		
	<u>Dubiraphia</u> sp	6+		
	<u>Berosus</u> sp	+		
Diptera:	<u>Culicoides(?)</u> sp	4		
	<u>Glyptotendipes</u> sp	663+	43,401+	17,833
	<u>Glyptotendipes senilis</u>	643		
	<u>Dictotendipes</u> sp	271+		2,176
	<u>Pentaneura</u> sp	125+		271
	<u>Einfeldia</u> sp	121	1,551	
	<u>Polypedilum</u> sp	30+	+	
	<u>Chironomus</u> sp	30	+	
	<u>Cryptochironomus</u> sp		+	
	<u>Procladius</u> sp	30		
	<u>Tanytarsus</u> sp	+		
	<u>Endochironomus</u> sp	+		
	<u>Harnischia abortiva</u>		+	
	<u>Harnischia amachaerus</u>		+	

Organisms Collected on Artificial Substrate Samplers
from the Portage River, July 2 to August 13, 1974 (a)
(Cont'd)

Taxa	I	Station IIR ^(b)	IIW ^(b)
Gastropoda:			
<u>Physa</u> sp	+		
<u>Lymnaea</u> sp	+		
Number of organisms/Sq. Ft. (c)	466	9246	4321
Total number of taxa	41	14	9
\bar{d} (c)	3.02	0.42	1.01
e (c)	0.56	0.20	0.29

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) W=West bank, E=East bank.

(c) Artificial substrate sample only.

The diversity index (3.02) and equitability calculation (0.56) indicate that a high water quality condition existed at station I. Numerous taxa from Ephemeroptera and Trichoptera were collected in the qualitative and quantitative samples at this site. The number of taxa collected from these groups was greatly reduced at station II. The diversity index and equitability calculation for the East Bank of station II were 0.42 and 0.20 respectively; the same values for the West Bank were 1.01 and 0.29. These values represented a substantial reduction from those at station I indicating a severe deterioration in stream water quality. The chironomids increased from 1800 at station I to over 40,000 at the East Bank at station II.

The water quality of the Portage River as reflected by the benthic fauna undergoes a substantial deterioration downstream from the discharge of Brush Wellman.

MALMEE RIVER BASIN

Ottawa River Lima Sewage Treatment Plant, Vistron Corporation, Standard Oil

The Ottawa River, located in Putnam and Allen Counties, drains 372.7 square miles and enters the Auglaize River near Kalida, Ohio. The Lima Sewage Treatment Plant, Vistron Corporation, and Standard Oil Corporation are the major point source dischargers to this stream in the area near Lima, Ohio. The present average daily load of these entities is shown in Table 22 (OEPA, 1974c). Static bioassay analyses conducted on the effluents of these entities resulted in 96 hour median tolerance values of 32% for Vistron Acrylonitril (Nov., 1973), 20% Vistron Agricultural (Jan., 1974), and no significant acute toxicity observed on the effluent of the Lima Sewage Treatment Plant (July, 1974).

The Ottawa River upstream from Lima and near Thayer Road is essentially dry at critical low flow. At 15 cfs this segment of the stream is in violation of water quality standards for fecal coliforms (654/100 ml). The average condition reported for dissolved oxygen is 7.5 mg/l, BOD 2.2 mg/l, total dissolved solids 645 mg/l, and no measurable amounts of phenols and chromium (OEPA, 1974c).

Seven miles downstream from Lima near Allentown, at critical low flow (6.49 cfs) the stream is in violation of water quality standards for hexavalent chromium (0.18 mg/l). At 57.3 cfs, the stream at this point violates standards for fecal coliforms (2190/100 ml), hexavalent chromium (0.18 mg/l) and ammonia (14.2 mg/l). The average condition reported for dissolved oxygen is 5.1 mg/l, BOD 5.7 mg/l, total dissolved solids 931 mg/l, and phenols .013 ug/l (OEPA, 1974c).

Table 22
LOADINGS FROM MUNICIPAL AND INDUSTRIAL DISCHARGERS
ON THE OTTAWA RIVER

	Lima STP	Vistron Agricultural Chemical Div.	Vistron Acrylonitril Division	Standard Oil Corp.	Total	
Flow	22.3	4.24	0.516	6.92	33.97	mgd
BOD ₅	1110	295	97.4	572	2074.4	lbs/day
TDS	73,618	66,605	15,050	70,001	225,274	lbs/day
TSS	2906	1164	153	1393	5616	lbs/day
NO ₂ -NO ₃	182	1566	34.9	10.2	1793.1	lbs/day
Tot. P	570	25	7.79	34.1	636.89	lbs/day
NH ₃	1512	2251	43.7	1292	5098.7	lbs/day
TKN	1674	4148	82.3	1375	7279.3	lbs/day
Tot. Cr.	16.5	80.9	3.4	UK	100.8	lbs/day
Cn	1.4	24.8	0.24	4.96	31.4	lbs/day
MBAS	29.4	UK	0.87	UK	30.27	lbs/day
Oil & Grease	0.13	78.3	2.38	106	186.81	lbs/day
Phenols	0.70	1.08	0.03	2.12	3.93	lbs/day
Cl	6226	1439	6808	17,600	32,073	lbs/day
Hex. Cr.	UK	69.3	2.73	UK	72.03	lbs/day

Six stations were established for biological sampling in the Ottawa River for the period of July 11 to August 22, 1974. The general locations of these stations are shown on Figure 9. Station I was located approximately three miles upstream from Lima near Thayer Road. Station II was located immediately upstream from the Lima Sewage Treatment Plant discharge and station III 100 yards below the plant. Station IV was located downstream from the Vistron and Standard Oil outfalls about 100 yards downstream from Adgate Road bridge. Station V was located 50 yards upstream from Route 117 and station VI 50 yards below Copus Road bridge and about seven miles downstream from Lima (see the Appendix). The results are shown in Table 23.

