Greater Cleveland Area Environmental Water Quality Assessment 1989-1990

GREATER CLEVELAND AREA

ENVIRONMENTAL WATER QUALITY ASSESSMENT

1989-1990 REPORT

NORTHEAST OHIO REGIONAL SEWER DISTRICT

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PREFACE

Environmental water quality concerns are addressed at several governmental levels. Responsibilities at the state, national, and international levels include providing answers to questions about how pollutants can affect water uses to be protected, such as aquatic life, wildlife, and human health.

Unfortunately, the toxicological and epidemiological information necessary to answer these questions with certainty is sorely deficient, largely due to the prohibitively high expense of adequate research. This is evidenced by the U.S. EPA Great Lakes Water Quality Initiative's recognition of the need for a two-tier approach to setting water quality standards and the fact that criteria for most chemical pollutants do not meet the first-tier database requirements. (Under the Initiative, second-tier water quality criteria would be established for the majority of chemical pollutants based on limited toxicological data, with conservative assumptions to account for uncertainty. These criteria would then be used to develop or revise point source discharge limitations.)

"Toxic" pollutants in the Great Lakes and their tributaries are now at very low levels, which are often not detectable by current analytical capabilities. The effects at these levels on the uses to be protected are generally uncertain, not only due to the lack of toxicological and epidemiological data, but also because of unanswered scientific questions about the validity of interspecies high-to-low dose extrapolations and estimations of bioaccumulation potential.

In the face of these uncertainties and inadequate resources for their resolution, there is a risk that water quality standards revision and implementation may be driven, not by developments in scientific research, but by advocacy group hypotheses and political exploitation of public fears. This risk is of particular concern because the "point of diminishing return" may have already been reached in point source water pollution control.

Many billions of dollars have been spent over the last two decades by municipalities and industry to achieve the low levels of pollutants now being seen in environmental waters. An example of these efforts is the implementation of municipal pretreatment programs, which have substantially reduced the discharges to the environment of pollutants from indirect industrial effluents (Figure 1). As a result of such successes, the bulk of the remaining pollution of surface waters by toxic pollutants is now attributed to nonpoint sources; i.e., atmospheric deposition, agricultural and urban run-off, and resuspension of historically contaminated sediments. Therefore, to simply legislate

AVERAGE TOTAL METALS

(CADMIUM, CHROMIUM, COPPER, LEAD, NICKEL, ZINC)

SOUTHERLY WWTP DISCHARGE TO THE CUYAHOGA RIVER

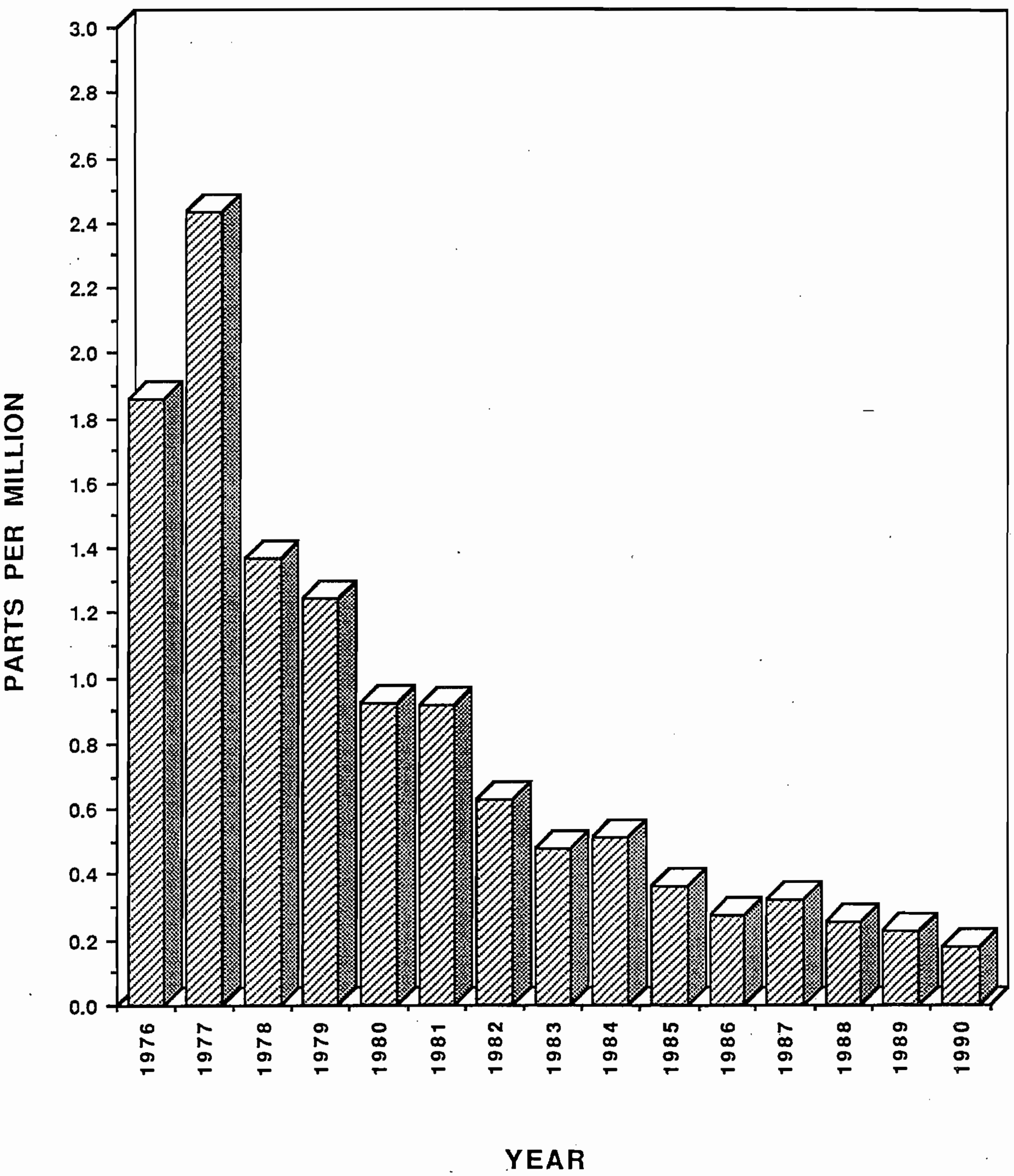


Figure 1

ever-increasingly stringent point source regulations, reflecting scientific uncertainty through worst-case assumptions, may result in no measurable environmental benefit and could inflict an unnecessarily heavy burden on scarce public and private resources.

The remaining sources of pollution in environmental waters are not appropriately addressed by the traditional governmental regulatory approach of enforcing numerical limits at the ends of pipes. What is needed is an integrated, "holistic" approach involving pollution prevention strategies, research to improve understanding of chemical toxicity, and site-specific studies to measure relative loadings of pollutants and identify their sources. This approach would enable a prioritization of expenditures on pollution control which is scientifically sound and environmentally effective.

While many of these issues must be dealt with by governmental entities at the state, national, and international levels, there is an essential role to be played at the local level in addressing environmental water quality concerns. The Northeast Ohio Regional Sewer District (NEORSD) has spent over 900 million dollars of public money since 1972 upgrading wastewater treatment plants and the sewer system to protect the water quality of Lake Erie and other Greater Cleveland Area waterways. Yet, significant detrimental water quality impacts have been continuing in area waterways. Some of these impacts occur during wet weather conditions and are attributable to combined sewer overflows (CSOs), storm sewers, and the solids loadings associated with erosion, siltation, and sedimentation. The impacts of CSOs and their possible remediation are to be assessed by a 4.4 million-dollar NEORSD-contracted study initiated in 1991. These and other water quality impacts on the Cuyahoga River and the Cleveland nearshore area of Lake Erie are also being addressed by the Cuyahoga River Remedial Action Plan (RAP), a joint effort involving state, federal, and local agencies, industrial and commercial entities, and community interest groups. The NEORSD has made substantial contributions to Stage One of the RAP, which in 1989 and 1990 included funding, manpower, equipment, and analytical services for studies of chemical contaminants in fish tissue and fecal coliform bacteria levels in the river.

The NEORSD Greater Cleveland Area Stream Monitoring Program 1987 and 1988 Reports had identified numerous dry weather sources of pollution as also having significant detrimental impacts on area waterways. Most of these dry weather impacts have been due to the failure of sanitary sewage to reach NEORSD treatment facilities as the result of sewer system deterioration, malfunction, or obstruction. A fewer number of other impacts have been due to direct unpermitted industrial discharges or accidental chemical spills. The dry weather sources can have far more significant impacts on water quality and biota than wet weather sources, because the dry weather impacts occur when the assimilative capacity of receiving waters is at a minimum. Dry weather impacts are also of concern because they occur at times of the greatest probability of human exposure through recreational contact. Contamination of waterways by sanitary sewage, as indicated by elevated bacterial levels, can be accompanied by the presence of infectious organisms, posing a potential threat to public health.

Aside from the concerns about impacts on stream biota and human health, degradation of the aesthetic quality of waterways is by itself a considerable concern. Streams transect residential, commercial, and recreational property throughout the Greater Cleveland Area. A community's quality of life is closely tied to its environmental health.

Again in 1989 and 1990, the NEORSD demonstrated that these types of water quality problems can be most effectively addressed at the local level. The NEORSD has the knowledge of the sewer system, the geographical access, and the analytical capabilities to perform this role. The details of the NEORSD Environmental Assessment 1989-1990 efforts and findings are presented in this report.

Contributing to the writing of this report were Cathy Zamborsky, Tom Zablotny, Bill Mack, Keith Linn, and Tim Dobriansky of NEORSD Water Quality & Industrial Surveillance. The stream and lake maps were prepared by Tim Dobriansky. Benthic macroinvertebrate identification was accomplished by Bill Mack, with independent verification provided by the Battelle Great Lakes Environmental Center in Traverse City, Michigan and Dr. Benjamin Foote, Professor of Biological Sciences at Kent State University. The information presented in the report was made possible by the efforts of NEORSD Analytical Services, NEORSD Sewer Maintenance & Control, NEORSD Planning, and especially each member of NEORSD Water Quality & Industrial Surveillance. Typing was performed by Judy Himes and Lisa Sulik. The report was edited by Keith Linn, Supervisor of Environmental Assessment.

EXECUTIVE SUMMARY

Since it was first developed for the Northeast Ohio Regional Sewer District (NEORSD) Industrial Waste Section in 1986, the NEORSD Environmental Assessment (formerly Stream Monitoring) Program has identified and initiated remediation of well over one hundred significant sources of pollution in Greater Cleveland Area waterways. This remediation has resulted in the removal from the waterways of millions of gallons per day of untreated wastewater, mostly sanitary sewage. These efforts continued through 1989 and 1990 and are described in detail in this report.

Identification of environmental water quality problems has been facilitated by chemical and biological measurements of water quality at locations on rivers, creeks, and culverted streams throughout the NEORSD's jurisdictional area and, beginning in 1990, the nearshore area of Lake Erie. The most useful tools in identifying sources of sanitary sewage in the waterways have been sampling for fecal coliform bacteria and benthic macroinvertebrates.

Fecal coliform bacteria are found in the intestinal tracts of warm-blooded animals, including humans, and therefore their elevated concentration in urban or suburban waterways is usually indicative of the presence of sanitary sewage. These bacteria are not harmful to aquatic life or humans, but the sanitary sewage in which they are carried are likely to also carry heavy loads of decomposing organic waste, which are harmful to aquatic ecosystems, and pathogens, which can pose a threat of disease through human contact. Although bacterial concentrations in the external environment are subject to high temporal and spatial variability from factors including reproduction/die-off rates, temperature, and background toxins, fecal coliform concentration elevations of several orders of magnitude can be used as rather conclusive indicators of pollution.

Benthic macroinvertebrates are aquatic organisms which inhabit the benthic regions of waterbodies and include insect larvae, crustaceans, snails, clams, worms, etc. The presence in an aquatic environment of a high diversity of benthic macroinvertebrates is typically indicative of a healthy ecosystem, while a low diversity is usually indicative of an ecosystem under environmental stress, such as from pollution. Furthermore, various taxa of benthic macroinvertebrates exhibit various sensitivities to pollution by organic waste, and through identification of the taxa and knowledge of their tolerance of pollution, the quality of a waterbody over time may be characterized.

These biological indicators have been employed successfully by the NEORSD in identifying numerous environmental disruptions and measuring the recovery of water quality following remediation. An example is provided by the West Branch of Big Creek upstream of its confluence with the East Branch north of Memphis Avenue and Tiedeman Road. In 1986, the water at this West Branch location exhibited fecal coliform concentrations as high as 3,200,000 organisms per 100 ml. Sampling for benthic macroinvertebrates at this location in 1987 and 1988 produced only oligochaetes, which can be highly tolerant of organic pollution.

The NEORSD had identified a major source of dry weather contamination by sanitary sewage upstream in a culverted section of the Big Creek West Branch at Cooley Avenue. In 1988, in response to NEORSD requests, the City of Cleveland Division of Water Pollution Control removed a sanitary sewer blockage responsible for this contamination. Following the remediation, the NEORSD determined that the most significant remaining dry weather pollution in the West Branch was occurring in another culverted section of the creek between Victory Boulevard and West 130th Street. A wall had been constructed in this section of the culvert to separate sanitary sewage from the creek. However, NEORSD dye studies demonstrated that the wall was leaking, allowing sanitary sewage to contaminate the creek.

In 1990, a NEORSD-contracted construction firm repaired the leaking wall between Victory Boulevard and West 130th Street. Fecal coliform samples collected from the creek upstream and downstream of the wall before and after the repair demonstrated the remediation's effectiveness in eliminating this source of contamination (Figure 2).

The West Branch of Big Creek downstream at the location north of Memphis Avenue and Tiedeman Road had already shown, in 1989 and 1990, considerable water quality improvement resulting from the Cooley Avenue remediation in NEORSD fecal coliform sampling (Figure 3) and benthic macroinvertebrate sampling (Table 1). Additionally, indications of water quality improvement resulting from this and other Big Creek remediation had been noted in bacteriological sampling further downstream in the Big Creek main stem at Jennings Road (Figure 4). Further improvement is expected to be evident in future sampling at these locations as Big Creek's recovery from pollution impacts continues.

This example illustrates the value of a historical perspective in evaluating water quality information. Recognition of this value has led to the inclusion in this report of several comparisons of historical and recent water quality data (Appendices XI, XIV, XV, XVI). Some of the improvements evident in these comparisons, such as of the fecal coliform concentrations in Lake Erie at Edgewater Beach (Figure 5), are directly attributable to NEORSD efforts - in this case, the construction of the Northwest Interceptor.

In 1990, the NEORSD Environmental Assessment Program's routine monitoring of 19 area streams at 68 sites was expanded to include 15

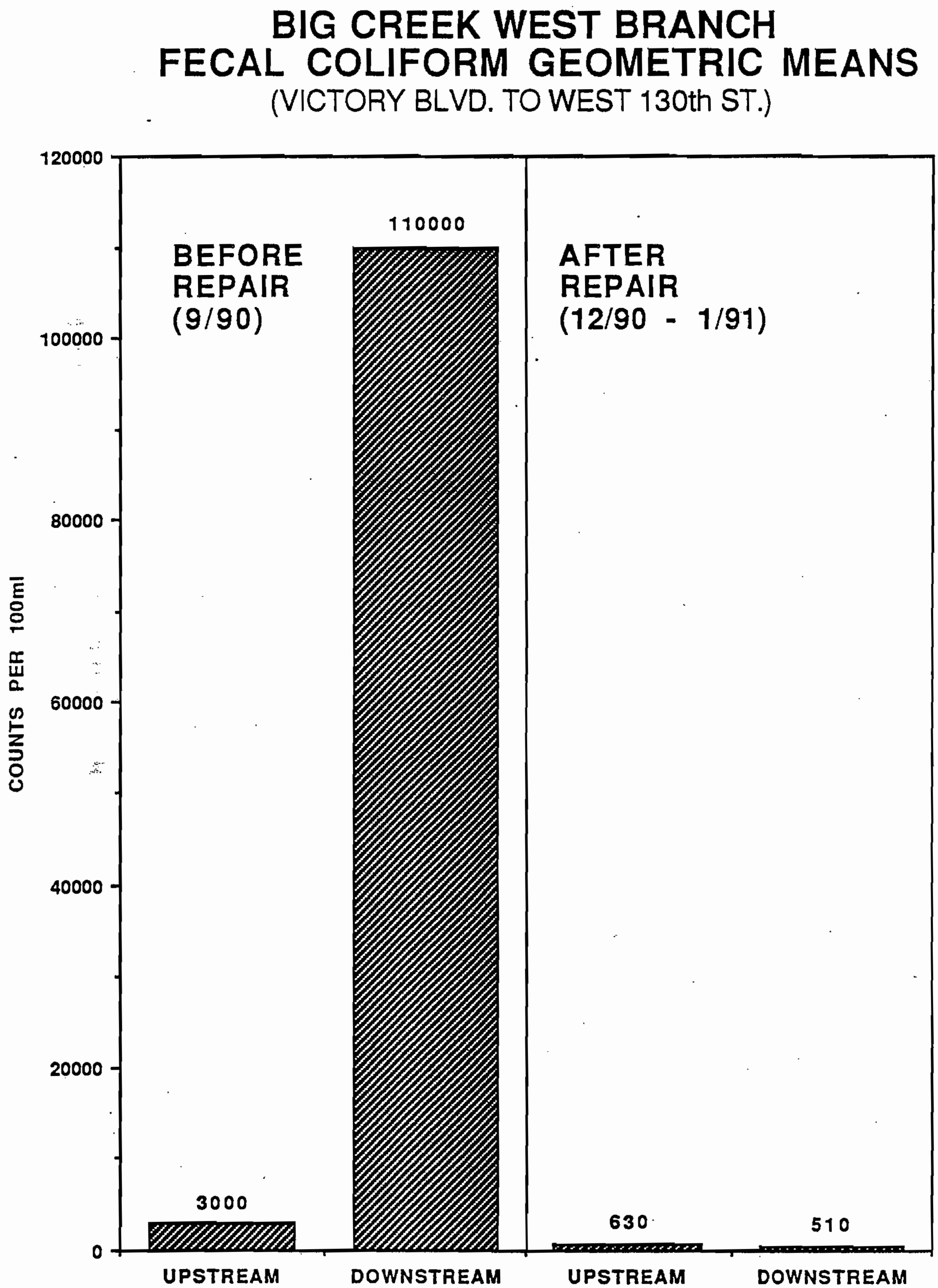

BIG CREEK WEST BRANCH
FECAL COLIFORM GEOMETRIC MEANS
(VICTORY BLVD. TO WEST 130th ST.)
120000
100000
80000
60000
40000
20000
0
COUNTS PER 100ml
BEFORE REPAIR (9/90)
AFTER REPAIR (12/90 - 1/91)
110000
3000
630
510
UPSTREAM
DOWNSTREAM
UPSTREAM
DOWNSTREAM

Figure 2

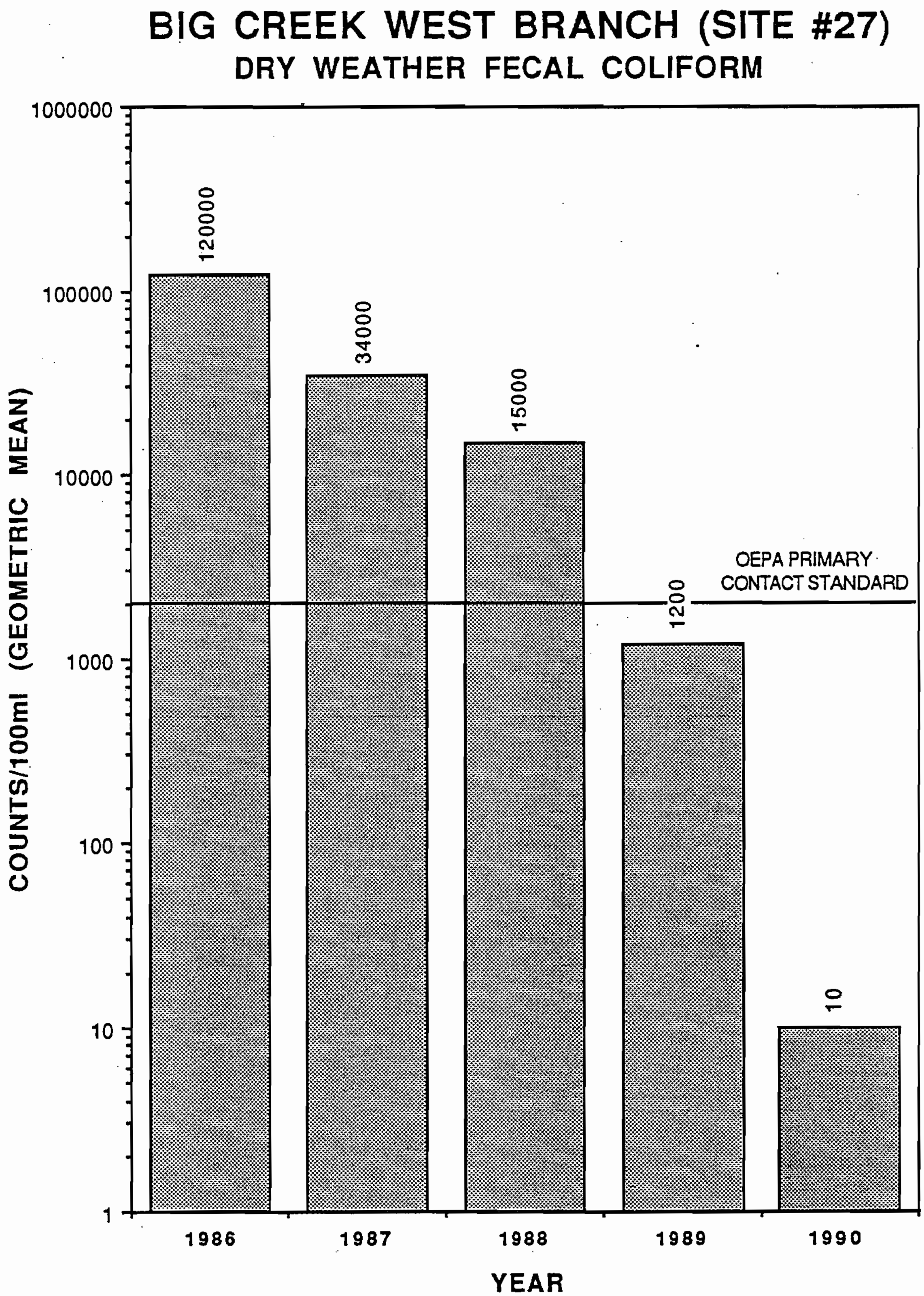

BIG CREEK WEST BRANCH (SITE #27)
DRY WEATHER FECAL COLIFORM
1000000
100000
10000
1000
100
10
1
COUNTS/100ml (GEOMETRIC MEAN)
120000
34000
15000
1200
10
OEPA PRIMARY CONTACT STANDARD
1986
1987
1988
1989
1990
YEAR

Figure 3

Table 1. Qualitative Data from Sampling for Benthic Macroinvertebrates at Site #27, Big Creek West Branch

Sampling Date	Taxa Collected	Pollution Tolerance
10/29/87	Oligochaeta	Tolerant
06/21/88	Oligochaeta	Tolerant
05/22/89	*Physella* sp.	Tolerant
07/19/90	Oligochaeta	Tolerant
"	*Hellobdella stagnalis*	Tolerant
"	*Hydropsyche betteni*	Facultative
"	*Thienemannimyia* sp.gr.	Facultative
"	*Cricotopus* sp.	Tolerant
"	*Cricotopus trifascia*	Facultative
"	*Physella gyrina*	Tolerant

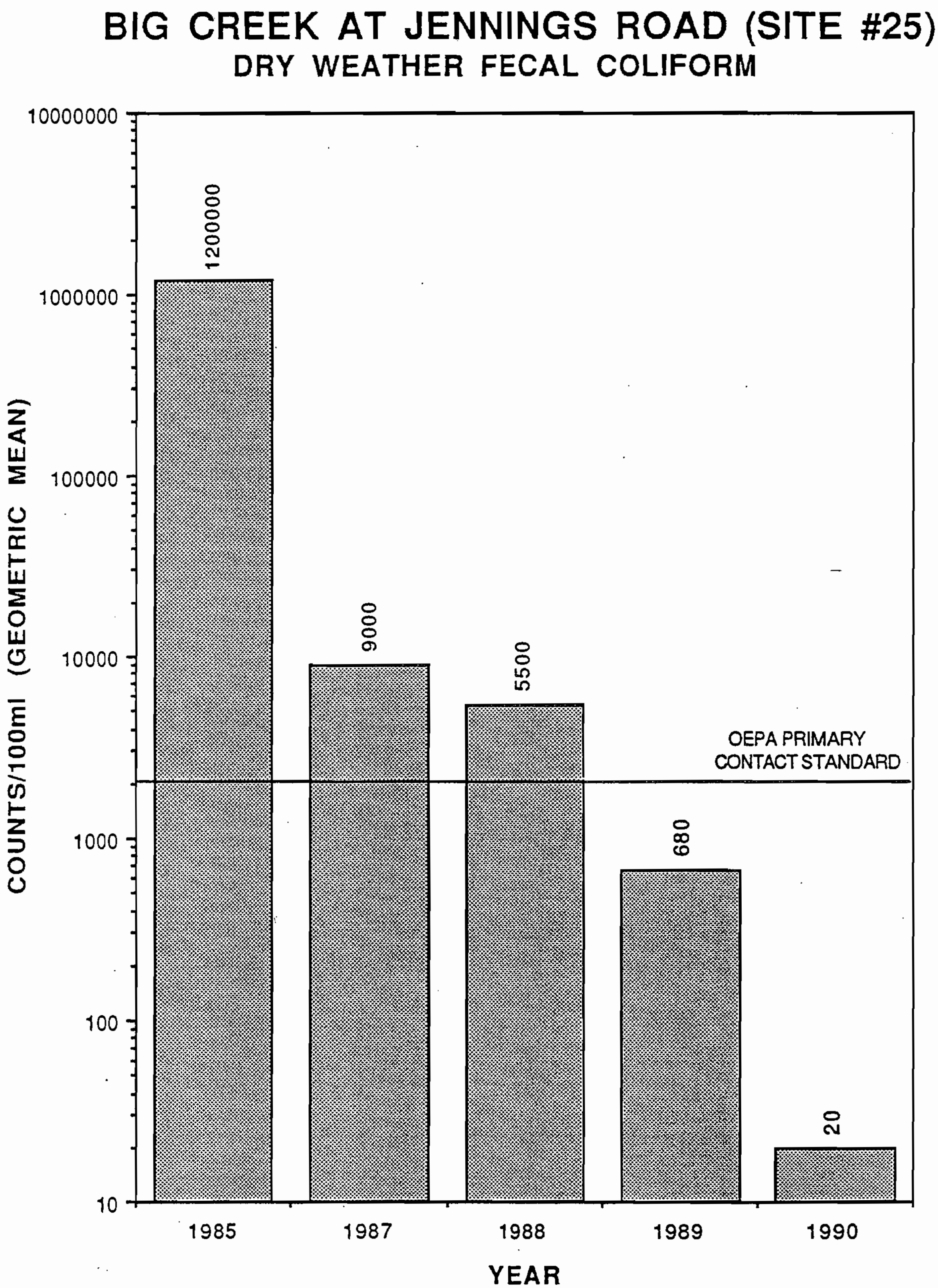
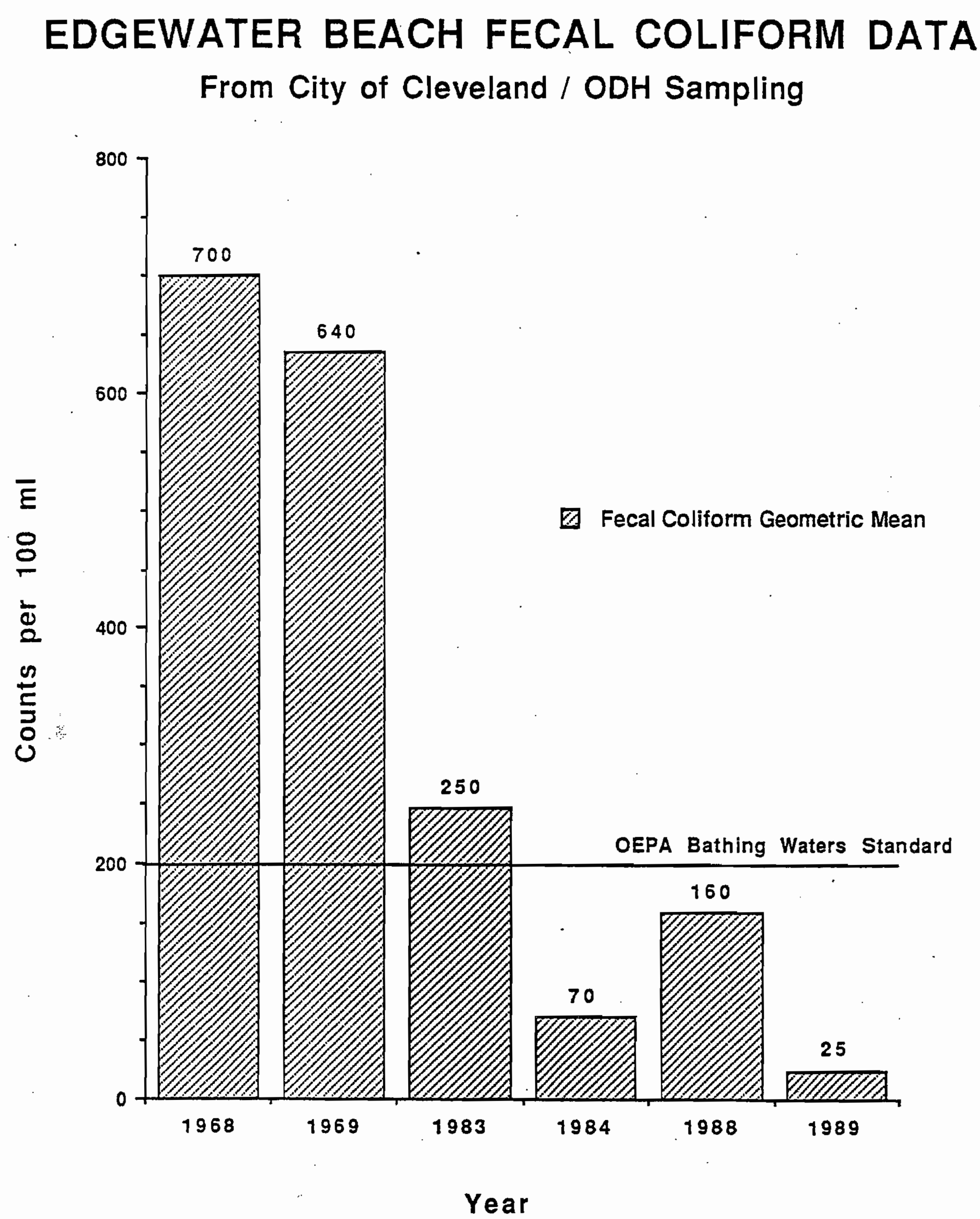

BIG CREEK AT JENNINGS ROAD (SITE #25)
DRY WEATHER FECAL COLIFORM
10000000
1000000
100000
10000
1000
100
10
COUNTS/100ml (GEOMETRIC MEAN)
1200000
9000
5500
680
20
OEPA PRIMARY
CONTACT STANDARD
1985
1987
1988
1989
1990
YEAR

Figure 4



EDGEWATER BEACH FECAL COLIFORM DATA
From City of Cleveland / ODH Sampling
Counts per 100 ml
800
600
400
200
0
700
640
250
70
160
25
Fecal Coliform Geometric Mean
OEPA Bathing Waters Standard
1968
1969
1983
1984
1988
1989
Year

Figure 5

sites in the nearshore area of Lake Erie. Waters from all NEORSD facilities are eventually tributary to the lake, where the City of Cleveland water intakes are located and the greatest amount of human exposure through recreational contact occurs. Chemical and bacteriological samples were collected from a rented boat throughout the summer of 1990. Unlike the stream sites where sampling was conducted only under dry weather conditions (following at least three days of no significant rainfall), the lake sites were sampled under a variety of weather conditions. Nevertheless, fecal coliform levels were generally considerably lower at the lake sites than at stream sites, as had been expected due to greater dilution and distance from sources.

Chemical and bacteriological data from the lake and the streams were compared to numerical criteria in Ohio EPA Water Quality Standards. For convenience in comparison and interpretation, only criteria from the 1990 revision of the standards were applied to the data, regardless of sampling date. Many of the water quality criterion "exceedances" discussed in the report result from comparison of single data with average criteria and would not necessarily constitute standards "violations" if the sampling frequency could have been greater.

For nearly all chemical parameters, concentrations measured by the NEORSD in 1989 and 1990 in the streams and Lake Erie rarely or never exceeded the applicable water quality criteria. Some of the rare exceedances were localized and directly attributable to known sources of pollution. However, exceedances were noted for copper, iron, and mercury at many sites on the streams and the lake. The copper exceedances are not discussed in this report because many were found in 1990 to be attributable to contamination of laboratory glassware rinsewater by copper piping, and therefore they do not necessarily reflect environmental conditions. Nevertheless, this situation points to copper waterpipes as a common potential source of this metal in the environment, especially through domestic wastewater in municipal effluents.

Iron is relatively nontoxic to aquatic life and is essential to human health, and therefore the minor exceedances of the water quality criterion noted for this metal are not a priority concern. Iron in the environment has numerous human and natural sources.

Mercury was measured in many samples at or slightly exceeding the NEORSD minimum analytical detection level, and therefore it is a statistical probability that some false positives may be included. Nevertheless, any detection of mercury is more than an order of magnitude higher than the Ohio EPA human health criterion for mercury of 12 parts per trillion. This criterion was developed with the intent of preventing mercury from bioaccumulating in fish tissue to levels higher than the U.S. Food & Drug Administration (FDA) Action Level of 1.0 part per million. However, the Remedial Action Plan fish tissue sampling of the Cuyahoga River, Chagrin River, and nearshore area of Lake Erie in 1989 and 1990 (in which the NEORSD participated) revealed that no fish exhibited mercury levels exceeding or approaching the FDA Action Level. Therefore, these data indicate that the use which the mercury criterion was developed to protect is not impaired and mercury concentrations in the water are not a water quality problem in the Greater Cleveland Area. Mercury in the environment has been attributed to coal combustion, paint application, medical and laboratory uses, and natural background levels, among other nonpoint sources.

Sampling for priority pollutant chemicals in Cuyahoga and Chagrin river sediments was conducted by the NEORSD in 1989 and 1990. Sediment concentrations of some metals and polycyclic aromatic hydrocarbons (PAHs) were measured at higher levels in the Cuyahoga River shipping channel than in the river upstream or in the Chagrin River. No direct correlation between the elevated sediment concentrations and the NEORSD Southerly Wastewater Treatment Plant effluent discharge was evident in these data.

Similar conclusions were drawn from the NEORSD 1990 quantitative fish surveys of the Cuyahoga River upstream and downstream of the Southerly plant effluent. The fish community in the river continued to fail to meet biological criteria set by the Ohio EPA for Erie/Ontario Lake Plain Warmwater Habitat. However, the depression of the fish community could not be correlated to any identifiable impact from the plant effluent, and in fact, biological index scores downstream of the plant were higher than scores upstream of the plant. Possible causes of the fish community depression other than point source discharge impacts continue to warrant further consideration.

The NEORSD contributed to other efforts to study the Cuyahoga River in support of the Cuyahoga River Remedial Action Plan, including intensive monitoring of fecal coliform levels in the river during the summer of 1990. The results of these efforts are to be presented in detail in the Remedial Action Plan Stage One Report.

CUYAHOGA RIVER

In 1969, oil and debris at the Cuyahoga River's head of navigation caught fire, and the "river that burns" received international notoriety. The fire drew attention to the heavily polluted condition of the Cuyahoga River, which flowed orange with industrial and municipal waste under slicks of oil, providing an impetus for a worldwide environmental movement.

In the two decades that followed, massive efforts to improve environmental water quality were undertaken by industry and government. Among these efforts was the creation in 1972 of the Cleveland Regional Sewer District, eventually to become known as the Northeast Ohio Regional Sewer District (NEORSD).

At the top of the NEORSD agenda was the clean-up of the Cuyahoga River basin's largest municipal discharge, the Southerly Wastewater Treatment Plant (WWTP) effluent. Following years of reconstruction and expansion at the plant, accompanied by intercepting sewer construction, industrial pretreatment installation, and initiation of combined sewer overflow control, dramatic improvements in the water quality of the Cuyahoga River became evident. Two of these improvements are reflected in the annual NEORSD monitoring data presented in Appendix XV. As the loadings of raw, untreated sanitary sewage to the river dropped between the 1970's and 1980's, so did the levels of fecal coliform bacteria in the water (Figure 6). When the NEORSD installed nitrification as an advanced wastewater treatment stage at the Southerly WWTP in the mid-1980's, levels of ammonia, a urea hydrolysis product which is oxygen-demanding and toxic to aquatic life, also dropped (Figure 7).

Aquatic organisms returned to the now increasingly habitable river, and between 1988 and 1991, 49 species of fish were found living in the river within the boundaries of Cuyahoga County (Appendix XI-C). The public's appreciation of the Cuyahoga River as a resource also returned as recreational boating on the river and commercial development in the Cleveland Flats along the river banks boomed in popularity.

Nevertheless, the Cuyahoga River's recovery was not yet complete and concerns about the river's water quality remained. The river was failing to achieve Ohio EPA biological criteria for balanced, reproducing fish and invertebrate populations. Tumors were being found in bottom-dwelling catfish. Analyses of dredged river sediments were revealing levels of contaminants unacceptable for open-lake disposal. Low dissolved oxygen levels were occurring periodically in the river's navigation channel. Following storms, muddy discoloration and floating debris continued to be eyesores, and elevated wet weather bacterial concentrations continued to raise public health concerns.

