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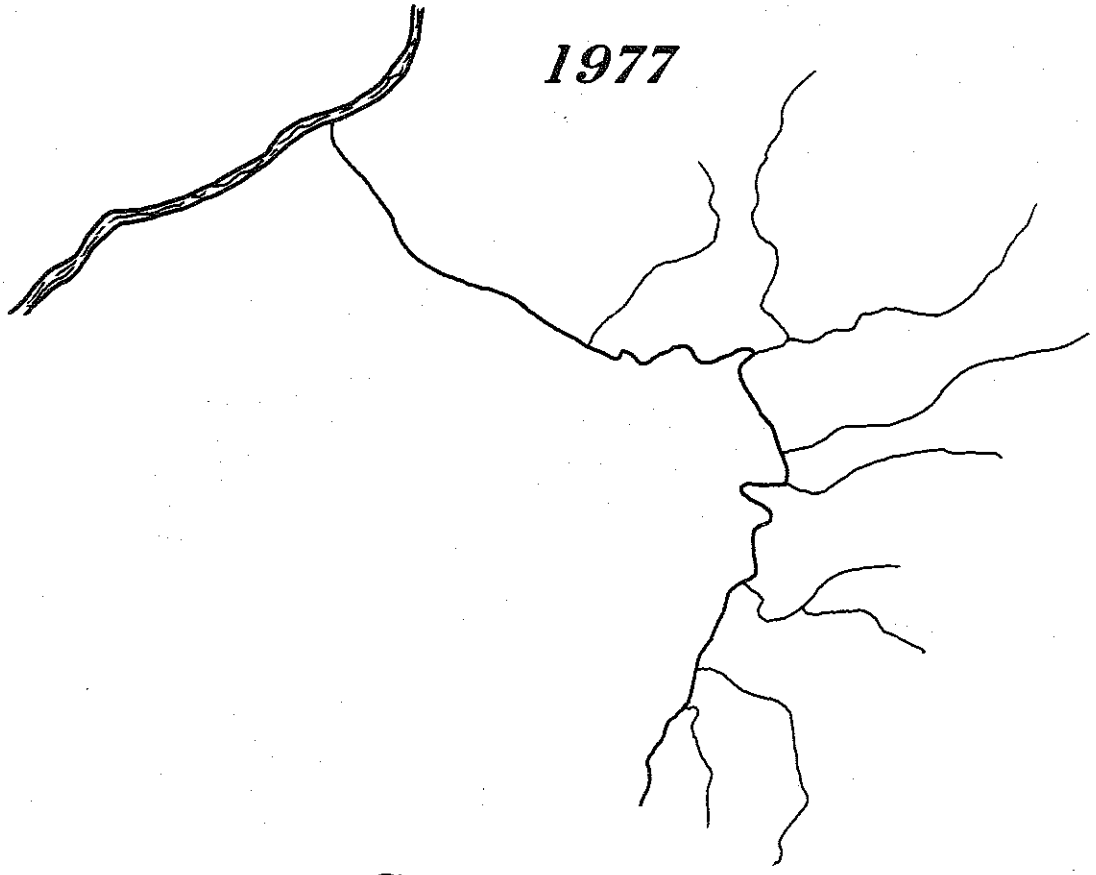
BIOLOGICAL SURVEY OF PLASTER CREEK

1977



State of Michigan
Department of Natural Resources
Water Quality Division
Biology Section

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INTRODUCTION AND BACKGROUND

A biological survey was conducted on 11 stations located on the lower nine miles of Plaster Creek in Grand Rapids, Michigan, from July 19 to September 8, 1977 (Figure 1). A combination of aquatic macroinvertebrate and fish communities, sediment chemistry composition and habitat observations were used to assess present water quality conditions.

Plaster Creek is protected for partial body contact and warm-water fish. It flows through a heavily industrialized section of Grand Rapids before its confluence with the Grand River. This creek receives substantial wastewater flows from industrial sources and storm water runoff. There are three combined storm-sanitary overflows which empty into Plaster Creek (Figure 1).

The three major storm drains discharging into Plaster Creek are the Silver Creek, Lee Street and Burton Street storm drains. Industries which have discharges to these drains include Reynolds Metal, GM Diesel, Kelvinator and Guardsman Chemical Coating Company. In May 1975, Guardsman Chemical Coating had large xylene leakage from a storage tank. No detectable impact on the creek was reported. Reynolds Metal Company had an oil loss in April, 1977, and Dexter Lock has had contaminated groundwater with hexavalent chromium. These are the only recent significant industrial losses reported for this area.

SUMMARY AND RECOMMENDATIONS

1. Sediments at the control station (PC-2) contained "heavily polluted" concentrations of lead, cyanide and phosphorus. Below the first combined sewer outfall (Buchanan Avenue, PC-4), phosphorus, copper, zinc, lead, cyanide and oils were found at "heavily polluted" levels. Further downstream, from the Kelvinator bridge to the mouth, in addition to the above parameters, cadmium and nickel were also elevated. Sediment values significantly exceeded Michigan background values (+ 2 std. dev.) for zinc, lead and arsenic at all stations.

2. The ditched portion of Cole Drain was found to contain extremely elevated levels of an assortment of unrelated toxicants, including heavy metals, PCB's and phthalates. This ditch has been dredged out and its contents were disposed of properly. No source(s) were determined for these contaminants.

3. Sediments in the Silver Creek storm drain outfall contained high levels of phosphorus, arsenic, copper, cadmium, chromium, zinc, lead, nickel, cyanide, phenols, oil and 1254 PCB's. Oils at 10,000 mg/kg were extremely elevated above background levels. The source(s) for these parameters should be further investigated.

4. Plaster Creek has good to excellent habitat in the river reach studied for the establishment of diverse benthic communities. However, the macroinvertebrate communities were limited. The upstream stations (Breton Avenue to Eastern Avenue) contained significant numbers of mayflies and caddisflies which indicated fair water quality.

5. Mayfly and caddisfly numbers were reduced from 76% to 6.7% of the total organisms between Eastern Avenue (Station PC-3) and Buchanan Avenue (Station PC-4), respectively. From Buchanan to Burton Street these groups continued to be depressed. This may be attributable to the large number of storm drains from the streets, homes and commercial businesses in the vicinity and a combined storm-sanitary drain.

6. Severely reduced benthic communities were found below Burton Street to the mouth with the elimination of mayflies and caddisflies. It appears that municipal storm drains and industrial discharges are degrading water quality to the extent that only very tolerant worms, snails, sowbugs and midges were found. Approximately 1.5 miles of the river are grossly degraded.

7. It is recommended that a survey be conducted on the headwaters of Plaster Creek to ascertain whether or not leachates from an old city landfill have been detrimental to Plaster Creek.

METHODS

SEDIMENTS

Concentrations of metals in sediments reflect either natural background levels or those resulting from man's activities. Wastewater discharges which contain metals cause the downstream river sediments to accumulate abnormally high heavy metal concentrations.

Once precipitated out of the water column, the majority of heavy metals remain in the sediments. However, some may return to the water by conversion to more biologically active forms and by the scouring action of water currents. These accumulations of metals are therefore potentially available for uptake and biomagnification, by organisms in the aquatic food chain. (Evans and Hesse, 1972).

Concentrations of chlorinated hydrocarbons and phthalates in sediments are strictly a function of man's activities. These activities include the use of hydrocarbons as pesticides and phthalates as plasticizers. Polychlorinated biphenyls are frequently used as fire resistant heat transfer and hydraulic fluids. These substances can move from the sediments and can be converted to more biologically active forms, which are potentially available for uptake by aquatic organisms. These substances are also bio-accumulating.

Grab samples of loose, organic sediments were collected on September 8, 1977, at the stations located on Figure 2. Each sample was divided into two parts, one placed in a glass jar for analysis of hydrocarbons while the other was placed in a plastic bag for analysis of heavy metals. Following collection, samples were cooled and transported to the Environmental Services Division laboratory in Lansing for analysis (Table 2). Parameters sampled include: total Kjeldahl nitrogen, total phosphorus, arsenic, copper, mercury, cadmium, total chromium, iron, zinc, nickel, lead, cyanide, phenols, PCB's, oil and DEPH. Analytical techniques are those of EPA 1972.