High diversity (3.35) and equitability calculations (0.87) were derived at station I. A limited number of mayflies and caddisflies were collected. Dipterans from the family Chironomidae were the dominant organisms at this station.

During periods of low flow, effluent from the Lima Sewage Treatment Plant is pumped upstream from station II and discharged to the river. Therefore, though station II is located above the outfall normally used, this segment of the stream does on occasion receive effluent from the sewage treatment plant. Data from station II indicate a severe reduction in water quality as reflected by the diversity index (1.50) and the equitability calculation (0.40). As at station I, chironomids dominated this station and especially species of the genus Glyptotendipes. Organisms representing this genus are found throughout a wide range of water quality levels. The only species, in our sample, identified from this taxon was G. senilis which has been classified as intolerant/facultative.

Station III, located below the usual sewage outfall, produced so few organisms that diversity indices could not be calculated. Station IV and V located below the Vistron and Standard Oil outfalls had indices of 1.17 and

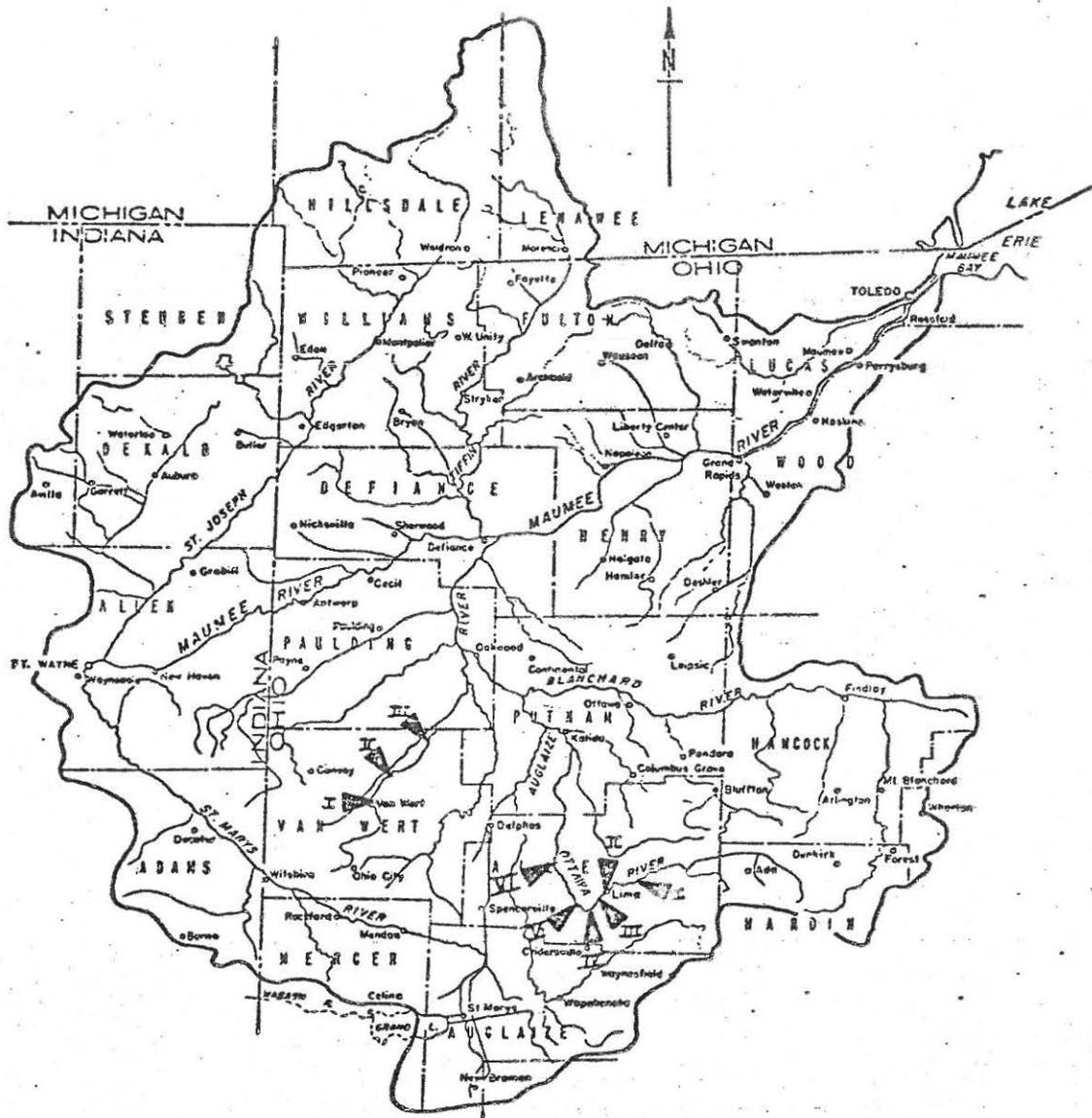


Figure 9
 MAUMEE RIVER BASIN
 1974 Biological Sampling Stations



Table 23
Organisms Collected on Artificial Substrate Samplers
from the Ottawa River, July 11 to August 22, 1974 (a)