Because of the continuing water quality concerns, the International Joint Commission's Great Lakes Water Quality Board identified the

Figure 6

CUYAHOGA RIVER

MAY-TO-OCTOBER FECAL COLIFORM CONCENTRATIONS

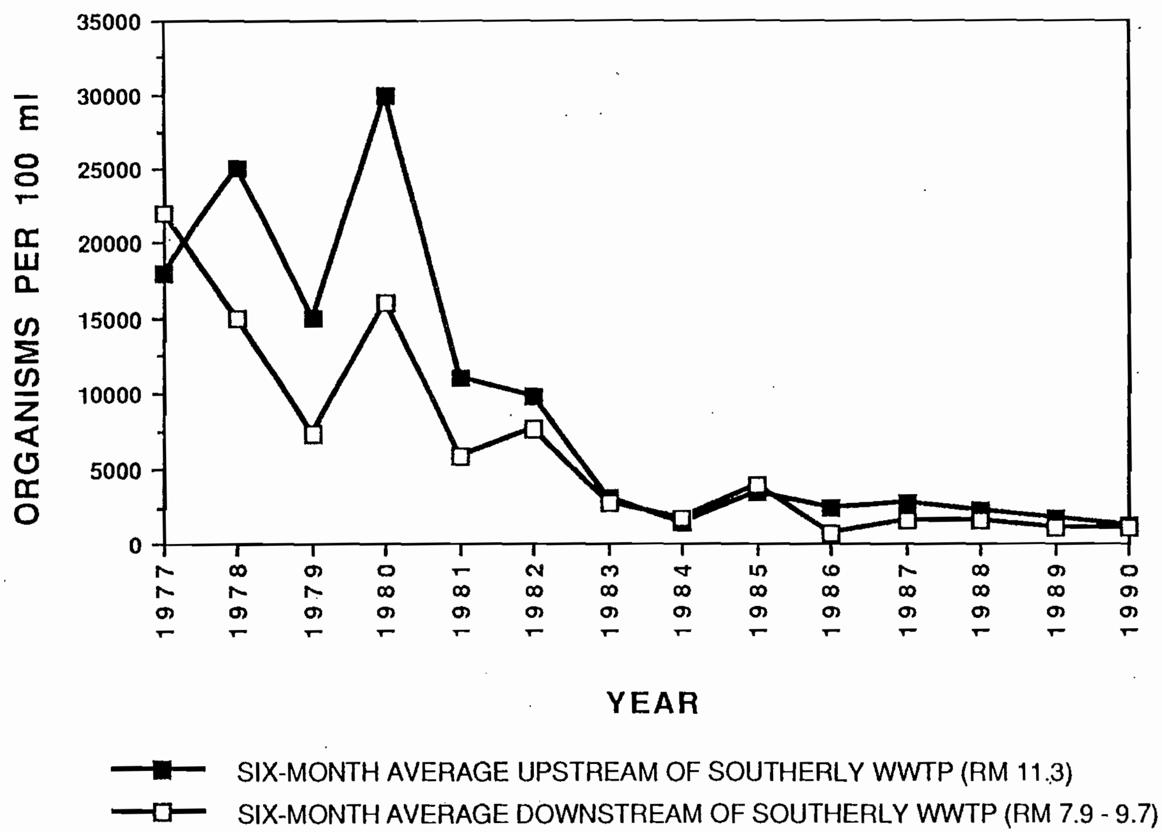
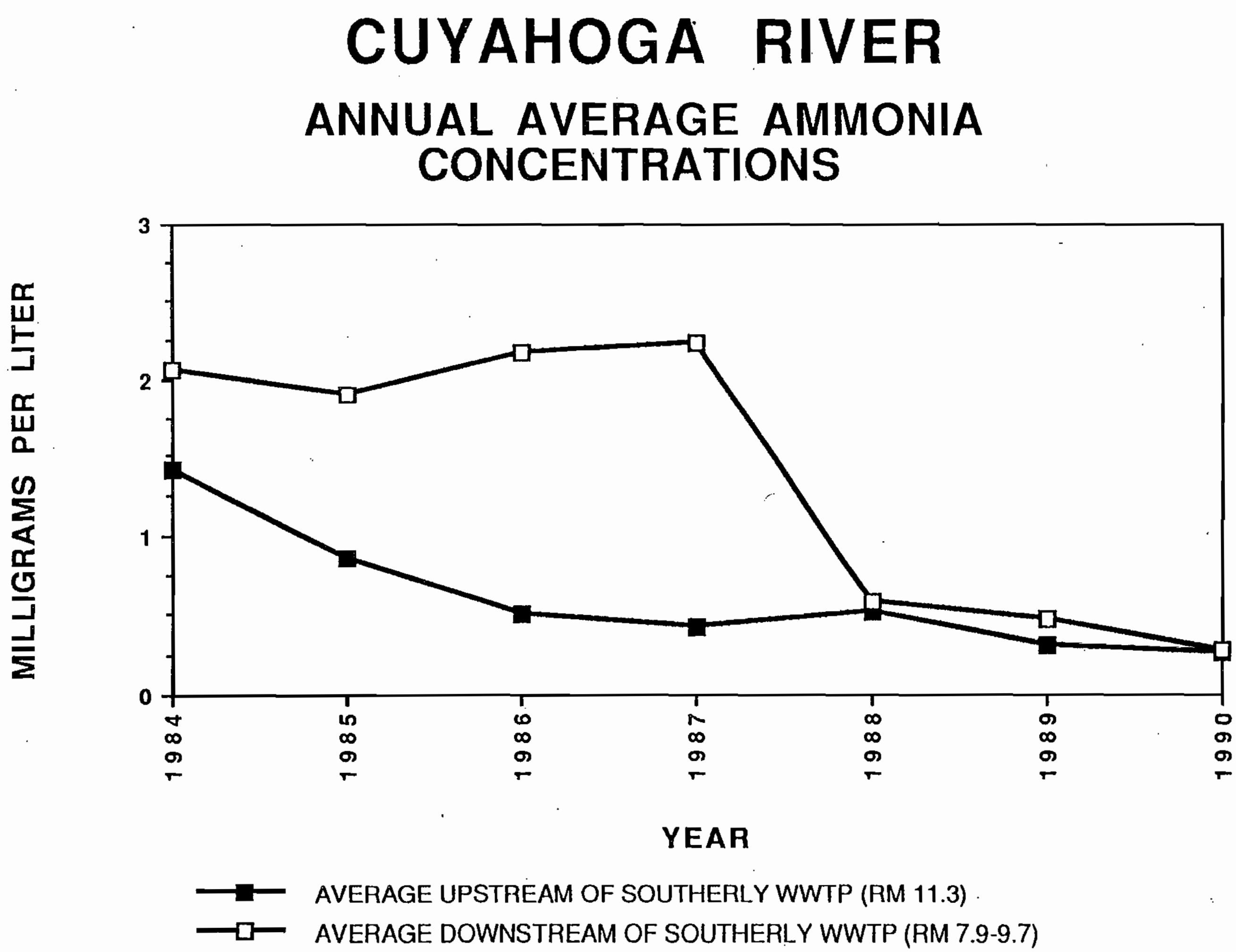


Figure 7


CUYAHOGA RIVER
ANNUAL AVERAGE AMMONIA CONCENTRATIONS
MILLIGRAMS PER LITER
0
1
2
3
1984
1985
1986
1987
1988
1989
1990
YEAR
AVERAGE UPSTREAM OF SOUTHERLY WWTP (RM 11.3)
AVERAGE DOWNSTREAM OF SOUTHERLY WWTP (RM 7.9-9.7)

Cuyahoga River as one of 43 Areas of Concern in the Great Lakes basin. To restore uses which have been impaired, the eight Great Lakes states and the Province of Ontario have committed to developing a Remedial Action Plan (RAP) for each Area of Concern.

The Cuyahoga River RAP is a joint effort involving state and federal agencies, industrial, commercial, and private interests, community interest groups, and local public jurisdictions. The NEORSD has participated heavily in the Cuyahoga River RAP. The involvement of NEORSD Water Quality & Industrial Surveillance has constituted providing data for the RAP Stage One efforts to describe the environmental condition of the Cuyahoga River watershed. In 1989 and 1990, this involvement included two major studies: a sampling and analysis of fish tissue for chemical contaminant levels; and an intensive sampling of the lower river for fecal coliform bacteria levels.

A paucity of data had existed on the concentrations in Cuyahoga River fish tissue of chemical substances that could pose a threat to human health through consumption. To fill this data gap, the RAP Technical Committee established a RAP Fish Tissue Group, co-chaired by the Ohio EPA and the NEORSD. Sampling was commenced in 1989 and continued in 1990. NEORSD investigators assisted throughout the fish collection efforts, which were aided by the employment of the NEORSD electrofishing vessel. Some fish tissue analyses were performed by NEORSD Analytical Services, and the NEORSD contributed to the funding of the bulk of the analyses, which were performed by the Ohio EPA Laboratory.

The fish tissue analyses detected trace levels of some metals, pesticides, and PCBs (polychlorinated biphenyls), most of which are attributable to the Cuyahoga River's polluted past. For example, the PCB concentrations, are slightly elevated when lipid-normalized and compared to non-urban reference sites. PCBs had been used extensively in capacitors, transformers, hydraulic fluids, sealants, and elsewhere. However, the manufacture and utilization of PCBs have been banned since the 1970's, and the concentrations in fish at urban locations are relatively uniform irrespective of the proximity of major point sources, suggesting diffuse sources of PCBs, such as from historical sediment contamination. Although not detected in Cuyahoga River sediments, PCBs present in sediments below levels of detectability may yet be responsible for the fish tissue levels due to their high bioaccumulation potential.

Nevertheless, none of the contaminants detected in any of the Cuyahoga River fish tissue samples from the 1989 collection exceeded U.S. Food & Drug Administration Action Levels. The data were evaluated by the Ohio Department of Health, who found no reason to issue a fish consumption advisory for the Cuyahoga River based upon the data. Initial results from analysis of the samples from the 1990 fish tissue collection indicate similar levels. A brief discussion of the 1989 RAP Fish Tissue Analysis is presented in Appendix XIX. The results in detail and a more comprehensive discussion are to be presented in the Cuyahoga River RAP Stage One Report.

Throughout the summer of 1990, the NEORSD participated in an intensive RAP sampling of the lower Cuyahoga River for fecal coliform bacteria concentrations. NEORSD investigators collected bacteriological samples regularly at seven river sites between Old Rockside Road and the head of navigation at the Newburg & South Shore Railroad crossing. The samples were analyzed for fecal coliform by NEORSD Analytical Services. This sampling and analysis was coordinated with sampling and analysis by the Ohio EPA, the Northeast Ohio Areawide Coordinating Agency, and the Ohio Department of Health in the Cuyahoga River shipping channel and the Cleveland Harbor.

Results revealed that in dry weather conditions (i.e., at least 72 hours following precipitation of more than 0.20 inches per day) applicable Ohio EPA Water Quality Standards for Recreational Use were met consistently at all locations. However, in wet weather conditions acceptable levels of fecal coliform bacteria were frequently exceeded. These elevated concentrations have been attributed to combined sewer overflows and storm sewers throughout the Cuyahoga River basin.

Nevertheless, the study showed that fecal coliform concentrations in the Cuyahoga River have decreased dramatically since the early 1970's, despite the fact that 1990 had a relatively wet summer. The decrease is clearly evident in a comparison of historical City of Cleveland bacteriological data to the NEORSD data from the 1990 RAP study. This comparison is presented in Appendix XIV. A more complete data summary and a comprehensive discussion of the 1990 RAP fecal coliform study are to be presented in the Cuyahoga River RAP Stage One Report.

The NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report focused on water quality of the Cuyahoga River. However, so as not to be duplicative of the Cuyahoga River RAP Stage One Report, the remainder of this report will focus on NEORSD sampling and remediation efforts apart from the RAP participation.

The Cuyahoga River and its tributaries drain approximately 813 square miles of land in northeastern Ohio (SAIC, 1986). The headwaters of the river originate in Geauga County and drop from approximately 1,300 feet above sea level at an average rate of three to four 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 five feet per mile. 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 urban, suburban, and rural land. Each of the residential, commercial, industrial, agricultural, and recreational uses exert their influences on the river, either directly or indirectly.

The hydrologic characteristics of the Cuyahoga River vary 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. Low flow levels have been altered upward due to this condition. The average annual precipitation is 34.9 inches in Cleveland and 35.1 inches in the Akron area. The soils in the basin range from slightly erodible to highly erodible.

Flow data for the Cuyahoga River is measured by a United States Geological Survey (USGS) station at Old Rockside Road in Independence (RM 13.2). The average flow recorded at this station was 971 cubic feet per second (CFS) for water year 1989 and 1,083 CFS for water year 1990. The average discharge recorded during the 54-year period of record, up to 1984 was 823 CFS (SAIC, 1986). The measured flow at Old Rockside Road does not include most of the flow diverted to the Ohio Canal at State Route 82 upstream of the gauge.

The flow in the Cuyahoga River in its navigable section, downstream of RM 5.6, is strongly influenced by Lake Erie. The dynamics of river and lake mixing near the confluence are primarily a function of the prevailing nearshore currents as well as the physical characteristics of the lower channel and the Lake Erie shoreline. The area 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 six to seven 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 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). 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).

In 1990, the Ohio Supreme Court upheld an Ohio EPA decision to designate the Cuyahoga River segment from RM 10.8 (Southerly's WWTP effluent channel) to RM 5.6 (head of the river's navigation channel) Warmwater Habitat for aquatic life use. Since the designation in 1986, the NEORSD has challenged the Ohio EPA assessment of the Cuyahoga River's ability to sustain, in this segment, balanced, reproducing populations of warmwater fish, vertebrate and invertebrate organisms, and plants on an annual basis. The NEORSD contends that factors such as lack of physical habitat, silt and sediment load, and nonpoint sources of pollutants (e.g., seasonally elevated concentrations of chlorides from roadsalt runoff) are negatively influencing the river's potential for aquatic life habitation in this segment. It is the Ohio EPA's contention that stricter controls on point source discharges from municipalities and industry will allow the river to attain Warmwater Habitat status. The NEORSD plans no further appeals on this decision and fully intends to comply with any effluent discharge limits applied as a result of the habitat designation. However, whether the river habitat is equally obliging in meeting its use designation remains to be seen.

A NEORSD suggestion to consider stocking the Cuyahoga River downstream of Akron with representative Warmwater Habitat fish species to test longterm habitability of the river was rejected by the Ohio Department of Natural Resources (ODNR). In a January 1990 correspondence with the NEORSD, the ODNR Division of Wildlife asserted that it is unreasonable to "expect the Cuyahoga River to develop a fauna comparable in diversity to the Chagrin and Grand Rivers. They are very different systems."

As of the end of 1990, the Ohio EPA's use designations of the Cuyahoga River navigation channel remained "Reserved." The Ohio EPA has recognized the habitat restrictions in this river segment resulting from physical factors such as continual dredging, steel shoring of banks, and the total lack of riparian buffer and shallow water habitat. Consequently, the Ohio EPA has reserved designation of the Cuyahoga River navigation channel pending completion of a use attainability analysis on this unique water body.

For the purposes of this report, the Ohio EPA Limited Resource Water criteria, which represent the minimum water quality to be met in all surface waters in the state outside of mixing zones, are assumed to apply to the NEORSD sampling sites within the Cuyahoga River navigation channel. For comparison with bacteriological data, Primary Contact Recreational Use criteria are assumed to apply at all NEORSD Cuyahoga River sites. Upstream of the navigation channel, the Cuyahoga River has been designated by the Ohio EPA State Resource Water, Aquatic Life Warmwater Habitat, Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreational Use.

ROUTINE SITE SAMPLING

All "routine" NEORSD stream sampling was performed under dry weather conditions, following at least three days of no significant rainfall. At each site, surface grab samples were collected with an acid-cleaned, distilled water-rinsed plastic bucket and drop line. The bucket was further rinsed with stream water from the sample site prior to the collection of each sample. All samples obtained at bridge sites were collected at midstream while all others were collected near the bank. Closed and labeled plastic containers were used to transport samples, on ice for preservation, to NEORSD Analytical Services. All bottles used to transport samples for bacteriological analysis had been sterilized prior to sampling.

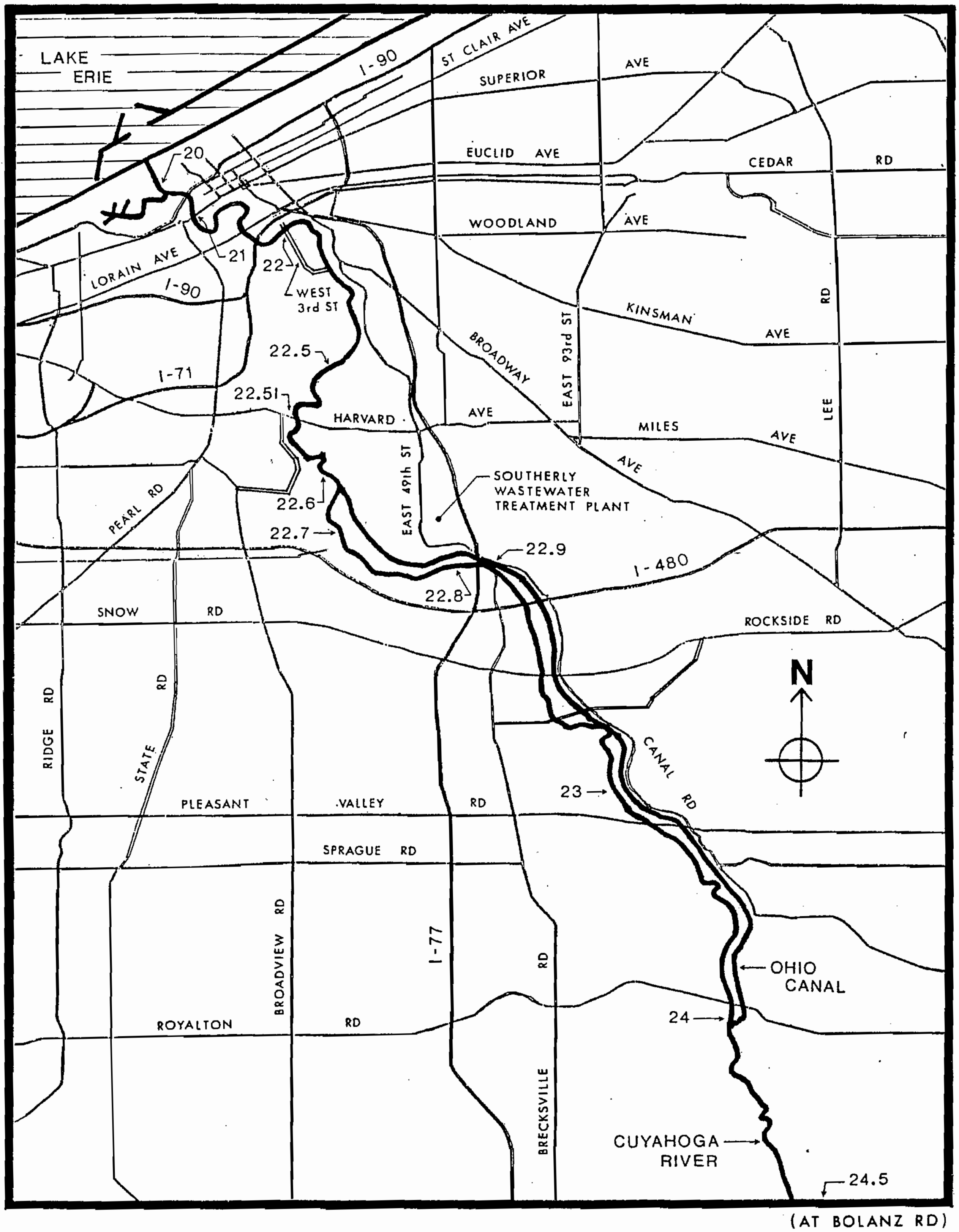
At all sites, field measurements were obtained at the time of sampling for water temperature and dissolved oxygen, using a calibrated YSI Model 51B Oxygen Meter or Nester Instruments Model No. 8500 Oxygen Meter. At many sites, field measurements at the time of sampling were obtained for specific conductance using a Beckman Industrial Model RC-16D Conductivity Bridge, turbidity using a Monitek Model 21PE Portable Nephelometer, and pH using a Fisher Model No. 607 Digital pH Meter. Average field measurements are presented with the chemical data in Appendices II and III.

In 1989 and 1990, the NEORSD performed only qualitative sampling for benthic macroinvertebrates. Organisms were collected using a D-frame Kicknet, a Surber sampler, handpicking, or occasionally a Petite Ponar Bottom Grab sampler. Only organisms large enough to be retained by a No. 30-mesh screen were collected. Sampling was performed at all accessible microhabitats at a site until no new taxa were being collected. This period of time usually ranged from one-half hour to one hour at each site. Benthic macroinvertebrate samples were retained in labeled vials and preserved with AGW (a mixture of 85% denatured ethanol, 5% glycerol, and 10% water) for laboratory identification. Taxa identified are presented in Appendices VIII and IX with general pollution tolerance classifications and the literature sources for these classifications.

In 1989 and 1990, routine sampling for chemical and bacteriological analysis was performed by NEORSD investigators at twelve sites on the Cuyahoga River between the river mouth at River Mile (RM) 0.3 and Bolanz Road in the Cuyahoga Valley National Recreation Area at RM 33.2 (Figure 8).

Site #20

Site #20 is off the east bank of the Cuyahoga River at RM 0.3 behind Fagan's Restaurant, 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. Undirectional flow in the river is barely evident on most occasions during dry weather conditions. A cessation in flow or backflow, which are occasionally observed, are a result of the interfacing of the river with Lake Erie's waters. At this site and at all of the other sites where the depth is at least three feet, the river generally appears turbid or light brown in color. On sunny days during the summer months, however, the river typically appears murky or greenish brown in color, which is reflective of algal production. The sheen of small patches of surface oil and the accumulation of a small amount of natural and/or manmade debris have been often observed near the river edge 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 a natural, riverine habitat due to the extensive shoreline development, the existence of



Cuyahoga River

(NOT TO SCALE)

Figure 8

steel-lined banks with virtually no vegetative cover, and the fact that the channel is routinely dredged to maintain its depth.

Site #20 was sampled twice for chemical analysis in 1989 (Appendix II-A). With the exception of zinc, all chemical data were within Ohio EPA criteria in Water Quality Standards for Limited Resource Water. Zinc was measured at 0.24 mg/L on October 26, slightly exceeding the numerical criterion of 0.22 mg/L.

Site #20 was sampled twice for bacteriological analysis in 1989 (Appendix II-A). The fecal coliform concentrations were below the Ohio EPA criteria for Primary Contact Recreational Use. These data are comparable to some of the dry weather results obtained from this location in 1987 and 1988.

Qualitative sampling for benthic macroinvertebrates at Site #20 on August 31, 1989 produced eight taxa (Appendix VIII-A). Organisms of the phyla Annelida and Mollusca were collected from the substrate using a Petite Ponar Bottom Grab sampler. The taxa are described in literature as tolerant and facultative in their responses to organic pollution. The low diversity of taxa collected is reflective of the substrate type and habitat conditions. Historical sediment contamination by organic and inorganic pollutants may also be a factor, based upon elevated sediment concentrations of metals, cyanide, and oil & grease measured by the U.S. Army Corps of Engineers.

Site #20 was sampled twice in 1990 for chemical analysis (Appendix III-A). Chemical data showed mercury exceeding its numerical criterion. Mercury was measured at 0.2 ug/L on July 25 compared to the 0.012 ug/L criterion. All other chemical data were within Ohio EPA criteria for Limited Resource Water.

Site #20 was sampled once by the NEORSD for bacteriological analysis in 1990 (Appendix III-A). The fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. Comparable dry weather results had been obtained by the NEORSD from Site #20 in 1987 to 1989.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #20 in 1990.

Site #21

Site #21 is at the north downstream side of the Center Street bridge (RM 1.0). The river at this location is approximately 200 feet wide and 30 feet deep. Like Site #20, this segment of the river is within the navigation channel. Both banks consist of steel seawall with developed shorelines. The water color ranges from light brown to murky green, and the substrate is silt. Lake-effect backflow has been observed at this site. Samples are collected from the bridge at midstream.

In late 1987, the Center Street bridge was closed for repair, prohibiting access to Site #21 for sampling. Following completion of the bridge repair in 1989, NEORSD sampling at this location was resumed.

Site #21 was sampled twice for chemical analysis in 1989 (Appendix II-A). All chemical data from Site #21 in 1989 were within Ohio EPA criteria for Limited Resource Water.

Site #21 was sampled twice for bacteriological analysis in 1989 (Appendix II-A). The fecal coliform concentrations of 220 and 600 organisms per 100 ml were below the Ohio EPA criterion for Primary Contact Recreational Use. These bacteriological data are comparable to some of the results obtained at this site in 1987.

Historical City of Cleveland records indicate that in 1972 the annual fecal coliform geometric mean in the Cuyahoga River at the Center Street bridge had been measured at 5,800 organisms per 100 ml (Appendix XIV-F).

Qualitative sampling for benthic macroinvertebrates was not performed by the NEORSD at Site #21 in 1989 or 1990.

Site #21 was sampled twice in 1990 for chemical analysis (Appendix III-A). An exceedance of the numerical criterion for mercury was noted. Mercury was measured at 0.7 ug/L on July 25. All other chemical data were within Ohio EPA criteria for Limited Resource Water and were comparable to results obtained in 1987 and 1989.

Site #21 was sampled once in 1990 by the NEORSD for bacteriological analysis (Appendix III-A). Bacteriological data showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. These results were slightly higher than the bacteriological data obtained from this location in 1989 but comparable to some of the data from 1987.

Site #22

Site #22 (RM 3.3) is at the West 3rd Street bridge in the Cleveland 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 evident on most occasions under dry weather conditions. The sheen from small patches of oil is frequently observed along the shoreline near the bridge. The physical characteristics of the river are very similar to those of Sites #20 and #21, with the exception of a 0.1- to 0.2-mile stretch of exposed earthen bank along the west side of the river at this location. Substrate type and quality are also similar to those of Sites #20 and #21. Samples are collected from the bridge at midstream.

Site #22 was sampled twice for chemical analysis in 1989 (Appendix II-A). All chemical data were within Ohio EPA water quality criteria for Limited Resource Water at Site #22.

Site #22 was sampled twice for bacteriological analysis in 1989 (Appendix II-A). The fecal coliform concentrations of 120 and 420 organisms per 100 ml were below the Ohio EPA criterion for Primary Contact Recreational Use. These bacteriological data were generally lower than those obtained in 1987 and 1988, when fecal coliform geometric means of 1,500 organisms per 100 ml were measured each year at Site #22.

Historical City of Cleveland records indicate that in June 1970 a fecal coliform geometric mean of 430,000 organisms per 100 ml had been measured in the Cuyahoga River at the West 3rd Street bridge (Appendix XIV-F).

Site #22 was sampled twice in 1990 for chemical analysis (Appendix III-A). Chemical data showed two exceedances of the numerical criterion for mercury. Mercury was measured at 0.9 ug/L on July 25 and 0.2 ug/L on September 14. All other chemical data were within Ohio EPA criteria for Limited Resource Water and similar to results obtained by the NEORSD at Site #22 in 1987 to 1989.

Site #22 was sampled once in 1990 by the NEORSD for bacteriological analysis (Appendix III-A). The fecal coliform concentration did not exceed the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological data are comparable to those obtained at this location in 1987 and 1988.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22 in 1990. As with Sites #20 and #21 (also located within the navigation channel), past sampling had shown a predominance of oligochaetes and molluscs. This lack of macroinvertebrate diversity is indicative of the relatively low habitability of the fine sediment/muck substrate type and possibly sediment contamination.

Site #22.5

Site #22.5 (RM 5.6) is at the Newburg and South Shore Railroad bridge on the property of the LTV Steel Company and can be accessed by following the river onto the steel mill property from either Independence Road or Campbell Road. There are two parallel railroad bridges located approximately 30 feet apart at the site. The Newburg and South Shore Railroad bridge is located on the upstream side and is the downstream boundary of the Ohio EPA Warmwater Habitat designation. 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 four feet nearshore to about ten feet midstream. 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, has been noted. 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 extensive along the east bank than the west bank. As one approaches Site #22.51, which is 1.6 miles upstream at the Lower Harvard bridge, the buffer is intermittent 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. Several industrial discharges are evident both upstream and downstream of this site.

Site #22.5 was sampled once for chemical analysis in 1989 (Appendix II-B). With the exception of iron, all chemical data were within Ohio EPA water quality criteria for Warmwater Habitat. Iron was measured at 2.4 mg/L on September 21.

Site #22.5 was sampled once for bacteriological analysis in 1989 (Appendix II-B). Bacteriological data showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. Comparable results had been obtained by the NEORSD at this location in 1988. The 1989 data were lower, however, than the fecal coliform concentration of 6,900 organisms per 100 ml measured at Site #22.5 in 1987.

Qualitative sampling for benthic macroinvertebrates at Site #22.5 on August 29, 1989 produced five taxa described in literature as facultative and tolerant in their responses to organic pollution (Appendix VIII-B). These results are comparable to those obtained at this site in 1988, when eight taxa were collected. The low diversity of taxa collected may be attributed to the habitat at this location. The substrate consists primarily of sand, silt, and muck along the margins, which are not as conducive to benthic habitation as substrates at other locations. Lacking are boulders, cobble, and riffles, which would provide suitable habitat for a more diverse macroinvertebrate community.

Site #22.5 was sampled twice in 1990 for chemical analysis (Appendix III-B). Chemical data showed exceedances of numerical criteria for iron and mercury. Iron was measured at 1.2 mg/L on July 25 and 1.8 mg/L on September 14. Mercury was measured at 0.5 ug/L on July 25. All other chemical data in 1990 at Site #22.5 were within the Ohio EPA criteria for Warmwater Habitat.

Site #22.5 was sampled once for routine bacteriological analysis in 1990 (Appendix III-B). The bacteriological data were below the Ohio EPA criteria for Primary Contact Recreational Use. These data are comparable to bacteriological results obtained by the NEORSD from Site #22.5 in 1987 to 1989.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22.5 in 1990.

Site #22.51

Site #22.51 (RM 7.1) is at the Lower Harvard bridge. It is located less than 0.2 miles downstream of the Cuyahoga River/Big Creek confluence. The river at this location is approximately 100 feet wide and the depth ranges from two feet nearshore to about eight 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 velocity as far upstream as this site. The habitat type upstream of the bridge is riffle and run. Some pooling exists underneath and near the bridge, while a long stream run starts downstream of the bridge. The substrate is a mix of sand, gravel, cobble, 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 manmade debris is fairly common at this site. Concrete and steel shoring is found further downstream toward the lower channel. On the upstream side of the bridge, upland industrial activity predominates as well, although wooded areas are more extensive and the shoreline vegetation provides greater cover.

Site #22.51 was sampled twice for chemical analysis in 1989 (Appendix II-B). Single exceedances of the numerical criteria were noted for iron and mercury. Iron was measured at 1.3 mg/L and mercury was measured at 1.0 ug/L on October 26. All other chemical data from Site #22.51 in 1989 were within the numerical criteria for Warmwater Habitat.

Site #22.51 was sampled twice for routine bacteriological analysis in 1989 (Appendix II-B). The bacteriological data were below the Ohio EPA criterion for Primary Contact Recreational Use. These data were lower than bacteriological results obtained in 1987 and 1988, when the fecal coliform geometric means were 1,600 and 1,100 organisms per 100 ml, respectively. Additionally, a fecal coliform concentration of 16,000 organisms per 100 ml was measured at Site #22.51 on May 15, 1989, but this elevated bacteria level was due to the Ohio EPA-approved NEORSD Big Creek Interceptor diversion, which was occurring at the time of sampling and is discussed in detail in Appendix XIII.

Historical City of Cleveland records indicate that in 1972 and 1973 annual fecal coliform geometric means of 5,500 and 2,000 organisms per 100 ml, respectively, had been measured in the Cuyahoga River at the Lower Harvard bridge (Appendix XIV-E). Furthermore, in June 1970 a fecal coliform geometric mean of 1,800,000 organisms per 100 ml had been measured at this location.

Qualitative sampling for benthic macroinvertebrates at Site #22.51 on August 14, 1989 produced 29 taxa, including one ephemeropteran taxon (Leucrocuta sp.), which is described in literature as intolerant in its response to organic pollution (Appendix VIII-C). The remaining taxa include organisms predominantly facultative in their responses to organic pollution. This was an increase from sixteen taxa collected in 1988 and is due, in part, to improved taxonomic identification skills.

Site #22.51 was sampled twice for chemical analysis in 1990 (Appendix III-B). With the exception of iron, all chemical parameters were within water quality criteria for Warmwater Habitat. Iron was measured at 3.2 mg/L on July 25 and 2.9 mg/L on September 13. The 1990 chemical data were generally comparable to those obtained by the NEORSD at this location in 1987 to 1989.

Site #22.51 was sampled once for routine bacteriological analysis in 1990 (Appendix III-B). The bacteriological data showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. This concentration was comparable to some of the results obtained by the NEORSD in 1987 and 1988 at this location.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22.51 in 1990.

Site #22.6

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, at the southeast end of the company's dirt-and-gravel front lot. The river at this location is approximately 150 feet wide and the water depth ranges from five feet nearshore to about eight 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 or absent at places along the west bank, where in the upland area the setting is industrial. The east bank is wooded and grassy and, near the bank, 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. Site #22.6 is about one-half mile upstream of the Cuyahoga River/Big Creek confluence.

Site #22.6 was sampled on three occasions for chemical analysis in 1989 (Appendix II-B). With the exceptions of iron and mercury, all 1989 chemical data were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 2.8 mg/L on May 15 and 1.5 mg/L on September 26. Mercury was measured at 0.2 ug/L on May 15.

Site #22.6 was sampled on three occasions for bacteriological analysis in 1989 (Appendix II-B). The bacteriological data were below the Ohio EPA criteria for Primary Contact Recreational Use. These data were comparable to results obtained by the NEORSD at Site #22.6 in 1988.

Qualitative sampling for benthic macroinvertebrates was not performed by the NEORSD at Site #22.6 in 1989 or 1990.

Site #22.6 was sampled twice for chemical analysis in 1990 (Appendix III-B). With the exceptions of iron and mercury, all chemical data were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 2.6 mg/L on July 25 and 2.2 mg/L on September 14. Mercury was measured at 0.4 ug/L on July 25. The 1990 chemical data were comparable to those obtained at this location by the NEORSD in 1988 and 1989.

Site #22.6 was sampled once for routine bacteriological analysis in 1990 (Appendix III-B). The bacteriological data showed that the fecal coliform concentration (2,900 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 14. This concentration was higher than fecal coliform levels measured in 1989 but comparable to some of the concentrations measured in 1988 at Site #22.6.

Site #22.7

Site #22.7 (RM 9.7) is at the east bank of the river underneath the crossing of the NEORSD Southwest Interceptor. This site is located one mile downstream of the effluent discharge from the NEORSD 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 four feet nearshore to about eight 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 percent 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. Nearshore upland areas are primarily wooded and grassy, although a few sections of the land are under cultivation. Industrial and commercial land uses occur further upland from the river valley.

Site #22.7 was sampled twice for chemical analysis in 1989 (Appendix II-C). All chemical parameters, with the exception of iron, were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 1.1 mg/L on September 26. The 1989 chemical data are comparable to results obtained by the NEORSD at Site #22.7 in 1988.

Site #22.7 was sampled twice for bacteriological analysis in 1989 (Appendix II-C). Bacteriological data showed that the fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use and comparable to some of the results from this site in 1988.

Qualitative sampling for benthic macroinvertebrate at Site #22.7 on August 29, 1989 produced three taxa (Appendix VIII-D). Fewer total taxa were found at this site than had been found in 1988, when thirteen taxa were collected. However, the difference is attributable to factors other than water quality. The 1988 qualitative sampling had been accomplished using Hester-Dendy artificial substrates, which were not employed by the NEORSD in 1989. Additionally, high river flow at the time of the 1989 sampling restricted access to benthic habitats at the location, and debris which had been inspected for benthic organisms in 1988 could not be found in 1989. The presence of a facultative taxon (*Gyraulus parvus*) at Site #22.7 in 1989 suggested that water quality was probably not a factor in the difference.

Site #22.7 was sampled twice for chemical analysis in 1990 (Appendix III-C). With the exception of iron, all 1990 chemical data were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 2.7 mg/L on July 25 and 2.4 mg/L on September 13. The 1990 chemical data were comparable to those obtained by the NEORSD in 1988 and 1989.

Site #22.7 was sampled once for routine bacteriological analysis in 1990 (Appendix III-C). The bacteriological data showed that the fecal coliform concentration (2,600 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 13. Although higher than the 1989 concentrations, this fecal coliform level was comparable to some of the data obtained by the NEORSD at Site #22.7 in 1988.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22.7 in 1990.

Site #22.8

Site #22.8 (RM 11.3) is at the chlorine-access railroad bridge to the Southerly Treatment WWTP plant and is located near the southwest end of the plant's ash lagoons. This site is about one-half mile upstream of the effluent discharge from the NEORSD Southerly WWTP and 0.1 miles downstream of the West Creek confluence. The site can be accessed from Canal Road across from the NEORSD's Southerly Treatment Plant's main entrance gate. The river at Site #22.8 is approximately 100 feet wide and the water depth ranges from two feet nearshore to four 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 six feet. A swifter current flows over and through the riffle-and-run site upstream. Substrate in the riffle-and-run habitat is composed primarily of sand, gravel, cobble, rubble, and some occasional boulders and 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 percent 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 mix of commercial, industrial, wooded land uses.

Site #22.8 was sampled on three occasions for chemical analysis in 1989 (Appendix II-C). With the exception of iron, all 1989 chemical data from Site #22.8 were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 1.1 mg/L on September 26. The 1989 chemical data were comparable to results obtained by the NEORSD at Site #22.8 in 1988.