MACROINVERTEBRATES

The evaluation of water quality by analysis of biological conditions is the most reliable method known (Wilhm and Dorris, 1968). Aquatic organisms and community structures are particularly useful in evaluating water quality. Some species of animals spend their entire life cycle associated with the stream waters while other species have life stages (egg, larvae, and pupae) dependent on the aquatic environment for varying periods (from as short as two weeks to more than a year).

Generally a naturally unpolluted stream reach will support many different kinds of organisms, but because of predation and competition for food and living space, relatively few individuals of a given species are present. Stonefly, caddisfly and mayfly species constitute a large portion of the community. The converse often occurs in polluted sections of streams. In such a reach most predators are eliminated by water quality or substrate changes. Living space presents no problem because the remaining organisms are well adapted to organic sludge and food is essentially inexhaustable (Mackethum and Ingram, 1966). Stoneflies, mayflies and caddisflies will be poorly represented.

Artificial Substrates

Artificial substrate samplers were exposed July 19 to September 7, 1977, in Plaster Creek to allow colonization of species. Two samplers were fastened to rods suspended just above the sediments at each station (Figure 1). These samplers consisted of 6 hard-board discs and spacers held together by an eye-bolt (Figure 3). Approximately 619 cm^2 of artificial habitat were available for colonization. Samplers were retrieved and placed in a wide-mouth labeled glass jar and preserved with 95% ethyl alcohol prior to transporting back to the WQD biological laboratory in Lansing. Samplers were then disassembled and the contents were washed in a standard No. 30 mesh screen. Specimens were identified, tabulated and analyzed in Lansing (Figure 4 and Tables 3 & 4). Community structure of benthic fauna can be analyzed by calculating diversity indices. Disturbed communities which are characterized by large numbers of individuals and small numbers of species have low information per

individual and low diversity indices. Information per individual and diversity indices will be higher in undisturbed communities. The formula described by Wilhm and Dorris (1968) using Shannon's equation:

$$\bar{d} = -\sum_{i=1}^{s} \left[\frac{ni}{N} \left(\log_2 \frac{ni}{N} \right) \right]$$

where N = total number of individuals in a sample; n_i = number of individuals in the ith species, and s = total number of species; is commonly the method used.

Qualitative Samples

Qualitative samples were collected at the same locations as the artificial substrates, with the exception of Cole Drain (Station PC-6). The collections were made using long-handled triangular dip nets and by hand picking. Collecting at each location was continued until the representatives of the available species had been collected; usually 30 minutes of sampling time was sufficient. All samples were labeled and preserved with formalin at the station site prior to their transportation back to Lansing. Samples were identified and tabulated (Figures 5 & 6, and Table 5).

Animals from both the quantitative (artificial substrate) and qualitative collections were assigned a tolerance status according to the published accounts and past experience of staff biologists. Tolerance status refers to the animals' relative ability to withstand and/or respond to adverse environmental conditions. An individual's tolerance status is generally derived from the animals' reaction to organic wastes or to modification of bottom deposits. Tolerance status is generally defined as:

Tolerant (T) - organisms which can grow and develop in a wide range of environmental conditions. They are often found in poor water quality. These specimens are generally able to endure a variety of environmental stresses.

Intolerant (I) - organisms whose growth and development are dependent upon a narrow range of environmental conditions are rarely found in areas of organic enrichment, cannot adapt to adverse conditions and are replaced by more tolerant organisms if the quality of their environment is degraded.

Facultative (F) - organisms with the ability to survive over a wide range of environmental conditions. They possess medium tolerance and often respond positively to moderate organic enrichments but cannot endure severe environmental stresses.

Surface Dependent (S) - animals which do not possess an intimate relationship with their aquatic environment. They are dependent upon surface air for respiration and are separated from those which are surface independent, because they are not affected by adverse conditions, such as low dissolved oxygen.

The tolerance status of a species inhabiting a given environment provides information with respect to the pollution status of that environment. A biotic index (B.I.) developed by Beck (1955) was used to evaluate those species according to their ability to withstand degraded environmental conditions. The formula B.I. = 2(I) + F was used where I = the number of intolerant species and F = the number of facultative species. This index weights the intolerants, includes the facultatives and disregards the tolerant forms. Lower values include reduced representation of the more sensitive intolerant - facultative portions of the benthic communities (Figure 6).

FISH

The fish community of a river system is generally comprised of numerous populations of different fish species. These populations may include fish species that are resident in a river throughout their entire life cycle and those species that are migratory and present only during specific life stages or during certain times of year.

The composition of the resident fish community is dependent upon the availability of the suitable chemical and physical environment and the necessary food resources. The requirement of suitable food resources for all stages is most dependent on water quality and certain river habitats. Long term changes in water quality indicated by changes in the primary food base (algae, macroinvertebrates and aquatic plants) will also reflect in the changes in the size and diversity of fish communities.

A sport yak was used to carry the electro-shocker, to collect fish in Plaster Creek. Fish communities were collected at two stations. The first beginning at the mouth of Plaster Creek (Station PC-11) and collecting approximately 500 yards upstream. The next station was collected at Nelson Avenue (Station PC-2) and upstream for over 50 yards. These fish were filleted and their tissues were analyzed for heavy metals and PCB content. Tissue analysis results will be submitted in a future report.

RESULTS AND DISCUSSION

The headwater areas of Plaster Creek above Breton Avenue had clay sediments with slow water velocities. No macroinvertebrates were collected because of the vast change in physical conditions with respect to the downstream characteristics. However, an old city landfill in this area has been reported to have severe leachate problems, and a future survey should be conducted in this vicinity, to ascertain whether or not these leachates are detrimental to Plaster Creek.

Because the headwaters have a habitat unfavorable for colonization of diverse aquatic macroinvertebrate communities it appears that downstream drift of organisms is minimized. For this reason only fair water quality was indicated at the control stations (PC-1, 2 & 3). These stations had representatives of both mayfly and caddisfly species (Figures 4 & 5). An unusually large number of early instar mayflies were found in Nelson Avenue (Station PC-2) and Eastern Avenue (Station PC-3) suggesting a newly established community. Although habitat was excellent, benthic community members and species were reduced. Apparently intermittent high flows (during rains, etc. . .) which brings in storm water are substantial enough to severely reduce or eliminate populations of these organisms. Recolonization and repopulation following these high flow periods may occur. Plaster Creek turns a heavily opaque color during rains due to a high suspended solid load. This fact alone, is probably significant in the restriction of macroinvertebrate community establishment. The only sources of discharge in this river reach were stormwater runoff and drainage. Sediment chemistry results in this reach indicate elevated levels of cyanide, lead and total phosphorus.

At Nelson Avenue (Station PC-2), white suckers and rock bass were very abundant in only a few yards of river.

Between Eastern Avenue (Station PC-3) and Buchanan Avenue (Station PC-4) a noticeable decrease in mayfly numbers was observed. Mayflies and caddisflies were 76% of the total number of individuals at Eastern Avenue and were reduced to 6.7% at Buchanan Avenue (Figure 4). There are over 15 storm drain outfalls as well as one combined storm-sanitary outfall in this river reach. A relatively high diversity of 2.89 at Buchanan Road resulted from low numbers of organisms comprised of evenly distributed facultative species.

The sediment chemistry results from Station PC-4 revealed 700 µg/kg of 1254 PCB's along with elevated concentrations of lead, zinc, copper, total phosphorus and Kjeldahl nitrogen.

The confluence of Plaster Creek and Cole Drain (Station PC-5) is located immediately downstream from Buchanan Avenue. Cole Drain has been channeled and the banks are partially cement covered. The water quality in this drain was poor, indicated by the absence of mayflies and the presence of large numbers of tolerant worms.