Taxa	Station					
	I	II	III	IV	V	VI
Turbellaria:	Unidentified	+				
Annelida:	Oligochaeta	2	193	388+		
	<u>Placobdella papillifera</u>	+				
	<u>Eprobodella punctata</u>		7+			
	<u>Dina microstoma</u>		1			
Isopoda:	<u>Asellus sp</u>	+				
Amphipoda:	<u>Hyalella azteca</u>	+				
	<u>Crangonyx sp</u>	+				
Decapoda:	<u>Orconectes sp</u>	1+				
Plecoptera:	<u>Acroneuria sp</u>	+				
Ephemeroptera:	<u>Hexagenia sp</u>	+				
	<u>Stenonema interpunctatum</u>	18+				
	group					
	<u>Stenonema tripunctatum</u>	+				
	group					
	<u>Eaetis sp</u>	7+				
	<u>Caenis sp</u>	1				
	<u>Callibaetis sp</u>					+
Odonata:	<u>Coenagrion sp</u>			+		
	<u>Enallagma sp</u>	+		+		
	<u>Hetaerina sp</u>	+				
	<u>Libellulidae</u>	+				
	<u>Boyeria virosa</u>	+				
	<u>Anax sp</u>		+	+		
	<u>Plathemis lydia</u>		+			+
	<u>Ischnura sp</u>					+
Hemiptera:	<u>Trichocorixa sp</u>					+
	<u>Sigara sp</u>		+		+	+
	<u>Notonecta sp</u>					+
Megaloptera:	<u>Sialis sp</u>	+				
Trichoptera:	<u>Cheumatopsyche sp</u>	+				
	<u>Polycentropus sp</u>	+				
	<u>Neophylax sp</u>	+				
Coleoptera:	<u>Tropisternus sp</u>				+	+
	<u>Laccophilus sp</u>		+			+
	<u>Peltochytes sp</u>					+
	<u>Psephenus sp</u>	+				
	<u>Dubirachia sp</u>	+				
	<u>Macronychus glabratus</u>	+				
	<u>Stenelmis sp</u>	+				
	<u>Dineutus sp</u>		+			
	<u>Berosus sp</u>		+		+	+

Organisms Collected on Artificial Substrate Samplers
from the Ottawa River, July 11 to August 22, 1974 (a)
(Cont'd)

Taxa	Station					
	I	II	III	IV	V	VI
Diptera:						
<u>Polypedilum fallax</u>	2					
<u>Procladius</u> sp	10	71			163+	
<u>Glyptotendipes senilis</u>	18	354				
<u>Glyptotendipes</u> sp	39+	3892+	6		342+	10416+
<u>Stictochironomus</u> sp	+					
<u>Tribelos</u> sp	2+					
<u>Cryptochironomus</u> sp						64
<u>Polypedilum</u> sp	5+					
<u>Pentaneura</u> sp	+					16
<u>Kiefferulus</u> sp	10					
<u>Chironomus</u> sp	+	141+	3	87+	472+	+
<u>Ablabesmyia</u> sp	7					
<u>Phaenopsectra</u> sp	2					
<u>Einfeldia</u> sp	10					
<u>Tanytarsus</u> sp	2					
<u>Psectrotanypus</u> sp		+		17+	+	+
<u>Cricotopus</u> sp		+	1	+	1836+	+
<u>Harnischia abortiva</u>		354		34+	2379+	
<u>Culex</u> sp		+	4	+		+
<u>Stratiomys</u> sp				+		
<u>Ephydra</u> sp						+
Tipulidae	+					
Unidentified						40
Gastropoda:						
<u>Physa</u> sp		320+				
<u>Ferrissia</u> sp	2					
<u>Heliscna trivolvis</u>		+				
<u>Goniobasis livescens</u>	+					
Mollusca:						
<u>Sphaerium</u> sp	+					
Unionidae	+					
Number of organisms/ Sq. Ft. (b)	27	1321	3	105	1038	2107
Total number of taxa	44	19	5	9	10	18
\bar{d} (b)	3.35	1.50	(c)	1.17	1.78	0.11
e (b)	0.87	0.40	(c)	0.67	0.86	0.06

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

(c) Inadequate number of individuals to calculate \bar{d} .

1.78 respectively, which, though poor, was an improvement over station III. Equitability values at these stations are in contradiction of \bar{d} values (0.67 and 0.86) and are much higher than expected. At station VI over 10,000 chironomids of the genus Glyptotendipes were collected and a low index (0.11) and equitability value (.06) were determined.

It is apparent that the Ottawa River is severely degraded below the Lima Sewage Treatment Plant taking into account that station II also receives, at least on occasion, effluent from the plant site. There was no apparent recovery zone between the treatment plant outfall and the discharge point of Vistron Corporation and Standard Oil. Therefore, though the water quality below Vistron and Standard Oil is poor, the degree that the observed biological effects can be attributed to their outfalls is presently uncertain. It is equally uncertain as to what occurred at station VI. The stream has obviously undergone additional stress at some point between station V and VI although there are no known point source discharges within this segment.

MAUMEE RIVER BASIN

Town Creek Van Wert Sewage Treatment Plant, Chrysler-Amplex, Federal-Mogul, Continental Can

Town Creek, located in Van Wert County, drains 51.4 square miles and joins Middle Creek approximately ten miles downstream from Van Wert, Ohio. Continental Can, Federal-Mogul, Chrysler-Amplex Corporation, and the Van Wert Sewage Treatment Plant are the greatest point source dischargers to this stream. The present average daily loads are shown in Table 24 (OEPA, 1974c).