Site #22.8 was sampled on three occasions for bacteriological analysis in 1989 (Appendix II-C). The bacteriological data showed that all fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use. These results are generally lower than, but comparable to some of, the data obtained at Site #22.8 in 1988 by the NEORSD.

Qualitative sampling for benthic macroinvertebrates at Site #22.8 on August 14, 1989 produced 23 taxa, the majority of which are described in literature as facultative in their responses to organic pollution (Appendix VIII-E). One intolerant taxon, Leucrocuta sp. of the order Ephemeroptera, was also collected at Site #22.8. This was the first year that benthic macroinvertebrate sampling was performed by the NEORSD at Site #22.8.

Site #22.8 was sampled twice for chemical analysis in 1990 (Appendix III-C). The 1990 chemical data showed two exceedances of the numerical criterion for iron. Iron was measured at 3.4 mg/L on July 25 and 2.5 mg/L on September 13. All other chemical data were within the Ohio EPA criteria for Warmwater Habitat and comparable to results obtained by the NEORSD in 1988 and 1989.

Site #22.8 was sampled once in 1990 for bacteriological analysis (Appendix III-C). The bacteriological data showed that the fecal coliform concentration (4,000 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 13 and was higher than fecal coliform data obtained by the NEORSD Industrial Waste Section at Site #22.8 in 1988 and 1989. 1990 was a wet summer, and the fecal coliform exceedances noted at this and other river sites on September 13 may be associated with elevated flow conditions. A much more intensive bacteriological sampling of the river was performed during the 1990 Cuyahoga River Remedial Action Plan (RAP) fecal coliform study, in which the NEORSD participated. The results from this study are to be presented in the RAP Stage One Report.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22.8 in 1990.

Site #22.9

Site #22.9 (RM 11.7) is at the railroad bridge crossing southeast of 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 water depth ranges from two feet nearshore to six feet midstream. Substrate in the run-type habitat underneath the bridge is composed primarily of sand, cobble, and gravel. A riffle, run, and pool-type habitat occurs just upstream and the substrate there is composed of boulders, cobble, rubble, gravel, and sand. There is also an 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 banks are wooded and grassy, and trees provide up to 50 percent cover along the river. Land uses in the upland area are similar to those of Site #22.8.

Site #22.9 was sampled twice for bacteriological analysis in 1989 (Appendix II-C). The bacteriological data were below the Ohio EPA criterion for Primary Contact Recreational Use. These data are comparable to bacteriological results obtained from Site #22.9 by the NEORSD in 1988.

Qualitative sampling for benthic macroinvertebrates at Site #22.9 on August 4, 1989 produced 26 taxa, the majority of which are described in literature as facultative in their responses to organic pollution (Appendix VIII-F). One intolerant taxon, Leucrocuta sp. of the order Ephemeroptera, and two intolerant coleopteran taxa, Ancyronyx variegata and Macronychus glabratus, were also collected at Site #22.9. This was an increase from the eight taxa collected in 1988. However, the relatively low number of taxa collected in 1988 had been attributed to high flow levels on the river from a rain event prior to the sampling date, which had restricted access for benthic sampling.

Site #22.9 was sampled twice in 1990 for chemical analysis (Appendix III-C). The chemical data showed two parameters, iron and mercury, with exceedances of numerical criteria. Iron was measured at 3.2 mg/L on July 25 and 2.9 mg/L on September 13. Mercury was measured at 0.2 ug/L on July 25. All other chemical data from Site #22.9 in 1990 were within Ohio EPA criteria for Warmwater Habitat.

Site #22.9 was sampled once in 1990 for routine bacteriological analysis (Appendix III-C). The bacteriological data showed that the fecal coliform concentration (3,400 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 13 and was higher than fecal coliform concentrations measured by the NEORSD at Site #22.9 in 1988 and 1989.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #22.9 in 1990.

Site #23

Site #23 (RM 16.8) is at the Riverview Road bridge location. The bridge was removed in early August 1988. Prior to its demolition, grab samples had been obtained off the bridge at midstream. Samples in 1989 and 1990 were 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 Cuyahoga River/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 water depth ranges from two feet nearshore to five feet midstream. Substrate in the riffle and run-type habitat which exists here is composed primarily of sand, gravel, cobble, 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 at the old bridge site, the immediate banks are wooded and grassy, and trees provide up to 25 percent 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.

Site #23 was sampled twice for chemical analysis in 1989 (Appendix II-D). All chemical data were within Ohio EPA criteria for Warmwater Habitat. These results are comparable to data obtained by the NEORSD at this site in 1988 and 1987.

Site #23 was sampled twice for bacteriological analysis in 1989 (Appendix II-D). Bacteriological data showed that the fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use and comparable to some of the data obtained by the NEORSD at this site in 1987 and 1988.

Qualitative sampling for benthic macroinvertebrates at Site #23 on August 29, 1989 produced 38 taxa, the majority of which are described in literature as facultative in their responses to organic pollution (Appendix VII-G). One intolerant taxon, Symphitopsyche sparna of the order Trichoptera, and two intolerant coleopteran taxa, Ancyronyx variegata and Macronychus glabratus, were also collected at Site #23. These results are comparable to those obtained in 1988 when qualitative sampling for benthic macroinvertebrates produced 15 taxa and quantitative sampling, using Hester-Dendy artificial substrates, produced 36 taxa.

Site #23 was sampled twice in 1990 for chemical analysis (Appendix III-D). With the exception of iron, all chemical data from Site #23 were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 3.0 mg/L on July 25 and 1.7 mg/l on September 13.

Site #23 was sampled once in 1990 of bacteriological analysis (Appendix III-D). The bacteriological data showed that the fecal coliform concentration (2,600 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 13 and was higher than data obtained by the NEORSD at this site in 1987 to 1989.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #23 in 1990.

Site #24

Site #24 (RM 20.8) is at the Station Road bridge. This site is also in the CVNRA and is located 0.4 miles downstream of the Cuyahoga River/Chippewa Creek confluence and 0.1 miles upstream of the Ohio Canal diversion dam. This site can be accessed from Riverview Road south of its intersection with State Route 82. NEORSD chemical and bacteriological samples are collected from the Station Road bridge at midstream. The river at this location is approximately 150 feet wide and the water depth ranges from five feet nearshore to about ten 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 samples are collected, the habitat type is riffle-and-run. Also, an island splits the river downstream of the dam. The depth in this area ranges form one to four feet. Substrate here is composed primarily of sand, gravel, cobble, rubble, and boulders instream and silt, muck, detritus, gravel, and rubble near the margins. Near the bridge site upstream of the dam, the substrate is composed of silt, sand, and gravel instream with silt and muck underlying smaller amounts of 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 percent cover along the river. Forest, wetland, open-field, and agricultural land uses occur in the upland area.

Site #24 was sampled twice for chemical analysis in 1989 (Appendix II-D). All chemical data from this site were within Ohio EPA criteria for Warmwater Habitat. These results are comparable to those obtained at this location by the NEORSD in 1987 and 1988.

Site #24 was sampled twice for bacteriological analysis in 1989 (Appendix II-D). The bacteriological data showed that the fecal coliform concentrations of 320 and 40 organisms per 100 ml were below the Ohio EPA criterion for Primary Contact Recreational Use. These results were generally comparable to data obtained by the NEORSD in 1988 and lower than data obtained in 1987 at this location.

Historical City of Cleveland records indicated that in June 1970 a fecal coliform geometric mean of 220,000 organisms per 100 ml had been measured in the Cuyahoga River at the Station Road bridge (Appendix XIV-F).

Qualitative sampling for benthic macroinvertebrates at Site #24 on August 4, 1989 produced 38 taxa, including an ephemeropteran (Leucrocuta sp.), a plecopteran (Acroneuria sp.) and a trichopteran (Symphitopsyche sparna), which are described in literature as intolerant in their responses to organic pollution (Appendix VIII-H). This was an increase from 22 taxa collected in 1988 and is due, in part, to improved taxonomic identification skills and benthic sample-processing techniques.

Site #24 was sampled twice in 1990 for chemical analysis (Appendix III-D). With the exception of iron, all chemical data were within Ohio EPA criteria for Warmwater Habitat. Iron was measured at 2.1 mg/l on July 25 and 2.0 mg/L on September 13.

Site #24 was sampled once in 1990 for bacteriological analysis (Appendix III-D). The bacteriological data showed that the fecal coliform concentration (2,400 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use on September 13. This concentration was comparable to some of the data obtained by the NEORSD at this site in 1987 and 1988 but higher than the data obtained in 1989.

Qualitative sampling for benthic macroinvertebrates at Site #24 on July 16, 1990 produced 20 taxa, most of which are described in literature as facultative in their responses to organic pollution (Appendix IX-A). One intolerant taxon, Leucrocuta sp. of the order Ephemeroptera, was also collected at Site #24.

Site #24.5

Site #24.5 is located east of the intersection of Bolanz Road and Riverview Road in Summit County at RM 33.2. This site is approximately four miles downstream of the City of Akron Wastewater Treatment Plant effluent discharge and less than 0.2 miles upstream of the Cuyahoga River/Furnace Run confluence. Site #24.5 was selected to evaluate Cuyahoga River water quality upstream and outside of the NEORSD jurisdictional area for comparison with downstream water quality.

The Cuyahoga River at this site is approximately 100 feet wide and the water depth ranges from two feet nearshore to six feet midstream. The substrate of this run-type habitat is composed of sand, silt, gravel, and cobble. Also within the CVNRA, the site has minimal vegetative cover at the banks and agricultural cropland use upland.

Site #24.5 was sampled once in 1990 for chemical analysis (Appendix III-D). With the exception of iron, all chemical data were within the Ohio EPA criteria for Warmwater Habitat. Iron was measured at 1.4 mg/L on September 13. 1990 was the first year for NEORSD sampling at this location.

Site #24.5 was sampled once for bacteriological analysis in 1990 (Appendix III-D). The bacteriological data showed that the fecal coliform concentration (1,700 organisms per 100 ml) was below the Ohio EPA criterion for Primary Contact Recreational Use.

SEDIMENT SAMPLING

Sampling of sediments in the Cuyahoga River navigation channel by the U.S. Army Corps of Engineers has resulted in classification of the sediments as "Heavily Polluted" by the U.S. EPA. Concentrations of cadmium, chromium, lead, zinc, cyanide, and oil & grease in the sediments were at levels that require the classification according to the data. Although the "Heavily Polluted" classification is not as severe as classifications of "Hazardous" or "Toxic," it nevertheless prohibits open-lake disposal and requires that sediments dredged to maintain navigation be placed in a confined disposal facility.

In an effort to characterize the levels of sediment contamination relative to the location of the Southerly WWTP effluent discharge, NEORSD investigators collected Cuyahoga River sediment samples from four sites in 1989 and five sites in 1990. Additionally, sediment samples were collected from two Chagrin River sites for reference. Sediments were collected with a 15-pound, 36-square inch Petite Ponar bottom grab sampler from several locations at each site and composited in an acid-cleaned, distilled and stream water-rinsed plastic bucket. Attempts were made to obtain the finest sediments at each site to reflect the worst-case contamination. The samples were stored in glass jars, preserved by refrigeration, and sent to Technical Testing Laboratories in Charleston, West Virginia, for analysis of particle size distribution, priority pollutant metals, acid/base/neutral-extractable organic compounds, volatile organic compounds, pesticides, PCBs, and cyanide. Additionally, a spectral library scan for tentative identification of non-priority pollutant compounds was performed. The results of these analyses are summarized in Appendices V and VI.

Sediment samples were collected by the NEORSD on September 28, 1989 at the following Cuyahoga River sites:

- RM 11.3) The chlorine-access railroad bridge over the Cuyahoga River south of the Southerly WWTP ash lagoons and upstream of the Southerly WWTP effluent discharge;
- RM 7.1) The Lower Harvard bridge over the Cuyahoga River;
- RM 5.6) The Newburg & South Shore railroad bridge over the Cuyahoga River at the head of navigation;
- RM 3.3) The West 3rd Street bridge over the Cuyahoga River navigation channel.

On July 24-25, 1990, all of the above sites were again sampled for sediment analysis, in addition to the following site:

- RM 10.5) The Cuyahoga River "Far-Field Site" identified by Battelle in 1990 as the point at which the Southerly WWTP discharge effluent is completely mixed with the river, approximately 1,500 feet downstream of the effluent channel confluence.

During each of the above samplings, sediment samples were also collected at the following Chagrin River reference sites:

RM 4.5) The Pelton Road bridge over the Chagrin River;
RM 1.0) The Lake Shore Boulevard bridge over the Chagrin River.

The sediment analysis data are compared graphically in Appendix VII. Because of differences in analytical methods between 1989 and 1990, minimum method detection limits were different in the two years. Nevertheless, site-to-site comparisons reveal that sediment concentrations of most metals and some polycyclic aromatic hydrocarbons (PAHs) generally increased from upstream to downstream in the Cuyahoga River and were higher than concentrations measured in Chagrin River sediments. Conversely, the site downstream of the Southerly WWTP at RM 10.5 generally exhibited sediment metals concentrations comparable to the Chagrin River concentrations and slightly lower than concentrations measured in Cuyahoga River sediments upstream of the plant at RM 11.3. The extent to which these observations may be attributable to differences in sedimentation characteristics or pollutant loadings warrants further exploration.

The only organic priority pollutants detected in Cuyahoga River sediments by the NEORSD sampling were PAHs, chloroform, and bis(2-ethylhexyl)phthalate. PAHs are common constituents of fossil fuels such as coal and petroleum and may be attributed to numerous point and nonpoint sources. Some PAHs are suspected of causing tumors in bottom-dwelling bullhead catfish (Baumann, et al., 1982).

Chloroform, which was detected in Cuyahoga River sediments only at RM 10.5 immediately downstream of the Southerly WWTP effluent discharge, can be a by-product of chlorination and was probably attributable at this site to disinfection of the plant's effluent.

Bis(2-ethylhexyl)phthalate is a phthalate ester extensively used as a plasticizer. The presence of this compound in the environment may be associated with polyvinyl chloride piping. Bis(2-ethylhexyl)phthalate was detected at comparable levels in Chagrin River sediments (Appendix VII-P).

FISH SURVEYS

Since 1984, the Ohio EPA has conducted fish surveys of the Cuyahoga River employing electroshocking techniques. In the first year, a stretch of the river 17.6 miles downstream of the Akron WWTP was found to be almost devoid of fish. Toxicity in the Akron WWTP discharge was suspected as a cause for this condition. Subsequent Ohio EPA surveys have revealed considerable improvements in the fish communities in this river segment. However, the fish communities between Akron and the

Cuyahoga River mouth have continued to fail to achieve biological criteria set by the Ohio EPA for Erie/Ontario Lake Plain Warmwater Habitat.

The biological criteria are based upon ecoregional reference site scores of the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) developed by the Ohio EPA. The indices are used to evaluate over-all fish community health in Ohio streams by gauging attributes against those at relatively unimpacted habitats. Attributes examined include relative abundance, condition of fish, trophic composition, and other fish community characteristics which are potentially affected by water quality disturbances or habitat alterations.

The IBI incorporates twelve fish community metrics which represent structural and functional attributes. Structural attributes are those that are based on community aspects such as fish diversity, numbers, and biomass. Functional attributes of fish communities are those that consider feeding strategies, environmental tolerances, and disease symptoms. Individual scores for each metric are assigned based on comparison with ecoregional reference data. Each metric is assigned a score of 5, 3, or 1. The scores are based on whether collected data meet, approach, or deviate from values expected at reference sites. The summation of twelve metric scores provides the IBI score. The minimum and maximum possible IBI scores are 12 and 60, respectively. The Ohio EPA minimum criterion for Erie/Ontario Lake Plain Warmwater Habitat is an IBI score of 40, with a significant departure from the criterion considered to be more than 4.

The MIwb incorporates four measures of fish communities to generate a single-value score. Examined are the number of individuals, their biomass, and the Shannon Diversity Indices based on the numbers and weights of fish. Unlike the IBI score, the MIwb score is entirely the result of a mathematical calculation based on the measured results from the fish survey. The Ohio EPA minimum criterion for Erie/Ontario Lake Plain Warmwater Habitat is a MIwb score of 8.7, with a significant departure from the criterion considered to be more than 0.5.

In 1989, the NEORSD purchased a Coffelt Electrofishing Boat with a Model VVP-ZE Electroshocker for the primary purpose of monitoring the fish communities of the Cuyahoga River in the vicinity of the Southerly WWTP. In the summer of 1990, following trial runs, two quantitative fish surveys of the river were conducted by the NEORSD upstream and downstream of the plant effluent. IBI and MIwb scores were calculated based upon the results of these surveys, and the data used in these calculations are presented in Appendix X. Detailed procedures for calculating IBI and MIwb scores can be found in the Ohio EPA's Users Manual for Biological Field Assessment of Ohio Surface Waters (1987).

IBI scores of 16 and 14 and MIwb scores of 4.1 and 4.6 were obtained by the NEORSD upstream of the Southerly WWTP effluent at Cuyahoga RM 11.3.

IBI scores of 18 and 14 and MIwb scores of 4.7 and 4.8 were obtained downstream of the plant effluent at RM 10.5. All of these scores have narrative ratings of "Poor" to "Very Poor" and are consistent with scores obtained by the Ohio EPA near these locations on the Cuyahoga River in recent years. Compared site-to-site, the scores from both NEORSD survey dates were either identical or slightly higher downstream of the Southerly WWTP effluent, although probably not significantly. They indicate however, along with the greater numbers of fish species and individuals noted downstream, that the fish community depression in the river is attributable to factors other than this discharge.

In Appendices X-E, X-F, and X-G, IBI and MIwb scores obtained by various entities performing quantitative fish surveys in this segment of the Cuyahoga River are compared. For the graphs, different scores from the same year at the same location are averaged. Although the scores have similar narrative ratings, any temporal or spatial trends were in this case relatively insignificant and are masked by data variability. Sources of variability include inter-microhabitat differences, seasonal community composition changes, extreme flow variation, and sample collection efficiency, through which an element of subjectivity may be introduced. According to Rankin and Yoder (1990), "high variability, among samples in a year was a characteristic of impacted water bodies," and "streams with impacted fish communities (IBI scores generally less than 40) had 75th percentile [coefficient of variation] values...as high as 30-40%." They add that "variability among sampling passes also increased with decreasing habitat quality."

Qualitative fish surveys have shown in recent years that an increasing variety of fish species is present in the Cuyahoga River (Appendix XI). However, the fish community in the lower reaches of the river continues to be dominated by species more tolerant of chemical or physical disturbances, resulting in depressed quantitative index values. Continuing NEORSD fish surveys with increasing consistency in collection efficiency should in the future reduce data variability and show whether or not the fish community in this segment of the Cuyahoga River can improve to levels expected by the Ohio EPA.

PROBLEMS & REMEDIATION

-1-

The culverted Walworth Run, prior to late 1987, contributed significant quantities of raw, untreated sanitary sewage to the Cuyahoga River navigation channel during dry weather periods. Overflows to the river at University Road, just west of the Interstate 90 Innerbelt, resulted from blockage of the Westerly Low-Level Interceptor and operational difficulties at the City of Cleveland owned Division Avenue sewage lift station. A fecal coliform concentration of 2,000,000 organisms per 100 ml was measured by the NEORSD in a Walworth Run dry weather overflow to the river on June 8, 1987. Since late 1987, however, maintenance by NEORSD Sewer Control Systems has cleared the interceptor of grit and debris, and the sewage lift station has been obtained and renovated by the NEORSD. As a result, Walworth Run has ceased to be a dry weather source of pollution in the Cuyahoga River.

Following this remediation, the NEORSD identified the most significant remaining dry weather source of untreated sanitary sewage in the Cuyahoga River navigation channel as the City of Cleveland-owned Mary Avenue sewage lift station. Due to equipment problems, the station had been inoperative, and its estimated 4.3-million gallon per day influent of sanitary sewage was tributary to the river at Mary Avenue, east of West 3rd Street. On September 29, 1987, a NEORSD bacteriological analysis of a sample from the station's overflow pipe, which had been diluted by river water in the pipe, showed a fecal coliform concentration of 23,000 organisms per 100 ml.

The City of Cleveland contracted to repair the station, and on September 21, 1989, the Mary Avenue sewage lift station became operable. Following removal of a blockage at the station's inlet by NEORSD Sewer Control Systems, this dry weather source of pollution in the Cuyahoga River was eliminated. A subsequent inspection by NEORSD investigators on October 30, 1989 confirmed the remediation.

-2-

On March 3, 1989, NEORSD investigators provided assistance to the U.S. Coast Guard in identifying a source of diesel fuel first noted on the Cuyahoga river near the head of navigation. The investigators determined that the fuel was entering the river through West Creek from a storm sewer on Schaaf Road. The source was identified as C & K Industrial Services, 5617 Schaaf Road, where a dispensing nozzle had been left engaged overnight, resulting in a ruptured diesel fuel pump hose. The spilled diesel fuel had entered the storm sewer through a catch basin in the company's fueling area. An estimated 500 to 1,200 gallons of diesel fuel had been lost.

The NEORSD investigators had placed a containment boom in West Creek to control the flow of diesel fuel to the Cuyahoga River. Samsel Services Company was contracted to complete the creek and river clean-up, which was monitored by the U.S. Coast Guard and the Ohio EPA.

-3-

On March 9, 1989, the U.S. Coast Guard reported gasoline on the river's surface in the vicinity of Morgana Run. NEORSD investigators attempted to identify the source of the gasoline throughout that day but were unsuccessful.

By March 10, approximately 2,000 gallons of gasoline/oil had accumulated on the river behind a U.S. Coast Guard-placed containment boom. That afternoon, as investigations were on-going, the Inland Pipe Company reported a drop in pressure in the Sohio Inland Pipeline, and shut off its flow for an inspection. Samsel Services Company removed approximately 8,000 gallons of gasoline/oil from the river, and BP America assumed responsibility for the spill and all associated clean-up costs.

-4-

On June 8, 1989, a City of Cleveland contractor hired to repair a retaining wall along the Cuyahoga River reported pipes leaking a blue-colored liquid into the ground and, presumably, the river adjacent to Zaclon, Inc., 2981 Independence Road. The material, which had a pH of 2.3 standard units, was flowing at a rate of about five gallons per minute from several cast iron and vitrified clay pipes, which had been exposed by river bank deterioration. Analysis of a NEORSD sample revealed elevated concentrations of iron (190 mg/L), zinc (90.0 mg/L), chromium (64.0 mg/L), copper (12.0 mg/L), lead (2.70 mg/L), and other metals.

Officials of Zaclon, Inc. were informed and attempted to identify and plug the leaks, through which the material had evidently entered abandoned piping from active piping. The Ohio EPA was notified and performed an inspection of the site with assistance from NEORSD investigators. Final decision on any required remediation was to be determined by the Ohio EPA.

-5-

On November 14, 1990, NEORSD investigators responded to a report of a black substance on the surface of the Cuyahoga River near Morgana Run. The minute floating black particles, estimated at about 10 gallons in quantity, were identified by LTV Steel Company officials as coal, coke, and tar from a "flushing liquor" spill which had occurred earlier that day at the company's #1 Coke Plant. The spill of approximately 100 gallons had resulted from a cooling line blockage, and although most of it had entered the sanitary sewer, a smaller portion had entered the storm sewer and eventually the Cuyahoga River. Other constituents of the flushing liquor were ammonium sulfate (8% to 12%) and sulfuric acid (less than 1%). Samsel Services Company was contracted to remove the remaining spilled material from the river.

-6-

In late 1989, the land owned by Kurtz Bros., Inc. east of the Cuyahoga River in the flood plain between the Southerly WWTP effluent channel and the Ohio Canal was stripped of its vegetation. Top soil was removed for sale by Kurtz Bros., Inc. and the property was utilized for construction/demolition material disposal. Dikes were constructed at the perimeter of the property using materials excavated from off-site tunneling operations. Following a later storm event during which the property was flooded, the dikes were further elevated.

On February 13, 1990, NEORSD personnel reported a discharge to the Cuyahoga River from a landfill on the west bank of the river across from the Southerly WWTP effluent channel. An inspection by NEORSD investigators revealed that pooled surface stormwater had been pumped to the river from the Gnatovich Demolition Disposal facility on Amser Corporation property, 980 Valley Belt Road. Loose materials along the bank of the river at the perimeter of this property, which is devoid of vegetation and protected from erosion only by scattered slabs of concrete, had been noted previously by NEORSD investigators at this location.

Concerns about a potential detrimental impact on downstream Cuyahoga River biota from these two sites, and any run-off of ash materials from the riverbank south of the Southerly ash lagoons, prompted a NEORSD investigation in March-April 1990 (Appendix XII).

On March 15-16, 1990, soil and sediment samples were collected at the stations shown in Appendix XII-A for metals analysis at Technical Testing Laboratories. The analytical results are presented in Appendix XII-B. The highest concentrations of metals were found in the soils at the crest of the river bank south of the Southerly ash lagoons (Stations #2, 4), the materials used to construct dikes on the Kurtz Bros. property (Stations #7, 10), and sediment in the Southerly WWTP effluent channel (Station #8). However, metals concentrations elevated to corresponding levels were not detected in soils at the waterline or in Cuyahoga River sediments near these locations. The elevated effluent channel sediment concentrations may be attributable to historical deposits pre-dating the current level of industrial pretreatment removal effectiveness (Figure 1).

During sampling to evaluate relative sources of dissolved and suspended solids, field measurements of specific conductance and turbidity were obtained from river water in the vicinity of the Southerly WWTP effluent under both dry and wet weather conditions (Appendices XII-C, XII-D). Wet weather had the greatest effect on the measurements, substantially elevating upstream turbidities in the river. Increases in specific conductance and decreases in turbidity were noted resulting from the confluence with the plant effluent. The magnitude of these influences obscured any effects from other sources in this vicinity, which would have been more subtle.

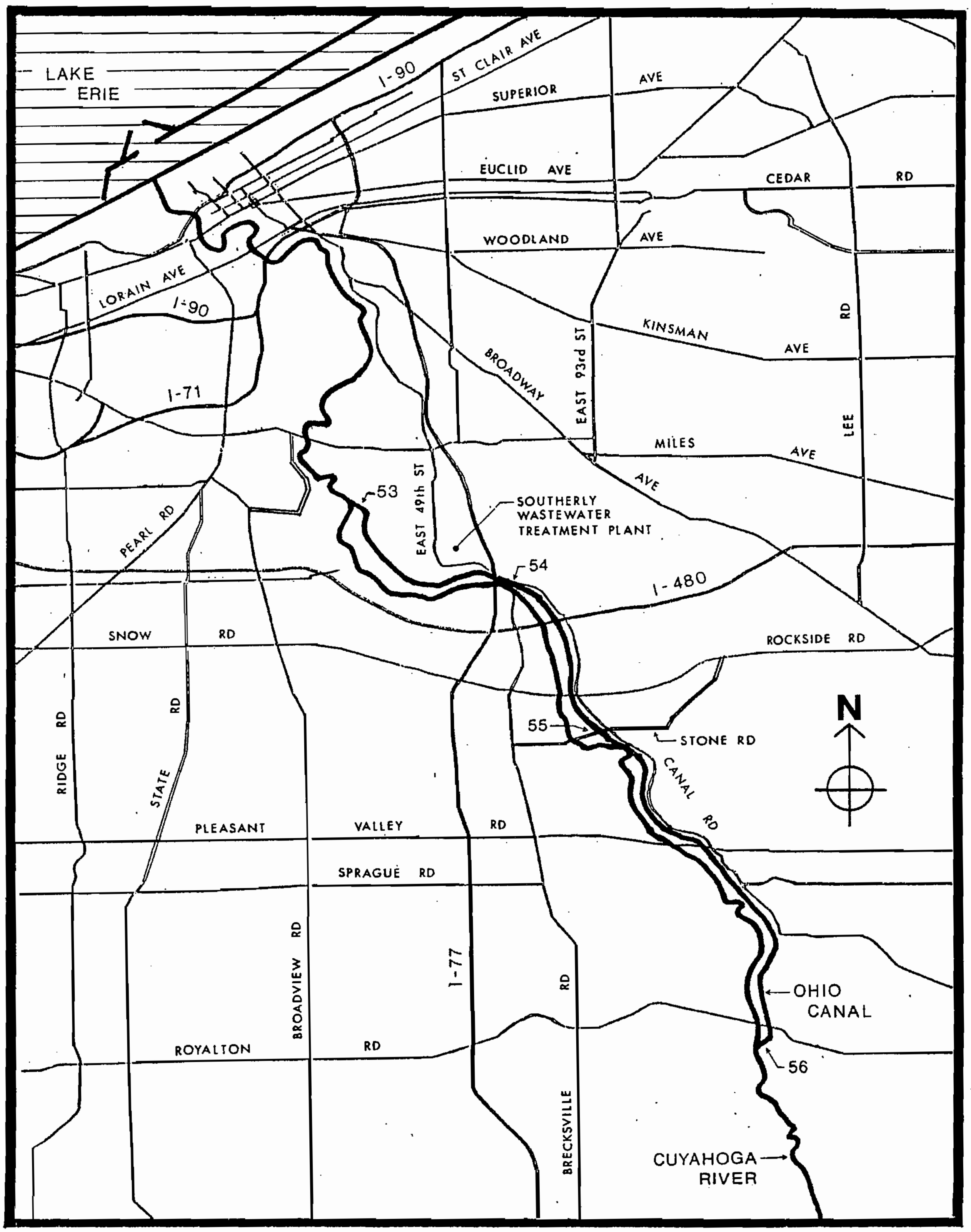
OHIO CANAL

The Ohio Canal, which was opened between Cleveland and Akron in 1827, had replaced the Cuyahoga River as the major transportation artery in this region. The canal system opened up Ohio and the Midwest to commerce and industrialization. 53 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 not much more than historical significance. The only remaining wetted section stretches for eleven miles northward along the east bank of the Cuyahoga River from the State Route 82 bridge crossing between Brecksville and Sagamore Hills.

The NEORSD incorporated sampling of the Ohio Canal into the Stream Monitoring Program as a result of arguments raised in early 1988 concerning designation of the Cuyahoga River as Warmwater Habitat from River Mile (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. Thus, for experimental and informational purposes, chemical, bacteriological, and benthic sampling has been performed on the canal by the NEORSD.

The exact drainage area tributary to the canal's wetted section is unknown. It is fed by partial flow from the Cuyahoga River, near Site #24, through an inlet structure located just upstream of the low-head dam under the State Route 82 bridge. The canal is receiving flow from the river to provide a source of cooling water for the American Steel and Wire Corporation, located at 4300 East 49th Street in Cuyahoga Heights. The company leases the canal for this purpose from the Ohio Department of Natural Resources, and its intake line is located 0.4 miles upstream of the canal's confluence with the river. Downstream of the diversion of river water into the canal, no other large drainages which would significantly affect its flow are known to enter the canal. 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 for most of its length, and elevation drops are facilitated by lock structures and weirs.

In 1988, NEORSD investigators measured the canal flow downstream of its inlet structure at an average rate of 67 million gallons per day (MGD) with a maximum rate of 107 MGD and a minimum rate of 43 MGD. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.) The flow variability was probably due to the varying rate at which Cuyahoga River water was being fed to the canal.



Ohio Canal
(NOT TO SCALE)

Figure 9

By also measuring the flow rate downstream at the canal's confluence with the Cuyahoga River, NEORSD investigators estimated in 1988 that an average flow of 58 MGD was being returned to the river via the return structures and/or used by the American Steel and Wire Corporation before reaching the confluence.

SAMPLING

The Ohio Canal's 1988 Nuisance Prevention Use Designation was replaced by Ohio EPA in 1990 with the Limited Resource Water Use Designation. The Limited Resource Water 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.

The Ohio Canal has four locations for routine chemical, bacteriological, and benthic sampling and analysis (Figure 9). No samples were collected by the NEORSD from the Ohio Canal in 1989. In 1990, chemical and bacteriological analysis was performed on August 1 (Appendix III-E).

A qualitative survey for fish was performed on the Ohio Canal at the Southwest Interceptor crossing (adjacent to Site #22.7 on the Cuyahoga River) on June 5, 1990. The fish collected by electroshocking included: Common Carp (Cyprinus carpio), Goldfish (Carassius auratus), Largemouth Bass (Micropterus salmoides), Bluegill Sunfish (Lepomis marcrochirus), and Pumpkinseed Sunfish (Lepomis gibbosus). All of these species had been collected from the Ohio Canal during the August 1988 NEORSD/EA Science & Technology quantitative survey, with the exception of Largemouth Bass. The possibility that the appearance of this species in the 1990 survey may represent improving water quality warrants further investigation.

Site #53

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. From the flow control structure, located 0.4 miles upstream of the confluence, to Site #53, 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.

The Limited Resource Water criteria were not exceeded, based on a review of the chemical data collected at Site #53 in 1990 (Appendix III-E). Bacteriological data obtained from Site #53 in 1990 showed that the fecal coliform concentration was low at less than 10 organisms per 100 ml. All 1990 chemical and bacteriological data at this location were comparable to those obtained in 1988.

Site #54

Site #54 is at the railroad bridge crossing near the intersection of East 71st Street and Canal Road (Figure 9). Parallel to this location is 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 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.

The 1990 chemical data from Site #54 (Appendix III-E) indicated that the Limited Resource Water criteria were not exceeded. The bacteriological concentration was as low at Site #54 in 1990 as at Site #53 (less than 10 organisms per 100 ml). The 1990 chemical and bacteriological data were similar to those obtained at this location in 1988.

Site #55

Site #55 is at the Stone Road bridge and can be accessed from Canal Road (Figure 9). 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.

The Limited Resource Water criteria were not exceeded, based on a review of the analysis of the sample collected at Site #55 in 1990

(Appendix III-E). Bacteriological data obtained from Site #55 in 1990 showed that the fecal coliform concentration was slightly higher than at the two downstream sites but still relatively low. These data are comparable to results obtained from Site #55 in 1988.

Site #56

Site #56 is at the inlet structure through which Cuyahoga River flow is diverted into the canal (Figure 9). 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 are obtained at the canal side of the inlet structure. At approximately 100 yards downstream, where benthic macroinvertebrate sampling has been 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. 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 Cuyahoga Valley National Recreation Area.

The 1990 chemical data from Site #56 (Appendix III-E) indicated that the Limited Resource Water criteria were not exceeded. The fecal coliform concentration was slightly higher than at Site #55 but still relatively low. The 1990 chemical and bacteriological data were similar to results obtained at Site #56 in 1988.

PROBLEMS AND REMEDIATION

-1-

On March 28, 1989, NEORSD investigators responded to a report of a milky white substance flowing in a drainage ditch tributary to the Ohio Canal. The drainage ditch runs along the eastern boundary of NEORSD's Southerly WWTP property, 6000 Canal Road, adjacent to Interstate 77. The substance was identified as lubricating oil and its source was determined to be Variety Stamping Corporation, 4620 East 21st Street. Approximately 200 to 300 gallons of lubricating oil had been discharged to the sanitary sewer system. An inspection by NEORSD investigators revealed a blockage in the sanitary sewer downstream, causing the flow to be diverted to the storm sewer via the sanitary sewer's relief overflow structure at Klima Gardens Recreation Park on East 71st Street in Cuyahoga Heights. The flow to the canal consisted of sanitary sewage in addition to the lubricating oil.

On March 29, an absorbant boom was installed on the canal under the Southwest Interceptor crossing, approximately one mile downstream of the discharge, to contain the oil. Variety Stamping Corporation assumed responsibility for the discharge of oil to the environment and provided clean-up of the canal on April 3, 1989. Notification of the City of Cuyahoga Heights Service Department resulted in correction of the dry weather overflow problem by removal of the sanitary sewer blockage.

-2-

On June 5, 1990, NEORSD investigators responded to a report of an oil spill on the Ohio Canal near the intersection of Canal Road and West Canal Road. Investigators on the scene reported no material entering the Canal; however, puddles of what appeared to be used crank case oil were present on the surrounding soil. A clean-up was conducted by the investigators using oil absorbant pads. A construction worker in the area reported seeing a truck dump the oil. However, the source of this oil was not identified. The incident was reported to the Ohio EPA that day.

BIG CREEK

Big Creek drains southwestern Cleveland and the southwest suburbs. It has a total drainage area of 38.6 square miles and a total length of 12.0 miles. 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 major 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 northeast 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 measured in the East Branch, while 2.4 MGD of the flow was measured in the West Branch.