Sediments were collected from a ditched portion of Cole Drain (Station PC-5) located south of the Darling Freight Line property, between U.S. 131 and 28th Avenue (Figure 2). Extremely high levels of Kjeldahl nitrogen, total phosphorus, copper, cadmium, iron, zinc, nickel, lead, cyanide and 1242 and 1254 PCB's, oil and DEHP were found. This unusual combination of apparently unrelated waste contaminants with no obvious point(s) of discharge in the area was assumed to have resulted from unauthorized industrial waste hauler dumping(s). After determining the contents of this ditch, the Michigan DNR and the U.S. EPA dredged it and the contents were removed and disposed of properly. Presently oils are still seeping into this area and are being removed accordingly. Below the ditched portion of the drain, a bed of black sludge was observed along the east bank. Samples were not collected from these sludge deposits.

Below the confluence of Cole Drain, Station PC-6, habitat was excellent. In the riffle areas only sowbugs and worms were common; however, in lateral margins early instars of mayflies and caddisflies were found. This could indicate that a toxic substance is being washed downstream on an intermittent basis.

At Burton Street (Station PC-7), mayflies were not found in the qualitative collections, indicating reduced water quality (Figure 5).

The Burton Street storm sewer outfall is located between Burton Street and the Kelvinator bridge. Sowbugs, worms, damselflies and midges were common at Station PC-8, the Kelvinator Bridge. Mayflies and caddisflies were sparsely observed on rocks during initial observations of the study; however they were not found during the retrieval of samplers at Station PC-8, suggesting degraded water quality.

Below Burton Street mayflies and caddisflies were absent (Figures 4 & 5). The biotic index decreased from 13 to 1 at Burton Street and Indian Mounds Road, respectively, indicating severely degraded water quality conditions (Figure 6). In this river reach Plaster Creek is abused by numerous storm drains, two combined storm-sanitary drains as well as industrial discharges and occasional oil spills.

High levels of sediment contaminants including Kjeldahl nitrogen, copper, total phosphorus, zinc, nickel, lead, cyanide and oil were found throughout this reach. The Silver Creek outfall had 1,500 µg/kg of 1254 PCB's and 10,000 mg/kg of oil. The sources for these parameters should be determined.

The fish communities were severely reduced near the mouth. White suckers and rock bass were most prevalent, but were sparsely found in this area. Only three carp were found and a number of fingerlings small mouth bass were also collected.

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Field Work by: James Grant, Aquatic Biologist
Susan Sylvester, Aquatic Biologist

Biological Laboratory Work by: Mary Linebaugh, Student Aide
Susan Sylvester, Aquatic Biologist

Chemical Determinations by: Environmental Services Division Laboratory

Drawings by: Ruben Rosalin

Report by: Susan Sylvester
Biology Section
Water Quality Division
Environmental Protection Bureau
Michigan Department of Natural Resources

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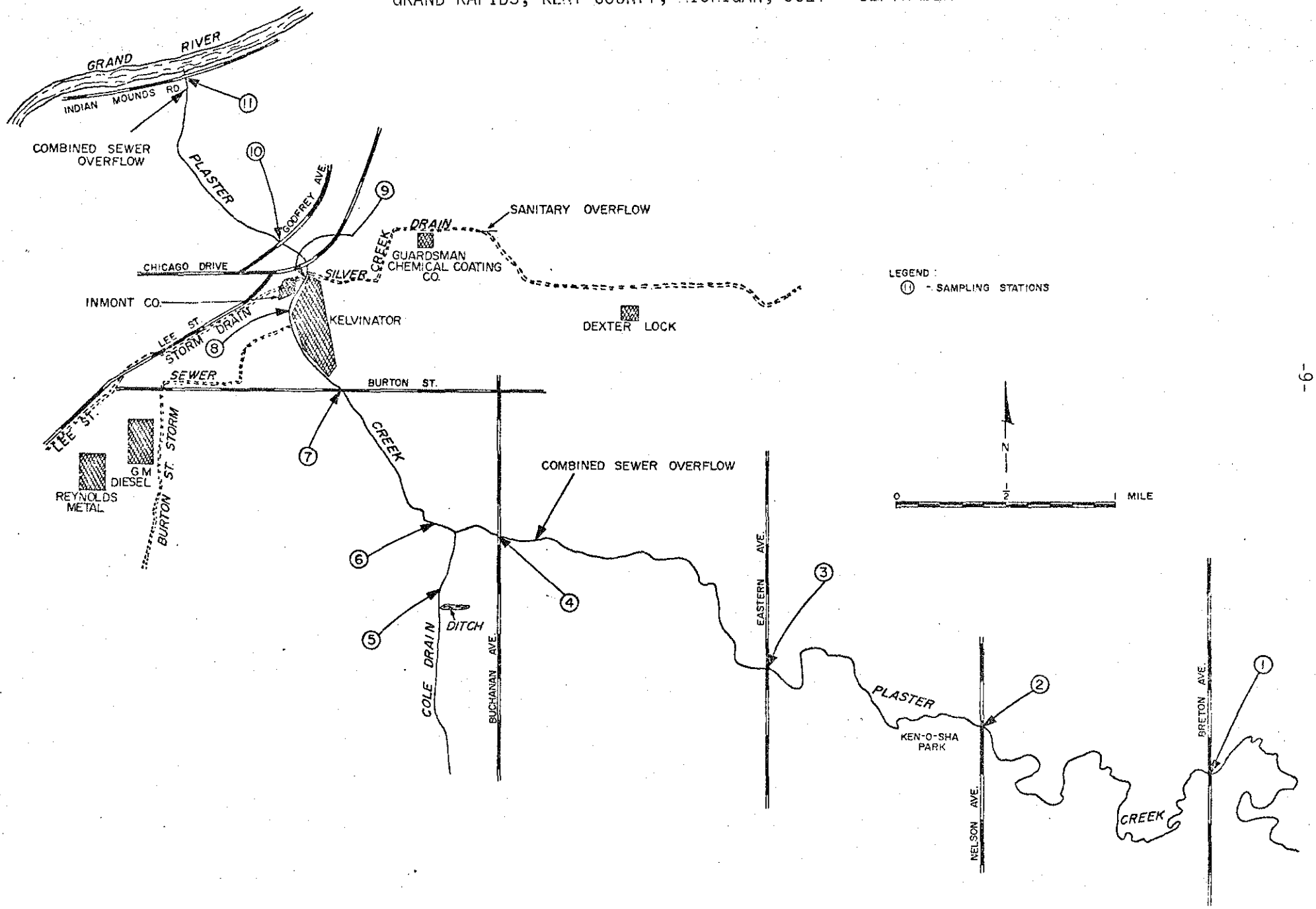
Plaster Creek

May 30, 1978

FIGURE 1
MACROINVERTEBRATE SAMPLING STATIONS LOCATIONS ON PLASTER CREEK,
GRAND RAPIDS, KENT COUNTY, MICHIGAN, JULY - SEPTEMBER 1977.



ıle 1 Station observations and habitat observations on Plaster Creek, Grand Rapids, Kent County, Michigan, July 19, 1977.