Four stations for biological sampling were established on Town Creek during the period July 10 to August 21, 1974. The general locations of these stations are shown in Figure 9. Station I was located 0.5 mile above Dutch John Road bridge and below the industrial dischargers. All samplers were lost from a fourth upstream station located above the Chrysler, Federal-Mogul, and Continental Can outfalls. Station II was located 1.5 miles below the sewage treatment plant, approximately ten yards upstream from March Road bridge. Station III was located seven miles below the plant approximately 2.5 miles from the confluence of Town and Middle Creeks (see the Appendix). The results are shown in Table 25.

Data from station I and II indicate that very poor water quality existed above and below the sewage treatment plant. Only three taxa were taken on the artificial substrate samplers at station I, and not enough individuals were collected at station II to calculate a diversity index. It cannot be determined if a similar condition existed above the Continental Can, Chrysler-Amplex, and Federal-Mogul outfalls because of the loss of samplers above these discharges. Though water quality is still poor at station III, seven miles below the sewage treatment plant, improvement is evident by the increase in numbers of taxa and a diversity index of 1.73.

Table 24
 Average Daily Loadings of Major Dischargers
 in Town Creek (OEPA, 1974c)

	Continental Can	Federal Mogul	Chrysler-Amplex	Van Wert STP	Total	
Flow	0.018	0.387	0.669	3.14	4.214	MGD
BOD	0.320	56.1	2.16	311	369.58	lbs/day
TDS	543	3189	5745	11110	20587	lbs/day
TSS	1.0	17.6	81.6	476	576.2	lbs/day
NO ₂ NO ₃	1.03	0.312	0.250	81.3	82.892	lbs/day
P	0.150	0.104	30.8	73.5	104.554	lbs/day
NH ₃	0	0.312	1.08	25.9	27.292	lbs/day

Table 25
Organisms Collected on Artificial Substrate Samplers
from Town Creek, July 10 to August 21, 1974(a)

Taxa	Station		
	I	II	III
Nematoda:	Unidentified	2	1
Nematomorpha:	<u>Paragordius</u> sp		+
Annelida:	<u>Oligochaeta</u>	117+	5
	<u>Dina microstoma</u>	+	142+
	<u>Helobdella papillata</u>		33
Decapoda:	<u>Astacidae</u>		1
Ephemeroptera:	<u>Callibaetis</u> sp		4+
Odonata:	<u>Plathemis lydia</u>		+
Hemiptera:	<u>Sigara</u> sp		+
	<u>Notonecta</u> sp		+
Trichoptera:	<u>Cheumatopsyche</u> sp	+	
Coleoptera:	<u>Laccophilus</u> sp		+
	<u>Bidessus</u> sp		+
	<u>Peltochytes</u> sp		+
	<u>Tropisternus</u> sp		+
	<u>Berosus</u> sp		+
Diptera:	<u>Chironomus</u> sp		119+
	<u>Kiefferulus</u> sp		+
	<u>Einfeldia</u> sp		1233
	<u>Tanytarsus</u> sp		4
	<u>Glyptotendipes</u> sp		239
	<u>Psectrocladius</u> sp		123
	<u>Culex</u> sp	1	
	<u>Telmatoscopus albipunctatus</u>		+
Gastropoda:	<u>Physa</u> sp	+	
	<u>Ferrissia</u> sp		9+
	<u>Heliscma trivolvis</u>		1
Pelecypoda:	<u>Sphaerium</u> sp	+	1
	Number of organisms/Sq. Ft. (b)	24	2
	Total number of taxa	7	4
	\bar{d} (b)	0.19	(c)
	e(b)	0.16	(c)
			381
			22
			1.73
			0.38

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

(c) Inadequate number of individuals to calculate \bar{d} .

MAHONING RIVER BASIN

Mahoning River North American Rockwell Corporation

The Mahoning River, located in the northeastern part of Ohio, drains 1133 square miles and joins the Beaver River in Lawrence County, Pennsylvania. North American Rockwell International, located in Newton Falls, Ohio, has two outfalls in the Mahoning River; one originating from their treatment plant and the other from their sludge lagoons. The treatment plant effluent has a flow of 2.765 million gallons per day and an average daily loading of 6.47 pounds of nickel, 4.63 pounds of hexavalent chromium, 5.34 pounds of total chromium, 1.44 pounds of total iron, 2105.2 pounds of suspended solids, and 39.2 pounds of total phosphates. The effluent from the sludge lagoons has a flow of 0.073 million gallons per day and an average daily loading of 0.105 pounds of nickel, 0.102 pounds of hexavalent chromium, 0.108 pounds of total chromium, 0.002 pounds of total iron and 1.093 pounds of suspended solids. The treatment plant effluent was toxic to 50% of the fish in 96 hours at a concentration of 43% as determined by static bioassays conducted in August, 1974.

The stream segments above and below the plant are in violation of stream water quality standards for fecal coliforms. Above the plant the average condition reported for dissolved oxygen was 9.44 mg/l, suspended solids 304.5 mg/l, dissolved solids 292.8 mg/l, ammonia 0.12 mg/l, nitrate 0.70 mg/l, BOD 2.75 mg/l, COD 17.64 mg/l, chloride 24.58 mg/l, and fecal coliforms 2075/100 ml. The average condition reported below the plant for dissolved oxygen was 9.82 mg/l, suspended solids 292.9 mg/l, dissolved solids 274.9 mg/l, ammonia 0.10 mg/l, nitrate 0.63 mg/l, BOD 2.35 mg/l, COD 17.6 mg/l, chloride 26.1 mg/l, and fecal coliforms 1218/100 ml.

