NORTHEAST OHIO
REGIONAL
SEWER DISTRICT

GREATER CLEVELAND AREA

STREAM MONITORING PROGRAM

1988

REPORT

AUGUST 1989

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NORTHEAST OHIO REGIONAL SEWER DISTRICT

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PREFACE

In 1972, a ruling by the Court of Common Pleas of Cuyahoga County established the Cleveland Regional Sewer District as an independent political subdivision of the State of Ohio. Later named the Northeast Ohio Regional Sewer District (NEORSD), its charge was to solve water pollution problems affecting the City of Cleveland and the suburbs through resolution of jurisdictional impediments to massive sewage treatment plant and interceptor sewer improvements.

Prior to 1972, the severely degraded water quality of the Cuyahoga River and Lake Erie were so infamous that these two bodies of water had become rallying cries for the national environmental movement of the late 1960's and early 1970's. When debris and oil slicks accumulating on the surface of the Cuyahoga River caught fire in 1969, it became the focus of international attention, seriously damaging the reputation of the City of Cleveland for years to come.

Enormous volumes of untreated and poorly treated sewage were leaking, overflowing, or being discharged to the environment. The sewage treatment plants operated by the City of Cleveland were generally undersized and subject to frequent bypasses of sewage. There was essentially no control over industrial waste discharged to the sewer system. Toxic metals, acids, cyanides, and oils freely released by industry further added to the environmental problems by causing inhibition of sewage treatment plant performance. High concentrations of toxic metals were passing through the treatment plants to the environment.

The focus of the newly-formed NEORSD in its first decade was on building a modern, effective pollution-control infrastructure to improve the quality of the Greater Cleveland Area's surface waters. The NEORSD began construction of major intercepting sewers and upgrading of all three of its Wastewater Treatment Plants: Easterly, Westerly, and Southerly. By the date of this report, many of these projects have been completed or nearly completed: expansion of the Easterly WWTP; expansion and reconstruction of the Southerly WWTP to include advanced level (tertiary) treatment; reconstruction of the Westerly WWTP into a physical/chemical facility; construction of the Northwest and Cuyahoga Valley Interceptors. Twenty-five computer-controlled automated combined sewer regulators were installed, minimizing the amount of sewage spilled to the environment during rain events. Control of the Strongsville "A" and Berea WWTP's was transferred to the NEORSD. Construction was begun on the Heights/Hilltop and Southwest Interceptors. In total, over 750 million dollars have been committed to capital improvements by the NEORSD.

The NEORSD's Industrial Waste Section was formed to protect the District's facilities and personnel from the deleterious and hazardous effects of chemical discharges by industry. The Industrial Waste Section developed an EPA-approved Pretreatment Program, which, by the end of 1988, had required and

Figure 1. Cuyahoga River at the head of navigation (Scene of the 1969 "River Fire.")

overseen the installation and operation of almost 6 million dollars worth of pretreatment by industry. Since 1976, the total concentration of metals flowing into and passing through the NEORSD's treatment plants to the environment has been reduced by over 80 percent, largely due to these efforts. Additionally, the Industrial Waste Section has taken on numerous other responsibilities, including: emergency response to reported chemical spills and complaints by the public; monitoring of industrial discharges for the application of surcharge billing rates; monitoring of scavenger companies and municipal waste haulings; adding new accounts and applying exemptions to billing; training District employees in safety practices and first-aid techniques; and recently, assuring the District's compliance with "Right-to-Know" legislation and hazardous chemical storage practices.

The focus of water quality assessment by federal and state pollution control regulatory agencies began shifting in the 1980's to the receiving waters themselves. In light of the NEORSD's commitment of massive expenditures to achieving improvements in the quality of Greater Cleveland area surface waters, a need to demonstrate and document these improvements became evident. In 1986, the NEORSD hired Mr. Timothy Whipple to develop a Stream Monitoring Program. In 1987, the Industrial Waste Section began implementation of the Program, generally following the guidelines set forth by Mr. Whipple.

The charge of the NEORSD's Stream Monitoring Program is to:

1) Document the water quality improvements due to NEORSD facilities and programs;

2) Determine sources of environmental disruptions and make recommendations for their elimination;

3) Coordinate monitoring activities with other agencies with interests in water quality;

4) Provide a scientifically sound current information basis for environmental planning and future abatement projects.

In the Program's first full year, 1987, Industrial Waste Section personnel performed visual surveys of 13 area streams within the NEORSD's jurisdictional boundaries. While walking as much of the streams' lengths as was possible, their physical characteristics were noted. The suitability of the 53 sampling locations selected by Mr. Whipple was assessed, and new additional Sample Sites were assigned where deemed appropriate. Samples for chemical and bacteriological parameters were collected at each site on at least one, and usually several, occasions. Qualitative sampling for benthic macroinvertebrates, which can be valuable indicators of water quality, was performed at almost all sites. Measurements of temperature, dissolved oxygen concentrations, and flow rates were performed on-site. Environmental disruptions noted during the stream surveys and reflected in the initial samplings were reported to local communities and agencies responsible for their remediation. The resulting observations and conclusions were included in <u>The Greater Cleveland Area Stream Monitoring Program 1987 Report</u>.

During 1987, Industrial Waste Section personnel found that in many cases, rather than being able to demonstrate the environmental improvements that have resulted from District activities, the Stream Monitoring Program was identifying sources of pollution in the streams which were obscuring these improvements. The most significant of these was domestic sewage entering the environment in dry weather without ever reaching the NEORSD's sewage treatment plants. Of the 48 specific sources of dry weather contamination in streams that were identified by the Stream Monitoring Programs in 1987, 25 were eliminated that year. After several more of these problems were remediated in 1988, a total of over 5 million gallons per day of untreated sanitary sewage in dry weather had been removed from the environment.

In 1988, the Stream Monitoring Program focused its efforts on the Cuyahoga River, its tributaries, and the Ohio Canal, because of issues resulting from the Ohio EPA's designation of the river upstream of the Navigation Channel as Warmwater Habitat and because of the implications of the new NPDES Permit for the Southerly WWTP. Additional sample sites were selected, and monitoring was expanded to include quantitative sampling on the river and canal for benthic macroinvertebrates using Hester-Dendy artificial substrate samplers. Quantitative sampling for fish was also performed on the river and canal utilizing electroshocking techniques. Chemical and bacteriological sampling was continued at most of the Stream Monitoring Program Sites. However, qualitative sampling for benthic macroinvertebrates was limited to the Cuyahoga River and its tributaries. Follow-up investigations were performed in 1988 on all streams for environmental disruptions discovered and reported during the previous year.

Acknowledgements are due to the following contributors to the 1988 Stream Monitoring Program: William Mack and Catherine Zamborsky, who accomplished the benthic macroinvertebrate identifications; Rosemary Kieliszek and Eric Parham, who prepared the stream maps; Paul Beck, who provided the photographs; Greg Seegert of EA Science and Technology, who directed and supplied the equipment for the electrofishing surveys; Robert Kleinhenz, who directed and documented the other studies on the Cuyahoga River and Ohio Canal (on which the 1988 Program focused); all of the members of the NEORSD Industrial Waste Section, who provided the information which constitutes this report. The Greater Cleveland Area Stream Monitoring Program 1988 Report was compiled and edited by Keith Linn, Program Coordinator.

Approximately 100 copies of this report are being distributed to various educational institutions, scientists, and governmental agencies concerned with water quality issues. Comments on and questions about the NEORSD's Stream Monitoring Program are welcomed. The NEORSD also wishes to encourage suggestions and advice regarding possible future studies on the quality of surface waters in the Greater Cleveland Area.

OVERVIEW AND CONCLUSIONS

Program Direction

The NEORSD's Director and Board of Trustees have provided the staffing and structure for a comprehensive survey and analyses of the Cuyahoga River and other area river systems. The challenge to the NEORSD Stream Monitoring Program for 1988 was:

1) To continue to develop stream monitoring skills to accurately measure existing water quality in terms of chemistry, bacteriology, and fish and benthic macroinvertebrate communities.

2) To seek out, identify, and eliminate point and nonpoint sources of pollution.

3) To evaluate the effectiveness of the previous year's remediation activities.

4) To coordinate and dovetail stream monitoring-related activites with other agencies.

During 1988, the Industrial Waste Section (IWS) collected a total of 200 samples for chemical/bacteriological analysis from area streams in support of the Stream Monitoring Program. In budgeting terms, $132,000 was spent by the IWS in manpower and equipment. The figure is indicative of the resolve of the NEORSD to ferret out and provide impetus for the elimination of the area's water pollution problems. This investment in direct water pollution monitoring is expected to increase substantially in future years as ambient bioassays, studies on the impact of the Southerly WWTP, and toxics confirmation testing in support of the RAP are implemented.

The scope of the water pollution control efforts of the Northeast Ohio Regional Sewer District expanded substantially during 1988 with the inclusion and implementation of the Combined Sewer Overflow (CSO) Monitoring Program, bioassays, electrofishing, and staff involvement at various levels of the Remedial Action Plan.

Under NPDES Permit Number 3PA00002*DD, 128 separate combined sewage overflows have been placed on a monitoring cycle. The wet weather discharges are measured for number of overflow events, volumes of overflow, duration of overflow, and concentrations of BOD and suspended solids. The monitoring of CSO's commenced in November of 1988. Two staff members of the Industrial Waste Section are assigned these CSO monitoring duties.

The Southerly Wastewater Treatment Plant was issued a new NPDES Permit, Number 3PF00002*FD, in September of 1988. This new permit requires the NEORSD to conduct acute and chronic bioassays on fathead minnows (Pimephales promelas) and water fleas (Ceriodaphnia sp.) on a quarterly basis. These bioassays are designed to measure the degree of toxicity that the Southerly WWTP may contribute to the Cuyahoga River. The NEORSD Laboratory, through 1988, developed the in-house capabilities to perform these difficult bioassay toxicity tests.

Because attainment of the designated levels of water quality in Ohio is determined partly by fish community structure and function, the NEORSD, in association with its contractor, conducted an electrofishing survey of the Cuyahoga River and Ohio Canal in the vicinity of the Southerly WWTP. The results of both this survey and a survey conducted by the Ohio EPA indicate that, based upon fish communities, the Cuyahoga River is still not attaining Warmwater Habitat status anywhere downstream of Akron, Ohio. Because of continuing Water Quality Standard violations for metals and bacteria in the Cuyahoga River upstream of the Southerly Wastewater Treatment Plant, biological data representing the fish and benthic communities are important in demonstrating any impact by the Southerly WWTP effluent.

The lower Cuyahoga River is among the 42 designated Areas of Concern (AOC's) on the Great Lakes. These areas were chosen by the International Joint Commission's (IJC's) Great Lakes Water Quality Board (GLWQB) for being water bodies which have a history of persistent and complex pollution problems. In 1988, the GLWQB initiated development of Remedial Action Plans (RAP's), which are comprehensive strategies to identify and plan remediation of persistent pollution problems in the Areas of Concern and assign appropriate use designations. The Ohio EPA is required to submit an approved RAP for the Cuyahoga River to the IJC by 1991. The Cuyahoga River RAP will be developed by the local community in cooperation with the Ohio EPA.

The NEORSD is involved with the Cuyahoga River Remedial Action Plan on two levels: as participants on the Cuyahoga Coordinating Committee (CCC) and as operatives in the field to confirm or refute the existing toxic conditions which lead to the designation of the Cuyahoga River as an Area of Concern. The activities of the CCC are:

A) To provide a forum for all community interests in the development of water quality goals.

B) To provide structured means of communicating technical information on water quality needs and specific remedial actions.

C) To provide assistance in the preparation and review of the RAP document which is to be submitted to the IJC.

D) To assist Ohio EPA in supporting implementation of the RAP.

Area Streams

The 1988 Stream Monitoring Report does not present any surprises to the perception that streams near the central core of the city tend to be more polluted than those streams in the more sparsely populated suburban areas. Chemical and biological data clearly demonstrate the degradation of water quality but do not indicate that industrial waste discharged to the environment is a principal cause. Bacteriological data strongly implicate that sewage, in general, provides the most significant volume of polluted water tributary to the environment. Hydraulically overloaded sewers, combined sewer overflows, broken and/or blocked sewers, and malfunctioning sewage pumping stations are all mechanisms for the release of sewage into the environment.

Monitoring data indicate that small urban streams tend to recover quickly once a major source of sewage has been eliminated. The 1988 Stream Monitoring Report describes numerous streams which were disrupted by large quantities of dry weather sewage discharges. Sources of many of these dry weather discharges were identified but some of them remain uncorrected. It is therefore still unclear as to whether these urban streams can recover to the point of sustaining a Warmwater fishery. It remains to be determined whether or not the dry weather sources of sewage are masking nonpoint source contributions of toxic chemicals, i.e., urban runoff or air pollution washout, that may continue to impact urban streams even after dry weather sources are eliminated.

The chemical analyses of the Cuyahoga River indicate that the quality of the river water may no longer be an impediment to a good fishery. The occasional minor violations of Ohio Water Quality Standards are not unusual for other Ohio rivers, such as the Rocky River, known locally as a fairly clean stream. Table 1 demonstrates the very slight chemical differences among average concentrations in the Cuyahoga and other rivers of northeastern Ohio.

Since the lower fifteen miles of the Cuyahoga River is rarely used for swimming or fishing, the public perception of this river is based upon its appearance. The part the Cuyahoga River with which the public is most familiar is in the downtown Cleveland flats area. Here the typically muddy, "chocolatey" brown color of the river is seen in stark contrast to the blue of Lake Erie. Here also are numerous floating hulks of trees and pools of bark, branches, and wood chips that have been carried downstream by the river's currents. These natural pollutants contributed by the highly erodable glacial soils in the Cuyahoga River basin are an offense to the eye as well as to the reputation to the river. For those who know the river, however, it is important that the mental images of high turbidity and flotsam from natural sources of pollution be segregated from the often invisible and deleterious anthropogenic sources of pollution. The elimination of the remaining man-made sources of pollution will not significantly improve the appearance of the river.

As water pollution abatement programs such as municipal and industrial wastewater treatment systems have been implemented and optimized, the concentrations of many pollutants are falling to or below their detection limits. Furthermore, because of the potential toxicity imparted by even trace concentrations of some organic materials, there is a growing problem in measuring concentrations of many parameters. Commonly used analytical techniques and instrumentation of the 1960's and 1970's are no longer adequate

Table 1:

COMPARISON OF CHEMICAL CONCENTRATIONS
IN THREE NORTHEASTERN OHIO RIVERS

(For explanation of parameter abbreviations and units, see Appendix II.)

	CUYAHOGA RIVER below Southerly WWTP	ROCKY RIVER at Berea	CHAGRIN RIVER at RM 10.5
BOD	4	9	2
COD	26	18	33
SS	44	35	18
Total Solids	532	600	380
TDS	492	557	367
Sp.Con.(umhos/cm)	746	921	582
NH_3	0.40	0.78	0.05
P	0.43	0.24	0.12
Soluble P	0.31	0.10	0.05
NO_3	4.50	1.42	0.28
NO_2	0.05	0.04	0.12
TKN	2.89	2.24	1.96
Cl	123	222	81
SO_4	95	62	62
Alkalinity	114	116	136
Hardness	306	214	120
Ni	0.03	0.08	<0.01
Cu	0.01	0.01	0.02
Cr	0.01	0.02	<0.01
Zn	0.09	0.01	0.02
Fe	1.80	1.80	0.60
Cd	<0.01	<0.01	<0.01
Pb	0.05	<0.01	<0.01
Hg (ug/L)	0.08	0.05	0.30

to detect many of the pollutants that may or may not be in the river. Flameless atomic absorption spectrophotometry and gas chromotography/mass spectrometry, two techniques beyond the routine analytical capabilities of the NEORSD Laboratory must be acquired if further water quality improvements are to be measured and documented.

The fish community of the Cuyahoga River remains severely degraded both upstream and downstream of the NEORSD's Southerly WWTP effluent discharge. Data collected to date do not indicate any causal factor for the poor fishery. Persistent toxicity caused by an unknown chemical, lack of adequate fish populations to restock the river, deleterious synergistic effects of various chemicals, toxic effects of seasonal high chloride concentrations from road salting, stream bed scouring by highly erodable soils, and bedload movement have all been suggested as possible causes for the failure of the Cuyahoga River to support Warmwater Habitat-achieving fish populations (a "sports fishery").

Of all the factors potentially causing the continued low quality fishery, the factor of the lack of a breeding stock of fish may be the simplest to confirm. The Ohio Department of Natural Resources should be encouraged to consider stocking the river from downstream of Akron to the Navigation Channel with a balanced community of riverine fish, i.e., darters, sunfish, bass. Success of such a community could answer some of the most nagging questions about the present and future water quality of the Cuyahoga River.

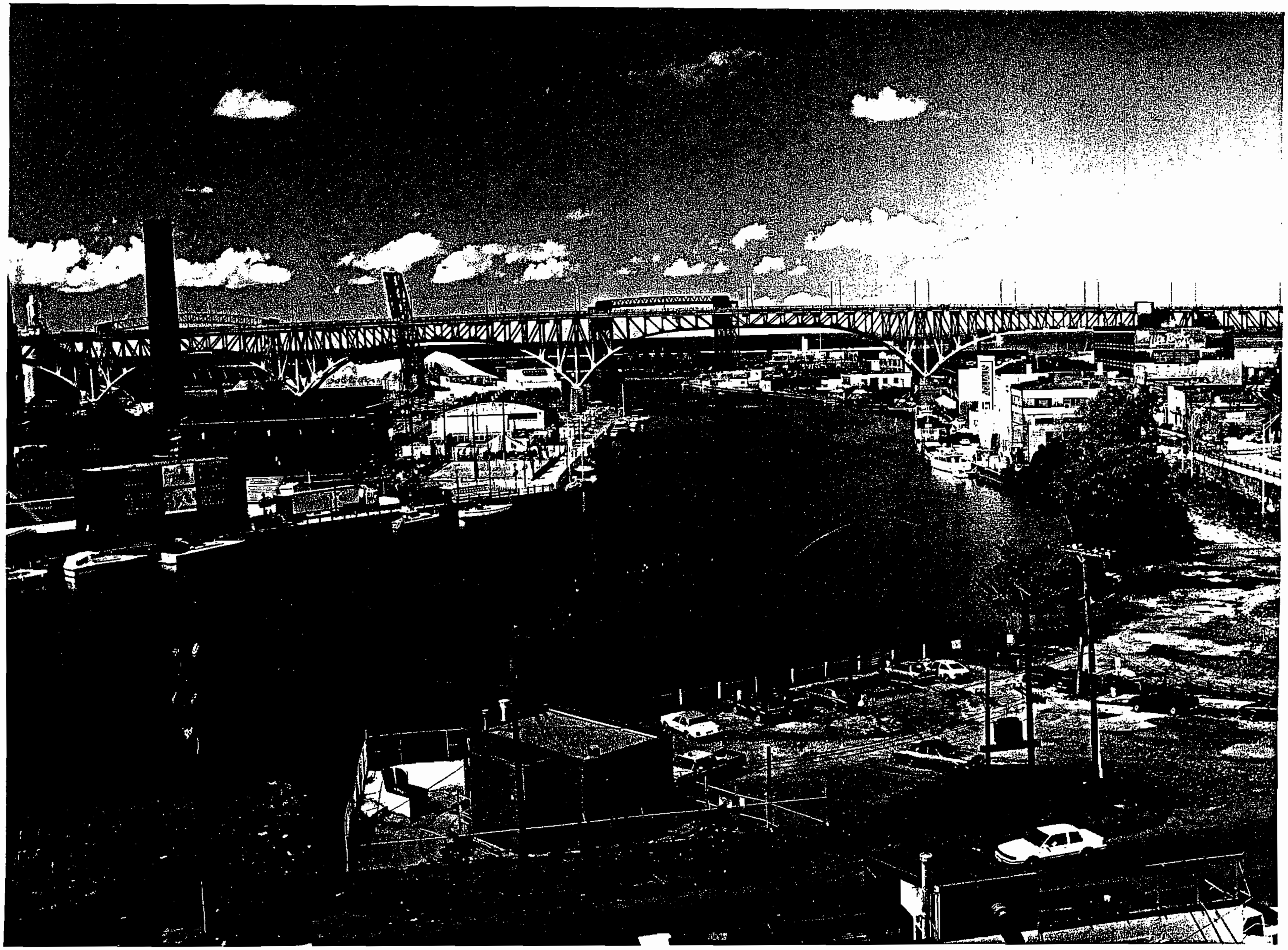


Figure 2. Present-day commercial development near the mouth of the Cuyahoga River.

CUYAHOGA RIVER

The Cuyahoga River was the focus of attention of the Stream Monitoring Program in 1988 and will continue to be in the immediate future. The river is of special concern to the NEORSD primarily because of the Southerly Wastewater Treatment Plant NPDES permit and Ohio EPA Warmwater Habitat Designation issues. Additionally, its more persistent pollution problems have recently generated broad-based community support for developing a Remedial Action Plan (RAP) for the river. The requirement of the RAP is a direct result of the designation of the lower reaches of the Cuyahoga River by the International Joint Commission as one of 42 "Areas of Concern" in the Great Lakes basin having substantial water quality problems.

Though significant improvements in the appearance and water quality of the river have occurred in the last 10 to 15 years, due largely to the control of point source discharges from municipal and industrial operations, continued and long-standing problems with the river's biological condition have enlightened the concerned public and regulatory entities on the complexities of riverine systems. The Cuyahoga River is indeed a complex system. The exact effect of the river's natural physical characteristics on its water quality and biology is not fully understood, nor are the impacts on this ecosystem of a wide array of "urban" activities. Thus, the impetus exists for the present and future studies on the river. These studies are especially important in light of the fact that regulatory programs and controls may be prematurely implemented to improve the condition of the river without any assurance of environmental benefits, and at a considerable financial expense to the regulated community.

The NEORSD has an active role in improving the condition of the lower Cuyahoga River through its programs designed to regulate industrial discharges, maintain the current high quality of the Southerly Wastewater Treatment Plant effluent, reduce combined and sanitary sewer overflows, and identify pollution sources.

The efforts undertaken in the Stream Monitoring Program to follow the improvements in the river resulting from the District's activities, as well as to document existing water quality problems, were stepped up from 1987. Four sampling sites were added to the existing list of sites for routine chemical and bacteriological sampling. A more comprehensive benthic macroinvertebrate sampling and analysis program was undertaken in 1988, and a fish survey using electroshocking techniques was performed. Also, a diurnal temperature and dissolved oxygen study and a priority pollutants analysis were conducted on the river upstream and downstream of the Southerly Treatment Plant effluent discharge.

The remaining sections of this chapter will cover specific descriptions and characteristics of the Cuyahoga River and present, in detail, the results of the Program's 1988 studies on the river.

Figure 3. Cuyahoga River and Ohio Canal from the State Route 82 bridge.

The Cuyahoga River and its tributaries drain approximately 813 square miles of land in northeastern Ohio (SAIC, 1986). The Stream Monitoring Program's 11 sampling sites on the river are located within the 230 square miles in the furthest downstream area. The major communities served in this part of the drainage basin are as follows: Sagamore Hills, Northfield, Brecksville, Broadview Heights, Walton Hills, Independence, Valley View, Bedford, Maple Heights, Garfield Heights, Brooklyn Heights, Warrensville Heights, North Randall, Cuyahoga Heights, Newburgh Heights, Parma, Parma Heights, Brooklyn, and Cleveland.

The headwaters of the river originate in Geauga County and drop from approximately 1300 feet above sea level at an average rate of 3 to 4 feet per mile. Flowing south/southwest, the river moves through Lake Rockwell in Portage County and then continues west/southwest through Kent. Entering Summit County, the river flows through Cuyahoga Falls and Akron. As the river moves through the Cuyahoga Gorge above Akron, it falls at a rate of about 25 feet per mile. At Akron, the river moves north/northwest and continues down through Cuyahoga County and Cleveland, descending at a rate of about 5 feet per mile. As compared to its upstream stretches, the river is influenced less by dam structures and diversions as it moves from Akron to Lake Erie.

As the Cuyahoga River flows through northeastern Ohio and finally empties into Lake Erie through Cleveland Harbor, it passes through and around approximately equal areas of urban, suburban, and rural land uses. Each of the residential, commercial, industrial, agricultural, recreational, and open-space uses exert their influences on the river, either directly or indirectly.

The river's flow varies widely depending on regional precipitation, predominant soil types and their water-holding capacities, and the proportion of the drainage basin covered by impermeable surfaces. The latter is especially influential as the river moves through the highly developed Cleveland area, and has probably significantly increased low flow conditions as compared to historic low flow records. The closest USGS gauge station to Lake Erie for the Cuyahoga River is located in Independence at approximately RM 13.8. The average discharge recorded at the Independence gauge for the 1988 water year was 659 cubic feet per second (cfs). During the drought period, which in northeastern Ohio lasted from approximately late May to early October, the seven-day (7/4-7/10/88) low flow average was 90 cfs (USGS, 1988). Additionally, the average discharge recorded at the gauge for the period of record (54 years) up to 1984 was 823 cfs (SAIC, 1986). These discharge readings do not include the flow from the Cuyahoga River which is diverted to the Ohio Canal. All issues related to Ohio Canal flows will be covered in a separate chapter.

The flow in the Cuyahoga River in its navigable section is strongly influenced by Lake Erie. The dynamics of river and lake mixing near the confluence is primarily a function of the prevailing nearshore currents and the physical characteristics of the lower channel and the Lake Erie shoreline. Where the mixing is most predominant can be considered a freshwater estuary. The effect of Lake Erie on the flow of the Cuyahoga River can be observed as far as 6 to 7 miles upstream. Additionally, the slow moving current in the lower channel has led to the deposition of large amounts of sediment. A high rate of solids settling requires that the lower navigation channel be dredged routinely to maintain a depth of 25 to 30 feet. This dredged sediment has been carried downstream from the river's upper and middle reaches and originates primarily from upland areas in the basin. (U.S. Army Corps of Engineers, 1981). The soils in the basin range from slightly erodible to highly erodible and a river transport of 211,000 and 530,000 tons of sediment per year have been estimated by the USGS and the Army Corps of Engineers, respectively (SAIC, 1986).

SAMPLING

The NEORSD is directly concerned with that stretch of the Cuyahoga River which lies within its jurisdictional boundaries. The effects of upstream perturbations, of which the District has no control, are undoubtedly reflected in downstream water quality and biological assessments.

Eleven sampling sites on the Cuyahoga River have been selected for the purpose of routine chemical and bacteriological sampling. The location of each site is presented in Figure 4. Four of these sites (#'s 22.6 through 22.9) were added in 1988 in an effort to gather more data on the river. Three of the four sites (#'s 22.6 through 22.8) were added midway through the sampling season. The Cuyahoga River was not sampled at the Center Street bridge (Site #21) in 1988 because, in late 1987, the bridge was removed for repair and, as of the end of 1988, was still out of commission.

All sampling sites are in Ohio EPA-designated Warmwater Habitat, except Site #'s 20 through 22, which are in the navigation channel, where the habitat status is reserved. Sampling Site #'s 22.5 through 22.9 are in that segment of the river which stretches from the District's Southerly Treatment Plant effluent discharge to the head of the navigation channel at the Newburgh & South Shore Railroad bridge (Site #22.5). This segment was designated Warmwater Habitat in 1986 and is still the subject of litigation.

In early 1988, the NEORSD challenged the Ohio EPA's decision designating the Cuyahoga River as Warmwater Habitat from RM 10.8 to RM 5.6. A hearing on this decision was presented in front of the Environmental Board of Review, State of Ohio. Ohio EPA's definition of a Warmwater Habitat states that the waters should be capable of supporting balanced, reproducing populations of warmwater fish and associated vertebrate and invertebrate organisms and plants on an annual basis. The data presented at the hearing clearly showed that the segment of the river in question is far short of achieving this status. In fact, the upstream stretches of the river as far as the Akron Wastewater Treatment Plant do not demonstrate Ohio EPA's expectation of a balanced aquatic community. Ohio EPA has claimed that a major deterrent to achieving Warmwater Habitat quality in the upstream stretches, and to some degree the lower reaches, is partly due to a toxicity problem which was associated with the Akron Plant's effluent in 1984. This toxicity problem severely depressed biological conditions downstream of the plant at that time. More recent studies have shown that, since the problem has ceased, the

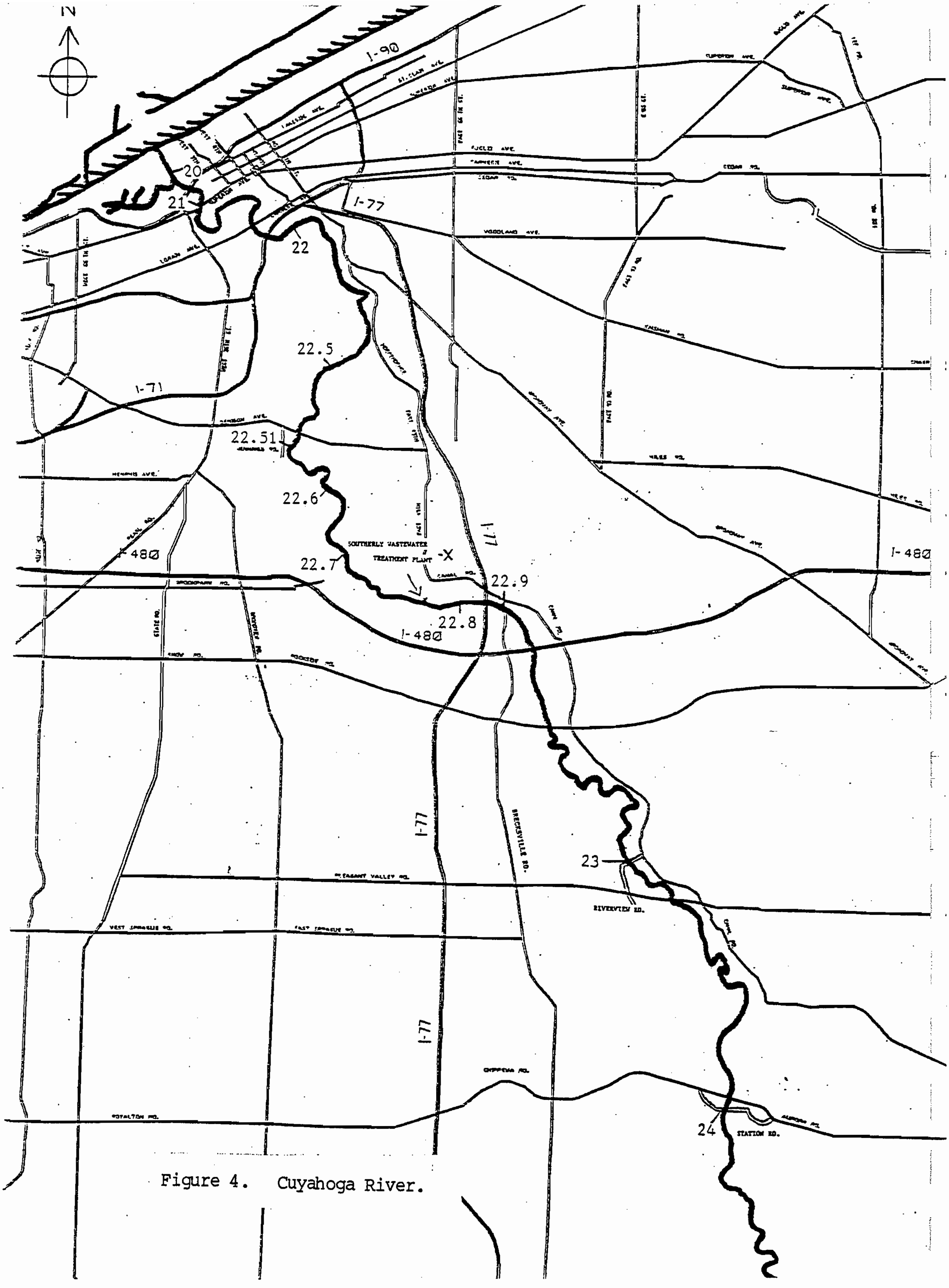


Figure 4. Cuyahoga River.

biological communities in the river have been responding favorably.

At the hearing, the Ohio EPA opined that stricter controls on point source discharges from municipalities and industry will allow the river to attain Warmwater Habitat status. On the other hand, the NEORSD and its expert witnesses opined that factors such as physical habitat, silt and sediment, and non-point source pollutants are negatively influencing the Cuyahoga River more than the Ohio EPA contends. For example, the connection between the poor condition of biological communities in the river and the unsuitable habitat, which is reflected in low ICI, I_{wb}, IBI, and QHEI scores, is apparently being overlooked. Additionally, the stretch of the segment in question, which runs from the Lower Harvard bridge (Site #22.51) to the Newburgh & South Shore Railroad bridge (Site #22.5), bears little resemblance to a natural, free-flowing river, but is more similar to the the navigation channel, where the habitat status is reserved. The absence of riffles, the relative depth, the slow flow, the sedimentation problem, the presence of concrete and steel shoring, the sparsity of shoreline vegetation, the dominance of industrial activity upland, and the evidence of channelization are habitat limitations quite common to both the lower half of the recently-designated Warmwater Habitat segment and the navigation channel.

Samples for chemical and bacteriological analyses were obtained on the river from April 4 to September 7, 1988. Appendix II-A through -C presents the averages of the data for the various water quality parameters measured on the samples collected at each site. Individual sample analyses are available for review upon request at the Industrial Waste Section offices. Through the sampling season, Site #'s 22.6 through 22.8 were sampled 3 times while the remainder of the sites were sampled 7 times.

Sample analyses have been compared with the applicable surface water quality criteria (OEPA, 1985). These criteria reflect the designated use of the segment of the river where each sampling site is located. The criteria which apply to Site #'s 20 through 22, located in the navigation channel, are Nuisance Prevention Maximum Criteria. With regard to these criteria, a range of values are applied as the standard for ammonia because it is pH and temperature dependent. This is also the case for the metals nickel, copper, cadmium, and zinc, which are hardness dependent. The criteria which apply to all of the remaining sites are Warmwater Habitat 30-day Average Criteria and include the bacteria limits covered under the Primary Contact Recreational Use Designation. With regard to these criteria, the fecal coliform standard is applied to the geometric mean of at least 5 samples collected within a 30-day period or to a percentage of the samples (greater than 10%) taken over a 30-day period.

At those sampling sites which lie within the segment designated Warmwater Habitat, the 30-day average criteria have been applied only to the averages of those sets of analyses on samples collected within 30-day periods and not to the averages presented in Appendix II. Comparisons with the applicable water quality criteria will be presented in the site-by-site discussions of the sample analyses.

All sampling was performed under dry weather conditions. At each site, surface grab samples were collected with a clean plastic bucket and drop line. The bucket was rinsed at each site prior to the collection of the sample. All samples obtained at bridge sites were collected at midstream while all others were sampled near the bank. Approximately 4.5 liters of sample were obtained for chemical analyses during each sampling event at a site. Two plastic cubitainers, properly labeled, were used to transport the samples. Samples obtained for bacteriological analyses were transported in small sterile plastic containers. All samples were preserved with ice and analyzed by District personnel at the NEORSD's laboratory facility. Also, during each sampling event, dissolved oxygen and temperature measurements were taken on the sampled water using a YSI oxygen meter.

In 1988, the Stream Monitoring Program began quantitative collections of benthic macroinvertebrates at sites on the Cuyahoga River. In the past, only qualitative sampling had been performed by the NEORSD. The primary sampling gear which is used by the Ohio EPA for the quantitative collection of benthic macroinvertebrates in streams and rivers is the modified multiple-plate artificial substrate or "Hester-Dendy" sampler. (Figure 5.) A detailed description of the sampling and analysis methods for quantitative collections can be found in the Ohio EPA's Biological Criteria for the Protection of Aquatic Life (1987). The NEORSD's efforts in this regard were made to duplicate these methods.

The Hester-Dendy sampler is a one-square-foot unit constructed of 1/8-inch tempered hardboard. The sampler is designed using 8 three-inch square plates and 12 one-inch square spacers. The plates and spacers are secured using a 1/4-inch eyebolt. According to the Ohio EPA, a routine monitoring sample consists of a composite of five Hester-Dendy samplers which are colonized at a site in a river or stream over a six-week period falling between June 15 and September 30. The reliability using the artificial substrates depends on the physical conditions under which the sampling units are set and the accuracy of identification of the sample organisms. Accurate identification to the levels specified by the Ohio EPA is important for calculation of the Invertebrate Community Index (ICI), a measurement derived by the Ohio EPA and used to rate the condition of the benthic macroinvertebrate community at a particular site. Because the amount of current which passes over the samplers tends to have a profound effect on the types and numbers of organisms collected, placing the samplers in a consistent fashion with respect to current speed is also important since it affects the interpretation of the ICI (OEPA, 1987).

The ICI is a single number which has incorporated into it ten measurements, or metrics, of the structural and functional components of the benthic macroinvertebrate community. A calibrated point system is used to score each metric based on how it compares to a database of relatively undisturbed reference stream and river sites plotted against drainage area. One of four scoring categories (6, 4, 2 and 0) is chosen for each metric and reflects an "exceptional", "good", "fair", or "poor" community condition, respectively, for that metric. The summation of the individual metric scores provides the ICI value. It is thought that the ICI value can be used not only to evaluate the condition of the benthic macroinvertebrate community at selected sites along a watercourse, but also as a gauge to track improvements

Figure 5. Hester-Dendy artificial substrate benthic macroinvertebrate sampler.

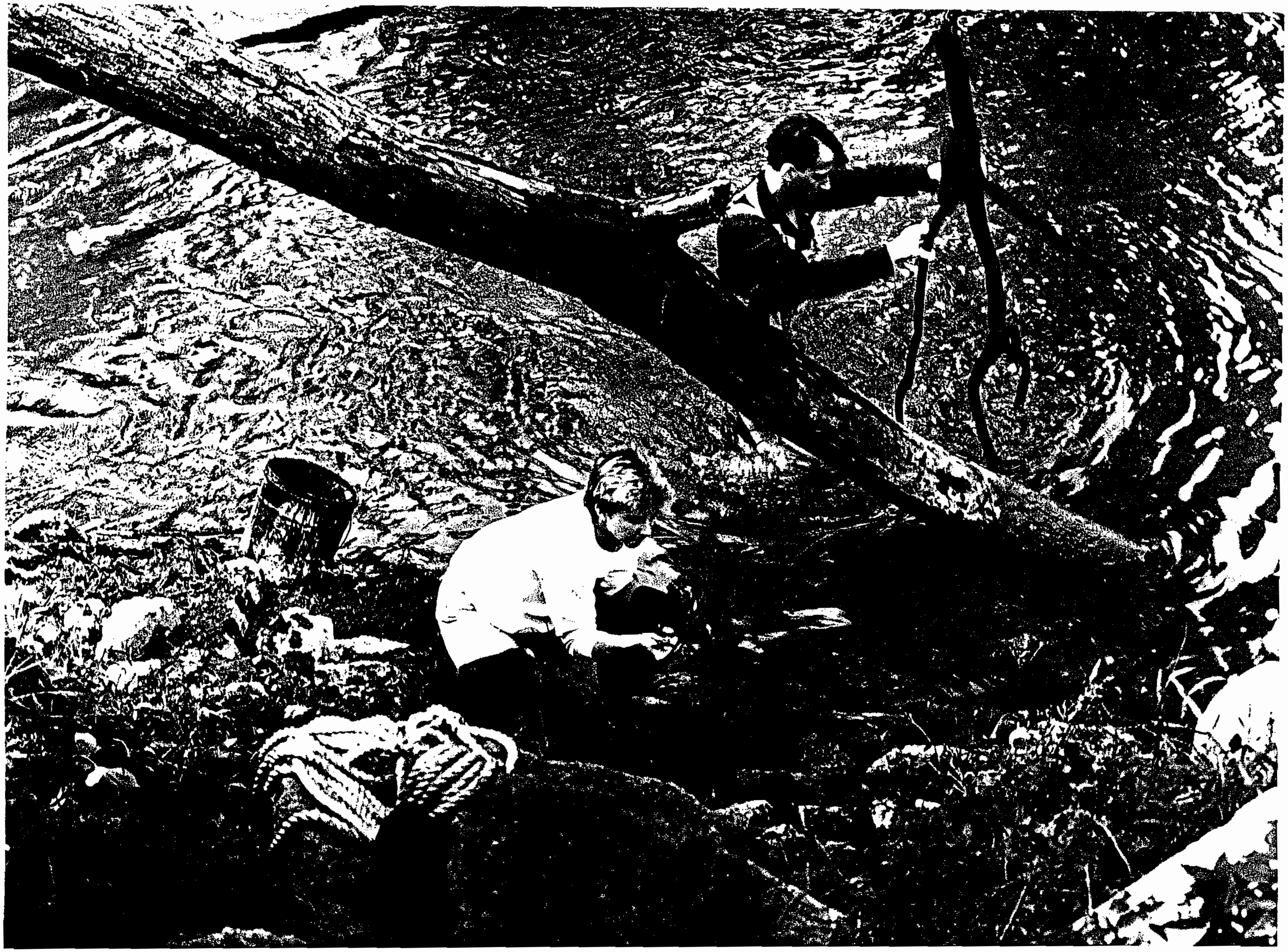


Figure 6. Qualitative sampling of benthic macroinvertebrates on the Cuyahoga River.

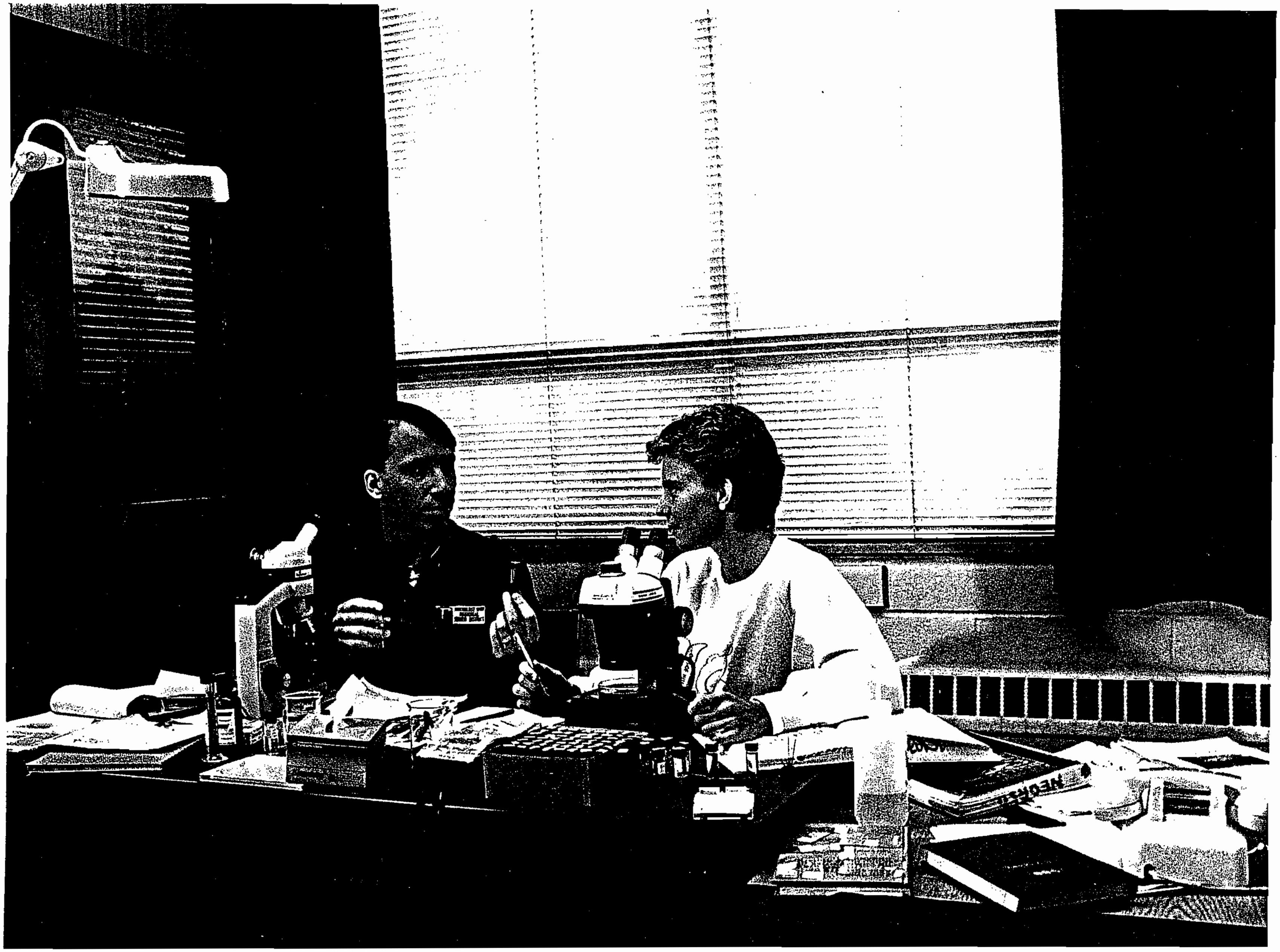


Figure 7. Identification of benthic macroinvertebrates.

or declines in water quality (OEPA, 1987).

Hester-Dendy samplers were installed in the Cuyahoga River at Site #'s 22.7, 22.9, and 23. Five individual samplers were secured to a concrete block anchor using nylon cord and placed in a run-type habitat at each site. Care was taken to place each set of samplers under comparable current conditions. The samplers were installed on July 28th and retrieved six weeks later on September 8th. In addition to the quantitative sample collected off the artificial substrates, a qualitative collection of benthic macroinvertebrates was performed in the natural substrates of all the available habitat types at each site. This additional sampling was performed at the time the Hester-Dendy samplers were removed and is required for calculation of the ICI. The qualitative sampling was conducted using a Surber sampler for "kick samples" and the hand-pick method until such time no new organisms were being found at a site. This time period generally ranged from one half hour to one hour.

Qualitative sampling was also performed at Site #'s 22, 22.5, 22.51 and 24 and was not associated with any artificial substrate sampling. At Site #22, a Ponar bottom grab sampler was used to make the collection. In 1988, Site #'s 20, 21, 22.6 and 22.8 were not sampled for benthic macroinvertebrates.

Samples collected using a Surber sampler or by the hand-pick method were retained in small vials and bottles, properly labeled, and preserved with AGW (70% alcohol, 20% glycerol, 10% water). At the time the Hester-Dendy sampler set was retrieved, each individual sampler was removed from the anchor block while it was still submerged and then placed in a one-quart plastic container, properly labeled, and preserved with AGW. In the laboratory, Surber and Ponar grab samples were washed through a No.30 mesh screen to remove fine sediments and debris and to retain the macroinvertebrate organisms. Larger pieces of debris and rocks were removed by hand. Organisms were removed from a Hester-Dendy sampler by first placing it in a pan or bucket of water, dismantling it, and then scrubbing the individual plates and spacers with a small, soft brush. The remaining sample was also washed through a No.30 mesh screen to retain the organisms.

Identification of samples was accomplished by sorting the organisms into gross taxonomic groups, either by eye or with the use of a dissecting stereoscope. Family-, genus-, and/or species-level identification was done with either a stereoscope or a high-power compound microscope. Organisms collected off the Hester-Dendy samplers were first separated into two groups: the dipterans and the non-dipterans. Each group was identified separately. The dipterans were further divided by separating out those organisms belonging to the family Chironomidae. The head capsules of chironomids need to be removed to make accurate genus- and species-level identifications under a high-power microscope. Various taxonomic keys were used to aid in the identification of the organisms and are listed in Appendix I.

Appendix III-A through -H and -FF presents a listing of the organisms identified in the 1988 benthic macroinvertebrate sampling on the river on a site-by-site basis. The listings include those organisms collected off the artificial substrates as well as those collected during qualitative sampling.

Also presented are the taxa's "tolerance" determinations, which are based on classifications relating to the organisms' general pollution tolerances. A "facultative" determination can be considered an intermediate between "tolerant" and "intolerant" determinations. The references used to make the determinations are listed. Appendix IV-A and -B presents a listing of organisms and their numbers collected off the artificial substrates alone. For each quantitatively sampled site, the calculation of the ICI is also presented.

Appendix II-A through -C presents the averages, on a parameter-by-parameter basis, of the chemical and bacteriological sample data for each site on the Cuyahoga River. The data show that the average dissolved oxygen (D.O.) concentrations are lowest at the sites in the navigation channel while the average ammonia (NH_3) and total kjeldahl nitrogen (TKN) concentrations are highest at these sites. With the exception of these three parameters, and excluding the metals and bacteria concentrations which will be discussed on a site-by-site basis, no other trends appear to exist across the sampling sites with respect to the data. The general variability that exists in the entire data set is characteristic of the river and similar to the results of the sampling performed in 1987. In addition, the low-flow condition resulting from the drought did not appear to have a noticeable effect on water quality. General observations did show that water clarity had improved slightly during the drought period. Compared to historical data, the water quality of the river is much better as declining concentrations of BOD, COD, ammonia, nitrogen, phosphorus, metals, and bacteria have been noted over the years. Obvious improvements in the river's general appearance have also occurred.

ROUTINE SAMPLING

The results of the 1988 chemical, bacteriological, and benthic macroinvertebrate sampling on the river is described on a site-by-site basis in the following paragraphs.

Sampling Site #20 is off the east bank of the river at River Mile (RM) 0.3 behind Fagan's Restaurant and Bar in the Flats. Fagan's is located at the intersection of Old River Road and Front Street. The river at this location is approximately 350 feet wide and 30 feet deep. Flow in the river is barely noticeable on most occasions under dry-weather conditions. The cessation in flow or backflow which is sometimes observed is a direct result of the interfacing of the river's and the lake's waters. At this site and at all of the other sites where the depth is at least 3 feet, the river generally appears turbid or light brown in color. On sunny days during the summer months, however, the river typically appears murky on greenish brown in color, which is reflective of algal production. The sheen of small patches of surface oil and grease and the accumulation of a small amount of natural and/or manmade debris was often observed near the shoreline at Site #20. A substrate of fine sediment and muck is typical in the lower navigation channel and the habitat type can be considered either a very slow run or large pool. It is not really a natural, riverine habitat due to the extensive shoreline development, the existence of steel-lined banks with virtually no vegetative cover, and the fact that the channel is routinely dredged to maintain its depth.

Nuisance Prevention Maximum Criteria were not exceeded based on a review of the analyses of the samples collected at Site #20. For comparison, in 1987, early summer D.O. violations were noted and one-day exceedances of the copper and zinc limits had occurred. In addition to meeting the water quality criteria in 1988, average bacteria concentrations declined from last year, although the coliform counts are still highly variable among sample dates. Fecal coliform/fecal streptococcus (FC/FS) ratios indicate that bacterial contamination was of human origin.

In 1988, no benthic macroinvertebrate collection was made at Site #20. Analysis of a sample collected in 1987 had revealed only the presence of oligochaetes, which is reflective of the substrate type and the high degree of sediment contamination. (Regulations require that all sediment dredges be placed in a confined disposal facility.)

Sampling Site #22 (RM 3.1) is at the West 3rd Street bridge in the Flats. The river at this location is approximately 250 feet wide and 28 feet deep. Again, the velocity of flow in the river is very slow and barely noticeable on most occasions under dry weather conditions. The sheen of small patches of oil and grease is commonly observed along the shoreline near the bridge. The physical characteristics of the river are very similar to those of Site #20. A 0.1- to 0.2-mile stretch of exposed earthen bank does occur along the west side of the river at this location. Substrate type and quality are also similar to those of Site #20.

Nuisance Prevention Maximum Criteria were not exceeded, based on a review of the analyses of the samples collected at Site #22. On 6/29/88, however, a dissolved oxygen concentration of 1.5 mg/L was measured with the YSI oxygen meter and is in violation of the 2.0 mg/L minimum limit. For comparison, in 1987, an early summer D.O. violation had been noted and a one day exceedance of the copper and zinc limit had occurred. Average bacteria concentrations are higher than those at Site #20 but have declined since 1987. FC/FS ratios indicate that bacterial contamination was of human origin. On two occasions in 1988 (7/20 and 8/17), mid-depth and bottom grab samples were obtained along with the surface grab sample. The lower depth samples were collected with a Kemmerer-type water column sampler. Dissolved oxygen measurements revealed violations on both occasions near the bottom and, on one occasion, at mid-depth. The lowest D.O. concentration recorded was 1.2 mg/L. The results of the chemical and bacteriological analyses on the lower depth samples were similar to those of the surface grabs.

In 1988, one sediment grab was obtained for a collection of benthic macroinvertebrates at Site #22. As was the case the previous year, the sample revealed only the presence of oligochaetes (Appendix III-FF).

It should be noted that, at Site #'s 20 and 22, which are located in the navigation channel, the pollutant loadings to the river may be more reflected in the quality of the bottom sediment than in the water column. Because of the settling effect of the slow-moving water in the lower channel under dry weather conditions, and if no large ore boats have just passed through the channel mixing the water column, the fallout of pollutants can be missed by water column grab sampling. As a result, the samples may not truly reflect the degree of pollutant loading to the river from upstream and nearshore sources. In a report by the Great Lakes Water Quality Board, the sediments in the navigation channel were reported to be heavily polluted with ammonia, total kjeldahl nitrogen, phosphorus, cyanide, oil and grease, cadmium, copper, chromium, and volatile solids. Elevated levels of PCB's, PAH's, and phthalates have also been found (GLWQB, 1987).