ıtion ıber	Station Location	Average Stream Depth	Average Stream Width	Watershed Type	Shoreline Vegetation	Turbidity	Bank Erosion	Parameters Sampled
-1	Breton	2 ft.	15 ft.	20% Agricultural 80% Suburban	10% Brush 10% Herbaceous 80% Deciduous Trees	Opaque	Moderate	Macroinvertebrates-Qual.- Multi-plate
-2	Nelson Avenue (Ken-O-Sha Park)	2 ft.	20 ft.	25% Forested 25% Suburban 50% Urban	10% Brush 10% Herbaceous 80% Deciduous Trees	Opaque	Moderate	Sediments Macroinvertebrates-Qual.-Multi-plate Fish
-3	Eastern Avenue	3 ft.	20 ft.	80% Suburban 10% Urban 10% Industrial	10% Brush 10% Herbacecus 80% Deciduous Trees	Turbid	Slight	Macroinvertebrates-Qual.- Multi-plate
-4	Buchanan Avenue	1 ft.	15 ft.	10% Suburban 50% Urban 40% Industrial	10% Brush 10% Herbaceous 80% Deciduous Trees	Slightly Turbid	Slight	Sediments Macroinvertebrates-Qual.- Multi-plate
-5	Cole Drain	1/2 ft.	3 ft.	100% Industrial	20% Brush 80% Herbaceous	Slightly Turbid	Moderate "concrete Channel"	Sediments-collected in ditched portion Macroinvertebrates-Multi-plate
-6	Below Confluence of Cole Drain	2 ft.	20 ft.	50% Urban 50% Industrial	20% Brush 10% Herbaceous 70% Deciduous Trees	Slightly Turbid	Moderate	Macroinvertebrates-Qual.- Multi-plate
-7	Burton Street	1 ft.	20 ft.	100% Industrial	50% Brush 10% Herbaceous 40% Deciduous Trees	Slightly Turbid	Severe	Macroinvertebrates-Qual.- Multi-plate

Table 1 (continued)

Station Number	Station Location	Average Stream Depth	Average Stream Width	Watershed Type	Shoreline Vegetation	Turbidity	Bank Erosion	Parameters Sampled
PC-8	Kelvinator Bridge	2 ft.	15 ft.	100% Industrial	80% Brush 10% Herbaceous 10% Deciduous Trees	Slightly Turbid	Slight	Sediments Macroinvertebrates-Qual.- Multi-plate
PC-9	Chicago Drive (Between Silver Creek and Lee Street Storm Drain)	3 ft.	15 ft.	100% Industrial	20% Brush 80% Deciduous Trees	Slightly Turbid	Moderate	Sediments-at Silver Cr. outfall Macroinvertebrates-Qual.- Multi-plate
PC-10	Godfrey Road	2 ft.	30 ft.	20% Urban 80% Industrial	40% Brush 20% Herbaceous 40% Deciduous Trees	Slightly Turbid	Moderate	Macroinvertebrates-Qual.- Multi-plate
PC-11	Indian Mounds Road	1 ft.	40 ft.	30% Suburban 40% Urban 30% Industrial	10% Brush 10% Herbaceous 80% Deciduous Trees	Slightly Turbid	Moderate	Sediments Macroinvertebrates-Qual.- Multi-plate Fish

ıle 1 (continued)

ıtion ıber	Station Location	Estimated Velocity	Overall Macroinvertebrate Habitat	Substrate Type	Sediment Oils	Aquatic Plants	Comments
-1	Breton	0.12 M/sec	Fair	30% coarse gravel 10% sand 40% clay 20% detritus	none	Benthic Blue-green	Anaerobic sediments Riffle area Poor visibility
-2	Nelson Avenue (Ken-O-Sha Park)	> 0.2 M/sec	Fair	20% coarse gravel 40% sand 30% clay 10% detritus	none	none	Good velocity and macroinvertebrate habitat. Poor visibility, no aquatic plants Mayflies/caddisflies present near bridge.
-3	Eastern Avenue	0.12 M/sec	Fair	40% med. gravel 40% sand 20% detritus	slight	none	Sowbugs common
-4	Buchanan Avenue	0.3 M/sec	Excellent	40% coarse gravel 40% sand 20% detritus	none	Potamogeton P. gramineus Fontinalis	Caddisflies, mayflies, sowbugs, scuds and crayfish common
-5	Cole Drain	0.3 M/sec	Fair	30% med. gravel 70% sand	abundant	Spirogyra	Macroinvertebrate multi-plate samples were silt laden. Sludge found below ditch portion. Oils abundant on surface and in sediments. Diptera larvae abundant along with sowbugs. Heavy silt deposits on rock. See report for description of ditch.
-6	Below Confluence of Cole Drain	0.3 M/sec	Excellent	10% rubble 60% coarse gravel 10% med. gravel 20% sand	none	Fontinalis	Excellent habitat, good meandering section of creek. Mayflies/caddisflies sparsely found in quiet areas only.

Table 1 (continued)

Station Number	Station Location	Estimated Velocity	Overall Macroinvertebrate Habitat	Substrate Type	Sediment Oils	Aquatic Plants	Comments
PC-7	Burton Street	0.3 M/sec	Good	20% med. gravel 40% sand 40% broken concrete	none	P. crispus Fontinalis	On left bank gravel fill washed down bank and into creek. Multi-plate sampler results affected by gravel fill-in. Scuds abundant, few caddisflies.
PC-8	Kelvinator Bridge	0.3 M/sec	Good	20% rubble 40% med. gravel 40% sand	slight	P. crispus P. filiformis Elodea Watercress Spirogyra Fontinalis	Sowbugs/flatworms common, few sparse young mayflies. One multi-plate sampler had cellophane on it.
PC-9	Chicago Drive (Between Silver Creek and Lee Street Storm Drain)	0.3 M/sec	Good	30% rubble 30% coarse gravel 40% sand	abundant	P. crispus P. filiformis Fontinalis	Lee St. Drain appears clear w/no sediment oils at outfall. Sludge deposits and sediment oils found bet. Lee St. and Silver Creek Drain. Silver Creek Drain had surface oils discharging from it. Sediments oily-greasy. Drain across fr. Silver Creek Drain had what appeared to be gasoline discharging from it.
PC-10	Godfrey Road	0.3 M/sec	Good	40% bricks/large rocks 20% med. gravel 40% sand	abundant	P. crispus Cladophora Moss	Snails extremely abundant-hundreds per din net scoop. Surface oils abundant Evidence of raw sewage discharge.
PC-11	Indian Mounds Road	0.3 M/sec	Good	10% rubble 30% med. gravel 60% sand	slight	none	Nice stream reach, good flow, large rocks, logs; good habitat. Macroinvertebrates sparse, only snails and flatworms.