This area of the Mahoning River was the site of four biological sampling stations established in 1974. The general locations of these stations are shown on Figure 10. Due to high water and flooding conditions, the normal six week period was extended to twelve weeks from July 18 to October 10. Stations I and II were upstream from the North American Rockwell discharges, station I being located in the West Branch, and station II in the East Branch of the river. Station III was below the outfalls and approximately two miles downstream from the confluence of the West and East Branch, and station IV about five miles downstream from the confluence. The results are shown in Table 26.

Station I in the West Branch, was characterized by a high diversity index (3.71) and equitability calculation (0.82) indicating very high water quality. Although the equitability calculation (0.49) from station II in the East Branch indicates poor conditions, the diversity index (3.25) indicates good water quality. The diversity indices for stations III and IV were 2.90 and 2.29, and the equitability calculations were 0.56 and 0.67, respectively. Although these values indicate moderate to good water quality conditions they demonstrate a definite reduction from the high values attained at stations I and II. The number of taxa was substantially reduced downstream, dropping from 36 and 37 at stations I and II to 23 and 17 at stations III and IV, possibly reflecting a stress situation.

Though the water quality as reflected by biological data was generally good throughout the study area, the benthic fauna of the Mahoning River indicated some deterioration downstream from the North American Rockwell plant site.

Table 26
Organisms Collected on Artificial Substrate Samplers
from the Mahoning River, July 18 to October 10, 1974 (a)

Taxa		Station			
		West Branch I	East Branch II	Mahoning III	IV
Coelenterata:	<u>Hydra</u> sp		1	16	
Turbellaria:	Unidentified		7	112	8
Nematoda:	Unidentified		2	24	
Bryozoa:	<u>Plumatella repens</u>		9	8	+
Annelida:	<u>Oligochaeta</u>	165	104+	512+	172+
Isopoda:	<u>Asellus communis</u>	33+			
Amphipoda:	<u>Hyalella azteca</u>	+	+		
	<u>Cranonyx</u> sp		+		
Decapoda:	<u>Oroonectes</u> sp		+		
Ephemeroptera:	<u>Stenonema pulchellum</u>	4+	397		
	group				
	<u>Stenonema interpunctatum</u>	10+	179+		
	group				
	Baetidae	+			
	Heptageniidae			4	
Odonata:	<u>Basiaeschna</u> sp			+	
	<u>Enallagma</u> sp		+	+	+
	<u>Argia</u> sp	+	1+	16+	
	<u>Gomphus</u> sp				+
Hemiptera:	<u>Belastoma</u> sp		+		
	<u>Sigara</u> sp	+			+
Megaloptera:	<u>Sialis</u> sp	2			
Trichoptera:	<u>Polycentropus</u> sp	3+	1+	8	84+
	<u>Limnophilus(?)</u> sp	+			
	Psychomyiidae	33	1		
	<u>Neureclipsis</u> sp		5	75+	12
	<u>Cheumatopsyche</u> sp	12+	449+	108+	
	<u>Hydropsyche orris</u>		107	17	
	<u>Hydropsyche betteri</u>		3		
	<u>Hydropsyche bifida</u> group		1		
	<u>Hydropsyche</u> sp	+	4	12	
	Limnephilidae				4
Coleoptera:	<u>Pelodytes</u> sp				+
	<u>Iaccophilus</u> sp		+		
	<u>Dineutus</u> sp			+	
	<u>Ancyronyx variegata</u>		8		+
	<u>Dubiraphia</u> sp	9	+		
	<u>Macronychus glabratus</u>	19	25		
	<u>Stenelmis</u> sp	+			
Diptera:	<u>Tipula</u> sp	+			
	<u>Simulium vittatum</u>		31		
	Simuliidae	+			
	Empididae	18		4	
	<u>Culicoides(?)</u> sp	3		4	4

Organisms Collected on Artificial Substrate Samplers
from the Mahoning River, July 18 to October 10, 1974 (a)
(Cont'd)

Taxa		West Branch	East Branch	Mahoning	
		I	II	III	IV
Diptera: (Cont'd)	<u>Chrysops</u> sp	+			
	<u>Chironomus</u> sp	+			
	<u>Cryptochironomus</u> sp	+			
	<u>Tribelos</u> sp	58+			
	<u>Polypedilum fallax</u>	40			
	<u>Polypedilum</u> sp	40			4
	<u>Pentaneura</u> sp	18	53		
	<u>Tanytarsus</u> sp	18	293		
	<u>Microtendipes</u> sp	46			
	<u>Cricotopus</u> sp	23	9		
	<u>Stenochironomus</u> sp	6	26	32	4
	<u>Tricoccladius</u> sp	6			
	<u>Eukiefferiella</u> sp		18		
	<u>Psectrocladius</u> sp		9		
	<u>Glyptotendipes</u> sp		18		
	<u>Phaeropsectra</u> sp				+
Gastropoda:	<u>Amnicola</u> sp	+	+		
	<u>Physa</u> sp			64+	20
	<u>Ferrissia</u> sp	8	31		
Pelecypoda:	<u>Menetus dilatatus</u>			140	24
	<u>Musculium</u> sp		+	24+	32
	<u>Sphaerium</u> sp		+		
	<u>Pisidium</u> sp	7+			
	Unionidae				+
	Number of organisms/ Sq. Ft. (b)	116	368	236	72
	Total number of taxa	36	37	23	17
	d	3.71	3.25	2.90	2.29
	e	0.82	0.49	0.56	0.67

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated in the table by a +.