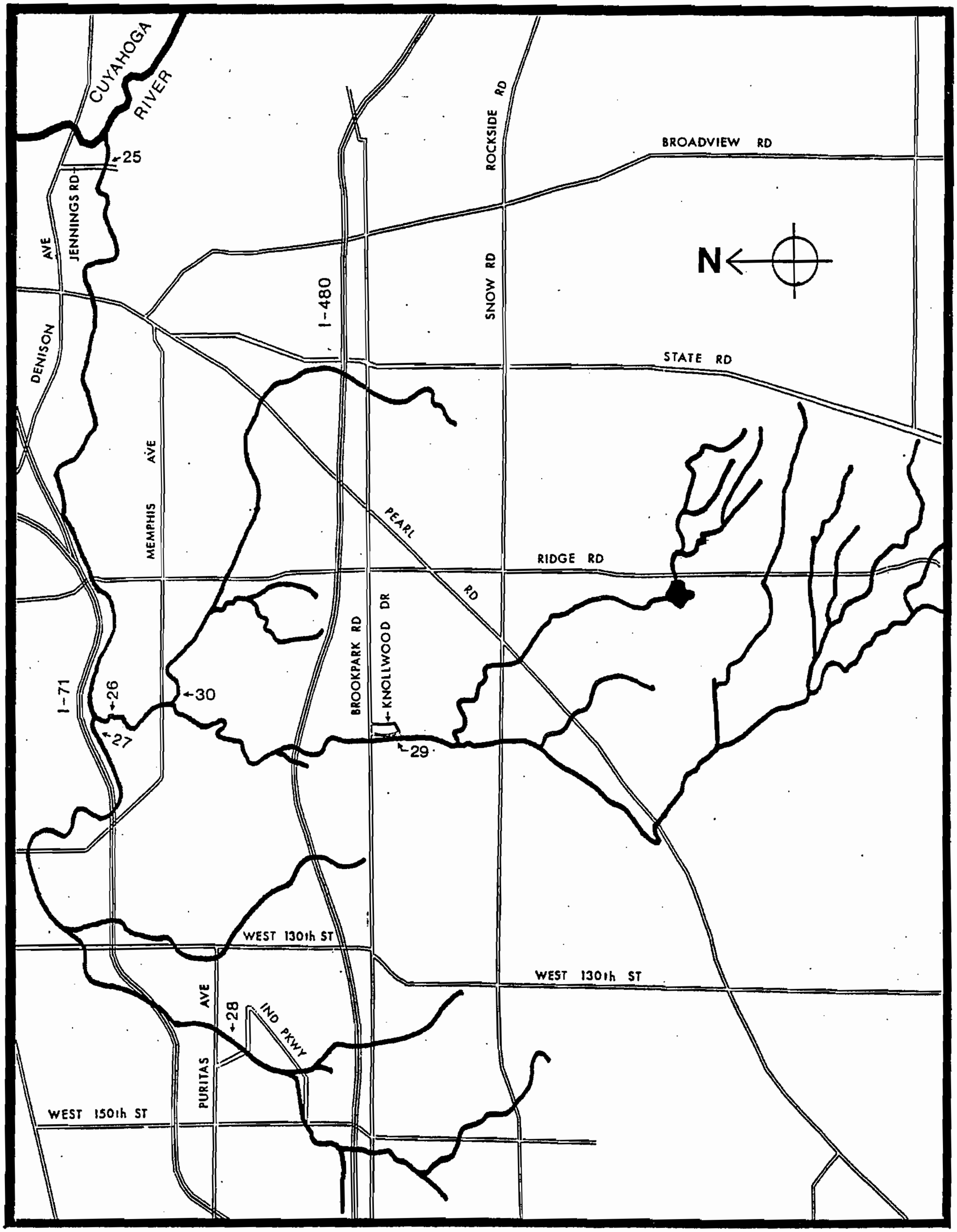
Most of Big Creek is open, with only two major portions culverted: approximately 0.4 miles underneath the Cleveland Metroparks Zoo; and approximately 2.6 miles of the West Branch between West 117th Street and Puritas Avenue.

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 predominantly 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 and Primary Contact Recreational Use by the Ohio EPA. The East Branch has been designated Warmwater Habitat and Primary Contact Recreational Use. Portions of Big Creek within the boundaries of the Cleveland Metroparks have been designated Warmwater Habitat and Primary Contact Recreational Use.

SAMPLING

Big Creek has six locations that are routinely sampled by NEORSD investigators for chemical, bacteriological, and benthic analysis (Figure 10).



Big Creek
(NOT TO SCALE)

Figure 10

Site #25

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 boulders, cobble, gravel, 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.

Site #25 was sampled on two occasions in 1989 for routine chemical analysis (Appendix II-E). On May 19, exceedances of the Ohio EPA criteria for Limited Warmwater Habitat were noted for mercury (0.3 ug/L) and iron (1.8 mg/L). These elevated contaminant levels may be attributed to residual contamination from an Ohio EPA-approved diversion of the NEORSD Big Creek Interceptor to Big Creek which had occurred between May 15 and 18, 1989. This diversion and another diversion beginning October 30, 1989 were necessary for structural inspections of the interceptor and are discussed in detail in Appendix XIII. All other chemical data from this site were within the numerical criteria for Limited Warmwater Habitat.

One grab sample for bacteriological analysis was obtained under normal dry weather conditions at Site #25 in 1989, on October 5 (Appendix II-E). The fecal coliform concentration (680 organisms per 100 ml) was lower in 1989 than during any previous NEORSD dry weather sampling of this location (as high as 89,000 organisms per 100 ml in 1987 and 7,200 organisms per 100 ml in 1988) and was below the Ohio EPA criterion for Primary Contact Recreational Use.

Site #25 was qualitatively sampled on three occasions in 1989 for benthic macroinvertebrates, on May 19, October 6, and November 13 (Appendices XIII-N, VIII-I, XIII-P). The May 19 sampling followed the cessation of the Big Creek Interceptor diversion from May 15 to 18. The November 13 sampling was conducted after the October diversion.

On May 19, 1989, a total of five benthic macroinvertebrate taxa were present and all are described in literature as tolerant in their responses to organic pollution. The collection of only tolerant organisms may be attributed to impact from the interceptor diversion. On October 6, 1989 at Site #25, a total of five taxa were present, including two taxa described in literature as facultative in their responses to organic pollution (Appendix VIII-I). These results indicated that the benthic community was recovering after the diversion. On November 13, 1989, one macroinvertebrate taxon was present at Site #25 and is described in literature as tolerant in response to organic pollution. The presence of only one taxon may be attributed to the impact of the October diversion, although seasonal variability could be a factor.

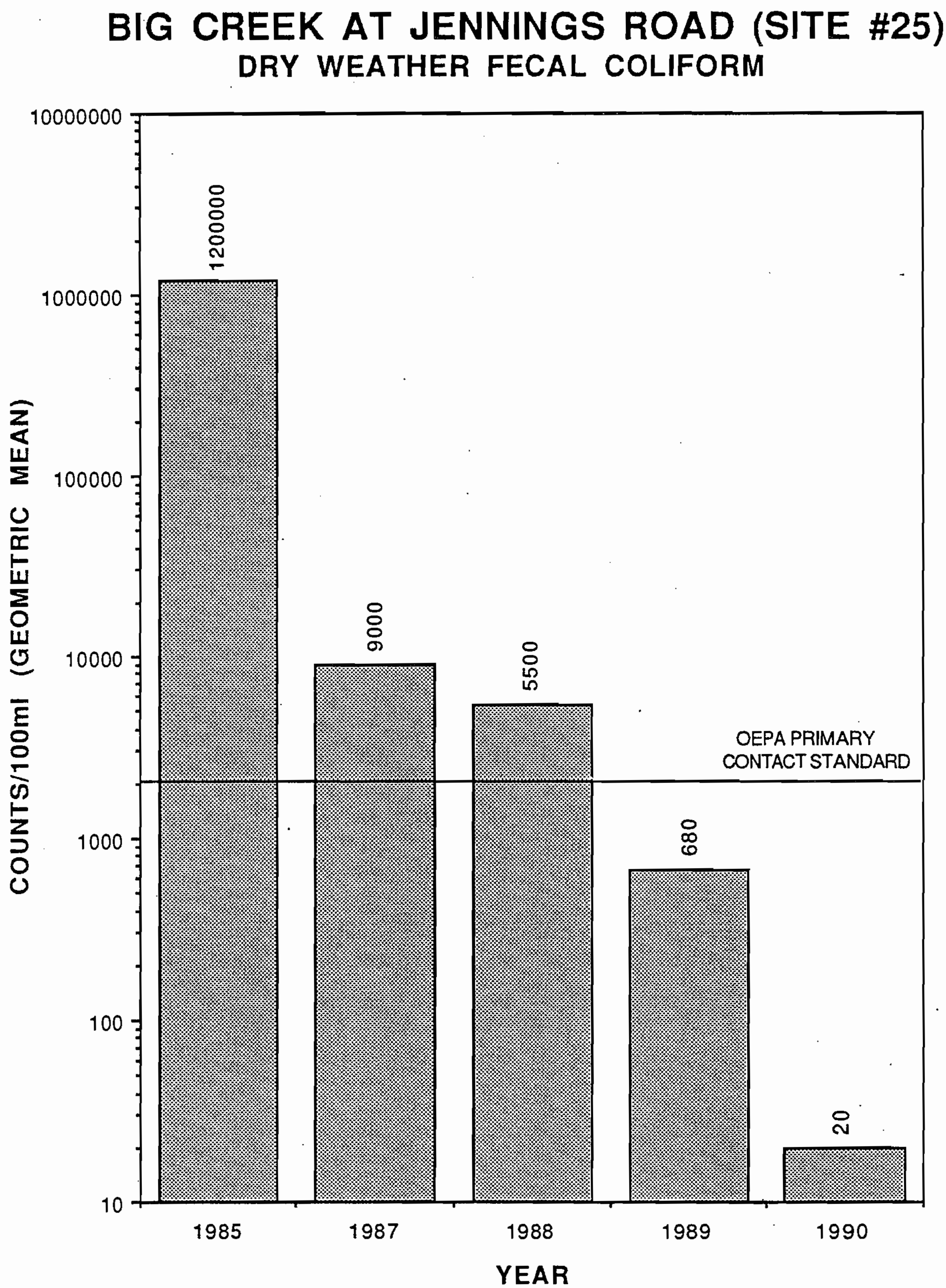

BIG CREEK AT JENNINGS ROAD (SITE #25)
DRY WEATHER FECAL COLIFORM
10000000
1000000
100000
10000
1000
100
10
COUNTS/100ml (GEOMETRIC MEAN)
1200000
9000
5500
680
20
OEPA PRIMARY
CONTACT STANDARD
1985
1987
1988
1989
1990
YEAR

Figure 11

Site #25 was sampled on two occasions in 1990 for chemical analysis (Appendix III-F). With the exception of a mercury concentration on June 20 (2.2 ug/L), all of the chemical data were within the numerical criteria for Limited Warmwater Habitat.

One grab sample for bacteriological analysis was obtained in 1990 at Site #25, on October 16 (Appendix III-F). As on October 5, 1989, the fecal coliform concentration (20 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. In fact, these results are lower than results obtained at this site in any previous year and may be attributed to upstream remediation in Big Creek, which is discussed later in this report.

Site #25 was qualitatively sampled for benthic macroinvertebrates on November 1, 1990 (Appendix IX-B). There were six taxa collected, of which two are described in literature as facultative in their responses to organic pollution, with the remaining taxa being tolerant of organic pollution. This indicates a water quality improvement when compared to previous years, when only tolerant taxa were collected. It also indicates a significant recovery from the impact of the 1989 Big Creek Interceptor diversions. Further sampling is required to verify this trend.

Site #27

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 Cleveland Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road. The stream is approximately 22 feet wide and the banks are surrounded by trees and extensive 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 1988, after remediation upstream had occurred, and in 1989 and 1990, a significant improvement in the water's appearance was noted. Although some septic sediment remained, the water was relatively clear and free from sanitary debris.

Two grab samples for chemical analysis were obtained in 1989 at Site #27 (Appendix II-E). A slight exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for iron (2.2 mg/L on May 22). The exceedance may be attributable to continuing contamination upstream from leaks in the dividing wall of the double-barrel culvert between Interstate 71 and West 130th Street. (This problem is discussed later in this report.) All other 1989 chemical data are within applicable Ohio EPA water quality criteria and are comparable to data following the 1988 Cooley Avenue remediation, which is described below.

Site #27 was sampled once in 1989 for bacteriological analysis, on October 5 (Appendix II-E). The fecal coliform concentration of 1,200

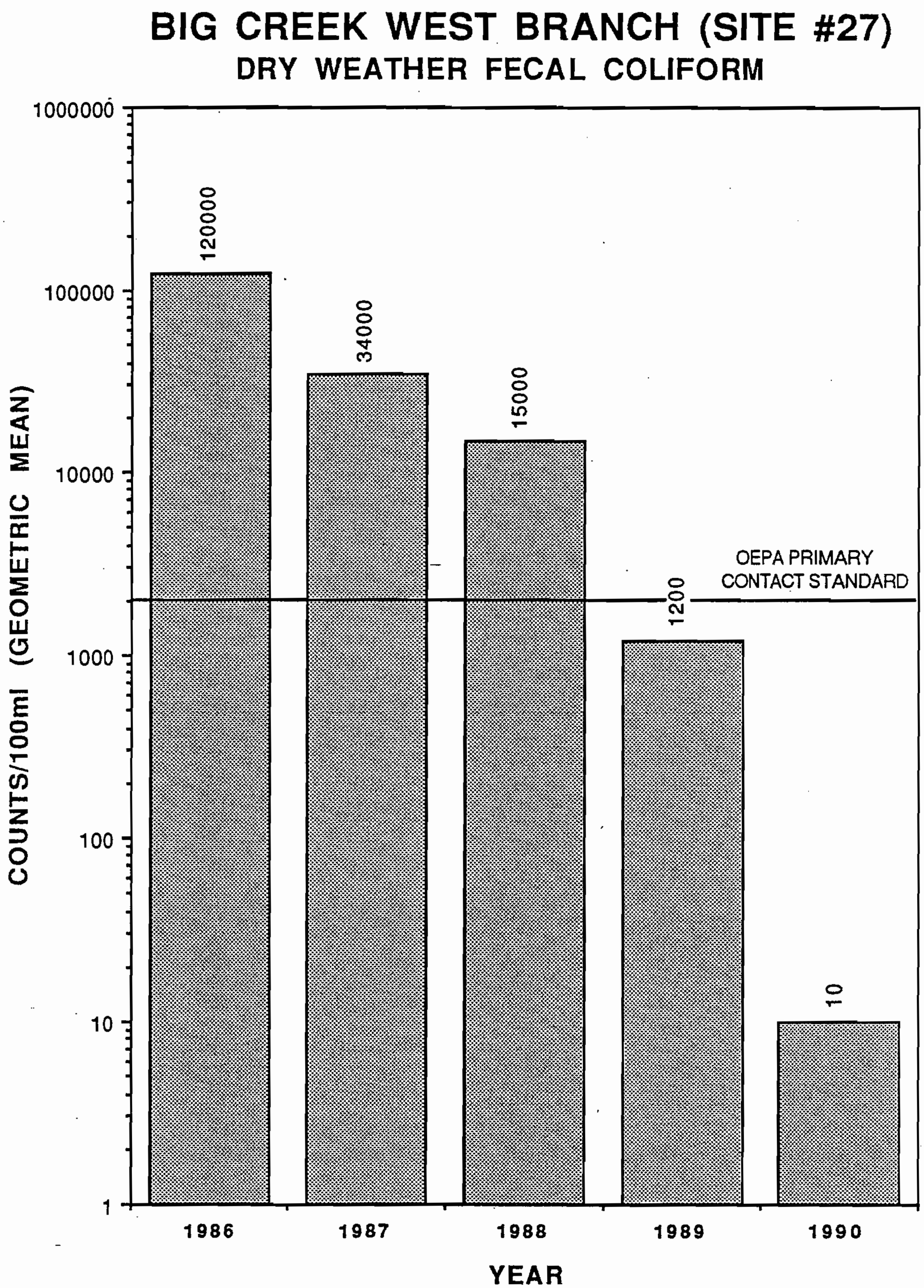

BIG CREEK WEST BRANCH (SITE #27)
DRY WEATHER FECAL COLIFORM
COUNTS/100ml (GEOMETRIC MEAN)
1000000
100000
10000
1000
100
10
1
120000
34000
15000
1200
10
OEPA PRIMARY
CONTACT STANDARD
1986
1987
1988
1989
1990
YEAR

Figure 12

organisms per 100 ml was below the Ohio EPA criterion for Primary Contact Recreational Use of 2,000 organisms per 100 ml and was dramatically lower than the June 1988 concentration of 1,800,000 organisms per 100 ml and historical concentrations as high as 3,200,000 organisms per 100 ml (July 1986). This improvement reflects the remediation which occurred in 1988, when the City of Cleveland Division of Water Pollution Control removed a blockage in the 24-inch sewer west of Bosworth Road, resulting in the elimination of a substantial dry weather overflow to Big Creek West Branch at Cooley Avenue. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.)

Qualitative sampling for benthic macroinvertebrates was conducted at Site #27 on May 22, 1989 (Appendix VIII-J). The only benthic macroinvertebrate taxon collected was the snail Physella sp., which is described in literature as tolerant in its response to organic pollution.

Site #27 was sampled on three occasions in 1990 for chemical analysis (Appendix III-F). One exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.3 ug/L), on June 20. All other 1990 chemical data were within the numerical criteria in Ohio EPA Water Quality Standards for Warmwater Habitat.

One grab sample was obtained in 1990 for bacteriological analysis at Site #27, on October 16 (Appendix III-F). The fecal coliform concentration (less than 20 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use and was dramatically lower than in all previous years (Figure 12). This improvement is attributable to the remediation which occurred upstream in 1988.

Site #27 was qualitatively sampled for benthic macroinvertebrates on July 19, 1990. A total of seven taxa were collected and identified (Appendix IX-D). This is a dramatic increase in the number of taxa collected here when compared to previous years (one taxon in 1989 and 1988). Furthermore, three of the seven taxa collected are described in literature as facultative in their responses to organic pollution and had not been present at this location during any previous sampling. The remaining four taxa are known to be tolerant of organic pollution. These data indicate that the water quality at Site #27 has significantly improved. Further sampling is required to verify continuation of this trend.

Site #28

Site #28 is located on the West Branch of Big Creek immediately upstream of the beginning of the double-barrel culvert south of Puritas Avenue. The stream at this point has passed 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 million gallons per day.

In 1989, one grab sample for chemical analysis was obtained at Site #28, on October 5 (Appendix II-F). All of the chemical data were within the numerical criteria in Ohio EPA Water Quality Standards for Limited Warmwater Habitat, and were comparable to data obtained from this location in 1987 and 1988.

Site #28 was sampled once in 1989 for bacteriological analysis, on October 5 (Appendix II-F). The fecal coliform concentration (2,100 organisms per 100 ml) slightly exceeded the Ohio EPA criterion for Primary Contact Recreational Use and was higher than most of the concentrations (as low as 60 organisms per 100 ml) measured at Site #28 in 1987 and 1988. The cause for this apparent increase in bacterial contamination has not been identified and further investigation may be necessary.

Qualitative benthic macroinvertebrate sampling was conducted at Site #28 on May 24, 1989. A total of four taxa were collected and identified (Appendix VIII-K). This low diversity may be attributed to the fact that this site is channelized and may not be a conducive habitat for a more diverse community. These results are comparable to results obtained in 1987 and 1988.

Site #28 was sampled twice in 1990 for chemical analysis (Appendix III-G). A single exceedance of the Ohio EPA water quality criterion for Limited Warmwater Habitat was noted for mercury (0.6 ug/L) on June 20. All other 1990 chemical data were within the numerical criteria for Limited Warmwater Habitat. These results are comparable to data obtained in previous years.

One grab sample for bacteriological analysis was obtained in 1990 at Site #28, on October 16 (Appendix III-G). The fecal coliform concentration (less than 20 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use and is lower than the fecal coliform concentration measured at Site #28 in 1989.

No qualitative benthic macroinvertebrate sampling was conducted at Site #28 in 1990.

Site #26

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 Site #27, this section of the creek passes through a portion of the Cleveland Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road. The banks are surrounded by trees, and boulders are scattered along the banks and in the creek. The substrate is composed of sand, gravel, cobble, and boulders coated with green and brown algae. The stream width at this point is approximately 22 feet.

Two grab samples for chemical analysis were obtained in 1989 at Site #26, on May 22 and October 5 (Appendix II-E). All 1989 chemical data were within the numerical criteria in Ohio EPA Water Quality Standards for Warmwater Habitat. These data are comparable to results obtained in previous years.

One grab sample for bacteriological analysis was obtained in 1989 at Site #26, on October 5 (Appendix II-E). The fecal coliform concentration (520 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than concentrations measured at Site #26 in 1987 and 1988. Fecal coliform concentrations had been noted as high as 480,000 organisms per 100 ml in 1987 and as high as 44,000 organisms per 100 ml in 1988. Contributing to this improvement is the upstream remediation at Snow Road, which occurred just prior to the October 5 sampling and is discussed later in this report.

No qualitative benthic macroinvertebrate sampling was conducted at Site #26 in 1989.

Site #26 was sampled on three occasions in 1990 for chemical analysis (Appendix III-F). One exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (1.4 ug/L), on June 20. All other 1990 chemical data were within numerical criteria in Ohio EPA Water Quality Standards for Warmwater Habitat and are comparable to results obtained in previous years.

Elevated mercury concentrations were noted at all Big Creek sample locations on June 20, 1990. However, subsequent sampling in 1990 did not reveal elevated mercury concentrations, and the source of mercury contamination remains unknown.

One grab sample for bacteriological analysis was obtained in 1990 at Site #26, on October 16 (Appendix III-F). The fecal coliform concentration (20 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. This concentration is lower than concentrations obtained in all previous sampling. This improvement in water quality can be attributed to upstream remediation which is discussed later in this report. Further sampling is required to verify this trend.

Qualitative benthic macroinvertebrate sampling was conducted at Site #26 on July 19, 1990. A total of 15 taxa were collected and identified (Appendix IX-C). This is approximately the same number of taxa as had been collected in 1988, but four facultative taxa and one intolerant taxon replace those tolerant of pollution. This improved benthic macroinvertebrate community can be attributed to the improved water quality at Site #26 due to the upstream remediation. Further sampling is required to verify continuation of this trend.

<u>Site #29</u>

Site #29 is located upstream on the East Branch of Big Creek at the Fernhill Picnic Area in the Metroparks Big Creek Reservation, south of

Brookpark Road. Overhanging trees and relatively sparse vegetation surround the creek, which is approximately 30 feet wide at this location. The substrate consists of shale, cobble, logs, and natural debris, with riffles and some pooled areas. The flow in dry weather conditions was measured at this location at about 6.5 million gallons per day in 1987.

One grab sample was obtained at Site #29 for chemical analysis, on October 5 (Appendix II-F). All of the chemical data obtained at Site #29 in 1989 were within Ohio EPA Water Quality Standards for Warmwater Habitat.

Site #29 was sampled once in 1989 for bacteriological analysis, on October 5 (Appendix II-F). The fecal coliform concentration (3,500 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use. However, this concentration was lower than all of the fecal coliform concentrations (as high as 36,000 organisms per 100 ml) measured at Site #29 in 1987 and 1988. The decrease in bacterial contamination can be attributed to the remediation upstream at Snow Road, which is discussed later in the report. Dry weather sanitary sewage overflows along the Big Creek Parkway at Fernhill Avenue and Onaway Oval were largely responsible for the continuing bacterial contamination at this site and are also discussed later in the report.

In 1989, qualitative benthic macroinvertebrate samples were collected at Site #29 on May 24 and June 21 (Appendix VIII-L). A total of 14 taxa were collected and identified. Five of the taxa are described in literature as facultative in their responses to organic pollution and the remaining taxa are described in literature as tolerant of organic pollution. Similar results had been obtained at this site in 1988.

In 1990, Site #29 was sampled twice for chemical analysis, on June 20 and October 16 (Appendix III-G). With the exceptions of iron (1.8 mg/L) and mercury (0.8 ug/L, 0.3 ug/L), which exceeded numerical criteria, all other chemical data obtained at Site #29 in 1990 were within Ohio EPA Water Quality Standards for Warmwater Habitat. These results are comparable to data obtained at Site #29 in previous years.

One sample was obtained in 1990 for bacteriological analysis at Site #29, on October 16 (Appendix III-G). The fecal coliform concentration (580 organisms per 100 ml) was well below the Ohio EPA water quality criterion for Primary Contact Recreational Use. This is lower than fecal coliform concentrations measured at Site #29 in 1987 (36,000 organisms per 100 ml), 1988 (as high as 11,000 organisms per 100 ml), and 1989 (3,500 organisms per 100 ml). This improvement can be attributed to upstream remediation at Snow Road, Fernhill Avenue, and Onaway Oval, which are discussed later in the report.

Site #29 was qualitatively sampled for benthic macroinvertebrates once in 1990, on October 19. A total of 13 taxa were collected and identified (Appendix IX-E). This number of taxa is similar to the number identified in previous years. However, two species of mayflies present in 1990 had not been present in 1988 or 1989. These mayflies are described in literature as facultative in their responses to organic pollution. The presence of these mayflies and other facultative taxa indicate that the water quality is improving at Site #29. Further sampling is required to verify this trend.

Site #30

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 extensive vegetation. The stream's substrate consists of solid flat shale, with a few shale fragments, gravel, and sand. This section has numerous riffles and some pooled areas. Periphytic green algae has been noted. Measurements performed in 1987 indicated a dry weather flow of about 0.6 million gallons per day from Stickney Creek.

Two samples for chemical analysis were collected at Site #30 in 1989 (Appendix II-F). Other than exceedances for mercury (0.5 ug/L) and iron (1.8 mg/L) on May 22, all chemical data obtained from Stickney Creek in 1989 were within Ohio EPA Water Quality Standards for Warmwater Habitat.

On October 5, 1989, a sample was obtained at Site #30 for bacteriological analysis (Appendix II-F). The fecal coliform concentration (9,000 organisms per 100 ml) exceeded the Ohio EPA water quality criterion for Primary Contact Recreational Use but was similar to fecal coliform concentrations measured at this site in 1988 (as high as 12,000 organisms per 100 ml). Further investigation is required to identify the source(s) of this continuing bacteriological contamination of Stickney Creek.

Qualitative benthic macroinvertebrate sampling was conducted twice at Site #30 in 1989, on March 29 and May 22 (Appendix VIII-M). There were a total of five taxa collected and identified, of which two are described in literature as facultative in their responses to organic pollution. There was one facultative taxon (Hydropsyche betteni) collected in 1989 that had not been present in 1987 or 1988. In 1989, there was approximately the same number of taxa collected at Site #30 as in previous years.

Site #30 was sampled twice in 1990 for chemical analysis, on June 20 and October 16 (Appendix III-G). Other than exceedances for mercury (0.4 ug/L and 0.2 ug/L on June 20 and October 16, respectively), all chemical data obtained from Stickney Creek in 1990 were within Ohio EPA Water Quality Standards for Warmwater Habitat.

One sample for bacteriological analysis was obtained from Site #30 in 1990, on October 15 (Appendix III-G). The fecal coliform concentration

(20 organisms per 100 ml) was well below the Ohio EPA water quality criterion for Primary Contact Recreational Use. This fecal coliform concentration was lower than all fecal coliform concentrations measured at this site in 1987, 1988, and 1989 (geometric means of 1,800, 7,600, and 9,000 organisms per 100 ml, respectively).

Qualitative benthic macroinvertebrate sampling was conducted at Site #30 on October 19, 1990 (Appendix IX-F). A total of nine taxa were collected and identified. Five of the nine taxa are described in literature as facultative in their responses to organic pollution. The slight increase in the number of taxa may be attributed to seasonal variability and/or improving water quality. The presence of Baetis flavistriga, which was not found at this site in previous years indicates water quality improvement. Further sampling is required to verify this trend and evaluate the importance of seasonal variability as a factor.

PROBLEMS AND REMEDIATION

-1-

Historically, Big Creek's West Branch has been one of the most severely polluted streams in the Greater Cleveland area. Fecal coliform concentrations, were measured by the NEORSD as high as 3,200,000 organisms per 100 ml in 1986 in the West Branch at the Cleveland Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road (Site #27).

In 1988, in response to requests by the NEORSD, the City of Cleveland removed a blockage in the 24-inch sanitary sewer which parallels the creek west of the Crestmont Apartments on Bosworth Road. This blockage had been responsible for a 0.4 million gallon per day dry weather overflow from the sanitary sewer into the culverted section of the Big Creek West Branch at Cooley Avenue west of West 117th Street. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.) Following this remediation, a significant improvement in the water quality of the Big Creek West Branch downstream was visually evident and was reflected in substantially reduced fecal coliform concentrations at Sites #25 and #27 (Figures 11,12).

However, past NEORSD investigations had shown that a significant dry weather source of pollution remained in the Big Creek West Branch double-barrel culvert between Puritas Avenue and West 130th Street. The culvert is divided by a median wall, and the creek flows through the southeast side of the culvert. The northwest side of the culvert collects combined sewer overflows and dry weather sanitary sewage from a 5 foot-by-8 foot box culvert south of West Avenue between West 134th Street and West 133rd Street. The flow in the northwest side of the double-barrel culvert travels to a perpendicular weir at West 130th Street, where the sewage flows through a sanitary outlet to the Big Creek Interceptor.

Sampling in 1987 had shown that the fecal coliform concentration in the creek upstream of the double-barrel culvert (at Site #28) was only 100 organisms per 100 ml, while simultaneously the fecal coliform concentration downstream in the creek side of the culvert at West 130th Street was 140,000 organisms 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 the two locations, sanitary sewage was crossing the dividing wall.

On August 28, 1989, NEORSD investigators performed a walk-through inspection of the double-barrel culvert. Downstream of the 5 foot-by-8 foot box culvert influent to the northwest side of the culvert, dye tests at several locations revealed significant exfiltration through the two-foot median wall to the creek side of the culvert.

Also noted during the August 28, 1989 inspection was a significant amount of dry weather flow in the northwest side of the double-barrel culvert upstream of the 5 foot-by-8 foot box culvert influent. The source of this flow was identified as a combined sewer overflow structure located at 4156 Victory Boulevard. On September 11, 1989, NEORSD Sewer Maintenance & Repair crews removed a blockage caused by a rubber car mat in the sanitary outlet of this structure and eliminated the dry weather flow in the northwest side of the culvert upstream of the box culvert influent. More frequent monitoring of the combined sewer overflow structure was planned.

On September 4, 6, and 21, 1990, NEORSD investigators performed dry-weather bacteriological sampling in the Big Creek side of the double-barrel culvert at two locations at the upstream end of the two-foot median wall (near Victory Boulevard) and at two locations at the downstream end of the median wall (near West 130th Street). Geometric means of the data showed an increase in the fecal coliform concentration from the upstream end to the downstream end of nearly 4,000 percent - from 3,000 to 110,000 organisms per 100 ml (Table 2; Figure 13). Consequently, leaks in the median wall were determined to be responsible for significant contamination of the Big Creek West Branch by sanitary sewage.

To eliminate this source of contamination, the NEORSD resolved to repair the leaking median wall. In October and November of 1990, a NEORSD-contracted construction firm lined the invert of the sanitary sewage side of the double-barrel culvert with two inches of Gunite and lined the median wall with a radius of twelve inches of Gunite, sealing all gaps in the wall.

On December 12, 14, and 20, 1990 and January 4, 1991, following completion of the wall repair, NEORSD investigators resampled the creek. These samplings revealed no increase in fecal coliform concentration in Big Creek West Branch between Victory Boulevard and West 130th Street

Table 2

BIG CREEK WEST BRANCH
FECAL COLIFORM CONCENTRATIONS
Before and After NEORSD Repair of
Double-Barrel Culvert Median Wall
(organisms per 100 ml)

	Upstream at Victory Blvd.		Downstream at West 130th St.		Geometric Means	
Date	Site A	Site B	Site C	Site D	Victory Blvd.	W.130th Street
09/04/90	6,000	6,400	-	140,000	6,200	140,000
09/06/90	10,000	18,000	-	160,000	13,000	160,000
09/21/90	320	320	58,000	50,000	320	54,000
Fecal coliform geometric means before wall repair:					3,000	110,000
12/12/90	150	140	210	210	140	210
12/14/90	200	180	90	100	190	90
12/20/90	3,500	3,000	1,700	2,500	3,200	2,100
01/04/91	1,700	2,200	1,800	1,600	1,900	1,700
Fecal coliform geometric means after wall repair:					630	510

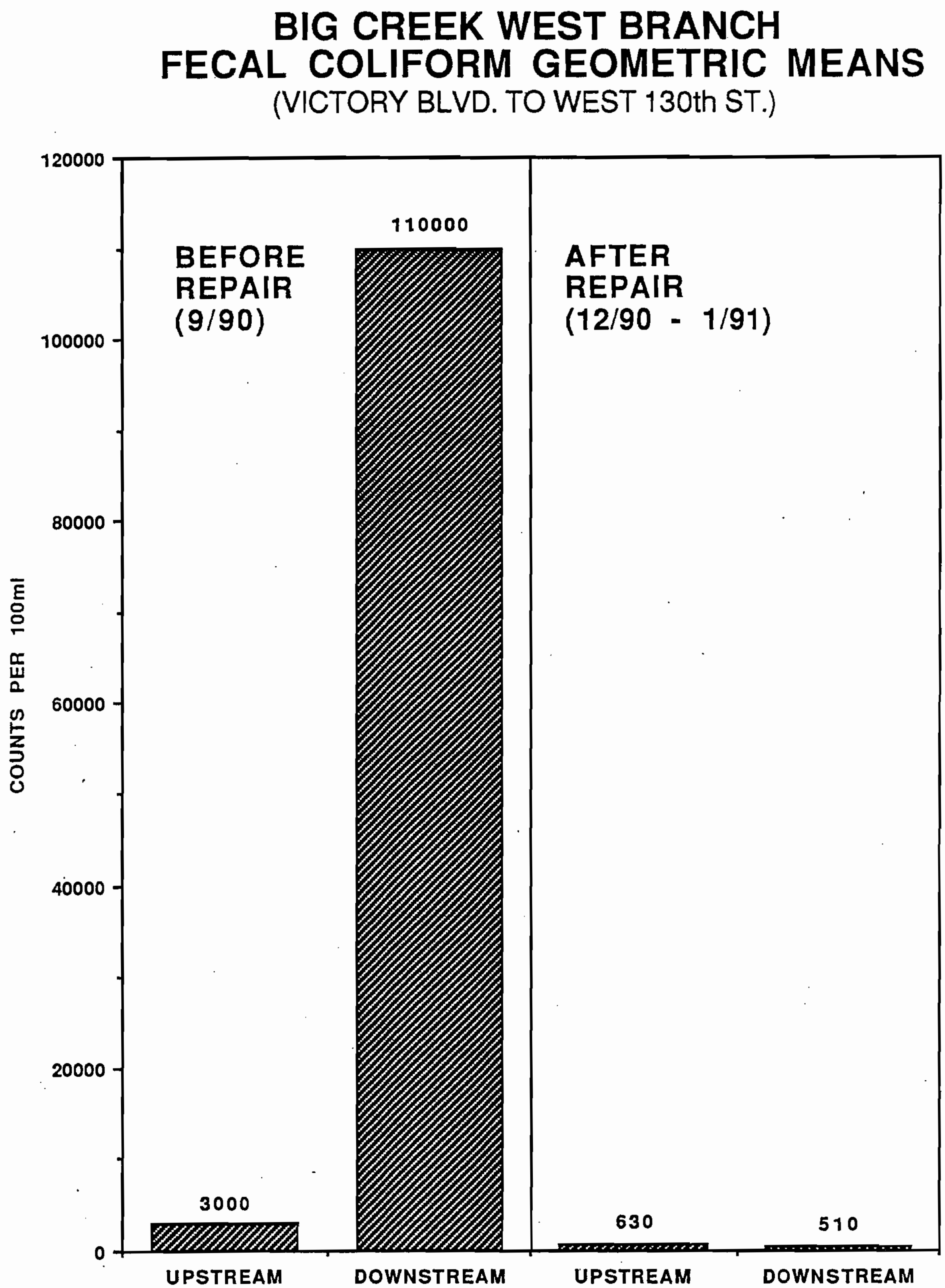

BIG CREEK WEST BRANCH
FECAL COLIFORM GEOMETRIC MEANS
(VICTORY BLVD. TO WEST 130th ST.)
COUNTS PER 100ml
120000
100000
80000
60000
40000
20000
0
BEFORE
REPAIR
(9/90)
AFTER
REPAIR
(12/90 - 1/91)
3000
110000
630
510
UPSTREAM
DOWNSTREAM
UPSTREAM
DOWNSTREAM

Figure 13

(Table 2; Figure 13). The remediation had been successful in eliminating this source of contamination in Big Creek.

-2-

Another major source of contamination of Big Creek by sanitary sewage had been identified by the NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report, in the East Branch under Snow Road. Measurements had indicated that water containing sanitary sewage was entering the creek through an eastbound 20-inch storm sewer on Snow Road at a rate of 180,000 gallons per day, with fecal coliform concentrations as high as 6,400,000 organisms per 100 ml.

On March 10, 1989, NEORSD investigators introduced dye into the northbound 36-inch sanitary sewer at the intersection of Parma Heights Boulevard, Snow Road, and Hauserman Road. The dye appeared in the flow entering the creek through the 20-inch storm sewer outfall under Snow Road, indicating the source was a leak in the 36-inch sanitary sewer near the border between Parma and Parma Heights. These findings were reported to both cities and to the Cuyahoga County Sanitary Engineering Department.

Also noted during the March 10 investigation was a significant flow of apparently clean water in the eastbound 24-inch storm sewer on Snow Road west of Hauserman Road. This water was contributing to the flow to the creek under Snow Road. The source of the flow was later identified as a probable water main break entering the storm sewer between 5818 and 5856 Royal Parkway in Parma Heights. The City of Cleveland Water Department was notified of this situation.

During the summer of 1989, the Snow Road bridge over Big Creek was closed for structural repairs. On October 4, 1989, NEORSD investigators, with assistance from the Cuyahoga County Sanitary Engineering Department, performed more dye tests, inspections, and bacteriological sampling in an attempt to further pinpoint the cause of the sanitary sewage contamination of Big Creek under Snow Road. These efforts revealed that the sanitary sewage was entering the 20-inch storm sewer at a manhole on Snow Road about 100 feet west of Big Creek. The sewage was entering the manhole from a supposedly abandoned 8-inch sanitary sewer eastbound on Snow Road. This sanitary sewer had a bulkhead at the intersection of Snow Road and Parma Heights Boulevard, separating it from the 36-inch sanitary sewer northbound on Parma Heights Boulevard. The bulkhead was evidently leaking.

Later that day, the Cuyahoga County Sanitary Engineering Department inserted a mechanical plug in the 8-inch sanitary sewer at the manhole on Snow Road 100 feet west of Big Creek and cemented it in with Octocrete. On October 5, 1989, a NEORSD bacteriological analysis of the remaining dry weather flow to Big Creek from the 20-inch storm sewer outfall under Snow Road revealed a fecal coliform concentration of less than 20 organisms per 100 ml. In contrast, the fecal coliform concentration in this outfall had been greater than 300,000 organisms per 100 ml on the previous day. These analyses demonstrated that the source of sanitary sewage in Big Creek at this location had been eliminated.