FIGURE 2

SEDIMENT

SAMPLING STATION LOCATIONS ON PLASTER CREEK, GRAND RAPIDS, KENT COUNTY, MICHIGAN. JULY TO SEPTEMBER 1977

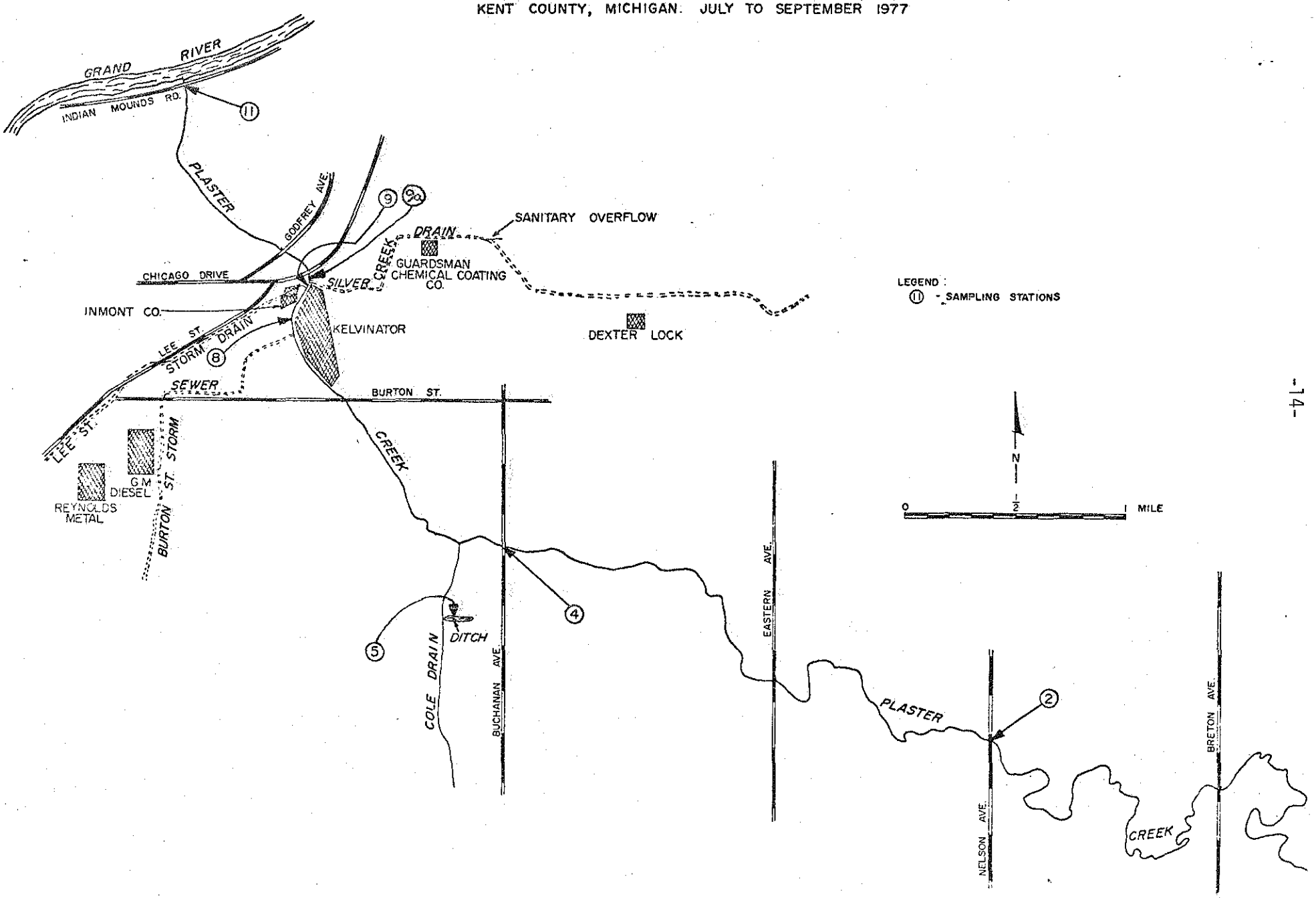


Table 2

Heavy metals, nutrients, phenols and hydrocarbons found in Plaster Creek sediments in September, 1977, Grand Rapids, Michigan.

Station Location:	Nelson Avenue (Ken-O-Sha Park)	Buchanan Road	Cole Drain US 131 & 28th Avenue ÷	Kelvinator Bridge
Station Number:	PC-2	PC-4	PC-5	PC-8
Parameters (mg/kg)				
Kjeldahl Nitrogen	1,600	2,300 *	2,200 *	6,000 *
Total Phosphorus	780 *	920 *	780 *	1,400 *
COD	90,000 *	140,000 *	530,000 *	140,000 *
Arsenic	5.6	7.2	74	4.0
Copper	31	58 *	190 *	190 *
Mercury	0.08	0.17	0.16	0.14
Cadmium	3.5	4.9	8.3 *	7.2 *
Total Chromium	28	28	33	54
Iron			66,000 *	
Zinc	200	310 *	500 *	230 *
Nickel	40	41	56 *	52 *
Lead	240 *	660 *	1,000 *	360 *
Cyanide	0.5 *	0.9 *	< 0.1	1.9 *
Phenols	0.2	0.3	1.6	0.5
Hydrocarbons				
1242 PCB µg/kg	< 500	< 500	170,000	< 500
1254 PCB µg/kg	< 500	700	38,000	500
1260 PCB µg/kg	< 500	< 500	<10,000	< 500
DEPH µg/kg	< 1,000	<1,000	200,000	<1,000
Oil mg/kg	1,600	2,800 *	2,000	5,300 *

* indicating those values exceeding EPA 1975 proposed sediment classification levels of heavily polluted.
÷ collected in the ditched portion at the end of Darling Freight Lines property.

Table 2 (continued)

Station Location:	Chicago Drive††	Silver Creek Storm Drain Outfall	Indian Mounds Road	Heavily Polluted†††	Michigan Background (+2 std. dev.)
Station Number:	PC-9	PC-9a	PC-11		
Parameters (mg/kg)					
Kjeldahl Nitrogen	7,400 *	20,000 *	6,100 *	> 2,000	
Total Phosphorus	1,800 *	5,000 *	1,200 *	> 650	
COD	40,000 *	370,000 *	130,000 *	> 80,000	
Arsenic	7.7	14 *	4.8	> 8	2
Copper	510 *	1,200 *	150 *	> 50	
Mercury	0.22	< 0.01	0.22	> 1	0.29
Cadmium	8.8 *	18 *	6.7 *	> 6	11
Total Chromium	60	180 *	59	> 75	
Iron				> 25,000	
Zinc	300 *	810 *	300 *	> 200	53
Nickel	61 *	140 *	56 *	> 50	
Lead	430 *	1,100 *	460 *	> 60	99
Cyanide	1.1 *	2.1 *	1.0 *	> 0.25	
Phenols	28	180	1.4		
Hydrocarbons					
1242 PCB µg/kg	< 500	< 500	< 500		
1254 PCB µg/kg	670	1,500	< 500		
1260 PCB µg/kg	< 500	< 500	< 500		
DEPH µg/kg	1,600	< 1,000	< 1,000		
Oil mg/kg	8,000 *	10,000 *	2,600 *	> 2,000	

* indicating those values exceeding EPA 1975 proposed sediment classification levels of heavily polluted.
† collected in the ditched portion at the end of Darling Freight Lines property.
†† collected below the Lee Street Storm Drain outfall and above the Silver Creek Drain outfall.
††† EPA 1975 proposed sediment classifications.