(b) Artificial substrate sample only.

FISH AND INVERTEBRATE BIOASSAYS

Fish and invertebrate bioassays are performed by the Ohio Environmental Protection Agency relative to section 303 of the 1972 Federal Water Pollution Control Act as an aid in the identification of problem areas, in prioritization of abatement efforts and in the planning of abatement strategies. Bioassays are also conducted in conjunction with the biological water quality evaluation program that has been undertaken by OEPA, pursuant to section 106 of the FWPCA. Evaluations made under section 106 requirements will be used not only for biological base-line data, but will be incorporated into section 303 planning as well.

The bioassays are of the acute, static type, but in situ studies are also performed on some dischargers with highly variable effluent.

The standard vertebrate used in the bioassays are laboratory-reared fathead minnows (Pimephales promelas), while a variety of invertebrates have been employed, including Daphnia magna, Daphnia pulex, Chironomus riparius and Gammarus fasciatus.

A summary of the bioassays and their results are shown in Table 27.

Table 27
Summary of Fish and Invertebrate Bioassay Data

Basin	Entity	CENTRAL DISTRICT Waste Source Category								TIm Value (As % Effluent)	
		OC	W	C	M	P	S	PC	Misc.	Fathead	Invertebrate
Scioto	PPG Industries	X								56	N.A.T. (<u>Gammarus</u>)
Scioto	DuPont	X								N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	Delaware STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	Mt. Gilead STP		X							13	26 (<u>Gammarus</u>)
Scioto	Marysville STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	Jackson Pike STP		X							N.A.T.	83 (<u>Daphnia</u>)
Scioto	Southerly STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	London STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	Washington CH STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Hocking	Anchor-Hocking								X	N.A.T.	
Muskingum	Newark STP		X							75	
Scioto	Ranco			X						26	N.A.T. (<u>Chironomus</u>)
Scioto	Amer. Smelting				X					20	
Scioto	Buckeye Steel Casting				X					N.A.T.	
Scioto	Lennox Industries				X					N.A.T.	N.A.T. (<u>Chironomus</u>)
Scioto	PPG Industries	X								N.A.T.	
Scioto	Crown-Zellerbach						X			75	
Hocking	Lancaster STP		X							N.A.T.	
Scioto	PPG Industries	X								N.A.T.	
Muskingum	Kaiser Alum.				X					N.A.T.	
Muskingum	Newark STP		X							37	
Muskingum	Oxford Tile								X	N.A.T.	
Muskingum	Buckeye Lake STP		X							N.A.T.	
Scioto	PPG Industries	X								N.A.T. (Lab)	100% Deaths <u>In Situ</u>
Muskingum	Newark STP									77	
Scioto	Crown-Zellerbach						X			80	
Scioto	Buckeye Steel Casting				X					24	
Scioto	Delaware STP		X							N.A.T.	

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CENTRAL DISTRICT (Cont'd)

Basin	Entity	OC	Waste Source Category						Misc.	TLM Value (As % Effluent)	
			W	C	M	P	S	PC		Fathead	Invertebrate
Muskingum	Newark Landfill								X	N.A.T.	
NORTHWEST DISTRICT											
Scioto	Marion STP		X							N.A.T.	N.A.T. (<u>Gammarus</u>)
Scioto	Galion STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Scioto	Vistron							X		24	32 (<u>Gammarus</u>)
Scioto	Vistron Agri. Chem.							X		6	
Scioto	Rocky Fork Ck.								X	N.A.T.	
Sandusky	PPG Industries	X								75	
Maumee	Petrodyne								X	N.A.T.	
Scioto	Marion STP	X								20	
Maumee	Van Wert STP		X							N.A.T.	
Maumee	Lima STP		X							N.A.T.	
Muskingum	Empire-Detroit							X		N.A.T.	
Muskingum	Ohio Steel Tube							X		N.A.T.	
Portage	Brush-Wellman				X					N.A.T.	
Muskingum	Mansfield STP		X							N.A.T.	
Maumee	Hayes-Albion				X					N.A.T.	
SOUTHWEST DISTRICT											
Mad River	I.T.E. Imperial				X					N.A.T.	10 (<u>Gammarus</u>)
Grt. Miami R.	Amco 003							X		18	11 (<u>Gammarus</u>)
Grt. Miami R.	Amco 001							X		N.A.T.	N.A.T. (<u>Gammarus</u>)
Grt. Miami R.	W. Carrollton Parchment						X			12.5	
Grt. Miami R.	Montgomery Co. Reduction Plant		X							N.A.T.	
Scioto	Sabina STP		X							42	32 (<u>Gammarus</u>)
Scioto	Greenfield STP		X							N.A.T.	N.A.T. (<u>Daphnia</u>)
Grt. Miami R.	Kaiser Agr. Chem.			X						26	
Grt. Miami R.	Anna STP		X							N.A.T.	