Sampling Site #22.5 (RM 5.6) is at the Newburgh & South Shore Railroad bridge (Figure 1). The bridge is on the property of the LTV Steel Corporation and can be accessed by following the river onto the steel mill property from either Independence Road or Campbell Road. At this site, there are actually two railroad bridges located approximately 30 feet apart. The Newburgh & South Shore Railroad bridge is located on the upstream side and is the point where the Warmwater Habitat Designation of the river ends. The bridge on the downstream side is at the head of the navigation channel. The river at this location is approximately 200 feet wide and the depth ranges from 4 feet nearshore to about 10 feet midstream. Here, on the upstream side of the twin bridges, the bottom contour is more riverine. On the downstream side, the depth is greater and more uniform due to maintenance dredging. On most occasions while sampling at this site, the accumulation of natural and/or manmade debris at the bridge supports, especially near the east bank, could be observed. In this run-type habitat, the substrate is primarily composed of sand and fine gravel midstream and silt and muck along the margins. An industrial setting predominates in the upland area. Separating the river and the industry is a very narrow vegetative buffer upstream of the sampling site. The vegetative buffer begins at Site #22.5 and is more common along the east bank than the west bank. As one approaches Sampling Site #22.51, which is 1.6 miles upstream at the Lower Harvard bridge, the buffer is quite patchy and is interspersed with small sections of open or "raw" land. Also, immediately upstream of Site #22.5, the lower west bank is concrete-lined. Industrial discharges are commonly observed both upstream and downstream of this site.

Based on a review of the analyses of the samples collected at Site #22.5, three violations of the copper limit, one violation of the zinc limit, one violation of the lead limit, and four violations of the iron limit were noted. Each violation was only a minor exceedance of the water quality criteria, which is reflected in the overall averages for these parameters (Appendix II-A). Also, each violation is based on the average of only two sample analyses because that was the maximum number of samples collected within a 30-day period in 1988. No comparison is made with the results of the previous year's sample analyses because only one grab sample was obtained in 1987 at this site. The Primary Contact Recreational Use Designation Limit for fecal coliform (2,000 counts/100 ml in more than 10% of the samples collected during a 30-day period) was exceeded on one occasion in 1988. On average, the total coliform concentration was higher than at the sites downstream. FC/FS ratios generally indicated that bacterial contamination was of human origin. However, on three occasions the ratios were indicative of contamination from mixed human and animal waste sources.

A qualitative benthic macroinvertebrate sample collection was made on 8/22/88 near the east bank of the river approximately 30 to 50 yards upstream of the twin bridges. Only tolerant- and facultative-type taxa were found in the collection (Appendix III-A). For comparison, in 1987, a similar collection had been made, though fewer genera of Gastropoda and Odonata were found. Also, no adult coleopterans were collected in 1988 but had been found the previous year. In general, the substrate conditions at this site are not conducive to the existence of a highly diverse benthic macroinvertebrate community. This is primarily the case because of the heavy deposition of silt and the presence of oily sludge or muck underneath occasional nearshore rocks, logs, and debris at the site.

Sampling Site #22.51 (RM 7.2) is at the Lower Harvard bridge. It is located 0.2 miles downstream of the Big Creek confluence. The river at this location is approximately 175 feet wide and the depth ranges from 2 feet nearshore to about 8 feet midstream. Downstream of the bridge, the river begins to slow as it moves through the "LTV stretch" from RM 7.1 to RM 4.3. Lake Erie has the potential to exert an effect on the river's flow rate as far upstream as this site. While sampling at this location, small patches of oil and grease were commonly observed. The habitat type upstream of the bridge is riffle and run. Some pooling exists underneath and near the bridge while downstream of the bridge is the start of a long stream run. The substrate type instream is a mix of sand, gravel, rubble, bricks, and concrete pieces. Margin substrate is composed of silt and sand and underlies the larger materials. Smaller substrate materials predominate in the pools and in the channel downstream of the bridge. Shoreline deposition of gravel, concrete blocks, and human artifacts is fairly common at this site and leads to concrete and steel shoring as one travels downstream toward the lower channel. Past the Lower Harvard Bridge, upland development is dominated by industry. On the upstream side of the bridge, upland industrial activity predominates as well, though wooded areas become more common and the shoreline vegetation provides increasingly more cover.

Based on a review of the analyses of the samples collected at Site #22.51, two violations of the copper limit, one violation of the zinc limit, one violation of the lead limit and two violations of the iron limit were noted. Each violation was a minor exceedance of the water quality criteria, and is reflected in the overall averages for these parameters (Appendix II-A). Compared to Site #22.5, which is also located in the segment designated as Warmwater Habitat, the types of violations were the same, though a fewer number had occurred at Site #22.51. The previous year, only one violation was noted based on NEORSD sampling, and it was an exceedance of the copper limit. However, in 1987, only one set of samples had been collected within a 30-day period, while, in 1988, five sets of samples were collected within 30-day periods. This can inherently lead to more violations when compared to the previous year. Based on the overall averages for these parameter concentrations in 1987 and 1988, copper stayed the same, zinc and lead declined, and iron increased slightly in 1988. The Primary Contact Recreational Use Designation Limit for fecal coliform was exceeded on two occasions. (In 1987, fecal coliform concentrations had been in violation of the limits throughout the sampling period.) Additionally, all of the average bacteria concentrations were higher than at Site #25 downstream. FC/FS ratios generally indicated that bacterial contamination was derived from mixed human and animal waste sources. On two occasions, the ratios indicated bacterial contamination primarily of human origin.

A qualitative benthic macroinvertebrate sample collection was made on 8/22/88 in all habitat types present at this location. Approximately 70% of the taxa collected were described as facultative, while the remaining taxa were of the tolerant or facultative/intolerant types (Appendix III-B). As was the case at downstream sites, no intolerant taxa were identified. For comparison, in 1987, the range in types of taxa collected had been similar, though one or two taxa in the Ephemeroptera, Odonata, Trichoptera, and Crustacea groups were found in 1988 and not the previous year, and vice versa. Overall, the difference between the two years is not significant in terms of a change in community diversity and the presence or absence of the intolerant-, tolerant- and facultative-type taxa. In general, the benthic macroinvertebrate community which exists at this site is not highly diverse, though substrate conditions appear to be suitable.

Sampling Site #22.6 (RM 7.9) is at the west bank of the river adjacent to the River Smelting & Refining Company, 4195 Bradley Road. The site can be accessed from Bradley Road, to the southeast end of the company's dirt-and-gravel front lot. The river at this location is approximately 150 feet wide and the depth ranges from 5 feet nearshore to about 8 feet midstream. In this run-type habitat, the substrate is primarily made up of sand, gravel, and rubble instream with smaller percentages of silt, muck, and detritus underlying rubble and concrete pieces near the margins. The vegetative buffer is very narrow and sometimes absent along the west bank, where in the upland area the setting is industrial. The east bank is wooded and grassy and, near the shore, partially submerged logs and tree branches are common. The upland area behind the east bank is wooded and stretches upward to the site of the Alcoa Cleveland Works on Harvard Avenue.

Based on a review of the analyses of the samples collected at Site #22.6, two violations of the copper limit, two violations of the lead limit, and two violations of the iron limit were noted. The exceedances of the iron limit and lead limit were slightly higher than those at the two downstream sites, which are also located in the segment designated Warmwater Habitat. This is also reflected in the overall averages for these parameter concentrations at the sites (Appendix II). Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. Average coliform concentrations were lower at this site than at the two sites downstream. FC/FS ratios indicate that bacterial contamination was derived from mixed human and animal waste sources on two occasions and was of human origin on one occasion. Because Site #22.6 is a new site for 1988, no comparisons can be made with past sampling.

Sampling Site #22.7 (RM 9.8) is at the east bank of the river underneath the crossing of the Southwest Interceptor. This site is located one mile downstream of the effluent discharge from the Southerly Wastewater Treatment Plant. The site can be accessed from the tow path which runs between the river and the Ohio Canal. Access can be made to the tow path at the Southerly Ash Lagoons off Canal Road. The river at Site #22.7 is approximately 100 feet wide and the depth ranges from 4 feet nearshore to about 8 feet midstream. In this run-type habitat, the substrate conditions are very similar to those of Site #22.6 downstream. Near the sampling site, the bank has been shored extensively with concrete pieces and gravel. These materials are common along the lower bank both upstream and downstream of this location. Additionally, the banks are wooded and grassy with few open sections and trees provide up to 50% cover along the river. Between RM 10.0 and RM 10.5 upstream, however, two trash-material disposal sites are located on the west bank and are not protected by vegetative cover. (Figure 13.). Nearshore upland areas are primarily wooded and grassy, though a few sections of the land are under cultivation. Industrial and commercial land uses occur further upland from the river valley.

Based on a review of the analyses of the samples collected at Site #22.7, one violation of the copper limit, one violation of the lead limit, and two violations of the iron limit were noted. This site had fewer violations than any of the sites downstream located in the segment designated Warmwater Habitat. With the exception of zinc, the parameters in violation at the sites are consistent. At this location, the overall average concentrations reflect only minor exceedances of the limits, though the iron concentration was higher than at all of the downstream sites, including those located in the navigation channel. Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. The average total coliform concentration was lower than at all of the sites downstream. The average fecal streptococcus concentration was higher than at all of the sites. FC/FS ratios indicate that bacterial contamination is derived from mixed human and animal waste sources. Because this site is a new site for 1988, no comparisons can be made with past sampling.

In 1988, a set of Hester-Dendy samplers was installed at Site #22.7 and provided a quantitative sample of benthic macroinvertebrates. A qualitative sample collection was made on 9/9/88 at the time the artificial substrates were retrieved. Compared to the samples collected at downstream sites, intolerant-type taxa were identified for the first time, and 2 such taxa were represented in the qualitative collection (Appendix III-C). Also, only 2 tolerant-type taxa were found out of the 13 taxa collected qualitatively. Most of the remaining organisms are described as facultative. The range in types of taxa was similar to that found at Site #22.51, the next site downstream where a collection was made, but it was greater than that found further downstream at Site #22.5. Also, an increase in the number of desirable taxa (i.e., Ephemeroptera, Trichoptera, Odonata, Coleoptera) was found at Site #22.7. Based on qualitative sampling, this site shows a minor improvement in community diversity over Site #22.51.

At Site #22.7, the results of the quantitative sampling were quite different from the qualitative sampling results. For example, an additional 27 taxa were collected off the artificial substrates. In other words, only 32% of the taxa represented in the artificial substrates sample were also represented in the qualitative sample. Also, only 2 taxa were collected in the qualitative sample that were not represented on the substrates (Appendices III-C, IV-A). Combining the two samples, the greatest percentage of taxa collected were of the facultative type, followed by the tolerant types. The remaining taxa are described as intolerant and intolerant/facultative. The major difference in the types of taxa collected between the quantitative and qualitative samples was the number of dipterans identified off the artificial substrates, which was just over half of the total number of taxa. The reasons for the difference in the types of taxa collected using the two methods may be related to the fact that the artificial substrates are providing a more suitable colonizing substrate than that naturally available in the river at this site. A more likely explanation is that the qualitative sampling could only be done in the very nearshore areas due to the depth of the water. The Hester-Dendy set was placed 5 to 6 feet out into the river, using a float as a marker. The result of this is that the artificial substrates were underlying more of the water column and were thus able to "attract" potentially more benthic macroinvertebrate taxa.

An ICI has been calculated based on the results of the artificial substrate sampling. The score of 32 falls into the fair-to-good range with respect to the quality of the benthic macroinvertebrate community that exists at this site (Figure 8). The figure also includes the results of Ohio EPA's quantitative sample collections at sites other than those sampled by the NEORSD. For this location, the ICI score appears to fall in line with scores the Ohio EPA generated in 1987. The obvious trend is a decline in the quality of benthic macroinvertebrate communities from upstream to downstream.

With regard to this site's calculated ICI score, though the metrics representing overall taxa diversity received the highest marks, the total ICI value was brought down because of the low marks received for the high- and low-percentage abundances of the tolerant- and intolerant-type taxa, respectively. This implies that a sediment and/or water quality problem exists, and based on NEORSD data, is affecting the quality of the benthic macroinvertebrate communities at least as far upstream as RM 16.8 (ICI score = 34).

The discharge channel which receives the effluent from the Southerly Treatment Plant is tributary to the Cuyahoga River between Site #'s 22.7 and 22.8. A Hester-Dendy set was placed in the channel downstream of the plant's discharge, not to provide a quantitative sample of benthic macroinvertebrates, but to provide an indication of the types of organisms that may be colonizing the substrates which underlie the effluent-dominated flow in the channel. An unknown volume of canal flow mixes with the effluent and is tributary to the channel through an overflow structure located just east of the effluent discharge. The results of the artificial substrate sampling and hand-picking done at the time the Hester-Dendy set was retrieved indicate that the benthic macroinvertebrate community diversity in the channel is relatively low but that it is made up of tolerant-, facultative-, and intolerant-type organisms (Appendix III-D). These results are unexpectedly good considering the fact that the Southerly Treatment Plant's effluent is undergoing chlorination just upstream of this location.

Sampling Site #22.8 (RM 11.3) is at the chlorine-access railroad bridge to the Southerly Treatment Plant and is located near the southeast end of the plant's Ash Lagoons. This site is 0.5 miles upstream of the effluent discharge from the Southerly Plant and 0.1 miles downstream of the West Creek

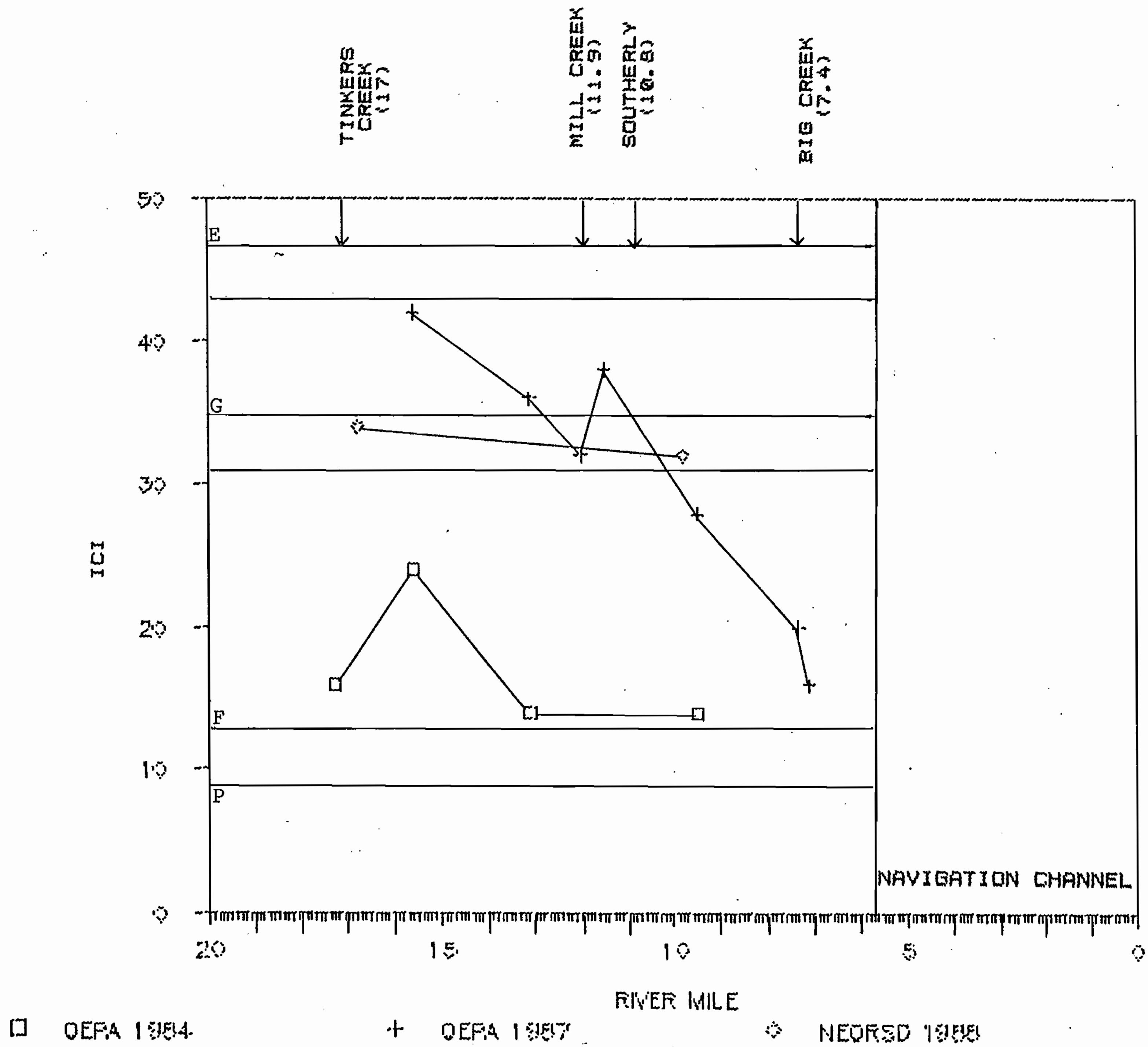


Figure 8. Cuyahoga River Invertebrate Community Indices.

confluence. The site can be accessed from Canal Road across from the Southerly Treatment Plant's main entrance gate. The river at Site #22.8 is approximately 100 feet wide and the depth ranges from 2 feet nearshore to 4 feet midstream underneath the bridge. Greater depths can be found just downstream. A riffle, run, and pool-type habitat occurs upstream of the bridge. The depth in the pools can be as great as 6 feet. A swifter current flows over and through the riffle-and-run site upstream. Due to the river's shallow nature under the bridge, it usually appears clear. Substrate in the riffle-and-run habitats is composed primarily of sand, gravel, rubble, and some occasional boulders and large logs. Margin areas and pools consist of silt, sand, and detritus, which underlie larger substrate materials. At the West Creek confluence, an island splits the river. The immediate banks are wooded and grassy, and trees provide up to 50% cover along the river, except near the upstream bend and island, where the river is wide open and the banks are grassy and earthen. The upland area has a nearly equal mix of commercial, industrial, wooded and open-space land uses.

Based on a review of the analyses of the samples collected at Site #22.8, two violations of the copper limit, one violation of the zinc limit, two violations of the lead limit, and two violations of the iron limit were noted. The types of parameters in violation were again similar to those of the sites downstream. The number of violations is greater than that at each of the next three sites downstream. At Site #22.8, the average iron concentration is higher than at all of the other sites on the river. Also, this site had only the second occurrence of a zinc violation, the other one being at Site #22.51. Except for iron, the violations are minor exceedances of the limits and this is reflected in the overall averages (Appendix II-B). Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. The overall average fecal coliform concentration is lower than those of all the other sites on the river; however, average total coliform and fecal streptococcus concentrations are comparatively high. FC/FS ratios indicate that bacterial contamination is derived from mixed human and animal waste sources. Because this site is a new site for 1988, no comparisons can be made with past sampling.

Sampling Site #22.9 (RM 11.7) is at the railroad bridge crossing near the intersection of East 71st Street and Canal Road. This site is located 0.2 miles downstream of the Mill Creek confluence. The river at this location is approximately 150 feet wide and the depth ranges from 2 feet nearshore to 6 feet midstream. Substrate in the run-type habitat underneath the bridge is composed primarily of sand and gravel. A riffle, run, and pool-type habitat occurs just upstream and the substrate there is composed of boulders, rubble, gravel, and sand. There is also a large accumulation of fallen tree debris just upstream. A small, shallow riffle occurs downstream of the bridge as well. Margin areas consist of silt, sand, and detritus which underlie larger substrate materials. Except at the railroad bridge and the State Route 21 bridge crossing, the immediate banks are wooded and grassy, and trees provide up to 50% cover along the river. Land uses in the upland area are similar to those of Site #22.8.

Based on a review of the analyses of the samples collected at Site #22.9, two violations of the copper limit, one violation of the lead limit, four violations of the iron limit, and one violation of the mercury limit were noted. Again, with the exception of mercury, the types of parameters in violation remain consistent from site to site. Given that the potential exists for more violations at this site because of the larger number of sets of data collected within 30-day periods, this site had more violations than at each of the next four sites downstream. This includes Site #22.51, at which seven samples were also collected. All of the violations are only minor exceedances of the limits and this is reflected in the overall averages (Appendix II-B). Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. Average coliform concentrations fall within the range of concentrations found at the sites downstream located in Warmwater Habitat. The average fecal streptococcus concentration is comparatively low. FC/FS ratios indicate that bacterial contamination is derived from mixed human and animal waste sources on all but one sampling occasion. Because this site is a new site for 1988, no comparisons can be made with past sampling.

In 1988, a set of Hester-Dendy samplers was installed at Site #22.9. However, though considerable effort was made, the set was not found when the time came to retrieve it from the river. It is likely that the unit was either buried or carried some unknown distance downstream. A qualitative benthic macroinvertebrate collection was made on 9/8/88 in all habitat types present at this location. Most of the taxa identified in the collection were of the facultative type, though only 8 taxa were found (Appendix III-E). Despite the limited number of taxa collected, the predominance of ephemeropterans and the general lack of oligochaetes, dipterans, and the tolerant air-breathing molluscs is an indication that a fair-to-good quality benthic macroinvertebrate community may exist at this site. Substrate conditions appear suitable for colonization, however, water quality conditions may be limiting. This site and Site #22.5 had the lowest diversity of organisms out of all of the sites sampled which are located in the segment designated Warmwater Habitat.

Sampling Site #23 (RM 16.8) is at the old Riverview Road bridge location. The bridge was removed in early August 1988. Prior to its removal, grab samples were obtained off the bridge at midstream. Samples are now being obtained at the east bank. This site is in the Cuyahoga Valley National Recreation Area (CVNRA) and is located 0.2 miles downstream of the Tinkers Creek confluence. The site can be accessed from Canal Road at the intersection with Tinkers Creek Road. The river at Site #23 is approximately 125 feet wide and the depth ranges from 2 feet nearshore to 5 feet midstream. Substrate in the riffle and run-type habitat which exists here is composed primarily of sand, gravel, rubble, and boulders. Pool development is minimal at this site. Margin areas consist of sand, silt, detritus, and muck which underlie larger substrate materials. Except right near the old bridge site, the immediate banks are wooded and grassy, and trees provide up to 25% cover along the river. A mix of forest, open-field, and agricultural land uses occur in the upland area. Minimal suburban and commercial development exists near the site.

Based on a review of the analyses of the samples collected at Site #23, one violation of the copper limit, two violations of the lead limit, three violations of the iron limit, and two violations of the mercury limit were noted. This is the second instance in which mercury was in violation, and the overall average for this parameter is higher at this site than at any other site located in the segment designated Warmwater Habitat (Appendix II-C). The first mercury violation occurred at Site #22.9, the next site downstream. The overall average concentration of the other parameters in violation reflect the fact that the exceedances were minor. This site had the same total number of violations as Site #22.9, which was higher than at the next five sites downstream. In 1987, because no set of data was collected within a 30-day period, no violations were noted. Comparing the overall averages of the metal concentrations at this site between 1987 and 1988, they were the same or higher in 1988. Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. Average coliform concentrations fall within the range of concentrations found at the sites downstream located in Warmwater Habitat. The average fecal streptococcus concentration is comparatively low. In 1987, fecal coliform had been in violation of the limit on one occasion and the average bacteria concentrations had been much higher than in 1988. FC/FS ratios indicate that bacterial contamination is derived from mixed human and animal waste sources on all but one sampling occasion.

In 1988, a set of Hester-Dendy samplers was installed at Site #23 and provided a quantitative sample of benthic macroinvertebrates. A qualitative sample collection was made on 9/8/88 at the time the artificial substrates were retrieved. Compared to the qualitative samples collected at the downstream sites, the majority of the taxa identified continue to be of the facultative type (Appendix III-F). At those sites located in the segment designated Warmwater Habitat, and with the exception of Site #'s 22.5 and 22.9, the total number of taxa and range in types of taxa collected were similar to those of this site. As was the case at the next site downstream, no intolerant-type taxa were found in the sample. In 1988 at Site #23, intolerant taxa had been identified in the sample, though their numbers were small. Again, the majority of the taxa collected the previous year had been of the facultative type. Based on qualitative sampling, the community diversity at this site does not show a noticeable improvement from the previous year or when compared to downstream sites.

The results of the quantitative sampling at Site #23 were quite different from the qualitative sampling results, as was the case at Site #22.7. An additional 40 taxa were collected off the artificial substrates. In other words, only 18% of the taxa represented in the artificial substrate sample were also represented in the qualitative sample. Also, only 3 taxa were collected in the qualitative sample that were not represented on the artificial substrates (Appendices III-F, IV-B). Combining the two samples, the greatest percentage of taxa collected were of the facultative type, followed by the tolerant types. The remaining taxa are described as intolerant and facultative/intolerant. As at most sites, for some of the organisms, their pollution tolerances were not known. As was the case at Site #22.7, over half of the total number of taxa collected off the artificial substrates were dipterans, and this constituted the major difference in the types of taxa collected between the qualitative and quantitative samples. The primary reason for the difference in the types of taxa collected using the two methods may have been the more thorough identification process applied to the collection off the samplers as compared to the hand-picking and identification done in the field.

An ICI has been calculated based on the results of the artificial substrate sampling. The score of 34 falls just into the fair-to-good range with respect to the quality of the benthic macroinvertebrate community at this site (Figure 8). This score is not significantly higher than the score of 32 calculated for Site #22.7. The figure also shows that Ohio EPA's 1987 sampling at a location approximately one mile downstream of Site #23 generated an ICI value well into the good range. More suitable conditions may exist at that site for the occurrence of a better quality benthic macroinvertebrate community. As was the case at Site #22.7, the metrics representing overall taxa diversity received the highest marks in the ICI calculation. The total score was brought down because of the low marks received for the low- and high-percentage abundances of the intolerant- and tolerant-type taxa, respectively.

The final sampling site, #24 (RM 21), is at the Station Road bridge. This site is also in the CVNRA and is located 0.4 miles downstream of the Chippewa Creek confluence and 0.1 miles upstream of the Ohio Canal diversion dam. This site can be accessed from Riverview Road south of the intersection of Riverview Road and State Route 82. The river at this location is approximately 150 feet wide and the depth ranges from 5 feet nearshore to about 10 feet midstream. The flow is restricted here because of the presence of the low-head dam downstream, which has created a very slow run or pool-type habitat near the bridge. On the other side of the dam, where the benthic macroinvertebrate collections are made, the habitat type is riffle and run. Also, an island splits the river downstream of the dam. The depth in this area ranges from 1 to 4 feet. Substrate here is composed primarily of sand, gravel, rubble, and boulders instream and silt, muck, detritus, gravel, and rubble near the margins. Near the bridge site upstream of the dam, substrate is composed of silt, sand, and gravel instream and silt and muck underlying smaller amounts of large rubble and boulders near the margins. With the exception of a few open sections near the dam, the Station Road bridge, and the State Route 82 bridge, the banks are wooded and grassy, and trees provide up to 25% cover along the river. Forest, wetland, open-field, and agricultural land uses occur in the upland area.

Based on a review of the analyses of the samples collected at Site #24, one violation of the copper limit, two violations of the lead limit, two violations of the iron limit, and one violation of the zinc limit were noted. Except for zinc, the overall averages of the concentrations of the parameters in violation reflect the fact that the exceedances were minor (Appendix II-C). The high average zinc limit was due to a concentration of 1.5 mg/L measured on the last sample collected at this site (9/7/88). This concentration is the highest measured for this parameter at all of the sites. In 1987, because no set of data had been collected within a 30-day period, no violations were noted. Comparing the overall averages of the metal concentrations at this site between 1987 and 1988, except for copper, they were the same or higher in 1988. Fecal coliform concentrations were not in violation of the Primary Contact Recreational Use Designation Limit. All average bacteria concentrations are low compared to the other sites. In 1987, fecal coliform had been in violation of the limit on one occasion and the average bacteria concentrations had been much higher than in 1988. FC/FS ratios indicate that bacterial contamination is derived from mixed human and animal waste sources on all but one sampling occasion.

In 1988, a qualitative benthic macroinvertebrate sample collection was made on 8/23/88 in all habitat types present at this location. Almost 50% of the taxa collected are described as facultative, while the remaining taxa were of the tolerant, intolerant, and facultative/intolerant types (Appendix III-G). More taxa were found at this site using qualitative sampling techniques than at any other site on the river. The range in types of taxa collected is very similar to that of the downstream sites. In 1987, fewer taxa had been found but the percentages of intolerant-, tolerant- and facultative-type taxa collected were comparable. Based on qualitative sampling, the community diversity at this site is slightly higher than at Site #23 and is higher than at all the sites downstream.

The previous discussions on the results of the water quality sampling and benthic macroinvertebrate collections performed at selected sites on the river do not pinpoint the causes of any associated problems. Of great interest to the NEORSD is the effect, if any, the effluent from the Southerly Wastewater Treatment Plant may have on the river, especially during low flow conditions as occurred during the 1988 summer drought. The sampling data does not show, though the extent of its interpretation is limited, that the Southerly Treatment Plant effluent, which is discharged to the river between Site #'s 22.7 and 22.8, is negatively impacting the water quality of the river. At a minimum, any impact is masked by other factors. It is difficult to determine what the actual problem sources are without further study. Impacted tributaries, which will be discussed in following chapters, some other point source and non-point source pollutant contributors, and perhaps physical habitat limitations are likely problem sources harming the water quality and/or biological condition of the river.

CHAGRIN AND GRAND RIVER SAMPLING

In addition to the chemical, bacteriological and benthic macroinvertebrate sampling that was performed at sites on the Cuyahoga River in 1988, a comparative analysis was made at one site each on the Chagrin and Grand Rivers. All three of these rivers are located in the same ecoregion of the state, the Erie/Ontario Lake Plain. An ecoregion is an area generally homogeneous in physical and terrestrial characteristics, including land surface form, land use, soil types, and potential natural vegetation. According to the Ohio EPA, ecoregions provide a geographical basis for establishing attainable biological criteria. This is done primarily through the selection of reference sites within a region, which are representative of post-settlement, least-impacted conditions and serve as benchmarks for measuring the condition of other sites within the same region (OEPA, 1987). The Cuyahoga River has only one reference site along its entire length and it is located well upstream between RM 64.3 and 64.5. The Chagrin and Grand Rivers have three reference sites each and are located as far downstream as RM 9.0 on the Grand River and RM 13.0 on the Chagrin River. These locations on the three rivers are reference sites for either attainable fish communities or benthic macroinvertebrate communities, or both (OEPA, 1987). Although neither the Chagrin nor the Grand River are truly analogous to the Cuyahoga River, the attainable biological condition of the Cuyahoga River may be estimated based on a comparative analysis with the Chagrin, Grand, or any other river within the ecoregion. Any differences in perturbations to water quality or biological condition at sites on these rivers should be recognized when making the comparisons.

The Chagrin River and the Grand River were sampled on two occasions in 1988. Surface grabs for chemical and bacteriological analyses and benthic macroinvertebrate collections were obtained on 8/16/88 and 11/1/88 (Appendices II-P, III-GG, III-HH). The Chagrin River sampling site (RM 10.5) is at a location approximately 200 yards north of State Route 6, just upstream of the Pleasant Valley Drive bridge. The Grand River sampling site (RM 21) is at a location approximately 100 yards upstream of the State Route 528 bridge near the site of the old Bailey Road/Klasen Road Bridge. Both sites are located in Lake County.

On the Chagrin River, the habitat-type characteristic of the site sampled is riffle and run. The river at this location is approximately 100 feet wide and the depth ranged from one to three feet. Substrate consists of boulders, rubble, gravel, and sand instream with smaller amounts of the larger substrate materials near the margins and overlying silt, sand, and detritus. At this site, the banks are wooded and grassy and steeper to the east. Cover provided by overhanging vegetation is minimal. A commercial and residential environment predominates in the upland area. Recreational activity in nearby wooded and open-space areas is also common.

The characteristics of the Grand River site are similar to those described for the Chagrin River. The Grand River, however, lies in a deeper valley with steep slopes, and is slightly deeper at the sampling site. Wooded, open-space, and agricultural land use is more common in the upland area than in that near the Chagrin River site.

Based on the results of the qualitative sampling for benthic macroinvertebrates at each site, the Chagrin and Grand Rivers had similar community assemblages. The overall range in types of taxa collected compared favorably. On the Chagrin River, 28 taxa were identified, 5 of which were of the intolerant type. On the Grand River, 24 taxa were identified, 3 of which were of the intolerant type. The majority of taxa collected at each site were of the facultative type. Also, at neither site were the tolerant-type dipteran, annelid, or mollusc taxa common. It is interesting to note that at RM 13.0 on the Chagrin River, an OEPA reference site, which is 2.5 miles upstream of the NEORSD sampling location, an ICI score of 46 was calculated from the results of OEPA's artificial substrate sampling (OEPA, 1987). This score is in the good-to-excellent range in terms of the quality of the benthic macroinvertebrate assemblage.

The scarcity or lack of tolerant-type taxa differentiates the benthic macroinvertebrate communities at these sites from those sampled on the Cuyahoga River. A higher diversity of benthic organisms was found in the

Chagrin and Grand Rivers than at any site on the Cuyahoga River. With regard to habitat conditions and types of taxa present, the only sites on the Cuyahoga River which reasonably compare with the Chagrin and Grand Rivers are Site #'s 23 and 24, the two located furthest upstream.

Comparisons of chemical and bacteriological parameters between sites on the three rivers are limited due to the fewer sampling occasions on the Chagrin and Grand Rivers. However, suspended solids, total dissolved solids, specific conductance, chlorides, nitrates, sulfates, soluble phosphorus, TKN, and NH_3 concentrations were lower at the Grand and Chagrin River sites when compared to the average values at sites on the Cuyahoga River. Except for mercury at the Chagrin River site, metals concentrations measured on the Grand and Chagrin Rivers were the same or lower than those measured on the Cuyahoga River. Additionally, bacteria concentrations on the Grand and Chagrin Rivers were very low in comparison. However, because of the limited chemical and bacteriological sampling conducted on the Grand and Chagrin Rivers, it would be premature to conclude that the water quality in these rivers is considerably better than that in the Cuyahoga River.

OTHER CUYAHOGA RIVER MONITORING ACTIVITIES

In 1988, other sampling and measurement activities were performed on the Cuyahoga River which were separate from the routine chemical, bacteriological, and benthic macroinvertebrate sampling previously discussed. These additional activities are presented below and included wet-weather grab sampling for chloride analysis, total toxic organics (TTO) sampling, a diurnal D.O. study, and fish surveys.

At Site #'s 22 and 22.51 and at the Granger Road bridge (RM 12.1), midstream surface grab samples were obtained during periods of wet weather. Sampling dates were 3/4/88, 12/14/88, and 12/19/88 and corresponded to high surface runoff, including snowmelt. The samples collected were analyzed for chlorides, solids, and specific conductance. The highest chloride concentrations measured were on the samples collected at the Lower Harvard bridge, Site #22.51. Chloride concentrations over all the sites range from 223 mg/L to 390 mg/L. Compared to the average chloride concentration at all of the sites on the river sampled during dry weather, the average wet-weather concentration is higher by a factor of 2.25. A corresponding increase in solids concentrations and specific conductance was also evident in the wet-weather samples.

In 1987, a grab sample was obtained of the runoff discharge from a six-inch storm drain at the west bank of the river directly underneath the Interstate 480 bridge (RM 12.6). The chloride concentration in that sample was 14,520 mg/L. Another grab sample was obtained at the same discharge outlet on 12/14/88 and the chloride concentration was similarly high (17,800 mg/L). Comparing these concentrations with the range of concentrations measured on the samples collected at the three wet weather sites, chlorides in storm drain discharges are being significantly diluted by the associated high flows.

Nevertheless, compared to other Lake Erie tributaries, such as the

Maumee, Sandusky, and Raisin Rivers, the Cuyahoga River has the highest unit area yield of chloride. In fact, the chloride export in the Cuyahoga River is 4 to 5 times higher than in these other rivers (Baker, 1987). Unit area yield is calculated by dividing annual yields by the total watershed area upstream from the sampling stations. The sampling station on the Cuyahoga River, where the chloride data were generated to make this conclusion, is at the USGS Independence gauge site. It is not known if this high yield is associated with point sources, with geological features, or with some other sources.

At Site #'s 22.7 and 22.8, downstream and upstream, respectively, of the effluent discharge from the Southerly Treatment Plant, ISCO automatic samplers were installed simultaneously to collect samples for chemical analysis, including Total Toxic Organics. At Site #22.7, the sampler probe was placed 12 feet from the east bank and at a depth of two feet. At Site #22.8, the sampler probe was placed midstream and at the same depth. Samples at each site were collected hourly from 10:45 AM on 8/17/88 to 10:30 AM on 8/18/88. At the termination of the sample collections, a composite sample from each site was prepared and sent to Burmah Technical Services, Inc. in Pontiac, Michigan for analysis. A priority pollutant analysis for organic and inorganic parameters and a library scan of the ten highest non-priority pollutant peaks were performed by Burmah.

The results of the analyses on the sample from each site showed that for all organic parameters measured, including volatile organic compounds, base/neutral compounds, acid compounds, pesticides, and PCB's, concentrations were below detection limits (Appendix VI). In addition, no significant response was recorded in the library scan performed on the samples from either site. At Site #22.8, upstream of Southerly, the metals concentrations were all below detection limits, except arsenic, which was right at the detection limit, and zinc, which was well below the 30-day average criteria for Warmwater Habitat. The phenolics concentration was also below the Water Quality Standard. Cyanide was the only parameter measured at this site which had a concentration above the 30-day average limit, though it was only a slight exceedance. At Site #22.7, downstream of Southerly, the metals concentrations were also below detection limits, except nickel and zinc, both of which were within the 30-day average limit. Phenolics and cyanide were the only parameters measured at this site which had concentrations above their 30-day average limits, though they too were only slight exceedances. The cyanide concentration was even lower than that measured at the upstream site.

Diurnal dissolved oxygen (D.O.) measurements were made at Site #'s 22.7 and 22.8 concurrent with the composite sampling. The hourly D.O. measurements were obtained using a Nester Instrument Model 8500 Portable Dissolved Oxygen Meter. The instrument probe was placed at the same location as the automatic sampler probe. For comparison, lower depth measurements were also obtained during the day, but no significant differences were noted in the D.O. and temperature readings between the lower depth and surface measurements. Dissolved oxygen and temperature measurements commenced during the 11:00 AM hour on 8/17/88 and ceased during the 10:00 AM hour on 8/18/88.

At neither site was a D.O. deficit evident during the measurement period. At Site #22.7, the D.O. measured 7.1 mg/L (88% saturation at 26.1°C)

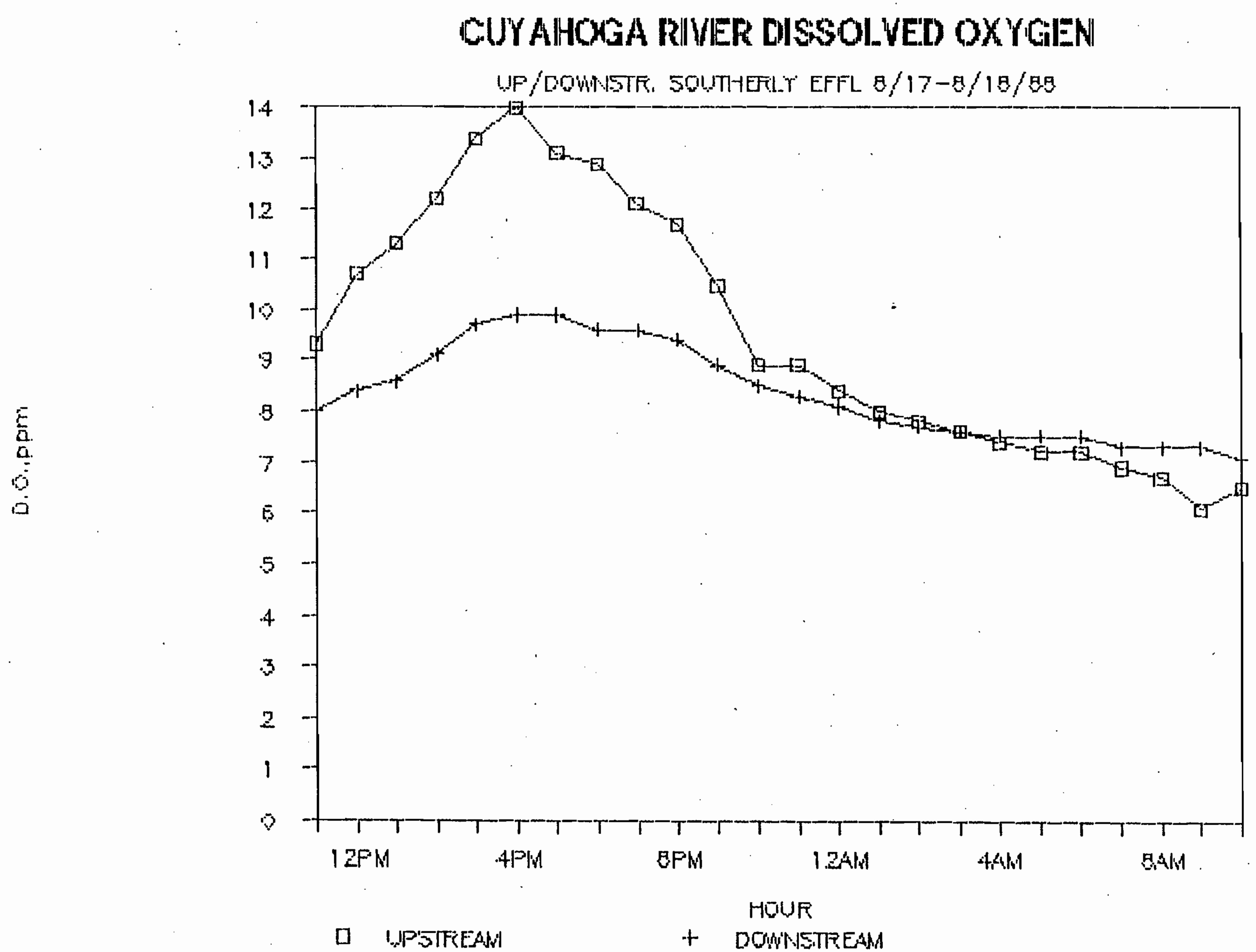


Figure 9. Results of diurnal D.O. study.

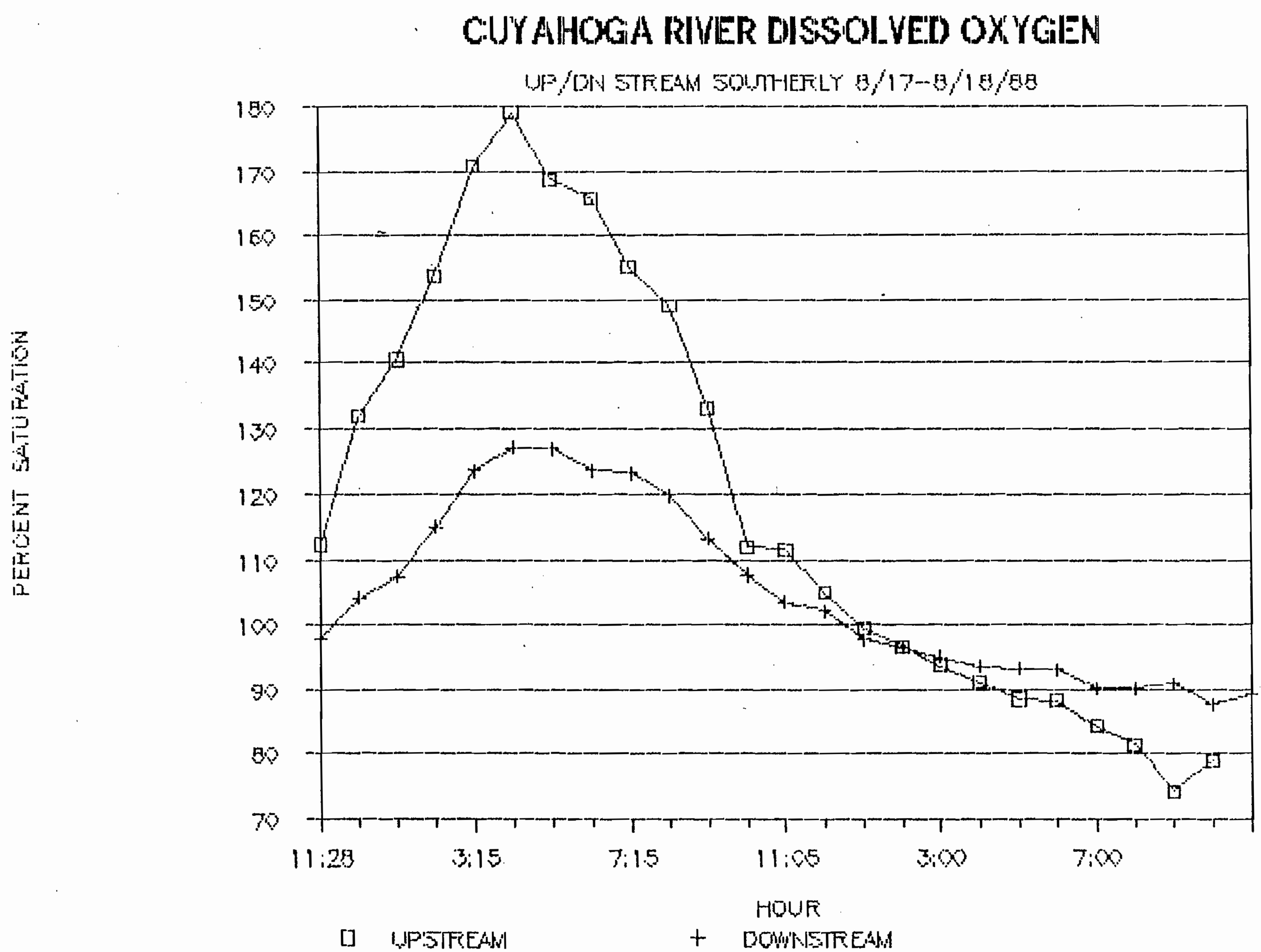


Figure 10. Results of diurnal D.O. study.

at 10:00 AM on 8/18 and was the lowest concentration recorded at the downstream site. The D.O. measured 9.9 mg/L (127% saturation at 28.2°C) at 5:00 PM on 8/17 and was the highest concentration recorded at the downstream site. At Site #22.8, the D.O. measured 6.1 mg/L (74% saturation at 25.3°C) at 9:00 AM on 8/18 and 14.0 mg/L (179% saturation at 28.1°C) at 4:20 PM on 8/17. These were the lowest and highest concentrations recorded, respectively, at the upstream site. As is typical in river systems, the diurnal D.O. variation shows a peak concentration in the late afternoon and declines during the early morning hours. This type of variation is largely related to photosynthetic activity by phytoplankton and aquatic plants, which increases the D.O. concentration in the water column during the daylight hours. In fact, the condition of supersaturation with dissolved oxygen had occurred during daylight hours at both sites and is not uncommon under low flow conditions where a considerable mass of phytoplankton has built up. The murky or greenish brown appearance of the river is evidence that this was the case. The nighttime decline in D.O. is related to respiration activity and the oxidation of organic matter. These processes occur throughout the day, though their effects are masked during the daylight hours by photosynthetic activity. The sinusoidal fluctuation in D.O. concentration at these sites is also affected, either directly or indirectly, by such factors as temperature, atmospheric reaeration, turbidity, and the concentration of dissolved salts.

The biggest difference in the fluctuation in the D.O. concentration between the sites is best depicted by the high and low peaks on the D.O. curves (Figure 9). The figure shows that the range in concentrations was greater at Site #22.8, which is upstream of the Southerly Treatment Plant effluent discharge. At this site, the river is shallower and appears to be less turbid. A higher degree of turbidity affects light penetration by reducing that available for photosynthetic activity. If all other factors are equal, a less turbid condition would promote algal growth at a rate greater than that under higher turbidity conditions. Higher algal densities would also exert a greater demand on the oxygen supply at nighttime due to respiratory activity. Thus, it is likely that the difference in turbidity between the two sites is indirectly affecting their respective oxygen profiles.

FISH SAMPLING

Based upon studies conducted in 1984 through 1987 by the Ohio EPA, the fish communities in the Cuyahoga River downstream of Akron have been characterized as being in the "very poor" and "poor" ranges. This characterization was made as a direct result of the index scores received for the fish communities at particular sites on the river following analysis of data collected in extensive fish surveys. Much like the index scoring used to evaluate benthic macroinvertebrate communities, the Ohio EPA uses two indices, the modified Index of Well Being (I_{wb}) and the Index of Biotic Integrity (IBI) to evaluate overall fish community health in Ohio rivers and streams (OEPA, 1987). The relative abundance and condition of fish, species richness, species composition, trophic composition, and other attributes are directly affected by water quality disturbances and/or habitat alterations. The I_{wb} and, particularly, the IBI are used to gauge these fish community attributes in impacted sites against those in relatively undisturbed sites.

The IBI incorporates 12 community metrics representing such structural and functional attributes as total number of fish, total number of species, percent abundance of particular feeding types, etc. These metrics are individually scored by comparing the data collected at a survey site with values expected at reference sites within the ecoregion. High or low marks for a metric correspond to values which approximate or strongly deviate from, respectively, the value expected at the reference sites. The summation of the 12 metric scores, which are adjusted for drainage area and stream site differences, provides a single value (the IBI score) and determines an "exceptional", "good", "fair", "poor", or "very poor" community (OEPA, 1987).

The I_{wb} incorporates only structural attributes of a fish community. It consists of measures which have historically been used separately in fish community analyses. These measures include numbers of individuals, biomass, and two separate calculations of the Shannon Diversity Index: one based on numbers of fish, and one based on weights. Unlike the IBI, the I_{wb} is strictly a mathematical calculation and has been used by the Ohio EPA to monitor environmental quality and to measure the effectiveness of water pollution control programs (OEPA, 1987).

One additional index used by the Ohio EPA and associated with fish community evaluations is the Qualitative Habitat Evaluation Index, or QHEI. The QHEI is a subjective evaluation and assists in determining whether or not the observed biological response at a survey site, measured by the IBI and/or the I_{wb}, is partly or wholly affected by habitat. The index is based on such characteristics as substrate type, amount and type of instream cover, channel morphology, development, and stability, riparian zone width and composition, pool, riffle, and run quality, gradient, and drainage area. The higher the index score, the better the quality of habitat available for biological communities. In the Erie/Ontario Lake Plain ecoregion, reference site QHEI evaluations received a mean score of 75. The theoretical range of scores possible is 0 to 100.

A detailed description of the sampling and analysis methods utilized in fish surveys, including the generation of IBI, I_{wb} and QHEI scores, can be found in OEPA's Biological Criteria for the Protection of Aquatic Life (1987).

In 1988, the NEORSD contracted EA Science and Technology (EA) to conduct a fish survey of the Cuyahoga River and the Ohio Canal. The purposes of the survey were the following: to provide training for District personnel on the sampling procedure used by the Ohio EPA - namely, pulsed DC electrofishing; to duplicate Ohio EPA's survey efforts on the Cuyahoga River; to assess any effects the Southerly Treatment Plant effluent may have on the river's biological quality; and to compare the survey results of the river with those of the canal. A report on the results of this survey was prepared by EA and is provided in Appendix V. The remainder of this section will clarify and highlight certain aspects of the report.

The sites selected for the fish survey on the river were the same as, or very near to, sites surveyed by the Ohio EPA in the recent past. These sites also closely correspond to NEORSD chemical and bacteriological sampling locations, except for the site at RM 12.2. The river mile indications presented in the report represent the location of the start of each fishing pass. The distance fished at the sites averaged 597 meters and approximates the 500-meter distance required for a fishing pass in Ohio EPA methods. Each sampling zone was electrofished only once. Pulsed DC electrofishing, according to the Ohio EPA, is the single most comprehensive and effective method for collecting river and stream fishes that is currently available.

In addition to the physical/chemical measurements (temperature, D.O., conductivity) made in conjunction with the electrofishing at each survey station and performed on the boat, a grab sample was obtained in each sampling zone and sent to the District's laboratory for analysis. The same parameters were analyzed for as in the routine water quality monitoring previously discussed in this report. The results of the analyses of the samples collected in the river showed parameter concentrations very similar to those presented earlier from sampling sites located in the segment designated Warmwater Habitat. No major exceedances of the 30-day average limit for metals concentrations had occurred. Only slight exceedances of the copper limit (at the RM 7.8, 9.8 and 12.2 stations), the zinc limit (at the RM 12.2 station), and the nickel limit (at the RM 11.7 station) were found. Except for nickel, slightly elevated concentrations of these metals were typically found at various sites during routine water quality monitoring efforts. Fecal coliform concentrations were comparatively high: 11,000 and 2,400 counts/100 ml at the RM 7.8 and 9.8 stations, respectively. The analyses of the samples obtained on the Ohio Canal were quite similar to those on the river. A slightly elevated concentration of copper and a high iron concentration (18.0 mg/L) were found at the time the electrofishing was performed. Fecal coliform concentrations were very high in the canal and ranged from 5,700 to 760,000 counts/100 ml. (The source of this bacterial contamination was unknown at the time of the survey.)

In summary, the quantitative fish survey yielded a total of 195 individuals distributed among 12 species in the Cuyahoga River and a total of 309 individuals distributed among 14 species in the Ohio Canal. All of the dominant species, except for the gizzard shad, caught on both the river and the canal are considered pollution-tolerant types (OEPA, 1987). No intolerant species were collected. The IBI scores calculated based on the survey results reflect a "very poor" fish community in both the river and the canal. Figure 12 also shows that the scores compare well with Ohio EPA sampling results on the river. The modified I_{wb} scores for the river reflect either a "very poor" or "poor" fish community, depending on the location. Figure 11 shows that these scores also compare well with Ohio EPA sampling results. For the canal, the I_{wb} scores approach or are in the "poor" range. Based on the index scores, no effect of the Southerly Treatment Plant effluent was evident. The effluent is discharged to the river between the RM 9.8 station and the RM 11.7 station. In fact, the I_{wb} score increased slightly downstream of the effluent discharge. According to the EA report, this increase is due primarily to the greater number of gizzard shad in the catch. The gizzard shad is a species of intermediate pollution tolerance. QHEI scores reflect poor-to-fair habitat in the river and poor habitat in the canal. These associated low habitat scores suggest that habitat may be limiting the existence of high quality fish communities, though it is not likely that it is the only controlling factor.