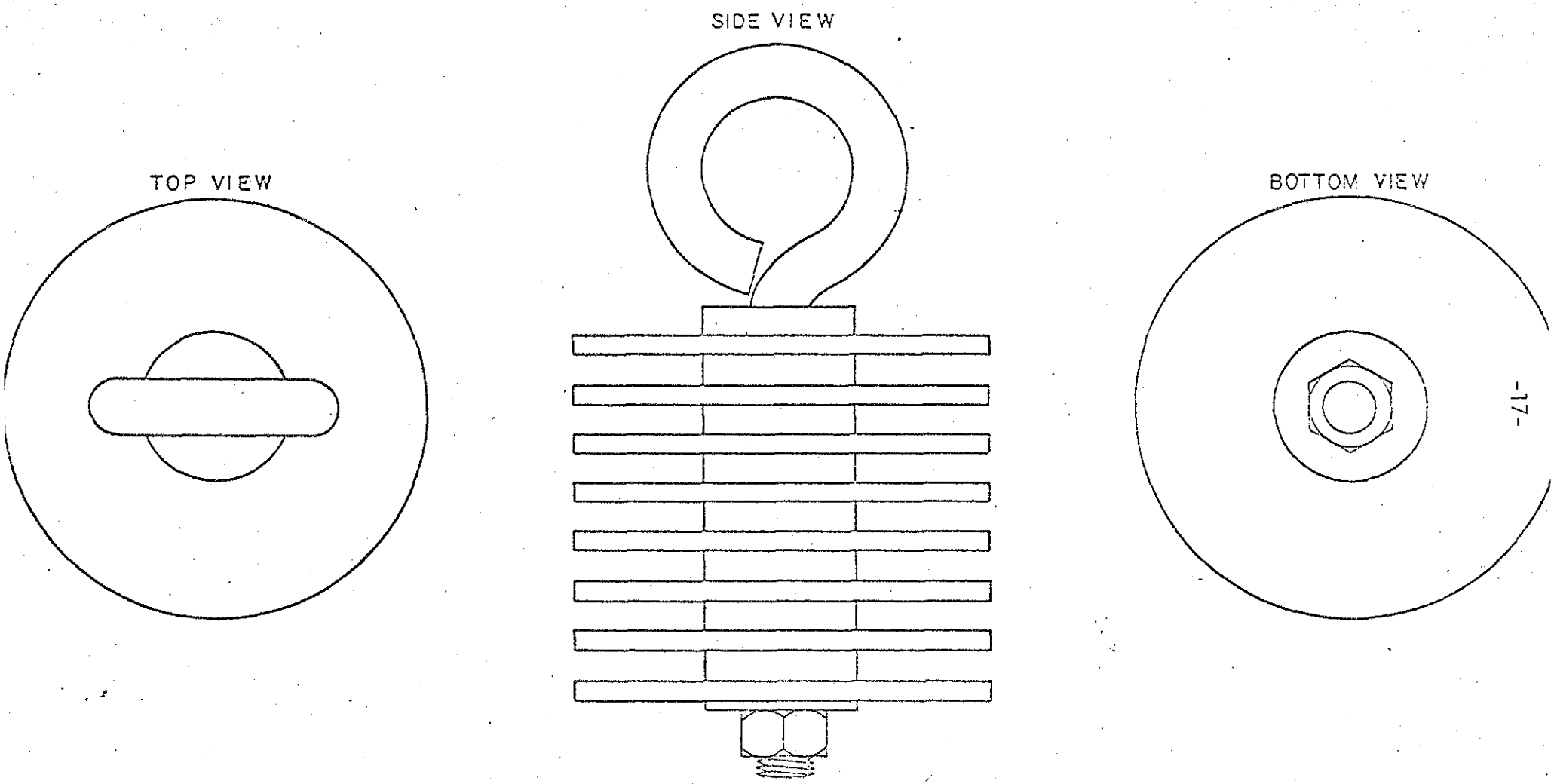


FIGURE 3: Circular multi-plate artificial substrate sampler with 619 cm^2 of surface area. (actual size)

FIGURE 4 MAYFLIES AND CADDISFLIES FROM ARTIFICIAL SUBSTRATE SAMPLES IN PLASTER CREEK, GRAND RAPIDS, MICHIGAN JULY 19 - SEPT. 7, 1977.

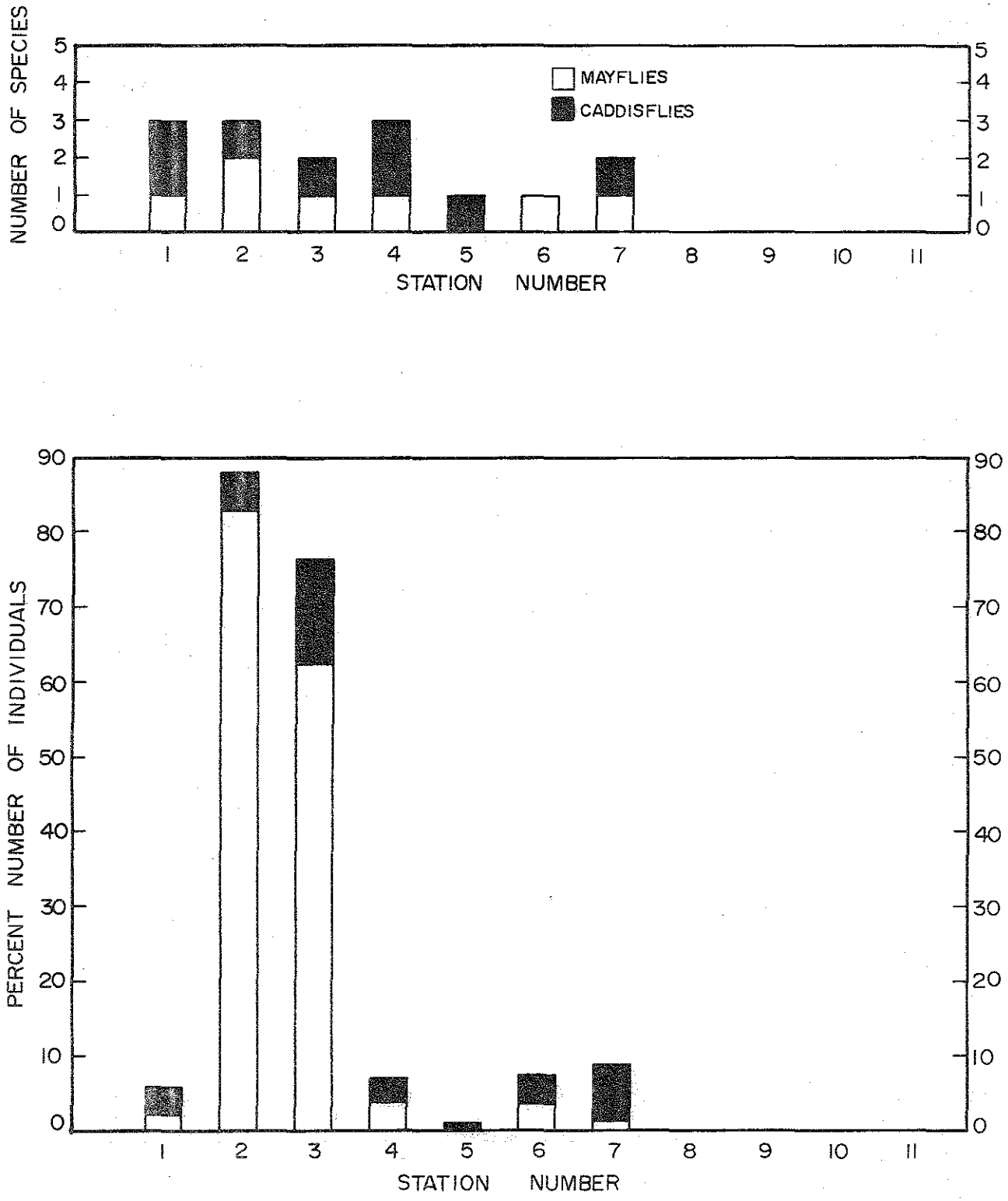


Table 3

Benthic macroinvertebrates collected from multi-plate samplers, exposed in Plaster Creek in Grand Rapids, Kent County, Michigan, from July 19, 1977 to September 7, 1977. All numbers are estimates per meter squared.

	Station Location:	Breton Ave.		Ken-O-Sha Pk. Nelson Ave.		Eastern Ave.		Buchanan Ave.		Cole Drain		Below Confluence of Cole Drain	
	Station Number:	PC-1		PC-2		PC-3		PC-4		PC-5		PC-6	
	Sample:	A	B	A	B	A	B	A	B	A	B	A	B
TS	Scientific Name												
	Turbellaria (flatworms)												
F	Dugesia										16		
	Nematoda (roundworms)												
	Oligochaeta (aquatic earthworms)	16	16				16			500			
T	Hirudinea (leeches)									16			
	Gastropoda (snails)												
F	Ferrissia	32	48	48	81	48	97	113	258			113	129
T	Physa									129	516		
	Isopoda (sowbugs)												
T	Asellus		16					16	113	32			65
	Amphipoda (scuds)												
F	Gammarus												
	Ephemeroptera (mayflies)												
F	Caenis			16									
F	Stenacron interpunctatum		32	242	775	452	484	16	48			32	
F	Stenonema spp. (early instars)			226	565	210	113						
I	S. vicarium												
F	Tricorythodes												
	Odonata (dragonflies, damselflies)												
F	Coenagrionidae	16									65		
	Trichoptera (caddisflies)												
F	Cheumatopsyche	32			65	129	129	16	16				32
F	Hydropsyche spp. (early instars)												
F	H. betteni	16							16				
F	H. bifida gr.									16			
	Hydropsychidae pupae												
	Coleoptera (beetles)												
F	Ancyronyx variegata (larvae)						16						
	Diptera (true flies)												
F	Limnophora										16		
	Chironomidae (midges)												
	pupae	16					16			48	32	16	32
F	Ablabesmyia	16								16			
I	Brillia												
I	B. par												
T	Chironomus	16							32	97	16		
T	C. plumosus												
F	Cricotopus	16	81					48	16		291	32	48
F	Cryptochironomus							16					
T	Glyptotendipes	16											
T	Microcricotopus	97	194			32	16	161	178			113	
F	Phaenopsectra												
F	Polypedilum	32	32										
F	P. fallax	274	81			81	32	242	113			16	32
T	Procladius												
F	Psectrocladius												
F	Psectrotanypus												
F	Rheocricotopus	16	48										
F	Rheotanytarsus								16				
I	Stictochironomus												
F	Tanypus										113		
F	Thienemannimyia (gr.)	81	113		16	81	16	178	81		355	113	81
	Eggs												