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NORTHEAST DISTRICT

Basin	Entity	Waste Source Category					TIm Value (As % Effluent)	
		C	M	W	P	Misc.	Fathead	Invertebrate
Mahoning	Union Carbide	X					0.01	
	Kemcool-D4							
Mahoning	Union Carbide	X					0.01	
	Kemicide-L							
Mahoning	N. American		X				43	
	Rockwell							
Grand	Diamond-Shamrock					X		

SOUTHEAST DISTRICT

Scioto	Jackson STP			X			N.A.T.	85	(Daphnia)
Scioto	Mead Paper				X		N.A.T.	N.A.T.	(Gammarus)
Muskingum	Marietta STP			X			22.5	15	(Daphnia)
Muskingum	Gould Foil	X					24		
Muskingum	Gould Bearing	X					70		
Muskingum	Gould Battery	X					32		
Muskingum	Champion Spark Plug	X					N.A.T.		
Ohio Brush Ck.	Peebles STP			X			90		
Ohio Brush Ck.	W. Union STP			X			42		
Ohio Brush Ck.	Winchester STP			X			N.A.T.		
Ohio Brush Ck.	Seaman STP			X			69		
Muskingum	Barnet West	X					44		
Muskingum	Dover Chemical					X	N.A.T.		
Muskingum	St. Regis Paper				X		N.A.T.		
Muskingum	Stone Container				X		35		
Scioto	Mead Paper				X		75		

SOUTHWEST DISTRICT (Cont'd)

Basin	Entity	Waste Source Category								TIm Value (As % Effluent)	
		OC	W	C	M	P	S	PC	Misc.	Fathead	Invertebrate
Grt. Miami R.	Armco 003								X		11
Grt. Miami R.	Bellefontaine STP	X									N.A.T.
Grt. Miami R.	Armco Coke Plant								X		N.A.T.
Grt. Miami R.	Sidney STP	X									N.A.T.
Grt. Miami R.	Sidney STP	X									N.A.T.
Mad River	ITE Imperial				X						24
Mad River	W. Liberty STP	X									43
Grt. Miami R.	Miami Paper							X			N.A.T.
Grt. Miami R.	Bergstorm Paper							X			43
Grt. Miami R.	Sorg Paper							X			N.A.T.
Grt. Miami R.	Wrenn Paper							X			N.A.T.
Grt. Miami R.	Harding-Jones Paper							X			N.A.T.
Grt. Miami R.	Crystal Tissue							X			N.A.T.
Mad River	W. Liberty STP	X									N.A.T.
Grt. Miami R.	K & S Circuits				X						N.A.T.

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Legend

- OC - Organic Chemical Processes
- W - Waste Treatment Plants
- C - Cooling Tower Effluents
- M - Metal Processing Industry
- P - Paper Industry
- S - Steel Industry
- PC - Petro Chemical Industry
- Misc. - Miscellaneous

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APPENDIX

LOCATION AND DESCRIPTION OF BIOLOGICAL SAMPLING STATIONS

Basin	Stream	Entity	Station	Quadrangle	Latitude-Longitude	Average Depth (Feet)	Character of Substrate
Scioto	Little Scioto River	Marion STP	I	Marion West	40°36'01"-83°10'59"	3.0	silt, clay; detritus, fibrous peat, pulpy peat
			II	Marion West	40°34'17"-83°12'14"	2.5	muck
			III	Marion West	40°32'50"-83°11'23"	2.7	gravel, sand
	Scippo Creek	PPG Industries	I	Circleville	39°32'50"-82°56'25"	2.5	gravel, sand; detritus, pulpy peat
			II	Circleville	39°32'34"-82°56'45"	3.0	gravel, sand, silt; detritus, fibrous peat, pulpy peat
			III	Circleville	39°31'49"-82°58'16"	2.5	rubble, gravel, sand; detritus, fibrous peat, pulpy peat
	Paw Paw Creek	Crown Zellbach	I	Baltimore	39°50'57"-82°35'54"	2.5	boulders, rubble, gravel, sand; detritus, fibrous peat, pulpy peat
			II	Baltimore	39°50'41"-82°36'10"	3.0	gravel, sand, silt; detritus, fibrous peat
			III	Baltimore	39°50'33"-82°36'45"	2.5	rubble, gravel, sand, silt, clay; detritus, fibrous peat
Hocking	Hocking River	Lancaster STP	I	Lancaster	39°42'22"-82°35'36"	2.0	gravel, sand; detritus, fibrous peat
			II	Lancaster	39°41'57"-82°35'00"	3.0	gravel, sand, silt clay; detritus, fibrous peat, pulpy peat, muck
			III	Lancaster	39°41'10"-82°36'54"	3.5	gravel, sand, silt; detritus, fibrous peat, pulpy peat
	Clear Creek	None	I	Clearport	39°36'03"-82°38'43"	2.5	gravel, sand, silt; fibrous peat
			II	Clearport	39°35'40"-82°37'56"	2.5	boulders, gravel, silt, sand; detritus, fibrous peat
			III	Rockbridge	39°35'21"-82°36'40"	2.0	boulders, gravel, sand, silt; fibrous peat
			IV	Rockbridge	39°35'23"-82°35'34"	3.0	gravel, sand, silt; fibrous peat
			V	Rockbridge	39°35'21"-82°34'54"	2.5	gravel, sand, silt; detritus, fibrous peat

APPENDIX

LOCATION AND DESCRIPTION OF BIOLOGICAL SAMPLING STATIONS
(Cont'd)