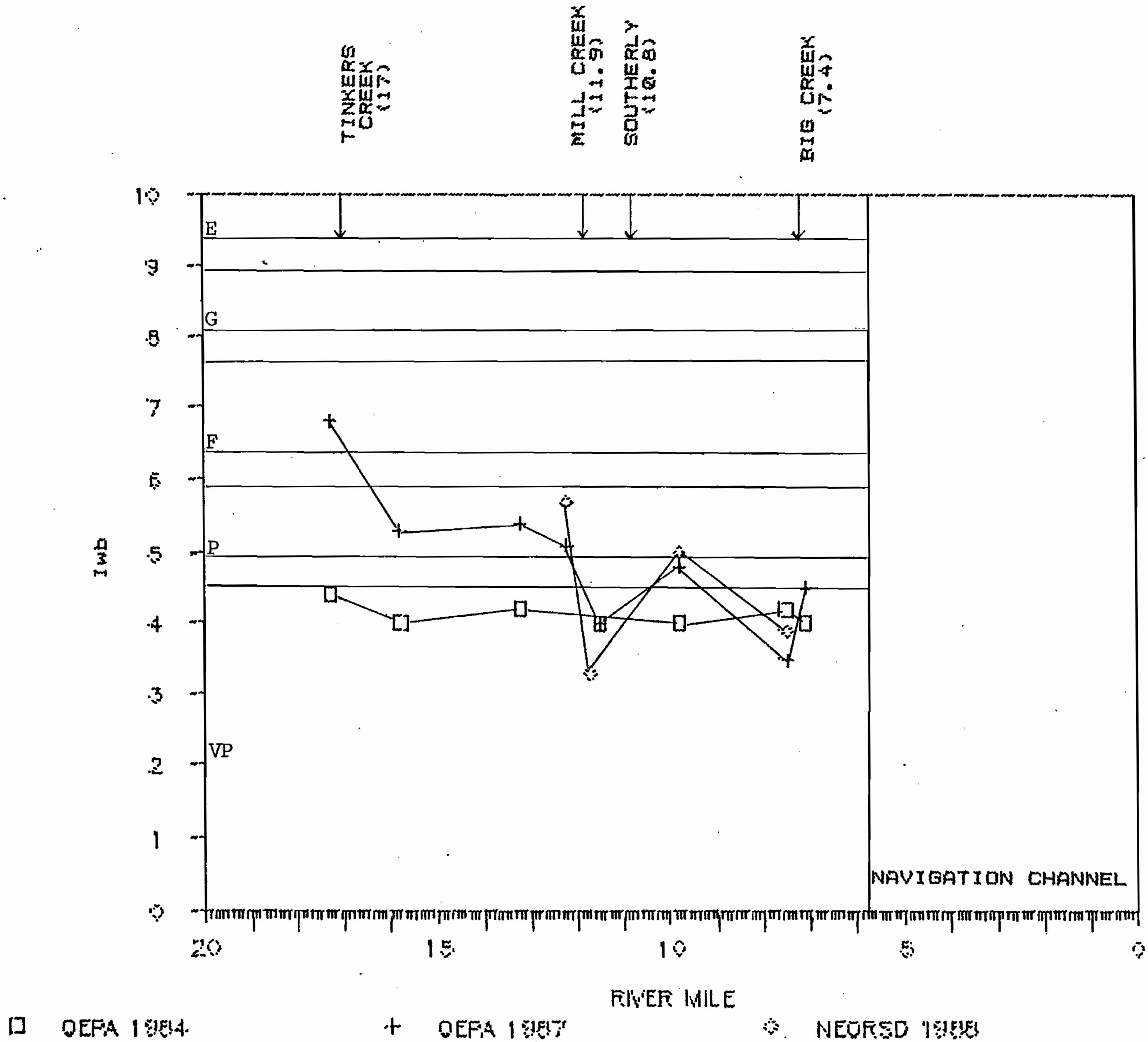


Figure 11. Cuyahoga River Modified Indices of Well-Being.

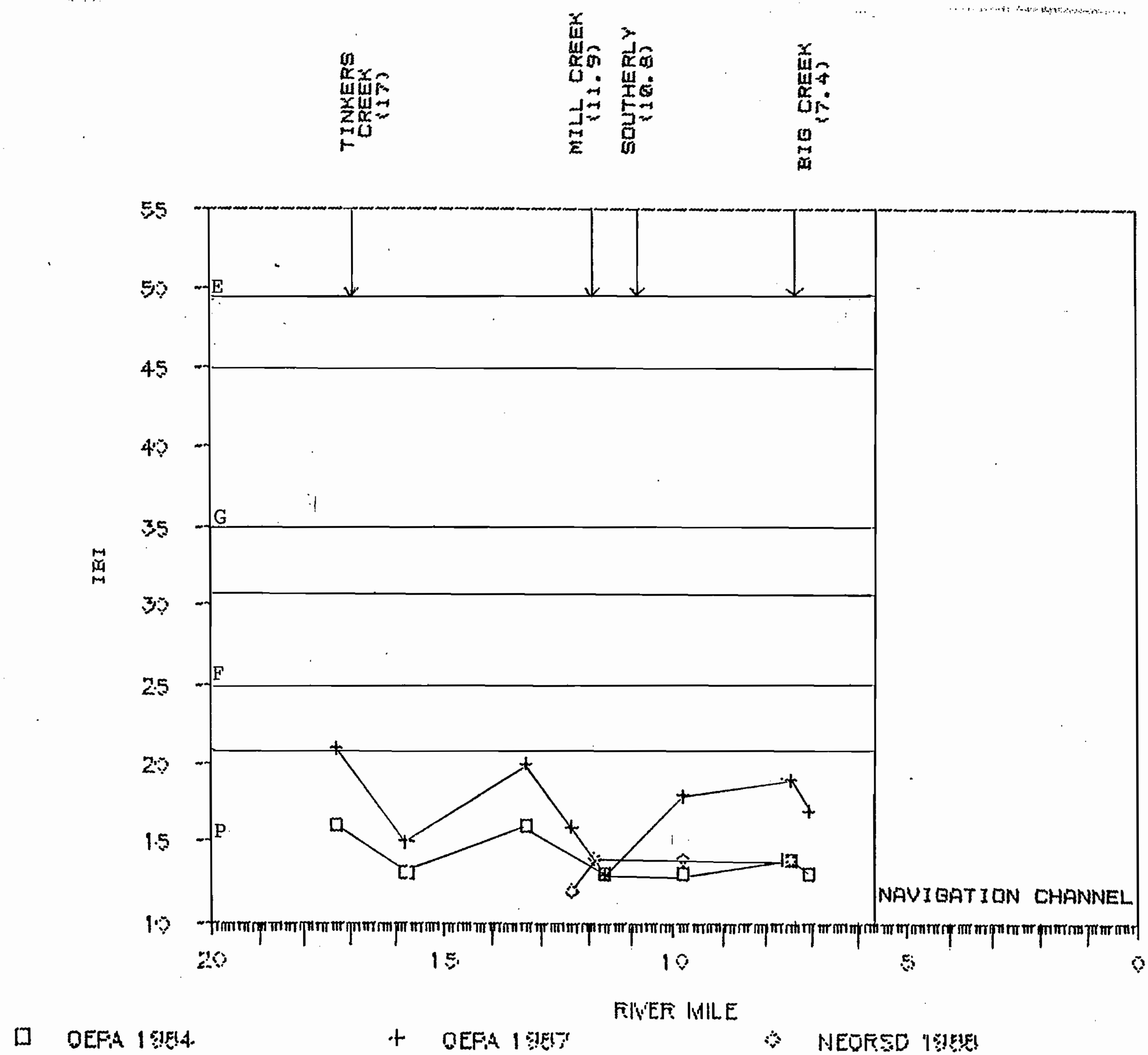


Figure 12. Cuyahoga River Indices of Biotic Integrity.

Apart from the EA survey, fish sampling was conducted by District personnel on three occasions (7/15, 8/24 and 8/26/88) at six sites on the river using dip nets for young-of-the-year (yoy) capture, a 5-foot diameter throw net, a 4-foot by 8-foot minnow seine and a 4-foot by 15-foot bag seine. Site locations were as follows: Hillside Road bridge (RM 15.9); Old Rockside Road bridge (RM 13.5); Granger Road bridge (RM 12.1); railroad bridge near the intersection of East 71st Street and Canal Road (RM 11.7, Site #22.9); chlorine-access railroad bridge at the Southerly Ash Lagoons (RM 11.3, Site #22.8); and downstream of the Southerly Treatment Plant effluent discharge (RM 11.0). At each site, 5 to 10 sweeps with a net were made in all habitat types that were not too deep to survey. Schooling yoy and juveniles were observed in shallow pools, margin areas and near the margins of islands. More numbers of fish were seen than caught, but based on the results of the sampling efforts, species diversity was low. The following is a list of the species caught: white sucker, carp, goldfish, spotfin shiner, creek chub, central stoneroller minnow, bluntnose minnow and the fathead minnow. These same species were also caught in the EA survey. The most common fishes captured were the spotfin shiner and the bluntnose minnow, followed by smaller numbers of the creek chub, central stoneroller minnow, and the white sucker. Relatively few carp, goldfish, and fathead minnows were caught. Additionally, the two carp and one goldfish captured were juveniles. The only yoy captures were white suckers, creek chubs, bluntnose minnows, and central stoneroller minnows. Except for the spotfin shiner and the central stoneroller minnow, all of the species collected are considered by the Ohio EPA to be highly tolerant to a wide variety of environmental disturbances, including water quality and habitat degradation.

PROBLEMS AND REMEDIATION

The results of the sampling, measurements, and surveys conducted on the Cuyahoga River in 1988 by NEORSD personnel simply document some of the problems associated with the river's water quality and biological condition. The District's monitoring efforts by no means encompass the entire spectrum of disturbances to the river that may be occurring. This past year's data indicate that minor surface water quality problems still exist and that the river's biological condition is degraded. Though the Cuyahoga River is designated Warmwater Habitat down to the navigation channel, the data clearly shows that it is currently not attaining that status. Additionally, there is no assurance that the river will ever reach the quality of a Warmwater Habitat. Not until the causes of the water quality and biological problems are determined and addressed can a sound prediction be made on when the river will return to a fishable/swimmable watercourse. Currently, there appears to be a lack of an adequate data base from which to identify the problems. The work conducted as part of the RAP, in which the NEORSD will be actively involved, will certainly improve our knowledge of the river and its associated disturbances.

In 1987, NEORSD personnel had identified numerous drainage outlets to the river while traversing by boat its lower reaches included in the Stream Monitoring Program. Grab samples were obtained of the discharges from certain outlets and the analysis results were presented in the 1987 Report. In 1988, due primarily to time constraints, further investigations of the sources of flow through these outlets were not performed. Only those known to be combined sewer overflows are currently being monitored. In the future, a closer characterization of the remaining outfalls and their discharge contributions "up the pipe" will need to be made. It will be important to identify those discharges, whether intermittent or continuous, which are having a negative effect on water quality.

ACCIDENTAL DISCHARGES TO THE RIVER

In 1988, discharges from certain drainage outlets to the river were either results of accidental spills or malfunctions in operation equipment at facilities tributary to the sewer systems. On at least one occasion, an accidental discharge was caused by a malfunction in the sewer system itself. The Cuyahoga River's discharge problems of which the NEORSD Stream Monitoring Program was made aware in the past year are described below.

On 11/22/88, a spill of diesel fuel at the site of the Carolina Freight Company contributed approximately 200 to 800 gallons of the liquid to a storm drain which runs along Wall Street in Valley View. The discharge outlet is located at the west bank of the river approximately 500 yards upstream of the Interstate 480 bridge crossing. The spill was responded to by the Ohio EPA and the NEORSD. Company officials confirmed that the remainder of the spill not washed down the river was contained and cleaned from the river by the Samsel Services Company, a hazardous materials management firm. The effect that this small spill had on the river is not known, though it was probably negligible.

On 6/20/88, a traffic accident on Interstate 71 near the Jennings Road exit caused an estimated 6,000 gallons of gasoline to be spilled to a nearby storm drain from an overturned tanker truck which had been hauling the liquid. The incident was responded to by about 75 police, fire and environmental officials, including representatives from the NEORSD. The outlet of the 96-inch storm drain that received much of the spill is located at the west bank of the river approximately 100 yards downstream of the N&W Railroad bridge crossing. The majority of the fuel was contained near the storm drain outlet, and what did not evaporate was cleaned from the river by the Samsel Services Company. Reports issued later indicated that the spill caused little or no damage to the river.

On 8/12/88, NEORSD personnel noted a heavy flow of raw wastewater discharging to the river from an outlet located at the west bank directly underneath the Big Creek Interceptor crossing. The discharge was reported to NEORSD Sewer Control Systems. A crew was dispatched to the site and shortly thereafter corrected the problem, which had been caused by stoplog deterioration in the Big Creek Interceptor diversion chamber. No sample of the discharge was taken and it is not known how long the problem had been occurring prior to its correction.

On two occasions in 1988, large accumulations of solidified grease were reported seen on the river downstream of the Walworth Run storm sewer. It was quickly determined that each incident had resulted from a wet-weather overflow to the 16-foot storm sewer from upstream drain lines. Investigations by NEORSD personnel revealed that the source of the grease discharge on each occasion was A.W. Stadler, Inc., a meat-rendering company at 3275 West 65th Street. The excess grease discharged to the sewer system upstream of Walworth Run was the result of pretreatment equipment malfunction at the company. Much of the grease that was released to the river on the first occasion was washed downstream to the lake. On the second occasion, the material was contained just downstream of the Walworth Run sewer outfall and cleaned from the river with the help of the U.S. Coast Guard and the Samsel Services Company. In total, A.W. Stadler, Inc. incurred a cost of over $60,000 for the clean-up. The grease loadings to the river may have contributed considerable BOD; however, because no river samples were obtained at the time the problems occurred, the exact effect of the loadings is unknown.

The last discharge problem known to have occurred in 1988 concerned the quality of treated wastewater from Zaclon, Inc., a chemical manufacturer located near the steel mills at 2981 Independence Road. On 12/1/88, NEORSD personnel obtained a grab sample of the company's treated effluent discharge to the river, which is regulated under a NPDES permit. The results of the analyses on the sample revealed extremely high concentrations of metals, particularly zinc (170.0 mg/L) and chlorides (1,150 mg/L) and a slightly acidic pH (5.7 Standard Units). The data was sent to a company official with a request to respond to the high parameter concentrations. The Ohio EPA was also informed of the findings. The company's response indicated that they were experiencing some problems with their wastewater treatment system and that they were working to remedy the situation as soon as possible.

Discharge problems such as this should be quickly addressed if water quality conditions in the Cuyahoga River are to continue to improve. All industrial and municipal point source dischargers to the river are expected to be closely regulated under the NPDES permitting process. The contributions of these dischargers to the pollution problems of the river can be large if wastestream treatment equipment is not closely monitored for performance. In a general sense, area steel mills and chemical companies have improved their discharging practices, and with continual updating of NPDES permits, the reduced pollutant loadings from these dischargers should minimize any associated water quality problems.

OTHER SOURCES OF WATER QUALITY PROBLEMS

Combined sewer overflows, or CSO's, which are a major source of uncontrolled pollution to area waters, including the Cuyahoga River, will be one of the primary focuses of the RAP. The NEORSD has recently been issued a permit by the Ohio EPA which requires that 128 CSO's in the District's service area be monitored. The permit also includes a provision for requiring the District to plan to correct any problems that are identified through CSO monitoring efforts. In the future, this significant source of sanitary sewage loading to the river during wet-weather periods should be reduced, helping to improve water quality conditions.

Dry-weather sanitary sewage discharges to the river continue to occasionally occur. Most of the problems associated with sanitary sewage overflows are addressed by ensuring more efficient collection system flow control. In addition, the NEORSD's ongoing interceptor construction projects are relieving some of the environmental problems associated with sanitary sewer overflows as well as septic tank discharges. One of the current primary dry-weather overflow problems concerns the inoperative Mary Street Pump Station. For about one and a half years, the overflow line from this station, which is tributary to the river at the west bank approximately 1,000 feet upstream of the Kingsbury Run confluence, has been receiving an estimated 4.3 million gallons per day (MGD) of sanitary wastewater. The City of Cleveland is presently attempting to contract the repairs needed for the pump station. Also, the Mahoning Street Pump Station has had equipment problems since late 1988. The City is addressing these problems so as to eliminate the overflow to the river at the West 3rd Street bridge.

The Walworth Run storm sewer, prior to late 1987, contributed significant amounts of sanitary sewage to the Cuyahoga River during dry-weather periods. Sanitary sewage overflows to the storm sewer were caused primarily by blockages in the Westerly Low-Level Interceptor and operational problems with the Division Road Pump Station. Since late 1987, however, the Interceptor has been cleared of grit and debris by NEORSD Sewer Control Systems and the pump station has been taken over from the City of Cleveland by the NEORSD and renovated. As a result, Walworth Run is no longer a dry-weather source of pollution in the river.

Pollutant loadings to the Cuyahoga River during wet-weather events via storm drain runoff is another problem now receiving considerable attention. Separate storm drain runoff can potentially carry eroded soils, oil and grease, and a wide array of impermeable land surface chemical residues. Currently, Best Management Practices are required and have been implemented at urban and suburban development sites to help to control any runoff problems. Consideration is now being made to separately collect and treat stormwater discharges. The Water Quality Act of 1987 established a program for the control of separate storm sewer discharges, and under proposed regulations which have been issued by the USEPA, municipalities and industries will be required to apply for NPDES permits for these discharges. Also, large municipal areas will have to submit permit applications with accompanying stormwater quality analyses and land use data. Currently, however, there is no institutional structure in place to manage and regulate such a program. Though pollutant loadings from storm drainages may be significant, as may be other non-point sources, including runoff from cultivated land surfaces, dumpsites and hazardous waste landfills, atmospheric deposition, polluted groundwater, etc., they are much less quantifiable than point source discharges and their impacts will be difficult to assess.

The high erosion potential of the river's steep banks reflect the unstable, unconsolidated glacial till deposits into which the river has cut its channel (U.S. Army Corps of Engineers, 1981). Evidence of bank erosion, slippage and collapse is quite common along the lower river, despite the fact that extensive sections of the river's top banks are wooded and grass covered. The common presence of felled tree debris and high turbidity conditions (440 NTU following one storm event) are signs that erosion may be a major problem. According to a detailed report on sediments and nutrients in

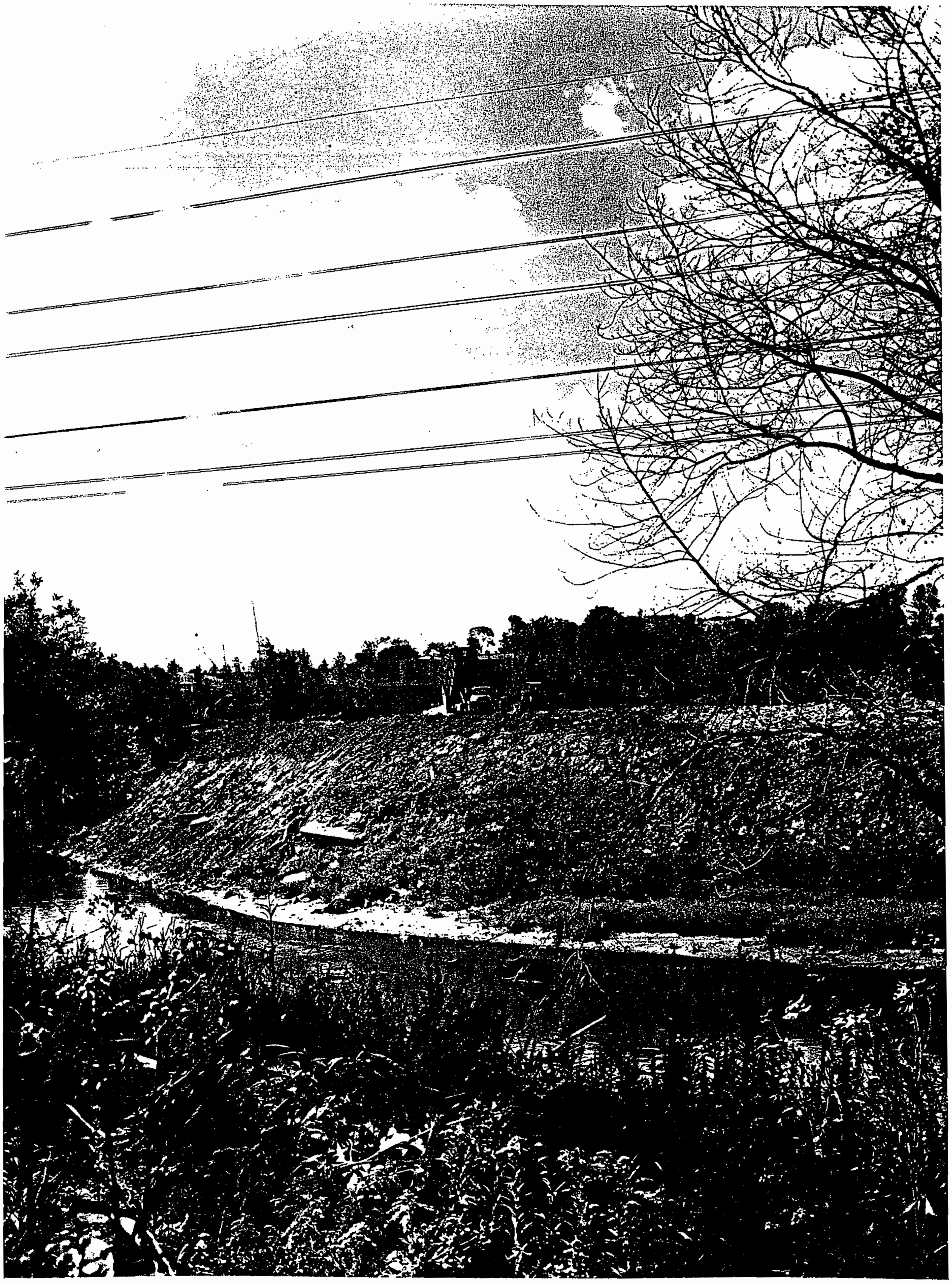


Figure 13. Material disposal site on the west bank of the Cuyahoga River at RM 10.

Lake Erie tributaries, out of all the rivers studied, the Cuyahoga River had the highest unit area yield of sediments and the highest percentage of total suspended solids exported during runoff events (Baker, 1987). Thus, erosion, siltation, sedimentation, and even bedload movement during storm events have a high probability of being key factors in causing the depressed biological conditions in the lower Cuyahoga River (EA Sci. and Tech., 1987). The biologically debilitating effect that these factors can have in river systems should be well known among area biologists since it has been documented by one of Ohio's most notable fisheries experts and author of The Fishes of Ohio, Dr. Milton B. Trautman.

OHIO CANAL

The Ohio Canal, which was opened between Cleveland and Akron back in 1827, had replaced the Cuyahoga River during those times as the major transportation artery in this region. The canal system opened up Ohio and the Midwest to commerce and industrialization. Fifty-three years later, however, it was replaced as a transportation route by the railroads and subsequently abandoned. What is presently left of the canal system is of historical significance only. The only wetted section that remains stretches for eleven miles northward along the east bank of the Cuyahoga River from approximately the location of the State Route 82 bridge crossing in Brecksville. (Figure 3).

The NEORSD incorporated sampling of the Ohio Canal into the Stream Monitoring Program as a result of arguments raised in early 1988 concerning the recent designation of the Cuyahoga River as Warmwater Habitat from RM 10.8 to RM 5.6. Because the lower eleven miles of the canal are fed by the river, the two systems are expected to be quite similar in water quality characteristics. The NEORSD hypothesized that because of this similarity, any major differences in biological condition between the river and the canal must be related to differences in other factors, perhaps the quality of physical habitat and/or erosion and sedimentation problems. At the hearing in front of the State of Ohio Environmental Board of Review, concerning the habitat designation of the river, NEORSD expert witnesses testified that these other factors may be the primary causes of the river's poor biological quality. Thus, for experimental and informational purposes, chemical, bacteriological, and benthic macroinvertebrate sampling was performed on the canal in 1988. A fish survey was also conducted and has already been discussed as part of the study on the Cuyahoga River.

The exact drainage area tributary to the canal's wetted section is unknown. It is fed by partial flow from the Cuyahoga River, near Sampling Site #24, through an inlet structure located just upstream of the low-head dam. The reason the canal is receiving flow from the river is to provide a source of cooling water for the American Steel & Wire Corporation located in Cuyahoga Heights. The company leases the canal for this purpose from the Ohio Department of Natural Resources. Downstream of the diversion of river water, no other large drainages are known to enter the canal which would significantly affect its flow. The flow in the canal is regulated by the inlet structure and five return structures located along its west bank. The water surface gradient is nearly zero down to Canal Mile (CM) 0.4 and elevation drops are facilitated by lock structures and weirs.

Listed below from upstream to downstream is the location of each of the canal's flow control structures of which the NEORSD is aware.

1) Cuyahoga River low-head dam and inlet structure (canal feeder). CM 11.0.
2) Return structure. Near the intersection of Canal Road and Sagamore

Road. CM 8.4.
3) Return structure, lock, and weir control of canal flow. Fitzwater Road (at Wilson's Mill). CM 7.9.
4) Lock, and weir control of canal flow. Hillside Road (at the Locktender's House). CM 6.6.
5) Return structure, lock, and weir control of canal flow. South of Rockside Road. CM 5.2.
6) Return structure. At the Mill Creek crossing. CM 2.9.
7) Lock. Underneath the Interstate 77 bridge. CM 2.6.
8) Return structure. Across from the discharge channel which receives the effluent from the Southerly WWTP. CM 2.0.
9) Culvert. Behind the property of the American Steel & Wire Corporation. CM 0.4.
10) Confluence with the Cuyahoga River. At RM 8.5.

NEORSD personnel measured the flow in the canal at a site approximately 100 yards downstream of the inlet structure and at a site approximately 30 feet upstream of its confluence with the Cuyahoga River. At both locations, instantaneous velocity measurements were obtained, using a Marsh-McBirney portable velocity meter, in equally spaced segments along a transverse line connecting the banks. The discharge rate was calculated by multiplying the average velocity reading by the cross-sectional area of the canal at each site. At the upstream location, velocity measurements were obtained on eleven separate occasions during the period from 7/7/88 to 7/22/88. The average flow rate over the eleven days was calculated to be 104 cubic feet per second (cfs). The maximum flow rate was 165 cfs, while the minimum was 67 cfs. The difference between the high and low values is likely due to the varying rate at which Cuyahoga River flow is being fed to the canal. The precipitation that was recorded during the measurement period was minimal and did not have a significant effect on the flow. It is interesting to note that, in the early 1920's, the USGS had operated a gauge at the inlet structure. Actual flow data that is available indicates that during the period from 3/1/23 to 2/29/24, the average flow rate recorded was 101.7 cfs. The maximum flow rate over the 12-month period was 160 cfs, while the minimum was 44 cfs. Though it is rather outdated, this data compares well with NEORSD measurements at this site. At the downstream location near the confluence, velocity measurements were obtained on ten separate occasions during the period from 7/6/88 to 7/20/88. The average flow rate over the ten days was calculated to be 13.8 cfs. The maximum flow rate was 18.7 cfs, while the minimum was 8.8 cfs.

The difference in flow rate between the two sites (90.2 cfs) is an approximation of the amount of flow, under dry weather conditions, which is returned to the Cuyahoga River via the return structures, plus that which is used as cooling water by the American Steel & Wire Corporation. The company's water intake line is located just upstream of the flow control structure at CM 0.4. Additionally, the USGS formerly operated a gauge on the canal which was located at approximately CM 4.8 in Independence. The average discharge recorded at the gauge for the period of record (46 years) up to 1980 was 62.3 cfs (SAIC, 1986). The measurements taken here would not have included the flow lost through the first three return structures on the canal. They would have included the flow lost through the last two return structures, as well as that used for cooling water and that discharged to the Cuyahoga River at the canal confluence.

SAMPLING

Samples for chemical and bacteriological analyses were obtained at four sites on the canal on four occasions each from July 6 to September 28, 1988. The locations of the sites are presented in Figure 14. Appendix II-D presents the averages of the sample data on a parameter-by-parameter and site-by-site basis. Additionally, Hester-Dendy samplers were installed in the canal at Site #'s 54 and 56 on July 28th and retrieved six weeks later on September 8th. A qualitative sample collection of benthic macroinvertebrates was performed at the time each set of artificial substrates was pulled from the canal. Appendix III-I and -J presents a listing of the organisms identified at the two sites and includes both the artificial substrate sample and the qualitative sample collections. Appendix IV-C and -D presents a listing of organisms and their numbers collected off the artificial substrates alone. For each site, the calculation of the ICI is also presented.

Sampling Site #53 is approximately 30 feet upstream of the confluence with the Cuyahoga River (RM 8.5). The site can be accessed from a walking trail that travels to the north between the river and the canal for 0.4 miles from the end of the old tow path. At this site, the canal is approximately 22 feet wide and the depth ranges from 8 inches nearshore to 2 feet midstream. At this site and downstream of the flow control structure located at CM 0.4, the canal resembles a small creek with riffle, run, and pool habitat. Substrate is composed primarily of fine gravel, small rubble, sand, silt, and detritus. Near the confluence, little cover is provided by bank vegetation; however, just upstream, the vegetative buffer is heavy and composed of a mix of trees, shrubs, and grasses. The upland area behind the east bank is wooded and grassy and stretches up to the Alcoa Cleveland Works on Harvard Avenue. The upland area to the east between the river and the canal is also wooded and grassy.

Nuisance Prevention Maximum Criteria were not exceeded based on a review of the analyses of the samples collected at Site #53. These criteria represent the minimum water quality to be met in all surface waters of the state. The canal is not a natural watercourse and is not subject to any stricter controls. Average bacteria concentrations were relatively low and FC/FS ratios indicate that bacterial contamination was derived from mixed human and animal waste sources on three occasions and animal waste sources on one occasion.

Sampling Site #54 (CM 2.7) is at the railroad bridge crossing near the intersection of East 71st Street and Canal Road. Parallel to this location is sampling Site #22.9 on the Cuyahoga River. The canal here is approximately 20 feet wide and the depth ranges from 3 feet nearshore to about 6 feet midstream. The canal flow velocity past the sampling site is often barely evident and the water is generally turbid or murky in appearance. The entire canal system down to the stream-like section where Site #53 is located does not have any distinguishable pool, riffle, or run habitat. The bottom contour

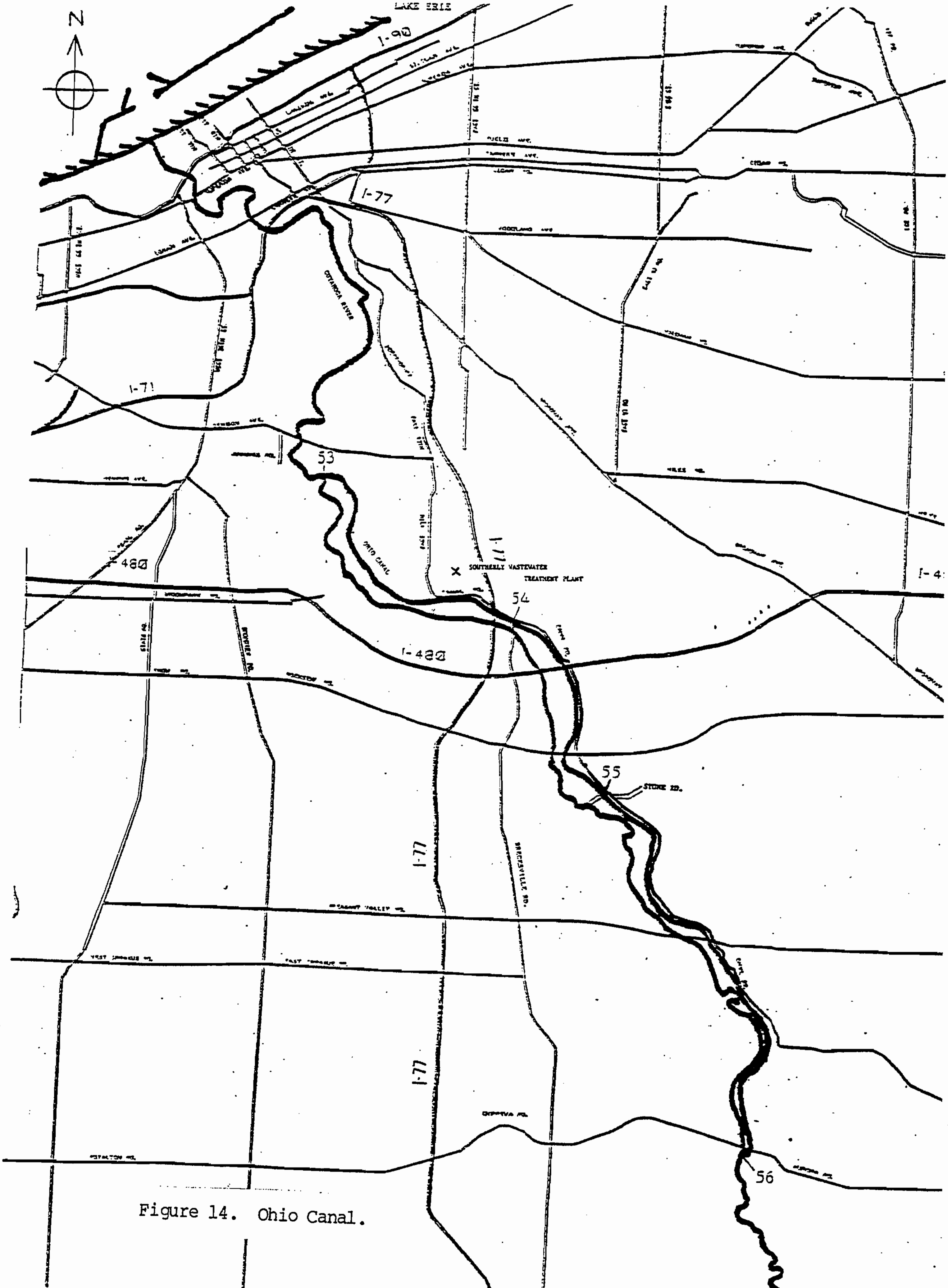


Figure 14. Ohio Canal.

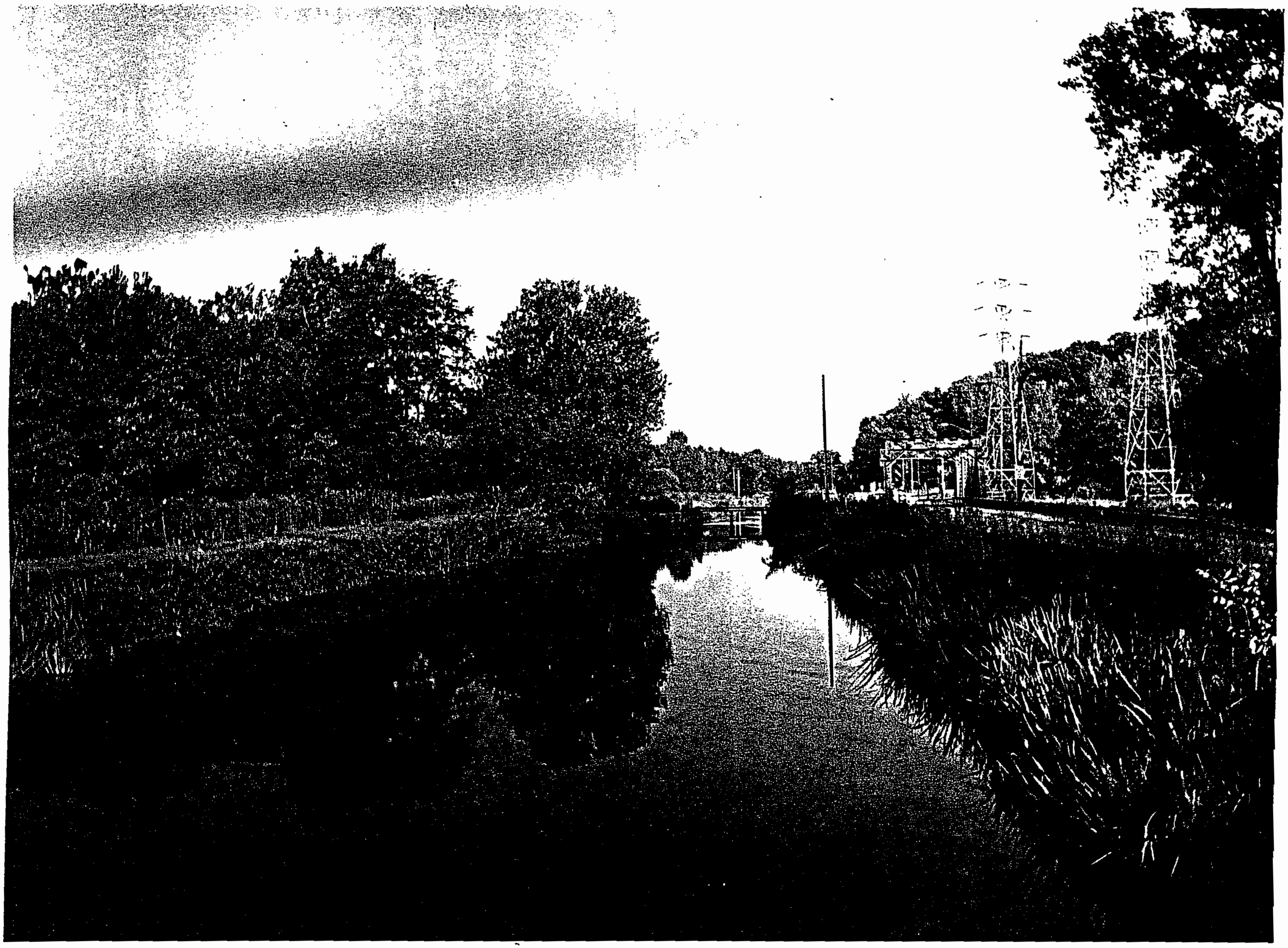


Figure 15. Ohio Canal at Tinkers Creek.

is rather uniform and the substrate is composed primarily of silt, muck, and detritus. The banks near this site are covered with grasses and weeds. The old tow path and the river parallel the canal to the south while Canal Road parallels it to the north. Commercial and industrial land uses predominate in the upland area near this site.

Nuisance Prevention Maximum Criteria were not exceeded based on a review of the analyses of the samples collected at Site #54. Average bacteria concentrations are slightly higher than at Site #53 downstream. FC/FS ratios indicate that bacterial contamination was from mixed human and animal waste sources.

A set of Hester-Dendy samplers was placed at site #54 to provide a quantitative sample of benthic macroinvertebrates. Of the 17 taxa which were collected off the artificial substrates, 3 were of the intolerant type, in addition to the facultative and tolerant types found. Facultative-, facultative/intolerant-, and tolerant-type taxa were collected during the qualitative sampling that was performed at the time the Hester-Dendy set was retrieved from the canal (Appendix III-H). Dipteran taxa were found on the artificial substrates and not in the qualitative sample collection. This was the major difference in the types of organisms collected using the two sampling methods. Similar differences were found in the benthic macroinvertebrate sampling results from the Cuyahoga River.

An ICI score of 28 was calculated for Site #54 which translates to a fair quality benthic macroinvertebrate community (Appendix IV-C). However, the interpretation of this score is limited because of the very slow flow velocity at this site, which is below the Ohio EPA minimum requirement of 0.3 ft/sec, and because of the fact that the drainage area upstream was roughly estimated. Drainage area is important because it affects the scoring of 8 out of the 10 ICI metrics. Also, according to the Ohio EPA, after water quality, the amount of flow which passes over the Hester-Dendy set has the largest effect on the types and numbers of organisms collected (OEPA, 1987). Despite these limitations and ignoring the ICI score, the benthic macroinvertebrate community diversity at this site is slightly lower than at sites on the Cuyahoga River where the communities are rated fair to good (Appendices III, IV).

Sampling Site #55 (CM 5.5) is at the Stone Road bridge and can be accessed from Canal Road. The canal at this location is approximately 40 feet wide and the depth ranges from 4 feet nearshore to about 6 feet midstream. The canal is generally turbid or murky in appearance. Habitat characteristics are very similar to those of Site #54. Duckweed floating on the water surface was commonly observed while sampling at this location. In fact, in the nearshore areas, along certain sections of the canal system where the flow is barely evident, assemblages of aquatic macrophytes are quite common and include plant types typically found in the littoral habitat of ponds in the region. The most noticeable plants, besides duckweed, include water lillies and cattails. Wooded, open-space, agricultural, recreational, and residential land uses are the most common in the upland area near this site.

Nuisance Prevention Maximum Criteria were not exceeded based on a review of the analyses of the samples collected at Site #55. Average bacteria concentrations were similar to those at Site #53 and slightly lower than at Site #54. FC/FS ratios indicate that bacterial contamination was from mixed human and animal waste sources on two occasions, primarily human wastes on one occasion, and animal wastes on another occasion.

The final sampling site, #56 (CM 11.0), is at the inlet structure through which Cuyahoga River flow is diverted to the canal. At this location, the canal is approximately 15 feet wide and 6 feet deep. The flow drops into the canal at high velocity and the appearance of the water is generally turbid. Samples for chemical and bacteriological analyses were obtained at the canal side of the inlet structure. At approximately 100 yards downstream, where the benthic macroinvertebrate sampling was performed, the canal is 40 feet wide and the depth ranges from 2 feet nearshore to 3 feet midstream. The canal flow velocity slows at this location. Substrate is composed primarily of silt, muck, and detritus, and the banks are grass- and weed-covered to the west and wooded and grassy to the east. This site is located in the rural environment of the CVNRA.

Nuisance Prevention Maximum Criteria were not exceeded based on a review of the analyses of the samples collected at Site #56. Average bacteria concentrations were similar to those at the other three sites. FC/FS ratios indicate that bacterial contamination was from mixed human and animal waste sources on three occasions and human waste on one occasion.

A set of Hester-Dendy samplers was placed at Site #56 to provide a quantitative sample of benthic macroinvertebrates. The majority of the taxa collected off the artificial substrates from this location are described as facultative. Four intolerant-type taxa were also found. Facultative-, tolerant-, and facultative/intolerant-type taxa were collected during the qualitative sampling that was performed at the time the Hester-Dendy set was retrieved (Appendix III-I). Again, the greater number of dipteran taxa found on the artificial substrates was the major difference in the types of organisms collected using the two sampling methods.

An ICI score of 30 was calculated for Site #56, which translates into a fair quality benthic macroinvertebrate community (Appendix IV-D). The drainage area of the Cuyahoga River at Site #24, located just upstream of the inlet structure, is the same drainage area used to score the ICI metrics at this site. It is not quite a proper determination, as was also the case at Site #54, but given the wide drainage area ranges between scoring possibilities for a metric (OEPA, 1987), it is a reasonable approximation. The flow velocity at this site, contrary to that of Site #54, was suitable for artificial substrate sampling. Because of flow velocity differences between the two canal sites and between the canal sites and river sites where Hester-Dendy sets were installed, ICI score comparisons are limited. By just comparing the types of organisms collected at the sites and ignoring the ICI scores, results show that benthic macroinvertebrate diversity at Site #56 is slightly higher than at Site #54. On the other hand, benthic macroinvertebrate diversity is lower at the canal sites than at the river sites (Appendices III, IV).

As discussed, minor water quality violations were noted in the Cuyahoga River and not in the canal. The difference here is simply related to the fact that the river, as a designated Warmwater Habitat, is subject to stricter water quality standards. In fact, the average data from analyses of samples collected at sites on both the river and the canal show a high degree of similarity (Appendix II). In the canal, only higher average total dissolved solids and chlorides concentrations, and correspondingly higher specific conductance readings, were noted.

The results of the benthic macroinvertebrate sampling and the fish sampling (Appendix V) that were performed in the river and the canal in 1988 revealed that both community types in both systems are of poor or fair quality. The hypothesis that factors other than water quality are resulting in major differences in biological conditions between the river and the canal was thus nullified. The two systems flow through two completely different channels, yet habitat quality is poor in both and is reflected in the low QHEI scores (Appendix V). Sedimentation, which occurs especially in the low-velocity sections upstream of lock and weir structures in the canal, is excessive and may be negatively impacting the canal's benthic macroinvertebrate and fish communities, just as it may be impacting the biological communities of the Cuyahoga River.

BIG CREEK

Big Creek drains southwestern Cleveland and the southwest suburbs. It has a total drainage area of 38.60 square miles and a total length of 12.0 miles (Havens & Emerson, 1968). Big Creek has two main branches: the East Branch, which originates in North Royalton south of Pleasant Valley Road, and flows north through Parma and Parma Heights into Brooklyn; and the West Branch, which originates in Brook Park and flows northeast through the west side of Cleveland into Brooklyn, where it combines with the East Branch. From the confluence of the two main branches, Big Creek flows east through Brooklyn and Cleveland to the Cuyahoga River at River Mile 7.4. Additionally, each branch has a significant tributary stream: Stickney Creek, which originates in Parma and flows northwest through a section of Cleveland into Brooklyn, where it combines with the East Branch; and the "Chevrolet" branch, which originates in Parma south of Brookpark Road and flows north into Cleveland, where it combines with the West Branch.

Under dry weather conditions, flow measurements obtained at Jennings Road in 1987 indicated that Big Creek discharges approximately 11.3 million gallons per day (MGD) into the Cuyahoga River. About 7.0 MGD of the flow was from the East Branch, while 2.4 MGD of the flow was from the West Branch.

Most of Big Creek is open, with only two major portions culverted: approximately 0.4 miles underneath the Metroparks Zoo; and approximately 2.6 miles of the West Branch between West 117th Street and Puritas Avenue.

Along Interstate 71, from downstream of the East and West Branch confluence to Brookside Park, the creek has been relocated and channelized with concrete beds. Other than this 1.6 miles of channelization and the culverted portions, the creek's substrate is predominately natural.

The creek's drainage area is largely residential and commercial but also includes significant portions of land used for industrial and recreational purposes. Big Creek's main stem and West Branch have been designated Limited Warmwater Habitat by the Ohio EPA. The East Branch has been designated Warmwater Habitat.

SAMPLING

Big Creek has 6 locations for chemical, bacteriological, and benthic sampling and analysis. (Figure 16).

Stream Monitoring Program Sample Site #25 is located on the main stem downstream of Jennings Road and approximately 900 feet upstream of the confluence with the Cuyahoga River. This section's substrate consists of large rocks, pieces of concrete, and miscellaneous debris. The stream bed is about 20 feet wide with many riffles present. This section of the creek is located in an industrial area of the city.

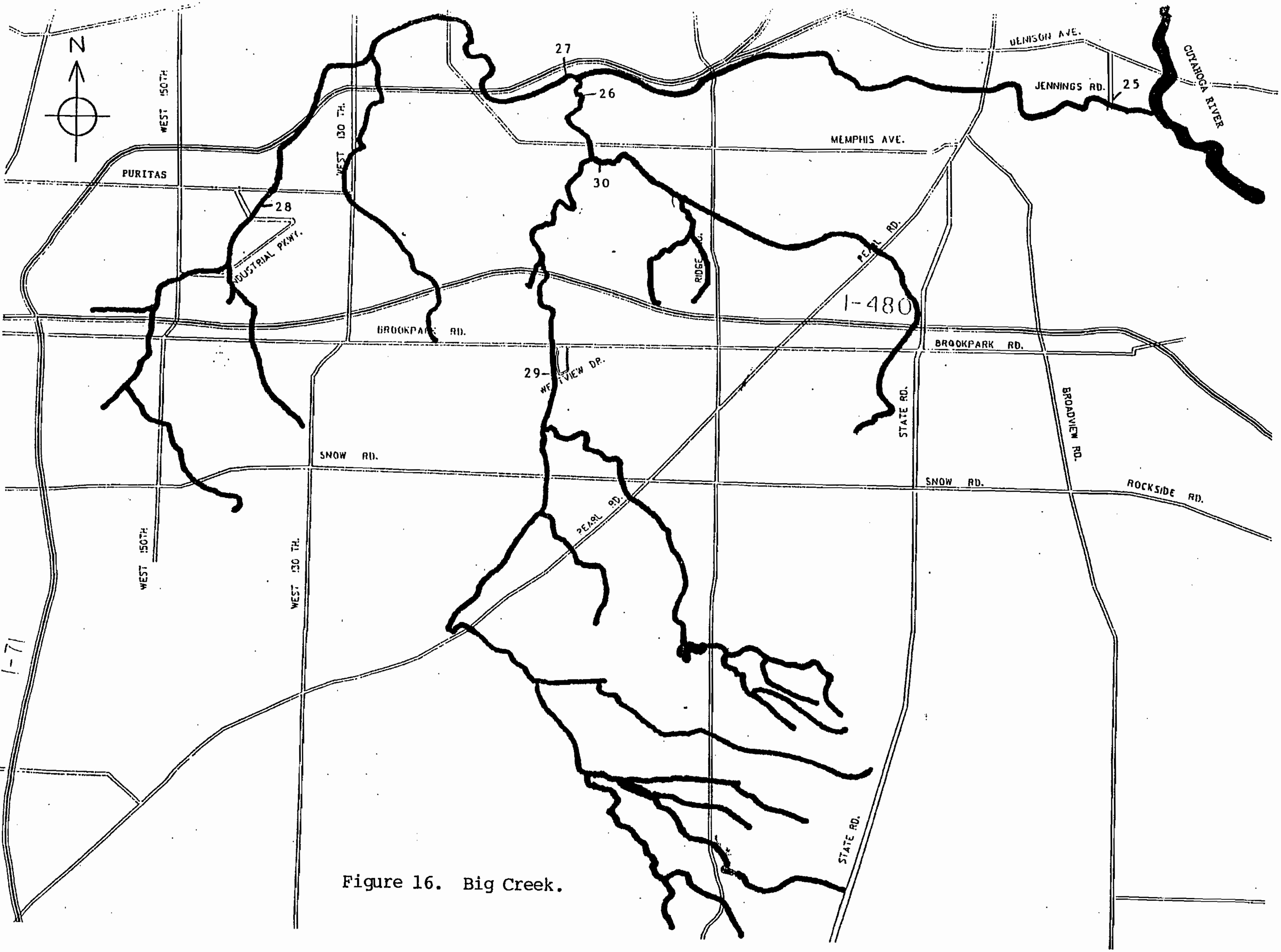


Figure 16. Big Creek.

Three grab samples for chemical and bacteriological analyses were obtained at Site #25 in 1988. (Appendix II-E). On all three occasions, the fecal coliform concentrations were lower than they were at this site in 1987. Nevertheless, they all exceeded the Primary Contact Recreational Use Designation limit. The average fecal coliform/fecal streptococcus ratio was significantly higher in 1988, indicating that the bacterial contamination was of human origin. This may suggest that the Cleveland Metroparks Zoo, which was believed to be a factor in 1987, ceased to be so in 1988 - at least, during the sampling periods.

All other parameters tested for at Site #25 were within the Limited Warmwater Habitat Criteria with the exception of mercury, which only slightly exceeded the limit of 0.2 micrograms per liter on one occasion (August 10, 1988). All chemical data were comparable to 1987 data.

Qualitative sampling for benthic macroinvertebrates was performed at Site #25 on June 21, 1988. (Appendix III-J). Five taxa were identified, which is equal to the number identified at this site in 1987. As was the case in the previous year, most of the taxa identified can be tolerant of heavy organic pollution. The only facultative organism found at this site in 1987, Dugesia tigrina, was not found at this site in 1988. These results indicate that relatively serious organic pollution of Big Creek's main stem occurred in 1988. Future studies should reflect improvements made in water quality upstream during 1988 and the reasons for this are discussed later in this report.

Sample Site #27 is located on the West Branch of Big Creek approximately 100 feet upstream of the confluence with the East Branch. It is in a portion of the Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road. The stream is 22 feet wide and the banks are surrounded by trees and much vegetation. Early in 1988, this section of the creek was obviously grossly polluted with sanitary sewage. The water had a gray tint and the substrate, when disturbed, was black in color and had a septic odor. Large rocks in the substrate were coated with slime. However, later in the year, after remediation upstream had occurred, a significant improvement in the water's appearance was noted. Though some septic sediment remained, the water was relatively clear and free from sanitary debris.

Three grab samples for chemical and bacteriological analyses were obtained at Site #27 in 1988. (Appendix II-E). On June 20, 1988, the fecal coliform concentration was 1,800,000 counts per 100 mL, greatly exceeding the Primary Contact Recreational Use Designation Limit. However, the next two samples obtained at this site (on August 10, 1988 and September 28, 1988) had fecal coliform concentrations within the Primary Contact Standards and as low as 940 counts per 100 mL on the latter date, reflecting the upstream remediation.

This dramatic improvement in water quality at Site #29 was evident in other parameters as well. Dissolved oxygen increased from 1.9 parts per million (below the Limited Warmwater Habitat minimum standard) on June 20th to 9.3 parts per million on September 28th. Ammonia concentrations decreased from 6.39 mg/L (above the LWWH limit) to less than detectable. Phosphorus concentrations decreased from 2.04 mg/L to 0.26 mg/L. Iron concentrations decreased from 3.2 mg/L (above the LWWH limit) to 0.4 mg/L. The only chemical parameters which continued to have levels higher than the water quality standards were copper and mercury, which only slightly exceeded their respective limits of 8.0 and 0.2 micrograms per liter. Provided that disruptions do not recur, the trends toward improved water quality should continue as residual contamination is gradually flushed from the West Branch of Big Creek.

Qualitative sampling for benthic macroinvertebrates at Site #27 was performed on June 21, 1988, prior to the completion of remedial measures. (Appendix III-L). The only organisms that were found were oligochaetes, which are highly tolerant of severe organic pollution. Future sampling should reflect the improvement in water quality through a corresponding increase in benthic diversity.