Table 3 . (Continued)

Station Location:	Burton St.		Kelvinator Br.		Chicago Dr.		Godfrey Aye.		Indian Mounds Rd.	
Station Number:	PC-7		PC-8		PC-9		PC-10		PC-11	
Sample:	A	B	A	B	A	B	A	B	A	B
TS Scientific Name										
Turbellaria (flatworms)										
F Dugesia		16		16	355	323	16	242	16	242
Nematoda (roundworms)				16		32				
Oligochaeta (aquatic earthworms)		16	113	32	323	113	307	678	48	178
T Hirudinea (leeches)										
Gastropoda (snails)										
F Ferrissia	48	48					16			16
T Physa							291	1162		129
Isopoda (sowbugs)										
T Asellus	145	32	32	16	339	16				
Amphipoda (scuds)										
F Gammarus						16				
Ephemeroptera (mayflies)										
F Caenis										
F Stenacron interpunctatum										
F Stenonema spp. (early instars)										
I S. vicarium										
F Tricorythodes		16								
Odonata (dragonflies, damselflies)										
F Coenagrionidae										
Trichoptera (caddisflies)										
F Cheumatopsyche	32	32								
F Hydropsyche spp. (early instars)										
F H. betteni										
F H. bifida gr.										
Hydropsychidae pupae	16									
Coleoptera (beetles)										
F Ancyronyx variegata (larvae)										
Diptera (true flies)										
F Limnophora										
Chironomidae (midges)										
pupae	48	48	65	97	16		129		16	
F Ablabesmyia			97	81	16	16		32	16	
I Brillia				16						
I B. par							32	16		
T Chironomus			32	97		16			32	
T C. plumosus	16	32								
F Cricotopus		65	839	1662	307	129	872	16	97	
F Cryptochironomus			16			16				
T Glyptotendipes					16					
T Microcricotopus	242	65	371	226	32					
F Phaenopsectra									16	
F Polypedilum										
F P. fallax	16	16	113	97	48	48	97	32		16
T Procladius										
F Psectrocladius					16	32			178	32
F Psectrotanypus										
F Rheocricotopus				16						
F Rheotanytarsus										
I Stictochironomus		48								
F Tanypus										
F Thienemannimyia (gr.)	16	48	274	307	97	97	113	32	32	16
Eggs	+									+

Table 4

Summary table of the macroinvertebrate communities found colonizing multi-plate samplers in Plaster Creek from July 19 to September 7, 1977.

Station Location:	Breton Road	Nelson Avenue (Ken-O-Sha Park)	Eastern Avenue	Buchanan Avenue	Cole Drain	Below Confluence of Cole Drain
Station Number:	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6
Total estimated number per m^2	1353	1243	1903	1693	2354	854
Station Diversity	3.19	.96	1.99	2.89	2.73	2.66
Percent Mayflies	2	83	62	3	0	3
Percent Caddisflies	3	5	13	2	.6	3
Percent Chironomids	83	1	14	63	41	56
Percent Other	10	10	9	29	59	35

	Burton Street	Kelvinator Bridge	Above Chicago Drive	Godfrey Road	Indian Mounds Drive
	PC-7	PC-8	PC-9	PC-10	PC-11
Total estimated number per m^2	1061	4631	2419	4083	1080
Station Diversity	3.01	2.17	2.86	2.28	2.85
Percent Mayflies	1	0	0	0	0
Percent Caddisflies	7	0	0	0	0
Percent Chironomids	62	95	37	33	41
Percent Other	28	4	62	66	58

FIGURE 5 MACROINVERTEBRATES COLLECTED IN QUALITATIVE COLLECTS FROM PLASTER CREEK, GRAND RAPIDS, MICHIGAN SEPTEMBER 7, 1977.

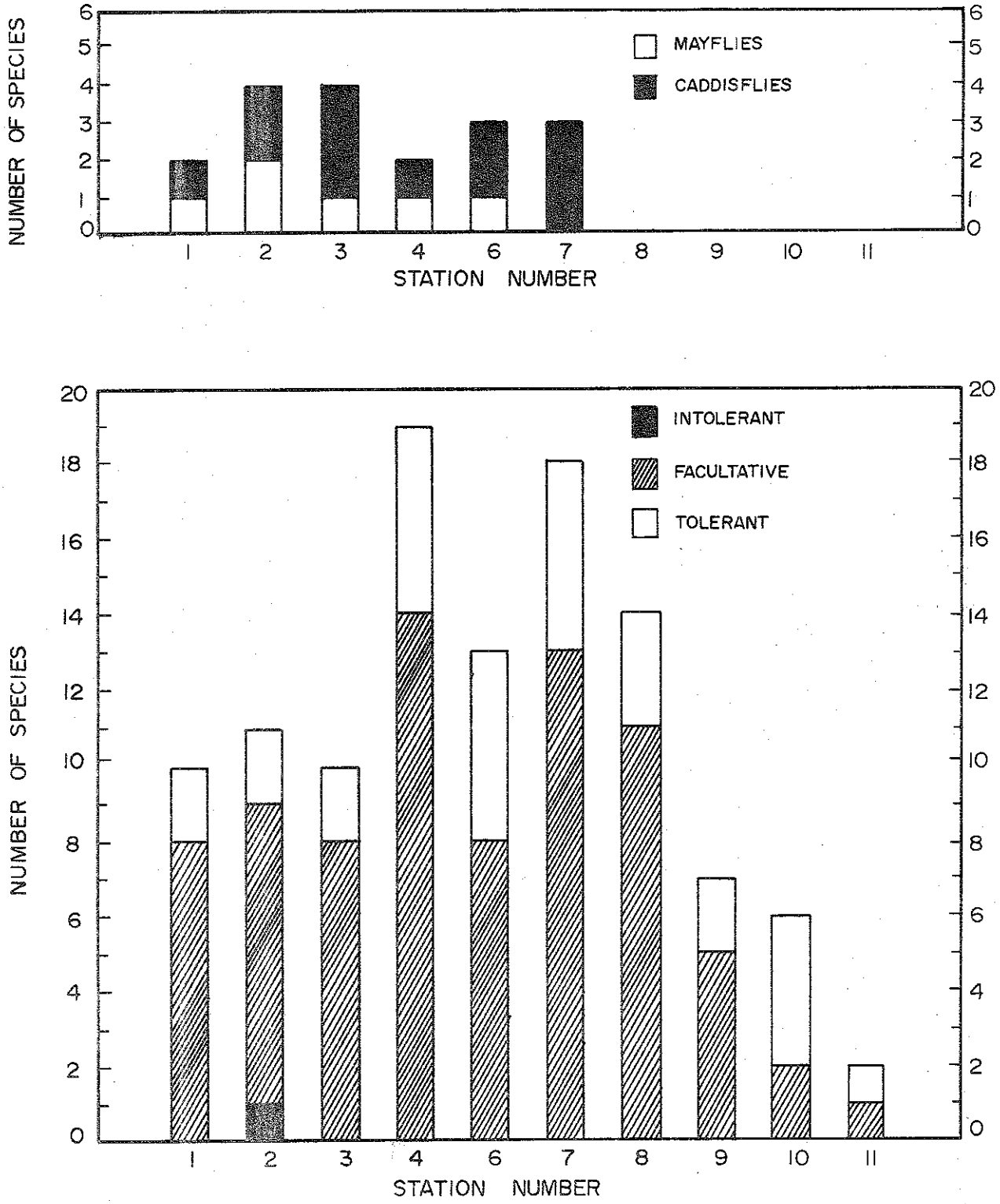


FIGURE 6

QUALITATIVE MACROINVERTEBRATE BIOTIC INDICES FOR STATIONS IN PLASTER CREEK, GRAND RAPIDS, MICHIGAN. SEPTEMBER 7, 1977.