Basin	Stream	Entity	Station	Quadrangle	Latitude-Longitude	Average Depth (Feet)	Character of Substrate
Beaver	Little Beaver Creek	None	I	West Point	40°43'05"-80°38'13"	1.5	boulders, rubble, gravel
			II	East Liverpool	40°43'41"-80°37'05"	2.5	rubble, gravel, silt; fibrous peat
			III	East Liverpool	40°42'16"-80°35'07"	2.0	boulders, gravel, silt; fibrous peat
			IV	East Liverpool	40°42'44"-80°33'01"	2.0	bedrock, boulders, gravel
Muskingum	Black Fork Mahican River	Ohio Steel Tube	I	Shelby	40°52'43"-82°39'36"	2.5	gravel, sand; fibrous peat
			II	Shelby	40°52'47"-82°39'39"	2.0	rubble, gravel; fibrous peat, pulpy peat, muck
			III	Shelby	40°52'50"-82°39'34"	2.0	rubble, gravel, silt; fibrous peat, pulpy peat
			IV	Shelby	40°53'07"-82°39'35"	2.7	rubble, sand, silt, clay
	Rocky Fork Mahican River	Empire-Detroit Steel	I	Mansfield North	40°47'34"-82°31'31"	3.2	boulders, silt, clay; fibrous peat, pulpy peat
			II	Mansfield North	40°46'47"-82°31'08"	2.5	gravel, sand; detritus
Portage	Portage River	Brush Wallman	I	Lindsey	41°29'27"-83°13'31"	2.5	bedrock, gravel; detritus
			II	Lindsey	41°29'43"-83°12'01"	3.0	gravel, sand; detritus, pulpy peat
Maumee	Ottawa River	Lima STP	I	Cairo	40°45'57"-84°00'44"	2.5	bedrock, rubble; detritus, fibrous peat
			II	Cridersville	40°43'30"-84°07'33"	2.5	silt; muck
			III	Cridersville	40°43'25"-84°07'42"	3.0	muck
			IV	Cridersville	40°42'52"-84°08'16"	2.5	bedrock, rubble; muck
			V	Cridersville	40°43'21"-84°10'25"	2.5	bedrock; muck
			VI	Elida	40°45'12"-84°11'29"	2.5	bedrock, rubble; detritus, fibrous peat
	Town Creek	Van Wert STP	I	Scott	40°53'01"-84°35'18"	2.5	gravel, sand; muck
			II	Scott	40°54'08"-84°34'20"	2.5	silt, clay; muck
III			Wetzel	40°58'05"-84°28'49"	2.5	bedrock, sand, silt; detritus	

APPENDIX

LOCATION AND DESCRIPTION OF BIOLOGICAL SAMPLING STATIONS
(Cont'd)

Basin	Stream	Entity	Station	Quadrangle	Latitude-Longitude	Average Depth (Feet)	Character of Substrate
Great Miami	Mad River Dugan's Run	IT and E	I		40°06'18"-83°45'52"	4.5	sand; fibrous peat
			II	Urbana West	40°06'04"-83°47'54"	3.5	boulders, gravel, sand
			III	Urbana West	40°05'59"-83°47'53"	2.7	boulders, gravel, sand, silt; detritus, fibrous peat
			IV	Urbana West	40°04'16"-83°48'34"	4.0	gravel, sand; detritus
	Dicks Creek	Armco Steel	I	Trenton	39°28'28"-84°22'18"	2.5	sand, silt; detritus
			II	Trenton	39°28'21"-84°23'53"	2.5	gravel, sand, silt
			III	Trenton	39°28'39"-84°25'14"	3.0	gravel, sand, silt; detritus
	Bluejacket Creek	Bellefontaine STP	I	Bellefontaine	40°20'57"-83°46'01"	3.2	boulders, gravel, sand
			II	Bellefontaine	40°20'56"-83°47'11"	3.0	boulders, gravel, sand
			III	Bellefontaine	40°20'33"-83°48'13"	3.0	boulders, gravel, sand; detritus
			IV	Bellefontaine	40°20'34"-83°49'24"	2.5	sand, silt; detritus
			V	Bellefontaine	40°21'47"-83°50'59"	2.0	gravel, sand, silt
	Great Miami River	Sidney STP	I	Sidney	40°17'30"-84°08'53"	3.5	boulders, gravel, silt; detritus
			II	Sidney	40°17'13"-84°09'00"	1.5	boulders, gravel; detritus- lime sludge
			III	Sidney	40°15'52"-84°10'03"	2.5	boulders; detritus, fibrous peat
IV			Piqua East	40°14'50"-84°10'46"	1.5	bedrock, boulders, gravel, sand, silt; detritus, fibrous peat	
Mad Creek	Park Lane STP	I	New Carlisle	39°53'45"-84°01'56"	2.0	gravel, sand, silt	
		II	New Carlisle	39°52'42"-84°02'37"	3.5	gravel, sand; detritus, fibrous peat	
		III	Fairborn	39°51'34"-84°03'19"	3.0	gravel, sand, silt; detritus, fibrous peat	

APPENDIX

LOCATION AND DESCRIPTION OF BIOLOGICAL SAMPLING STATIONS
(Cont'd)

Basin	Stream	Entity	Station	Quadrangle	Latitude-Longitude	Average Depth (Feet)	Character of Substrate
Mahoning	Mahoning River	North American Rockwell	I	Newton Falls	41°11'48"-80°57'59"	4.0	silt, clay; detritus, fibrous peat
			II	Newton Falls	41°11'52"-80°58'12"	3.5	boulders, rubble, gravel, silt; detritus, fibrous peat
			III	Newton Falls	41°13'01"-80°56'41"	4.0	silt, clay; detritus, fibrous peat
			IV	Newton Falls	41°14'25"-80°54'53"	3.5	silt, clay; detritus, fibrous peat