Sample Site #28 is located on the West Branch immediately upstream of the beginning of the "double-barrel" culvert south of Puritas Avenue. The stream at this point passes through a flat marshland with high grass. Near the culvert, it has concrete beds which are covered with sand and a dense growth of green algae. The stream bed is approximately 10 feet wide, and flow measurements under dry weather conditions in 1987 indicated a rate of 0.5 MGD.

Three grab samples for chemical and bacteriological analysis were collected at Site #28 in 1988. (Appendix II-E). As was the case in 1987, all chemical data was within Water Quality Standards for Limited Warmwater Habitat with the exception of copper, which slightly exceeded the limit of less than 9.0 micrograms per liter on September 28, 1988. The chemical data showed no significant changes from 1987 to 1988.

Very high concentrations of dissolved oxygen (17.1 parts per million on August 10th) were noted at Site #28. The supersaturation may be attributed to photosynthesis by the large amount of periphytic green algae exposed to direct sunlight in the creek at this location.

Bacteriological data at Site #28 in 1988 were all lower than in the previous year. Fecal coliform concentrations were all within Primary Contact Recreational Use Designation standards and on one occasion (September 28th) as low as 60 counts per 100 mL.

Qualitative sampling for benthic macroinvertebrates at Site #28 in 1988 produced only five taxa. (Appendix III-M). Most of the taxa identified can be tolerant of organic pollution. Similar results had been obtained at this site in 1987, although three taxa (Erpobdellidae, *Bithynia* sp., and *Ischnura* sp.), which had been found the previous year, were not found in 1988. This difference between the years may be insignificant due to the sampling error factor. More significant is the lack of benthic diversity in light of the apparent lack of bacterial or chemical contamination when compared to other sample sites. The previous annual report offered periodic contamination by human waste, for which evidence was found in 1987, as an explanation for the relative lack of benthic diversity. Another probable factor is that the concrete beds of the channelized stream at this location may not be as conducive to benthic habitation as substrates at other locations. A third explanation could be that a contaminant not chemically analyzed for may be impacting the benthic community.

Sample Site #26 is located on the East Branch of Big Creek approximately 100 feet upstream of its confluence with the West Branch. As is the case with Sample Site #27, this section of the creek passes through a portion of the Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road. The banks are surrounded by trees and many large rocks are scattered along the banks in the creek. The substrate is composed of sand, pebbles, and rocks coated with green and brown algae. The stream width at this point is about 22 feet.

Three grab samples for chemical and bacteriological analysis were collected at Site #26 in 1988. (Appendix II-F). All chemical data were within the Water Quality Criteria for Warmwater Habitat with the sole exception of copper on one occasion (September 28th), when it slightly exceeded the limit of less than 9.0 micrograms per liter. No significant differences in the chemical data at this location were noted when compared to the data from the previous year.

Bacteriological data at Site #26 in 1988 was below Primary Contact Recreational Use Designation Standards during the first two samplings. However, on September 28th, the fecal coliform concentration of 44,000 counts per 100 mL exceeded the limits. Apparently, periodic contamination by sanitary sewage under dry weather conditions continues to occur on this portion of Big Creek's East Branch, as was noted during the 1987 samplings. The specific cause for the September 28th event is not known.

Qualitative sampling for benthic macroinvertebrates at Site #26 in 1988 produced 12 taxa, most of which are usually described as tolerant or facultative in their response to organic pollution. (Appendix III-K). As in the previous year, more benthic taxa were identified at Site #26 than at any other sample site on Big Creek. Yet, no organisms exclusively described as intolerant of organic pollution were found at this site or at any other location on Big Creek.

Sample Site #29 is located upstream on the East Branch of Big Creek at the Fern Hill Picnic Area in the Metroparks Big Creek Reservation, south of Brookpark Road. Overhanging trees and relatively sparse vegetation surround the creek, which is 30 feet wide at this location. The substrate consists of shale, rocks, logs, and mostly natural debris with riffles and some pooled areas. The flow under dry weather conditions was measured to be 6.5 MGD in 1987. Dense green and a brown algae cover the substrate.

Three grab samples for chemical and bacteriological analysis were obtained at Sample Site #29 in 1988. (Appendix II-F). With exceptions of copper on two occasions and iron on one occasion, which slightly exceeded their respective Water Quality Standards for Warmwater Habitat, all chemical data at this site were within the standards. For the most part, the chemical

Figure 17. Big Creek East Branch at Sample Site #26.

data were comparable to those of the previous year.

Bacteriological data at Site #29 in 1988 showed that fecal coliform concentrations exceeded Primary Contact Recreational Use Standards on all three sampling occasions. The probable cause for these exceedences is the continuous sanitary sewer dry weather overflow at Snow Road, which is less than one mile upstream of this sample site and is discussed later in this report.

Qualitative sampling for benthic macroinvertebrates performed at Sample Site #29 in 1988 produced 11 taxa. (Appendix III-N). Of these, most are usually described as facultative in their responses to organic pollution. Similar numbers had been obtained in the benthic sampling at this site in 1987. As had been the case that year, both sample sites on the East Branch apparently continue to have higher water quality than does the West Branch, but the data indicate the presence of significant organic pollution nevertheless.

Sample Site #30 is located on Stickney Creek about 100 feet upstream of its confluence with the East Branch of Big Creek south of Memphis Avenue. The creek is surrounded by many overhanging trees and thick vegetation. The stream's substrate consists of solid flat shale with a few shale pieces and sand. This section has many riffles and some pooled areas. Some periphytic green algae was noted. Measurements performed in 1987 indicated a dry weather flow of about 0.6 MGD from Stickney Creek.

Three grab samples for chemical and bacteriological analyses were collected at Sample Site #30 in 1988. (Appendix II-F). Copper concentrations on two occasions slightly exceeded the Water Quality Standards for Warmwater Habitat, and iron on one occasion (June 20th) exceeded its standard. Otherwise, all chemical parameters tested for were lower than the standards.

Bacteriological data at Site #30 showed fecal coliform in excess of Primary Contact Recreational Use Designation limits on all three sampling occasions. Fecal coliform/fecal streptococcus ratios on two of the three occasions were considerably greater than 4.1, indicating this bacterial contamination is primarily of human origin. Further investigation to isolate the sources of this organic pollution in Stickney Creek is warranted.

Qualitative sampling for benthic macroinvertebrates was performed at Sample Site #30 on June 20, 1988. (Appendix III-O). Only five taxa were identified at this site. These results are similar to those obtained at this location in 1987. In addition to the apparent organic pollution, the relatively small number of taxa may also be due to the unsuitable nature of the shale substrate for many benthic organisms. Furthermore, intermittent high solids loadings from the construction of Interstate 480 and the Southwest Interceptor upstream may have also been factors, and these are discussed later in this report.

PROBLEMS AND REMEDIATION

Historically, the single most significant source of pollution on Big Creek had been occurring at Cooley Avenue in Cleveland. A 24-inch sanitary sewer north of Bellaire Road and Kensington Avenue was blocked and the flow was severely restricted. The sanitary sewage had been backing up the pipe to the overflow structure at Cooley Avenue, where it had been entering the West Branch at a rate of 0.4 MGD in dry weather conditions. Bacteriological analyses of this influent to the creek had indicated fecal coliform concentrations as high as 3,400,000 counts per 100 mL. Daily BOD and suspended solids loadings were calculated to be 410 pounds and 417 pounds respectively. This situation resulted in severely degraded conditions downstream in Big Creek. Evidence of this is the fact that, although minnows have been noted at several locations on the East Branch, no fish have been observed by the Stream Monitoring Program in the West Branch or main stem of Big Creek.

In April 1988, City of Cleveland sewer maintenance crews began removing debris from the 24-inch sanitary sewer west of the Crestmont Apartments on Bosworth Road. An inspection by NEORSD investigators revealed on May 18, 1988 that surcharge conditions continued to exist in the 24-inch sanitary sewer and the overflow of sanitary sewage to the creek at Cooley Avenue was continuing to occur. On July 1, 1988, City of Cleveland crews jackhammered a hole on the 24-inch sanitary sewer. This relieved the back-up of flow and permitted the crew access to the sewer to remove the blockage.

Inspections on July 13th and July 18th revealed that the sewer system in the vicinity of Cooley Avenue to Bellaire Road had been repaired, was operating as designed, and was no longer responsible for dry weather pollution of Big Creek's West Branch. These conditions prevailed into November 1988. Chemical and bacteriological analyses of samples obtained downstream at Sample Site #27 on August 10th and September 28th reflected a dramatic increase in the water quality of the West Branch.

However, on November 23, 1988, a routine inspection by a NEORSD Sewer Control Systems crew revealed that the dry weather overflow of sanitary sewage was recurring at Cooley Avenue. NEORSD investigators identified the apparent cause as a partial blockage of the 24-inch sanitary sewer north of Bellaire Avenue. The City of Cleveland Division of Water Pollution Control was notified immediately and had the sewer "completely cleared" of obstruction by November 30, 1988. Subsequent inspections by NEORSD investigators on December 7, 1988, January 3, 1989, and January 12, 1989 have indicated that the problem has been corrected and the dry weather overflow of sanitary sewage at Cooley Avenue has been eliminated. However, due to the recurring nature of the problem, continued frequent monitoring of this section of Big Creek is warranted.

On October 19, 1988, a puddle appearing to be contaminated by sanitary sewage was found less than ten feet north of a raised manhole located in the Big Creek West Branch ravine directly west of 3704 Bosworth Road. The source of the sewage was probably an underground rupture in the 24-inch sanitary sewer alongside the creek. While the quantity of flow entering the creek from the puddle was yet only minimal as of the end of 1988, further erosion could potentially result in significant contamination of the creek. Therefore, further close monitoring of this location is warranted. This problem has also been reported to City of Cleveland officials.

Provided that the two previously discussed problems continue to have a negligible detrimental effect on the water quality of the West Branch of Big Creek, the only remaining significant contributor of dry weather sanitary sewage to the West Branch is the "double-barrel" culvert between Puritas Avenue and West 130th Street in Cleveland. The culvert is divided by a median wall, and Big Creek West Branch flows through the southeast side of the culvert. The northwest side of the culvert collects combined sewer overflows which travel to the perpendicular weir at West 130th Street, where the sewage flows through a sanitary outlet to the Big Creek Interceptor. Sampling in 1987 showed that the fecal coliform concentration in the creek upstream of this "double-barrel" culvert (at Puritas Avenue) was only 100 counts per 100 mL, while, at the same time, the fecal coliform concentration downstream in the creek side of the culvert (at West 130th Street) was 140,000 counts per 100 mL. Fluorescent dye injected into the sanitary sewage side of the culvert at Puritas Avenue appeared in the creek side of the culvert at West 130th Street, verifying that at some point between these two locations, sanitary sewage is crossing the dividing wall. In 1988, the NEORSD Stream Monitoring Program was aware of no remediation to correct this situation. A question of ownership and responsibility remains.

Upstream of the "double-barrel" culvert at Puritas Avenue, the West Branch of Big Creek showed no conclusive signs of chemical or bacteriological pollution. Although the industrial nature of the tributary area and the presence of Interstate 71 and 480 could account for numerous non-point sources of pollution, the grassy marsh, through which the West Branch flows upstream of Puritas Avenue, may be acting as a retention basin. The Ohio Department of Natural Resources (1988) identified retention basins and "grass swales" as effective methods of removal of pollutants from non-point sources.

On the East Branch of Big Creek, the most serious dry weather source of pollution continues to be the sanitary sewage overflow under Snow Road at the border between Parma and Parma Heights. (Figure 18). According to measurements, sewage is entering the creek through a pipe from the west at a constant rate of approximately 180,000 gallons per day under dry weather conditions. Fecal coliform concentrations in this influent to the creek have been as high as 6,400,000 counts per 100 mL. Daily BOD and suspended solids loadings were calculated to be 134 pounds and 108 pounds respectively.

Further investigation is required to identify the specific cause of the overflow under Snow Road, and the NEORSD Stream Monitoring Program has plans to focus its efforts on this problem in early 1989. City of Parma, Parma Heights, and Cuyahoga County officials have been made aware of the problem.

On January 28, 1988, the NEORSD received a report from the Ohio Environmental Protection Agency of a white substance in Stickney Creek north of Traymore Avenue in Brooklyn. NEORSD investigators found the creek, at the

Figure 18. Dry-weather influent of raw sewage to Big Creek under Snow Road.

opening of the culvert north of Traymore Avenue, to contain a high concentration of very fine white solids. The source was identified as the 3-foot-by-4 foot culvert northbound under West 47th Street from south of Wetzel Avenue to north of Oak Park Avenue. Since Stickney Creek had been diverted from this culvert by the Interstate 480 construction, the only remaining source of flow during dry weather was ground water pumped from the Southwest Interceptor construction shaft at Wetzel Avenue and Pearl Road. A sample obtained from the discharge of the pump indicated high concentrations of COD (992 mg/L), suspended solids (10,300 mg/L), chlorides (1630 mg/L), and alkalinity (1160 mg/L). The NEORSD Engineering Department was notified, and subsequent inspections indicated that this problem had ceased.

A similar problem was reported in Stickney Creek near the intersection of Interstate 480 and State Road on August 29, 1988. NEORSD investigators found flow with a high solids concentration entering Stickney Creek northeast of Interstate 480 and State Road from a 24-inch storm sewer under the highway. The substance in the water was later identified as uncured slag used as the base for the Interstate's construction. The high concentration was attributed to flushing by sudden heavy rainfall following a long period of drought during the summer of 1988.

Solids concentrations in the East Branch of Big Creek may have been also periodically increased during 1988 by yet another major construction project. Northeast of Brookpark Road and Tiedeman Road in Brooklyn, a heavily wooded area of land surrounding the creek was completely cleared of vegetation for the construction of the Makro wholesale outlet building and adjacent parking lots. According to the Ohio Environmental Protection Agency (1983), such construction activity has a greater impact per area on the environment than any other land use, by contributing higher volumes of sediment per acre through erosional run-off than any other nonpoint source of pollution.

On May 31, 1988, NEORSD investigators identified an industrial source of pollution in Big Creek. Dye tests showed that sanitary and process wastewaters from Karyall-Telday, Inc., 8221 Clinton Road, which has an iron phosphate metal-finishing operation, were tributary to a storm sewer draining into Big Creek. The Ohio EPA was notified, and on November 12, 1988, rerouting of all of this company's wastewater to the sanitary sewer was complete. Subsequent dye tests by NEORSD investigators verified that this source of contamination in Big Creek has been eliminated.

Finally, on the main stem of Big Creek, a significant dry weather source of pollution by sanitary sewage was discovered on July 5, 1988 by NEORSD investigators. A small tributary to Big Creek, entering the main stem east of Jennings Road, and known as "Treadway Creek," was found to be heavily contaminated with sanitary sewage. The contamination was traced to a raised manhole located in the middle of Treadway Creek, southwest of the intersection of Jennings Road and Crestline Avenue. The manhole was missing its cover and was spewing sewage into the creek, apparently due to a blockage in the underground sanitary sewer downstream. The City of Cleveland Division of Water Pollution Control was then notified. A follow-up inspection by NEORSD investigators on August 9, 1988 revealed that the manhole collar had been replaced and the cover had been concreted down. Sanitary sewage was no longer overflowing to Treadway Creek, and this source of pollution of Big Creek had been eliminated.

MILL CREEK

Mill Creek drains southeastern Cleveland and the suburbs along the southeastern border of Cleveland. It has a total drainage area of 18.10 square miles and a total length of 9.0 miles, according to Havens & Emerson (1968). Mill Creek originates in the vicinity of Warrensville Township, flows southwest through Warrensville Heights and a small section of Cleveland to near Broadway Avenue in Maple Heights, along which it flows northwest through Garfield Heights into Cleveland and then south along the border of Cuyahoga Heights and Garfield Heights to the Cuyahoga River at River Mile 11.9.

Almost the entire creek is open, with the only significant culverted sections being short segments of the creek upstream of Garfield Park, under Interstate 480, and downstream of the Kerruish Park detention basin. Except for the concrete beds in the culverts, the creek's substrate is predominately natural.

Mill Creek's drainage area is mostly residential and industrial. The Ohio E.P.A. has classified Mill Creek from its mouth to near Granger Road as "Limited Warmwater Habitat" and upstream of this point as "Warmwater Habitat."

In July 1988, during a severe drought, flow measurements of Mill Creek were obtained at Canal Road, approximately 200 yards upstream of its confluence with the Cuyahoga River. On ten occasions, instantaneous measurements were obtained using latitudinal cross-sectional areas and average velocities. The results indicated that the flow at this location, which represents the entire flow entering the Cuyahoga River from Mill Creek, averaged 3.0 million gallons per day when no significant precipitation had occurred in the area for at least 24 hours prior to the measurements.

SAMPLING

Mill Creek has 6 locations for chemical, bacteriological, and benthic sampling and analysis. (Figure 19).

Sample Site #31 is located on Mill Creek, approximately 600 feet upstream of the confluence with the Cuyahoga River, between Canal Road and the Ohio Canal. The creek is about 25 feet wide at this point and the substrate consists of mud, rocks, and miscellaneous rubble. Dense vegetation with overhanging trees surrounds the creek. The water appeared slightly turbid. The water depth was about 8 inches in dry weather, and the accumulation of septic sediment was noted.

Only one grab sample for chemical and bacteriological analyses was obtained at Site #31 in 1988. (Appendix II-G). The fecal coliform concentration was considerably lower (7200 counts per 100 mL) than it had been the previous year (300,000 counts per 100 mL). This enormous decrease in bacterial contamination is probably most attributable to the two following

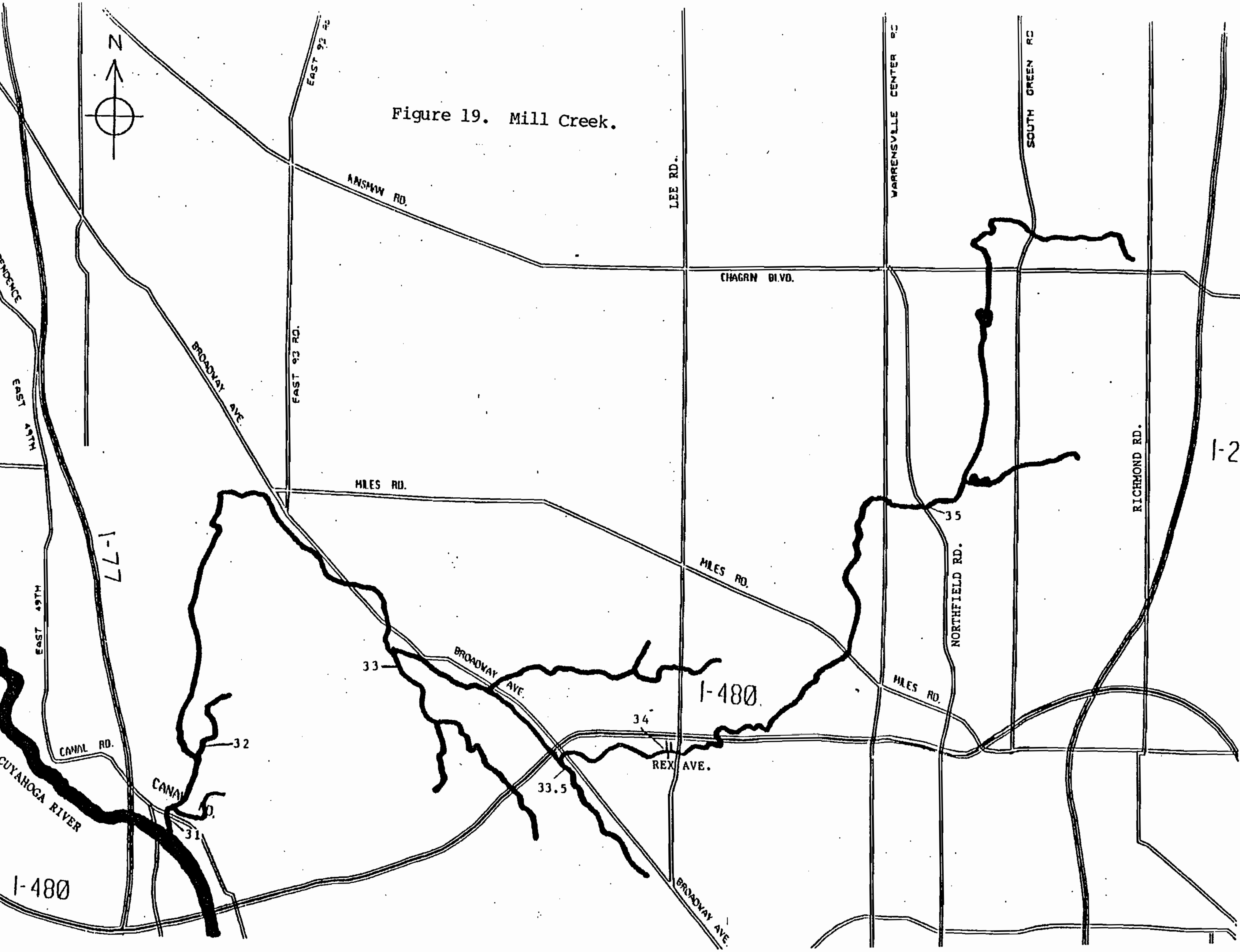


Figure 19. Mill Creek.

factors: the repair of the Mill Creek Interceptor rupture south of Longbrook Road, which was completed after the 1987 sampling; the cessation of the sanitary sewer overflow at Vista Park, which occurred prior to the 1988 sampling. Nevertheless, the fecal coliform concentration at Site #31 continued to exceed the Primary Contact Recreational Use Designation limit in 1988, probably due to the fact that the sanitary sewage overflow behind Mapletown Shopping Center had not yet been eliminated on June 8th. Future sampling for bacteriological parameters should reflect further water quality improvements. All of the above-mentioned factors are discussed later in this report.

Chemical analyses of the water at Sample Site #31 revealed that all of parameters tested for were within Water Quality Standards for Limited Warmwater Habitat. This is also an improvement over the previous year's results and may also be attributed to the factors mentioned above.

Qualitative sampling for benthic macroinvertebrates at Site #31 was performed on June 21, 1988. (Appendix III-P). The results were identical to those obtained in 1987 with one exception: Planariidae, which are facultative in their response to pollution, were found at Site #31 only in 1988. All other benthic taxa collected at this location, in both years, can be tolerant of heavy organic pollution. The difference could reflect the improvement in water quality discussed above. Future sampling of benthos is expected to reflect further improvement at Site #31.

Sample Site #32 is located on a small tributary to Mill Creek from the northeast which is culverted underneath Warner Road. It enters the creek less than one half mile upstream of Mill Creek's confluence with the Cuyahoga River. This tributary is about 10 feet wide and the substrate consisted of small rocks, gravel, silt, and septic sediment. The water depth was approximately 2 inches at Site #32, and flow velocity was minimal during the drought conditions of the summer of 1988. The creek in this vicinity is surrounded by moderate vegetation with some tree cover.

Grab samples for chemical and bacteriological parameters were obtained at Site #32, which is just west of Warner Road, on June 8 and July 6, 1988. (Appendix II-G). Although the fecal coliform concentration (5000 counts per 100 ml) continued to exceed the Primary Contact Recreational Use Designation limit, it was considerably lower than the 1987 concentration of 340,000 counts per 100 ml. This significant reduction in bacterial contamination is probably due to the fact that, because of the drought conditions, the overflow of sanitary sewage to the tributary at Vista Park in Garfield Heights, which had been a problem in 1987, was no longer occurring. This situation is to be discussed later in this report.

Chemical analysis at Site #32 showed that pH and the total dissolved solids concentration both exceeded the Limited Warmwater Habitat Water Quality Standards. A heavy accumulation of light green silt was noted at the site. This may be attributable to run-off from the Independence Excavating, Inc. concrete recycling plant at 4905 Warner Road, through which the creek's tributary flows, upstream of the sample site. The lead concentration also slightly exceeded its Water Quality Standard. However, the relatively high concentration of mercury (0.4 micrograms per liter) found in 1987 was not repeated at Site #32 in 1988.

Qualitative sampling for benthic macroinvertebrates at Site #32 produced only oligochaetes and chironomids, both of which can be highly tolerant of pollution by organic waste and low-oxygen conditions. (Appendix III-Q). In fact, the measured dissolved oxygen at this site on July 7th was only 0.9 parts per million, which is well below the Water Quality Standard minimum concentration. Similar results had been obtained in 1987. Fortunately, due to the drought of the summer of 1988, the flow in this tributary was minimal and therefore, its impact on the main stem of Mill Creek must have been negligible.

Sample Site #33 is located on the "Wolf Creek" tributary to Mill Creek in the Cleveland Metroparks Garfield Park Reservation, approximately 100 feet upstream of its confluence with Mill Creek. This tributary is about 12 feet in width at the sample site, with a depth of about 4 inches in dry weather. The substrate consists of mud, sand, and small rocks, and the creek has riffles and pools. The rocks were covered with green algae. Slight, grassy slopes surround the creek and there was no tree overhang at this point.

Chemical analyses of a grab sample obtained from Site #33 on June 8, 1988 (Appendix II-G) showed no exceedences of Water Quality Standards for Limited Warmwater Habitat. This had also been the case during the previous year's sampling.

Bacteriological analyses of a grab sample obtained at Site #33 on July 6, 1988 indicated that the fecal coliform concentration slightly exceeded the Primary Contact Recreational Use Designation limit. Similar results had been obtained in 1987. The fecal coliform/fecal streptococcus ratio was 5.6 in 1988, indicating that the bacterial contamination was of human origin.

Qualitative sampling for benthic macroinvertebrates at Site #33 (Appendices III-R, III-S) also produced results similar to those obtained in the previous year. Eight taxa were collected on Wolf Creek in 1988 and are described in literature as being facultative and tolerant in their responses to organic pollution. The 1988 chemical, bacteriological, and benthic data, like the 1987 data, all indicate that, although not severely polluted, Wolf Creek continues to exhibit some contamination by sanitary sewage. Periodic overflows from sewers on surrounding streets in Garfield Heights and storm sewers which may be contaminated by cross connections have been thought to be at least partially responsible for this pollution of the creek.

In addition to the six previously specified sampling locations on Mill Creek, samples were also obtained in 1988 from two lagoons south of Calvary Cemetery, off Broadway Avenue in Garfield Heights. Inspection by NEORSD investigators indicated that a small, mostly-culverted stream, which flows toward Mill Creek from south of the lagoons, is the only apparent outlet from either of the two lagoons.

Magnesium dross is submersed in the northernmost lagoon by Garfield Alloys, Inc., 4878 Chaincraft Rd., as part of their industrial operation.

Chemical concentrations in the northernmost lagoon significantly exceeded concentrations in the southernmost lagoon for several parameters, including pH, magnesium, hardness, chlorides, specific conductance, and dissolved solids, all of which may be attributable to the submersion of magnesium dross. pH on one occasion was measured on-site at the northernmost lagoon to be as high as 10.3 Standard Units.

The northernmost lagoon was also sampled qualitatively for benthic macroinvertebrates, but no organisms were found, suggesting that this lagoon's biota has been severely impacted. By contrast, qualitative sampling in the southernmost lagoon produced the following benthic organisms: <u>Libellula</u> sp.; <u>Pantala</u> sp.; <u>Macromia</u> sp.; <u>Lymnaea</u> sp.; <u>Physella</u> sp.; <u>Lestes</u> sp.; <u>Berosus</u> sp.; and Chironomidae. Several of these taxa can be described as facultative in their responses to organic pollution.

Chemical analyses of the small stream south of the lagoons (IWS Sample No. 1571-8) showed a greater similarity to that of the southernmost lagoon (IWS Sample No. 1570-8) than to that of the northernmost lagoon (IWS Sample No. 1569-8). However, when compared to Water Quality Standards for Limited Warmwater Habitat, the concentrations of zinc (0.27 mg/L), cadmium (0.06 mg/L), and iron (1.20 mg/L) in the stream exceeded the standard levels. These concentrations, along with the presence of cyanide (0.30 mg/L) in the stream, may be attributable to a wastewater discharge by Erieview Metal Treating Co., 4465 Johnston Parkway. In June, 1987, the sanitary sewer downstream of this company had been found to be ruptured, and its contents were entering a stream which is tributary to the southernmost lagoon. Chemical analyses of the electroplating wastewater entering the stream northwest of East 147th Street and Sunview Avenue had extremely high concentrations of cyanide (19.0 mg/L), chromium (60.0 mg/L), zinc (90.0 mg/L), cadmium (65.0 mg/L), and iron (84.5 mg/L). Although the sewer has been repaired, some residual contamination of downstream water bodies probably remains and may be responsible for the elevated levels found in 1988 at the small stream south of the two lagoons.

Sample Site #33.5 is located on a tributary to Mill Creek known as the "Mapletown Branch," which flows in a northwestern direction parallel to Broadway Avenue in Maple Heights. The sample site is about thirty feet upstream of this tributary's confluence with Mill Creek, south of Interstate 480 at Broadway Avenue. At the time of sampling, in June and July 1988, the tributary was obviously grossly polluted with sanitary sewage for reasons discussed in detail later in this report. The overflow of sanitary sewage behind Mapletown Shopping Center had not yet been eliminated, and the substrate, composed of slime-coated rocks, sand and sludge, was colored black from septic conditions. Overhanging trees and thick vegetation surround this tributary of Mill Creek throughout its length.

Chemical analyses of a grab sample at Site #33.5 (Appendix II-G) produced concentrations of zinc (1.60 mg/L) and lead (0.04 mg/L), which exceeded the Water Quality Standards for Limited Warmwater Habitat. While the lead concentration only slightly exceeded its standard of 0.03 mg/L, the zinc concentration is significant and may be attributable to an industrial discharge in the sanitary sewage overflows to be discussed later. Also, indicative of the pollution by sanitary sewage at Site #33.5 was the dissolved oxygen concentration of 1.4 parts per million on July 6, 1988, which was well below the Water Quality Standard minimum allowable concentration.

Bacteriological analysis of Site #33.5 on July 6, 1988 produced a fecal coliform concentration of 310,000 counts per 100 ml, further demonstrating the severity of pollution on the "Mapletown Branch" prior to the remediation upstream later in 1988. This concentration greatly exceeded the Primary Contact Recreational Use Designation limit for fecal coliform.

Finally, qualitative sampling for benthic macroinvertebrates at Site #33.5 on June 17, 1988 produced no organisms. Future sampling at this location should reflect a vast improvement in water quality resulting from the upstream remediation.

Sample Site #34 is located on Mill Creek at Rex Avenue and Glenburn Avenue in Maple Heights. The creek at this point was about 18 feet wide and about 5 inches deep during dry weather. It is surrounded by thick vegetation with partially overhanging trees. The substrate consisted of mud, sand and large rocks. At the time of sampling for chemical parameters, on June 8, 1988, considerable visual evidence of contamination by sanitary sewage was noted at the site, including septic sediment and heavy algae growth on the rocks. A source of sanitary sewage was found at Lee Road, immediately upstream of Site #34. This problem and its remediation, which occurred on June 14th, are discussed in detail later in this report.

Chemical analysis of the grab sample obtained at Sample Site #34 in 1988 (Appendix II-H) showed that concentrations of copper, zinc, and lead exceeded the Water Quality Standards for Warmwater Habitat. As was the case at Site #33.5, the lead concentration (and the copper concentration) only slightly exceeded its standard, while the zinc concentration appeared to be more significant. However, unlike at Site #33.5, this location has no immediately identifiable possible source of metals contamination. Whether the zinc concentration is to be considered a problem or an analytical anomaly can only be revealed by future sampling. All other 1988 chemical data at Site #34 were comparable to those of the previous year and within Water Quality Standards.

Bacteriological sampling at Site #34 was performed on July 7, 1988, after the remediation of the problem at Lee Road. While the fecal coliform concentration of 3300 counts per 100 mL exceeds the Primary Contact Recreational Use Designation limit, it is considerably less than the March 1987 fecal coliform concentration of 130,000 counts per 100 ml. This improvement is mostly attributable to the repair of the Mill Creek Interceptor rupture under Mill Creek south of Longbrook Rd., which had been accomplished by September 1987.

Qualitative sampling for benthic macroinvertebrates at Sample Site #34 on June 17, 1988 produced four taxa, all of which can be highly tolerant of pollution by sanitary sewage. (Appendix III-T). Although this is two more taxa than were found at this site in 1987, the low benthic diversity probably reflects the continuing detrimental impact of several upstream problems described in this report and the 1987 Stream Monitoring Program Report, especially the sanitary sewage influent at Lee Road, which was less than 100 yards upstream. Hopefully, future sampling at Site #34 will reflect the remediation of many of these problems.

Sample Site #35 is located on Mill Creek about 100 feet upstream of Northfield Road in Warrensville Township. The creek at this point was about 15 feet wide and averaged about 2 inches deep during dry weather. The substrate consisted primarily of small rocks and sand. The creek was surrounded by dense vegetation and many overhanging trees. The appearance of the water was less turbid at Site #35 than at any of the other Mill Creek sample sites. This is also the only sample site on Mill Creek where minnows have been noted during sampling.

Chemical analysis of the grab sample obtained at Sample Site #35 in 1988 (Appendix II-H) showed that concentrations of copper, lead, and zinc exceeded the Water Quality Standards for Warmwater Habitat. However, as was true at Site #34, the copper and lead exceedances were only slight, while the zinc concentration appeared to be more significant though it is unexplained. Again, only further sampling may be able to demonstrate whether this data indicated a problem or should be considered an analytical anomaly. All other 1988 chemical data at Site #35 were comparable to those of the previous year and were within Water Quality Standards.

Bacteriological analysis of the water at Sample Site #35 in 1988 showed that the fecal coliform concentration of 4200 counts per 100 ml exceeded the Primary Contact Recreational Use Designation standard. This concentration was considerably higher than the fecal coliform concentration of 100 counts per 100 ml at Site #35 in 1987. However, the 1988 fecal coliform/fecal streptococcus ratio was less than 1.0, indicating that this bacterial contamination may have been primarily of non-human origin. Further investigation may identify possible sources of the bacteria at Site #35.

Qualitative sampling for benthic macroinvertebrates in 1988 at Site #35 produced only five taxa, suggesting that some factor may be impacting water quality. (Appendix III-U). Similar results had been obtained by benthic sampling at this site in 1987.

PROBLEMS AND REMEDIATION

During the 1987 survey of Mill Creek, the stream's water quality had been found to be severely degraded, primarily by two major dry weather sources of sanitary sewage: the Mill Creek Interceptor rupture underneath Mill Creek south of Longbrook Road in Warrensville Heights; and a dry weather sanitary sanitary sewage overflow to the "Mapletown Branch" of Mill Creek occurring west of Mapletown Shopping Center in Maple Heights. The total daily BOD and Suspended Solids loadings from these two sources were calculated to be 3287 pounds and 3065 pounds respectively.

After Cuyahoga County officials were notified, contractors replaced 600 feet of the Mill Creek Interceptor, eliminating this source of sanitary sewage contamination in the creek by September 1987. (Figure 20). At that time, the most significant remaining dry weather source of pollution on Mill

Figure 20. Site of the repaired Mill Creek Interceptor rupture south of Longbrook Road.

Creek was the problem behind Mapletown Shopping Center. (Figure 21). The flow of sewage entering the creek from this source had been measured to be approximately 1.8 million gallons per day, and fecal coliform concentrations in this influent had been as high as 7,100,000 counts per 100 ml. A gate in a "regulator chamber" on a 24-inch sanitary sewer at the intersection of Maple Heights Boulevard and Broadway Avenue had been removed, resulting in the overflow of sanitary sewage to a 90-inch storm sewer tributary to the creek. These conditions are believed to have existed for at least 12 years prior to this NEORSD investigation. During the drought of the summer of 1988, numerous complaints were received from citizens about the degraded condition of Mill Creek downstream. The drought conditions had minimized the dilutive effect of rainwater, and consequently, Mill Creek, including the section through Garfield Park, was dominated by untreated sanitary sewage.

On September 8, 1988, representatives from the Ohio EPA and the NEORSD met with Mr. Ken Tyrpak, Maple Heights City Engineer, and Mr. Frank Novak, Maple Heights Service Director. At this meeting, Mr. Tyrpak proposed that a concrete wall be constructed at the "regulator chamber" to prevent dry weather overflow of sanitary sewage from entering the 90-inch storm sewer. The Ohio EPA required that the construction necessary to eliminate the dry weather overflow of sanitary sewage at this location be completed by the end of the following week.

On September 19, 1988, NEORSD investigators inspected the "regulator chamber" and found that the concrete wall had been completed and was functioning as designed. However, a dye test of the 24-inch sanitary sewer showed that sewage was entering a 72-inch storm sewer further downstream on Broadway Avenue through breaks in the 24-inch sewer. Consequently, despite the wall construction at the "regulator chamber," a significant amount of sanitary sewage continued to enter Mill Creek, but through the 72-inch storm sewer, which was also tributary to the creek west of Mapletown Shopping Center. Both the City of Maple Heights and the Ohio EPA were then informed of this new development.

On September 20, 1988, a representative of the City of Maple Heights reported that leaks in the 24-inch sanitary sewer on Broadway Avenue had been located. Repair of this sewer was commenced on September 26th, and inspection by NEORSD investigators on September 29th indicated that the repair was complete. Additionally, according to City of Maple Heights officials, considerable amounts of debris, which had been restricting the flow downstream in the 24-inch sewer on Broadway Avenue, were removed. A dye test was performed on the 24-inch sewer by NEORSD investigators, and the results indicated that the dry weather overflow of sanitary sewage from this sewer to Mill Creek has been eliminated.

Subsequent inspections of the "Mapletown Branch" in 1988 have revealed that the sewer system in the vicinity of Mapletown Shopping Center has been functioning as designed. However, dry-weather sanitary sewage continues to be tributary to this branch of Mill Creek through a storm sewer outfall west of the intersection of Home Avenue and Garden Street in Maple Heights. (Figure 22). This sewage contains the discharges of industrial facilities, including 92,000 gallons per day of process wastewater from the Metal Processing

Figure 21. Influent of raw sewage to Mill Creek west of Mapletown Shopping Center.

Figure 22. Influent of raw sewage to Mill Creek west of Home Avenue and Garden Street.

Corporation, 5800 Sterling Avenue, which is a steel pickling/zinc phosphating operation. According to officials, the City of Maple Heights is planning to spend 13 million dollars over the next ten years on projects to repair and improve the sewer system in this vicinity. Hopefully, these projects will be successful in redirecting to the Southerly Wastewater Treatment Plant sewage which is presently tributary to Mill Creek. Future sampling on the "Mapletown Branch" at Sample Site #33.5 should reflect the improvements in water quality resulting from the remediation in the vicinity of Mapletown Shopping Center and any further remediation, which is planned for the vicinity of Home Avenue and Garden Street.

Also in Maple Heights, NEORSD investigators discovered, on June 9, 1988, sanitary sewage entering Mill Creek under Lee Road at a rate of approximately 30,000 gallons per day, according to flow measurements. The sewage was traced back to Raymond Street, between Theodore Street and Anthony Street, where sanitary sewage was leaking into a storm sewer, due to a blockage in the sanitary sewer at this point. The City of Maple Heights Service Department was notified of this problem and, on June 14th, had a maintenance crew at the site. Subsequent inspections by NEORSD investigators revealed that the Raymond Street sanitary sewer was unblocked and this source of pollution in Mill Creek has been eliminated.

On July 6, 1988, NEORSD investigators, responding to a resident's complaint, discovered the underground rupture of an 8-inch sanitary sewer between Mill Creek and the intersection of Mayfair Lane and Eastwood Lane in Warrensville Heights. This was a recurrence of a rupture found at the same location on March 24, 1987 by NEORSD investigators. At that time, the problem was reported to Cuyahoga County officials and was subsequently repaired. Cuyahoga County sanitary engineers were notified of the recurrence on July 6, 1988 and responded on the following day. An inspection by NEORSD investigators on August 12th revealed that the necessary repairs had been completed and sanitary sewage was no longer tributary to Mill Creek from this location. The recurring nature of this problem warrants future inspections at this site.

In the 1987 Stream Monitoring Program Report, further investigation was cited as necessary to determine the cause of severe degradation of the Warner Road tributary to Mill Creek at Sample Site #32. On June 10, 1988, the source of pollution of this location by sanitary sewage was identified as an overflow structure at Vista Park, east of Warner Road, in Garfield Heights. At a pair of manholes located by the park's entrance road off Warner Road is an overflow chamber with a sidespill weir. The sanitary outlet of this chamber was partially blocked with debris, raising the level of sanitary sewage to the point where it had been overflowing the weir wall and entering a culverted section of the Warner Road tributary to Mill Creek.

The City of Garfield Heights Service Department was made aware of the nature of this problem on June 14, 1988. Subsequent inspections revealed, however, that, probably due to the drought conditions of summer 1987, this sewage overflow had temporarily ceased. Nevertheless, the partial blockage by debris of the sanitary sewage outlet remained, and the sewage level was always very near to the top of the weir wall. Any significant increase of flow in the sewer or further debris accumulation in the sanitary outlet would result in a resumed overflow. Therefore, continued monitoring of this location is warranted.

Also discussed in the 1987 Stream Monitoring Program Report was a source of untreated sanitary sewage west of Bancroft Avenue in Garfield Heights, where residences' sewers were inappropriately connected to a storm sewer. Sanitary sewage pooled at the storm sewer outlet at this point, and the pool's effluent flowed westward across the Harvard Refuse Landfill to Mill Creek. Although this situation continued through 1988, the City of Garfield Heights has informed the Northeast Ohio Regional Sewer District that a "pressure sewer system" redirecting the sanitary sewage to the Southerly Treatment Plant is to be completed by April 1, 1989.

On August 26, 1988, NEORSD investigators responded to a report by construction workers at 18090 Miles Avenue of unusual colors in a small tributary to Mill Creek by the construction site. The investigators found a black substance entering the creek through a storm sewer on Miles Avenue. The most probable source of this contamination was identified as Sobel Corrugated Container, Inc., 18612 Miles Avenue, which uses inks in its printing operation. These findings were reported to the Ohio EPA. Subsequently, an inspector from the Cuyahoga County Board of Health determined that Sobel's adhesive mixing room floor drain, to which printing machine wastewater had been tributary, was connected to the storm sewer. On September 12th, the company had the printing machine washwater repiped to a sewer in its boiler room. A dye test by NEORSD investigators at the boiler room sewer verified that it is now tributary to the sanitary sewer and this source of industrial wastewater to the storm sewer has been eliminated.

Finally, another source of industrial wastewater to Mill Creek continued to be a problem in 1988. During the initial survey of Mill Creek by the Stream Monitoring Program in March 1987, investigators discovered an unlicensed direct discharge to the creek between Miles Avenue and South Miles Road from the Empire Die Casting Company, 19800 Miles Avenue. The discharge was reported to the Ohio EPA, who sent an investigator to inspect the facility on April 7, 1987. As a result of this inspection, the Empire Die Casting Company was required by the Ohio EPA to either acquire a N.P.D.E.S. permit for the direct discharge or to have it eliminated from the environment. A compliance deadline of September 1, 1987 was set. However, as of the date of this report, all subsequent inspections by NEORSD investigators have revealed that this discharge to Mill Creek continues unabated. Although the discharge flows through an underground oil separator, which now appears to be more properly maintained than it had been prior to 1987, all soluble contaminants continue to pass through the separator to the creek. For example, concentrations of phenolics tributary to the creek have been determined through NEORSD sampling to be 6,600 micrograms per liter. If Mill Creek is to continue to show water quality improvements, improper discharges such as this one by the Empire Die Casting Company must be eliminated.

WEST CREEK

West Creek drains the eastern section of Parma and portions of Seven Hills, Brooklyn Heights, and Independence. It has an approximate drainage area of 20 square miles and a total length of approximately 8 miles. West Creek has two branches: the "Main" Branch, which originates in Parma just south of the intersection of Broadview Road and Pleasant Valley Road and flows north through the eastern section of Parma, then east through Seven Hills, Brooklyn Heights and Independence; a smaller branch, originating in Independence north of the Chestnut Road and Oakwood Drive intersection, and joining the Main Branch through a culvert under Interstate 480, west of the Interstate 77 interchange. From this confluence, West Creek flows north to the Cuyahoga River at RM 11.4.

West Creek's total flow was measured near Sample Site #36, about 200 feet upstream of the confluence with the river, during dry weather in July 1988 and was found to average approximately 3.0 MGD.

Most of West Creek is open and its substrate is predominately natural. Along Interstate 480, the Main Branch has a short section of channelization with concrete beds and sidewalls.

West Creek's drainage area is largely residential. The creek has been classified by the Ohio EPA as a "Warmwater Habitat."

SAMPLING

West Creek has been assigned three locations for chemical, bacteriological, and benthic sampling. (Figure 23).

Stream Monitoring Program Sample Site #36 is located on the Main Stem of West Creek under the Granger Road bridge, between Interstate 77 and Valley Belt Road, approximately 1000 feet upstream of the confluence with the Cuyahoga River. This location's substrate consists primarily of bedrock and rubble, and the stream is about 30 feet wide.

Chemical data from Site #36 in 1988 (Appendix II-I) indicated that all parameters, were within the Water Quality Standards for Warmwater Habitat. Noted during the sampling of May 4, 1988 was a relatively high chlorides concentration of 280 mg/L. 1988 mercury concentrations did not exceed 0.2 ug/L, and the 1987 mercury concentration of 36 ug/L at this site remains unexplained.

Bacteriological data from Site #36 in 1988 (Appendix II-I) showed that the fecal coliform concentrations, at 180 and 250 counts per 100 ml, were again well within the allowable limits for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates at Site #36 in

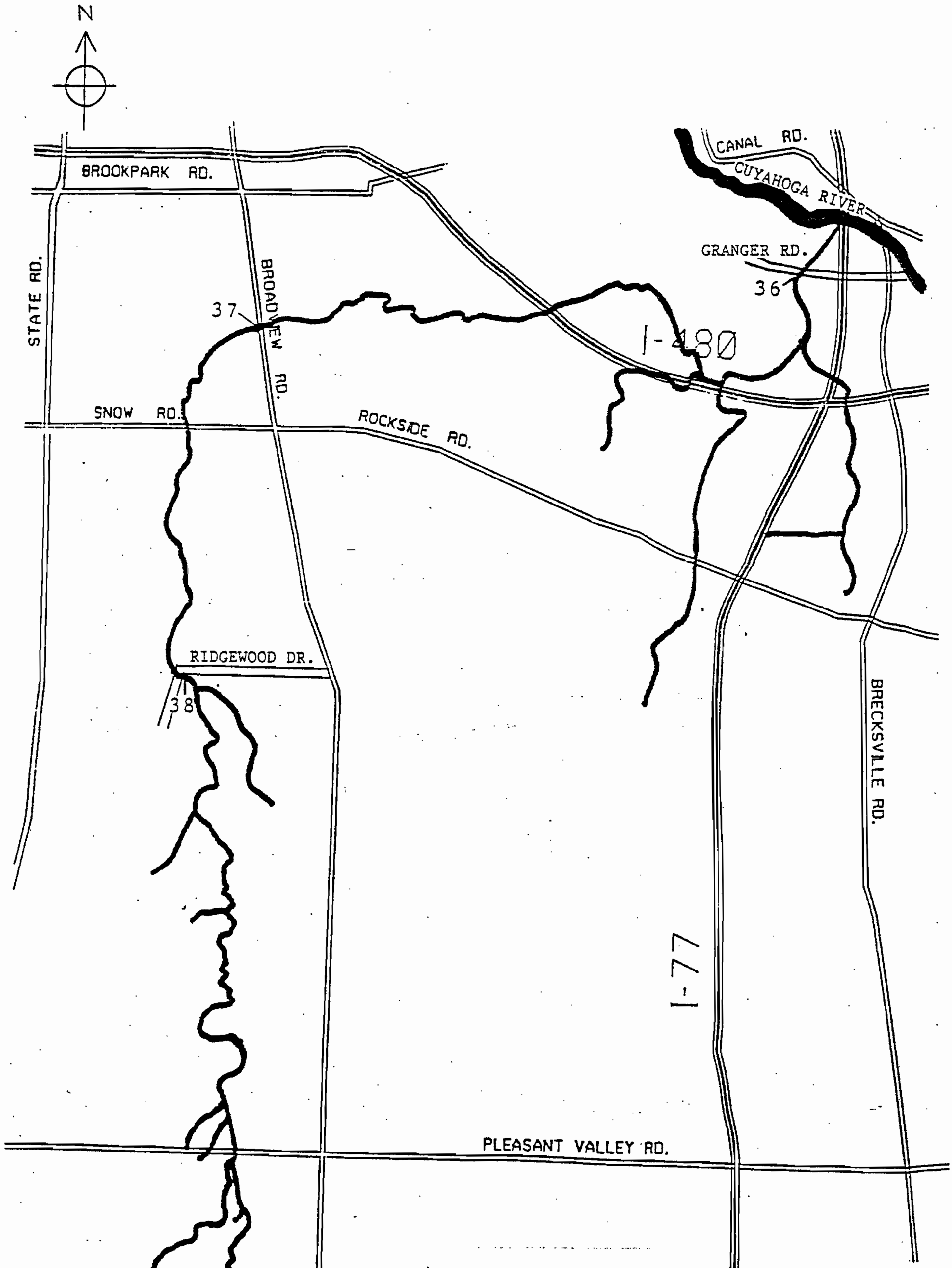


Figure 23. West Creek.

1988 produced nine taxa. (Appendix III-V). All of the data indicates that West Creek, at its furthest downstream sampling location, was relatively free from contamination by sanitary sewage in dry weather. Differences between the 1987 and 1988 benthic data could possibly be due to a slight change in sampling location to a point further downstream, which has a more conducive substrate.

Sample Site #37 is located on the Main Branch of West Creek under the Broadview Road bridge, between Brookdale Avenue and Sandpiper Drive in Parma. The substrate at this location consists of boulders, bedrock, and rubble. At the downstream end of the sample site is a very shallow section with a concrete bottom and a width of about 20 feet. The section under the bridge had many deep pools. Approximately 50 feet upstream is a City water leak (discovered during the 1987 NEORSD survey), which continues to discharge to the creek at a measured rate of 73 gallons per minute.

Chemical data from Site #37 in 1988 (Appendix II-I) indicated that all parameters, as in 1987, were within the Water Quality Standards for Warmwater Habitat. Noted during the sampling of May 4, 1988, was a high chlorides concentration (266 ug/L). Similar chlorides results were obtained at all the West Creek sampling locations on this date.

Bacteriological data from Site #37 in 1988 (Appendix II-I) showed that, as was the case in 1987, fecal coliform concentrations were well within the limits for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates at Site #37 in 1988 produced eleven taxa. (Appendix III-W). Comparable results had been obtained at this site during the previous year. All of the data from Site #37 indicated that this part of West Creek was also relatively free from contamination by sanitary sewage in dry weather.

Sample Site #38 is located on the Main Branch of West Creek just upstream of the West Ridgewood Drive bridge, west of Post Road, in Parma. The site is in a residential area, with steep slopes and lawns on one bank and dense vegetation with many trees on the other bank. The substrate consists of rubble, gravel, and silt, with poured concrete for erosion prevention. The creek's width at Site #38 is about 12 feet. Many minnows have been noted in West Creek at this location.

Chemical data from Site #38 in 1988 (Appendix II-I) indicated that all parameters, as in the previous year, were within the Water Quality Standards for Warmwater Habitat.

Bacteriological data from Site #38 in 1988 (Appendix II-I) showed that, as in 1987, fecal coliform concentrations were well within the limits for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates at Site #38 in 1988 produced eight taxa. (Appendix III-X). Comparable results had been obtained at this site in 1987 and at the other West Creek locations in 1988. All of the data from Site #37, as from all of the West Creek sample sites, indicated that West Creek was relatively free from contamination by sanitary sewage in dry weather.

PROBLEMS AND REMEDIATION

On July 18, 1988, NEORSD investigators responded to a report from the Ohio EPA of sanitary sewage in a small tributary to West Creek, east of 5245 West 10th Street. Sewage was found entering the creek from a storm sewer outfall at this location. A measurement indicated that the flow rate was 17 gallons per minute under dry weather conditions. Bacteriological analysis of this discharge produced a total coliform concentration of 540,000 counts per 100 ml, a fecal coliform concentration of 44,000 counts per 100 ml, and a fecal streptococcus concentration of 67,000 counts per 100 ml. The fecal coliform/fecal streptococcus ratio suggests that this sewage includes waste of non-human origin.

The immediate source of this environmental contamination was identified as an eastbound storm sewer on Brookview Road in Parma. No significant flow of sewage was found in the storm sewer on Brookview Blvd. west of Broadview Rd. Therefore, the sewage must have been flowing from either the north or the south on Broadview Road. The City of Parma Engineering Department was notified of this situation on October 10, 1988. As of the date of this report, the NEORSD has no indication that any action has been taken toward the alleviation of this problem.

Finally, the "City water leak" to West Creek west of Broadview Road, which was discussed in the NEORSD's Stream Monitoring 1987 Report, continued to occur throughout 1988 at a calculated rate of 105,000 gallons per day. The City of Cleveland Water Department has been notified a second time and assures the NEORSD that this situation will be investigated as soon as possible. Until the source is eliminated, this discharge will continue to have a dilutive impact on data obtained at Sample Site #37.

TINKERS CREEK

Tinkers Creek's tributary area includes: Solon; Glenwillow Township; Oakwood; Bedford Heights; Bedford (including the Metroparks Bedford Reservation); Walton Hills (including the Cuyahoga Valley National Recreation Area); Valley View; Twinsburg; Twinsburg Township; Reminderville; Aurora (including Aurora Lake and Tinkers Creek State Park); Streetsboro; Hudson (including Hudson Spring Lake). Tinkers Creek enters the Cuyahoga River south of Riverview Road and Canal Road at about RM 17.0.