A subsequent inspection by NEORSD investigators on December 5, 1989 revealed that all dry weather flow to Big Creek from the 20-inch storm sewer outfall under Snow Road had been eliminated.

-3-

On April 1, 1989, NEORSD investigators responded to reports of gasoline odors in several homes on Fernhill Avenue in Parma. The source was identified as a gasoline tank from a disabled vehicle, the contents of which had spilled into the sewer. Following the spill, the sewer system had been flushed with city water by the Parma Fire Department. The NEORSD investigators detected gasoline odors in the storm sewer but found no gasoline in the sewer system or in the East Branch of Big Creek downstream of the storm sewer outfall at the Cleveland Metroparks Fernhill Picnic Area. However, the investigators did note a significant flow of sanitary sewage entering the creek through this 30-inch outfall.

On April 7, 1989, a subsequent investigation revealed a blockage of the westbound 8-inch sanitary sewer at 9618 Fernhill Avenue, east of Big Creek Parkway. A dye test verified that sanitary sewage was entering the westbound 30-inch storm sewer at this location and was tributary to the creek in dry weather upstream of Site #29.

The City of Parma Engineering Department was informed of this situation on four occasions between the date of discovery and September 18, 1989. Following each notification, NEORSD investigations revealed that the flow of sanitary sewage to the creek from Fernhill Avenue continued. On August 15, 1989, a bacteriological analysis of the flow from the 30-inch storm sewer outfall revealed a fecal coliform concentration of 4,000,000 organisms per 100 ml. This influent contributed to the elevated fecal coliform concentration noted in Big Creek at Site #29 on October 5, 1989. Finally, on December 5, 1989, an inspection by NEORSD investigators revealed that dry weather flow to the creek at this location had been eliminated.

-4-

On September 22, 1989, NEORSD investigators identified another dry weather source of sanitary sewage in the East Branch of Big Creek contributing to elevated concentrations of fecal coliform at Site #29. Dye tests showed that sanitary sewage was entering a 24-inch storm sewer on the property of 9750 Parkland Drive, north of the intersection of Onaway Oval, Edgehill Drive, and Parkland Drive. From this location, it flowed north underneath the Big Creek Parkway and into the East Branch of Big Creek. On September 26, 1989, the City of Parma Engineering Department was informed of this situation. Subsequent inspections indicated that the sanitary sewage flow to the creek was intermittent.

On June 19, 1990, the flow was found to be recurring and the manhole at 9750 Parkland Drive was entered by NEORSD investigators for inspection. The inspection revealed that the flow was entering the 24-inch storm sewer through a four-inch hole in an 9-inch sanitary sewer pipe passing through the manhole. A flow measurement obtained at the time of inspection indicated that sanitary sewage was entering the storm sewer through this hole at an approximate rate of 40,000 gallons per day. The problem was again reported with these details to the City of Parma Engineering Department.

A subsequent NEORSD inspection on August 15, 1990 revealed that the sanitary sewage flow to Big Creek at this location was continuing. A bacteriological sample collected from the discharge on this date revealed a fecal coliform concentration of 4,000,000 organisms per 100 ml. Again, the City of Parma Engineering Department was informed of these details.

An inspection by NEORSD investigators on January 14, 1991 revealed that the leaking sanitary sewer had been patched and this source of contamination of Big Creek had been eliminated.

-5-

On December 13, 1989, the Ohio EPA requested assistance from the NEORSD in identifying the source of a small amount (less than 10 gallons) of brown oil in a tributary to Big Creek located at Softball World, 5500 West 130th Street. NEORSD investigators, upon arrival, noted a whitish precipitate in the creek at this location. The whitish residue was traced back through a northbound storm sewer on West 130th Street to a manhole on the west lawn of AMAC Enterprises, 5909 West 130th Street. Analysis of a sample of whitish-colored water obtained from this manhole revealed high concentrations of zinc (1,620 mg/L), nickel (22.1 mg/L), cadmium (3.10 mg/L), chromium (0.54 mg/L), and copper (0.48 mg/L) and a low pH (2.7 standard units). Also noted were elevated concentrations of chemical oxygen demand (742 mg/L), suspended solids (6,510 mg/L), phosphorus (1,570 mg/L), and chlorides (3,200 mg/L).

AMAC Enterprises was notified, and company dye tests on December 16, 1989 revealed a leak to the storm sewer from the company's zinc phosphating wastewater trench. AMAC Enterprises contracted a plumber to repair the leak. NEORSD investigators subsequently performed a 24-hour composite sampling on January 4, 1990 at the storm sewer manhole in the company's lawn. Analysis of the sample showed that concentrations had been reduced substantially, although an elevated zinc concentration (44.0 mg/L) was still noted, probably due to residual contamination.

-6-

On February 5, 1990, NEORSD investigators responded to a reported oil spill at AMAC Enterprises. A brass ball valve on the company's outside oil storage tank had cracked, resulting in a spill of approximately 1,000 gallons of oily water onto the parking lot southeast of the company plant. Although some of the oil was being cleaned up by company personnel, an undetermined quantity of oil had entered a storm sewer through a parking lot catch basin. This storm sewer is eventually tributary to the creek at Softball World west of 130th Street. Containment booms were placed at the storm sewer outlet to the creek and at an upstream open section north of Snow Road, east of West 130th Street.

On February 12, 1990, NEORSD investigators inspected the containment booms and found a substantial quantity of oil accumulated behind the booms north of Snow Road. Company officials were advised to clean up the accumulated oil and remove the booms. However, a February 15 NEORSD inspection indicated that heavy rains had scattered oily booms and absorbant materials along the creek's banks. Company officials were again advised to properly maintain the clean up materials.

Following more reports of oil in the creek in March 1990, which were probably attributable to residual from the February 5 spill, Ohio EPA personnel conducted an inspection of the AMAC Enterprises plant and vicinity. After the inspection, the company initiated several measures, including the construction of a containment dike around the outside oil storage tank, to eliminate unauthorized environmental discharges.

-7-

On June 7, 1989, NEORSD investigators responded to a report of a solvent spill at Waco International Corporation, 5251 West 130th Street. Company employees had been transferring xylene, which is used as a paint thinner, from an outside 800-gallon above-ground storage tank to a 55-gallon drum, when an overflow into a nearby catch basin resulted. According to company estimates, 50 to 100 gallons of xylene had been lost.

NEORSD investigators inspected a northbound storm sewer on West 130th Street, which turns eastbound on Brookpark Road and is tributary to the "Chevrolet" Branch of Big Creek north of the Chevrolet Parma Plant. Evidence of the solvent was detected in this storm sewer, including vapor in the sewer's atmosphere and globules of the material on the water's surface. A containment boom and absorbant pillows were positioned at the storm sewer's outlet near the Chevrolet Parma Plant south of Brookpark Road. No evidence of the solvent could be detected in the creek downstream at that time.

The Parma Fire Department was given approval by the Ohio EPA to flush the storm sewer to the creek, where the solvent could be cleaned up. By June 9, 1989, Samsel Services Company, which had been contracted by Waco International Corporation to conduct the clean-up, had removed from the creek two contaminated booms and five 55-gallon drums full of solvent-contaminated water for disposal.

-8-

During recent years, the NEORSD has received numerous reports of oil sheens and colors (including white and green) in the "Chevrolet" Branch of Big Creek in the neighborhood of Cleveland along West 130th Street between Brookpark Road and Interstate 71. Historically, NEORSD investigators have identified several sources of process wastewater and oil in the "Chevrolet" Branch, including Abex Corporation at 5372 West 130th Street (now Sinter Met Corporation) and Anchor Tool & Die Company at 11830 Brookpark Road, and remediation has resulted. However, reports of substances in this branch of Big Creek persisted in 1989 and 1990. The intermittent nature of these occurances has impeded identification of remaining sources, and further investigation is necessary.

-9-

Historically, colors have also been reported on numerous occasions in the Big Creek West Branch. One of these occasions occurred on April 12, 1989, and NEORSD investigators observed a purple-red color in the West Branch east of Highland Road. It was determined that a temporary bypass of a combined sewer overflow regulator upstream at West 145th Street and Puritas Avenue had earlier been necessitated for NEORSD maintenance. This flow contains wastewater from Phoenix Dye Works, 4755 West 150th Street, which is frequently discolored but within NEORSD Sewer Use Code regulations and acceptable for discharge to the sewer system.

-10-

On September 14, 1989, NEORSD investigators responded to a report of a grey-white substance in the "Ford" Branch of Big Creek north of Brookpark Road and Henry Ford Boulevard. The investigators found the substance entering the creek intermittently through a storm sewer pipe from the north at the west end of the creek's culvert under Interstate 71. A sample analysis indicated that the flow from this pipe had a suspended solids concentration of 4,610 mg/L.

The source of the substance was identified as the Southwest Interceptor construction site between Interstate 480 and Brookpark Road, west of Interstate 71. Water having a high solids content was being pumped out of the interceptor tunnelling shaft through PVC piping to a ditch south of Interstate 480. The piping had become disconnected from a basin designed to settle solids from the discharged water. The contractor responsible was informed of the problem and corrections were made that day.

-11-

Following reports of oil in Stickney Creek, NEORSD personnel initiated an investigation on September 29, 1989. Approximately 50 to 60 gallons of oil had been contained by an Ohio EPA-placed boom north of

Traymore Avenue and was subsequently removed for disposal by Samsel Services Company. Although no source of oil was identified, a source of suspended red clay solids in the creek was identified on October 10 at Pearl Road and Wetzel Avenue. The Pearl Road Relief Sewer had been under construction at this location and the drilling operation was determined to be responsible for the red coloration of the creek. The contractor agreed to install a separator at the site as soon as possible.

-12-

On July 5, 1989, NEORSD investigators responded to an anonymous complaint transmitted through the U.S. Department of Labor concerning Alex Brothers Rubbish Removal, 4150 Brookpark Road. Evidence of oil spillage were noted around the property and at a floor drain in the company's maintenance garage during the NEORSD inspection. A dye test showed that this floor drain was tributary to an eastbound storm sewer on Brookpark Road which is tributary to Stickney Creek. No evidence of waste oil storage was noted on the property.

The Ohio EPA was notified of this situation and, on October 3, 1989, required that the property owner disconnect the maintenance garage floor drain from the storm sewer system.

-13-

On May 22, 1990, NEORSD investigators responded to a report of black-colored flow in Stickney Creek at Archmere Avenue. The discolored flow was determined to be entering the creek from a ditch draining railroad tracks which parallel Interstate 480. Green and red colors were also noted in the ditch, which was traced to an 18-inch corrugated metal pipe located behind Ideal Builders Supply & Fuel Company, 4720 Brookpark Road. This company, which uses pigments, and Georgia Pacific Corporation, 4600 Brookpark Road, which uses inks, were both investigated as possible sources. Although the inspections revealed no routes of discharge to the environment at either company, a sample from the ditch revealed chemical oxygen demand (497 mg/L) and metals concentrations (no higher than 1.50 mg/L copper) which were more consistent with values expected in a discharge from Georgia Pacific Corporation.

On August 21, 1990, NEORSD investigators responded to a report of a blue color in Stickney Creek at Oak Park Avenue and traced it to the ditch south of Interstate 480. A repeat inspection of Georgia Pacific Corporation was conducted, and a temporary sump pump connection from the company's printing presses to a roof drain pipe was discovered. Around the area were noted splashings identical in color to the blue substance found in the creek. According to a company official, the temporary sump pump connection was made when the company's main sump malfunctioned. Evidently, the roof drain pipe was tributary to the ditch. Georgia Pacific Corporation agreed to have the temporary sump pumps rerouted to the sanitary sewer, eliminating this source of contamination in Stickney Creek.

-14-

On February 14, 1990, NEORSD investigators, during an inspection of Fab-Weld Technologies, Inc. at 8500 Clinton Road, discovered that the company's industrial process wastewater was entering a catch basin tributary to a storm sewer tributary to Big Creek. This wastewater included a washwater which had been used to clean and test welds and was being discharged at a rate of 200 gallons per day. Elevated concentrations of chemical oxygen demand (6,950 mg/L), phosphorus (93.5 mg/L), oil & grease (700 mg/L), and zinc (1.00 mg/L) were measured in the washwater.

Fab-Weld Technologies, Inc. was occupying the former Terex Corporation plant building. The process wastewater flowed into a sump, from which it was pumped toward the Terex Corporation wastewater treatment plant, which was now abandoned. Since the wastewater treatment plant's inlet had been sealed, the wastewater was overflowing into the storm sewer catch basin.

A representative of the property owner agreed to perform plumbing modifications to reroute the wastewater into the sanitary sewer system. NEORSD investigators verified these modifications through a dye test and a subsequent inspection.

-15-

On May 29, 1990, NEORSD investigators performing an inspection at Judd Industries, Inc., 5500 West 164th Street, noted a wastewater drainage trench tributary to a ditch behind the company, which was potentially tributary to the Big Creek West Branch. The ditch contained water-soluble oil and deburring wastewater. A company official agreed to reroute the wastewater trench to the sanitary sewer system and seal off the discharge to the environment. These modifications were verified by NEORSD investigators on January 11, 1991.

-16-

On May 18, 1989, NEORSD investigators assisted the Parma Fire Department and the Ohio EPA in response to an accidental gasoline spill at a Gastown station at the intersection of State Road and Pleasant Valley Road. An estimated 1,400 gallons of gasoline had been spilled onto the station's property and filled a construction pit. In addition to entering the sanitary sewer system, the gasoline was found flowing into a tributary of the Big Creek East Branch through a 30-inch storm sewer west of State Road near Dentzler Road. Earthen dikes were constructed and containment booms and absorbant pads were positioned in the creek to prevent further migration of the spill downstream. Following removal of gasoline from the sanitary and storm sewers by Samsel Services Company, the Parma Fire Department flushed the sewers while NEORSD personnel inspected the creek to ensure containment of the gasoline.

-17-

On November 12, 1990, NEORSD investigators responded to reports of gasoline odors in homes on Plainfield Avenue. A discharge containing a gasoline odor was found at the storm sewer outfall to Big Creek at Ridge Road and Interstate 71. Further investigation revealed ground contamination by gasoline at the Shell gasoline station at 7216 Memphis Avenue, resulting from a broken leak detector. The gasoline had been traveling underground to a strip drain, where it came to the surface and flowed into a catch basin. The gasoline leak was shut off by the Shell station maintenance service personnel, and the catch basin, which was tributary to a 30-inch storm at Southfield Avenue and Ridge Road, was deepened and used as a collection point for pumping the gasoline into 55-gallon drums. It was determined that the station had lost approximately 770 gallons of unleaded gasoline.

Engineering Science Ltd. was contracted to dig a recovery trench near the catch basin and install an oil-separation/carbon-filtration system to treat the groundwater. Samsel Services Company was contracted to install a containment boom at the storm sewer outfall to Big Creek and remove any gasoline that was collected. Following isolation of the contaminated groundwater from the 30-inch storm sewer, the Brooklyn Fire Department flushed the sewer system.

-18-

In October 1989, the Cuyahoga County Sanitary Engineering Department repaired a broken 15-inch sanitary sewer south of Interstate 71 at northbound Mile Marker 243. The flow of sanitary sewage from the break had entered the Big Creek West Branch at the Cleveland Metroparks Big Creek Reservation upstream of its confluence with the East Branch. Verification of the repair was made by NEORSD investigators on October 20, 1989.

-19-

Contamination of the main stem of Big Creek occurred from May 15 to May 18, 1989 and from October 30 to November 1, 1989, when the Big Creek Interceptor was diverted to the creek. The diversions were necessary for inspection and maintenance of the intercepting sewer and were approved by the Ohio EPA. An assessment of the impact of these diversions on the water quality and the biological community of Big Creek was performed by NEORSD investigators and is presented in Appendix XIII.

-20-

Construction of the NEORSD Southwest Interceptor continued through 1989 and 1990. It began receiving flow from as far west as the City of Brooklyn, including flow from the antiquated and heavily loaded Big Creek Interceptor. As overflows from the Big Creek Interceptor are minimized by relief from the Southwest Interceptor, the water quality of Big Creek, and the Cuyahoga River downstream, should continue to show improvement.

MILL CREEK

Mill Creek drains southeastern Cleveland and the suburbs along the southeastern border of Cleveland. It has a total drainage area of 18.1 square miles and a total length of 9.0 miles. 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, which it parallels northwest through Garfield Heights into Cleveland, and then flows 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 - the only significant culverted sections being short segments of the creek upstream of Garfield Park, under Interstate 480, and downstream of the detention basin east of Kerruish Park. Except for the concrete beds in the culverts, the creek's substrate is predominantly natural.

Mill Creek's drainage area is primarily residential and industrial. The Ohio EPA has designated Mill Creek from its mouth to near Granger Road as Limited Warmwater Habitat and Secondary Contact Recreational Use; upstream of that point the designations are Warmwater Habitat and Primary Contact Recreational Use.

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 flow 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, 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. This figure may represent minimum flow conditions in Mill Creek.

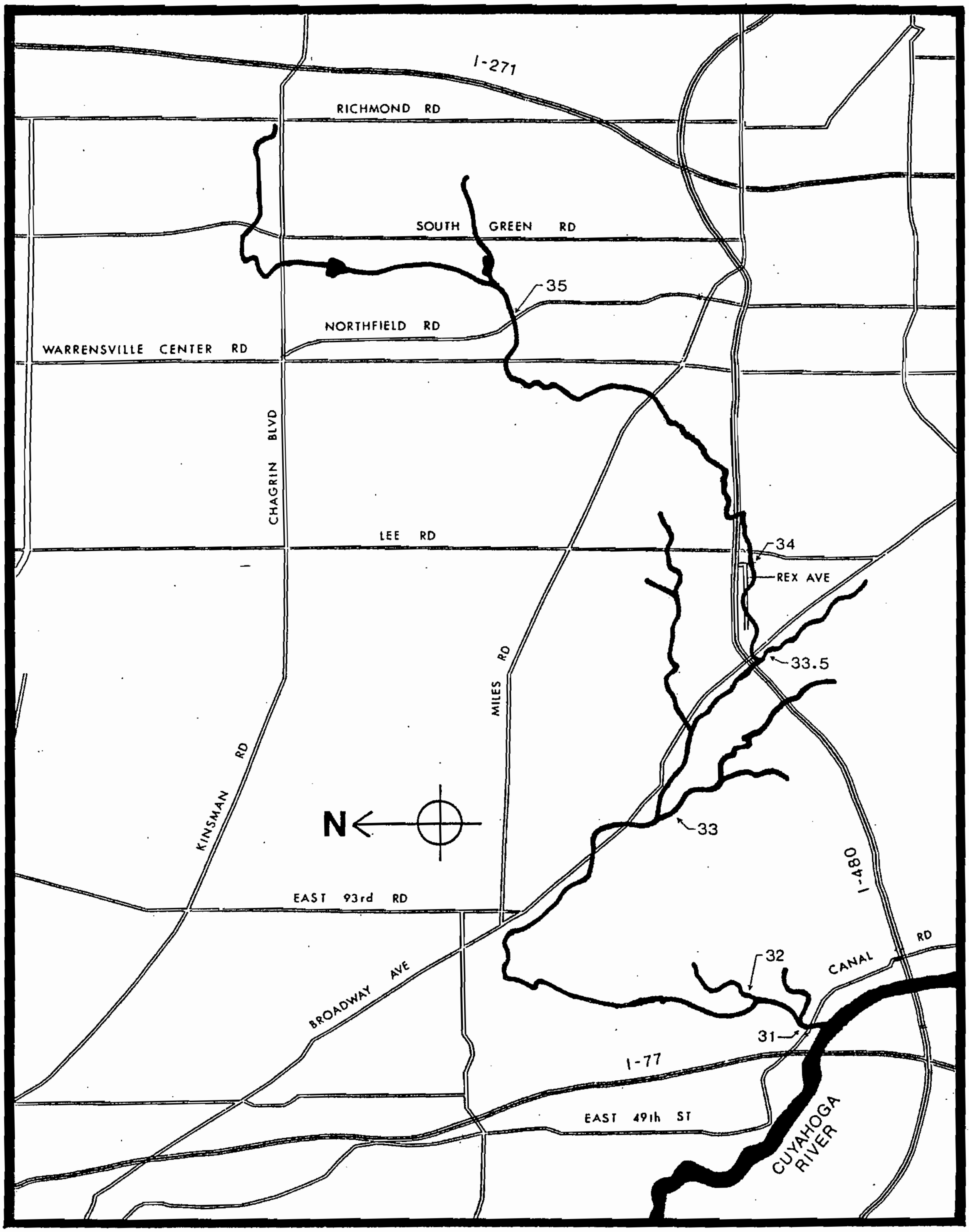
The water quality of Mill Creek is of particular concern to the NEORSD as it discharges into the Cuyahoga River approximately one mile upstream of the Southerly WWTP discharge to the River. Historically, Mill Creek has been one of the most heavily polluted streams in the Greater Cleveland Area.

SAMPLING

Six locations were chosen on Mill Creek for routine chemical, bacteriological, and benthic sampling and analysis (Figure 14).

SITE #31

Site #31 is located on the mainstem of Mill Creek, approximately 600 feet upstream of the confluence with the Cuyahoga River, under Canal



Mill Creek
(NOT TO SCALE)

Figure 14

Road. The creek is about 25 feet wide at this point and the substrate consists of mud, cobble, and miscellaneous rubble. Dense vegetation with overhanging trees surrounds the creek.

Two grab samples for chemical and bacteriological analyses were obtained at Site #31 in 1989 (Appendix II-G). The fecal coliform concentrations (1,500 and 4,600 organisms per 100 ml on June 27 and September 19, respectively) were below Ohio EPA water quality criteria for Secondary Contact Recreational Use and were significantly lower than in 1987 (300,000 organisms per 100 ml) and 1988 (7,200 organisms per 100 ml) (Figure 15). This continuing reduction in bacterial contamination in Mill Creek is reflective of the upstream remediation discussed later in this report.

With the exception of iron and mercury, all 1989 chemical data from Site #31 were within the numerical criteria for Limited Warmwater Habitat (Appendix II-G). Iron was measured at 3.2 mg/L on July 27 and 1.5 mg/L on September 19, compared to the 1.0 mg/L criterion. Mercury was measured at 0.1 ug/L on September 19, compared to the 0.012 ug/L criterion.

Qualitative sampling for benthic macroinvertebrates at Site #31 in 1989 produced seven taxa, the majority of which are described as tolerant in their responses to organic pollution (Appendix VIII-N). These results are similar to those obtained at this location in previous years' benthic macroinvertebrate sampling.

In 1990, Site #31 was sampled once for chemical and bacteriological analysis (Appendix III-H). Bacteriological data from the sample obtained on December 7, 1990 indicated that the fecal coliform concentration exceeded the Ohio EPA water quality criteria for Secondary Contact Recreational Use. The fecal coliform concentration was measured at 12,000 organisms per 100 ml, compared to the 5,000 organisms per 100 ml criterion. This increase in bacterial contamination is primarily attributable to a rupture in the Mill Creek Interceptor north of Longbrook Road, and this situation is discussed in detail later in the report.

All chemical parameters at Site #31 in 1990 were within Ohio EPA water quality criteria for Limited Warmwater Habitat with the exception of oil & grease and iron. Oil & grease was measured at 40 mg/L, compared to the 10 mg/L criterion. Iron was measured at 2.0 mg/L compared to the 1.0 mg/L criterion. Comparable results had been obtained at this location in previous years, with the exception of the chloride concentration, which was relatively high (429 mg/L) in December 1990 and attributable to roadsalt run-off from snowmelt.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #31 in 1990.

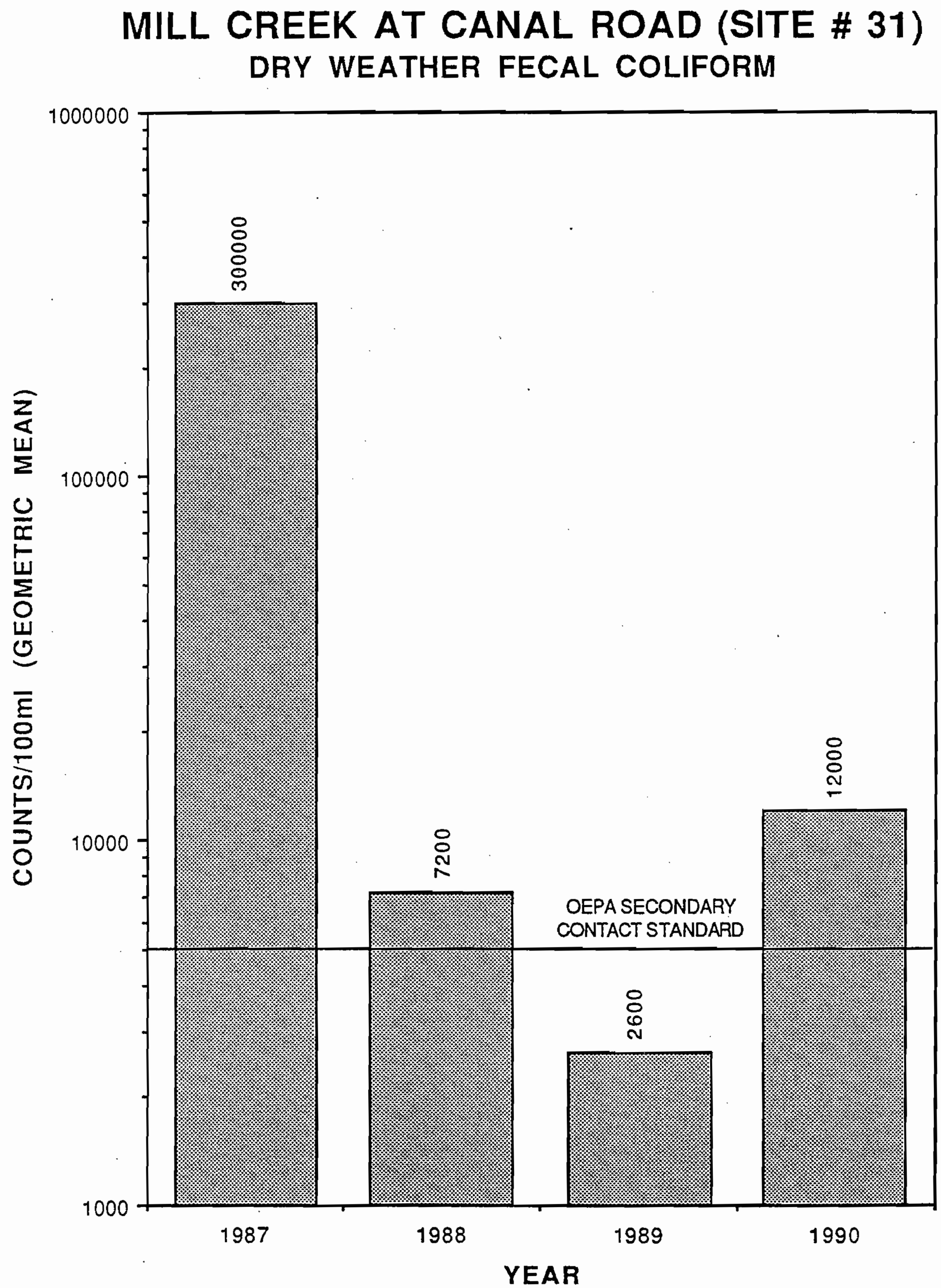

MILL CREEK AT CANAL ROAD (SITE # 31)
DRY WEATHER FECAL COLIFORM
COUNTS/100ml (GEOMETRIC MEAN)
1000000
100000
10000
1000
300000
7200
2600
12000
OEPA SECONDARY CONTACT STANDARD
1987
1988
1989
1990
YEAR

Figure 15

SITE #32

Site #32 is located on a small tributary to Mill Creek from the northeast which is culverted beneath Warner Road. The tributary enters the creek less than one half mile upstream of Mill Creek's confluence with the Cuyahoga River. This tributary is approximately 10 feet wide and the substrate consists of cobble, gravel, and silt. The tributary in this vicinity is surrounded by vegetation with some tree cover.

Two grab samples for chemical and bacteriological analyses were obtained at Site #32 in 1989 (Appendix II-G). Fecal coliform concentrations at Site #32 in 1989 (270 and 800 organisms per 100 ml) were within Ohio EPA water quality criteria for Primary Contact Recreational Use and were significantly lower than fecal coliform concentrations at this location in 1987 (340,000 organisms per 100 ml) and 1988 (5,000 organisms per 100 ml). This reduction in bacterial contamination may be attributed to the prevention of dry weather sewage overflows at Vista Park in Garfield Heights.

All chemical parameters at Site #32 in 1989 were within Ohio EPA water quality criteria for Limited Warmwater Habitat with the exceptions of mercury, pH, and dissolved oxygen (Appendix II-G). Mercury was measured at 0.2 ug/L on July 27 and 0.1 ug/L on September 19. The pH's of 9.1 and 9.3 standards units exceeded the maximum allowable pH during both samplings and were attributable to an industrial source on Warner Road, which is discussed later in this report. Also attributable to this industrial source may be the low dissolved oxygen concentrations of 0.1 and 0.5 mg/L, which could have resulted from relatively high chemical oxygen demand and low flow conditions.

In 1990, Site #32 was sampled once for chemical and bacteriological analysis (Appendix III-H). The fecal coliform concentration of 200 organisms per 100 ml on December 7 was well below the Ohio EPA water quality criterion for Primary Contact Recreational Use.

Chemical data from Site #32 in 1990 indicated that all parameters were within water quality criteria for Limited Warmwater Habitat with the exception of oil & grease, which was measured at 17 mg/L on December 7. The chloride concentration was high (300 mg/L) in December 1990 and, again, was attributable to roadsalt runoff from snowmelt.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #32 in 1989 and 1990.

SITE #33

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 was originally about 12 feet in width at the sample site, with a depth of about 4 inches in dry weather. The substrate consisted of mud, sand, and small rocks, and the creek had riffles and pools. The rocks were covered with green algae. Slight, grassy slopes surrounded the creek and there was no tree overhang at this point.

During 1989, the Cleveland Metroparks performed construction at the retaining wall located at Wolf Creek's confluence with Mill Creek. To allow for the construction activities, a ditch was dug north of the existing Wolf Creek stream bed, and Wolf Creek was diverted through the ditch. This alteration necessitated a change in the location of Site #33 to the diverted stream.

Nevertheless, two grab samples for chemical and bacteriological analyses were collected at Site #33 in 1989 (Appendix II-G). On both occasions, the fecal coliform concentrations (130 and 570 organisms per 100 ml) were well below the Ohio EPA criterion for Primary Contact Recreational Use. The previous samples at Site #33 in 1987 and 1988 had fecal coliform concentrations (3,000 to 4,500 organisms per 100 ml) which were higher than the criterion.

All 1989 chemical data from Site #33 were within water quality criteria for Warmwater Habitat with the exception of mercury. Mercury was measured at 0.3 ug/L on July 27.

Qualitative sampling for benthic macroinvertebrates at Site #33 in 1989 produced only four taxa (Appendix VIII-O). Fewer taxa were found at this location than had been collected in 1988, when eight taxa were collected. The decrease in taxa can be attributed to the diversion of Wolf Creek through the ditch. As a consequence, the new substrate, which consisted entirely of mud, was not as conducive to benthic habitation as the previous, natural stream bed.

In 1990, Site #33 was sampled twice in dry weather for chemical analysis and five times for bacteriological analysis (Appendix III-H). The fecal coliform concentrations ranged from 700 to 150,000 organisms per 100 ml, greatly exceeding the criterion for Primary Contact Recreational Use on several occasions. On surrounding streets in Garfield Heights, storm sewers, which may be contaminated by sanitary sewage from cross connections or leaks from sanitary sewers, are believed to be responsible for this bacterial contamination of Wolf Creek. This situation is discussed later in the report.

Chemical data from Site #33 in 1990 showed one exceedance of the water quality criteria for Warmwater Habitat. Mercury was measured at 0.4 ug/L on September 6. All other chemical data were within the criteria. Comparable results had been obtained from this location in previous years' sampling.

Qualitative sampling for benthic macroinvertebrates at Site #33 in 1990 produced results similar to those obtained in 1988 (Appendix IX-G).

Ten taxa were collected at this location in 1990 and are described in literature as being facultative and tolerant in their responses to organic pollution. The increase in the number of taxa in 1990 is attributable to benthic community recovery from the 1989 habitat modification previously noted, rather than an improvement in water quality. Cumulatively, the 1990 chemical, bacteriological, and benthic data indicate that Mill Creek Site #33 continues to exhibit contamination by sanitary sewage.

SITE #33.5

Site #33.5 is located on a tributary to Mill Creek known as the "Mapletown Branch," which flows in a northeastern direction parallel to Broadway Avenue in Maple Heights. The site is approximately thirty feet upstream of this tributary's confluence with Mill Creek, south of Interstate 480 at Broadway Avenue. Overhanging trees and thick vegetation surround this tributary of Mill Creek throughout its length.

Prior to September 1988, when remediation eliminated the dry weather discharge of approximately 1.8 million gallons per day of sanitary sewage west of Mapletown Shopping Center, the tributary had been obviously severely polluted. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.) The substrate, composed of slime-coated rocks, sand, and sludge, had been colored black from septic conditions. In 1989, improvements in the stream's water quality were evident. Although some residual septic sediment remained, the water was clear and the rocks in the stream bed were no longer slime-coated.

Two grab samples for chemical and bacteriological analyses were collected at Site #33.5 in 1989 (Appendix II-H). Although the fecal coliform concentration of 4,200 organisms per 100 ml on June 27 exceeded the Ohio EPA criterion for Primary Contact Recreational Use, both 1989 samples had fecal coliform concentrations lower than had been obtained at Site #33.5 during all previous samplings (Figure 16). In 1987, the fecal coliform concentration in the Mapletown Branch of Mill Creek had been greater than 2,000,000 organisms per 100 ml. In contrast, the September 19, 1989 fecal coliform concentration at this location was only 720 organisms per 100 ml, which is well within the applicable water quality criteria. This dramatic decrease in bacterial contamination is attributable to the elimination of the dry weather sewage discharge west of Mapletown Shopping Center. Remaining bacterial contamination in 1989 is attributed to the dry weather flow from a storm sewer upstream on this branch near Home Avenue and Garden Street. This situation is discussed later in the report.

Also reflecting the September 1988 remediation are dissolved oxygen concentrations at Site #33.5, which had been as low as 1.4 mg/L in July 1988. The 1989 dissolved oxygen concentrations were 8.5 mg/L and 5.2 mg/L, which are both above the Ohio EPA minimum for Warmwater Habitat.

MILL CREEK MAPLETOWN BRANCH (SITE #33.5)
DRY WEATHER FECAL COLIFORM

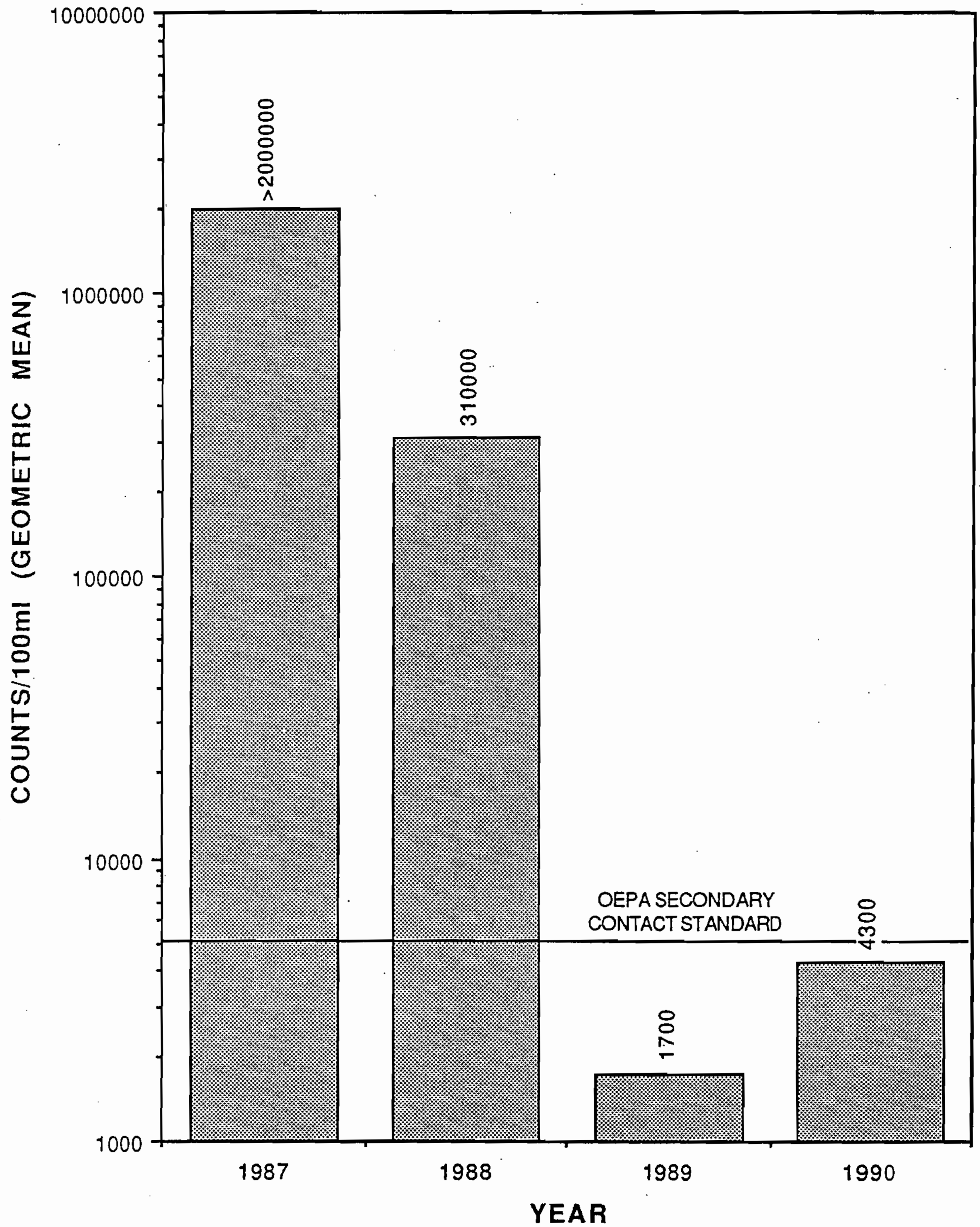


Figure 16

All the 1989 chemical data were within numerical criteria for Warmwater Habitat with the exception of mercury, which was measured at 0.2 ug/L on June 27. Exceedances of the criteria for zinc and lead, which had been noted in 1988, did not recur at this location in 1989.