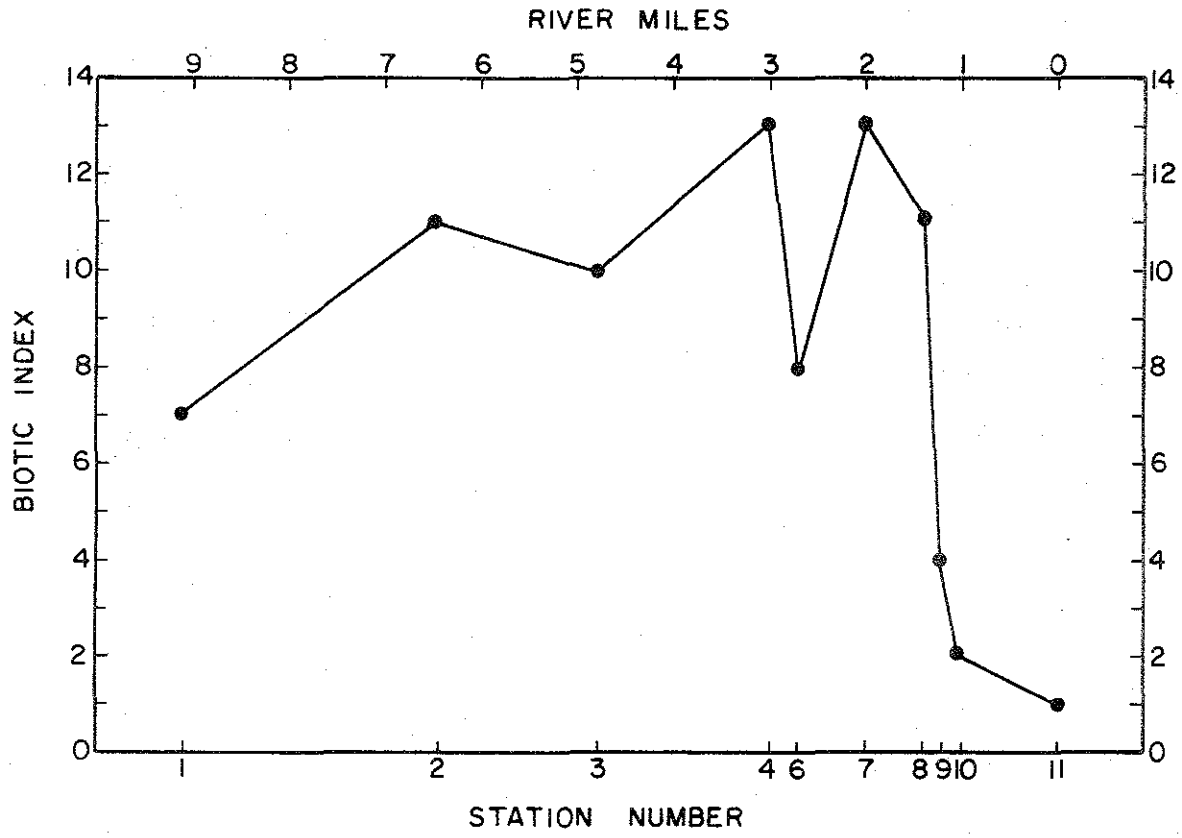


Table 5 Qualitative benthic macroinvertebrate data from samples collected in Plaster Creek in Grand Rapids, Michigan, Kent County, September 7, 1977. Actual numbers collected are recorded.

TS	Station Location: / Station Number: / Scientific Name	Breton Ave. PC-1	Ken-O-Sha-Pk. Nelson Ave. PC-2	Easton Ave. PC-3	Buchanan PC-4	Below Confluence of Cole Drain PC-6	Burton St. PC-7
	Turbellaria (flatworms)				2		
	Oligochaeta (aquatic earthworms)	6	5	1	50	15	5
T	Hirudinea (leeches)				2	1	1
	Gastropoda (snails)						
F	Ferrissia		3	4	6	3	3
T	Physa	1			4	1	2
	Pelecypoda (clams)						
F	Sphaerium	1	7	4	3		3
	Isopoda (sowbugs)						
T	Asellus			3	13	14	14
	Amphipoda (scuds)						
F	Gammarus				1	1	
F	Hyalella azteca				18		1
	Decapoda (crayfish)						
F	Orconectes	6		7	14	8	7
	Ephemeroptera (mayflies)						
F	Stenacron interpunctatum	10	25	9	7	21	
F	Stenonema spp. (early instars)		3	1			
I	S. vicarium		1				
	Odonata (dragonflies, damselflies)						
F	Argia	1					
F	Calopteryx				3		1
F	Coenagrionidae	1					
F	Enallagma				12		2
F	Ischnura						
F	Macrothemis						
	Hemiptera (true bugs)						
S	Belostoma					1	2
S	Corixidae	2					
S	Gerridae			1			
S	Gerris		1	1			
S	Limnogonus						
F	Ranatra						
	Trichoptera (caddisflies)						
F	Cheumatopsyche	1	25	21	7	7	3
	Hydropsychidae pupae			2			1
F	H. species A			1		2	18
F	H. betteni		1	1			3
	Coleoptera (beetles)						
F	Ancyronyx variegata			1			
F	Dubiraphia				4		1
S	Laccophilus						1
F	Macronychus		2				
F	Optioservus		2				
S	Peltodytes	1					
	Chironomidae (midges)						
	pupae		4	2	2	2	5
F	Ablabesmyia						
T	Chironomus		1		3	1	
T	C. plumosus						13
F	Cricotopus	3		3	7	4	35
F	Cryptochironomus		1				
F	Polypedilum				1		
F	P. fallax						2
T	Procladius	2					
F	Psectrocladius						
F	Psectrotanypus						
F	Thienemanniymia (gr.)				3	4	8
	Pisces						
	Etheostoma (darter)				4		
	Rhinchthus (dace)			2		3	
	R. atratulus (blacknose dace)						1

Table 5 (continued)

TS	Station Location: / Station Number: / Scientific Name	At Kelvinator Bridge PC-8	Above Chicago Drive PC-9	Godfrey Ave. PC-10	Indian Mounds Rd. PC-11
	Turbellaria (flatworms)	1	12	6	2
	Oligochaeta (aquatic earthworms)	5	110	81	12
T	Hirudinea (leeches)	1		1	
	Gastropoda (snails)				
F	*Ferrissia*				
T	*Physa*		1	6	
	Pelecypoda (clams)				
F	*Sphaerium*		1		
	Isopoda (sowbugs)				
T	*Asellus*	8			
	Amphipoda (scuds)				
F	*Gammarus*				
F	*Hyalella azteca*	5	1		
	Decapoda (crayfish)				
F	*Orconectes*	2	4		
	Ephemeroptera (mayflies)				
F	*Stenacron interpunctatum*				
F	*Stenonema* spp. (early instars)				
I	*S. vicarium*				
	Odonata (dragonflies, damselflies)				
F	*Argia*				
F	*Calopteryx*	1			
F	Coenagrionidae	4			
F	*Enallagma*				
F	*Ischnura*	4			
F	*Macrothemis*	1			
	Hemiptera (true bugs)				
S	*Belostoma*			1	
S	Corixidae		1		
S	Gerridae				
S	*Gerris*				
S	*Limnogonus*				
F	*Ranatra*	1			
	Trichoptera (caddisflies)				
F	*Cheumatopsyche*				
	Hydropsychidae pupae				
F	*H.* species A				
F	*H. betteni*				
	Coleoptera (beetles)				
F	*Ancyronyx variegata*				
F	*Dubiraphia*				
S	*Laccophilus*				
F	*Macronychus*				
F	*Optioservus*				
S	*Peltodytes*	2			
	Chironomidae (midges)				
	pupae			2	
F	*Ablabesmyia*			1	
T	*Chironomus*				
T	*C. plumosus*				
F	*Cricotopus*	13	8	3	
F	*Cryptochironomus*				
F	*Polypedilum*	2			
F	*P. fallax*				
T	*Procladius*				
F	*Psectrocladius*	2			
F	*Psectrotanypus*	3			1
F	*Thienemannimyia* (gr.)				
	Pisces				
	Etheostoma (darter)				
	Rhinichthus (dace)				
	R. atratulus (blacknose dace)		1		