According to NEORSD flow measurements upstream of Tinkers Creek's confluence with the river, which were obtained during the extreme dry weather conditions of the drought of the summer of 1988, the creek discharged a minimum of 14.9 MGD.

The Tinkers Creek drainage area is primarily agricultural, recreational, and residential. The Ohio EPA has designated Tinkers Creek as a Warmwater Habitat. Much wildlife, including frogs, salamanders, snakes, turtles, kingfishers, ducks, geese, great blue herons, beavers, and numerous fishes, has been noted during the NEORSD monitoring of this creek.

SAMPLING

Tinkers Creek has been assigned four locations by the Stream Monitoring Program for chemical, bacteriological, and benthic sampling and analysis. (Figure 24).

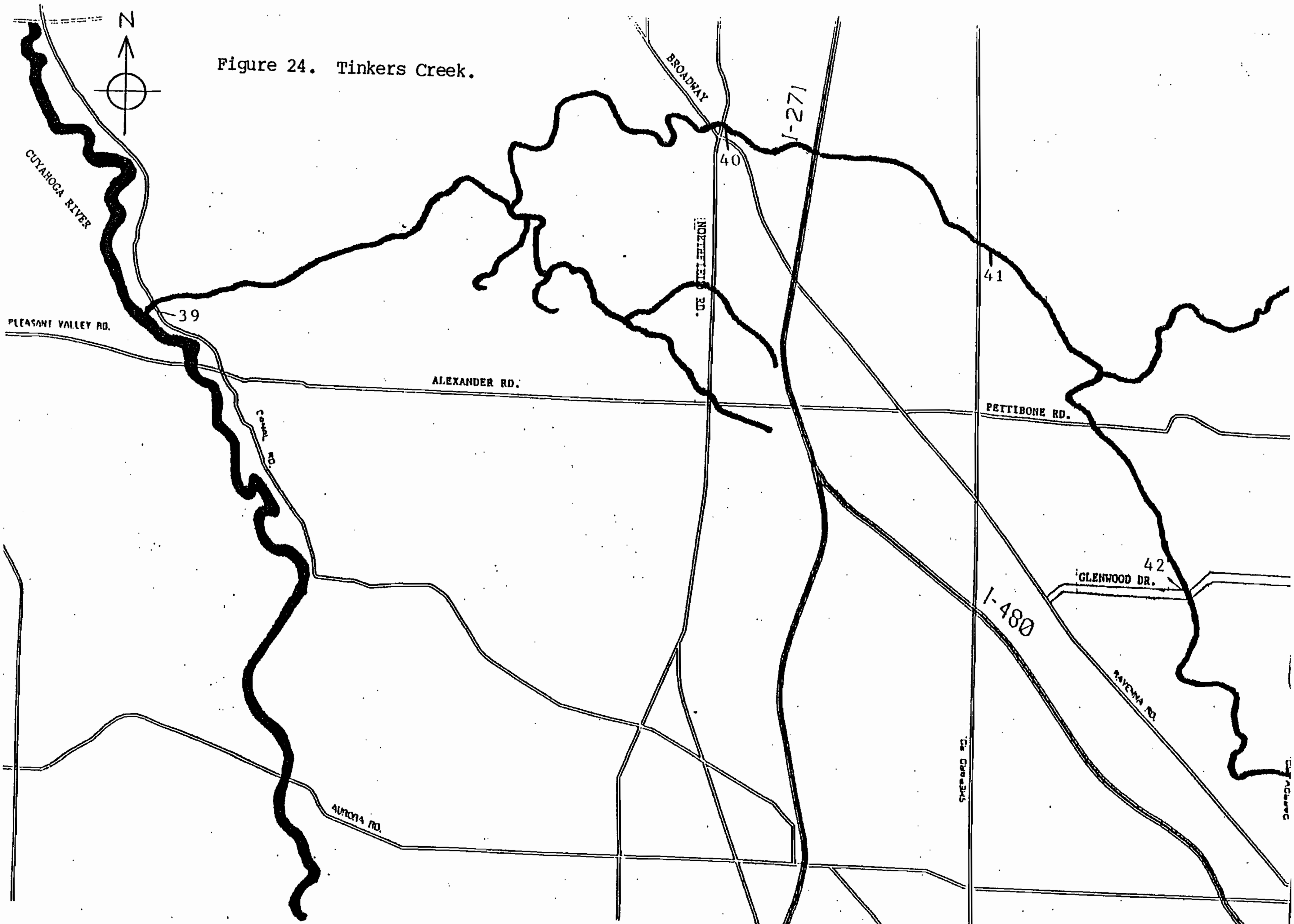
Sample Site #39 is located approximately 500 feet upstream of Tinkers Creek's confluence with the Cuyahoga River, south of the intersection of Canal Road and Tinkers Creek Road. Sampling is performed at the west face of the Ohio Canal, where it is channeled over the creek. The width of the creek in this section varies from 33 feet to 65 feet. The substrate consists primarily of silt, sand, and small rocks. The stream's banks are steep and about 10 feet high, with surrounding vegetation and some tree overhang.

Chemical analyses of samples obtained at Site #39 in 1988 (Appendix II-J) indicated that all parameters were within Water Quality Standards for Warmwater Habitat, with the exception of lead, which on one occasion (April 19th) slightly exceeded its standard. All other chemical data from Site #39 in 1988 were comparable to those obtained at this site during the previous year.

Bacteriological analyses of the samples from Site #39 in 1988 indicated that the fecal coliform concentrations were well within the standard for Primary Contact Recreational Use. These concentrations were also comparable to the data from 1987.

Qualitative sampling for benthic macroinvertebrates produced eight

Figure 24. Tinkers Creek.



taxa at Site #39. (Appendix III-Y). A higher diversity of organisms had been collected at this location during the previous year. Nevertheless, most of the data from 1988 indicated that Tinkers Creek at Site #39 was relatively unpolluted by sanitary sewage.

Sample Site #40 is located in Tinkers Creek underneath the Northfield Road bridge, off the Bedford Parkway near Broadway Avenue. The width of the creek at this point is approximately 50 feet. The substrate consists of bedrock, boulders, rubble, sand, and silt. Dense vegetation, including some tree overhang, surrounds the creek.

Chemical analyses of samples obtained at Site #40 in 1988 (Appendix II-J) indicated that all parameters were within Water Quality Standards for Warmwater Habitat, with the exceptions of lead and iron, which slightly exceeded the standards on one occasion each. All other chemical data from Site #40 in 1988 were comparable to those obtained at this site during the previous year.

Bacteriological data obtained from Site #40 in 1988 showed that fecal coliform concentrations slightly exceeded the standard for Primary Contact Recreational Use on one occasion, April 19th. Fecal coliform/fecal streptococcus ratios indicated that the bacterial contamination at this site was of human origin. On one occasion in 1987, extremely high concentrations of coliform bacteria had been found at Site #40. Otherwise, the 1987 bacteriological data had been very similar to the data obtained at this location in 1988.

Qualitative sampling for benthic macroinvertebrates at Site #40 produced ten taxa in 1988. (Appendix III-Z). Fewer total taxa with a higher proportion of tolerant organisms were found at this site than had been found here in 1987. This data may reflect a decrease in water quality in Tinkers Creek at this location. Future sampling will show whether this apparent trend continues.

Sample Site #41 is located east of Richmond Road, south of the Bedford Chagrin Parkway, behind the service garage at Inland Refuse Transfer, Inc., 6705 Richmond Road. The width of the creek at this point is approximately 35 to 40 feet. The substrate consists of boulders, rubble, sand, and silt. The banks are about 6 feet high and steep, with some vegetation and some tree overhang. There is a parking lot on the east side of the creek.

Chemical analyses of samples obtained at Site #41 in 1988 (Appendix II-J) indicated that all parameters were within Water Quality Standards for Warmwater Habitat with the exception of iron on one occasion (June 13th). But for one occasion in 1987, when the water at Site #41 had contained evidence of significant contamination by sanitary sewage, all 1988 chemical data at this location were comparable to those of the previous year.

Bacteriological data obtained from Site #41 in 1988 showed that fecal coliform concentrations were within standards for Primary Contact Recreational Use. By contrast, the bacteriological data from this site had exceeded the standards on two of three occasions in 1987. Many septic tank effluents noted

Figure 25. Tinkers Creek at Bedford Glens.

in the vicinity of this location had been possible sources of this past contamination of Tinkers Creek.

Qualitative sampling for benthic macroinvertebrates in 1988 at Site #41 produced ten taxa, including Stenacron interpunctatum, which is described in literature as intolerant in its response to organic pollution. (Appendix III-AA). Additionally, decapods were observed, though not collected, in the stream at Site #41. These findings, especially the presence of an intolerant organism, suggest that water quality of Tinkers Creek at this location was relatively good in 1988.

Sample Site #42 is located at the northeast face of the Glenwood Drive bridge over Tinkers Creek, between Idlewood Drive and Gary Drive in Twinsburg. The creek at this point is 33 to 42 feet in width. The substrate consists of rubble, clay, and small rocks covered with algae. The creek is surrounded with vegetation and has some tree overhang.

Chemical analyses of samples obtained at Site #42 in 1988 (Appendix II-J) indicated that all parameters were within Water Quality Standards for Warmwater Habitat with the exception of iron, which slightly exceeded its standard on one occasion (June 13th). Zinc concentrations in 1988 were considerably lower than they had been at this site in 1987. Otherwise, all chemical data at Site #42 in 1988 were comparable to those of the previous year.

Bacteriological data obtained from Site #42 in 1988 showed that fecal coliform concentrations were well within standards for Primary Contact Recreational Use. By contrast, the 1987 bacteriological data from this site had exceeded the standards on all three sampling occasions. Apparently, a significant decrease in bacterial contamination from sanitary sewage occurred in this section of Tinkers Creek during dry weather in 1988.

Qualitative sampling for benthic macroinvertebrates in 1988 at Site #42 produced ten taxa. (Appendix III-B). Fewer total taxa were found at the site than had been found in the previous year, and no intolerant organisms were identified in 1988 at Site #42. Nevertheless, most of the data from Site #42 indicates that, generally, this section of Tinkers Creek is relatively unpolluted by sanitary sewage.

Additionally, the City of Solon has submitted monthly to the NEORSD results of analyses of Tinkers Creek upstream and downstream of the Beaver Meadow Run confluence with Tinkers Creek. The Solon Central Wastewater Treatment Plant, 6951 Cochran Road, discharges its effluent to Beaver Meadow Run, which enters Tinkers Creek upstream of NEORSD Sample Site #41. The parameters reported include temperature, dissolved oxygen, BOD, pH, total non-filterable residue, fecal coliform, ammonia, cyanide, hardness, hexavalent chromium, trivalent chromium, total chromium, cadmium, copper, lead, nickel, zinc, and mercury. All of the 1988 chemical data reported by the City of Solon were within Water Quality Standards for Warmwater Habitat. The 1988 bacteriological data showed that fecal coliform concentrations exceeded Primary Contact Recreational Use Designation limits both upstream and downstream on May 16th and October 3rd. The 1988 reported data shows an improvement over the data reported by the City of Solon for 1987, when fecal coliform concentrations exceeded applicable standards on three occasions and hexavalent chromium concentrations were frequently in excess of applicable standards. These data are on file at at the NEORSD Industrial Waste Section offices.

PROBLEMS AND REMEDIATION

The NEORSD's construction of the Cuyahoga Valley Interceptor has allowed the elimination of many direct discharges to Tinkers Creek. Significant sources among these were the Walton Hills Wastewater Treatment Plant and several major industries in the Krick Road Industrial Park, which had been tributary to Tinkers Creek at the Lost Meadow Picnic Area in the Bedford Reservation via Deer Lick Run.

Continuing possible environmental problems include leachate from several landfills along Tinkers Creek.

In 1987, NEORSD investigators had identified sources of oily substances in Tinkers Creek as two pipes from the property of Inland Refuse Transfer, Inc., 6705 Richmond Road. This problem was reported to the Ohio EPA, representatives from which performed an inspection of the company's facility on April 6, 1988. The inspection revealed that oil, grease, truck washwater, and sanitary wastes were tributary to Tinkers Creek through a leach bed and from garage drains. As a result, the Ohio EPA required that Inland Refuse Transfer, Inc. connect sewers to the sanitary sewer system and/or install holding tanks to remove these flows from the creek.

Finally, the NEORSD received a report of a 500-gallon oil spill by the Ford Motor Company Walton Hills Plant, tributary to Tinkers Creek, on October 12, 1988. Response to this incident and clean-up measures were conducted by the Ohio EPA.

CHIPPEWA CREEK

Chippewa Creek's drainage area includes the communities and parks in the southernmost part of Cuyahoga County west of the Cuyahoga River. From the creek's mouth upstream, these include: part of the Cuyahoga Valley National Recreation Area; all of the Metroparks Brecksville Reservation; the City of Brecksville; the City of Broadview Heights; the southern tip of Seven Hills; the eastern portion of North Royalton.

Flow measurements by NEORSD investigators at Sample Site #43, the furthest downstream monitoring location, indicated that, during the severe drought of Summer 1988, Chippewa Creek had a minimum dry-weather total flow of 1.1 MGD.

Chippewa Creek's drainage area is primarily residential and recreational. It has been designated as a Warmwater Habitat by the Ohio EPA.

SAMPLING

Chippewa Creek has been assigned three locations for chemical, bacteriological, and benthic sampling and analysis (Figure 26).

Sample Site #43 is located at a concrete ford on which Chippewa Creek Drive crosses the creek east of Valley Parkway. This location is approximately 3000 feet upstream of the confluence with the Cuyahoga River at about RM 22.0, and it represents the total flow of Chippewa Creek. The stream is about 10 feet wide and the substrate consists of boulders, gravel, and sand, with riffles. It is surrounded by dense vegetation and much tree overhang.

With the minor exceptions of cadmium, which slightly exceeded its standard on April 27th, and copper, which slightly exceeded its standard on June 14th, all 1988 chemical data from Site #43 (Appendix II-K) were within Water Quality Standards for Warmwater Habitat. The chemical data at this location was generally comparable or slightly lower than in 1987, with the exception of the chlorides concentration in February 1988, which was extremely high (421 mg/L) and probably attributable to roadsalt run-off from snowmelt.

Bacteriological data from Site #43 in 1988 (Appendix II-K) indicated that all fecal coliform concentrations were well within the standards for Primary Contact Recreational Use and were generally comparable or slightly lower than the 1987 bacteriological data. Decreases in bacterial concentrations could be attributable to the wastewater treatment plant and septic tank abandonment discussed later in this report.

Qualitative sampling for benthic macroinvertebrates at Site #43 in 1988 produced nine taxa, including one ephemeropteran (<u>Isonychia</u> sp.) which is described in literature as intolerant in its response to organic pollution.

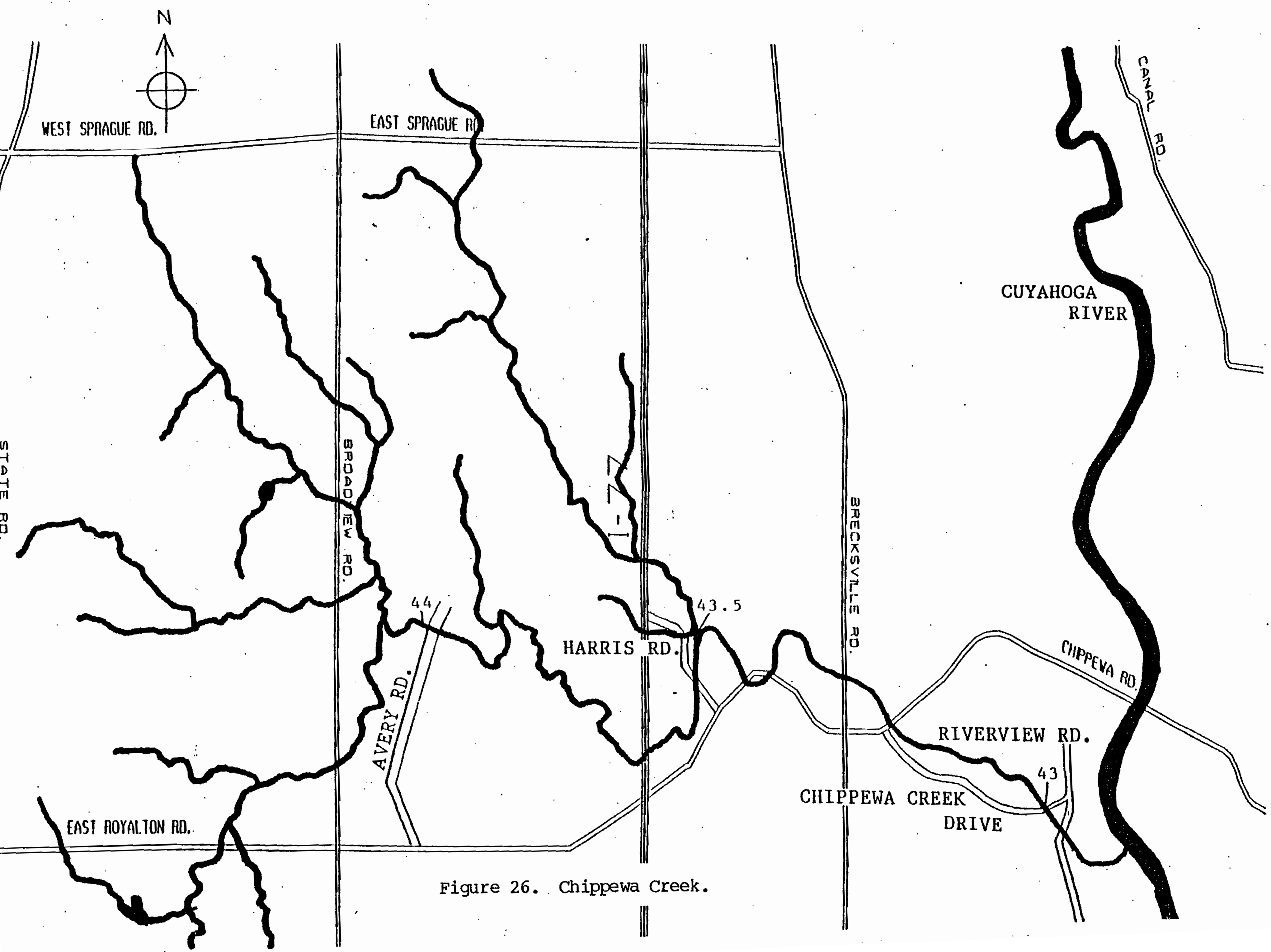


Figure 26. Chippewa Creek.

(Appendix III-CC). Comparable results had been obtained in 1987, reflecting relatively good water quality in Chippewa Creek at this location.

Sample Site #43.5 is located on the "Bramblewood Branch" tributary to Chippewa Creek, just upstream of its confluence with the main stem of Chippewa Creek, east of Harris Road, north of Old Royalton Road. The stream is about 10 feet wide and the substrate consists of boulders, bedrock, sand, and silt, with riffles. It is surrounded by steep banks, dense vegetation and overhanging trees.

All 1988 chemical data from Site #43.5 (Appendix II-K) were within Water Quality Standards for Warmwater Habitat and were comparable to those of the previous year. Chlorides concentrations were relatively high (261 mg/L) in February 1988, and they are probably attributable to roadsalt run-off in snowmelt.

Bacteriological data from Site #43.5 in 1988 (Appendix II-K) showed that all fecal coliform concentrations were well within the standards for Primary Contact Recreational Use. Similar results had been obtained at this site in 1987.

Qualitative sampling for benthic macroinvertebrates at Site #43.5 in 1988 produced nine taxa. (Appendix III-DD). Though no intolerant taxa were found, as had been the case in 1987, the data, in general, continued to be indicative of water relatively unpolluted by sanitary sewage.

Sample Site #44 is located on the main stem of Chippewa Creek Road bridge between Harris Road and East Royalton Road. It is just downstream of the confluences of the Seneca Branch, the Royalwood Branch, and the Briarwood Branch. The stream at Site #44 is 10 to 20 feet wide and the substrate consists of bedrock, boulders, gravel, sand, and silt. It is surrounded by dense vegetation with much tree overhang.

With the single minor exception of cadmium, which slightly exceeded its standard on April 27th, all chemical data (Appendix II-K) were within Water Quality Standards for Warmwater Habitat at Site #44 in 1988. The chlorides concentration was high (280 mg/L) in February and, again, was probably attributable to roadsalt run-off in snowmelt. The 1988 chemical data were comparable to those obtained at this location in 1987.

Bacteriological data from Site #44 in 1988 (Appendix II-K) showed that all fecal coliform concentrations were within the standards for Primary Contact Recreational Use, although they were higher than the concentrations downstream on Chippewa Creek at Site #43. Except for the extremely high bacterial concentrations which had been obtained at Site #44 on October 13, 1987, the bacteriological data from Site #44 in 1987 and 1988 are comparable. Differences in data may be attributable to the elimination of upstream wastewater treatment plants and septic tanks discussed later in this report.

Qualitative sampling for benthic macroinvertebrates at Site #44 in 1988 produced eight taxa, once again reflecting fairly good water quality. (Appendix III-EE).

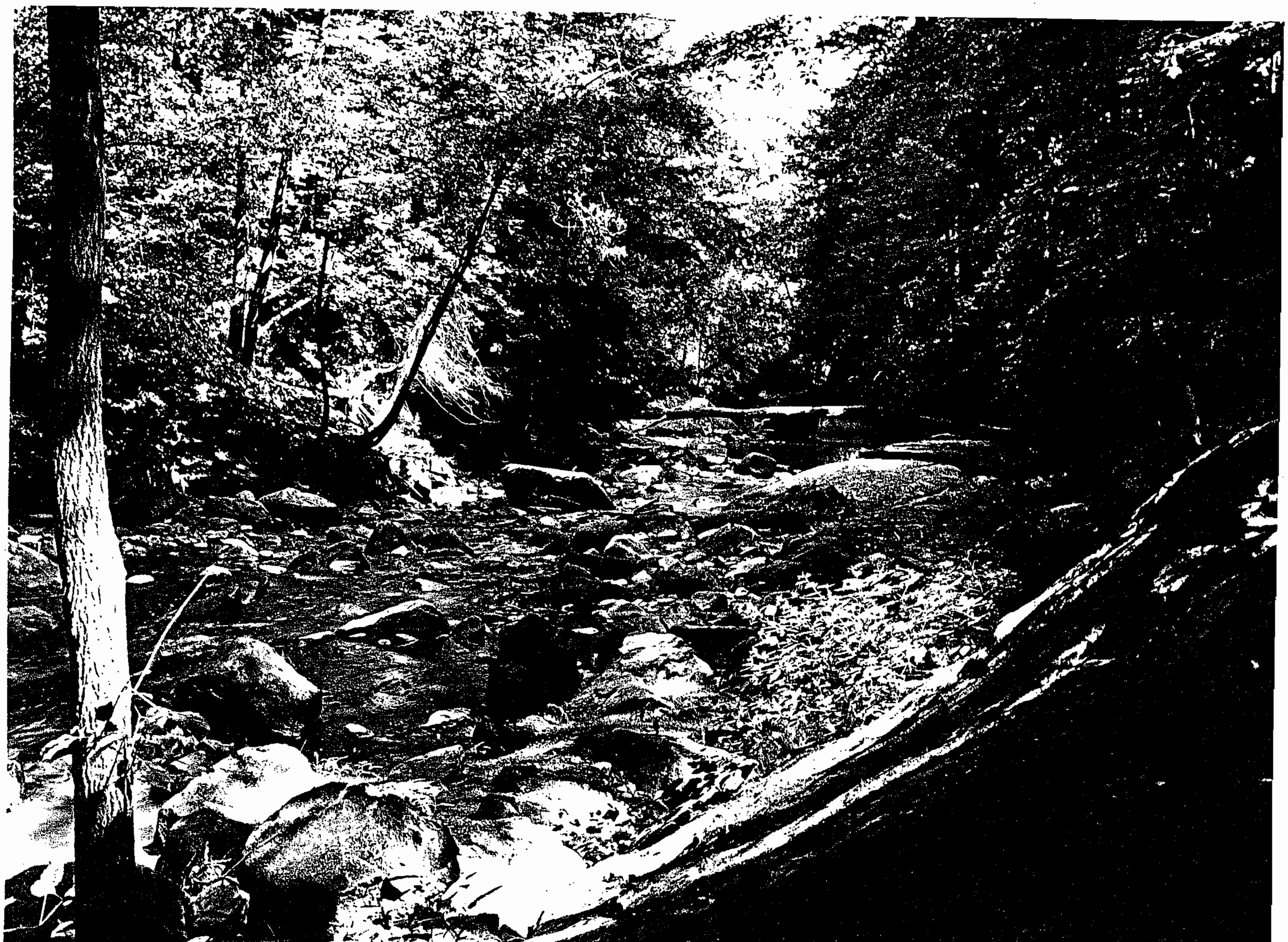


Figure 27. Chippewa Creek in the Metroparks Brecksville Reservation.

PROBLEMS AND REMEDIATION

Historically, eight municipal wastewater treatment plants, with discharges varying from 25,000 to 100,000 gallons per day, had been tributary to Chippewa Creek. Seven of them were within one mile upstream of Sample Site #44. One of them, the Bramblewood WWTP, was approximately one and a half miles upstream of Site #43.5 on the Bramblewood Branch.

The Avery Meadows WWTP, Briarwood WWTP, and Bramblewood WWTP had been abandoned in early 1987. The Vineyards WWTP was abandoned in June 1987 and the Seneca WWTP was abandoned in July 1987. The St. Sava's WWTP was abandoned in May 1988. The influents of these municipal plants, along with the former influents to hundreds of residential and commercial septic systems in the Chippewa Creek drainage area, have been diverted to the sanitary sewer system. This removal of wastewater formerly tributary to Chippewa Creek has been made possible by the construction of the NEORSD's Cuyahoga Valley Interceptor, to which the flows are now tributary.

Abandonment of the Tollis WWTP and the Royalton Heights WWTP are projected for early 1989 and Autumn 1989, respectively. Following these and further reconnections of septic system flows to the sanitary sewer system, Chippewa Creek, which is now one of the least polluted streams in Cuyahoga County, should show even further improvements in water quality.

KINGSBURY RUN

Kingsbury Run drains the central portion of Cleveland east of the Cuyahoga River and part of the west end of Shaker Heights. It has a total drainage area of 5000 acres and a total length of 4.3 miles (Havens and Emerson, 1968). Kingsbury Run flows predominately east-to-west with three branches that merge at different points. The main stem begins at East 37th St., south of Woodland Ave., and eventually enters the Cuyahoga River at approximately RM 4.0, just north of the old Jefferson Avenue bridge, 2785 Broadway Avenue.

Kingsbury Run is entirely underground and is a combination of culverted stream sections and storm sewers, serving as an overflow-receiving sewer for combined sewers during high flow conditions.

Under dry weather conditions, flow measurements obtained at the mouth of the culvert indicated that Kingsbury Run discharges approximately 2.4 cubic feet/second. The Havens & Emerson report of 1968 estimated dry weather flow to be 5 cubic feet/second. This reduction in flow will be discussed later in the report.

Kingsbury Run's drainage area has a combination of residential and industrial usages. The Ohio EPA has designated Kingsbury Run Warmwater Habitat.

SAMPLING

Kingsbury Run was originally assigned by the Stream Monitoring Program only one sampling location, which is at the mouth of the culvert. In 1988, four additional sampling locations were chosen to monitor the different branches of Kingsbury Run. (Figure 28). The locations selected were those used for the Havens & Emerson report of 1968:

Site #46 (Mouth of the culvert, north of the old Jefferson Ave. bridge);
Site #46.1 (Manhole in center of East 37th St., south of Woodland Ave.);
Site #46.2 (North Branch at East 78th St. and Crowell Ave.);
Site #46.3 (North Branch at East 68th St. and Beaver Ave. by railroad tracks);
Site #46.4 (South Branch at East 87th St. and Kinsman Ave. by railroad tracks).

Site #46 was the only Kingsbury Run location sampled during 1988. Chemical and bacteriological data in 1988 indicated that significant amounts of sanitary sewage are tributary to the stream in dry weather. (Appendix II-L). However, comparing 1988 data to Havens & Emerson data from 1968, a great improvement in Kingsbury Run's water quality is apparent. This is due, in part, to the closing of numerous industrial facilities which had been tributary to Kingsbury Run. Additionally, sewer system improvements have been made, including the corrections of many combined sewer overflow problems over the past 20 years.

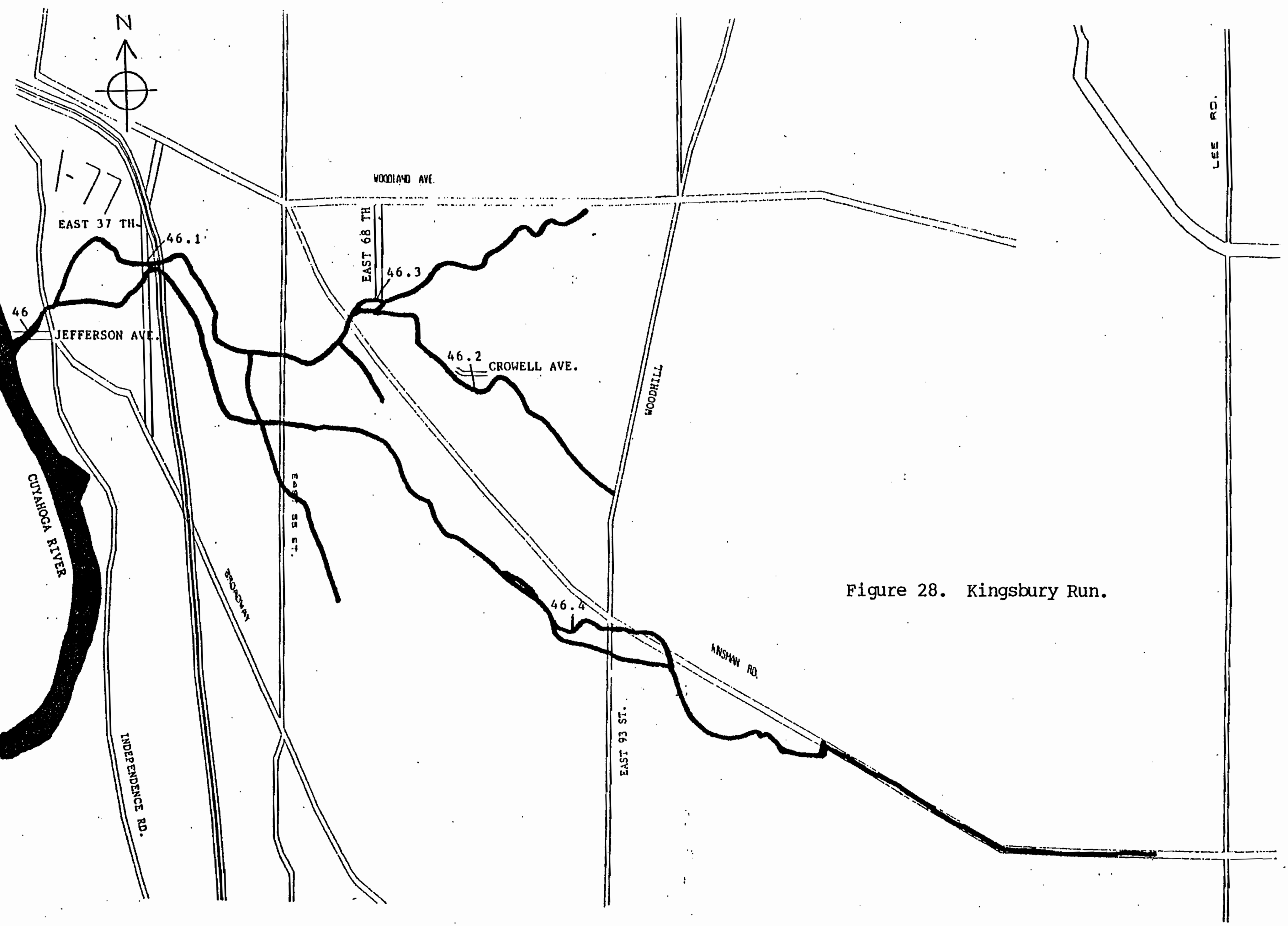


Figure 28. Kingsbury Run.

The chemical analysis of the water at Site 46 in 1988 revealed that ammonia, iron, and mercury all exceeded the Water Quality Standards for Warmwater Habitat and that dissolved oxygen was below the minimum acceptable concentration for Warmwater Habitat. Also noted were the levels of chlorides (173 mg/L) and sulfates (133 mg/L). The sources of these elevated concentrations have not been pinpointed but they are probably attributable to problems in the network of combined sewer overflows on Kingsbury Run. Further study to identify some of these sources is warranted.

Bacteriological data from Site #46 showed bacterial contamination with a fecal coliform concentration as high as 7,800 counts/100 mL (on 9/19/88), which exceeds the Primary Contact Recreational Use Standard.

Since Kingsbury Run is entirely a culverted stream, it is not conducive to sampling for benthos.

PROBLEMS AND REMEDIATION

In August 1988, two dry weather overflow problems on Kingsbury Run were corrected in Shaker Heights. The first of these was a blocked 15-inch sewer at Lomond Blvd. and Lynnfield Rd., and the second was a blocked 12-inch sewer at Ashby Rd. and Van Aken Blvd. The condition of Kingsbury Run should continue to improve with the completion of the NEORSD's Heights-Hilltop Interceptor, which will collect flows in the Shaker Heights area, where there is now a problem of sewers surcharging during wet weather. It is projected that the construction of the Interceptor and the construction of a Community Relief Sewer for Lomond Blvd. will eliminate many overflows to Kingsbury Run from this area.

A significant source of pollution still entering Kingsbury Run is from a series of five dry weather sewage overflows on East 111st Street, due to the blockage of the sanitary sewer on that street. City of Cleveland officials are aware of the problem but, to date, they have not had the blockage removed. In order to prevent residential basement flooding in this area, City of Cleveland personnel removed the overflow weir walls at these five intersections on East 111th St: Lamontier Avenue; Parkview Avenue; Continental Avenue; Lardet Avenue; Melba Avenue. Once the East 111th St. sewer problem is corrected, NEORSD Sewer Control Systems personnel will repair and/or replace the overflow weir walls, eliminating the dry weather overflow to Kingsbury Run from this vicinity. Flow measurements showed that the sanitary sewage entering Kingsbury Run from these overflows accounts for a significcant portion of the dry weather flow currently in Kingsbury Run.

Another problem degrading the water quality of Kingsbury Run is the frequently recurring breakdown of the City of Cleveland-owned pump station on East 37th Street north of Trumbull Street. When the pump station breaks down, all of its influent of sanitary sewage is diverted to the Kingsbury culvert. During 1988, the pump station was out of service for a combined total of two months.

On November 22, 1988, Kingsbury Run was found to be orange-brown in color. The source of the color was traced to the Northern Steel Processing Co. at 6605 Truscon Ave., a steel pickling/zinc phosphating operation, which had, in the past, discharged industrial wastewater directly to the Kingsbury culvert via a storm drain in the company's basement. NEORSD investigators found that all process wastewater generated at the facility was again being discharged in 1988 to the storm drain, because piping underneath the floor of the process area had become disconnected from the sanitary sewer. This wastewater entering the storm drain was found to have a pH of 2.0 Standard Units. An inspection of the sanitary sewer manhole in the company's parking lot showed that the sanitary sewer was blocked with driveway debris and sludge, so that very little flow was getting through. Subsequently, corrections were made to eliminate the problem, but, on November 28, 1988, Kingsbury Run was once again found to have the orange-brown color. The sanitary line in the basement of Northern Steel Processing had again become disconnected, allowing all of the process wastewater to enter Kingsbury Run. As of the end of 1988, the company's sanitary sewer has been cleaned out and repairs have been made to the piping in the basement so that all process wastewater is presently entering the sanitary sewer. However, this situation will require continued monitoring or a permanent seal of the basement storm drain to eliminate the possibility of future discharge to Kingsbury Run.

In the Kingsbury Run drainage area, there are 42 combined sewer overflows on an old and, in many places, undersized combined sewer system. NEORSD Sewer Control Systems has incorporated an effective preventive maintenance program to regularly inspect and correct blocked or deteriorating overflow structures. But it is inevitable that there will continue to be breakdowns and recurring problems which allow Kingsbury Run's waters to be contaminated. The Havens and Emerson Report of 1988 had made a recommendation that the closed Standard Oil Company refinery near the mouth of Kingsbury Run on Broadway Ave. be converted to allow treatment of all dry weather flow from Kingsbury Run. The refinery had included a waste treatment facility to handle 10,000 gallons per minute of oily waters prior to their discharge to the river. Standard Oil transferred ownership of the facility to the City of Cleveland in 1968, and a proposal was made for the primary treatment of all dry weather flow in Kingsbury Run prior to its discharge to the river. However, the proposed treatment facility was never constructed, and the Research Oil Co. has now purchased the property and plans to use the facility for its expanding operations.

MORGANA RUN

Morgana Run drains the central portion of the City of Cleveland east of the Cuyahoga River. According to Havens & Emerson (1968), it had a total drainage area of 2,280 acres and a total length of 4.8 miles. Morgana Run's culvert originates at East 97th Street between Sandusky Avenue and Way Avenue. It runs predominantly east-to-west to East 49th Street, where, in dry weather, its entire flow drops into the Southerly Interceptor and is tributary to the NEORSD's Southerly WWTP. The remaining section of Morgana Run enters the Cuyahoga River on the LTV Steel Co.'s property, south of the former location of the Clark Avenue bridge, at approximately RM 4.9.

Morgana Run was known as Morgana Creek until about 1910, when it was culverted, and in some places, relocated to follow the old Morgana Avenue. In 1960 and 1961, Morgana Run, from Interstate 77 to Independence Road, was reinforced, allowing the Republic Steel Corporation to use the land above Morgana Run as a bulk storage facility for coal, coke, and ore.

In 1969, all of the dry weather flow in Morgana Run upstream of East 49th Street was diverted by a weir, through a 42-inch pipe, into the Southerly Interceptor. The weir is overflowed only in wet weather, when many combined sewer overflows are tributary to Morgana Run upstream.

The LTV Steel Company's treated coke plant effluent and cooling waters are discharged to Morgana Run between the river and Independence Road at a rate of approximately 10,000 gallons per minute. Measurements by NEORSD investigators in dry weather indicate that, upstream of the LTV Steel Co. discharge, Morgana Run has around 1,000 gallons per minute of flow.

SAMPLING

Morgana Run has been assigned one sampling location for the NEORSD Stream Monitoring Program, Site #47, at a manhole on Independence Road. (Figure 29).

Only one sampling for chemical and bacteriological parameters was performed on Morgana Run in 1988. (Appendix II-L). A comparison of the 1988 data with the Havens & Emerson data from 1968, indicates a significant decrease in contamination by sanitary sewage at this location. For example, the total coliform concentration was 100,000 counts per 100 mL in 1968, but in 1988 it was only 120 counts per 100 mL. The fecal coliform concentration at Site #47 in 1988 was only 60 colonies per 100 ml, which is well within the allowable limit for Primary Contact Recreational Use. This water quality improvement is undoubtedly due largely to the diversion of Morgana Run to the Southerly Interceptor at East 49th Street. Sanitary sewage is known to overflow frequently at several locations upstream of East 49th Street, but it no longer reaches the sampling location at Independence Road in dry weather.

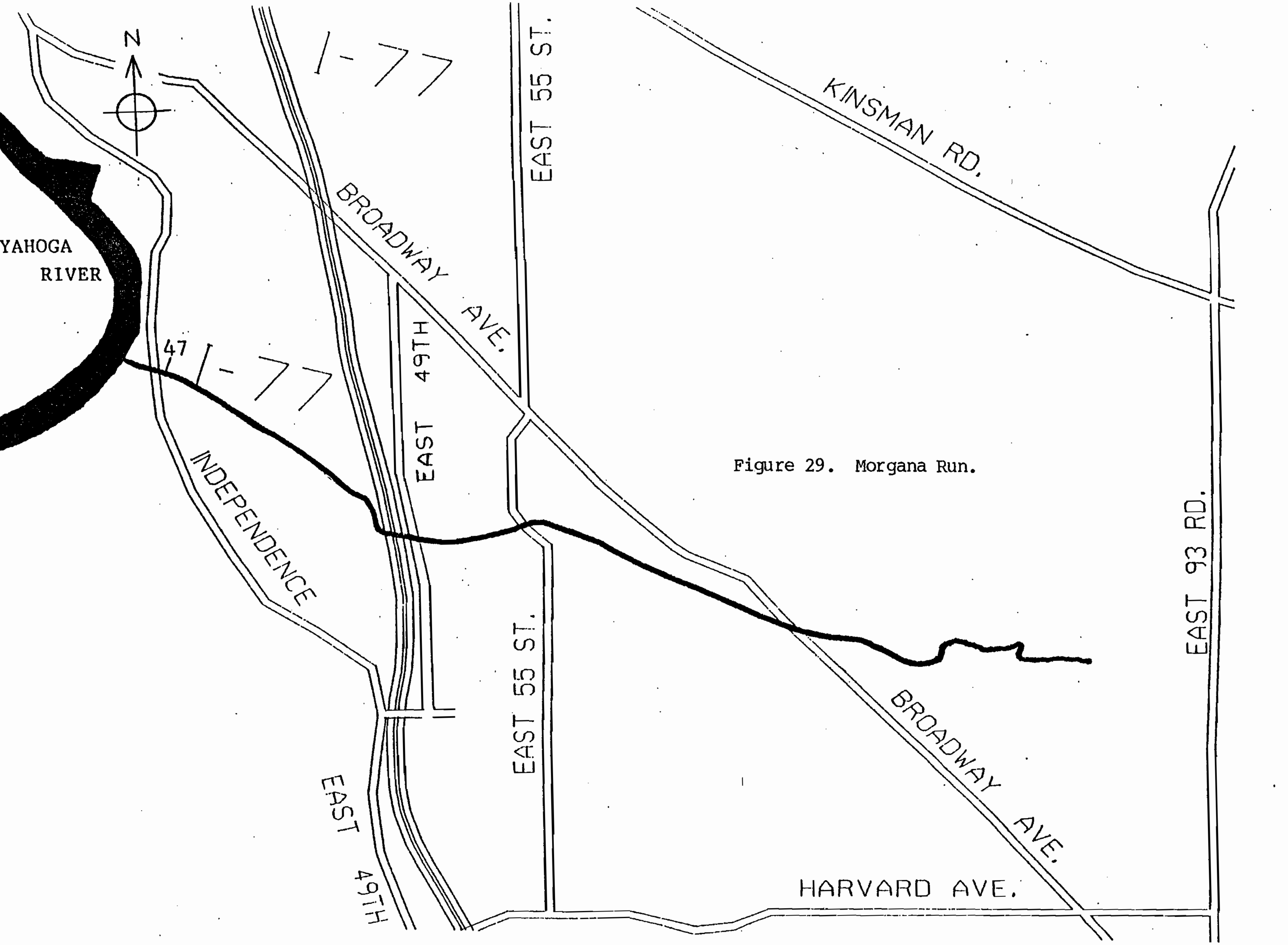


Figure 29. Morgana Run.

The chemical analysis of the water at Site #47 in 1988 showed that only the iron concentration exceeded its Water Quality Standard for Warmwater Habitat. Also noted were the chlorides concentration of 358 mg/L and the sulfates concentration of 184 mg/L. These relatively high data may be attributable to run-off from the LTV Steel Company's bulk storage facility over Morgana Run immediately upstream of this location, which is discussed below.

Since Morgana Run is entirely culverted, Site #47 is not conducive to sampling for benthos.

PROBLEMS AND REMEDIATION

During 1988, the NEORSD Stream Monitoring Program received no reports of spills or environmental disruptions on Morgana Run.

However, a known source of pollution in Morgana Run is stormwater run-off and infiltration to the culvert from the LTV Steel Company's bulk storage area for coal, coke, and ore. (Figure 30). On August 6, 1987, NEORSD investigators had obtained a grab sample from coal pile run-off tributary to Morgana Run from the LTV Steel Company's property. Analysis of this sample for toxic organics revealed the following polynuclear aromatic hydrocarbons: anthracene (2400 ug/L); benzo(k)fluoranthene (1950 ug/L); fluoranthene (1850 ug/L); napthalene (900 ug/L); phenanthrene (2500 ug/L); pyrene (1800 ug/L); chrysene and/or benzo(a)anthracene (3800 ug/L); benzo(b)fluoranthene and/or benzo(k)fluoranthene (5800 ug/L). Many polynuclear aromatic hydrocarbons (PAH's) have been shown to cause "at least benign tumors in mammalian experiments," according to Baumann, et. al. (1982). Of these, benzo(a)anthracene and benzofluoranthenes have been identified as "animal carcinogens" by the International Agency for Research on Cancer. The possible relationship between organics in coal pile run-off and tumors in bottom-feeding fishes downstream merits further study.

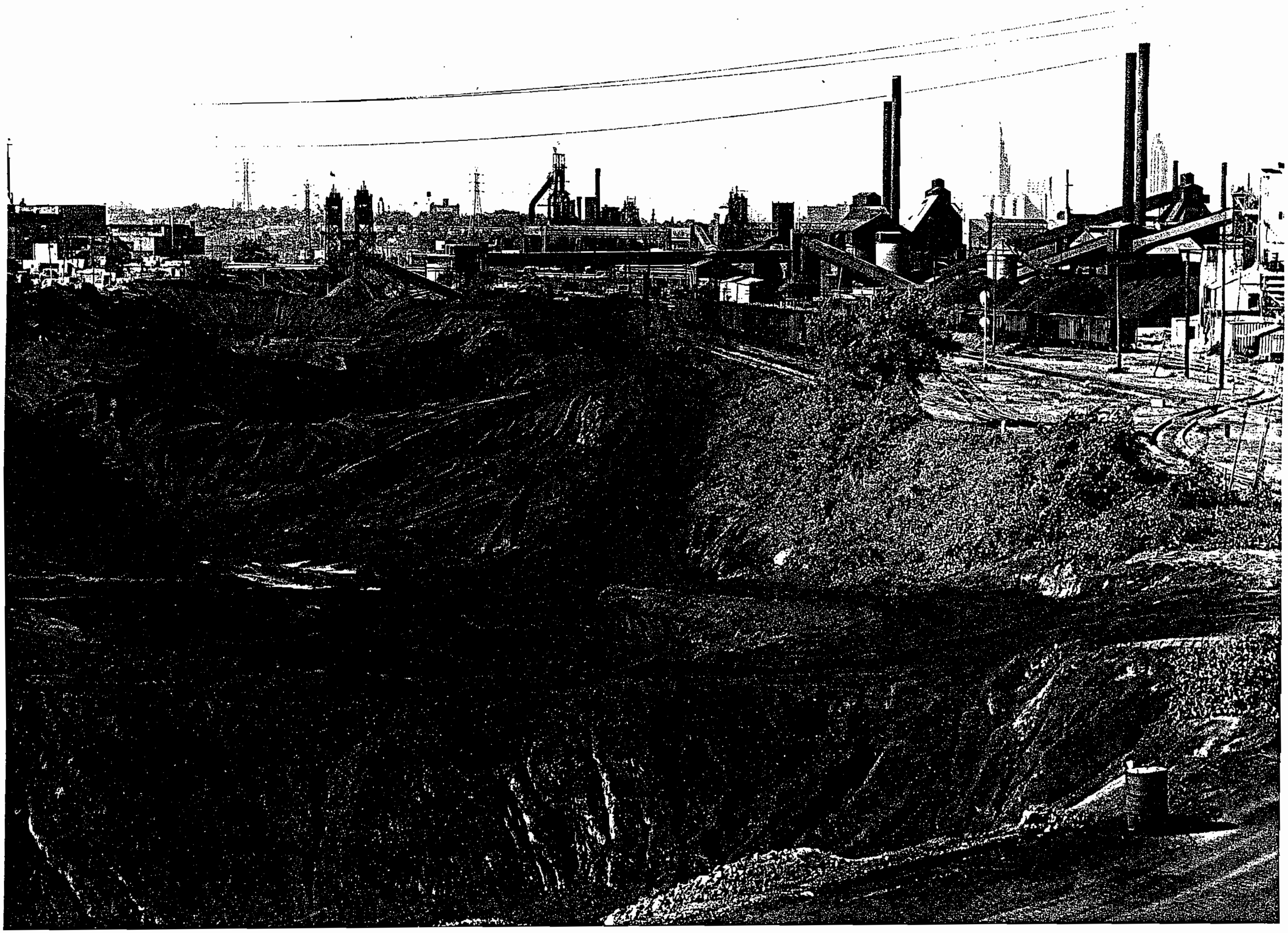


Figure 30. Coal piles on LTV Steel Company property over Morgana Run.

BURKE BROOK

Burke Brook carries surface run-off water and combined sewer overflows from the southern part of Cleveland east of the Cuyahoga River and from parts of Cuyahoga Heights and Newburgh Heights. The total drainage area was 1400 acres, according to Havens & Emerson (1968).

13 combined sewer overflow structures are located on Burke Brook. Tributary to these overflow structures is a drainage area of approximately 500 acres, over one third of the total drainage area of Burke Brook. Ten of the overflow structures are located on the brook's main branch, which is east of Interstate 77. In July 1982, the NEORSD activated a diversion chamber, east of Interstate 77, south of Fleet Avenue, which intercepts the entire dry weather flow of Burke Brook's main branch. From this chamber, the main branch's flow is diverted into the NEORSD's Southerly Interceptor, which is below the brook and southbound under Interstate 77.

The South Branch of Burke Brook originates as a 48-inch storm sewer on Grant Avenue in Cuyahoga Heights. Then, it flows through Newburgh Heights where it joins the former channel of the main branch downstream of the NEORSD's diversion chamber. From this point, Burke Brook flows under Interstate 77 and the LTV Steel Company's property northwest to its confluence with the Cuyahoga River at about RM 5.3.

Three combined sewer overflow structures are presently not tributary to the NEORSD's diversion chamber: one on Grant Avenue, east of Interstate 77 in Cuyahoga Heights, and one on Harvard Avenue, west of Interstate 77 in Newburgh Heights, both of which are maintained by the NEORSD; one in the Washington Park Horticultural Center, maintenance for which the Village of Newburgh Heights is responsible.

Except for 0.3 total miles of open section on both sides of Interstate 77, the entire length of Burke Brook is culverted. NEORSD investigators performed measurements on November 1988 near the mouth, on the LTV Steel Company's property, and determined that approximately 1.4 MGD was entering the Cuyahoga River from Burke Brook in dry weather.

SAMPLING

Burke Brook has been assigned two locations (Figure 31) for chemical, bacteriological, and benthic sampling and analysis: Site #48, which is located in an open chamber on the double culvert on the LTV Steel Company's property, about 200 yards upstream of the brook's confluence with the Cuyahoga River; Site #48.1, which is located off Independence Road, south of Fleet Avenue, on the open stretch of Burke Brook's main stem, just east of Interstate 77, downstream of the former confluence of the main branch and the South Branch.

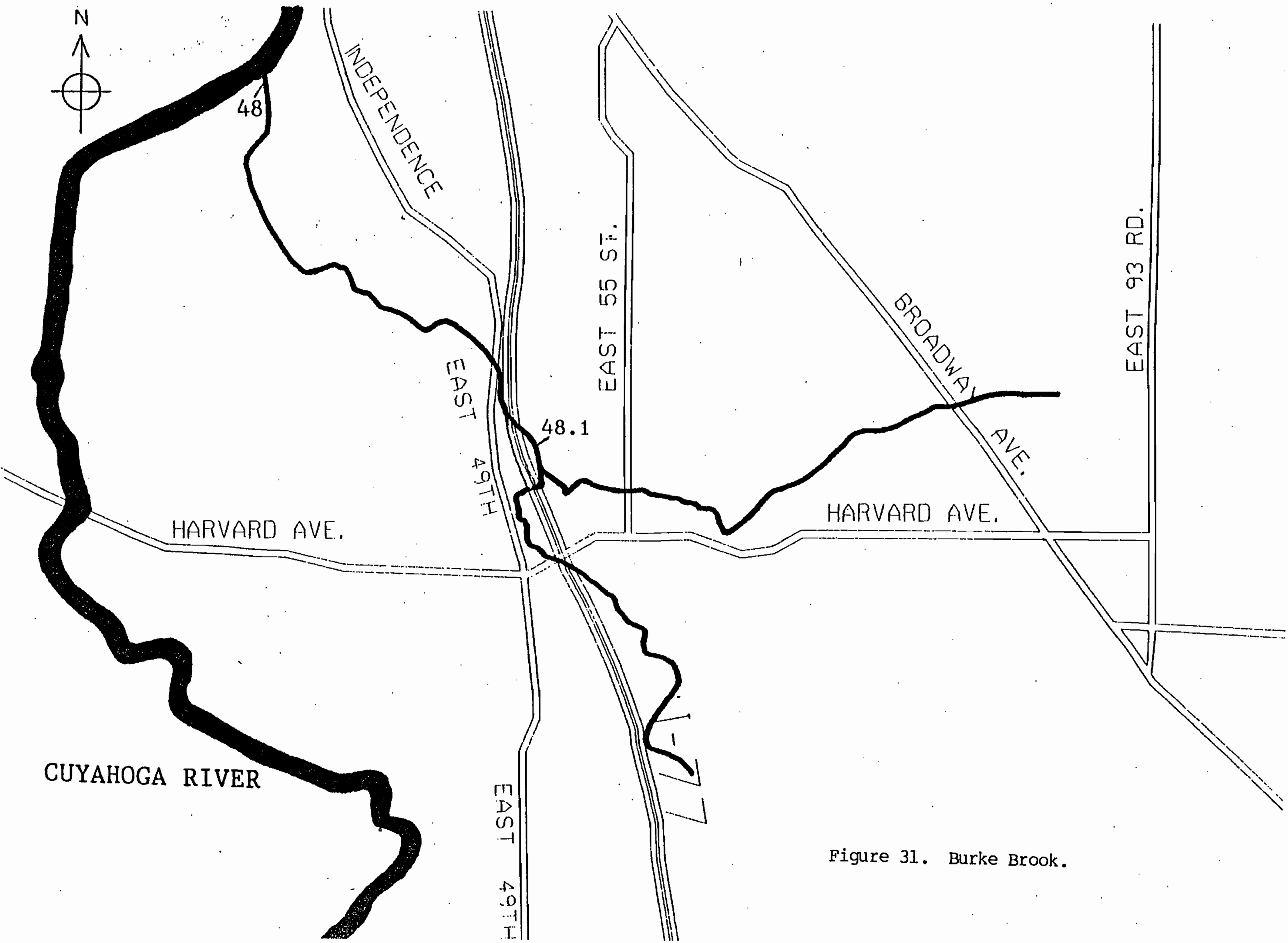


Figure 31. Burke Brook.