Qualitative sampling for benthic macroinvertebrates at Site #33.5 in 1989 produced four taxa (Appendix VIII-P). Previous years' benthic sampling had produced no organisms. These results reflect a vast improvement in water quality and are attributed to the factors mentioned above.

In 1990, Site #33.5 was sampled twice for chemical analysis and once for bacteriological analysis (Appendix III-I). The fecal coliform concentration (4,300 organisms per 100 ml) on December 7 exceeded the Ohio EPA water quality criterion for Primary Contact Recreational Use but continued to be lower than the concentrations in samples collected prior to the upstream remediation in 1988. In 1990, bacteriological data suggest some continuing contamination, which is attributed to dry weather flow from a storm sewer upstream on this branch near Home Avenue and Garden Street. This situation is discussed later in the report.

All chemical parameters tested for in 1990 at Site #33.5 had concentrations lower than Ohio EPA criteria for Warmwater Habitat. Comparable results had been obtained from this location in 1989.

Qualitative sampling for benthic macroinvertebrates at Site #33.5 in 1990 produced nine taxa described in literature as being facultative and tolerant in their responses to organic pollution (Appendix IX-H). These results are indicative of the return to this location of aquatic organisms and reflect the dramatic improvement in water quality subsequent to the 1988 remediation.

SITE #34

Site #34 is located on Mill Creek at Rex Avenue and Glenburn Avenue in Maple Heights. The creek at this point is about 18 feet wide and about 5 inches deep during dry weather. It is surrounded by thick vegetation with partially overhanging trees. The substrate consists of mud, sand, and boulders.

Since 1987, visual evidence of contamination by sanitary sewage, including septic sediment and heavy algal growth on the substrate, has been noted periodically at Site #34. Historically, it had been attributed to recurring ruptures of the Mill Creek Interceptor under Mill Creek upstream of Warrensville Heights and an intermittent dry weather discharge of sanitary sewage immediately upstream under Lee Road. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.)

Two grab samples for chemical and bacteriological analysis were collected at Site #34 in 1989 (Appendix II-H). On both occasions, the fecal coliform concentrations (22,000 organisms per 100 ml on June 27 and 7,200 organisms per 100 ml on September 19) exceeded the Ohio EPA criterion for Primary Contact Recreational Use. These elevated concentrations may be attributed to sources of sanitary sewage under Lee Road and at an upstream storm sewer on Myrtle Avenue east of Lee Road. These sources are discussed later in the report.

At Site #34 in 1989, all chemical concentrations tested were lower than Ohio EPA criteria for Warmwater Habitat except mercury, which exceeded the criterion on June 27. Mercury was measured at 0.2 ug/L. Relatively high concentrations of zinc and lead, which had exceeded their respective criteria in 1988, did not recur at this location in 1989.

Qualitative sampling for benthic macroinvertebrates at Site #34 in 1989 produced eight taxa, including several organisms which are facultative in their responses to organic pollution (Appendix VIII-Q). Although this is an improvement from the four tolerant taxa collected in 1988, the low benthic diversity reflects the continuing detrimental impact of several upstream problems described in this report. Hopefully, future sampling at Site #34 will reflect the remediation of many of these problems.

In 1990, Site #34 was sampled twice for chemical analysis and once for bacteriological analysis (Appendix III-I). At the time of sampling, December 1990, the creek was severely polluted with sanitary sewage. The elevated fecal coliform concentration (1,400,000 organisms per 100 ml) can be attributed to the source of sanitary sewage under Lee Road and a rupture in the Mill Creek Interceptor north of Longbrook Road. These sources are discussed in detail later in the report.

Chemical analysis of the samples obtained at Site #34 in 1990 indicated that all parameters were within Ohio EPA criteria for Warmwater Habitat. Similar results had been obtained at this location in previous years' sampling.

Qualitative sampling for benthic macroinvertebrates was not performed at Site #34 in 1990.

SITE #35

Site #35 is located on Mill Creek approximately 100 feet upstream of Northfield Road in Warrensville Township. The creek at this point is about 15 feet wide and averages about 2 inches deep during dry weather. The substrate consisted primarily of cobble and sand. The creek was surrounded by dense vegetation and many overhanging trees. The appearance of the water has been 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.

Two grab samples for chemical and bacteriological analyses were obtained at Site #35 in 1989 (Appendix II-H). The fecal coliform concentrations of 380 and 50 organisms per 100 ml on June 27 and September 19, respectively, were well below the Ohio EPA water quality criterion for Primary Contact Recreational Use and were both lower than concentrations at any other site on the main stem of Mill Creek. The low fecal coliform/fecal streptococcus ratio of 0.4 on September 19 suggests that the minimal remaining bacterial contamination was primarily of non-human origin, as had been the case in 1988 at Site #35.

In 1989, the chemical data showed that two parameters, cadmium and mercury, exceeded the Warmwater Habitat criteria. Cadmium was measured at 0.02 mg/L on September 19. Mercury was measured at 0.3 ug/L on June 27 and 0.2 ug/L on September 19. All other chemical data for 1989 at Site #35 were within the numerical criteria for Warmwater Habitat.

Qualitative sampling for benthic macroinvertebrates in 1989 at Site #35 produced twelve taxa (Appendix VIII-R). Of these, the majority are described as facultative in their responses to organic pollution. This was an increase from the five taxa identified in 1988, but the increase may be partially attributable to the further development of taxonomic identification skills by NEORSD investigators. The findings suggest that this section of Mill Creek was relatively unpolluted by sanitary sewage in 1989.

In 1990, Site #35 was sampled twice for chemical analysis and once for bacteriological analysis (Appendix III-I). The fecal coliform concentration (720 organisms per 100 ml) was below the Ohio EPA water quality criterion for Primary Contact Recreational Use and was comparable to bacteriological sampling data from this site in 1989.

At Site #35 in 1990, all chemical concentrations measured were lower than Ohio EPA criteria for Warmwater Habitat, with the exception of mercury, which was measured at 0.2 ug/L on September 6. Similar results had been obtained during the previous years' sampling.

Qualitative sampling for benthic macroinvertebrates in 1990 at Site #35 produced ten taxa (Appendix IX-I). Comparable results had been obtained in 1989. These findings suggest that the water quality of Mill Creek at Site #35 was relatively good in 1990.

In addition to the above dry weather sampling of Mill Creek, during 1990 samples were collected and flow measurements were obtained from three sites on Mill Creek and from five storm sewers and eight combined sewer overflows tributary to the creek during eight rain events. The purpose of this wet weather study was to conduct a comparison of storm event impacts on the creek's water quality from various sources. The results of this comparison are presented in Appendix XX.

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 sewage overflow to the "Mapletown Branch" of Mill Creek occurring west of Mapletown Shopping Center in Maple Heights. The total daily loadings of BOD and suspended solids from these two sources were calculated to be 3,300 pounds and 3,000 pounds, respectively.

After the Cuyahoga County Sanitary Engineering Department was notified, contractors replaced 600 feet of the Mill Creek Interceptor, eliminating this source of sanitary sewage contamination in the creek by September 1987. At that time, the most significant remaining dry weather source of pollution on Mill Creek was the problem behind Mapletown Shopping Center. The flow of sewage entering the creek from this source had been measured at approximately 1.8 million gallons per day, and fecal coliform concentrations in this influent had been as high as 7,100,000 organisms per 100 ml. It was determined that 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 dry weather overflow of sanitary sewage to a 90-inch storm sewer tributary to the creek. These conditions are believed to have existed for at least twelve years prior to the NEORSD investigation. Following a meeting with representatives from the Ohio EPA and the NEORSD in September 1988, the City of Maple Heights repaired the "regulator chamber" and leaks in the 24-inch sanitary sewer on Broadway Avenue. As a result, this major source of pollution in Mill Creek has been eliminated. Subsequent inspections of the "Mapletown Branch" in 1988 and 1989 have revealed that the sewer system in the vicinity of Mapletown Shopping Center has been functioning as designed. This fact is supported by the dramatic improvements in water quality indicated by bacteriological and benthic data at Site #31 and #33.5, previously discussed in this report.

Other environmental problems discussed in the NEORSD Greater Cleveland Area Stream Monitoring 1987 and 1988 Reports had remedial action taken on them in 1989 and 1990. Still other problems were discovered on Mill Creek in 1989 and 1990. Following is a discussion of recently remediated and continuing sources of pollution in Mill Creek, including two major dry weather sources of sanitary sewage in Mill Creek which had severely degraded the stream's water quality and were discovered during the 1990 surveys.

On June 13, 1990, NEORSD investigators discovered a rupture in the Mill Creek Interceptor underneath Mill Creek between Longbrook Road and Emery Road. The break occurred approximately 30 feet south of the location of the 1987 interceptor repair. The flow of sewage entering the creek from this source was measured at approximately 1.9 million gallons per day. The daily BOD and suspended solids loadings were calculated to be 3,800 pounds and 2,300 pounds respectively.

The Cuyahoga County Sanitary Engineering Department was notified of the problem and, on June 15, a sandbag dam was constructed under Miles Road in an effort to contain the sewage. The water behind the dam was pumped into a sanitary sewer until June 23, when heavy rains washed out the dam. By July 1990, 700 feet of the Mill Creek Interceptor had been replaced, thereby eliminating this source of sanitary sewage contamination in the creek.

-2-

A second rupture in the Mill Creek Interceptor was discovered by NEORSD investigators, in December 1990. This rupture occurred underneath Mill Creek north of Longbrook Road, between Brentwood Hospital and Meridia Suburban Hospital. At that time, the problem was reported to Cuyahoga County officials. According to the officials, the Cuyahoga County Sanitary Engineering Department has scheduled replacement of the Mill Creek Interceptor from Longbrook Road north to Warrensville Center Road to provide permanent remediation of the interceptor rupture problems.

-3-

A problem in Garfield Heights which had been discussed in the NEORSD Stream Monitoring 1987 and 1988 Reports was eliminated in 1989. Sanitary sewage from residences at the west ends of Grand Division Avenue, Bancroft Avenue, and Rosewood Avenue had been discharged into the storm sewer. As a result, the sanitary sewage had been pooling at the outlet of the storm sewer west of Bancroft Avenue. The pool's effluent had flowed westward across the Harvard Refuse Landfill to the main stem of Mill Creek. In 1989, the City of Garfield Heights installed sewage lift stations in several homes on the afore-mentioned streets to pump the sanitary wastewater to the sanitary sewer east of this location. Alarms were also installed in the homes' basements to notify residents of pump failure. An inspection by NEORSD investigators on September 6, 1989 revealed that sanitary sewage had ceased to be tributary to Mill Creek through the storm sewer at the west end of Bancroft Avenue during dry weather.

-4-

Another problem in Garfield Heights which had been identified as a source of pollution in Mill Creek in previous reports was found to be no longer contributing dry weather contamination in 1989 and 1990. An overflow structure located at a pair of manholes by the entrance to Vista Park west of Warner Road had been found to have a dry weather overflow to a culvert tributary to Mill Creek in 1988. The City of Garfield Heights

Service Department was notified and removed debris which had been partially blocking the structure's sanitary outlet. Subsequent inspections by NEORSD investigators in 1988 and throughout 1989 and 1990 revealed that this overflow had ceased occurring in dry weather conditions. Reductions in bacterial contamination at Site #32, as previously discussed in this report, are evidence of this remediation.

However, despite the improvements in bacteriological data at Site #32 in 1989, the chemical data indicated that water quality degradation continued in this tributary to Mill Creek. High pH's, low dissolved oxygen concentrations, and a noted accumulation of light green-colored solids in the sediment suggested that contamination from an industrial source was occurring. On September 6, 1989, a dry weather influent to the tributary was found at a storm sewer outfall from the north under Warner Road. The flow was measured at 50 gallons per minute, and analysis of the discharge revealed a pH of 12.4, alkalinity of 2,800 mg/L, chloride concentration of 810 mg/L, sulfate concentration of 394 mg/L, suspended solids concentration of 28 mg/L, and chemical oxygen demand of 57 mg/L. On September 11, 1989, NEORSD investigators performed dye tests and identified the source of this flow as Ohio Aluminum Industries Inc., 4840 Warner Road. In addition to non-contact cooling water, this company was discharging to the storm sewer sulfur dioxide fume scrubber water. This water's pH was being adjusted with caustic soda, accounting for the high pH measurements in the outfall under Warner Road and in the tributary to Mill Creek downstream. Also noted at the company was the presence of sand which resembled in appearance the solids in the sediment at Site #32.

The Ohio EPA was notified of the source of the contamination and, on September 19, 1989, required that Ohio Aluminum Industries Inc. immediately cease the discharge of scrubber water to the storm sewer. On November 13, 1989, NEORSD investigators verified that the scrubber system discharge had been rerouted to the sanitary sewer. However, boiler blow-down and compressor condensate water continued to be discharged to the storm sewer through a sand removal pit, which had been contaminated by scrubber water. Consequently, contamination of the creek by scrubber water was continuing and, therefore, company officials agreed to have this water also rerouted to the sanitary sewer. In March 1990, NEORSD investigators verified that the scrubber water discharges to the sanitary sewer and this source of industrial wastewater to the storm sewer has been eliminated.

-5-

In 1989, several modifications were made to the sewer system by the City of Garfield Heights, which resulted in reduction of the sanitary sewage contamination of Wolf Creek. In April 1989, the heights of weir structures were increased at East 115th Street, East 117th Street, and East 119th Street to retain more flow in the sanitary sewers and reduce the flow entering the storm sewers during rain events. In May 1989, the combined sanitary sewer and storm sewer systems were separated at East 120th Street and Tonsing Avenue. Finally, in November 1989, a sanitary sewer line was replaced in the vicinity of Marymount Hospital between Granger Road and Wallingsford Avenue. An improvement in water quality was apparent in the bacteriological data from Site #33 in 1989; however, numerous sources of pollution in Wolf Creek remain, resulting in continuing elevated fecal coliform concentrations.

-6-

In June 1990, NEORSD investigators attempted to trace back the source of dry weather flow entering Wolf Creek from a storm sewer outfall at East 117th Street and Edgepark Drive. The investigation revealed that the flow was from several sources in the sewer system. To determine where sanitary sewage was entering the storm sewers, bacteriological samples were taken at various locations in the storm sewer tributary to the discharge at East 117th Street and Edgepark Drive. Results of the analyses revealed fecal coliform concentrations as high as 860,000 organisms per 100 ml and showed that the contamination by sanitary sewage was from several directions throughout the sewer system. The sources may be improper connections of residential/commercial sanitary discharges to the storm sewers and/or exfiltration/infiltration from the sanitary sewers to the storm sewers through structural leaks.

-7-

Another source of pollution in Mill Creek was an unpermitted industrial discharge to the creek between Miles Avenue and South Miles Road from the Empire Die Casting Company, 19800 Miles Avenue, which had been discovered by NEORSD investigators in March 1987. The discharge was reported to the Ohio EPA, which sent an investigator to inspect the facility in April 1987. As a result of this inspection, the Empire Die Casting Company was required by the Ohio EPA to either acquire a NPDES permit for the direct discharge to the environment or to have it eliminated. A compliance deadline of September 1, 1987 was set. However, as of the writing of the NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report, all subsequent inspections by NEORSD investigators had indicated that this discharge to the creek was continuing unabated. Although the discharge was flowing through an underground oil separator, the proper function of which depends upon regular maintenance, all soluble contaminants, such as phenolics, continued to pass through the separator to the creek. On February 21, 1989, the NEORSD again notified the Ohio EPA of the status of the discharge from the Empire Die Casting Company.

On July 17, 1989, an Ohio EPA crew responded to a spill of oil in Mill Creek. The source of this spill was identified as the Empire Die Casting Company. The investigation revealed that a leak in the company's recirculation plumbing had resulted in an overloading of the underground oil separator. At least 2,000 gallons of fuel oil had been spilled, and the Empire Die Casting Company assumed liability for the clean-up of the spill.

On November 29, 1989, the Ohio EPA issued a permit to install an evaporator system to the Empire Die Casting Company so that the discharge to the environment could be eliminated. The evaporator system was scheduled to be "on-line" by December 15, 1989. On January 2, 1990, NEORSD investigators found that the evaporator system had been partially installed and was not yet in operation.

On September 21, 1990, the Ohio EPA conducted an inspection of the facility and found that all discharges to the creek had been eliminated. According to Ohio EPA records, on January 15, 1990, the company's process wastewater from the evaporation system was connected to the sanitary sewer, and, on June 14, 1990, the company's cooling water was diverted to the sanitary sewer. An inspection of the Empire Die Casting Company by NEORSD investigators in October 1990 verified that this industrial discharge is no longer tributary to Mill Creek.

-8-

Another source of industrial wastewater in Mill Creek was found in Warrensville Heights by NEORSD investigators. On May 7, 1990, NEORSD investigators responded to a report by construction workers of an unusual color in Mill Creek under the Miles Avenue bridge. The investigators found a milky-white substance entering the creek through a storm sewer on Miles Avenue. This discharge had been initially discovered by NEORSD investigators on August 22, 1989 and had been found to contain high concentrations of suspended solids. The probable source of this contamination was identified as O'Brien Cut Stone Company, 19100 Miles Avenue, which uses water on a saw blade as stone is cut. O'Brien Cut Stone Company has a NPDES Permit for its discharge to Mill Creek with a daily suspended solids limitation of 45 milligrams per liter. The suspended solids concentration as it entered the creek on August 22 was found by NEORSD sampling to be 485 milligrams per liter. The high concentration was attributed to the company's failure to maintain a solids settling pit. These findings were reported to the Ohio EPA in October 1989.

On May 7 and May 8, 1990, NEORSD investigators performed another sampling of the discharge to Mill Creek from the O'Brien Cut Stone Company and found suspended solids concentrations of 12,600 milligrams per liter and 17,600 milligrams per liter, respectively. Again the discharge was reported to the Ohio EPA, who sent an investigator to inspect the facility on July 5, 1990. As a result of this inspection, the O'Brien Cut Stone Company was required by the Ohio EPA to have the discharge eliminated from the environment no later than March 1, 1991. Future inspections at this location on Mill Creek should reflect improvements in water quality resulting from this remediation.

-9-

On November 1, 1989, NEORSD investigators provided assistance to an Ohio EPA crew attempting to locate the source of a brown oil in a tributary to Mill Creek west of Johnston Parkway north of McCracken Road and at Orchard Road south of Ohio Avenue. The investigation revealed that the source of the oil was the Erieview Heat Treating Company located in the Cleveland Industrial Square, 4500 Lee Road. Agitation in the company's waste cooling water/oil separator had apparently been responsible for the pass-through of quench oil to the sewer. Dye tests showed that, in addition to this sewer at Erieview Heat Treating Company, sanitary facilities at several other companies in the Cleveland Industrial Square, 4500 Lee Road, had been improperly connected to the storm sewer westbound on Seville Road and ultimately tributary to the creek. Erieview Heat Treating Company assumed responsibility for the spill and provided clean-up of the oil. Ohio EPA contacted the landlord of Cleveland Industrial Square to require reconnection of the companies' sewers to the sanitary sewer system. As of the date of this report, no remediation of this problem had yet occurred. Future inspections will be performed to verify the elimination of this source of pollution in Mill Creek.

-10-

Also in the vicinity of Johnston Parkway, on April 9, 1990, NEORSD investigators responded to a complaint of an oil-like substance in a tributary to Mill Creek at East 143rd Street and Saybrook Avenue. The substance was identified as heat-treat quench oil and its source was determined to be SPS Technologies, Inc., 4444 Lee Road. The quench oil entered the creek from the company's property via a storm sewer east of Alonzo Avenue and East 158th Street. A large volume of oil had spilled onto a company floor from the quench oil tanks and exited to the storm sewer through the floor drains. These findings were reported to the Ohio EPA, and SPS Technologies, Inc. assumed responsibility for the spill and provided clean-up of the oil. The company has implemented spill prevention procedures to avoid recurrences of this environmental disruption. Subsequent investigations by NEORSD investigators revealed that this pollution of Mill Creek had ceased by September 11, 1990.

-11-

Contributing to the continuing relatively high bacterial contamination at Site #34 was a recurrence of a dry weather sanitary sewage influent to Mill Creek under Lee Road. In June 1988, NEORSD investigators had first discovered the sanitary sewage entering the creek through a storm sewer outfall from the south, and it was traced back to Raymond Street, between Theodore Street and Anthony Street in Maple Heights. A blockage of the sanitary sewer at this location had been resulting in leakage of the sewage into the storm sewer. The City of

Maple Heights Service Department was notified and immediately removed the blockage, eliminating the influent under Lee Road.

However, on July 24, 1989, NEORSD investigators found the influent recurring and again traced its source to Raymond Street. Notification of the City of Maple Heights Service Department again resulted in correction of the problem by removal of the Raymond Street sanitary sewer blockage.

On December 7, 1990, a third occurrence of a blockage in the Raymond Street sanitary sewer was discovered by NEORSD investigators, again resulting in sewage entering Mill Creek under Lee Road. The City of Maple Heights Service Department was notified of this problem, and subsequent inspections by NEORSD investigators indicated no further pollution from this source, but the recurring nature of the problem warrants continued monitoring of this location.

-12-

Another recurrence of a dry weather sanitary sewage influent to Mill Creek, upstream of Site #34, contributed to the continuing bacterial contamination at this location in 1989. In March 1987, NEORSD investigators had first discovered an underground rupture of an 8-inch sanitary sewer between Mill Creek and the intersection of Mayfair Lane and Eastwood Lane in Warrensville Heights. The Cuyahoga County Sanitary Engineering Department was notified of this problem and repaired the leak. In July 1988, the 8-inch sanitary sewer was again found to be ruptured and leaking at Mill Creek east of Mayfair Lane and Eastwood Lane, and once again it was repaired by the Cuyahoga County Sanitary Engineering Department.

On July 24, 1989, NEORSD investigators found a sanitary sewer rupture at this location for the third time. The Cuyahoga County officials were contacted, and an inspection by NEORSD investigators on November 30, 1989 revealed that the sanitary sewage leak to Mill Creek had again been fixed. However, instead of exfiltration from the sanitary sewer, infiltration into the sanitary sewer from the outfall of an adjacent storm sewer was noted. The NEORSD has since been notified by the Cuyahoga County Sanitary Engineering Department that replacement of the 8-inch sanitary sewer at this location has been scheduled for January 1991.

-13-

In 1989 and 1990, remediation was made to the sewer system on Broadway Avenue in Maple Heights. According to City of Maple Heights officials, contractors replaced a section of the sanitary sewer on Broadway Avenue from the southern corporation limit of Maple Heights to Jefferson Street, in an attempt to eliminate a dry weather sanitary sewage discharge from a storm sewer into the "Mapletown Branch" of Mill Creek. Construction was reportedly completed in October 1990. This sewage, from a storm sewer outfall west of the intersection of Home Avenue and Garden Street, contained the discharges of industrial facilities, including 92,000 gallons per day of process wastewater from the Metal Processing Corporation, 5800 Sterling Avenue, a steel pickling/zinc phosphating operation. Deterioration and overloading of the sewer system in this vicinity had been the cause of this dry weather flow.

Subsequent inspections by investigators in 1989 and 1990 revealed that this remediation had reduced the dry weather sanitary sewage discharge from the storm sewer near Home Avenue and Garden Street, although a dry weather flow from this storm sewer continued. Contamination by process water from Metals Processing Corporation was no longer evident. However, in July 1990, a sample from this storm sewer outfall was obtained for bacteriological analysis. The fecal coliform concentration was measured at 2,500 organisms per 100 ml, indicating that some contamination by sanitary sewage remained. Further investigation is needed to determine the source of the continuing dry weather flow.

According to officials, the City of Maple Heights plans to spend 13 million dollars over the next ten years for projects to repair and improve the sewer system in this vicinity. Hopefully, these projects will be successful in redirecting sewage presently tributary to Mill Creek to the Southerly Wastewater Treatment Plant. Future sampling on the "Mapletown Branch" at Site #33.5 should reflect the improvement in water quality resulting from this and any further remediation in this area of Maple Heights.

-14-

Over the past few years, NEORSD has responded to complaints about sewage in a branch of Mill Creek at Cranwood Park, which is west of East 131st Street near Cleveland's border with Garfield Heights. An inspection by NEORSD investigators in November 1989 revealed that the dry weather flow from the northernmost of two culverts west of East 131st Street and Cranwood Drive has been contaminated with sanitary sewage. Bacteriological analysis of this flow showed a fecal coliform concentration of 40,000 organisms per 100 ml. The results indicate that it is responsible for the bacterial contamination in the creek's branch downstream. Investigations of the culvert were performed by NEORSD personnel in an attempt to identify the source(s) of this pollution, but they were unsuccessful and further investigation is needed.

-15-

On November 15, 1989, NEORSD investigators discovered sanitary sewage entering Mill Creek at the west end of Laumar Avenue in Cleveland. An inspection revealed that when flow in the East 77th Street sanitary sewer becomes obstructed, the sewage backs up into the sanitary sewer on Laumar Avenue, west of East 77th Street. It then enters the storm sewer at the west end of Laumar Avenue which is tributary to Mill Creek. Following this discovery, the problem was reported to the City of Cleveland Division of Water Pollution Control. Subsequent inspections by NEORSD investigators revealed that the East 77th Street sanitary sewer had been unblocked and this source of pollution in Mill Creek had been eliminated.

-16-

In August 1989, investigators discovered sanitary sewage entering Mill Creek from a storm sewer on Myrtle Avenue east of Lee Road. The sanitary sewage was traced back to a storm sewer on Lee Road. Subsequent inspections in 1989 and 1990 have revealed that the flow from the storm sewer is periodically contaminated with sanitary sewage. An investigation in June 1990 revealed several possible sources of sanitary sewage to the Lee Road storm sewer, but further investigation is needed.

-17-

On May 24, 1990, a spill of spent pickle liquor at the site of Metal Processing Corporation, 5800 Sterling Avenue, contributed approximately 100 gallons of the liquid to a storm sewer which discharges into the "Mapletown Branch" of Mill Creek at an outfall just west of the intersection of Home Avenue and Garden Street. The spill was responded to by NEORSD investigators, who recorded a pH of 1.5 standard units at the storm sewer outfall. An attempt was made by company officials to neutralize the remainder of spilled acid. An inspection of the creek downstream of the storm sewer outfall by NEORSD investigators on May 25 indicated that the spill caused no discernible environmental damage to the "Mapletown Branch" of Mill Creek.

-18-

On July 16, 1990, NEORSD investigators discovered sanitary sewage entering a creek tributary to Mill Creek at East 143rd Street and Saybrook Avenue. The flow was measured at approximately 2,500 gallons per day. The sewage was traced back to Christine Avenue and East 143rd Street, where sewage was leaking into a storm sewer due to a blockage in the sanitary sewer at this point. The City of Cleveland Division of Water Pollution Control was notified of this problem on July 17. Subsequent inspections by NEORSD investigators revealed that the Christine Avenue sanitary sewer at East 143rd Street had been unblocked and this source of pollution in Mill Creek had been eliminated.

-19-

On August 22, 1990, NEORSD investigators responded to a report by a Cleveland Metroparks naturalist at the Garfield Park Nature Center of an unusual color in Mill Creek at Garfield Park. The investigators found a white substance entering the creek through a storm sewer on Chaincraft Road. The source of this contamination was identified as the Collinwood

Cement Company, 12400 Broadway Avenue. An inspection by NEORSD investigators revealed that the company's failure to maintain a solids settling pit resulted in the overflow to a storm sewer of washwater which had been used to rinse out cement trucks. Company officials were informed of the necessity of maintaining the settling pit to prevent further such discharges to Mill Creek. Subsequent inspections by NEORSD investigators revealed that this source of industrial wastewater to the storm sewer had been eliminated.

-20-

On September 6, 1990, NEORSD investigators discovered a dry weather flow containing sanitary sewage entering Mill Creek from a storm sewer under Broadway Avenue in Maple Heights at a rate of approximately 32,000 gallons per day. However, as of the date of this report, the discharge to Mill Creek continues and NEORSD investigations are planned to attempt to identify its source.

-21-

During 1990, a partial blockage of the outlet of the Mill Creek stormwater detention basin north of Interstate 480 and east of Kerruish Park was resulting in continuous flooding of the basin. The blockage was reported to City of Cleveland officials on June 8, 1990. By June 12, an emergency contract had been requested to clear the basin's outlet. An inspection by NEORSD investigators on July 13 revealed that debris and sediments had been removed from the outlet by the City of Cleveland contractor. The detention basin's water level had then declined and the basin appeared to be functioning properly. Several of the previously discussed environmental disruptions had been tributary to the basin during this period, and therefore any interpretation of downstream water quality data from Mill Creek during this period should take influence by the basin outlet blockage into account.

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 stem, 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, joining the main stem through a culvert under Interstate 480, west of the Interstate 77 interchange. From this confluence, West Creek flows north to the Cuyahoga River upstream of the Southerly WWTP chlorine-access railroad bridge (RM 11.3).

West Creek's total flow was measured near Site #36, about 200 feet upstream of the confluence with the Cuyahoga River, during dry weather on October 25, 1989 and was found to be approximately 1.8 million gallons per day (MGD).

Most of West Creek is open and its substrate is predominately natural. Along Interstate 480, the main stem has a short section of channelization with concrete beds and sidewalks. Between Keynote Drive and Lancaster Drive in Brooklyn Heights, the stream has been re-routed to the northwest, with gabions installed on the banks to allow for construction of a new commercial/industrial park.

West Creek's drainage area is largely residential. The creek has been designated Warmwater Habitat and Primary Contact Recreational Use by the Ohio EPA.

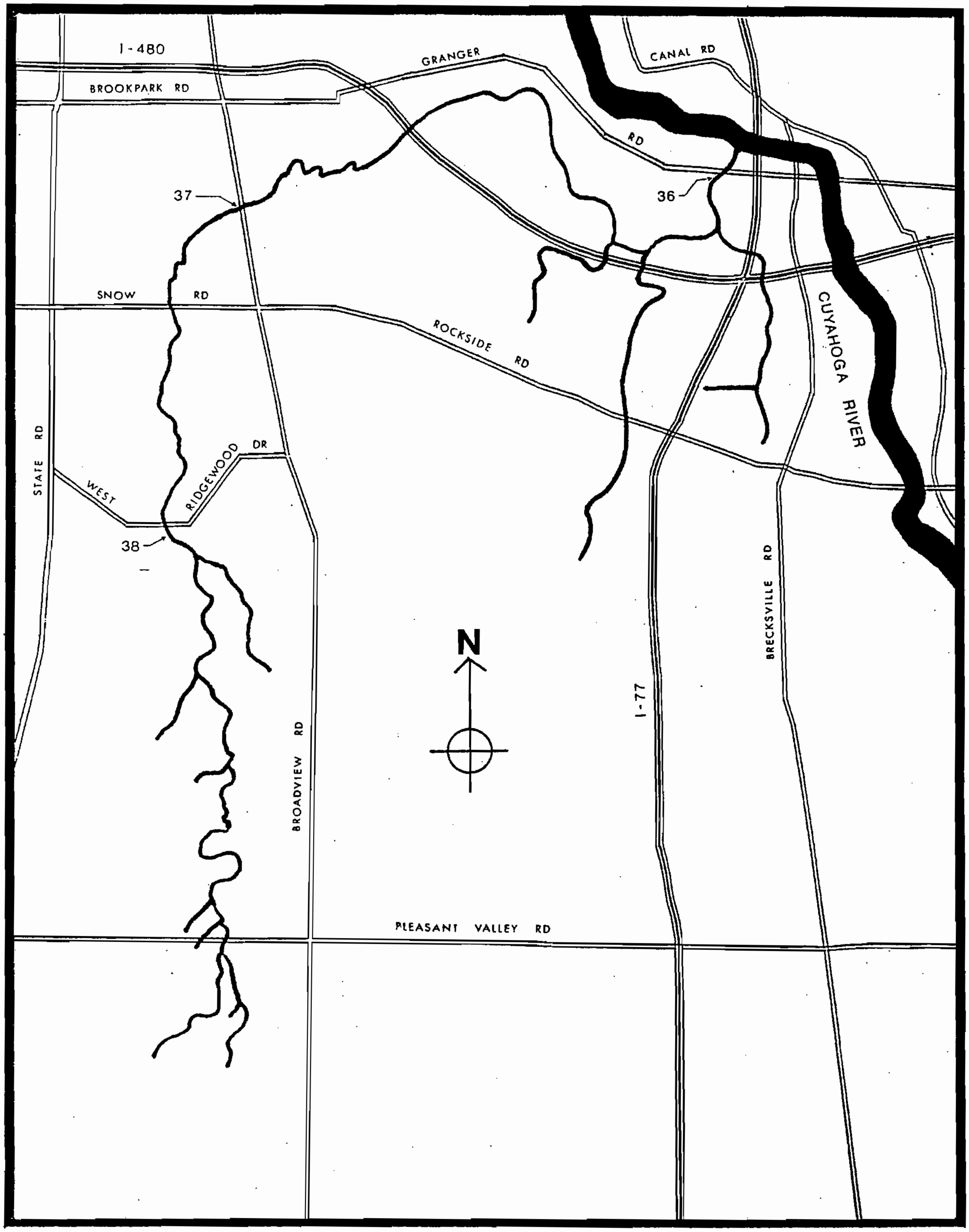
SAMPLING

The NEORSD has selected three locations on West Creek for routine chemical, bacteriological, and benthic sampling and analysis (Figure 17).

Site #36

Site #36 (Figure 17) is located on the main stem under the Granger Road bridge, between Interstate 77 and Valley Belt Road, approximately 1,000 feet upstream of the confluence with the Cuyahoga River. This location's substrate consists primarily of bedrock, cobble, rubble, silt, and gravel. The creek is about 16 feet wide at this location.

Site #36 was sampled once in 1989 for chemical analysis, on October 25 (Appendix II-I). The chemical data were within the Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. 1989 mercury concentration was less than 0.2 ug/L, and the 1987 mercury concentration of 36 ug/L at this site remains unexplained. Except for mercury, these results are similar to those obtained in previous years.



West Creek
(NOT TO SCALE)

Figure 17

Site #36 was sampled once in 1989 for bacteriological analysis, on October 25 (Appendix II-I). The fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. The data are comparable to bacteriological results obtained in previous years.

Qualitative benthic macroinvertebrate samples were obtained from West Creek at Site #36 on June 30, 1989 (Appendix VIII-S). Eight taxa were collected, most of which are described in literature as tolerant of organic pollution. These results are similar to those obtained at this location in previous years' macroinvertebrate sampling.

Site #36 was sampled twice in 1990 for chemical analysis (Appendix III-J). All of the chemical parameters, with the exception of iron, were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat. The iron concentration (2.2 mg/L) measured on March 16 exceeded the numerical criterion of 1.0 mg/L. An elevated chloride concentration (351 mg/L) was noted on March 16 and is attributed to roadsalt run-off from snowmelt. The 1990 mercury concentrations were less than 0.2 ug/L.

Site #36 was sampled once in 1990 for bacteriological analysis, on August 1 (Appendix III-J). The fecal coliform concentration (10 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. This is comparable to results obtained in previous years.

Qualitative benthic macroinvertebrate samples were obtained at Site #36 in 1990 on November 1 (Appendix IX-J). Four taxa were collected and identified. The sample contained only oligochaetes and three species of midges. Most of the taxa collected are described in literature as tolerant of organic pollution. These data indicate a decrease in the number of benthic macroinvertebrate taxa found at Site #36 when compared to the number of taxa collected in 1988 (nine taxa) and 1989 (eight taxa). In part, seasonal variability in macroinvertebrate populations may be responsible for the lower divesity. Also, various nonpoint and point sources may have impacted the water quality at this location. Potential sources of environmental stress will be discussed later in the report.

Site #37

Site #37 (Figure 17) is located on the main stem 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, cobble, gravel and rubble. The section under the bridge has 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. In 1989, dry weather flow in the creek at Site #37 was measured at approximately 1.4 MGD. Many minnows have been noted at this location.

Site #37 was grab sampled once in 1989 for chemical analysis, on October 25 (Appendix II-I). All of the chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. These data are comparable to results obtained in previous years.

Site #37 was grab sampled once in 1989 for bacteriological analysis, on October 25 (Appendix II-I). The fecal coliform concentration (20 organisms per 100 ml), was well below the Ohio EPA criterion for Primary Contract Recreational Use. This is comparable to data obtained in previous years.

Qualitative benthic macroinvertebrate sampling was conducted once in 1989 at Site #37, on July 7 (Appendix VIII-T). There were 15 taxa collected and identified. This was an increase from 11 taxa collected in 1988. The number of midge taxa were greater in 1989 because of improved taxonomic identification skills. However, in 1989, three caddisfly taxa were collected (*Hydroptila* sp., *Hydropsyche betteni*, *Symphitopsyche slossonae*) which had not been found in 1988. All of these caddisflies are described in literature as facultative in their responses to organic pollution. The majority of taxa collected in 1989 are described in literature as facultative in their responses to organic pollution.

The chemical, bacteriological, and benthic data indicate that West Creek at Site #37 has been relatively free from contamination by sanitary sewage in dry weather.

Site #37 was grab sampled once in 1990 for chemical analysis, on August 1 (Appendix III-J). All chemical data were within the Water Quality Standards for Warmwater Habitat. These data are comparable to results obtained in previous years.

Site #37 was grab sampled once in 1990 for bacteriological analysis, on August 1 (Appendix III-J). The fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. The results are comparable to those of previous years.

No qualitative sampling for benthic macroinvertebrates was conducted at Site #37 in 1990.

Site #38

Site #38 (Figure 17) is located on the main stem 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 extensive vegetation with many trees on the other bank. The substrate consists of rubble, shale, gravel, and silt, with a concrete embankment to prevent erosion. The creek's width at Site #38 is about 9 feet with an average depth of 6 inches. On October 25, 1989, a dry weather flow in the creek of approximately 0.6 MGD was measured. Many minnows have been noted at this site.

Site #38 was sampled once in 1989 for chemical analysis, on October 25 (Appendix II-I). All of the chemical data were within the Water Quality Standards for Warmwater Habitat. These results are similar to the results obtained in previous years.

Site #38 was sampled once in 1989 for bacteriological analysis, on October 25 (Appendix II-I). The fecal coliform concentration (20 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. These bacteriological results are similar to the results obtained in previous years.

Qualitative sampling of benthic macroinvertebrates was conducted at Site #38 on July 7, 1989, and 18 taxa were collected and identified (Appendix VIII-U). This was an increase from eight taxa collected in 1988. The increase is due in part to improved taxonomic identification skills. However, in 1989, there were two taxa of dragonflies collected (Lanthus sp. and Somatochlora sp.) which had not been found in 1988. Somatochlora sp. is described in literature as intolerant in its response to organic pollution. In total, the benthic community consisted predominantly of facultative organisms, with one intolerant taxon and six tolerant taxa. The diversity and presence of facultative and intolerant taxa indicate that this location on West Creek has good water quality.

Site #38 was grab sampled once in 1990 for chemical analysis, on August 1 (Appendix III-J). An exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.4 ug/L). All other chemical data were within the Water Quality Standards for Warmwater Habitat. These results are similar to those obtained in previous years.

Site #38 was sampled once in 1990 for bacteriological analysis, on August 1 (Appendix III-J). The fecal coliform concentration (less than 10 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. These data are comparable to results obtained in previous years.

No benthic sampling was conducted at Site #38 in 1990.

PROBLEMS AND REMEDIATION

-1-

On July 18, 1988, NEORSD investigators had 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 24,000 gallons per day under dry weather conditions. Bacteriological analysis of this discharge had shown a fecal coliform concentration of 44,000 organisms per 100 ml.

It was noted that, on October 25, 1989, this sanitary sewage continued to flow to the creek at this location. However, measurement indicated that the flow rate was 1,800 gallons per day under dry weather conditions, which was considerably lower than had been measured in 1988. The City of Parma informed NEORSD investigators that a water line break at 1700 North Avenue, entering the storm sewer tributary to this outfall, had been discovered and repaired by the City of Cleveland Water Department in April 1989. The discharge was continuing at the same rate (1,800 gallons per day) when the outfall was investigated on June 6, 1990. It has been reported to the City of Parma and is to be investigated further.

-2-

There was another environmental disturbance in this tributary to West Creek, east of 5245 West 10th Street, reported on June 6, 1990. A red color was reported by a resident who lives near the creek. An investigation by NEORSD investigators found that the color was caused by run-off from a large pile of red-orange mud behind the J. R. Goslee Co., located at 1570 Brookpark Road. There was a large puddle around the pile that was being drained by a trench to a storm sewer which is tributary to West Creek, east of West 10th Street. The mud, originally from a riverbed in Missouri, is used in aluminum slag processing and reclamation. A grab sample of the red-orange colored water was collected that day. The analysis showed elevated concentrations of iron (440 mg/L), aluminum (107 mg/L), zinc (0.61 mg/L), and copper (0.50 mg/L). The pile is now usually covered, and run-off from the pile no longer enters the storm sewer. A follow-up investigation is planned.

-3-

The city water leak to West Creek west of Broadview Road, which was discussed in the NEORSD Stream Monitoring Program 1987 and 1988 Reports, continued to occur throughout 1989 and 1990 at a calculated rate of 100,000 gallons per day. The City of Cleveland Water Department was notified numerous times during the years and assured the NEORSD that this situation will be investigated. Until the source is eliminated, the discharge will continue to have a dilutive impact on chemical and bacteriological data obtained at Site #37.

-4-

At Site #37, on October 25, 1989, a flow from a 12-inch pipe was discovered and measured at approximately one gallon per minute. This pipe is a bypass for a pump station which services a sanitary sewer from the Broadview Nursing Home, 5520 Broadview Road. An inspection by NEORSD investigators revealed a blockage in the sanitary sewer, causing the flow to be diverted to West Creek via the bypass pipe. A grab sample was obtained that day for bacteriological analysis, which showed a fecal coliform concentration of 1,000 organisms per 100 ml in the discharge.

Broadview Nursing Home officials were notified of this problem on October 25. Subsequent inspections by NEORSD investigators have revealed that the sanitary sewer has been unblocked and this source of pollution in West Creek has been eliminated.

-5-

A second dry weather flow was discovered tributary to West Creek from a storm sewer at Site #37. The flow was traced to a cracked sanitary sewer on Broadview Road, north of West Creek, from which sewage was leaking into the storm sewer. The City of Parma was notified of the problem but verification of repairs has not yet been made.

Chemical and biological data obtained at Site #37 have shown no evidence of a water quality impact caused by the two problems identified at this location, probably because of dilution by the city water leak which is also tributary to the location.

-6-

On April 17, 1990, an investigation was conducted on West Creek at Site #37. This investigation was in response to reports of sewer odors and a green color in the creek. During the investigation, in an area 10 to 20 yards wide and 100 yards long located in the flood plain at the north bank, investigators discovered many small pools of brown water with pH's of 11 to 12 standard units. It was noted that the entire surface of the ground in this area lacked vegetation and exhibited a white crusty material. All of the trees, large and small, were dead. It was discovered that the hillside to the north, behind the Broadview Nursing Home, contained land-filled material. It was also noted that new construction at the back of the nursing home is built on fill material, with evidence of garbage bags and bottle caps partly buried in the soil. A grab sample of the brown-colored water was obtained, and the analysis showed relatively high concentrations of ammonia (46.8 mg/L), phosphorus (2.35 mg/L) and iron (4.0 mg/L). Further investigation of this area is planned.

-7-

On October 25, 1989, NEORSD investigators discovered a 4-inch pipe discharging water to West Creek, just upstream of Site #38. The pipe exits the east bank about 10 yards upstream of the West Ridgewood Drive bridge. A grab sample of the discharge was obtained. The sample had a high ammonia concentration (29.3 mg/L) but no apparent effect on the water sample obtained at Site #38, just a few yards downstream of the discharge, could be detected. A follow-up investigation into this discharge is warranted.

-8-

On May 3, 1990, NEORSD investigators responded to a report of a white-colored discharge to West Creek approximately 25 yards upstream of Granger Road. This discharge was emanating from a 24-inch storm sewer outfall located on the east bank. An average flow rate of 17,000 gallons per day was measured over a four-day period. A grab sample of this discharge was obtained and the analysis showed a high chemical oxygen demand of 1,110 mg/L. There were also high concentrations of chloride (570 mg/L), oil & grease (164 mg/L), iron (2.9 mg/L), and total dissolved solids (1,860 mg/L), and a turbidity of 525 NTU.

This discharge was traced back to a storm sewer on the property of the Teledyne Efficient Industries Mold and Die Plant, 5514 Old Brecksville Road. The water in the discharge contained oil. This company had been using a water-miscible cutting and grinding fluid, which exhibited the same odor and appearance as the grab sample collected from the 24-inch storm sewer outfall. Investigators discovered a small pipe connected to a sump pump that drains a basement area under machines which use the fluid. Dye tests demonstrated that this pipe was tributary to the storm sewer that discharges to West Creek. Recommendations were made to the company to disconnect this pipe to eliminate further contamination of the creek by oil.

On November 1, 1990 NEORSD investigators verified that these recommendations had been followed. This remediation had eliminated the milky white discharge, but the large volume of water continued flowing in the storm sewer under dry weather conditions. The flow was measured on this date at a rate of 11,000 gallons per day and was traced through the storm sewer system as far as 5530 Old Brecksville Road. The flow may be attributable to a city water main leak. Further investigation would be necessary to confirm this hypothesis.

-9-

The lack of benthic diversity noted at Site #36 in 1990 can be attributed to a high amount of silt covering the substrate in this section of West Creek.

The close proximity of Interstate 480, which is upstream of Site #36, may contribute to the silt accumulation during rain events when road run-off is tributary to the creek.

A landfill is located along Interstate 480 east of Lancaster Drive. The creek flows along the south side of the landfill. During an investigation of this section of West Creek, barren ground, which has the potential for erosion during rain events, was noted around the landfill. Pieces of sheet plastic (i.e., bags, wrapping) have been noted along the creek in the area of the landfill.

Downstream of the landfill, property on the east bank of West Creek is owned by Great Lakes Construction, 6600 East Schaaf Road, and property on the west bank is owned by Independence Excavating, 5720 East Schaaf Road. Barren ground, machinery and construction materials may be responsible for silt and other substances entering the creek from these properties during rain events.

In previous years, minor spills to the creek of oil and diesel fuel by these companies have been discovered by NEORSD investigators. Company officials have responded by taking action to minimize these occurances.

-10-

On March 3, 1989, NEORSD investigators discovered diesel fuel entering West Creek from a storm sewer outfall at Schaaf Road, just upstream of Site #36. The fuel was traced back to C & K Industrial Services, Inc., 5617 Schaaf Road. On March 2, an accidental spill of a quantity between 500 and 1,200 gallons had occurred when a dispensing nozzle was left engaged overnight. The company was responsible for the subsequent clean-up of the spill, which had entered West Creek and the Cuyahoga River. This clean-up was monitored by the U.S. Coast Guard and the Ohio EPA.

-11-

On May 1, 1990, NEORSD investigators responded to a report of an orange-colored material emanating from the ground during rain events and entering a catch basin which is connected to a storm sewer tributary to West Creek. This material was reported to be coming from a two-inch hole between 894 Marcie Drive and 893 Sheryl Drive. At the time of the investigation a dried deposit was noted on the ground around the hole, and a sample of this material was obtained. The analysis revealed high concentrations of nickel (40.0 mg/L), copper (40.0 mg/L), zinc (360 mg/L), iron (46,000 mg/L), and lead (80 mg/L). Since this is an intermittent flow which occurs during rain events, the orange deposits may be leachate from fill material used in this area. Further investigation would be required to confirm this hypothesis.

TINKERS CREEK

Tinkers Creek enters the Cuyahoga River at River Mile 17.0, south of Tinkers Creek Road in the Cuyahoga Valley National Recreation Area. Tinkers Creek is the largest tributary to the Cuyahoga River with a drainage area of 96 square miles.

A northern run of Tinkers Creek originates in Warrensville Heights and flows south through Orange Township and into the City of Solon. In Solon, the run turns westward south of Solon Road and continues flowing west through Oakwood and into Bedford Heights. A southern run begins in Reminderville in Summit County. This run flows south into Twinsburg and then turns northwest and flows into Glenwillow. The run continues northwest through Oakwood and into Bedford Heights where it merges with the northern run. This confluence is in the Cleveland Metroparks Hawthorne Parkway, south of Solon Road.

The creek then flows northwest out of Bedford Heights and into Bedford. In the Cleveland Metropark Bedford Reservation, a southern run, originating from tributaries in Oakwood and Walton Hills, merges with Tinkers Creek north of Gorge Parkway. From Bedford the creek turns west and flows through Walton Hills, finally entering the Cuyahoga River in Valley View.

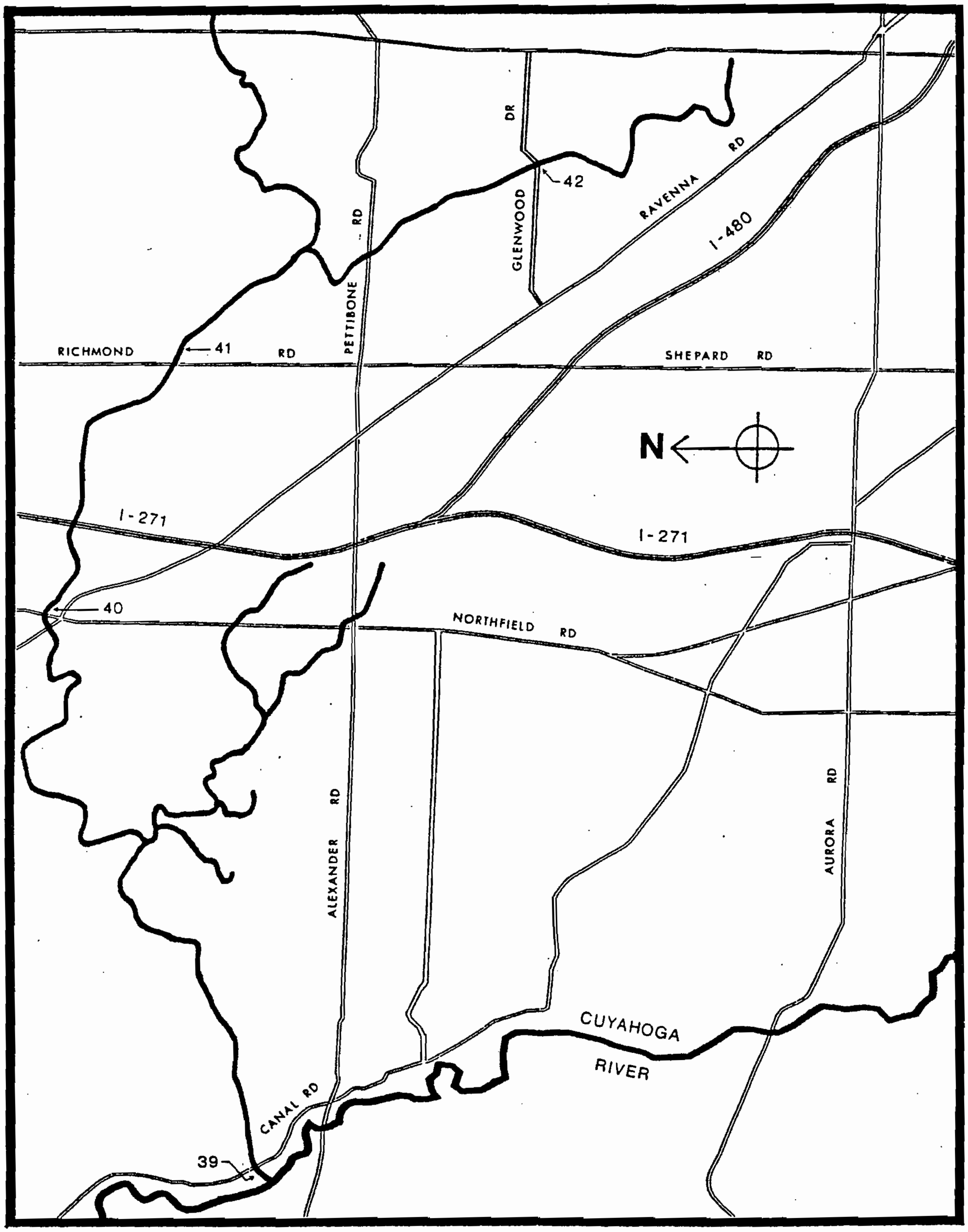
The Tinkers Creek drainage area is primarily residential and recreational, with some industry and agriculture. The Ohio EPA has designated the creek Warmwater Habitat and Primary Contact Recreational Use. NEORSD flow measurements in 1988, a drought year, produced a measured discharge of 1.5 million gallons per day upstream of the creek's confluence with the Cuyahoga River.

SAMPLING

Tinkers Creek has been assigned four sites for routine chemical, bacteriological, and benthic sampling by the NEORSD (Figure 18).

Site #39

Site #39 (Figure 18) is located on Tinkers Creek approximately 500 feet upstream from the confluence of Tinkers Creek with the Cuyahoga River. This sample site is south of the intersection of Canal Road and Tinkers Creek Road. Sampling is performed downstream of the west face of the Ohio Canal viaduct over the creek. The creek width at this section varies from 33 feet to 65 feet. The substrate at Site #39 consists mostly of cobble, rubble and gravel with some sandy areas. The stream bed lies approximately 10 feet below the top of the bank. The banks are relatively steep with some tree overhang. Ground vegetation is limited to the tops of the banks.



Tinkers Creek
(NOT TO SCALE)

Figure 18

Site #39 was sampled on three occasions for chemical and bacteriological analysis in 1989 (Appendix II-J). Two chemical parameters, iron and mercury, exhibited slight exceedances of Ohio EPA water quality criteria. On September 20, iron was measured at 1.1 mg/L, compared to the 1.0 mg/L criterion. An exceedance of the Ohio EPA water quality criterion for mercury (0.2 ug/L) was also noted, on August 10. All other chemical data were within Water Quality Standards for Warmwater Habitat. The chemical data from Site #39 were comparable to data obtained in previous years' sampling at this location.

A single exceedance of the bacteriological criterion for fecal coliform was observed at Site #39 in 1989 (Appendix II-J). On September 20, fecal coliform was measured at 3,400 organisms per 100 ml, compared to the Ohio EPA criterion for Primary Contact Recreational Use of 2,000 organisms per 100 ml. The other bacteriological samples from Site #39 in 1989 had fecal coliform levels (380 and 1,500 organisms per 100 ml) below the numerical criterion for Primary Contact Recreational Use. These levels were comparable to previous years' sampling results.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #39 in 1989 and a total of 26 taxa were collected (Appendix VIII-V). This was a considerable increase from the eight taxa collected in 1988 and 13 taxa collected in 1987. However, the increase in taxa identified is attributable to improved taxonomic skills. Most organisms identified are described in literature as either tolerant or facultative in their responses to organic pollution. One intolerant taxon, Symphitopsyche sparna of the order Trichoptera, was also identified. The diversity of organisms indicates good water quality at Site #39 in 1989.

In 1990, Site #39 (Appendix III-K) was sampled twice for chemical analysis and once for bacteriological analysis. One parameter had a single exceedance of its criterion. Iron was measured at 1.4 mg/L on March 15. All other chemical data for 1990 at Site #39 were within Warmwater Habitat Criteria and were similar to data obtained in previous years.

On June 18, 1990, a grab sample was obtained approximately 200 feet upstream of Site #39 for chemical analysis. This sample was used to evaluate the influence that water leaking into the creek from the Ohio Canal viaduct may have on the water quality at Site #39. All chemical data indicate that the leaking water had no significant impact on the water quality at Site #39.

Bacteriological sampling of Site #39 in 1990 showed no exceedances of criteria for Primary Contact Recreational Use. Bacteriological concentrations were also comparable to data collected during previous years.

The increase in taxa at Site #39 noted in 1989 was also observed in the 1990 benthic macroinvertebrate sampling. 22 taxa were collected at

Site #39 in 1990 (Appendix IX-K). The taxa identified are described in literature as either tolerant or facultative in their responses to organic pollution. The diversity of organisms found in 1989 and 1990 at Site #39 is an indication of good water quality.

Site #40

Site #40 (Figure 18) is located within the Cleveland Metroparks Bedford Chagrin Parkway. Specifically, the site is located off Bedford Chagrin Parkway, northeast of Broadway Avenue and underneath the Northfield Road bridge. The width of the creek at this point is approximately 50 feet. The substrate at Site #40 is predominantly shale and sandstone slabs, bedrock, boulders, cobble, and rubble mixed with areas of sand and gravel. The stream bed is located approximately six feet below the top of the bank. The banks are a mixture of sandstone block walls and gradually sloping soil. Trees overhang most of the bank with extensive vegetation extending beyond it.

Site #40 was sampled on three occasions for chemical and bacteriological analysis in 1989 (Appendix II-J). Iron had a single exceedance of water quality criterion. Levels of other chemical parameters measured in all samples were within water quality criteria for Warmwater Habitat. On August 10, iron was measured at 2.6 mg/L. All other chemical data from Site #40 were comparable to data obtained in previous years' sampling.

A single exceedance of the bacteriological criterion for fecal coliform was noted at Site #40 in 1989 (Appendix II-J). On September 20, fecal coliform was measured at 9,600 organisms per 100 ml. The other fecal coliform concentrations from Site #40 in 1989 (60 and 480 organisms per 100 ml) were within the numerical criterion for Primary Contact Recreational Use and were lower than concentrations measured at this site in previous years (geometric means of 8,000 and 1,200 organisms per 100 ml in 1987 and 1988, respectively).

Qualitative sampling for benthic macroinvertebrates was conducted at Site #40 in 1989 and 19 taxa were collected (Appendix VIII-W). This was an increase from the ten taxa identified in 1988. There was also an increase in the ratio of facultative taxa to tolerant taxa identified when compared to the 1988 results. As in 1988, no intolerant taxa were identified. Intolerant taxa had been identified in the samples collected at Site #40 in 1987. In 1988, taxa of the order Diptera were identified to the family Chironomidae. In 1989, improved taxonomic skills allowed identification of taxa of the order Diptera to three genera. No benthic macroinvertebrate sampling was performed at Site #40 in 1990.

In 1990, Site #40 was sampled once for chemical and bacteriological analysis (Appendix III-K). All chemical data were within Ohio EPA criteria and comparable to previous years' sampling results. Bacteriological analysis of the sample from Site #40 in 1990 (Appendix

III-K) showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. Similar results were obtained at this location in 1989.

Site #41

Site #41 (Figure 18) is located east of Richmond Road, south of the Cleveland Metroparks Bedford Chagrin Parkway, and is opposite 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, cobble, rubble, gravel, sand, and silt. The stream bed at the sample site lies approximately eight feet below the top of the bank. The banks are moderately steep and slightly eroded. Trees overhang some of the bank, where vegetation is sparse and intermittent. A cindered parking area separates the top of the bank from Richmond Road.

Site #41 was sampled on three occasions for chemical and bacteriological analysis in 1989 (Appendix II-J). An exceedance of the Ohio EPA water quality criterion was noted for iron, which was measured at 2.2 mg/L on August 10 and 1.8 mg/L on September 20. All other chemical data from 1989 were within the Ohio EPA numerical criteria for Warmwater Habitat. The 1989 sample data were comparable to data from previous years' sampling.

A single exceedance of the bacteriological criterion for Primary Contact Recreational Use was noted at Site #41 in 1989 (Appendix II-J). On August 10, fecal coliform was measured at 2,300 organisms per 100 ml. The other fecal coliform concentrations (160 and 200 organisms per 100 ml) from Site #41 in 1989 were well below the Ohio EPA criterion for Primary Contact Recreational Use. The 1989 bacteriological data were comparable to previous years' sampling results. Previous investigations cite local septic systems as sources of past bacterial contamination.

Qualitative sampling for benthic macroinvertebrates was performed and 18 taxa were collected at Site #41 in 1989 (Appendix VIII-X). Identified taxa are described in literature as either facultative or tolerant in their responses to organic pollutants. Although no intolerant organisms were found in 1989, as had been in the case in previous years' sampling, the diversity and number of organisms suggest that Site #41 had at least fair water quality in 1989.

In 1990, Site #41 (Appendix III-L) was sampled once for chemical and bacteriological analysis. All chemical data were within Ohio EPA criteria for Warmwater Habitat.

At Site #41 in 1990, the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. These bacteriological data are comparable to the 1988 sampling results, which also showed no exceedances of the criteria.

Site #42

Site #42 (Figure 18) is located upstream of the southeast face of the Glenwood Drive bridge crossing Tinkers Creek. The bridge lies between Idlewood Drive and Gary Drive in Twinsburg. The creek at this point varies in width from 33 to 42 feet. The substrate is composed of boulders, cobble, rubble (including construction materials), gravel, sand, and silt. The north bank of the creek lies approximately six feet above the stream bed. This bank has moderate ground cover with some tree overhang. The south bank of the creek lies approximately four feet above the stream bed. This bank has a grass covering and is slightly to moderately eroded. There are no trees on the south bank at the sample location.

Site #42 was sampled on three occasions for chemical and bacteriological analysis in 1989 (Appendix II-J). There were three exceedances of the chemical criterion for iron. Iron was measured at 1.2 mg/L on July 12, 3.1 mg/L on August 10, and 2.2 mg/L on September 20. All other chemical data were within the applicable criteria for Warmwater Habitat. The data collected were also consistent with values recorded from previous samplings.

No exceedances of the fecal coliform criterion for Primary Contact Recreational Use were noted in 1989 (Appendix II-J). The 1989 data (240 to 960 organisms per 100 ml) were similar to those obtained in 1988. Data showed a continued water quality improvement from the 1987 sampling in which all samples had fecal coliform concentrations exceeding the criterion for Primary Contact Recreational Use (2,700 to 37,000 organisms per 100 ml).

Qualitative sampling for benthic macroinvertebrates was performed and 36 taxa were collected at Site #42 in 1989 (Appendix VIII-Y). The majority of taxa are described in literature as facultative in their responses to organic pollution. Several tolerant taxa and two intolerant taxa were also collected. This was an increase from the 14 taxa collected in 1987 and the ten taxa identified in 1988. This increase is attributed to improved taxonomic skills, both in collection and identification. There was no sampling for benthic macroinvertebrates at this site in 1990.

One sampling for chemical and bacteriological parameters was performed at Site #42 in 1990 (Appendix III-L). All chemical data were within Ohio EPA water quality criteria for Warmwater Habitat and were similar to data obtained in previous years at this location.

Bacteriological data from Site #42 in 1990 (Appendix III-L) showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. Similar results have been obtained at this location in previous years.

In consideration of NEORSD stream monitoring efforts, additional chemical and bacteriological data have been submitted on a monthly basis by the City of Solon, which samples upstream and downstream of its Central Wastewater Treatment Plant, located at 6951 Cochran Road. This treatment plant discharges its effluent to Beaver Meadow Run which enters Tinkers Creek upstream of NEORSD Site #41. The parameters reported include temperature, dissolved oxygen, BOD, pH, total non-filterable residue, fecal coliform, ammonia, cadmium, copper, lead, nickel, zinc, and mercury.

The chemical data reported by the City of Solon for 1989 showed one exceedance of the ammonia criterion on May 9, at the site downstream of the treatment plant. Ammonia was reported at 30 mg/L, compared to the 13 mg/L criterion. The 1989 bacteriological data showed fecal coliform concentration exceedances of the criterion of 2,000 organisms per 100 ml at the upstream and downstream sites. The reported fecal coliform concentration at the upstream site on May 23 was 2,400 organisms per 100 ml. The reported values on October 3 were 5,400 organisms per 100 ml for the upstream sample and 2,700 organisms per 100 for the downstream sample.

Chemical data reported by the City of Solon for 1990 showed a March 20 downstream pH of 6.3 standard units, which is below the minimum criterion of 6.5 standard units. The 1990 bacteriological data showed fecal coliform concentrations exceeding the Primary Contact Recreational Use criterion at the upstream location on June 25 (6,250 organisms per 100 ml), July 11 (9,200 organisms per 100 ml), August 7 (6,250 per 100 ml), and September 24 (2,800 organisms per 100 ml). Exceedances of the fecal coliform criterion were also observed at the downstream location on June 25 (5,700 organisms per 100 ml), July 11 (5,700 organisms per 100 ml), and August 7 (3,900 organisms per 100 ml).

These data are on file at the NEORSD Water Quality and Industrial Surveillance offices.

PROBLEMS AND REMEDIATION

-1-

On November 7, 1989, NEORSD investigators observed a storm-induced discharge of metal sludges to Tinkers Creek by Norandex Incorporated, 7120 Krick Road. Due to full clarifier lagoons, rain events were noted allowing sludge-carrying waters to bypass the sanitary sewer line and discharge through standpipes to Tinkers Creek. Analysis of the discharge revealed a total chromium concentration of 1.6 mg/L. The discharge was reported to the Ohio EPA on November 8. Remediation was performed by Norandex, Inc., to avoid recurrences. On November 30, parking lot drains were rerouted from discharging to the sludge lagoons. On December 5, the standpipes were sealed to prevent overflows. Finally, on January 3, 1990, Norandex Inc. removed the accumulated sludge from the lagoons. The sludge was then dewatered and its solids hauled for disposal as normal process waste.

-2-

May 4, 1990, a brown, foaming liquid was discovered entering a ditch, tributary to Tinkers Creek, from roof drains on Associated Estates Corporation property at 24661-24771 Miles Road. Analysis of the liquid showed several parameters with concentrations that could have been detrimental to the biota of the creek downstream. These parameters included the chloride concentration (409 mg/L) and chemical oxygen demand (466 mg/L). Due to damming of the ditch by Associated Estates personnel at NEORSD request, the majority of this substance was contained and transferred via portable pump to a sanitary sewer.

-3-

On September 20, 1990, a spill of approximately 50 to 100 gallons of xylenol was reported by Ferro Corporation, 7050 Krick Road. NEORSD investigators on the scene reported no material entering the creek during clean-up; however, a follow-up inspection the next day revealed several locations where the xylenol had collected in the creek. The first location of xylenol accumulation was a pool at the storm sewer outfall to the creek at the end of Krick Road. The second location of xylenol accumulation in the creek was about 100 yards downstream of the storm sewer outfall in a pooled area which contained accumulated natural debris (i.e. sticks, leaves, branches, etc.). A third location of significant xylenol accumulation in the creek was approximately 150 yards downstream of the storm sewer outfall in a depositional zone of the creek. Between the storm sewer outfall and the furthest downstream location of xylenol accumulation, additional xylenol residue was noted along the margins of the creek, but very small quantities were present and appeared to be evaporating.

Hukill Chemical Corporation, 7013 Krick Road, which was responsible for the spill, was notified and instructed to recover the material from the creek. A second follow-up inspection, on September 22, showed that the xylenol had been cleaned up with no discernible environmental damage.

-4-

On September 21, 1990, a green discharge was observed entering a tributary of Tinkers Creek at the west end of Krick Road in Walton Hills. This discharge was traced to an abandoned wastewater treatment plant pond next to Barmet Industries, 7130 Krick Road. The constituents of the green discharge were identified as two genera of green algae (Anabaena sp. and Oscillatoria sp.). An algal bloom had developed in the pond due to nutrient enrichment by sanitary sewage entering from a surcharged manhole on the Barmet Industries property. A blockage in the sanitary sewer was the cause of this surcharge condition. The Walton

Hills Service Department was notified of the surcharge problem, which was remediated later that day.

-5-

A mixed solvent spill was reported on October 24, 1990 by Hukill Chemical Corporation, which was responsible for the spill of a mixture of mineral spirits, isopropyl alcohol, xylenes, phenols, and tars at Ferro Chemical Corporation, 7050 Krick Road. NEORSD investigators monitored the clean-up of the spill and estimated that approximately one gallon of the material may have reached Tinkers Creek via the storm sewers. Absorbant pads were employed to clean up the spilled material at the storm sewer outfall. The pads were collected and disposed of by Hukill Chemical Corporation. A follow-up investigation on October 25 verified completion of the clean-up.

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: a portion of the Cuyahoga Valley National Recreation Area; the Metroparks Brecksville Reservation; the City of Brecksville; the City of Broadview Heights; the southern tip of the City of Seven Hills; the eastern portion of the City of North Royalton.

Flow measurements by NEORSD investigators at Site #43, the furthest downstream monitoring location, indicated that, during the severe drought of the summer of 1988, Chippewa Creek had a minimum dry weather total flow of 1.1 million gallons per day.

Chippewa Creek's drainage area is primarily residential and recreational. It has been designated Warmwater Habitat and Primary Contact Recreational Use by the Ohio EPA.

SAMPLING

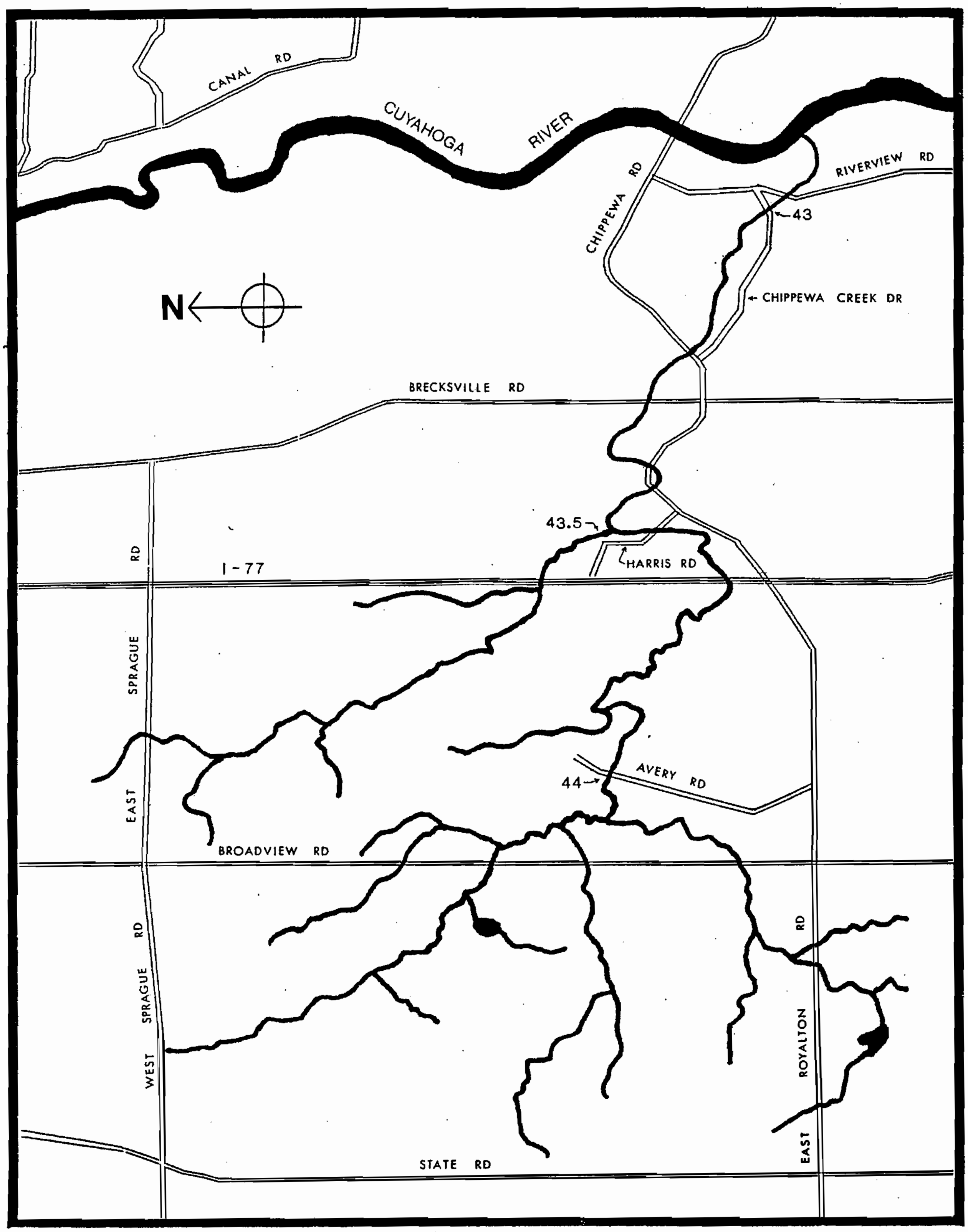
The NEORSD has selected three locations on Chippewa Creek which are routinely sampled for chemical, bacteriological, and benthic analysis (Figure 19).

Site #43

Site #43 is located at a concrete ford on which Chippewa Creek Drive crosses the creek east of Valley Parkway. This location is approximately 3,000 feet upstream of the confluence with the Cuyahoga River at about River Mile 22.0 and represents the total flow of Chippewa Creek. The stream is about 10 feet wide and the substrate consists of boulders, cobble, gravel, and sand, with riffles. It is surrounded by dense vegetation with extensive tree overhang.

In 1989, Site #43 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-K). With the exception of mercury, all 1989 chemical data from Site #43 were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. Mercury was measured at 0.2 ug/L and 0.3 ug/L on July 27 and August 24, respectively, compared to the 0.012 ug/L criterion. The chemical data were comparable to those obtained at this location in previous years.

Bacteriological data from Site #43 in 1989 (Appendix II-K) indicated that all fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use. Bacteriological concentrations in 1989 were comparable to the levels reported in 1988, which were also below the Ohio EPA criterion.



Chippewa Creek
(NOT TO SCALE)

Figure 19

Qualitative sampling for benthic macroinvertebrates was performed in 1989 at Site #43 and 39 taxa were collected, including one trichopteran taxon (Symphitopsyche sparna) which is described in literature as intolerant in its response to organic pollution (Appendix VIII-Z). This was a considerable increase from the nine taxa collected in 1988. However, the increase in taxa identified may be attributable to the NEORSD personnel's development of taxonomic identification skills, improved benthic sample-processing techniques, and increased familiarity with benthic taxa over the past few years. The high diversity of organisms, including the presence of an intolerant taxon, indicate good water quality in Chippewa Creek at Site #43.

In 1990, Site #43 was sampled once for chemical and bacteriological analysis (Appendix III-M). One exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.3 ug/L), on July 2. All other 1990 chemical data from this location were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. Similar results had been obtained in previous years' sampling at this location.

Bacteriological data from Site #43 in 1990 (Appendix III-M) showed that the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use. These results are also comparable to bacteriological concentrations from previous years' sampling.

Qualitative sampling for benthic macroinvertebrates was conducted in 1990 at Site #43 with 24 taxa collected, including an ephemeropteran taxon (Paraleptophlebia sp.) and a trichopteran taxon (Symphitopsyche sparna) which are described in literature as intolerant in their responses to organic pollution (Appendix IX-L). Fewer total taxa were found at this location than had been found in 1989. The decrease in taxa found may be attributed to the Metropark's modification of the stream bed through channelization, which disturbed the habitat in this section of Chippewa Creek. Nevertheless, the diversity of organisms found, especially the presence of two intolerant taxa, as well as the chemical and bacteriological data from Site #43 indicate that the water quality of Chippewa Creek was relatively good in 1990.