Only Sample Site #48 was sampled for chemical and bacteriological parameters in 1988. (Appendix II-L). Chemical analysis revealed that ammonia and iron exceeded the Water Quality Standards for Warmwater Habitat. Also noted at Site #48 were relatively high chlorides (322 mg/L) and sulfates (240 mg/L) concentrations. Upstream of this location, the Burke Brook culvert passes under the LTV Steel Co. Coke Plant operations, tie-ins, run-off, and/or infiltration from which could influence some chemical parameters.

1988 bacteriological data from Site #48 showed significant contamination by sanitary sewage in Burke Brook during dry weather. The fecal coliform concentration (83,000 counts per 100 ml) greatly exceeded the limit for Primary Contact Recreational Use. The fecal coliform/fecal streptococcus ratio indicates that this bacterial contamination is of human origin. Nevertheless, the 1988 total coliform concentration of 191,000 counts per 100 ml is considerably less than the 1968 total coliform concentration of 9,000,000 counts per 100 ml, reported by Havens & Emerson. This difference is undoubtedly due largely to the interception of the main branch of Burke Brook by the NEORSD's diversion chamber.

Sample Site #48, which is on the culverted section of Burke Brook is not conducive to sampling for benthos. However, sampling for benthos will be attempted by the Stream Monitoring Program in the future at Site #48.1, which is located on an open section of Burke Brook.

PROBLEMS AND REMEDIATION

Since the construction of the NEORSD's Burke Brook diversion chamber, which had been recommended by the Havens & Emerson Report of 1968, all dry weather flow, including combined sewer overflows, from the main branch east of Interstate 77 has been eliminated. Flow from this branch now only occurs during extremely heavy rainfall or during temporary bypasses of the diversion chamber for maintenance. In 1988, NEORSD Sewer Control Systems recorded only 5 overflow events at the diversion chamber, which had a total duration through the year of just over 6 hours.

Further investigation is required to determine the dry weather source of sanitary sewage found at Site #48 on Burke Brook in November 1988. A suspected source is the overflow structure in the Washington Park Horticultural Center. This overflow structure was found to be inaccessible for inspection due to lack of maintenance, and the Village of Newburgh Heights has been notified of the situation.

On November 18, 1988, NEORSD investigators found a discharge to the Burke Brook culvert at Site #48 on the LTV Steel Company property. The flow rate of this discharge was measured at 5 gallons per minute, and it had a black color. A grab sample was analyzed for polynuclear aromatic hydrocarbons (PAH's), but all parameters tested were below detectable limits. The source of this discharge was later identified by LTV Steel Company officials as coal pile storage facility runoff.

EUCLID CREEK

Euclid Creek's drainage area includes the communities of Cleveland, Euclid, Highland Heights, Richmond Heights and South Euclid. The total drainage area is approximately 15,500 acres, and the creek has a length of 9.5 miles, according to Havens & Emerson (1968). The average daily flow of Euclid Creek was about 16.1 MGD.

The entire length of the creek is unculverted. The section between Lake Shore Blvd. and Nottingham Road has been channelized by the U.S. Army Corps of Engineers with concrete stream beds for flood control. A dam is located downstream of the St. Clair bridge.

SAMPLING

Euclid Creek has been assigned four locations (Figure 32) for sampling: Sample Site #1 (south of the St. Clair Avenue bridge); Sample Site #2 (on the South Branch of Euclid Creek in the Highland Picnic Area of the Metroparks Euclid Creek Reservation, about 100 feet upstream of its confluence with the North Branch); Sample Site #3 (on the North Branch of Euclid Creek in the Highland Picnic Area of the Metroparks Euclid Creek Reservation, about 100 feet upstream of the confluence with the South Branch); Sample Site #4 (on the South Branch, adjacent to the South Euclid-Lyndhurst Public Library, 4645 Mayfield Road).

No samples were collected for the Stream Monitoring Program from Euclid Creek in 1988. Chemical, bacteriological, and benthic sampling is to be resumed in 1989.

PROBLEMS AND REMEDIATION

In 1987, high solids concentrations and low benthic diversity at Site #1 were attributed to backwash discharged to Euclid Creek by the City of Cleveland-operated Nottingham Water Filtration Plant. This backwash was redirected to the sanitary sewer system in August 1987. NEORSD billing records for 1988 indicate that suspended solids loadings to Euclid Creek from the backwash discharge have been reduced by a rate of 830 tons per year. Future sampling at Site #1 should reflect the improvements in water quality resulting from this remediation.

On July 19, 1988, NEORSD investigators found a 30-inch sanitary sewer leaking sewage into Euclid Creek, east of 1055 Anderson Road, at a rate of less than 1 gallon per minute. A dye test verified that the sewage was entering the creek through a 4-inch wall drain under Anderson Road. Bacteriological analysis of the influent showed fecal coliform concentrations greater than 200,000 counts per 100 ml. The Cuyahoga County Board of Health was notified of this problem on July 22, 1988.

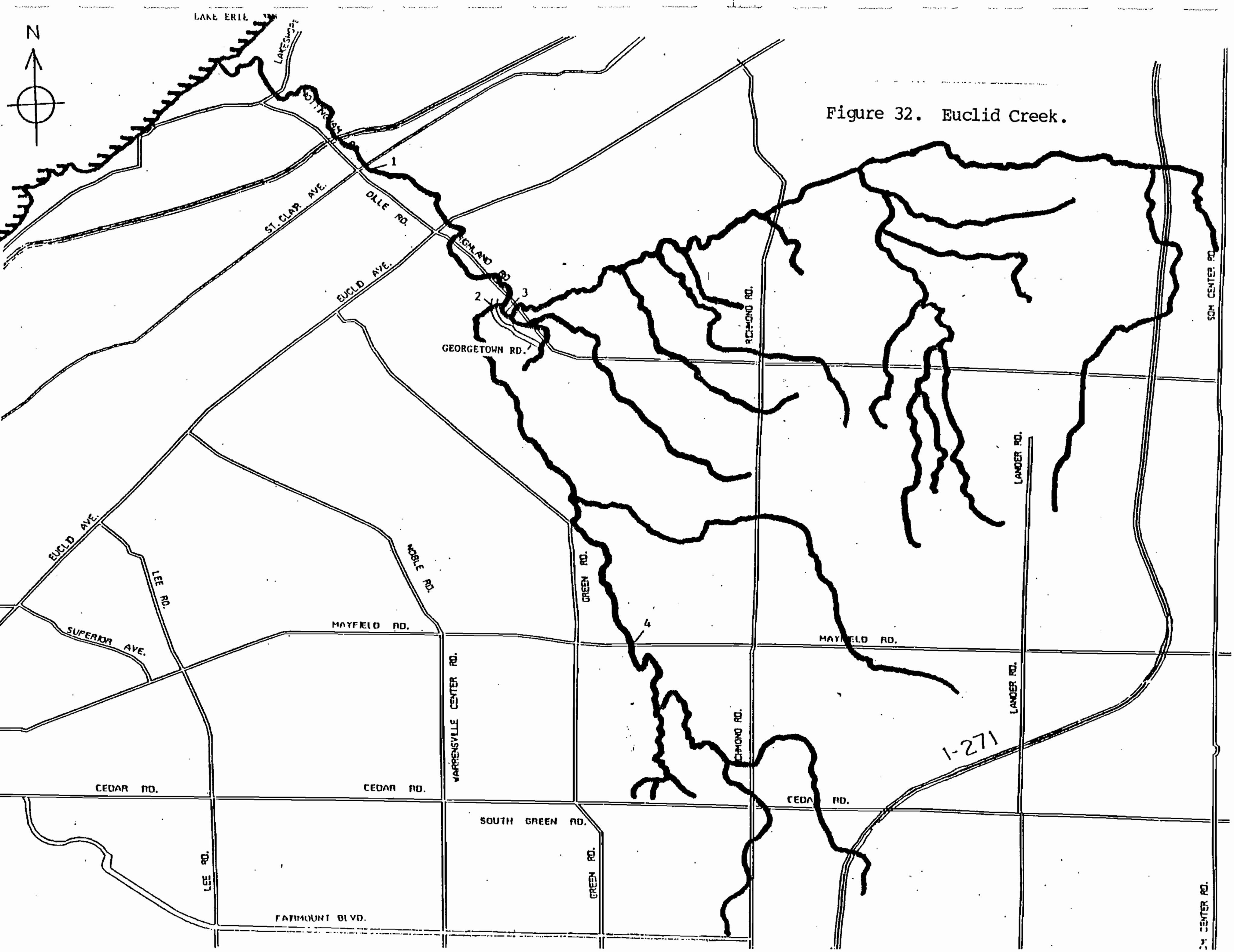


Figure 32. Euclid Creek.

In September 1988, a fish kill (27 salmonids and thousands of minnows) occurred in Euclid Creek below the Chardon Road storm sewer outlet. The cause was identified as ammonia entering the storm sewer from a General Electric Company plant in Euclid. Ammonia concentrations in Euclid Creek exceeded 20 mg/L. State officials from the Ohio EPA and the Ohio Division of Wildlife responded to the spill and took appropriate action.

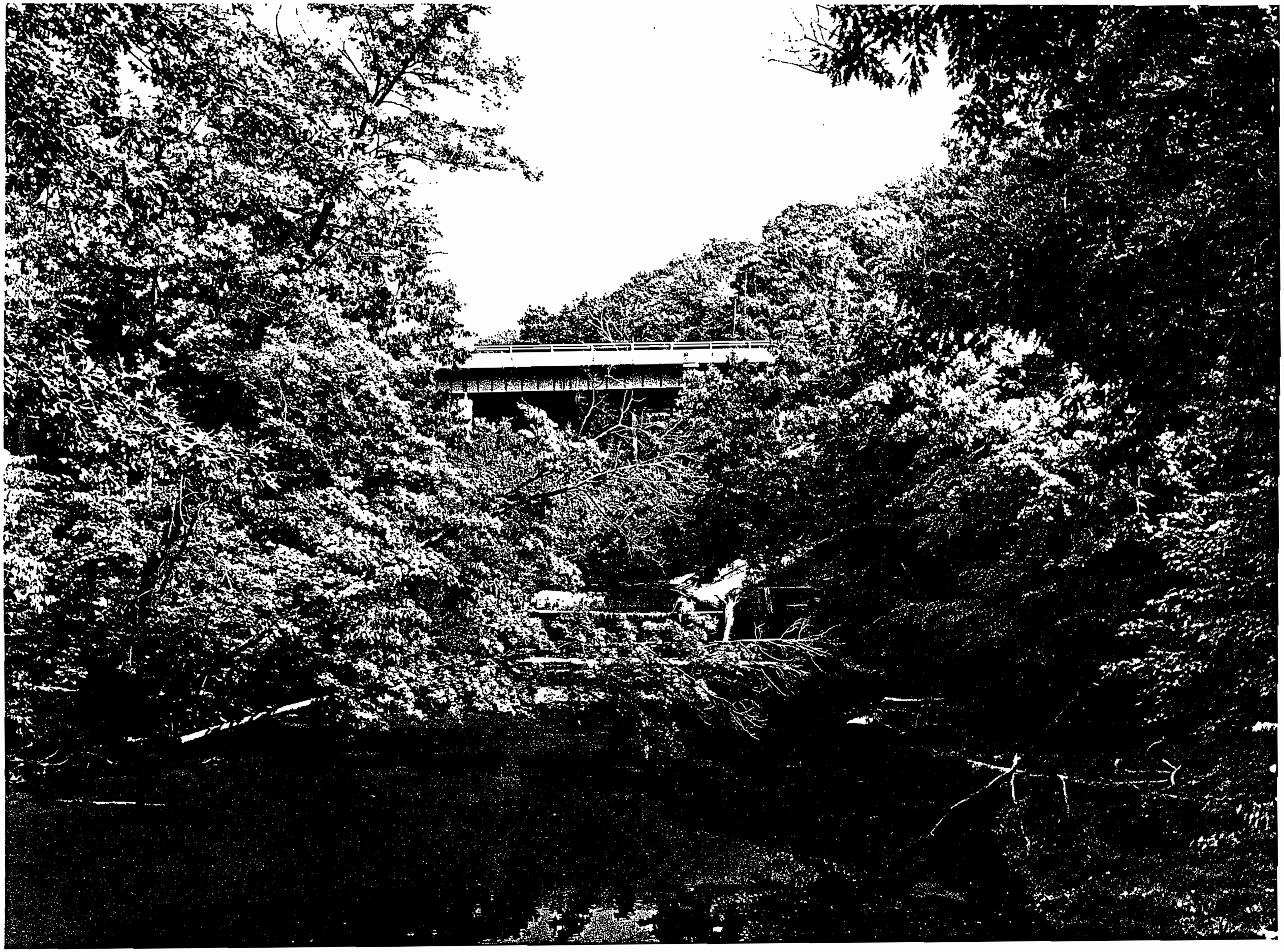


Figure 33. Euclid Creek North Branch in the Metroparks Euclid Creek Reservation.

GREEN CREEK

Green Creek drains a small portion of Cleveland and South Euclid. The drainage area, mostly residential and industrial, is approximately 660 acres and the stream is 6.1 miles in length, according to Havens & Emerson (1968). 2.3 miles of Green Creek, from Euclid Avenue to Lake Erie are culverted. The creek's average flow into the lake is about 1.2 MGD.

SAMPLING

Green Creek has been assigned three sample sites (Figure 34) for the Stream Monitoring Program: Site #5, on the culverted portion, at a manhole on Arcade Avenue, west of East 167th Street; Site #6, at a small opening between the culvert and railroad tracks, northwest of East 170th Street and Saranac Road; Site #7, at the downstream end of the open creek, south of Euclid Avenue and Upper Valley Drive.

No sampling was performed on Green Creek in 1988. Sampling on Green Creek for chemical, bacteriological, and benthic parameters will be resumed in 1989.

PROBLEMS AND REMEDIATION

No environmental disruptions on Green Creek were found by or reported to the NEORSD Stream Monitoring Program in 1988.

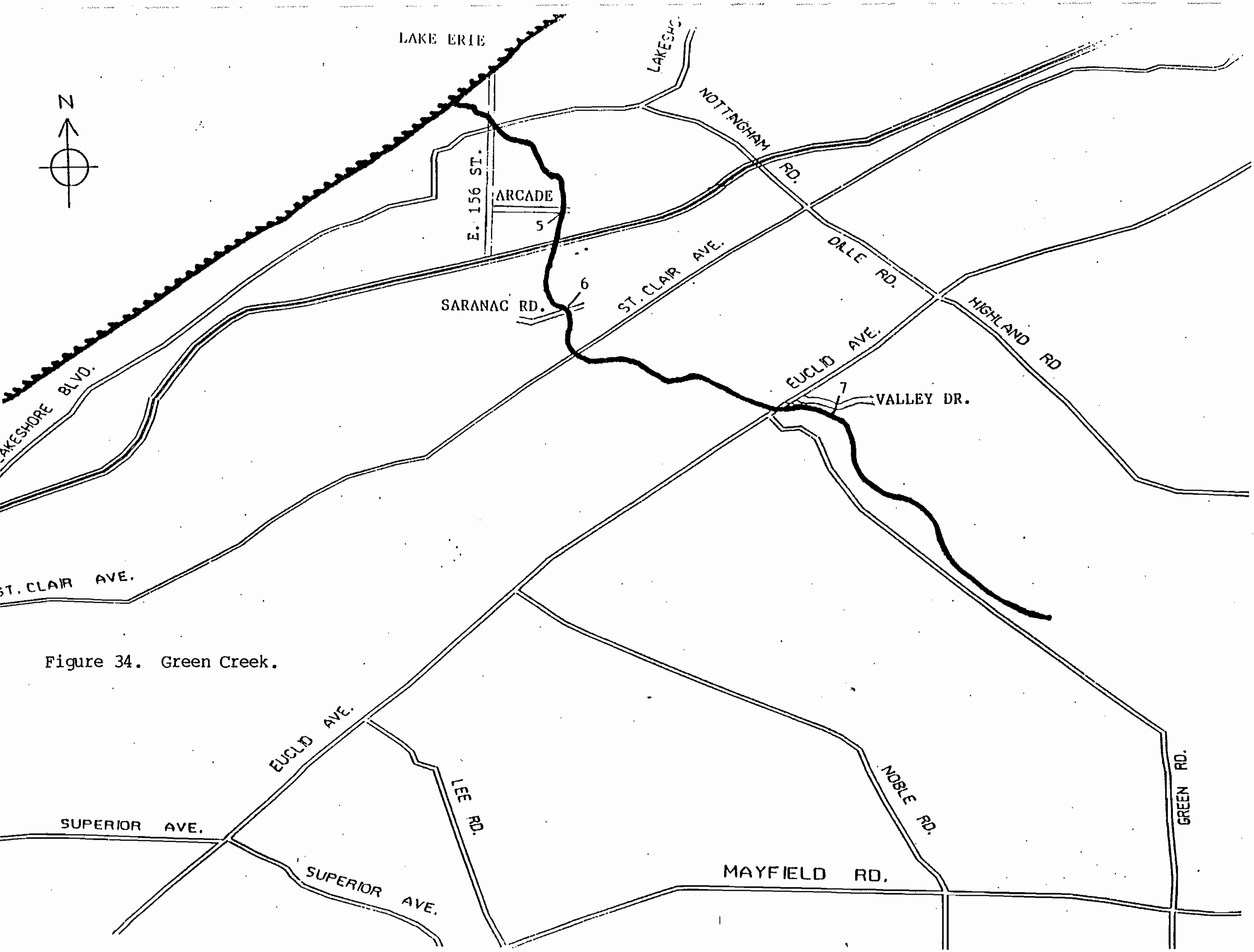


Figure 34. Green Creek.

NINE-MILE CREEK

Nine-Mile Creek's drainage area includes the communities of South Euclid, University Heights, Cleveland Heights, East Cleveland, Cleveland, and Bratenahl. The total drainage area is approximately 5000 acres, according to Havens & Emerson (1968). The average daily flow of Nine-Mile Creek was about 11.0 MGD.

Nine-Mile Creek is culverted from near its mouth at Lake Shore Blvd. to east of Belvoir Blvd. at the border between the cities of Cleveland and Cleveland Heights. Upstream of this location, the creek is open, and the "Nela Park" Branch, which enters the culverted main stem of Nine-Mile Creek south of Belvoir Blvd., east of Hillside Avenue in East Cleveland, is also open.

SAMPLING

Nine-Mile Creek has been assigned four locations (Figure 35) for sampling: Site #8a, on the main stem north of Lake Shore Blvd.; Site #8b, at a manhole on the culverted main stem, west of Ivanhoe Road and north of the railroad tracks; Site #9, on the "Nela Park" Branch, upstream of its confluence with the main stem; Site #10, on the main stem, upstream of Nine-Mile Creek's entry into the culvert, south of Belvoir Blvd.

No water samples were collected for the Stream Monitoring Program from Nine-Mile Creek in 1988. Chemical, bacteriological, and benthic sampling is to be resumed in 1989 at all locations.

PROBLEMS AND REMEDIATION

In July 1988, NEORSD investigators responded to complaints from residents of sanitary sewage in Nine-Mile Creek. The drought conditions of the summer of 1988 had aggravated the contamination of the creek by minimizing the dilutive impact from stormwater flow. The following problems were discovered as a result of these investigators.

On July 11, 1988, a significant flow of sanitary sewage was found entering the creek from a westbound storm sewer outfall at Mayfield Road east of Warrensville Center Road. The source of this sewage was subsequently identified as the Warrensville Manor apartment building, 1476 Warrensville Center Road, which had been improperly connected to the storm sewer. Reconnection of the building's sanitary sewage to the sanitary sewer system had been planned, and completion of the project was awaiting approval from the City of Cleveland Heights Building Department, according to a representative of the landlord, the Associated Estates Corp.

A hole was discovered in an inspection plate between the sanitary sewer and the storm sewer at 1464 Wilmar Road, south of Mayfield Road.

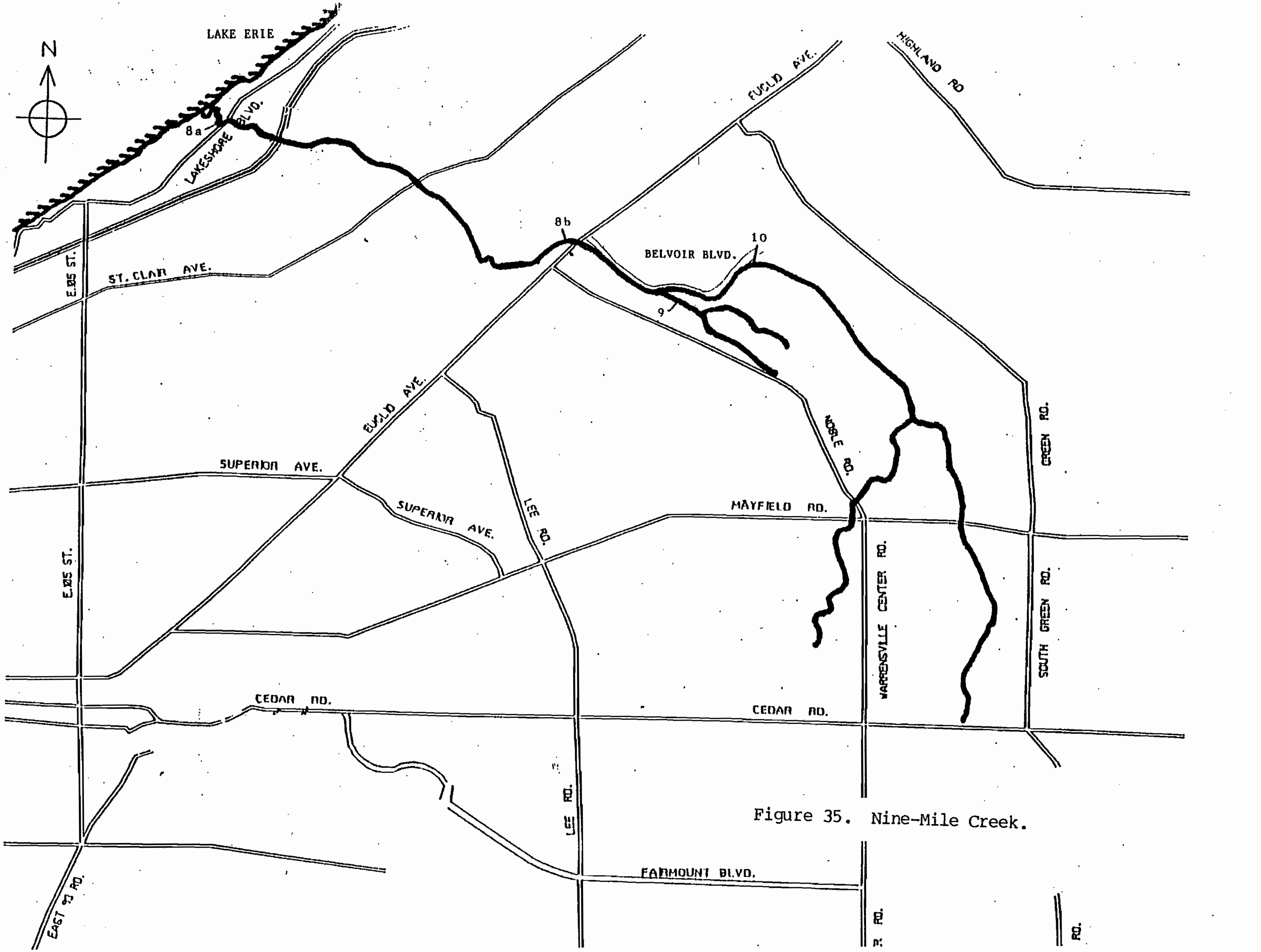


Figure 35. Nine-Mile Creek.

Although no sanitary sewage was entering the storm sewer at this location at the time of inspection, residual evidence of periodic flow of sanitary sewage in the storm sewer was noted. A similar situation was found at 1320 Warrensville Center Road, where the inspection plate had been improperly set in the bottom of the storm sewer.

At Fulton Road, south of Mayfield Road, a hole in the storm sewer was discovered allowing sanitary sewage to enter the creek through the storm sewer system. This alteration of the sewer was similar to the 14 separate "bootleg bypasses" identified in South Euclid during the previous year and discussed in the NEORSD's Stream Monitoring Program 1987 Report.

Sanitary sewage found in a northbound storm sewer on Brookline was traced to a storm sewer on Brookline was traced to a storm sewer on Holmden Road. A possible cross connection from a sanitary sewer exists at 1476 Holmden Road, but further investigation would be required for verification.

Sanitary sewage was also found in a northbound storm sewer on Plainfield Road, which enters the creek at Ardmore Road. The sanitary sewage was originating between 1351 and 1373 Plainfield Road. Again, further investigation would be required to pinpoint the source of this contamination in the creek.

Authorities from the cities of Cleveland Heights and South Euclid were notified of the above-mentioned problems on July 12, 1988. Future inspections and samplings by the Stream Monitoring Program should reflect any improvements in the water quality of Nine-Mile Creek resulting from remediation of these problems.

On November 18, 1988, a NEORSD Sewer Control Systems crew discovered sanitary sewage surcharging into Nine-Mile Creek through a manhole located on Belvoir Blvd. at the border between the cities of East Cleveland and Cleveland Heights. It was determined that blockage of the 12-inch intercommunity sanitary sewer on Belvoir Blvd. in East Cleveland was responsible for this situation. The problem was reported to the City of East Cleveland's Sewer Maintenance Supervisor. Subsequent inspections by NEORSD personnel in 1988 revealed that the blockage had been relieved and this source of sanitary sewage in Nine-Mile Creek had ceased.

Earlier in the year, NEORSD investigators had discovered chain lubricant tributary to Nine-Mile Creek from Hillside Dairy, 1418 Warrensville Center Road. On November 7, 1988, a company official informed the investigators that reconnection of the floor drains in the company's "empty case transfer" room to the sanitary sewer system should eliminate the problem and would be completed by February 1, 1989.

Finally, in August 1988, a Bratenahl resident alerted Ohio EPA and the news media of "medical wastes," i.e. syringes, washing up on the beaches of Lake Erie on Cleveland's east side. As a result, a wave of media attention and public awareness was touched off. A multijurisdictional investigation followed, involving the Ohio EPA, the Bureau of Criminal Investigation, the Health Departments of Cleveland, Cuyahoga County, and Ohio, the Ohio

Figure 36. Syringes found on White City Beach.

Department of Natural Resources, the Bratenahl Police Department, and the Northeast Ohio Regional Sewer District. Tips regarding the discovery of syringes lying in catch basins were called in by the public from various parts of the city.

The NEORSD's Industrial Waste Section responded to the syringe incidents as if they were chemical or substance spills to the environment. The syringes were found by NEORSD investigators principally in the Bratenahl and White City Beach areas, and along the banks of the three streams discharging to these areas: Nine-Mile Creek, Shaw Brook, and Dugway Brook. In total, over 300 syringes were found between August 8 and October 23, 1988. (Figure 36).

The NEORSD has concluded that the source of the syringes appears to be illegal intravenous drug use. Analysis of the contents of the syringes revealed the presence of human blood and cocaine. Additionally, "snow seals" (cocaine wrappers) were found with syringes on two occasions. Syringes were commonly found in catch basins located in known areas of high illegal drug use. Furthermore, the number of finds in September and October did not seem to decrease, indicating that the syringe finds were not related to isolated incidents.

The numbers of syringes found on the beaches appeared to be proportionate to the intensity and duration of rainfall during the prior one or two days. It is possible that the syringes were being placed into creek beds, sanitary sewers, or storm sewers after the clean-up of "crack houses" or "shooting galleries." The syringes may have been placed or washed into catch basins, where they collected until the turbulence of heavy rains flushed them into the combined sewer system and then out through combined sewer overflows to the streams. It is also possible that the syringes may have been flushed down toilets and then out of the sanitary sewers during storm events. Further investigations would be necessary to determine which mechanism or combination of mechanisms are responsible for the release of the syringes to the environment.

SHAW BROOK

Shaw Brook's drainage area includes the communities of Bratenahl, Cleveland, and East Cleveland. Most of Shaw Brook is culverted, with the only exception being a quarter-mile stretch from the East Memorial Shoreway to Lake Erie. (Figure 37). This open stretch's substrate consists of sand, rocks, tree branches, and debris from sanitary sewage. Waves from Lake Erie occasionally retain sanitary sewage debris at the mouth of the brook.

Shaw Brook had originally flowed over the Easterly Interceptor between the New York Central Railroad tracks and the Shoreway. At this location, a hole was punched through the top of the Interceptor, allowing all dry weather flow to drop into the Interceptor. NEORSD Sewer Control Systems in 1987 installed a grate over the opening to capture any large pieces of debris. Sewer Control Systems inspects and cleans this grate on a routine basis.

Shaw Brook's total length is 2.2 miles and its drainage area covers 1.3 square miles. (Havens & Emerson, 1968). Approximately 0.4 MGD flows from this stream into the Easterly Interceptor during dry weather, according to flow measurements obtained in 1987.

Because it is now essentially a combined sewer, no samples were collected on Shaw Brook by the Stream Monitoring Program in 1988. Sanitary sewage reaches Lake Erie only during high flow conditions when dilution minimizes its deleterious impact on the environment.

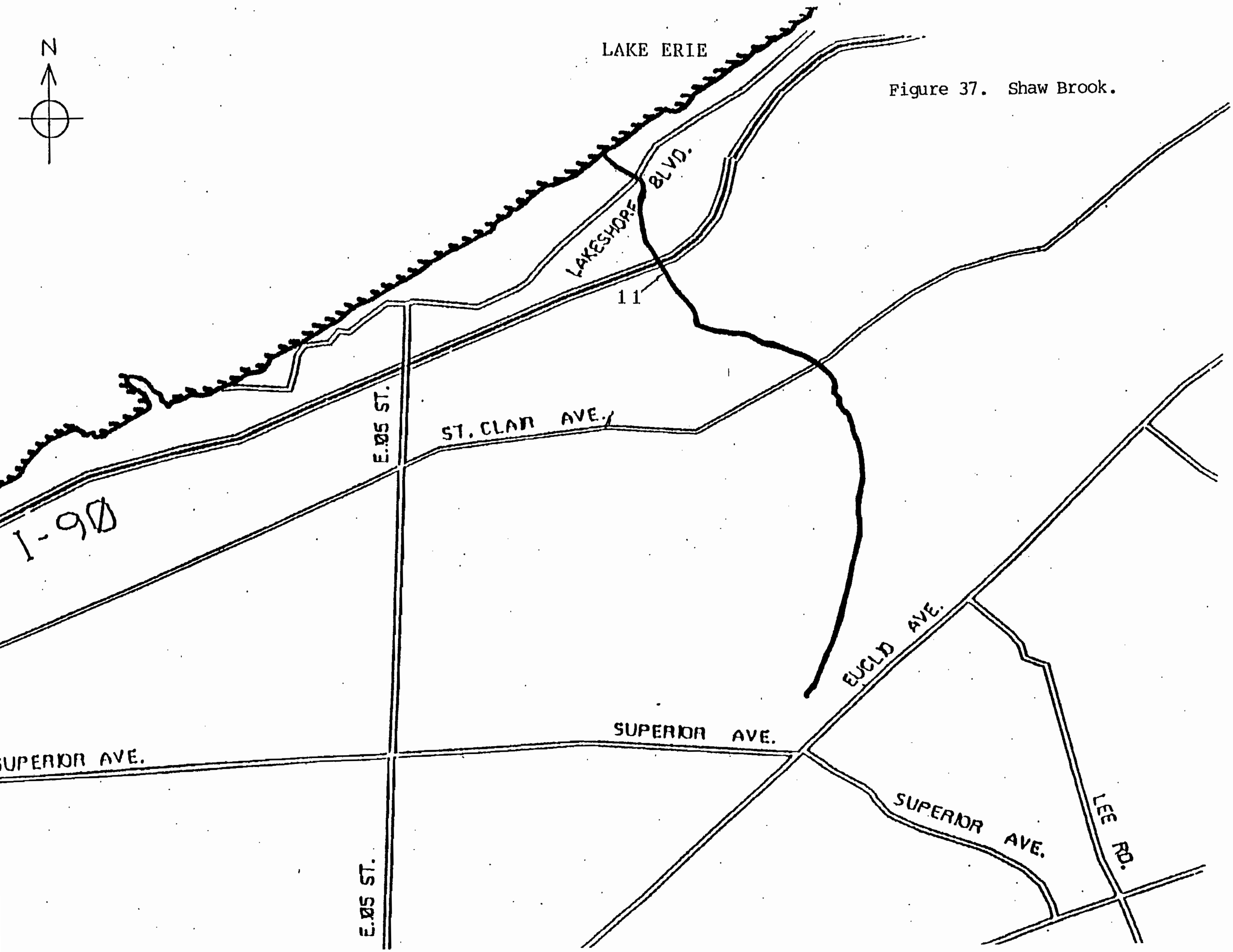


Figure 37. Shaw Brook.

DUGWAY BROOK

Dugway Brook's drainage area includes the communities of Cleveland, East Cleveland, Cleveland Heights, University Heights, and Bratenahl. The Brook has two main branches, East and West, and has a total length of 7.9 miles and a total drainage area of 9.53 square miles (Havens & Emerson, 1968). Most of the brook is culverted, with the following exceptions which are open: near the mouth, north of Lake Shore Blvd; on the West Branch, through the Lakeview Cemetery; on the East Branch, through Cumberland Park in Cleveland Heights.

Measurements of Dugway Brook on January 27th, near the mouth resulted in a flow of 2.4 MGD, an apparent increase in the flow of 0.9 MGD measured in 1987 at this location. This increase may be attributable to snowmelt at the time of measurement and/or an increase in sewage discharged through the combined sewer overflow system.

SAMPLING

Dugway Brook has been assigned four sample sites for the Stream Monitoring Program (Figure 38).

Sample Site #12 is located near the mouth of Dugway Brook, just north of Lake Shore Boulevard. The substrate consists primarily of rubble and septic sediment. Dense vegetation with tree overhang surrounds the stream.

Dugway Brook was grab sampled only once at Site #12 in 1988 for chemical and bacteriological parameters, on January 27th. (Appendix II-M). Only copper and dissolved solids concentrations (slightly) exceeded the Water Quality Standards for Warmwater Habitat.

However, bacteriological data indicated that Dugway Brook continues to be grossly polluted by sanitary sewage. The fecal coliform concentration at Site #12 was 580,000 counts per 100 ml, greatly exceeding the limit for Primary Contact Recreational Use. These results are comparable to those obtained at the site in 1987. Problems contributing to this contamination are discussed later in the report.

The chlorides concentration at Site #12 was extremely high, as it was at all of the Dugway Brook locations. The chlorides concentration of 830 mg/L was probably due to heavy road salting in the tributary area during the sampling period, which had some snowfall.

Sample Site #13 is located on Dugway Brook's West Branch at Primrose Avenue. The stream is culverted at this point and must be entered through the storm sewer outlet from the overflow regulator at Primrose Avenue and East 111th Street. The flow depth was about 4 inches in a 24-inch diameter trough during the 1988 sampling. The velocity was measured at 2.7 feet per second in

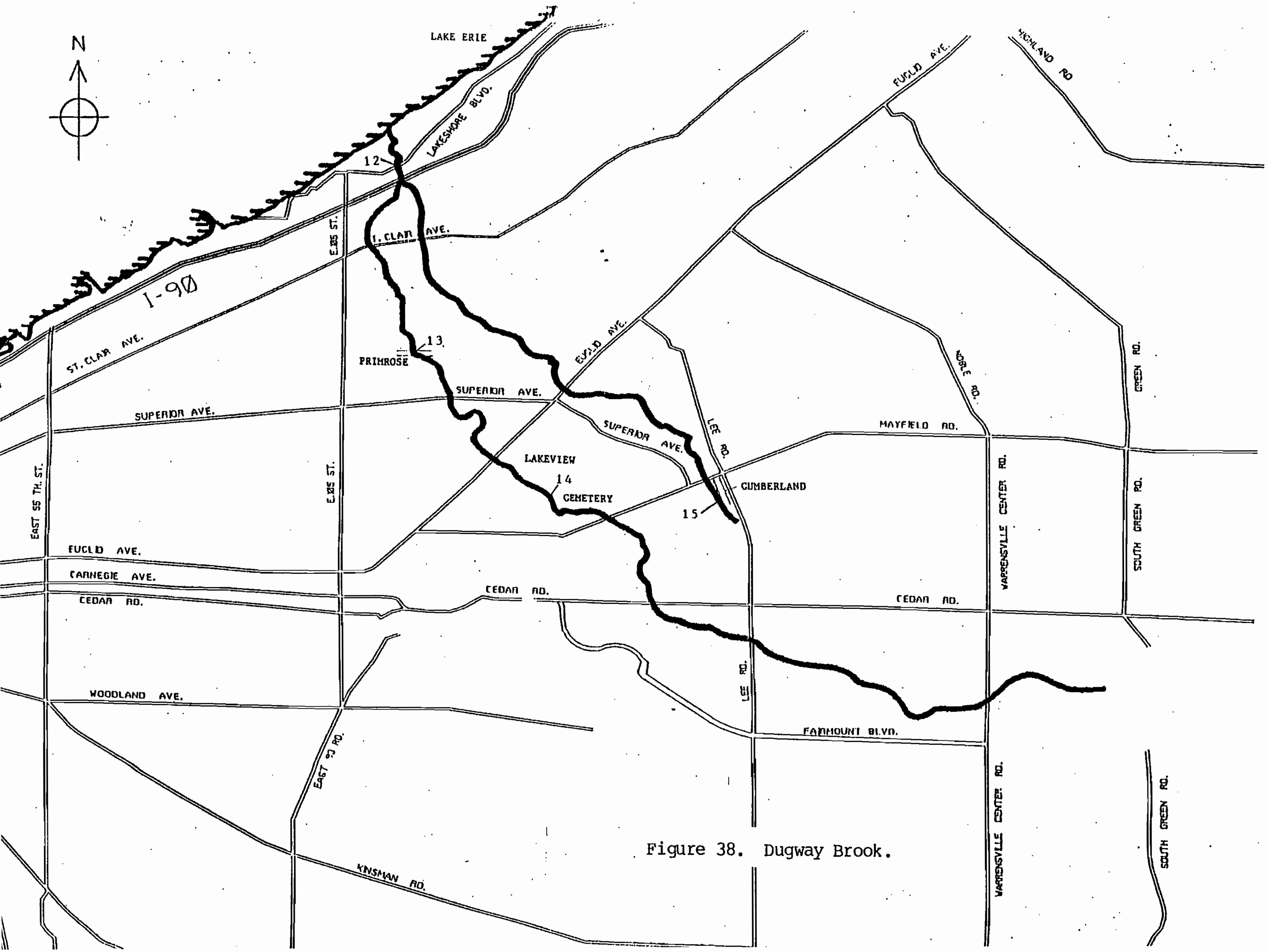


Figure 38. Dugway Brook.

the trough.

Dugway Brook was grab sampled only once at Site #13 in 1988 for chemical and bacteriological parameters, on January 27th. (Appendix II-M). Only the concentration of dissolved solids at this site exceeded the Water Quality Standards for Warmwater Habitat.

However, bacteriological data indicated that the West Branch of Dugway Brook at Site #13 was grossly polluted with sanitary sewage. The fecal coliform concentration of 110,000 counts per 100 ml greatly exceeded the limit for Primary Contact Recreational Use. This concentration was considerably higher than the highest fecal coliform concentration obtained at this location during the previous year (11,000 counts per 100 ml). No specific source of this bacterial contamination in 1988 has been identified, and only further sampling will be able to determine whether or not it continues to be a problem at Site #13. Considering the weather conditions at the time of sampling combined sewer overflows are a possible explanation.

The concentration of chlorides was also extremely high at Site #13. This concentration of 974 mg/L is probably due to run-off from heavy road salting in the tributary area during the sampling period.

Sample Site #14 is located on Dugway Brook's West Branch downstream of the NEORSD's flood control dam at Lakeview Cemetery. The substrate consists primarily of shale and many small rocks. The stream at this point is about 8 feet wide and about 4 inches deep. Relatively dense vegetation, with some overhanging trees, surrounds the stream.

Dugway Brook was grab sampled only once at Site #14 in 1988 for chemical and bacteriological parameters, on January 27th. (Appendix II-M). All chemical data was within Water Quality Standards for Warmwater Habitat at this location.

However, bacteriological data indicated that the West Branch of Dugway Brook was grossly polluted with sanitary sewage at Site #14. The fecal coliform concentration of 130,000 counts per 100 ml greatly exceeded the limit for Primary Contact Recreational Use. This concentration was considerably higher than the highest fecal coliform concentration obtained at this location during the previous year (7,000 counts per 100 ml). Since the 1988 bacteriological data at Site #14 were comparable to those obtained on the same day further downstream at Site #13, the same source of contamination may be responsible for both of these elevated fecal coliform concentrations.

Again, the chlorides concentration at Site #14 was very high (686 mg/L) and may be attributed to run-off from road salting.

Sample Site #15 is located on the East Branch of Dugway Brook at Cumberland Park, in Cleveland Heights south of Mayfield Road. The substrate consists primarily of shale with many small rocks that are coated with gray slime. The brook at this point is about 8 feet wide and averages about 6 inches deep. The stream is surrounded by dense vegetation with much tree overhang.

Dugway Brook was grab sampled only once in 1988 at Site #15 for chemical and bacteriological parameters, on January 27th. (Appendix II-M). All chemical data, with the exception of dissolved solids (2300 mg/L) and iron (1.2 mg/L) were within Water Quality Standards for Warmwater Habitat this location.

However, bacteriological data indicated that the East Branch of Dugway Brook was grossly polluted with sanitary sewage at Site #15. The fecal coliform concentration of 370,000 counts per 100 ml greatly exceeded the limit for Primary Contact Recreational Use. This concentration was considerably higher than the highest fecal coliform concentration obtained at this location during the previous year (61,000 counts per 100 ml). A source of sanitary sewage to the brook was later identified, upstream of Site #15, at Redwood Road and Parkway Drive, and it is discussed later in this report.

Finally, the chlorides concentration was extremely high (1190 mg/L) at Site #15 and, again, is probably attributable to run-off from road salting.

PROBLEMS AND REMEDIATION

In February 1988, after finding Sample Site #15 on Dugway Brook's East Branch grossly polluted with sanitary sewage, NEORSD investigators traced the sewage through the storm sewer system to a blocked sanitary sewer and a leaking inspection plate at the intersection of Redwood Road and Parkway Drive. The City of Cleveland Heights Service Department was notified of this problem in a letter dated February 18th. On February 26th, after being informed by City of Cleveland Heights personnel that the problem had been corrected, NEORSD investigators performed a follow-up inspection and found that, although the blockage had been cleared out, the damaged inspection plate had been removed but not replaced. Yet, at the time of this follow-up inspection, the sanitary sewage had ceased to enter the storm sewer at this location and, therefore, was no longer tributary to Dugway Brook.

In September 1988, another inspection by NEORSD investigators revealed that sanitary sewage was once again tributary in dry-weather to Dugway Brook's East Branch at Sample Site #15. This time, the source was identified as a sanitary sewer blockage on Superior Road between Lincoln Boulevard and Somerton Road. The City of Cleveland Heights Service Department was notified of the problem on September 22nd and, after two attempts, was able to remove the blockage and eliminate this source of sanitary sewage to Dugway Brook.

NEORSD Sewer Control Systems crews discovered dry weather overflows of sanitary sewage to Dugway Brook at the following locations on numerous occasions in 1988: Overflow No. D-35 at Tuscora Avenue and Linn Drive; Overflow No. D-37 at Primrose Avenue and Linn Drive; Overflow No. D-38 at Primrose Avenue and Linn Drive. Hopefully, the construction of the NEORSD's Heights-Hilltop Interceptor will eventually relieve the overloaded combined sewer system in this vicinity and provide long-term remediation for these and other frequently recurring problems on Dugway Brook.

Finally, on March 2, 1988, NEORSD Sewer Control System personnel had

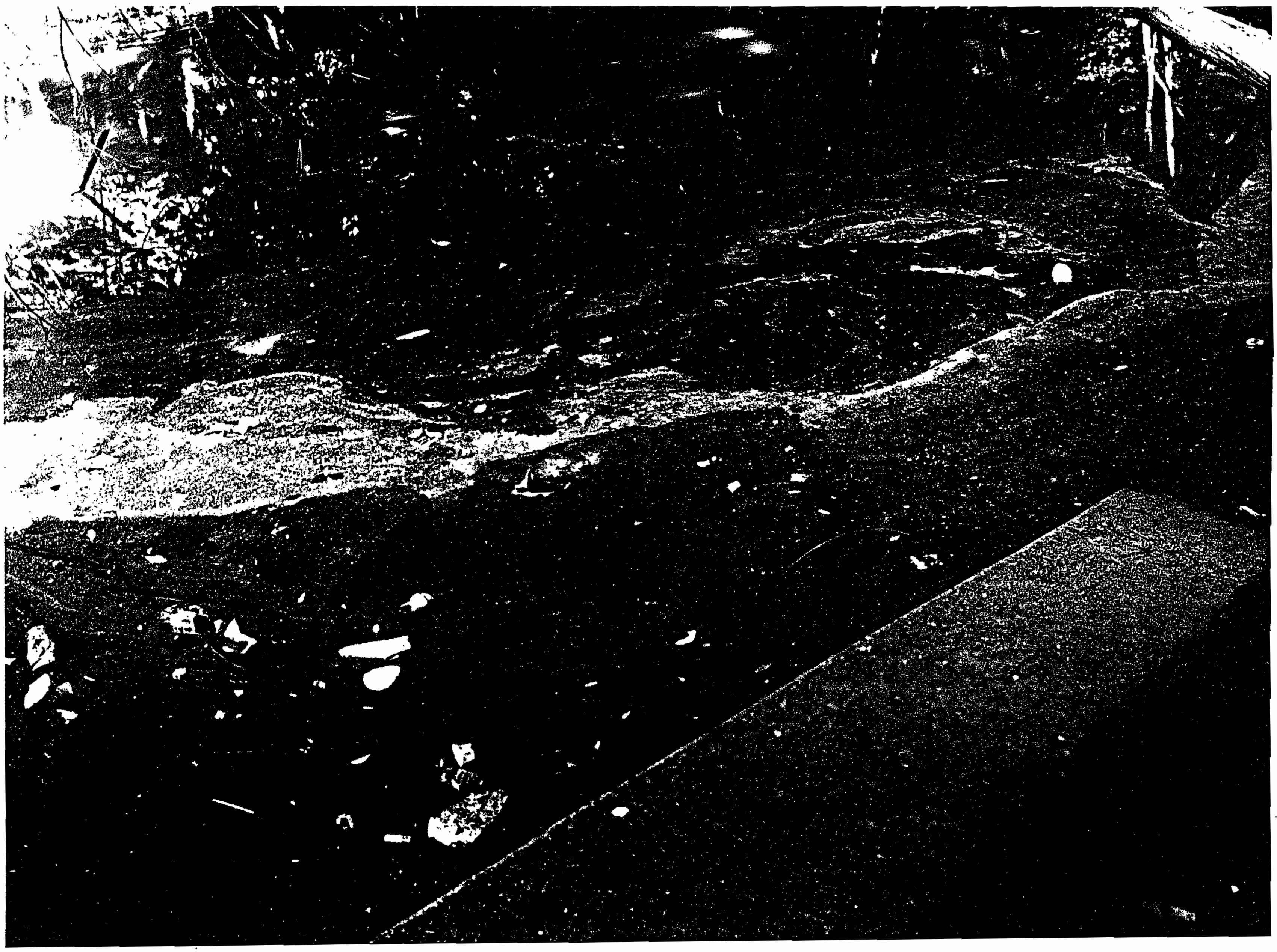


Figure 39. Scum and debris on the surface of Dugway Brook at Lake Shore Blvd.

discovered another dry weather source of sanitary sewage to the East Branch Dugway Brook west of Ablewhite Avenue and Dundee Drive in Cleveland. Inspections revealed a break in a 36-inch sanitary sewer over a 24-inch storm relief sewer at this location, allowing sewage to enter the storm sewer, which was tributary to the brook. Since the sanitary sewer is a NEORSD-owned interceptor, the District contracted O.C.I. Construction, Inc. to make the necessary emergency repairs. By April 12, 1988, this source of pollution in Dugway Brook had been eliminated.

DOAN BROOK

Doan Brook's drainage area includes the communities of Cleveland, Cleveland Heights, and Shaker Heights. According to Havens & Emerson (1968), Doan Brook has a total length of 8.1 miles and a drainage area of 11.7 square miles. About 1.3 miles of the brook is culverted. The brook flows through Shaker Lakes Park, Ambler Park, University Circle, and Rockefeller Park into Lake Erie near Gordon Park.

In 1987, measurements indicated that the dry weather flow in Doan Brook was approximately 8 MGD.

SAMPLING

Doan Brook has been assigned four sample sites for the Stream Monitoring Program (Figure 40).

Sample Site #16 is located on Doan Brook, north of St. Clair Avenue east of Martin Luther King, Jr. Drive. The substrate of the brook consists of small rocks, sand, and silt, and riffles are present. The banks are steep and wooded, with much tree overhang.

Samples for chemical and bacteriological parameters were collected at Site #16 only once in 1988, on January 26th. (Appendix II-N). All chemical data, with the exception of the iron concentration (2.90 mg/L), were within Water Quality Standards for Warmwater Habitat at this site. The chemical data, except for iron and chlorides, which were higher in 1988, were all comparable to those of the previous year.

Bacteriological data obtained at Site #16 in 1988 showed that the fecal coliform concentration was within the Primary Contact Recreational Use Designation limit. The concentration of 540 counts per 100 ml was considerably lower than those obtained at this site in 1987, which averaged over 20,000 counts per 100 ml. One factor may be snowmelt, which reduced the water temperature to 1.5^{o}C and may have provided a dilutive effect at the time of the 1988 sampling.

Also attributable to the snowfall which occurred prior to the sampling is the high chlorides concentration of 410 mg/L, probably from roadsalt run-off.

Sample Site #17 is located on Doan Brook, north of the Cleveland Museum of Art, 11150 East Boulevard. The substrate at this location consists primarily of rubble. The east bank is shale and soil, while the west bank is concrete, and the brook has some tree overhang.

Samples for chemical and bacteriological parameters were collected at Site #17 only once in 1988, on January 26th. (Appendix II-N). All chemical

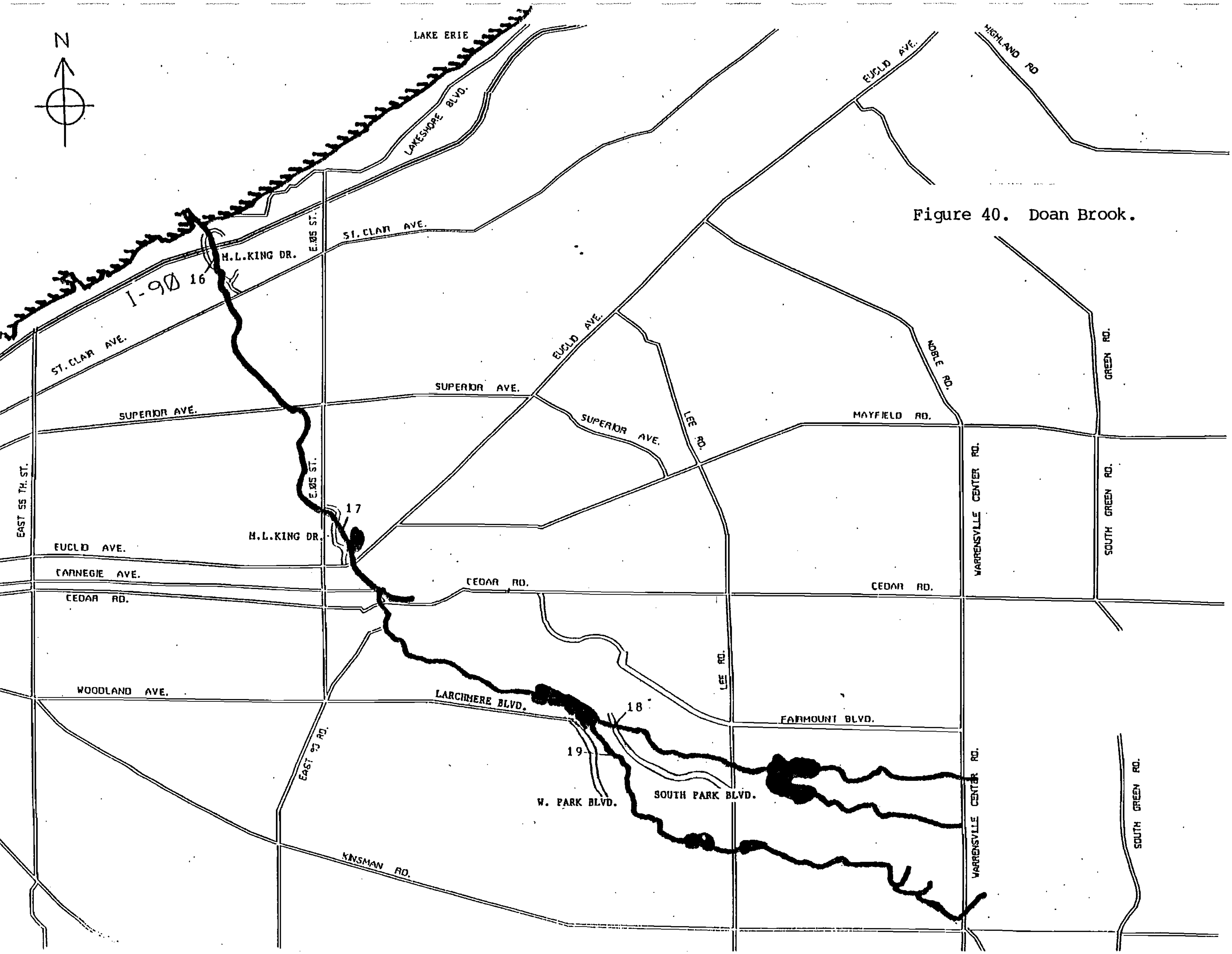


Figure 40. Doan Brook.

data at this site were within Water Quality Standards for Warmwater Habitat and, except for the chlorides concentration, were comparable to the 1987 data.

Bacteriological data at Site #17 showed that the 1988 fecal coliform concentration slightly exceeded the Primary Contact Recreational Use Designation Standard, but, at 3000 counts per 100 ml, was significantly lower than the 1987 average fecal coliform concentration of almost 30,000 counts per 100 ml. The cold-weather water temperature and the dilutive effect of snowmelt at the time of sampling may have contributed to the lower bacterial concentration. Nevertheless, evidence of contamination by sanitary sewage at Site #17 continued to exist in 1988, and may be attributed to an upstream problem near the Margaret Wagner House on Euclid Heights Boulevard, which is discussed later in this report.

Once again, the relatively high chlorides concentration of 222 mg/L at Site #17 may be attributed to snowmelt containing roadsalt run-off.

Sample Site #18 is located on the North Branch of Doan Brook, northeast of the Shaker Lakes Regional Nature Center Office, 2600 South Park Blvd. The substrate at this location consists of sand and small rocks. Vegetation surrounds the brook, which has much tree overhang.

All 1988 chemical data obtained at Site #18 (Appendix II-N) were within Water Quality Standards for Warmwater Habitat, except the concentrations of copper and iron which only slightly exceeded the standards. All of the chemical data were comparable to those of the previous year except the iron and chlorides concentrations, which were both higher in 1988. The chlorides (485 mg/L) are attributable to snowmelt containing roadsalt run-off during the time of sampling.

Bacteriological data at Site #18 (Appendix II-N) showed that the 1988 fecal coliform concentration, at 60 counts per 100 ml, was well within the standards for Primary Contact Recreational Use. 1987 bacteriological levels had also been very low at the location, but the 1988 data were even lower, possibly due, in part, to the cold-weather water conditions during sampling on January 26th. All data suggest that the North Branch of Doan Brook has been relatively free of contamination of sanitary sewage.

Sample Site #19 is located on the South Branch of Doan Brook, southeast of the Shaker Lakes Regional Nature Center Office. The substrate at this location consists of sand and small rocks. Vegetation surrounds the brook, which is completely covered by tree overhang here.

All 1988 chemical data from Site #19 (Appendix II-N) were within Water Quality Standards for Warmwater Habitat. All of the chemical data from this location were also comparable to data obtained the previous year, except the higher chlorides concentration, which, again, may be attributed to roadsalt run-off in snowmelt during the 1988 sampling.

Bacteriological data at Site #19 (Appendix II-N) showed that the 1988 fecal coliform concentration, at 220 counts per 100 ml, was within the standards for Primary Contact Recreational Use. The bacteriological levels were all lower at this location in 1988 than the averages from the previous year. The dilutive effect of snowmelt may have been a factor in the difference, but the data nevertheless suggest, as in the North Branch of Doan Brook, that the South Branch of Doan Brook has been relatively free of contamination by sanitary sewage.

PROBLEMS AND REMEDIATION

Only one dry weather source of sanitary sewage was identified as continuing to be an environmental problem on Doan Brook in 1988: a frequently recurring blockage in the sanitary sewer on Euclid Heights Boulevard in Cleveland Heights. The combined effect of downstream tree root intrusion into this sewer and the accumulation of paper and cloth products discharged from the Margaret Wagner House, a nursing home at 2373 Euclid Heights Boulevard, have resulted in the sanitary sewage overflow at NEORSD-maintained overflow structure No. DV-15 at 2330 Euclid Heights Boulevard. During inspections and maintenance of this overflow structure, NEORSD Sewer Control Systems personnel found dry weather overflows to Doan Brook from this location on 11 of 12 inspections in 1988. Planned rehabilitation of this section of sanitary sewer by the City of Cleveland Heights will, hopefully, eliminate this problem, and the future results of sampling at Site #17 should reflect improving water quality in this section of Doan Brook.

ROCKY RIVER

The Rocky River has two branches, East and West, the confluence of which is at Cedar Point Road in North Olmsted. The main stem of the Rocky River flows north from the confluence approximately ten miles through the communities of North Olmsted, Brook Park, Fairview Park, Cleveland, Rocky River, and finally, Lakewood, where the river enters Lake Erie.

The East Branch of the Rocky River enters Cuyahoga County from Medina County and flows northwest through the communities of North Royalton, Strongsville, Middleburg Heights, Berea, and Olmsted Township to its confluence with the West Branch in North Olmsted. The West Branch of the Rocky River enters Cuyahoga County from Lorain County and flows north through the communities of Olmsted Falls and North Olmsted to the confluence.

Wastewater Treatment Plants which discharge effluents to Rocky River include: Strongsville "A" WWTP (NEORSD operated); Strongsville "B" and "C" WWTP's; North Royalton "B" WWTP; Middleburg Heights WWTP; Brook Park WWTP; Berea WWTP (NEORSD-operated); Columbia Township Subdivision WWTP; Columbia Mobile Home Park WWTP; Olmsted Trailer Park WWTP; Brentwood Subdivision WWTP; Vinewood Subdivision WWTP; and others.

Major tributaries to the Rocky River include: Plum Creek, which joins the West Branch in Olmsted Falls; Blodgett Creek, which also joins the West Branch in Olmsted Falls, and includes the Strongsville "A" WWTP effluent; Baldwin Creek, which joins the East Branch in Berea, and includes the North Royalton "B" WWTP effluent; and Abrams Creek, which joins the main stem in Cleveland, and includes the Middleburg Heights WWTP effluent.

Measurements of the East Branch of Rocky River in 1987, under dry weather conditions, had indicated a flow rate of approximately 13 MGD upstream of its confluence with the West Branch. No other flow measurements of the Rocky River have been obtained by the NEORSD Stream Monitoring Program.

SAMPLING

The Rocky River has been assigned five sample sites for the Stream Monitoring Program (Figure 41).

Sample Site #49 is located in Berea on the East Branch of the Rocky River, at Valley Parkway north of Falls Lane. This site is about 200 yards downstream of the Berea WWTP effluent discharge. The river at Site #49 has many riffles, and the substrate consists of shale, fine gravel, small rocks, and boulders. The river is approximately 50 to 75 feet wide and has heavy vegetation along its banks, including numerous trees.

Sample Site #50 is located on the East Branch of the Rocky River at West Bridge Street in Berea. This site is upstream of the Berea WWTP effluent

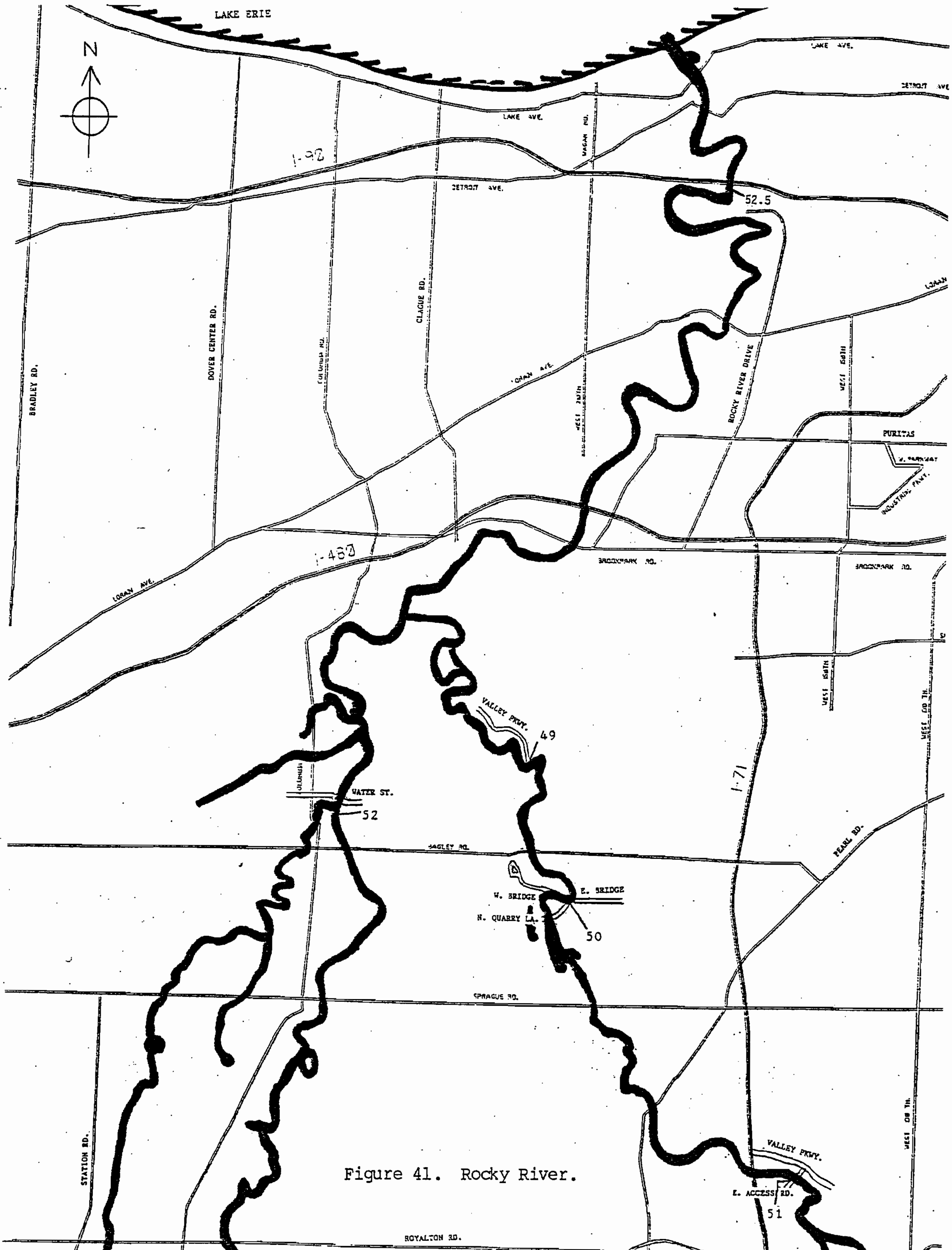


Figure 41. Rocky River.

discharge and about 100 yards downstream of the City of Berea Water Purification Plant. Steep banks on both sides of the river rise over 50 feet, and the river is about 40 feet wide at Site #50. The substrate consists of shale, concrete, asphalt, gravel, sand, and boulders.

Sample Site #51 is located on the East Branch of the Rocky River in Strongsville, approximately 75 feet upstream of East Access Road in the Metroparks Mill Stream Run Reservation. The river is about 45 feet wide, and the substrate consists of shale, gravel, boulders, and logs. The banks are covered with dense vegetation, and the river has some tree overhang.

Sample Site #52 is located on the West Branch of the Rocky River in Olmsted Falls north of Bagley Road. This site is immediately upstream of the confluence with Plum Creek. The location has a large pool, which flows over a six-foot drop at the downstream end, with smaller pools and riffles upstream. The river is about 75 feet wide at this point with a 100-foot steep bank on the east side and a public park on the west side. The west bank is vegetated, with numerous trees. The substrate consists of boulders, gravel, and sand.

Sample Site #52.5 is located on the main stem of the Rocky River in the Metroparks Rocky River Reservation approximately 30 yards upstream of the Hilliard Road Bridge. This site is approximately 200 yards downstream of the storm sewer outfall at Riverside Drive and Hog's Back Lane, which is the northernmost point of the NEORSD jurisdiction on the Rocky River. Sample Site #52.5 was selected to reflect the environmental impact on Rocky River from seven upstream storm sewer outfalls, to which numerous combined sewer overflows have been known to be tributary.

Grab samples for chemical and bacteriological analysis were collected on one occasion in 1988 at each of the Rocky River sites, with the exception of Site #52.5. (Appendix II-O). The results indicated that all chemical parameters tested were within Water Quality Standards for Warmwater Habitat, with the exception of iron, which slightly exceeded the standard of 1.0 mg/L at Sites #49 and #50. All chemical data were comparable to those obtained from the Rocky River in 1987, except chlorides, which were higher in 1988 at all locations. The elevated chlorides levels may be attributable to road salt run-off in snowmelt during the January 19th sampling.

Bacteriological data from Rocky River showed that fecal coliform concentrations exceeded limits for Primary Contact Recreational Use at all samples sites in 1988. All of the bacteriological data were higher than the average concentrations obtained the previous year on the Rocky River. The fecal coliform/fecal streptococcus ratios indicated that the bacterial contamination was from mixed human and non-human sources.

The highest fecal coliform concentration in 1988 was at Site #49 (11,000 counts per 100 ml). This contamination may be primarily attributable to a sanitary sewage overflow upstream of this site, at North Rocky River Drive in Berea, which is discussed below.

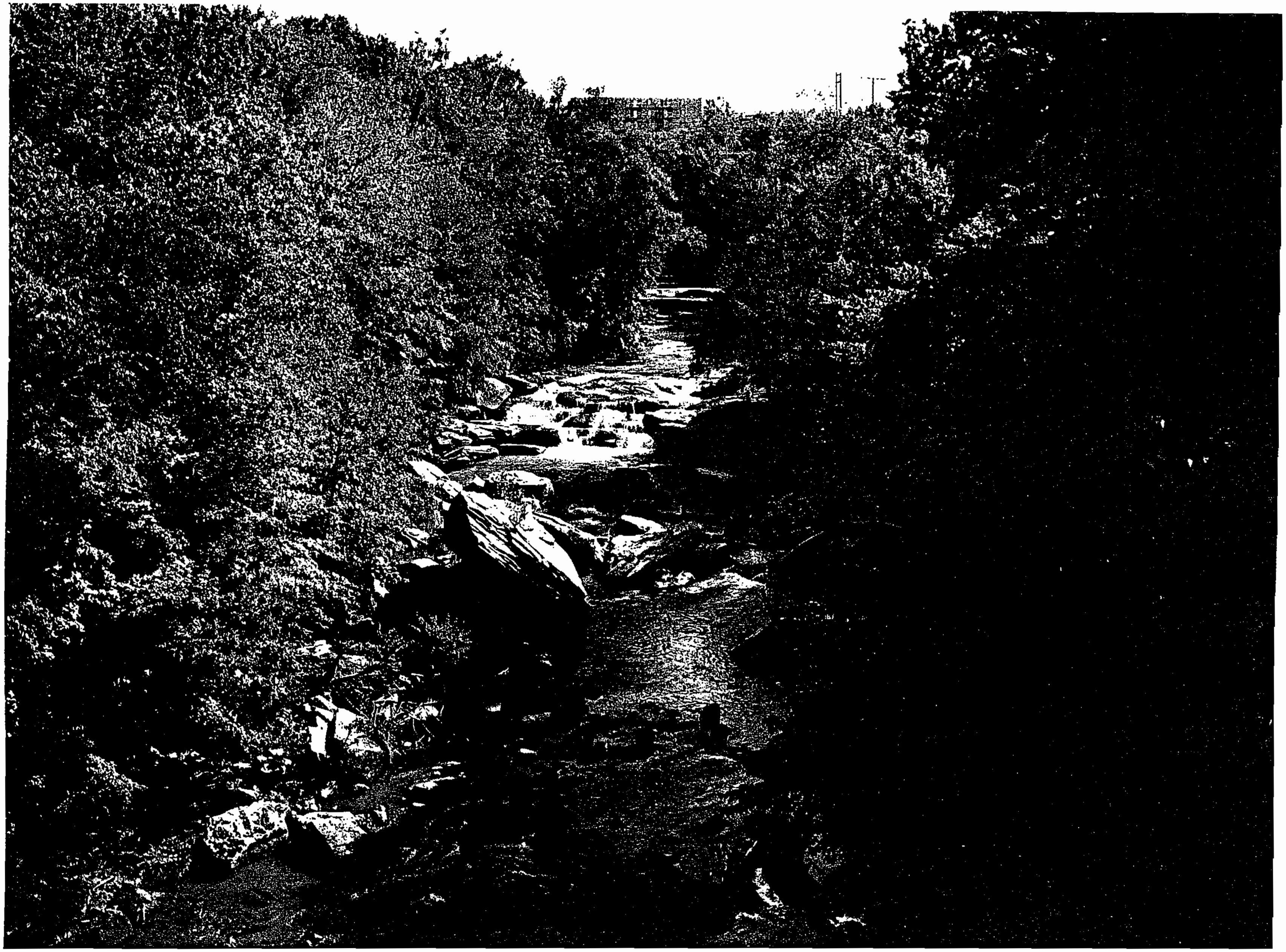


Figure 42. Rocky River at Berea Falls.

PROBLEMS AND REMEDIATION

In 1987, A 48-inch sewer discharging sanitary sewage into the East Branch of the Rocky River had been discovered by NEORSD investigators between Pulaski Street and Depot Street in Berea. The sewer was traced to an overflow of a partially blocked 12-inch sanitary sewer on North Rocky River Drive. City of Berea officials were notified of this problem, and a maintenance crew reduced the obstruction in the 12-inch sewer. However, subsequent inspections indicated that, due to limited sewer capacity, some overflow of sanitary sewage from this location continued, especially during high-flow conditions. 1988 inspections revealed that this situation remained a problem and was probably responsible for elevated bacteriological concentrations found downstream in the Rocky River at Sample Site #49.

On June 1, 1988, NEORSD investigators inspected a tributary to Baldwin Creek, southeast of West 130th and Pleasant Valley Road, in response to an expression of concern about the water quality from a Parma resident. Samples obtained at this location showed no signs of significant pollution, but the North Royalton "B" WWTP effluent is discharged upstream of this site. Therefore, the resident was advised that "direct contact with this creek water, as with any open stream in a well-populated area," should be avoided. It was added that, "while this [WWTP] effluent should ordinarily be treated to meet Ohio EPA Water Quality Standards, occasional sewage bypasses are possible, during which bacterial contamination of the creek could occur."

PROJECTIONS FOR 1989 PROGRAM

CONTINUING STUDIES

In 1989, the third year of the NEORSD's Stream Monitoring, plans are to continue developing those aspects of the Program begun during its first two years. All streams within the jurisdictional area of the District will again be visually inspected for environmental disruptions, focusing on those sections which were found to have been problems in the past. Action will be taken to initiate the remediation of any environmental problems found to be occurring or recurring. A rapport has been established with the various municipalities and governmental agencies responsible for water quality protection.

Chemical and bacteriological sampling will be performed at all of the sample sites throughout the District's jurisdictional area. Additional sites will be selected on streams in the jurisdictional area not previously included in the Program's routine sampling, such as Sagamore Creek and the Chagrin River. Sampling frequency will be increased to improve the statistical significance of the resulting data, especially at those sites which are of greatest environmental concern. In the future, attempts will also be made to meet sampling requirements for the application of Ohio EPA's Water Quality Standards. Thus far, in most cases, chemical and bacteriological data have been collected only for comparative purposes.

In cooperation with the Cuyahoga County Board of Health, additional chemical and bacteriological samples are being planned for streams previously identified as possibly impacted by landfills and septic tanks. It is hoped that some remediation may result from these studies.

In-the-field measurements of the physical characteristics of streams will be performed by NEORSD personnel wherever possible. Towards this goal, portable equipment for measuring various parameters, including temperature, dissolved oxygen, pH, turbidity, and specific conductance, have been purchased for the Stream Monitoring Program.

Qualitative sampling for benthos, which was limited to the Cuyahoga River and its tributaries in 1988 (Appendix IV), will be performed at as many sample sites throughout the jurisdictional area as possible in 1989. Development of biological taxonomic identification skills over the last two years has enabled IWS personnel to produce benthic data with much greater reliability and to interpret that data more meaningfully. Benthic sample-processing techniques improving through trial-and-error and increasing familiarity with benthic taxa have contributed to that development. Further evaluation of benthic communities will prove to be a valuable tool in assessing the long-term water quality of area streams.

Some quantitative sampling for benthic macroinvertebrates, which was conducted at several locations on the Cuyahoga River and Ohio Canal in 1988 (Appendix IV), will be repeated in 1989 for comparison of results. This data will again be subjected to the Ohio EPA's Invertebrate Community Index (ICI) and any other applicable biological indices for the assessment of water quality. Any significant quantitative differences found in results between sampling periods and/or locations will be noted and discussed in future reports.

Quantitative sampling for fish, which was conducted on the Cuyahoga River and Ohio Canal in 1988 (Appendix V) will also be duplicated in 1989. The Stream Monitoring Program is planning to obtain the necessary equipment in 1989 to perform electrofishing studies, which had been accomplished through the assistance of a consultant in 1988. Data obtained from the electrofishing results will be subjected to the Ohio EPA's Index of Well Being (I_{wb}), the Index of Biological Integrity (IBI), and any other applicable biological indices. As with the quantitative benthic data, results will be compared with previous Ohio EPA and NEORSD results and interpreted for the implications regarding the changing conditions of water quality.

CSO MONITORING PROGRAM

In compliance with the provisions of the federal and state water pollution control acts, the NEORSD is authorized by the Ohio EPA to discharge from its Combined Sewer Overflows (CSO's) only during wet weather periods when flow exceeds the maximum capacity of the sewer system. This authorization is in accordance with OEPA NPDES Permit No. 3PA00002*DD, which went into effect on May 25, 1988. Monitoring and sampling in compliance with the permit began on November 25, 1988.

The Industrial Waste Section was given the responsibility of monitoring the approximate 130 permitted CSO's. Five CSO's will be monitored simultaneously on a rotational basis as follows: A location will be monitored and sampled for a minimum of three weeks. Assuming that a minimum of two overflow events occur during this three-week period, the equipment will be removed at the end of the period and reinstalled the following week at a new location. If, during the three-week period, there is insufficient precipitation, the equipment will remain on site until two overflow events occur. Since the overflow events are weather-dependent, no definite time period for rotation can be predicted.

To collect overflow samples, an automatic sampler is used in conjunction with an sample actuator. The sample-collecting probe is positioned in the storm outlet to the environment, and the actuator is positioned in such a fashion that it triggers the sample collection when overflow begins. According to the permit, the NEORSD is required to sample during the first 30 minutes of overflow and analyze the sample for BOD and suspended solids concentrations.

To measure physical overflow conditions, an ISCO 1870 flow meter is being used to chart time versus depth. Background velocity measurements are taken during both dry-weather and wet-weather conditions to calibrate the flow meter. Also used is a Marsh-McBirney "Flo-Tote" open-channel flow meter, which can measure velocity with an electromagnetic (Faraday Principle) sensor and flow depth with a submerged pressure transducer. The depth, velocity, and duration of overflow are logged into solid-state memory until retrieval with a portable "lap-top" computer.

Following are the receiving waters and numbers of locations to be included in the CSO-Monitoring Program, in order of sampling priority: the Cuyahoga River (27); Big Creek (18); Mill Creek (26), West Creek (1); Lake Erie (19) Doan Brook (16); Dugway Brook (2); Nine-Mile Creek (3); Euclid Creek (2); Shaw Brook (1); Green Creek (1); the Rocky River (7).

The permit stipulates that the NEORSD is to report monthly chemical and flow data from the CSO-Monitoring Program to the Ohio EPA. These data will also be used in 1989 to help the NEORSD Stream Monitoring Program assess the impact of combined sewer overflows on the water quality of area streams. Most previous chemical sampling by the Stream Monitoring Program reflected only dry-weather conditions. With the addition of the CSO-Monitoring Program, the effect of wet weather on the environment will also be observed.

In a related study, the Stream Monitoring Program will also be sampling and measuring overflows which occur during storm events at NEORSD Wastewater Treatment Plants. The frequencies, volumes, and chemical and bacteriological content of these overflows will be looked at in 1989, along with their relation to weather conditions.

TOXIC SUBSTANCES CONFIRMATION STUDY

The Stream Monitoring Program is planning to include in 1989 a "Confirmation of Toxic Substances Problems" on the Cuyahoga River as recommended by the International Joint Commission's Monitoring Areas of Concern Workshop of 1985. This confirmation is advised for the Remedial Action Plans in areas of concern because data and information are often old and/or limited. It would include tests to confirm the presence of toxic substances through the following: contaminated sediment; contaminated fish; contaminants bioaccumulating in benthos; tumors in fish; toxicity of ambient waters.

The 1989 Stream Monitoring Program would perform these tests for at least the following locations: the Cuyahoga River upstream of the Southerly WWTP effluent; the Cuyahoga River downstream of the Southerly WWTP effluent; a comparable location on a river not classified as an Area of Concern (such as the Grand River or the Chagrin River).

Sediment will be sampled at each location by NEORSD personnel using a Ponar Bottom Grab. Each sediment sample will be analyzed by the NEORSD Laboratory for lead, nickel, copper, zinc, cadmium, chromium, iron, manganese, mercury, arsenic, total phosphorus, bioavailable phosphorus (NaOH-extractable), total organic matter (by ignition), and water content (by oven drying). Additionally, each sediment sample will be analyzed for Total Toxic Organics by a contracted laboratory.

Fish will be caught using nets and/or electroshocking at each location. The ten largest bottom-feeders (carp, suckers, or bullhead) caught at each location will be identified, weighed, and measured in the field, and then wrapped in hexane-rinsed aluminum foil and stored at -25°C. The age of each fish will be determined and recorded. Each fish will be processed for tissue analysis, following descaling and deboning, by homogenization. Portions of each homogenized fish tissue sample will be analyzed by the NEORSD Laboratory for the following parameters: lead, nickel, copper, zinc, cadmium, chromium, iron, manganese, mercury; arsenic. The remaining homogenized fish tissue samples will undergo an organics extraction procedure, and will be sent to a contracted laboratory for analysis of Total Toxic Organics.

Fish will also be caught at each location and analyzed for the incidence of tumors, following the guidelines set forth in Gross Signs of Tumors in Great Lakes Fish: A Manual for Field Biologists, to be published by the Great Lakes Fishery Commission. The Stream Monitoring Program has obtained a draft copy of this manual.

Benthic macroinvertebrates will be collected at each location, to determine contaminant bioaccumulation, using a Ponar Bottom Grab. At least 0.5 grams of chironomids or oligochaetes will be sieved, and the intestinal contents of the organics will be purged in distilled water for 24 hours. They will then be submitted to a laboratory for analysis of the following parameters: lead, nickel, copper, zinc, cadmium, chromium, iron, manganese, mercury, arsenic, and Total Toxic Organics.

Finally, bioassays to evaluate the toxicity of ambient water from the specified locations are to be prepared by the NEORSD Laboratory. The results of these analyses will be included with the other data obtained in this study when assessing the present nature, extent, and impact of the contamination by toxic substances in the Cuyahoga River.

NON-POINT SOURCE STUDIES

In the National Water Quality Inventory: Report to Congress (1986), the United States Environmental Protection Agency stated that non-point sources represent the dominant fraction of the nation's remaining surface water pollution problems. It attributed to non-point sources 65% of the remaining pollution in rivers and 76% of the remaining pollution in lakes. Therefore, due to their relative impact, non-point sources must not be overlooked in assessing water quality.

The NEORSD Stream Monitoring Program in 1989 is planning to devote more of its efforts towards identifying and evaluating the impacts of various non-point sources of pollution in Greater Cleveland Area Streams. For example, more sampling will be conducted to measure the contribution of chlorides to the Cuyahoga River from roadsalting during snowmelt. Sampling and analysis of rainwater will be conducted to measure the amounts of contaminants tributary to surface waters through atmospheric deposition. Further sampling and measurements could be used to evaluate the impact of solids loadings on waterways from erosional sources during rain events. All of these factors, and many more from other non-point sources, may contribute significantly to Water Quality Standards attainment failures. To identify them and evaluate their impacts are necessary steps in improving our understanding of the highly complex systems which are our creeks, rivers, and lakes.

APPENDIX I: REFERENCES

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APPENDIX II

1988 CHEMICAL AND BACTERIOLOGICAL DATA*

*NOTE: Data presented are from analyses of grab samples obtained under dry-weather conditions. Bacteriological data presented are geometric means in counts/100 ml; other data presented are arithmetic means in mg/L unless otherwise specified. In calculating the means, data lower than detection limits were considered half the detection limits, unless all the data at a site were lower than detection limits. Individual data are on file by date of sampling and are available for review upon request at the NEORSD Industrial Waste Section offices.

APPENDIX II Key:

mg/L = Milligrams/Liter
Temp. (°C) = Water temperature (in degrees Celsius)
D.O. = Dissolved Oxygen
BOD = Biological Oxygen Demand
COD = Chemical Oxygen Demand
SS = Suspended Solids
TDS = Total Dissolved Solids
Sp.Con.(umhos/cm) = Specific Conductance (in micromhos/centimeter)
NH_3 = Ammonia
P = Phosphorus
Soluble P = Soluble Phosphorus
NO_3 = Nitrates
NO_2 = Nitrites
TKN = Total Kjeldahl Nitrogen
Cl = Chlorides
SO_4 = Sulfates
Ni = Nickel
Cu = Copper
Cr = Chromium (total)
Zn = Zinc
Fe = Iron
Cd = Cadmium
Pb = Lead
Hg (ug/L) = Mercury (in micrograms/Liter)
Total Coli. = Total Coliform bacteria
Fecal Coli. = Fecal Coliform bacteria
Fecal Strep. = Fecal Streptococcus bacteria

APPENDIX II-A: Cuyahoga River

Sample Dates: 4/11, 4/26, 6/1, 6/29, 7/20, 8/17, 9/7/88

Sample Sites #	20	22	22.5	22.51
No. of Samples	7	7	7	7
Temp. (°C)	21.7	22.8	19.8	19.1
D.O.	5.0	4.9	7.3	8.2
BOD	2	3	4	4
COD	25	33	33	30
SS	26	35	30	28
Total Solids	566	651	633	592
TDS	453	535	513	509
Sp.Con.(umhos/cm)	757	862	789	804
NH_3	1.75	2.15	0.53	0.48
P	0.21	0.32	0.33	0.28
Soluble P	0.09	0.17	0.18	0.20
NO_3	3.38	4.85	5.17	5.14
NO_2	0.12	0.10	0.06	0.06
TKN	4.41	4.66	3.28	2.87
Cl	139	160	146	140
SO_4	84	105	101	94
Alkalinity	113	118	117	118
Hardness	267	213	241	225
Ni	0.23	0.03	0.05	0.03
Cu	0.01	0.01	0.01	0.01
Cr	<0.01	0.01	0.01	0.01
Zn	0.10	0.09	0.07	0.08
Fe	1.57	1.36	1.40	1.43
Cd	<0.01	<0.01	<0.01	0.01
Pb	0.03	0.03	0.02	0.02
Hg (ug/L)	0.08	0.21	0.07	0.08
Total Coli.	2,304	4,451	2,832	3,284
Fecal Coli.	571	1,582	1,026	1,133
Fecal Strep.	130	260	276	369

APPENDIX II-B: Cuyahoga River (continued)

Sample Dates: 4/11, 4/26, 6/1, 6/29, 7/20, 8/17, 9/7/88

Sample Sites #	22.6	22.7	22.8	22.9
No. of Samples	3	3	3	7
Temp. (°C)	22.3	20.0	19.8	17.4
D.O.	7.8	8.3	8.0	8.8
BOD	4	4	4	3
COD	29	26	31	28
SS	49	44	66	32
Total Solids	614	532	525	514
TDS	535	492	467	465
Sp.Con.(umhos/cm)	669	746	708	795
NH_3	0.70	0.40	0.47	0.55
P	0.42	0.43	0.27	0.20
Soluble P	0.26	0.31	0.11	0.09
NO_3	4.25	4.50	2.67	2.59
NO_2	0.05	0.05	0.05	0.05
TKN	2.90	2.89	2.52	2.48
Cl	140	123	117	136
SO_4	97	95	84	87
Alkalinity	125	114	121	130
Hardness	239	306	173	217
Ni	0.03	0.03	0.02	0.06
Cu	0.02	0.01	0.01	0.01
Cr	0.01	0.01	<0.01	0.01
Zn	0.05	0.09	0.09	0.03
Fe	1.50	1.80	2.17	1.54
Cd	<0.01	<0.01	0.01	0.01
Pb	0.05	0.05	0.05	0.02
Hg (ug/L)	0.12	0.08	0.08	0.11
Total Coli.	2,434	1,481	3,518	1,900
Fecal Coli.	699	734	374	570
Fecal Strep.	289	514	510	183

APPENDIX II-C: Cuyahoga River (continued)

Sample Dates: 4/11, 4/26, 6/1, 6/29, 7/20, 8/17, 9/7/88

Sample Sites #	23	24
No. of Samples	7	7
Temp. (°C)	17.0	16.9
D.O.	8.4	8.0
BOD	3	3
COD	31	28
SS	26	25
Total Solids	631	600
TDS	510	512
Sp.Con.(umhos/cm)	780	795
NH_3	0.43	0.49
P	0.22	0.22
Soluble P	0.11	0.13
NO_3	2.73	2.81
NO_2	0.04	0.07
TKN	2.36	2.36
Cl	136	137
SO_4	85	84
Alkalinity	128	127
Hardness	243	261
Ni	0.02	0.06
Cu	0.01	0.01
Cr	<0.01	0.01
Zn	0.04	0.25
Fe	1.07	1.05
Cd	<0.01	<0.01
Pb	0.03	0.03
Hg (ug/L)	0.17	0.07
Total Coli.	1,566	238
Fecal Coli.	402	503
Fecal Strep.	183	167

APPENDIX II-D: Ohio Canal

Sample Dates: 7/6, 7/27, 8/31, 9/28/88

Sample Sites #	53	54	55	56
No. of Samples	4	4	4	4
Temp. (°C)	20.9	20.2	20.2	19.8
D.O.	8.7	8.2	8.3	7.6
BOD	2	2	2	1
COD	23	24	25	21
SS	32	48	52	33
Total Solids	659	692	689	667
TDS	587	592	588	590
Sp.Con.(umhos/cm)	930	949	929	919
NH_3	0.19	0.25	0.21	0.25
P	0.25	0.30	0.31	0.29
Soluble P	0.12	0.14	0.16	0.18
NO_3	3.07	3.70	3.74	3.70
NO_2	0.09	0.05	0.05	0.04
TKN	3.15	3.02	2.38	2.89
Cl	161	177	165	165
SO_4	96	94	97	94
Alkalinity	141	141	139	139
Hardness	319	225	240	228
Ni	0.01	0.01	<0.01	0.01
Cu	0.01	0.01	0.01	0.01
Cr	0.02	<0.01	0.03	<0.01
Zn	0.03	0.04	0.06	0.04
Fe	1.40	1.58	2.47	1.10
Cd	<0.01	<0.01	<0.01	<0.01
Pb	0.03	0.02	0.02	0.01
Hg (ug/L)	0.01	0.01	0.08	0.06
Total Coli.	957	1,115	1,045	956
Fecal Coli.	243	517	281	487
Fecal Strep.	312	430	200	189

APPENDIX II-E: Big Creek (Main Stream/West Branch)

Sample Dates: 6/20, 8/10, 9/28/88

Sample Sites #	25	27	28
No. of Samples	3	3	3
Temp. (°C)	20.6	20.1	23.1
D.O.	7.2	6.8	14.7
BOD	3	4	3
COD	34	35	33
SS	13	23	9
Total Solids	577	673	687
TDS	576	643	639
Sp.Con.(umhos/cm)	827	950	891
NH_3	0.90	2.32	0.51
P	0.62	0.87	0.36
Soluble P	0.56	0.78	0.09
NO_3	0.56	0.60	0.32
NO_2	0.13	0.12	0.04
TKN	2.52	6.00	3.17
Cl	177	193	189
SO_4	80	94	97
Alkalinity	137	161	128
Hardness	183	190	231
Ni	0.06	0.02	<0.01
Cu	0.01	0.01	0.01
Cr	<0.01	<0.01	0.01
Zn	0.03	0.04	0.05
Fe	0.43	1.40	0.40
Cd	<0.01	<0.01	<0.01
Pb	<0.01	<0.01	<0.01
Hg (ug/L)	0.13	0.22	0.12
Total Coli.	14,486	41,877	1,364
Fecal Coli.	5,507	15,013	270
Fecal Strep.	933	7,106	86

APPENDIX II-F: Big Creek (East Branch/Stickney Creek)

Sample Dates: 6/20, 8/10, 9/28/88

Sample Sites #	26	29	30
No. of Samples	3	3	3
Temp. (°C)	20.2	20.5	19.9
D.O.	9.0	8.2	9.1
BOD	2	2	1
COD	24	32	28
SS	9	18	30
Total Solids	580	587	490
TDS	508	470	438
Sp.Con.(umhos/cm)	716	647	631
NH_3	0.22	0.43	0.11
P	0.23	0.21	0.24
Soluble P	0.19	0.16	0.31
NO_3	0.56	0.53	0.47
NO_2	0.05	0.08	0.05
TKN	2.15	2.52	2.52
Cl	133	113	118
SO_4	92	89	62
Alkalinity	125	115	125
Hardness	198	195	154
Ni	0.01	0.01	0.01
Cu	0.01	0.01	0.01
Cr	<0.01	0.01	0.01
Zn	0.02	0.03	0.08
Fe	0.23	0.63	2.53
Cd	<0.01	<0.01	<0.01
Pb	<0.01	<0.01	<0.01
Hg (ug/L)	0.05	0.10	0.08
Total Coli.	12,227	39,240	30,805
Fecal Coli.	3,977	8,707	7,629
Fecal Strep.	2,094	908	635

APPENDIX II-G: Mill Creek

Sample Dates: 6/8, 7/6/88

Sample Sites #	31	32	33	33.5
No. of Samples	2	2	2	2
Temp. (°C)	20.2	21.0	19.8	19.5
D.O.	7.4	3.4	7.6	3.1
BOD	30	-	23	-
COD	-	159	75	75
SS	15	6	6	7
Total Solids	800	1900	600	600
TDS	743	1550	545	488
Sp.Con.(umhos/cm)	1248	341	921	848
NH_3	3.70	1.16	1.33	3.95
P	0.53	0.15	0.55	0.88
Soluble P	0.27	0.02	0.42	0.66
NO_3	0.66	0.43	0.36	0.07
NO_2	0.37	0.05	0.17	0.03
TKN	5.88	3.08	2.24	5.88
Cl	220	160	161	106
SO_4	125	398	91	139
Alkalinity	232	866	152	130
Hardness	227	104	176	246
Ni	0.02	0.02	0.06	0.02
Cu	0.02	0.02	<0.01	0.01
Cr	<0.01	<0.01	<0.01	<0.01
Zn	0.12	0.48	0.05	1.60
Fe	1.80	0.70	0.60	1.00
Cd	<0.01	<0.01	<0.01	<0.01
Pb	<0.01	0.04	<0.01	0.04
Hg (ug/L)	0.05	0.05	0.05	0.10
Total Coli.	61,000	25,000	7,000	-
Fecal Coli.	7,200	5,000	3,000	310,000
Fecal Strep.	3,000	-	540	100,000

APPENDIX II-H: Mill Creek (continued)

Sample Dates: 6/8, 7/6/88

Sample Sites #	34	35
No. of Samples	2	2
Temp. (°C)	20.7	19.6
D.O.	8.4	8.0
BOD	23	15
COD	31	22
SS	2	11
Total Solids	600	700
TDS	505	640
Sp.Con.(umhos/cm)	952	1124
NH_3	1.55	0.12
P	1.14	0.06
Soluble P	0.84	0.04
NO_3	0.72	0.34
NO_2	0.16	0.05
TKN	5.04	2.10
Cl	182	251
SO_4	52	56
Alkalinity	158	154
Hardness	140	151
Ni	<0.01	<0.01
Cu	0.01	0.01
Cr	<0.01	<0.01
Zn	1.20	1.00
Fe	0.60	0.80
Cd	<0.01	<0.01
Pb	0.04	0.06
Hg (ug/L)	0.05	0.10
Total Coli.	20,000	5,300
Fecal Coli.	3,300	4,200
Fecal Strep.	420	4,300

APPENDIX II-I: West Creek

Sample Dates: 5/4, 8/8/88

Sample Sites #	36	37	38
No. of Samples	2	2	2
Temp. (°C)	16.9	15.6	15.4
D.O.	13.9	12.0	12.4
BOD	2	6	2
COD	24	20	19
SS	5	4	3
Total Solids	700	550	750
TDS	684	548	699
Sp.Con.(umhos/cm)	1146	916	1118
NH_3	0.32	0.15	0.39
P	0.09	0.04	0.11
Soluble P	0.03	0.04	0.08
NO_3	0.44	0.60	1.27
NO_2	0.04	0.03	0.05
TKN	2.44	2.66	2.94
Cl	280	197	219
SO_4	114	108	144
Alkalinity	117	106	124
Hardness	188	203	360
Ni	<0.01	0.01	0.04
Cu	0.01	<0.01	0.03
Cr	0.01	<0.01	0.01
Zn	0.05	0.02	0.02
Fe	0.26	0.22	0.40
Cd	<0.01	<0.01	<0.01
Pb	0.01	<0.01	0.01
Hg (ug/L)	0.12	0.08	0.12
Total Coli.	2,872	1,951	1,224
Fecal Coli.	212	112	229
Fecal Strep.	156	72	134

APPENDIX II-J: Tinkers Creek

Sample Dates: 4/19, 6/13/88

Sample Sites #	39	40	41	42
No. of Samples	2	2	2	2
Temp. (°C)	13.9	14.4	13.4	13.7
D.O.	12.9	12.5	9.3	11.6
BOD	4	4	3	5
COD	24	24	24	28
SS	60	38	25	46
Total Solids	600	600	600	600
TDS	440	434	418	366
Sp.Con.(umhos/cm)	883	872	837	789
NH_3	0.79	0.46	0.62	0.69
P	0.38	0.22	0.25	0.38
Soluble P	0.20	0.10	0.10	0.12
NO_3	3.24	3.17	2.25	0.90
NO_2	0.08	0.10	0.10	0.08
TKN	1.82	2.10	2.10	1.68
Cl	189	186	158	140
SO_4	84	74	66	58
Alkalinity	134	117	144	156
Hardness	198	188	212	152
Ni	<0.01	0.06	0.02	0.01
Cu	0.01	0.01	0.01	0.01
Cr	<0.01	0.01	<0.01	0.01
Zn	0.02	0.03	0.05	0.02
Fe	0.35	0.85	1.35	1.30
Cd	<0.01	<0.01	<0.01	<0.01
Pb	0.02	0.02	0.01	0.01
Hg (ug/L)	0.10	0.10	0.10	0.10
Total Coli.	1,677	4,756	5,970	3,294
Fecal Coli.	410	1,162	735	375
Fecal Strep.	94	95	65	70

APPENDIX II-K: Chippewa Creek

Sample Dates: 2/8, 4/27, 6/14/88

Sample Sites #	43	43.5	44
No. of Samples	3	3	3
Temp. (°C)	9.6	7.8	8.9
D.O.	13.1	12.7	12.7
BOD	1	1	2
COD	13	10	13
SS	9	6	4
Total Solids	800	1000	700
TDS	802	1028	633
Sp.Con.(umhos/cm)	1356	1504	1057
NH3	0.68	0.33	0.45
P	0.10	0.07	0.42
Soluble P	0.04	0.05	0.36
NO_3	0.52	0.59	0.95
NO_2	0.01	0.04	0.06
TKN	3.08	2.71	3.45
Cl	246	182	162
SO_4	171	326	150
Alkalinity	147	228	165
Hardness	200	337	283
Ni	0.06	0.02	0.04
Cu	0.01	<0.01	0.01
Cr	<0.01	<0.01	<0.01
Zn	0.03	0.03	0.06
Fe	0.12	0.11	0.29
Cd	0.01	0.01	0.01
Pb	<0.01	<0.01	0.01
Hg (ug/L)	0.07	0.12	0.12
Total Coli.	456	238	3,116
Fecal Coli.	94	22	551
Fecal Strep.	120	100	1,661

APPENDIX II-L: Kingsbury Run/Morgana Run/Burke Brook

Sample Dates: 9/19, 11/18, 12/5, 12/6/88

Sample Sites #	46	47	48
No. of Samples	4	1	1
Temp. (°C)	18.0	2.0	19.0
D.O.	3.2	8.0	8.0
BOD	21	6	14
COD	35	63	82
SS	14	-	52
Total Solids	700	1200	1200
TDS	707	1127	1187
Sp.Con.(umhos/cm)	975	-	1585
NH3	4.59	-	6.41
P	0.47	0.09	0.19
Soluble P	0.27	0.07	0.12
NO_3	2.28	-	2.16
NO_2	0.21	-	0.24
TKN	7.28	2.80	7.84
Cl	173	358	322
SO_4	133	184	240
Alkalinity	194	30	122
Hardness	688	-	940
Ni	0.02	0.01	0.04
Cu	0.01	<0.01	<0.01
Cr	0.19	0.02	0.01
Zn	0.10	0.08	0.10
Fe	1.40	3.60	1.70
Cd	<0.01	<0.01	<0.01
Pb	0.02	0.03	0.02
Hg (ug/L)	0.30	-	0.10
Total Coli.	18,099	120	191,000
Fecal Coli.	5,372	60	83,000
Fecal Strep.	1,265	60	6,300

APPENDIX II-M: Dugway Brook

Sample Dates: 1/27/88

Sample Sites #	12	13	14	15
No. of Samples	1	1	1	1
Temp. (°C)	4.0	2.0	0.0	2.0
D.O.	12.0	13.0	14.0	13.0
BOD	80	-	0	12
COD	196	31	20	73
SS	82	17	5	14
Total Solids	-	-	-	-
TDS	1633	1900	1437	2300
Sp.Con.(umhos/cm)	2460	2750	2020	3300
NH_3	6.46	1.67	1.87	5.46
P	1.16	0.73	0.81	0.87
Soluble P	1.08	0.66	0.76	0.79
NO_3	0.57	1.12	0.59	0.53
NO_2	0.06	0.11	0.12	0.11
TKN	14.84	2.52	5.32	12.04
Cl	830	974	686	1190
SO_4	78	103	86	100
Alkalinity	162	162	156	196
Hardness	254	-	-	-
Ni	<0.01	<0.01	<0.01	<0.01
Cu	<0.02	0.01	<0.01	<0.01
Cr	0.01	0.01	0.01	0.01
Zn	0.02	0.07	0.02	0.02
Fe	1.00	0.80	0.30	1.20
Cd	<0.01	<0.01	<0.01	<0.01
Pb	<0.01	<0.01	0.01	<0.01
Hg (ug/L)	0.20	0.20	-	0.20
Total Coli.	3,100,000	330,000	310,000	990,000
Fecal Coli.	580,000	110,000	130,000	370,000
Fecal Strep.	570,000	130,000	52,000	76,000

APPENDIX II-N: Doan Brook

Sample Dates: 1/26/88

Sample Sites #	16	17	18	19
No. of Samples	1	1	1	1
Temp. (°C)	1.5	1.8	1.0	1.0
D.O.	7.0	14.0	11.5	11.0
BOD	20	-	-	-
COD	31	20	22	16
SS	46	6	14	20
Total Solids	-	-	-	-
TDS	1266	540	1069	1056
Sp.Con.(umhos/cm)	1874	855	1764	1693
NH_3	1.08	0.72	0.22	0.44
P	0.50	0.35	0.06	0.10
Soluble P	0.14	0.27	0.04	0.06
NO_3	0.84	0.53	1.01	0.90
NO_2	0.06	0.02	0.07	0.04
TKN	3.92	2.80	2.24	1.96
Cl	410	222	485	498
SO_4	153	52	66	60
Alkalinity	337	102	131	122
Hardness	316	157	291	297
Ni	<0.01	<0.01	<0.01	<0.01
Cu	0.01	0.01	0.02	<0.01
Cr	<0.01	<0.01	<0.01	0.01
Zn	0.04	0.01	0.04	<0.01
Fe	2.90	0.20	1.20	0.90
Cd	0.01	<0.01	<0.01	<0.01
Pb	<0.01	0.02	0.01	<0.01
Hg (ug/L)	0.10	0.05	0.10	-
Total Coli.	20,000	230,000	300	2,500
Fecal Coli.	540	3,000	60	220
Fecal Strep.	450	7,800	40	350

APPENDIX II-O: Rocky River

Sample Dates: 1/19/88

Sample Sites #	49	50	51	52
No. of Samples	1	1	1	1
Temp. (°C)	1.7	1.7	1.1	1.2
D.O.	11.4	11.4	13.6	13.4
BOD	9	9	4	8
COD	16	18	16	22
SS	40	35	25	19
Total Solids	700	600	500	600
TDS	643	557	501	590
Sp. Con.(umhos/cm)	1020	921	805	931
NH_3	0.78	0.78	1.76	1.22
P	0.31	0.24	0.35	0.10
Soluble P	0.25	0.10	0.18	0.04
NO_3	0.48	1.42	1.49	0.09
NO_2	0.05	0.04	0.02	2.81
TKN	1.82	2.24	2.52	2.80
Cl	252	222	184	172
SO_4	67	62	83	109
Alkalinity	113	116	124	135
Hardness	220	214	239	122
Ni	0.07	0.08	0.08	0.01
Cu	0.01	0.01	<0.01	0.01
Cr	0.01	0.02	0.01	0.01
Zn	0.26	0.01	0.01	0.02
Fe	1.50	1.80	1.00	0.80
Cd	<0.01	<0.01	<0.01	<0.01
Pb	0.03	<0.01	<0.01	<0.01
Hg (ug/L)	0.05	0.05	0.10	0.05
Total Coli.	41,000	29,000	5,200	47,000
Fecal Coli.	11,000	4,700	1,600	4,800
Fecal Strep.	5,800	3,900	1,900	4,700

APPENDIX II-P: Chagrin River (RM 10.5)/Grand River (RM 21)

Sample Dates: 8/16, 11/1/88

River	Chagrin	Grand
No. of Samples	2	2
Temp. (°C)	13.5	15.2
D.O.	9.9	9.6
BOD	2	1
COD	33	30
SS	18	21
Total Solids	380	270
TDS	367	240
Sp.Con.(umhos/cm)	582	361
NH_3	0.05	0.20
P	0.12	0.08
Soluble P	0.05	0.04
NO_3	0.28	0.71
NO_2	0.12	0.18
TKN	1.96	1.26
Cl	81	34
SO_4	62	60
Alkalinity	136	75
Hardness	120	87
Ni	<0.01	<0.01
Cu	0.02	0.01
Cr	<0.01	<0.01
Zn	0.02	0.01
Fe	0.60	0.50
Cd	<0.01	<0.01
Pb	<0.01	0.01
Hg (ug/L)	0.30	0.10
Total Coli.	684	76
Fecal Coli.	167	32
Fecal Strep.	69	20

APPENDIX III

1988 QUALITATIVE RESULTS OF SAMPLING FOR BENTHIC MACROINVERTEBRATES

Including General Pollution Tolerances of Taxa and Literature Sources for Tolerances.

(Taxa with asterisks were only collected on artificial substrate samplers.)

Appendix III-A: Site #22.5, Cuyahoga River (8/22/88)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason,et.al.,1971
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Crangonyx gracilis	Facultative	Mason,et.al.,1971
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Gastropoda		
Helisoma anceps	Facultative	Ingram,1957
Physella sp.	Tolerant	OEPA,1987

Appendix III-B: Site #22.51, Cuyahoga River (8/22/88)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason,et.al.,1971
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Gammarus fasciatus	Facultative	Mason,et.al.,1971
Ephemeroptera		
Stenacron sp.	Facultative	Mason,et.al.,1971
Baetis sp.	Facultative/Intolerant	Roback,1974
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Libellula sp.	Facultative	Gaufin,et.al.,1956
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Coleoptera		
Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
Chironomidae	-	-
Hemerodromia sp.	Facultative	Mason,et.al.,1971
Gastropoda		
Ferrissia sp.	Tolerant	OEPA,1987
Physella sp.	Tolerant	OEPA,1987
Helisoma anceps	Facultative	Ingram,1957

APPENDIX III-C: Site #22.7, Cuyahoga River (9/9/88)

Taxon	Tolerance	Source
Annelida		
*Oligochaeta	Tolerant	OEPA,1987
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
*Stenonema integrum	Facultative	Lewis,1974
Stenacron interpunctatum	Intolerant	Mason,et.al.,1971
Stenonema pulchellum	Facultative	Lewis,1974
*Stenonema terminatum	Facultative	Lewis,1974
Tricorythodes sp.	Facultative	Mason,et.al.,1971
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Boyeria sp.	Facultative	Richardson,1928
Enallagma sp.	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
*Potamyia sp.	Facultative	Mason,et.al.,1971
Coleoptera		
Ancyronyx variegatus	Intolerant	Sinclair,1964
*Berosus sp.	Tolerant	Mason,et.al.,1971
*Macronychus sp.	-	-
Stenelmis sp.	Facultative	Sinclair,1964

(Continued on following page.)

APPENDIX III-C: Site #22.7, Cuyahoga River (continued)

Taxon	Tolerance	Source
Diptera		
*Atherix variegata	Facultative	Mason,et.al.,1971
Hemerodromia sp.	Facultative	Paine,et.al.,1956
*Tipulidae	-	-
*Ablabesmyia sp.	-	-
*Conchapelopia sp.	Facultative	Mason,et.al.,1971
*Larsia sp.	-	-
*Natarsia sp.	-	-
*Rheotanytarsus sp.	Facultative	Mason,et.al.,1971
*Tanytarsus "A"	Intolerant/Facultative	Mason,et.al.,1971
*Tanytarsus "B"	Intolerant/Facultative	Mason,et.al.,1971
*Paratanytarsus sp.	-	-
*Micropsectra sp. /Tanytarsus sp.	Intolerant/Facultative	Mason,et.al.,1971
*Thienemanniella sp.	Intolerant	Paine,et.al.,1956
*Polypedilum "A"	-	-
*Polypedilum "B"	-	-
*Dicrotendipes sp.	-	-
*Glyptotendipes sp.	Tolerant	Curry,1962
*Chironomus sp.	Tolerant	OEPA,1987
*Cricotopus "A"	-	-
*Cricotopus trifasciatus gr.	Facultative	Mason,et.al.,1971
*Cricotopus sp. (Isocladius sp.)	-	-
Mollusca		
Ferrissia sp.	Tolerant	OEPA,1987
*Physella sp.	Tolerant	OEPA,1987

APPENDIX III-D: Southerly Wastewater Treatment Plant Effluent Channel (9/8/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
*Asellus communis	Facultative	Mason,et.al.,1971
*Crangonyx gracilis	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Coleoptera		
*Ancyronyx variegatus	Intolerant	Sinclair,1964
*Berosus sp.	Tolerant	Mason,et.al.,1971
*Macronychus sp.	-	-
*Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
*Hemerodromia sp.	Facultative	Paine,et.al.,1956
Tipula sp.	-	-
*Polypedilum "A"	-	-
*Polypedilum "B"	-	-
*Polypedilum "D"	-	-
*Chironomus sp.	Tolerant	OEPA,1987
*Cryptochironomus sp.	Tolerant	Beck,1954
*Phaenopsectra sp.	Intolerant	Mason,et.al.,1971
*Paratanytarsus sp.	-	-
*Cricotopus sp. (Isocladius sp.)	-	-
*Cricotopus "A"	-	-
*Cricotopus "B"	-	-
*Cricotopus trifasciatus gr.	Facultative	Mason,et.al.,1971
*Cricotopus "E"	-	-
*Thienemannimyia sp. /Conchapelopia sp.	Facultative	Mason,et.al ,1971
Mollusca		
*Physella sp.	Tolerant	OEPA,1987

APPENDIX III-E: Site #22.9, Cuyahoga River (9/8/88)

Taxon	Tolerance	Source
Crustacea		
Orconectes obscurus (male)	Facultative	Mason,et.al.,1971
Ephemeroptera		
Stenonema femoratum	Facultative	Lewis,1974
Stenonema pulchellum	Facultative	Lewis,1974
Stenonema terminatum	Facultative	Lewis,1974
Baetis sp.	Facultative	Roback,1974
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Diptera		
Ablabesmyia sp.	-	-

APPENDIX III-F: Site #23, Cuyahoga River (9/8/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
*Gammarus fasciatus	Facultative	Mason,et.al.,1971
Asellus communis	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
*Stenonema integrum	Facultative	Lewis,1974
Stenacron interpunctatum	Intolerant	Mason,et.al.,1971
*Stenonema pulchellum	Facultative	Lewis,1974
Stenonema terminatum	Facultative	Lewis,1974
Tricorythodes sp.	Facultative	Mason,et.al.,1971
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Agrion sp.	-	-
Megaloptera		
*Corydalus cornutus	Facultative	Mason,et.al.,1971
Trichoptera		
*Agraylea sp.	Intolerant	Mason,et.al.,1971
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
*Potamyia sp.	Facultative	Mason,et.al.,1971
Coleoptera		
*Ancyronyx variegatus	Intolerant	Sinclair,1964
*Berosus sp.	Tolerant	Mason,et.al.,1971
*Dubiraphia sp.	Facultative	Sinclair,1964
*Macronychus sp.	-	-
Stenelmis sp.	Facultative	Sinclair,1964

(Continued on following page.)

APPENDIX III-F: Site #23, Cuyahoga River (continued)

Taxon	Tolerance	Source
Diptera		
*Hemerodromia sp.	Facultative	Mason,et.al.,1971
*Limnophora sp.	Facultative	Mason,et.al.,1971
Rheotanytarsus sp.	Facultative	Mason,et.al.,1971
Micropsectra sp. /Tanytarsus sp.	Intolerant/Facultative	Mason,et.al.,1971
*Paratanytarsus sp.	-	-
*Polypedilum "A"	-	-
*Polypedilum "B"	-	-
*Glyptotendipes sp.	Tolerant	Curry,1962
*Dicrotendipes sp.	-	-
*Chironomus sp.	Tolerant	OEPA,1987
*Paracladopelma sp.	-	-
*Parachironomus sp.	Facultative	Mason,et.al.,1971
*Cryptochironomus sp.	Tolerant	Beck,1954
*Corynoneura sp.	Intolerant	Mason,et.al.,1971
*Thienemanniella sp.	Intolerant	Paine,et.al.,1956
*Symposiocladius sp.	-	-
*Nanocladius sp.	-	-
*Rheocricotopus sp.	-	-
*Parametriocnemus sp.	-	-
*Cricotopus "A"	-	-
*Cricotopus "B"	-	-
*Cricotopus trifasciatus gr.	Facultative	Mason,et.al.,1971
*Cricotopus "D"	-	-
*Conchapelopia sp.	Facultative	Mason,et.al.,1971
*Larsia sp.	-	-
*Ablabesmyia sp.	-	-
*Natarsia sp.	-	-
Mollusca		
*Ferrissia sp.	Tolerant	OEPA,1987
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-G: Site #24, Cuyahoga River (8/23/88)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason,et.al.,1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Hirudinea	-	-
Crustacea		
Orconectes propinquus	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Stenacron interpunctatum	Intolerant	Mason,et.al.,1971
Stenonema integrum	Facultative	Lewis,1974
Stenonema femoratum	Facultative	Lewis,1974
Stenonema pulchellum	Facultative	Lewis,1974
Stenonema terminatum	Facultative	Lewis,1974
Tricorythodes sp.	Facultative	Mason,et.al.,1971
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Megaloptera		
Corydalus cornutus	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,i971
Coleoptera		
Ectopria sp.	-	-
Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
Atherix variegata	Facultative	Mason,et.al.,1971
Tipula sp.	-	-
Polypedilum sp.	-	-
Mollusca		
Physella sp.	Tolerant	OEPA,1987
Pelecypoda	-	-

APPENDIX III-H: Site #54, Ohio Canal (9/8/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Crangonyx gracilis	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
*Stenacron sp.	Intolerant	Mason,et.al.,1971
Stenonema sp.	Facultative	Lewis,1974
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Coleoptera		
Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
*Dasyhelea sp.	-	-
*Ablabesmyia sp.	-	-
*Paratanytarsus sp.	-	-
*Rheotanytarsus sp.	Facultative	Mason,et.al.,1971
*Polypedilum "A"	-	-
*Polypedilum "B"	-	-
*Dicrotendipes sp.	-	-
*Phaenopsectra sp.	Intolerant	Mason,et.al.,1971
*Endochironomus sp.	-	-
*Glyptotendipes sp.	Tolerant	Curry,1962
*Corynoneura sp.	Intolerant	Mason,et.al.,1971
*Nanocladius sp.	-	-
*Cricotopus trifasciatus gr.	Facultative	Mason,et.al.,1971
*Larsia sp.	-	-
*Thienemannimyia sp. /Conchapelopia sp.	Facultative	Mason,et.al.,1971

(Continued on following page.)

APPENDIX III-H: Site #54, Ohio Canal (continued)

Taxon	Tolerance	Source
Mollusca		
Ferrissia sp.	Tolerant	OEPA,1987
**Physella* sp.	Tolerant	OEPA,1987

APPENDIX III-I: Site #56, Ohio Canal (9/8/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Hirudinea	-	-
Crustacea		
*Gammarus fasciatus	Facultative	Mason,et.al.,1971
*Asellus communis	Facultative	Mason,et.al.,1971
Ephemeroptera		
*Baetis sp.	Facultative/Intolerant	Roback,1974
Stenonema sp.	Facultative	Lewis,1974
*Stenacron sp.	Intolerant	Mason,et.al.,1971
Tricorythodes sp.	Facultative	Mason,et.al.,1971
Odonata		
*Agrion sp.	-	-
Argia sp.	Facultative	Mason,et.al.,1971
*Lestes sp.	-	-
Boyeria sp.	Facultative	Richardson,1928
Megaloptera		
*Corydalus cornutus	Facultative	Mason,et.al.,1971
*Sialis sp.	Facultative	Mason,et.al.,1971
Trichoptera		
*Agraylea sp.	Intolerant	Mason,et.al.,1971
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Coleoptera		
*Ancyronyx variegatus	Intolerant	Sinclair,1971
Berosus sp.	Tolerant	Mason,et.al.,1971
*Dubiraphia sp.	Facultative	Sinclair,1964
Enochrus sp.	Tolerant	Roback,1974
Stenelmis sp.	Facultative	Sinclair,1964

(Continued on following page.)

APPENDIX III-I: Site #56, Ohio Canal (continued)

Taxon	Tolerance	Source
Diptera		
Atherix variegata	Facultative	Mason,et.al.,1971
Simulium sp.	-	-
*Pericoma sp.	-	-
*Tanytarsus sp.	Facultative/Intolerant	Mason,et.al.,1971
*Micropsectra sp. /Tanytarsus sp.	Facultative/Intolerant	Mason,et.al.,1971
*Rheotanytarsus sp.	Facultative	Mason,et.al.,1971
*Paratanytarsus sp.	-	-
*Polypedilum "A"	-	-
*Polypedilum "B"	-	-
*Dicrotendipes sp.	-	-
*Glyptotendipes sp.	Tolerant	Curry,1962
*Chironomus sp.	Tolerant	OEPA,1987
*Cryptochironomus sp.	Tolerant	Beck,1954
*Phaenopsectra sp.	Intolerant	Mason,et.al.,1971
*Nanocladius sp.	-	-
*Cricotopus "A"	-	-
*Cricotopus "B"	-	-
*Cricotopus trifasciatus gr.	Facultative	Mason,et.al.,1971
*Corynoneura sp.	Intolerant	Mason,et.al.,1971
*Eukiefferiella sp.	Facultative	Roback,1974
*Conchapelopia sp.	Facultative	Mason,et.al.,1971
*Larsia sp.	-	-
*Ablabesmyia sp.	-	-
*Apsectrotanypus sp.	-	-
Mollusca		
Ferrissia sp.	Tolerant	OEPA,1987
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-J: Site #25, Big Creek (6/21/88)

Taxon	Tolerance	Source
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus sp.	-	-
Diptera		
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-K: Site #26, Big Creek (6/21/88)

Taxon	Tolerance	Source
Platyhelminthes		
Tricladida	Facultative	Mason,et.al.,1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Hirudinea	-	-
Crustacea		
Decapoda	-	-
Asellus communis	Facultative	Mason,et.al.,1971
Gammarus sp.	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Coleoptera		
Berosus sp.	Tolerant	Mason,et.al.,1971
Diptera		
Simulium sp.	-	-
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987
Pelecypoda	-	-

APPENDIX III-L: Site #27, Big Creek (6/21/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987

APPENDIX III-M: Site #28, Big Creek (6/21/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus sp.	-	-
Coleoptera		
(Adult)	-	-
Diptera		
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-N: Site #29, Big Creek (6/20/88)

Taxon	Tolerance	Source
Coelenterata		
Hydra sp.	Facultative	Mason,et.al.,1971
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Annelida		
Hirudinea	–	–
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus sp.	–	–
Gammarus sp.	Facultative	Mason,et.al.,1971
Odonata		
Coenagriidae	Facultative	Mason,et.al.,1971
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Diptera		
Simulium sp.	–	–
Chironomidae	–	–
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-O: Site #30, Big Creek (6/20/88)

Taxon	Tolerance	Source
Annelida		
Hirudinea	-	-
Crustacea		
Gammarus sp.	Facultative	Mason,et.al.,1971
Diptera		
Chironomidae	-	-
Simulium sp.	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-P: Site #31, Mill Creek (6/21/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Coleoptera	-	-
Diptera		
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-R: Site #33, Mill Creek (6/17/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Gammarus sp.	Facultative	Mason,et.al.,1971
Asellus sp.	-	-
Odonata		
Anisoptera	-	-
Diptera		
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-S: Site #33, Mill Creek (10/18/88)

Taxon	Tolerance	Source
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Diptera		
Simulium sp.	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-T: Site #34, Mill Creek (6/17/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Hirudinea	-	-
Diptera		
Chironomidae	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-U: Site #35, Mill Creek (6/17/88)

Taxon	Tolerance	Source
Platyhelminthes		
Tricladida	Facultative	Mason,et.al.,1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Diptera		
Chironomidae	-	-
Simulium sp.	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-V: Site #36, West Creek (8/9/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Odonata		
Hetaerina sp.	Facultative/Intolerant	Roback,1974
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Coleoptera		
Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
Atherix variegata	Facultative	Mason,et.al.,1971
Empididae	Facultative	Mason,et.al.,1971
Chironomidae	-	-
Mollusca		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-W: Site #37, West Creek (8/8/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Crangonyx pseudogracilis	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Odonata		
Anisoptera	-	-
Agrion sp.	-	-
Coleoptera		
(Adult)	-	-
Diptera		
Chironomidae	-	-
Simulium sp.	-	-
Gastropoda		
Planorbidae	-	-
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-X: Site #38, West Creek (8/8/88)

Taxon	Tolerance	Source
Annelida		
Hirudinea	-	-
Crustacea		
Asellus communis	Facultative	Mason,et.al.,1971
Crangonyx pseudogracilis	Facultative	Mason,et.al.,1971
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Caenis sp.	Facultative	Mason,et.al.,1971
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Diptera		
Chironomidae	-	-
Simulium sp.	-	-

APPENDIX III-BB: Site #42, Tinkers Creek (7/6/88)

Taxon	Tolerance	Source
Annelida		
Hirudinea	-	-
Oligochaeta	Tolerant	OEPA,1987
Crustacea		
Asellus sp.	-	-
Gammarus sp.	Facultative	Mason,et.al.,1971
Decapoda	-	-
Coleoptera		
Stenelmis sp.	Facultative	Sinclair,1964
Diptera		
Chironomidae	-	-
Simulium sp.	-	-
Gastropoda		
Ferrissia sp.	Tolerant	OEPA,1987
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-DD: Site #43.5, Chippewa Creek (8/3/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Ephemeroptera		
Stenonema sp.	Facultative	Lewis,1974
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Coleoptera		
Hydrophilidae	-	-
Diptera		
Chironomidae	-	-
Limnophora sp.	Facultative	Mason,et.al.,1971
Simulium sp.	-	-
Gastropoda		
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-EE: Site #44, Chippewa Creek (8/3/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.1971
Annelida		
Oligochaeta	Tolerant	OEPA,1987
Ephemeroptera		
Baetis sp.	Facultative/Intolerant	Roback,1974
Trichoptera		
Hydropsyche sp.	Facultative/Intolerant	Mason,et.al.,1971
Diptera		
Limnophora sp.	Facultative	Mason,et.al.,1971
Simulium sp.	-	-
Gastropoda		
Ferrissia sp.	Tolerant	OEPA,1987
Physella sp.	Tolerant	OEPA,1987

APPENDIX III-FF: Site #22, Cuyahoga River (12/9/88)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA,1987

APPENDIX III-GG: Chagrin River, RM 10.5 (8/16, 11/1/88)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason,et.al.,1971
Plecoptera		
Paragnetina sp.	Intolerant	Roback,1974
Ephemeroptera		
Isonychia sp.	Intolerant	Mason,et.al.,1971
Caenis sp.	Facultative	Mason,et.al.,1971
Stenonema pulchellum	Facultative	Lewis,1969
Trichoptera		
Chimarra sp.	Intolerant	Beck,1954
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Hydropsyche dicantha	-	-
Hydropsyche simulans	Intolerant	Mason,et.al.,1971
Symphitopsyche bifida gr.	Facultative	Mason,et.al.,1971
Symphitopsyche etnieri	-	-
Symphitopsyche slossonae	-	-
Megaloptera		
Corydalus cornutus	Facultative	Mason,et.al.,1971
Coleoptera		
Stenelmis sp.	Facultative	Sinclair,1964
Optioservus sp.	Facultative	Sinclair,1964
Psephenus sp.	Facultative	Roback, 1974
Diptera		
Atrichopogon sp.	Facultative	Roback,1974
Atherix sp.	Facultative/Intolerant	Roback,1974
Tipula sp.	-	-
Molophilus sp.	-	-
Simulium sp.	-	-
Hemerodromia sp.	Facultative	Paine,et.al.1956
Microtendipes sp.	Intolerant	Curry,1962
Thienemannimyia sp. /*Conchapelopia* sp.	Facultative	Mason,et.al.,1971
Mollusca		
Ferrissia parallela	Tolerant	OEPA,1987
Fossaria humilis	Facultative	Ingram,1957
Physella vinosa	Tolerant	OEPA,1987
Sphaeriidae	-	-

APPENDIX III-HH: Grand River, RM 21 (8/16, 11/1/88)

Taxon	Tolerance	Source
Crustacea		
Decapoda	-	-
Plecoptera		
Acroneuria sp.	Facultative/Intolerant	Mason,et.al.,1971
Neoperla sp.	Facultative	Roback,1974
Phasganophora sp.	Facultative	Roback,1974
Ephemeroptera		
Ephemera sp.	Facultative	Roback,1974
Isonychia sp.	Intolerant	Mason,et.al.,1971
Stenonema pulchellum	Facultative	Lewis,1969
Litobrancha sp.	-	-
Odonata		
Argia sp.	Facultative	Mason,et.al.,1971
Megaloptera		
Corydalus cornutus	Facultative	Mason,et.al.,1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason,et.al.,1971
Chimarra sp.	Intolerant	Beck,1954
Hydropsyche betteni	-	-
Hydropsyche dicantha	-	-
Hydropsyche simulans	Intolerant	Mason,et.al.1971
Symphitopsyche bifida gr.	Facultative	Mason,et.al.,1971
Potamyia sp.	Facultative	Mason,et.al.,1971
Diptera		
Atherix sp.	Facultative/Intolerant	Roback,1974
Atrichopogon sp.	Facultative	Roback,1974
Cricotopus sp. /*Orthocladius* sp.	-	-
Nanocladius sp.	-	-
Thienemannimyia sp. /*Conchapelopia* sp.	Facultative	Mason,et.al.,1971
Gastropoda		
Goniobasis livescens	Facultative	Ingram,1957
Pelecypoda		
Pisidium sp.	-	-

APPENDIX IV

1988 RESULTS OF QUANTITATIVE SAMPLING FOR BENTHIC MACROINVERTEBRATES

(Taxa with asterisks were also collected qualitatively.)

APPENDIX IV-A: Site #22.7, Cuyahoga River (9/9/88)

Taxa	Quantity
Annelida	
Oligochaeta	1
Ephemeroptera	
*Baetis sp.	18
Stenonema integrum	4
*Stenacron interpunctatum	1
*Stenonema pulchellum	26
Stenonema terminatum	5
*Tricorythodes sp.	11
Odonata	
*Argia sp.	27
*Enallagma sp.	1
Trichoptera	
*Cheumatopsyche sp.	324
*Hydropsyche sp.	35
Potamyia sp.	2
Coleoptera	
*Ancyronyx sp.	8
Berosus sp.	2
Macronychus sp.	3
*Stenelmis sp.	8

(Continued on following page.)

APPENDIX IV-A: Site #22.7, Cuyahoga River (continued)

Taxa	Quantity
Diptera	
Atherix variegata	1
*Hemerodromia sp.	10
Tipulidae	1
Ablabesmyia sp.	12
Conchapelopia sp.	133
Larsia sp.	5
Natarsia sp.	1
Rheotanytarsus sp.	5
Tanytarsus "A"	1
Tanytarsus sp.	1
Paratanytarsus sp.	1
Micropsectra sp./Tanytarsus sp.	7
Thienemanniella sp.	1
Polypedilum "A"	10
Polypedilum "B"	83
Dicrotendipes sp.	22
Glyptotendipes sp.	5
Chironomus sp.	7
Cricotopus "A"	5
Cricotopus trifasciatus gr.	6
Cricotopus(Isocladius) sp.	1
Mollusca	
*Ferrissia sp.	21
*Physella sp.	7
Total Number of Organisms	822

APPENDIX IV-A: Site #22.7, Cuyahoga River (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (39)	6
2. Total Number of Mayfly Taxa (6)	4
3. Total Number of Caddisfly Taxa (3)	4
4. Total Number of Dipteran Taxa (21)	6
5. Percent Mayfly Composition (65/822 = 7.9%)	2
6. Percent Caddisfly Composition (361/822 = 43.9%)	6
7. Percent Tribe Tanytarsini Midge Composition (15/822 = 1.8%)	2
8. Percent Other Dipteran and Non-Insect Comp. (332/822 = 40.4%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (6)	2
Total ICI Value =	32

APPENDIX IV-B: Site #23, Cuyahoga River (9/8/88)

Taxa	Quantity
Annelida	
*Oligochaeta	14
Crustacea	
Gammarus fasciatus	1
*Asellus communis	1
Ephemeroptera	
*Baetis sp.	37
*Stenonema integrum	7
*Stenacron interpunctatum	4
*Stenonema pulchellum	32
*Stenonema terminatum	9
*Tricorythodes sp.	15
Megaloptera	
Corydalus cornutus	1
Trichoptera	
Agraylea sp.	14
*Cheumatopsyche sp.	657
*Hydropsyche sp.	45
Potamyia sp.	3
Coleoptera	
Ancyronyx sp.	6
Berosus sp.	1
Dubiraphia sp.	1
Macronychus sp.	5
*Stenelmis sp.	7

(Continued on following page.)

APPENDIX IV-B: Site #23, Cuyahoga River (continued)

Taxa	Quantity
Diptera	
Hemerodromia sp.	8
Limnophora sp.	1
Rheotanytarsus sp.	23
Micropsectra sp./Tanytarsus sp.	27
Tanytarsus sp.	10
Paratanytarsus sp.	5
Polypedilum "A"	13
Polypedilum "B"	194
Glyptotendipes sp.	23
Dicrotendipes sp.	176
Chironomus sp.	5
Paracladopelma sp.	1
Parachironomus sp.	1
Cryptochironomus sp.	1
Corynoneura sp.	3
Thienemanniella sp.	4
Symposiocladius sp.	1
Nanocladius sp.	22
Rheocricotopus sp.	1
Parametriocnemus sp.	2
Cricotopus "A"	95
Cricotopus "B"	18
Cricotopus trifasciatus gr.	153
Cricotopus "D"	20
Conchapelopia sp.	102
Larsia sp.	13
Ablabesmyia sp.	13
Natarsia sp.	2
Mollusca	
Ferrissia sp.	9
*Physella sp.	25
Total Number of Organisms	1831

APPENDIX IV-B: Site #23, Cuyahoga River (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (49)	6
2. Total Number of Mayfly Taxa (6)	4
3. Total Number of Caddisfly Taxa (4)	4
4. Total Number of Dipteran Taxa (28)	6
5. Percent Mayfly Composition (109/1831 = 5.7%)	2
6. Percent Caddisfly Composition (719/1831 = 39.3%)	6
7. Percent Tribe Tanytarsini Midge Composition (65/1831 = 3.5%)	2
8. Percent Other Dipteran and Non-Insect Comp. (922/1831 = 41.9%)	0
9. Percent Tolerant Organisms (768/1831 = 41.9%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (10)	4
Total ICI Value =	34

APPENDIX IV-C: Site #54, Ohio Canal (9/8/88)

Taxa	Quantity
Annelida	
*Oligochaeta	1
Crustacea	
**Crangonyx gracilis*	1
**Asellus communis*	6
Ephemeroptera	
**Baetis* sp.	1
Stenacron sp.	2
**Stenonema* sp.	132
Odonata	
**Argia* sp.	2
Trichoptera	
**Cheumatopsyche* sp.	167
Coleoptera	
**Stenelmis* sp.	1
Diptera	
Dasyhelea sp.	1
Paratanytarsus sp.	9
Rheotanytarsus sp.	3
Polypedilum "A"	6
Polypedilum "B"	53
Dicrotendipes sp.	7
Dicrotendipes "A"	2
Phaenopsectra sp.	1
Endochironomus sp.	1
Glyptotendipes sp.	1
Corynoneura sp.	3
Nanocladius sp.	18
Cricotopus trifasciatus gr.	1
Ablabesmyia sp.	3
Larsia sp.	19
Thienemannimyia sp./*Conchapelopia* sp.	56
Mollusca	
**Ferrissia* sp.	3
Physella sp.	1
Total Number of Organisms	501

APPENDIX IV-C: Site #54, Ohio Canal (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (27)	4
2. Total Number of Mayfly Taxa (3)	2
3. Total Number of Caddisfly Taxa (1)	0
4. Total Number of Dipteran Taxa (16)	6
5. Percent Mayfly Composition (135/501 = 26.9%)	6
6. Percent Caddisfly Composition (167/501 = 33.3%)	6
7. Percent Tribe Tanytarsini Midge Composition (12/501 = 2.4%)	2
8. Percent Other Dipteran and Non-Insect Comp. (184/501 =36.7%)	2
9. Percent Tolerant Organisms (93/501 =18.6%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (3)	0
Total ICI Value =	28

APPENDIX IV-D: Site #56, Ohio Canal (9/8/88)

Taxa	Quantity
Annelida	
*Oligochaeta	6
*Hirudinea	1
Crustacea	
Gammarus fasciatus	1
Asellus communis	1
Ephemeroptera	
Baetis sp.	5
Stenacron sp.	1
**Stenonema* sp.	51
**Tricorythodes* sp.	11
Odonata	
Agrion sp.	1
**Argia* sp.	35
Lestes sp.	5
Megaloptera	
Corydalus cornutus	1
Sialis sp.	1
Trichoptera	
Agraylea sp.	2
**Cheumatopsyche* sp.	805
**Hydropsyche* sp.	16
Coleoptera	
**Ancyronyx* sp.	5
**Berosus* sp.	2
Dubiraphia sp.	1
**Stenelmis* sp.	7

(Continued on following page.)

APPENDIX IV-D: Site #56, Ohio Canal (continued)

Taxa	Quantity
Diptera	
*Atherix variegata	1
Pericoma sp.	1
Tanytarsus sp.	6
Micropsectra sp./Tanytarsus sp.	57
Rheotanytarsus sp.	9
Paratanytarsus sp.	1
Polypedilum "A"	20
Polypedilum "B"	100
Dicrotendipes sp.	164
Glyptotendipes sp.	20
Chironomus sp.	7
Cryptochironomus sp.	4
Phaenopsectra sp.	3
Nanocladius sp.	50
Cricotopus "A"	9
Cricotopus "B"	1
Cricotopus trifasciatus gr.	71
Corynoneura sp.	1
Eukiefferiella sp.	1
Conchapelopia sp.	319
Larsia sp.	20
Ablabesmyia sp.	1
Apsectrotanypus sp.	1
Mollusca	
*Ferrissia sp.	24
*Physella sp.	5
Total Number of Organisms	1854

APPENDIX IV-D: Site #56, Ohio Canal (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (45)	6
2. Total Number of Mayfly Taxa (4)	2
3. Total Number of Caddisfly Taxa (3)	4
4. Total Number of Dipteran Taxa (23)	6
5. Percent Mayfly Composition (68/1854 = 3.7%)	2
6. Percent Caddisfly Composition (823/1854 =44.4%)	6
7. Percent Tribe Tanytarsini Midge Composition (73/1854 = 3.9%)	2
8. Percent Other Dipteran and Non-Insect Comp. (832/1854 = 44.9%)	0
9. Percent Tolerant Organisms (482/1854 = 25.9%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (4)	2
Total ICI Value =	30

APPENDIX V

1988 QUANTITATIVE SAMPLING FOR FISH

APPENDIX IV-C: Site #54, Ohio Canal (9/8/88)

Taxa	Quantity
Annelida	
*Oligochaeta	1
Crustacea	
*Crangonyx gracilis	1
*Asellus communis	6
Ephemeroptera	
*Baetis sp.	1
Stenacron sp.	2
*Stenonema sp.	132
Odonata	
*Argia sp.	2
Trichoptera	
*Cheumatopsyche sp.	167
Coleoptera	
*Stenelmis sp.	1
Diptera	
Dasyhelea sp.	1
Paratanytarsus sp.	9
Rheotanytarsus sp.	3
Polypedilum "A"	6
Polypedilum "B"	53
Dicrotendipes sp.	7
Dicrotendipes "A"	2
Phaenopsectra sp.	1
Endochironomus sp.	1
Glyptotendipes sp.	1
Corynoneura sp.	3
Nanocladius sp.	18
Cricotopus trifasciatus gr.	1
Ablabesmyia sp.	3
Larsia sp.	19
Thienemannimyia sp./Conchapelopia sp.	56
Mollusca	
*Ferrissia sp.	3
Physella sp.	1
Total Number of Organisms	501

APPENDIX IV-C: Site #54, Ohio Canal (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (27)	4
2. Total Number of Mayfly Taxa (3)	2
3. Total Number of Caddisfly Taxa (1)	0
4. Total Number of Dipteran Taxa (16)	6
5. Percent Mayfly Composition (135/501 = 26.9%)	6
6. Percent Caddisfly Composition (167/501 = 33.3%)	6
7. Percent Tribe Tanytarsini Midge Composition (12/501 = 2.4%)	2
8. Percent Other Dipteran and Non-Insect Comp. (184/501 =36.7%)	2
9. Percent Tolerant Organisms (93/501 =18.6%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (3)	0
Total ICI Value =	28

APPENDIX IV-D: Site #56, Ohio Canal (9/8/88)

Taxa	Quantity
Annelida	
*Oligochaeta	6
*Hirudinea	1
Crustacea	
Gammarus _fasciatus_	1
Asellus _communis_	1
Ephemeroptera	
Baetis sp.	5
Stenacron sp.	1
*_Stenonema_ sp.	51
*_Tricorythodes_ sp.	11
Odonata	
Agrion sp.	1
*_Argia_ sp.	35
Lestes sp.	5
Megaloptera	
Corydalus _cornutus_	1
Sialis sp.	1
Trichoptera	
Agraylea sp.	2
*_Cheumatopsyche_ sp.	805
*_Hydropsyche_ sp.	16
Coleoptera	
*_Ancyronyx_ sp.	5
*_Berosus_ sp.	2
Dubiraphia sp.	1
*_Stenelmis_ sp.	7

(Continued on following page.)

APPENDIX IV-D: Site #56, Ohio Canal (continued)

Taxa	Quantity
Diptera	
*Atherix variegata	1
Pericoma sp.	1
Tanytarsus sp.	6
Micropsectra sp./Tanytarsus sp.	57
Rheotanytarsus sp.	9
Paratanytarsus sp.	1
Polypedilum "A"	20
Polypedilum "B"	100
Dicrotendipes sp.	164
Glyptotendipes sp.	20
Chironomus sp.	7
Cryptochironomus sp.	4
Phaenopsectra sp.	3
Nanocladius sp.	50
Cricotopus "A"	9
Cricotopus "B"	1
Cricotopus trifasciatus gr.	71
Corynoneura sp.	1
Eukiefferiella sp.	1
Conchapelopia sp.	319
Larsia sp.	20
Ablabesmyia sp.	1
Apsectrotanypus sp.	1
Mollusca	
*Ferrissia sp.	24
*Physella sp.	5
Total Number of Organisms	1854

APPENDIX IV-D: Site #56, Ohio Canal (continued)

Invertebrate Community Index (ICI)

Metric	Score
1. Total Number of Taxa (45)	6
2. Total Number of Mayfly Taxa (4)	2
3. Total Number of Caddisfly Taxa (3)	4
4. Total Number of Dipteran Taxa (23)	6
5. Percent Mayfly Composition (68/1854 = 3.7%)	2
6. Percent Caddisfly Composition (823/1854 =44.4%)	6
7. Percent Tribe Tanytarsini Midge Composition (73/1854 = 3.9%)	2
8. Percent Other Dipteran and Non-Insect Comp. (832/1854 = 44.9%)	0
9. Percent Tolerant Organisms (482/1854 = 25.9%)	0
10. Total Number of Qualitative Ephemeropteran, Plecopteran, Trichopteran Taxa (4)	2
Total ICI Value =	30

APPENDIX V

1988 QUANTITATIVE SAMPLING FOR FISH

EA Report 10807

RESULTS OF A FISH SURVEY OF THE CUYAHOGA RIVER, AUGUST 1988

Prepared for

Northeast Ohio Regional Sewer District
3090 Broadway
Cleveland, Ohio

Prepared by

EA Science and Technology
612 Anthony Trail
Northbrook, Illinois

October 1988

The Northeast Ohio Regional Sewer District (NEORSD) contracted with EA Science and Technology (EA) to conduct a fish survey of the Cuyahoga River and the Ohio Canal located in Cleveland, Ohio. The purposes of the survey were (1) to supplement data collected by Ohio EPA (OEPA) and (2) provide NEORSD staff biologists with training in standard OEPA electrofishing techniques.

Methods

Sampling was conducted in the Cuyahoga River and the Ohio Canal on 2 and 3 August, respectively, at the following locations:

CUYAHOGA RIVER:	RM 12.2	Upstream of Mill Creek - distance fished: 685 meters
	11.7	Downstream of Mill Creek - distance fished: 564 meters
	9.8	Downstream of Southerly WTP - distance fished: 500 meters
	7.8	Upstream of Big Creek - distance fished: 884 meters
OHIO CANAL:	RM 3.8	Hillside Road Bridge - distance fished: 500 meters
	2.3	Southerly WTP-Ash Lagoons - distance fished: 548 meters
	1.4	Big Creek/Southwest Interceptors (located at the end of the fish pass) - distance fished: 500 meters

Shocking was accomplished using a 5000 watt generator whose output was passed through a Coffelt Model VVP-15 pulser. The output was adjusted to provide 60 pulses per second, 9-11 amps, and 140-200 volts DC in the river and 200-250 volts in the canal. The electrode array consisted of four 32" long 1/4" diameter stainless steel aircraft cable anodes hung from booms which extended approximately eight feet in front of the boat. Four 64" lengths of 1" O.D. flexible galvanized steel conduit, which served as cathodes were suspended directly from the bow in a line perpendicular to the length of the boat.

Collection and analytical procedures followed those described by OEPA (1987). These protocols are described briefly below.

Individual sampling zones were electrofished from upstream to downstream by slowly and steadily maneuvering the electrofishing boat as close to the shore and submerged objects as possible. The boat crew consisted of a driver and a netter. A net with an 8' long handle and 1/4" mesh knotless netting was used to capture fish as they were attracted to the anode array and/or stunned. An effort was made to capture every fish sighted. In instances where more fish swam to the surface than could be netted, an effort was made to capture as many fish as possible including all species present and a cross section of all size classes.

Captured fish were placed in an on-board livewell for later processing. All fish were identified, counted, and batch weighed by species. Weighing was done using calibrated scales. Fish were identified using Pflieger (1975) and Trautman (1981).

Individual fish were examined for the presence of gross external anomalies, lesions and ulcers, tumors, eroded fins, skeletal deformities, and anchor worms. Incidence was expressed as the percent of afflicted fish among all fish examined. Only so called delta anomalies (eroded fins, lesions, and tumors) were used in the incidence calculations as per OEPA (1987) guidance.

The fisheries data were computer processed and compiled to yield a variety of standard outputs (e.g., species number, catch per effort, etc.). In addition to preparing these standard outputs, the Composite Index was calculated for each sampling zone and month. The Composite Index or Index of Well-being (I_{WB}) was calculated as follows:

$$I_{WB} = 0.5 \ln N + 0.5 \ln Wt + \bar{H}\ (no.) + \bar{H}\ (wt.)$$

Where:

N = relative numbers of all species
Wt = relative weight (in Kg) of all species
$\bar{H}$ (no.) = Shannon diversity index based on relative numbers
$\bar{H}$ (wt.) = Shannon diversity index based on relative weight (in Kg)

As recommended by OEPA (1987), the Composite Index was modified by deleting 13 tolerant species and a hybrid from the 0.5 ln no. and 0.5 ln wt. aspects of the I_{WB} formula, but the tolerant species were retained in both $\bar{H}$ metrics of the I_{WB}. The "tolerant" species identified by OEPA are the central mudminnow, white sucker, common carp, goldfish, golden shiner, blacknose dace, creek chub, fathead minnow, bluntnose minnow, common carp x goldfish, yellow bullhead, brown bullhead, eastern banded killifish, and green sunfish. Of the aforementioned species, only three were not encountered during this study; central mudminnow, blacknose dace, and eastern banded killifish. Thus, the modification significantly reduced the Composite Index scores.

The fish community was also assessed using the Index of Biological Integrity (IBI) modified as per OEPA guidance (OEPA 1987).

Habitat was evaluated at each location using OEPA's Qualitative Habitat Evaluation Index (QHEI) (OEPA 1987).

Results of physicochemical measurements made in conjunction with the electrofishing at each station were as follows:

	Cuyahoga River				Ohio Canal		
	12.2	11.7	9.8	7.8	3.8	2.3	1.4
Temp (C)	27.6	28.2	28.2	28.1	24.5	27.8	27.8
D.O. (mg/l)	8.4	9.1	8.1	7.5	7.5	7.9	7.9
Conductivity (µhos/cm)	925	805	867	899	831	938	953

The 1988 I_{WB} scores are compared with those in other years below:

	Station (RM)			
	12.2	11.7(11.5)	9.8	7.5
OEPA-1984	-	4.0	4.0	4.2
OEPA-1985	-	6.5	5.1	3.6
OEPA-1987	5.1	4.2	4.8	3.5
EA-1988	5.7	3.3	5.0	3.9

The 1988 I_{WB} scores are comparable to those that have been reported in recent years. The 1988 I_{WB} scores and those of previous years would place the Cuyahoga River in the poor to very poor categories as defined by OEPA (OEPA 1987). The Ohio Canal would fall into the same categories. I_{WB} scores >5 in the Cuyahoga River have typically been associated with large catches of gizzard shad.

As summarized above, the 1988 IBI scores were consistently low (12-16), both in the river and the canal. These values are particularly low considering the fact that the minimum score possible is 12. The low IBI scores reflect the fact that the fish community is sparse, dominated by tolerant species, and lacks the intolerant and "desirable" species that are necessary to improve the scores of the IBI metrics.

Compared to the mean QHEI score of 75 for reference streams in the Erie/Ontario Lake Plains area (OEPA 1987), the habitat of the Cuyahoga River would be classified as poor to fair, depending on location, while the habitat of the Ohio Canal is poor. This suggests that lack of habitat is one reason for the poor fish communities in the Cuyahoga River and the Ohio Canal.

Based on the following reasons, we conclude that fish communities in the Cuyahoga River and the Ohio Canal are poor:

(1) low CPEs
(2) low species richness
(3) low I_{WB} scores
(4) low IBI scores
(5) dominance by tolerant species
(6) lack of intolerant species
(7) high incidence of physical anomalies

We further conclude that these poor fish communities are the result of poor habitat (as indicated by the low QHEI scores) and poor water quality (as indicated by the high incidence of "delta anomalies" and a fish community poorer than habitat alone would dictate).

References

Ohio Environmental Protection Agency. 1987. Biological criteria for the protection of aquatic life. Vol. I, II, and III. OEPA, Columbus, Ohio.

Pflieger, W.L. 1975. The Fishes of Missouri. Mo. Dept. Conserv. 343 pp.

Trautman, M.B. 1981. The Fishes of Ohio. (2nd Edition). Ohio State University Press, Columbus, Ohio. 782 pp.

TABLE 3. WEIGHT (grams) OF FISH COLLECTED IN THE CUYAHOGA RIVER, NORTHEAST OHIO, AUGUST 1988

SPECIES	LOC 12.2	LOC 11.7	LOC 9.8	LOC 7.5	LOC 3.8	LOC 2.3	LOC 1.4
GIZZARD SHAD	3100	150	1200	2500	0	1880	1500
GRASS PICKEREL	105	0	0	0	0	0	0
CENTRAL STONEROLLER	0	0	0	0	32	0	0
GOLDFISH	1000	0	0	400	1215	2100	2700
CARP	9300	24500	16000	27000	3300	3700	6600
GOLDEN SHINER	0	0	0	0	60	0	0
EMERALD SHINER	4	0	6	10	0	0	0
SPOTFIN SHINER	50	10	30	0	15	0	0
FATHEAD MINNOW	0	0	0	0	40	0	0
BLUNTNOSE MINNOW	20	0	0	0	275	0	0
CREEK CHUB	55	0	0	0	0	0	0
WHITE SUCKER	1050	2500	2900	0	37	950	0
BLACK BULLHEAD	0	0	0	0	5	0	0
YELLOW BULLHEAD	255	0	0	0	0	0	0
WHITE BASS	0	400	400	460	0	0	0
GREEN SUNFISH	0	0	0	0	155	43	0
PUMPKINSEED	0	23	0	0	65	33	33
BLUEGILL	0	0	0	0	0	0	25
HYBRID SUNFISH	0	0	0	0	0	45	0
TOTAL CATCH	14939	27583	20536	30370	5199	8751	10858

TABLE 4. WEIGHT CPE (grams/km) OF FISH COLLECTED IN THE CUYAHOGA RIVER, NORTHEAST OHIO, AUGUST 1988

SPECIES	LOC 12.2	LOC 11.7	LOC 9.8	LOC 7.5	LOC 3.8	LOC 2.3	LOC 1.4
GIZZARD SHAD	4526	266	2400	2828	0	3431	3000
GRASS PICKEREL	153	0	0	0	0	0	0
CENTRAL STONEROLLER	0	0	0	0	64	0	0
GOLDFISH	1460	0	0	452	2430	3832	5400
CARP	13577	43440	32000	30543	6600	6752	13200
GOLDEN SHINER	0	0	0	0	120	0	0
EMERALD SHINER	6	0	12	11	0	0	0
SPOTFIN SHINER	73	18	60	0	30	0	0
FATHEAD MINNOW	0	0	0	0	80	0	0
BLUNTNOSE MINNOW	29	0	0	0	550	0	0
CREEK CHUB	80	0	0	0	0	0	0
WHITE SUCKER	1533	4433	5800	0	74	1734	0
BLACK BULLHEAD	0	0	0	0	10	0	0
YELLOW BULLHEAD	372	0	0	0	0	0	0
WHITE BASS	0	709	800	520	0	0	0
GREEN SUNFISH	0	0	0	0	310	78	0
PUMPKINSEED	0	41	0	0	130	60	66
BLUEGILL	0	0	0	0	0	0	50
HYBRID SUNFISH	0	0	0	0	0	82	0
TOTAL CATCH	21809	48906	41072	34355	10398	15969	21716

APPENDIX VI

CHEMICAL ANALYSES OF 24-HOUR COMPOSITE SAMPLES
FROM THE CUYAHOGA RIVER
Upstream and Downstream of the
Southerly Wastewater Treatment Plant Effluent Discharge

Burmah

Burmah Technical Services, Inc.
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Northeast Ohio Regional Sewer District
3090 Broadway
Cleveland, OH 44115
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

P.O.# P42847

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43017
Client I.D.: Downstream of Southerly 8/17-18/88

Antimony, Sb, mg/l	<0.5
Arsenic, As, mg/l	<0.005
Beryllium, Be, mg/l	<0.01
Cadmium, Cd, mg/l	<0.01
Chromium, Cr, mg/l	<0.02
Copper, Cu, mg/l	<0.02
Lead, Pb, mg/l	<0.05
Mercury, Hg, mg/l	<0.0005
Nickel, Ni, mg/l	0.06
Selenium, Se, mg/l	<0.005
Silver, Ag, mg/l	<0.02
Thallium, Tl, mg/l	<0.5
Zinc, Zn, mg/l	0.05
Phenolics, (4AAP), mg/l	0.016
Cyanide, CN, mg/l	0.03

Susan K. Scott
Laboratory Supervisor

PP/lr

Burmah

Burmah Technical Services, Inc.
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43017
Client I.D.: Downstream of Southerly 8/17-18/88

Volatile Organic Compounds, ug/l

Acrolein	BDL
Acrylonitrile	BDL
Benzene	BDL
Bromoform	BDL
Carbon Tetrachloride	BDL
Chlorobenzene	BDL
Chlorodibromomethane	BDL
Chloroethane	BDL
2-Chloroethylvinyl ether	BDL
Chloroform	BDL
Dichlorobromomethane	BDL
1,1-Dichloroethane	BDL
1,2-Dichloroethane	BDL
1,1-Dichloroethylene	BDL
1,2-Dichloropropane	BDL
1,3-Dichloropropene	BDL
Ethylbenzene	BDL
Methyl Bromide	BDL
Methyl Chloride	BDL
Methylene Chloride	BDL
1,1,2,2-Tetrachloroethane	BDL
Tetrachloroethylene	BDL
Toluene	BDL
Trans-1,2-Dichloroethylene	BDL
1,1,1-Trichloroethane	BDL
1,1,2-Trichloroethane	BDL
Trichloroethylene	BDL
Trichlorofluoromethane	BDL
Vinyl Chloride	BDL

PP/2r

Burmah

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408 Auburn Avenue
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Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43017
Client I.D.: Downstream of Southerly
8/17-18/88

Base/Neutral Compounds, ug/l

Acenaphthene	BDL
Acenaphthylene	BDL
Anthracene	BDL
Benzidine	BDL
Benzo(a)anthracene	BDL
Benzo(a)pyrene	BDL
Benzo(b)fluoranthene	BDL
Benzo(ghi)perylene	BDL
Benzo(k)fluoranthene	BDL
Bis(2-chloroethoxy)methane	BDL
Bis(2-chloroethyl)ether	BDL
Bis(2-chloroisopropyl)ether	BDL
Bis(2-ethylhexyl)phthalate	BDL
4-Bromophenyl phenyl ether	BDL
Butylbenzyl phthalate	BDL
2-Chloronaphthalene	BDL
4-Chlorophenyl phenyl ether	BDL
Chrysene	BDL
Dibenzo(a,h)anthracene	BDL
1,2-Dichlorobenzene	BDL
1,3-Dichlorobenzene	BDL
1,4-Dichlorobenzene	BDL
3,3-Dichlorobenzidine	BDL
Diethyl phthalate	BDL
Dimethyl phthalate	BDL
Di-n-butyl phthalate	BDL
2,4-Dinitrotoluene	BDL
2,6-Dinitrotoluene	BDL
Di-n-octyl phthalate	BDL
1,2-Diphenylhydrazine	BDL
Fluoranthene	BDL

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September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43017
Client I.D.: Downstream of Southerly 8/17-18/88

Base/Neutral Compounds (cont'd.), ug/l

Fluorene	BDL
Hexachlorobenzene	BDL
Hexachlorobutadiene	BDL
Hexachlorocyclopentadiene	BDL
Hexachloroethane	BDL
Indeno(1,2,3-cd)pyrene	BDL
Isophorone	BDL
Naphthalene	BDL
Nitrobenzene	BDL
N-Nitrosodimethylamine	BDL
N-Nitroso-di-n-propylamine	BDL
N-Nitrosodiphenylamine	BDL
Phenanthrene	BDL
Pyrene	BDL
1,2,4-Trichlorobenzene	BDL

Acid Compounds, ug/l

2-Chlorophenol	BDL
2,4-Dichlorophenol	BDL
2,4-Dimethylphenol	BDL
4,6-Dinitro-o-cresol	BDL
2,4-Dinitrophenol	BDL
2-Nitrophenol	BDL
4-Nitrophenol	BDL
p-Chloro-m-cresol	BDL
Pentachlorophenol	BDL
Phenol	BDL
2,4,6-Trichlorophenol	BDL

PP/4r

Burmah

Burmah Technical Services, Inc.
Analytical Laboratories Division

408 Auburn Avenue
Pontiac, Michigan 48058

313-334-4747

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43017
Client I.D.: Downstream of Southerly
8/17-18/88

Pesticides and PCB's, ug/l

Aldrin	BDL
a-BHC	BDL
b-BHC	BDL
g-BHC	BDL
d-BHC	BDL
Chlordane	BDL
4,4'-DDT	BDL
4,4'-DDE	BDL
4,4'-DDD	BDL
Dieldrin	BDL
a-Endosulfan	BDL
b-Endosulfan	BDL
Endosulfan Sulfate	BDL
Endrin	BDL
Endrin Aldehyde	BDL
Heptachlor	BDL
Heptachlor Epoxide	BDL
PCB-1242	BDL
PCB-1254	BDL
PCB-1221	BDL
PCB-1232	BDL
PCB-1248	BDL
PCB-1260	BDL
PCB-1016	BDL
Toxaphene	BDL
Dioxin (TCDD)	BDL

BDL = Below Detection Level
The compounds reported were not detected at the detection levels specified in the EPA Methods 624, 625.

PP/5r

Burmah

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43018
Client I.D.: Upstream of Southerly 8/17-18/88

Antimony, Sb, mg/l	<0.5
Arsenic, As, mg/l	0.005
Beryllium, Be, mg/l	<0.01
Cadmium, Cd, mg/l	<0.01
Chromium, Cr, mg/l	<0.02
Copper, Cu, mg/l	<0.02
Lead, Pb, mg/l	<0.05
Mercury, Hg, mg/l	<0.0005
Nickel, Ni, mg/l	<0.02
Selenium, Se, mg/l	<0.005
Silver, Ag, mg/l	<0.02
Thallium, Tl, mg/l	<0.5
Zinc, Zn, mg/l	0.03
Phenolics, (4AAP), mg/l	0.005
Cyanide, CN, mg/l	0.05

Susan K. Scott
Laboratory Supervisor

PP/6r

Burmah

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43018
Client I.D.: Upstream of Southerly 8/17-18/88

Volatile Organic Compounds, ug/l

Acrolein	BDL
Acrylonitrile	BDL
Benzene	BDL
Bromoform	BDL
Carbon Tetrachloride	BDL
Chlorobenzene	BDL
Chlorodibromomethane	BDL
Chloroethane	BDL
2-Chloroethylvinyl ether	BDL
Chloroform	BDL
Dichlorobromomethane	BDL
1,1-Dichloroethane	BDL
1,2-Dichloroethane	BDL
1,1-Dichloroethylene	BDL
1,2-Dichloropropane	BDL
1,3-Dichloropropene	BDL
Ethylbenzene	BDL
Methyl Bromide	BDL
Methyl Chloride	BDL
Methylene Chloride	BDL
1,1,2,2-Tetrachloroethane	BDL
Tetrachloroethylene	BDL
Toluene	BDL
Trans-1,2-Dichloroethylene	BDL
1,1,1-Trichloroethane	BDL
1,1,2-Trichloroethane	BDL
Trichloroethylene	BDL
Trichlorofluoromethane	BDL
Vinyl Chloride	BDL

PP/7r

Burmah

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43018
Client I.D.: Upstream of Southerly 8/17-18/88

Base/Neutral Compounds, ug/l

Acenaphthene	BDL
Acenaphthylene	BDL
Anthracene	BDL
Benzidine	BDL
Benzo(a)anthracene	BDL
Benzo(a)pyrene	BDL
Benzo(b)fluoranthene	BDL
Benzo(ghi)perylene	BDL
Benzo(k)fluoranthene	BDL
Bis(2-chloroethoxy)methane	BDL
Bis(2-chloroethyl)ether	BDL
Bis(2-chloroisopropyl)ether	BDL
Bis(2-ethylhexyl)phthalate	BDL
4-Bromophenyl phenyl ether	BDL
Butylbenzyl phthalate	BDL
2-Chloronaphthalene	BDL
4-Chlorophenyl phenyl ether	BDL
Chrysene	BDL
Dibenzo(a,h)anthracene	BDL
1,2-Dichlorobenzene	BDL
1,3-Dichlorobenzene	BDL
1,4-Dichlorobenzene	BDL
3,3-Dichlorobenzidine	BDL
Diethyl phthalate	BDL
Dimethyl phthalate	BDL
Di-n-butyl phthalate	BDL
2,4-Dinitrotoluene	BDL
2,6-Dinitrotoluene	BDL
Di-n-octyl phthalate	BDL
1,2-Diphenylhydrazine	BDL
Fluoranthene	BDL

Burmah

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43018
Client I.D.: Upstream of Southerly 8/17-18/88

Pesticides and PCB's, ug/l

Aldrin	BDL
a-BHC	BDL
b-BHC	BDL
g-BHC	BDL
d-BHC	BDL
Chlordane	BDL
4,4'-DDT	BDL
4,4'-DDE	BDL
4,4'-DDD	BDL
Dieldrin	BDL
a-Endosulfan	BDL
b-Endosulfan	BDL
Endosulfan Sulfate	BDL
Endrin	BDL
Endrin Aldehyde	BDL
Heptachlor	BDL
Heptachlor Epoxide	BDL
PCB-1242	BDL
PCB-1254	BDL
PCB-1221	BDL
PCB-1232	BDL
PCB-1248	BDL
PCB-1260	BDL
PCB-1016	BDL
Toxaphene	BDL
Dioxin (TCDD)	BDL

BDL = Below Detection Level
The compounds reported were not detected at the detection levels specified in the EPA Methods 624, 625.

PP/10r

Burmah

Northeast Ohio Regional Sewer District
Attn: James F. Weber, Manager
Industrial Waste Section

September 22, 1988

PROGRAM: RESOLUTION 121-87

Date Received: 8-19-88
ALD Number: 43018
Client I.D.: Upstream of Southerly 8/17-18/88

FORWARD LIBRARY SEARCH

Volatile Fraction

No significant responses

Acid Fraction

No significant responses

Base Neutral Fraction

No significant responses

RP/r