Site #43.5

Site #43.5 (Figure 19) 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.

In 1989, Site #43.5 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-K). With the exception of mercury, all chemical data were within water quality criteria for Warmwater

Habitat in 1989. Mercury was measured at 0.4 ug/L on August 24. The 1989 chemical data were comparable to those obtained at this location in previous years.

Bacteriological data from Site #43.5 in 1989 showed that the fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological results are comparable to previous years' sampling results, which were also within the numerical criteria.

Qualitative sampling for benthic macroinvertebrates was performed at Site #43.5 in 1989 (Appendix VIII-AA) with four taxa collected and identified, all of which are described in literature as facultative in their responses to organic pollution. Fewer total taxa were found at this site than had been found in 1988, when nine taxa had been collected. The substrate at this location consists primarily of bedrock. This type of substrate, having a smooth surface, is not as conducive to benthic habitation as substrates at other locations. Nevertheless, the data from Site #43.5 indicate that this section of Chippewa Creek is unpolluted by sanitary sewage.

In 1990, Site #43.5 was sampled once for chemical and bacteriological analysis (Appendix III-M). An exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.3 ug/L), on July 2. All other 1990 chemical data from this location were within water quality criteria for Warmwater Habitat and were comparable to those of the previous years.

Bacteriological data from Site #43.5 in 1990 (Appendix III-M) showed that all fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. Similar results had been obtained at this site in previous years.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #43.5 in 1990 with 18 taxa collected, including an ephemeropteran taxon (Paraleptophlebia sp.) and a dipteran taxon (Diamesa sp.) which are described in literature as intolerant in their responses to organic pollution (Appendix IX-M). A plecopteran taxon (Leuctra sp.) was also found at this location and is described in literature as intolerant of organic pollution. This was an increase from four taxa collected in 1989 and is attributable to a change in the location of the benthic macroinvertebrate sampling. In 1990, the sampling was conducted at a more suitable habitat approximately 100 yards upstream of the original Site #43.5 location. These findings, especially the presence of three intolerant taxa, suggest that this section of Chippewa Creek had good water quality in 1990.

Site #44

Site #44 (Figure 19) is located on the main stem of Chippewa Creek at the Avery Road bridge between Harris Road and East Royalton Road. It is 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, cobble, gravel, sand, and silt. It is surrounded by dense vegetation with extensive tree overhang.

In 1989, Site #44 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-K). All 1989 chemical data from this site were within water quality criteria for Warmwater Habitat and were comparable to those obtained at this location in previous years.

Bacteriological analysis at Site #44 in 1989 (Appendix II-K) indicated that the fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological results are comparable to previous years' sampling results, which were also below the Ohio EPA criteria.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #44 in 1989 and 16 taxa were collected, including one ephemeropteran taxon (Baetis vagans), which is described in literature as intolerant in its response to organic pollution (Appendix VIII-BB). This was an increase from eight taxa collected in 1988. These results, including the presence of an intolerant taxon, reflect good water quality in Chippewa Creek at this location.

In 1990, Site #44 was sampled once for chemical and bacteriological analysis (Appendix III-M). One exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.4 ug/L), on July 2. All other 1990 chemical data from this site were within Ohio EPA water quality criteria for Warmwater Habitat and were comparable to those obtained in previous years.

Bacteriological data from Site #44 in 1990 (Appendix III-M) showed that the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. Similar results have been obtained at this location in previous years. Further decreases in fecal coliform concentrations are expected in the future upon further elimination of upstream septic tanks, as is discussed later in this report.

Qualitative sampling for benthic macroinvertebrates was performed at Site #44 in 1990 (Appendix IX-N) and 41 taxa were collected, once again reflecting improved benthic sampling techniques and more developed taxonomic identification skills. Four taxa, including a plecopteran (Leuctra sp.), which are described in literature as intolerant in their responses to organic pollution were found at this location. The high diversity of organisms, including four intolerant taxa, indicate that the water quality of Chippewa Creek at Site #44 was good in 1990.

CHIPPEWA CREEK AT AVERY ROAD (SITE #44)
DRY WEATHER FECAL COLIFORM

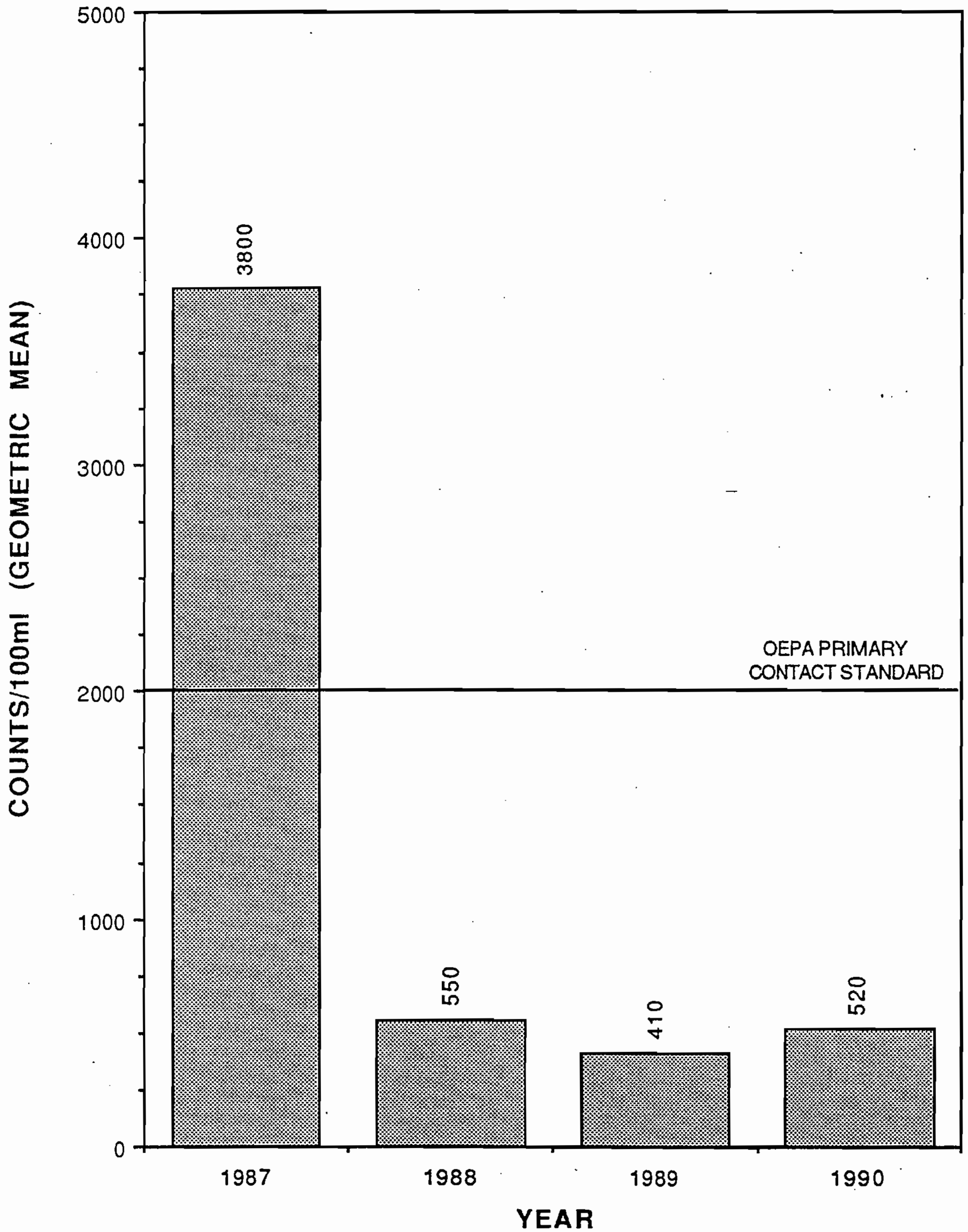


Figure 20

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. Presently, all of them have been abandoned.

The Avery Meadows Wastewater Treatment Plant (WWTP), the Briarwood WWTP, and the 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 Tollis WWTP was abandoned in February 1989, and the Royalton Heights WWTP was abandoned in October 1989.

The influents of these municipal wastewater treatment 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 Cuyahoga Valley Interceptor, through which the flows are now tributary to the Southerly WWTP.

Further reconnections of septic system flows to the sanitary sewer system should show even further improvements in the water quality of Chippewa Creek, which is now one of the least polluted streams in Cuyahoga County. The 1987-1990 improvements in Chippewa Creek water quality are reflected in the fecal coliform concentrations as shown in Figure 20.

SAGAMORE CREEK

Sagamore Creek enters the Cuyahoga River in Summit County, southwest of the intersection of Sagamore Road and Canal Road in the Cuyahoga Valley National Recreation Area (CVNRA). The creek originates in Macedonia and Sagamore Hills in Summit County as two intermittent runs flowing northwest and merging north of West Valley View Road. The combined intermittent run then flows in a mostly northwest direction, entering Cuyahoga County at Sagamore Road. While flowing toward Cuyahoga County, the creek adds five intermittent runs from the east and one intermittent run from the west.

In the area of the Summit County/Cuyahoga County boundary the creek becomes a constant flow. North of the boundary, a sixth intermittent run enters from the east. Once in Walton Hills, Cuyahoga County, the creek turns and flows in a northwest direction until it reaches the intersection of Alexander Road and Dunham Road. At this intersection the creek turns and flows generally southwest towards Canal Road. As the creek flows southwest it takes on three intermittent runs from the south. At the intersection of Sagamore Road and Canal Road the creek re-enters Summit County before it merges with the Cuyahoga River.

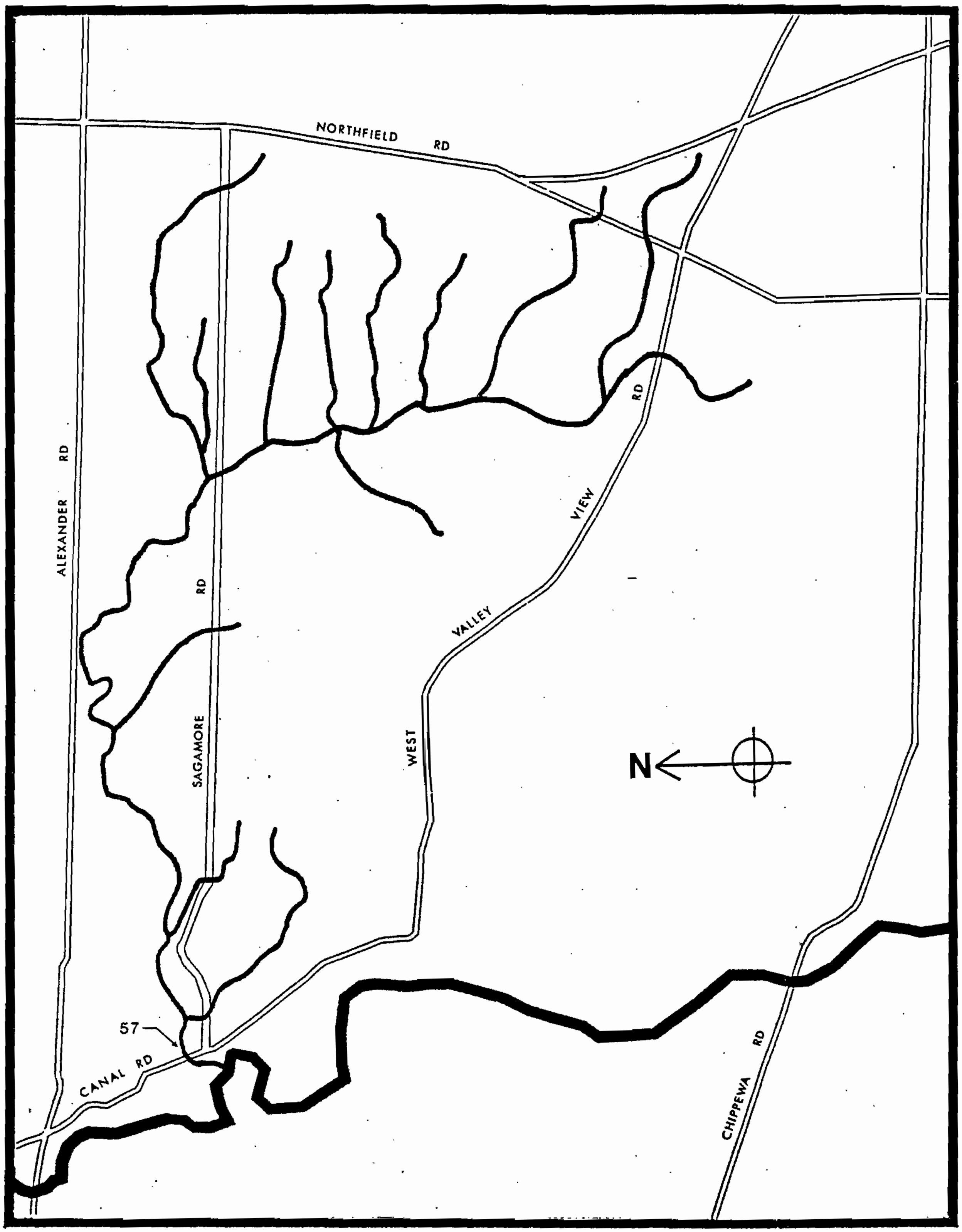
The Ohio EPA has designated Sagamore Creek Limited Resource Water for aquatic life habitat and State Resource Water within the CVNRA. The entire creek and its tributaries are designated Primary Contact Recreational Use by the Ohio EPA.

Sagamore Creek's drainage area is primarily low density residential with large undeveloped and recreational use areas. Flow measurements in October of 1989 produced a dry-weather flow of 1.3 million gallons per day.

SAMPLING

Sagamore Creek has been assigned one sample location for routine chemical, bacteriological, and benthic sampling. The site designation for Sagamore Creek is #57 (Figure 21).

Site #57 is located upstream of Canal Road as it crosses the creek north of Sagamore Road. The width of the creek at this section is approximately ten feet. The substrate at Site #57 consists of rubble, gravel, cobble, and some sandy areas. The stream bed lies approximately five feet below the tops of the banks. The banks have sparse ground covering with little tree overhang. Pullover parking off both Canal Road and Sagamore Road has left two areas with minimal ground cover adjacent to the creek. This is one of the few areas on the creek lacking ample bank cover however.



Sagamore Creek
(NOT TO SCALE)

Figure 21

Site #57 was sampled twice for chemical and bacteriological analyses in 1989 (Appendix II-L). The only chemical parameter not meeting Ohio EPA Water Quality Standards was pH. On August 2, pH was measured at 9.9 standard units, which was above the maximum of 9.0 standard units allowable for Limited Resource Water. The bacteriological data for 1989 were below the Ohio EPA criterion for Primary Contact Recreational Use. All other 1989 chemical data were well within Ohio EPA criteria in Water Quality Standards for Limited Resource Water. This was the first year of routine sampling on Sagamore Creek by the NEORSD.

Qualitative sampling for benthic macroinvertebrates was performed and 31 taxa were collected at Site #57 in 1989 (Appendix VIII-WW). The taxa collected are predominantly facultative in their responses to organic pollution. Additionally, two intolerant taxa were collected. The high diversity of taxa and the presence of two intolerant organisms indicate good water quality at Site #57 in 1989.

Site #57 was sampled once for chemical and bacteriological analyses in 1990 (Appendix III-N). No exceedances of the Ohio EPA water quality criteria were noted. The data from 1990 are comparable to those obtained in 1989.

Qualitative sampling for benthic macroinvertebrates also produced results similar to those of 1989 (Appendix IX-W). Differences in the types of organisms found each year may reflect seasonal variability.

PROBLEMS AND REMEDIATION

No environmental disruptions on Sagamore Creek were found by or reported to the NEORSD in 1989 or 1990.

KINGSBURY RUN

Kingsbury Run drains the central portion of Cleveland east of the Cuyahoga River and a portion of the west end of Shaker Heights. It has a total drainage area of 7.8 square miles and a total length of 4.3 miles. Kingsbury Run flows predominantly east-to-west with two branches that merge east of East 37th Street, south of Woodland Avenue. The main stem begins at East 37th Street, south of Woodland Avenue, and eventually enters the Cuyahoga River at approximately River Mile 4.0, just north of the old Jefferson Avenue bridge, 2785 Broadway Avenue.

Kingsbury Run has the following open sections: a 1,000-foot section from the confluence with the Cuyahoga River to the mouth of the culvert; a 1,100-foot section between East 75th Street and Grand Avenue, 250 feet north of Colfax Road; a 900-foot section between East 84th Street and East 87th Street, north of Kinsman Road. The remaining portion of 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 in 1988 indicated that Kingsbury Run discharges approximately 1.6 million gallons per day into the Cuyahoga River.

Kingsbury Run's drainage area has a combination of residential and industrial uses. The Ohio EPA has designated Kingsbury Run Warmwater Habitat and Primary Contact Recreational Use.

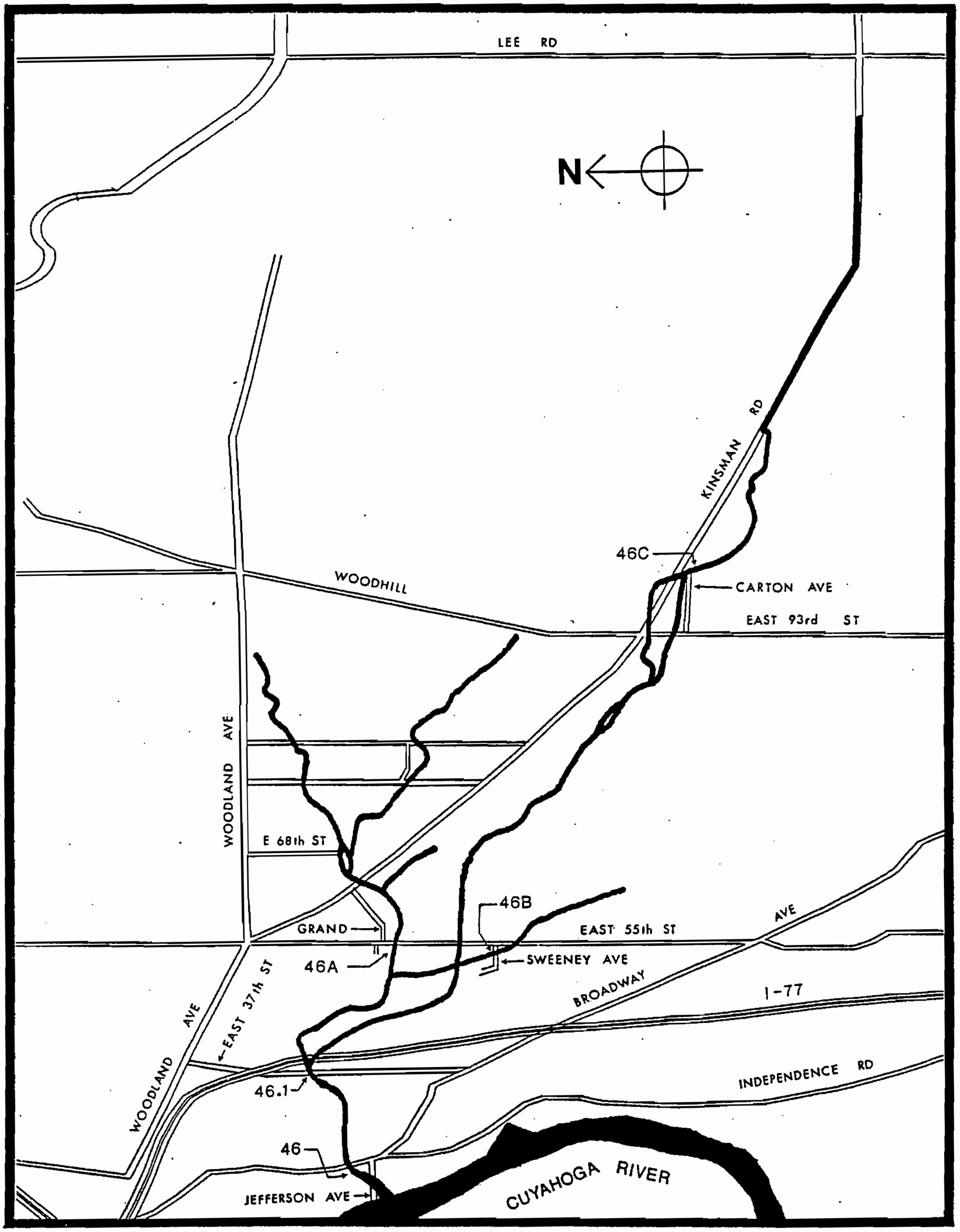
SAMPLING

In 1987, Kingsbury Run was assigned for the NEORSD Stream Monitoring Program one routine sampling location, which is at the mouth of the culvert. In 1988, four additional sampling locations were chosen to monitor the various branches of Kingsbury Run. In 1989, three of the sampling locations were changed to facilitate safe access to the culverted sections of Kingsbury Run (Figure 22).

The five routine sample sites on Kingsbury Run are:

Site #46: At the mouth of the culvert, approximately 1,000 feet upstream of the confluence with the Cuyahoga River and north of the old Jefferson Avenue bridge (same as in 1988);

Site #46.1: Main stem, at manhole on the culvert in the center of East 37th Street, approximately 2,000 feet south of Woodland Avenue (same as in 1988);



Kingsbury Run
(NOT TO SCALE)

Figure 22

Site #46-A: North Branch, a rectangular manhole on the culvert adjacent to the RTA Power Control Administrative Offices, 5400 Grand Avenue, approximately 200 feet west of East 55th Street (new location for 1989);

Site #46-B: Tributary to the North Branch, manhole on the culvert in the center of Sweeney Avenue, approximately 100 feet west of East 55th Street, near 5407 Sweeney Avenue (new location for 1989);

Site #46-C: South Branch, manhole located at Kingsbury Boulevard and Carton Avenue, approximately 150 feet south of Kinsman Road (new location for 1989). This site is approximately 30 feet downstream from the confluence of the 96-inch Kinsman/Union storm relief sewer and the Kingsbury Run culvert.

Site #46

Site #46 was grab sampled twice in 1989 for chemical analysis (Appendix II-M). Exceedances of the numerical criterion in Water Quality Standards for Warmwater Habitat were noted for iron (1.6 mg/L and 5.4 mg/L on August 17 and October 30, respectively). All other 1989 chemical data were within the water quality criteria for Warmwater Habitat. The average dissolved oxygen concentration (8.7 mg/L) measured in 1989 was considerably improved when compared to the dissolved oxygen concentration measured in 1988 (3.2 mg/L). All other 1989 chemical data are comparable to those obtained in previous years.

Site #46 was sampled twice in 1989 for bacteriological analysis (Appendix II-M). An exceedance of the Ohio EPA numerical criterion for Primary Contact Recreational Use was noted for fecal coliform (3,500 organisms per 100 ml) on October 30. This level was comparable to results obtained at this site in previous years' sampling. The other fecal coliform concentration, 560 organisms per 100 ml on August 17, was below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than levels measured at this site in previous years. Occasional combined sewer overflow problems may be a contributing factor to the elevated fecal coliform concentration on October 30, 1989. Further problems will be discussed later in the report.

No benthic macroinvertebrate sampling was conducted at Site #46 in 1989 and 1990. However, future benthic macroinvertebrate sampling is planned.

There were no chemical or bacteriological samples collected at Site #46 in 1990.

Site #46.1

Site #46.1 was grab sampled twice in 1989 for chemical analysis (Appendix II-M). Exceedances of the Ohio EPA numerical criterion for Warmwater Habitat were noted for iron (2.40 mg/L and 1.40 mg/L on August 17 and October 30, respectively). All other 1989 chemical data were within numerical criteria in Water Quality Standards for Warmwater Habitat. One source of high iron concentrations has been recurring problems experienced by Northern Steel Processing Company, which are discussed later in the report.

Site #46.1 was grab sampled twice in 1989 for bacteriological analysis (Appendix II-M). The bacteriological data were well below the Ohio EPA criteria for Primary Contact Recreational Use. The fecal coliform concentrations ranged from less than 20 to 60 organisms per 100 ml. This indicates that Kingsbury Run at Site #46.1 was relatively free from contamination by sanitary sewage at the time of sampling.

Since Site #46.1 is culverted, it is not conducive to sampling for benthic macroinvertebrates.

Site #46.1 was not sampled for chemical or bacteriological analysis in 1990.

Site #46-A

Site #46-A was grab sampled twice in 1989 for chemical analysis (Appendix II-M). Exceedances of the Ohio EPA numerical criterion for Warmwater Habitat were noted for iron (1.40 mg/L and 2.50 mg/L on August 17 and October 30, respectively). All other 1989 chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #46-A was sampled twice in 1989 for bacteriological analysis (Appendix II-M). The bacteriological data were well below the Ohio EPA criteria for Primary Contact Recreational Use.

Since Site #46-A is culverted, it is not conducive to sampling for benthic macroinvertebrates.

Site #46-A was not sampled for chemical or bacteriological analysis in 1990.

Site #46-B

Site #46-B was grab sampled twice in 1989 for chemical analysis (Appendix II-N). Exceedances of the Ohio EPA numerical criteria for Warmwater Habitat were noted for mercury (0.2 ug/L) on August 17 and for iron (11.0 mg/L and 18 mg/L on August 17 and October 30, respectively). All other 1989 chemical data were within numerical criteria in Water

Quality Standards for Warmwater Habitat. According to NEORSD records, iron concentrations measured at this site had been as high as 217 mg/L with zinc concentrations as high as 6.0 mg/L (on November 22, 1988). A source of elevated iron and zinc concentrations in Kingsbury Run upstream of Site #46-B, Northern Steel Processing Company, is discussed later in the report.

Site #46-B was sampled twice in 1989 for bacteriological analysis (Appendix II-N). Both fecal coliform concentrations were below the Ohio EPA numerical criterion for Primary Contact Recreational Use.

Since Site #46-B is culverted, it is not conducive to sampling for benthic macroinvertebrates.

Site #46-B was not sampled for chemical or bacteriological analysis in 1990.

Site #46-C

Site #46-C was grab sampled twice in 1989 for chemical analysis (Appendix II-N). All 1989 chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #46-C was sampled twice in 1989 for bacteriological analysis (Appendix II-N). Both fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use. These data indicate that Site #46-C has had good water quality during each sampling.

Since Site #46-C is culverted, it is not conducive to sampling for benthic macroinvertebrates.

Site #46-C was not sampled for chemical or bacteriological analysis in 1990.

PROBLEMS AND REMEDIATION

-1-

On March 6, 1989, NEORSD investigators responded to a report of oil in the wet well of the City of Cleveland-owned sewage pumping station on East 37th Street, north of Trumbull Street. At the time of the investigation, the pump station was out of service due to damaged electrical components. When the pump station is out of service, the influent, which contains sanitary sewage, is diverted to the Kingsbury Run culvert.

A layer of oil two inches thick was found floating on the surface of the water in the pump station wet well. The influent to the pump station had a layer of oil almost one inch thick on its surface. The source of this oil was the secondary oil separator at the Mobil Oil Corporation

Lube Oil Plant, 2846 East 37th Street, which had been malfunctioning. The secondary oil separator is located approximately 50 feet west of the pump station. The company was immediately notified about the oil in the wet well. Later that day, Research Oil Company removed approximately 25 gallons of oil along with 2,000 gallons of water from the wet well. An additional 30 gallons of oil and 2,000 gallons of water was removed from the wet well by the Research Oil Company on March 7.

The Mobil Oil Corporation's secondary separator was repaired on March 7, 1989. Subsequent inspections of the pump station, on March 8 and April 4, revealed accumulated oil on the surface of the wet well water, although the secondary oil separator had been functioning properly. The accumulated oil noted in the pump station may be attributed to an oil & grease concentration in the secondary separator effluent which is typical according to NEORSD records. The average oil & grease concentration measured in Mobil Oil Corporation Lube Oil Plant effluent samples collected in 1989 was 185 mg/L and was within the NEORSD regulations for discharge to a combined sewer system. This concentration of oil & grease only presents a problem when the East 37th Street Pump Station is out of service and has an overflow tributary to Kingsbury Run. For this reason, the NEORSD requested that the Mobil Oil Corporation periodically inspect the pump station wet well and remove any accumulated oil while the pump station is out of service. Mobil Oil Corporation has agreed to comply with the request.

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The City of Cleveland-owned sewage pump station on East 37th Street was out of service due to mechanical and electrical problems for 164 days, from March 1, 1989 to August 11, 1989. During this period, the pump station influent, which contains sanitary sewage and industrial wastewater, was diverted through an overflow structure to Kingsbury Run. Following repairs by the City of Cleveland, this dry weather source of pollution in Kingsbury Run was eliminated.

-3-

On May 8, 1989, NEORSD investigators discovered a broken eight-inch PVC pipe in the basement of Northern Steel Processing Company, 6055 Truscon Avenue. This pipe receives wastewater from the company's steel pickling and zinc phosphating processes. The wastewater was flowing from the broken pipe into a floor drain that is tributary to the North Branch of Kingsbury Run, approximately 1,100 feet upstream of Site #46-B. Analysis of a grab sample collected on May 8 from this wastewater revealed an iron concentration of 210 mg/L and a zinc concentration of 3.3 mg/L. On May 8, the company ceased operations until the line was repaired. At that time, the company plugged the floor drain, and the plumbing for the steel pickling and zinc phosphating wastewater was rerouted.

This incident is similar to several previous incidents that occurred at the Northern Steel Processing Company prior to 1989. Previous leaks from this company to Kingsbury Run had iron concentrations as high as 520 mg/L, zinc concentrations as high as 124 mg/L, and pH as low as 1.6 standard units (on February 3, 1986). The average process wastewater discharge to the sewer system from this company in 1989 was over 40,000 gallons per day, with iron and zinc concentrations as high as 1,750 mg/L and 15.5 mg/L, respectively. Discharges in 1986 had iron concentrations as high as 4,000 mg/L and zinc concentrations as high as 460 mg/L. On several occasions prior to 1989, the entire process wastewater discharge had been found tributary to Kingsbury Run. Because of the recurring problems at Northern Steel Processing Company, elevated iron concentrations measured at Sites #46, #46.1, and #46-B, which are located downstream, may be attributable to this company's discharges.

-4-

On June 12, 1990, NEORSD investigators discovered a ruptured rinse tank in the steel pickling and zinc phosphating line at the Northern Steel Processing Company. The wastewater from this ruptured tank was found to be flowing into the basement, mixing with old metals-contaminated sludge and discharging into Kingsbury Run through a crack in the floor. The crack was over the old discharge drain to Kingsbury Run, which had been plugged and cemented over in 1989. It was estimated that the leak occurred for one hour and twenty minutes with an estimated volume of 2,000 gallons of wastewater entering Kingsbury Run. Analysis of the wastewater from this discharge revealed an iron concentration of 110 mg/L and a zinc concentration of 0.83 mg/L. The hole in the ruptured tank was repaired and the crack over the basement discharge drain to Kingsbury Run was patched later that day.

-5-

On May 9, 1989, NEORSD investigators discovered significant dry weather flow in the Kingsbury Run culvert at Kingsbury Boulevard and Carton Avenue (Site #46-C). The dry weather flow was coming from the 96-inch Kinsman/Union storm relief sewer that receives drainage from the Kingsbury Run culvert in Shaker Heights. On May 17, grab samples for bacteriological analysis were obtained at Site #46-C and at the mouth of the culvert (Site #46) to determine if the dry weather flow contained sanitary sewage. The fecal coliform concentration in the grab sample from Site #46-C was 300,000 organisms per 100 ml, and at Site #46 it was 61,000 organisms per 100 ml. These concentrations greatly exceed the Ohio EPA criterion for Primary Contact Recreational Use and indicate substantial contamination by sanitary sewage.

This dry weather flow was traced back to East 149th Street and Spear Avenue, where a leaping weir overflow structure, which had been constructed by the City of Cleveland in the late 1970's was found to be blocked by debris. This overflow structure had been constructed to divert dry weather flow contaminated by sanitary sewage in the Kingsbury Run culvert from Shaker Heights into the combined sewer system.

During this investigation, five major sources of sanitary sewage tributary to this location were identified. It must be noted that the sources have the potential of contaminating Kingsbury Run downstream with sanitary sewage only when the leaping weir overflow structure is blocked or during rain events when the combined sewer receiving this flow reaches maximum capacity, resulting in an overflow to the 96-inch Kinsman/Union storm relief sewer. Description of each source follows:

A. Westbury Road between Sutton Place and Milverton Road: An eight-inch sanitary sewer is tied into the culvert from the south. An instantaneous flow approximation revealed 47 gallons per minute of sanitary sewage flow.

B. Ashby Road at Milverton Road: A three-foot by six-foot concrete box culvert, labeled on sewer maps as a storm sewer, was found to contain visual evidence of contamination by sanitary sewage in dry weather. An instantaneous flow approximation revealed 500 gallons per minute of flow in this box culvert. The source of this dry weather flow has not been located.

C. 16650 Van Aken Boulevard, in front of the Campbell Court Apartments: Investigators discovered an eighteen-inch sanitary sewer tributary to the Kingsbury Run culvert. An instantaneous flow approximation revealed 30 gallons per minute of flow in this pipe.

D. The Kingsbury Run Culvert along Winslow Road, from Winslow Court east to Avalon Road: In this section of the culvert, six outlet pipes were discovered - four eight-inch cast iron pipes tied in from the north, and two eight-inch cast iron pipes from the south. All of these exhibited evidence of sanitary sewage.

E. Winslow Road at Avalon Road: A 36-inch circular concrete pipe enters the culvert from the east. This pipe appears to have been added after the culvert was constructed. At the time of the investigation, there was only a trickle of sanitary sewage present in the 36-inch pipe. However, there is evidence of heavy flow during peak-use hours.

During these investigations, numerous storm sewers in Shaker Heights were found to contain visible signs of sanitary sewage. Also, there is no sanitary sewer on Winslow Road, where the Kingsbury Run culvert is the only sewer and is receiving residential wastewater discharges.

The blockage of the leaping weir at East 149th Street and Spear Avenue was removed by NEORSD personnel on June 28, 1989. A large piece of concrete was extracted from this overflow structure. This action eliminated approximately one million gallons per day of dry weather flow containing sanitary sewage from entering the Cuyahoga River via the Kingsbury Run culvert. In the summer of 1990, periodic maintenance and inspections of this structure by NEORSD Sewer Maintenance and Control personnel were initiated. These inspections will aid in maintaining good water quality in Kingsbury Run.

-6-

On May 22, 1989, a gasoline tanker truck loaded with 7,500 gallons of unleaded gasoline overturned on Pittsburgh Avenue at Broadway Avenue. Gasoline was observed leaking from the tanker and onto the ground. It was later determined that approximately 3,500 gallons of unleaded gasoline was lost, of which undetermined quantities may have entered the combined sewer system, saturated the ground, or evaporated. The combined sewer on Pittsburgh Avenue has a combined sewer overflow structure located downstream of the spill, at East 34th Street, which is tributary to the Kingsbury Run culvert upstream of Site #46. At the time of the spill, gasoline odors were detected in the culvert; however, no visible signs of gasoline were noted in the water. Approximately 4,000 gallons of gasoline were recovered from the overturned tanker. Subsequently, the soil saturated with spilled gasoline was excavated and hauled away for disposal by Samsel Services Company.

-7-

On August 14, 1990, NEORSD investigators responded to a chemical spill at Laidlaw Environmental Services, 7415 Bessemer Avenue. An estimated 1,500 to 1,600 gallons of an acidic liquid waste had spilled onto the ground from a tank following an overflow during mixing. The pH of the substance on the ground was measured at 1.0 standard unit. Company records indicated that the waste material contained high concentrations of nickel (2,000 mg/L), copper (720 mg/L), zinc (720 mg/L), and chromium (380 mg/L). The spill clean-up was monitored by Cleveland Fire Prevention and the Ohio EPA.

During the containment and clean-up of the spill, NEORSD investigators inspected the sewer system in the vicinity of the plant. Flow in a storm sewer at a manhole on the north side of Bessemer Avenue (near the entrance to AAA Pipe Cleaning Corp.) exhibited a light yellow color. A grab sample was obtained at the manhole and its analysis revealed elevated concentrations of nickel (32.0 mg/L), copper (8.00 mg/L), zinc (7.50 mg/L), chromium (3.60 mg/L), iron (19 mg/L), cadmium (0.16 mg/L), lead (0.22 mg/L), and mercury (0.8 ug/L). Since the metals concentrations were detected in ratios nearly identical to those of the chemical tank contents, it was concluded that some of the chemical spill had entered this storm sewer, which is tributary to Kingsbury Run.

On September 27, 1990, NEORSD investigators performed an inspection of the spill site at the east end of the Laidlaw Environmental Services property. A ground level break in an 8-inch vitrified clay pipe on a company building's rainwater downspout was noted. A dye test verified this as the probable route of the spilled material entering the Bessemer Avenue storm sewer.

-8-

An improvement in the water quality of Kingsbury Run was indicated by fecal coliform and dissolved oxygen levels in 1989. Much of this improvement may be attributed to regular inspections and maintenance of the 42 combined sewer overflow structures in the Kingsbury Run drainage area by NEORSD personnel. Another factor is the construction of the Community Relief Sewer for Lomond Boulevard, which should eliminate many overflows to Kingsbury Run from Shaker Heights. However, the combined sewer system throughout the Kingsbury Run drainage area is old, deteriorating in many places, and heavily loaded, and therefore recurring problems which allow Kingsbury Run's waters to become contaminated are inevitable.

MORGANA RUN

Morgana Run drains the central portion of the City of Cleveland east of the Cuyahoga River. It has 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 Southerly WWTP. The remaining section of Morgana Run enters the Cuyahoga River on the LTV Steel Company's property, south of the former location of the Clark Avenue bridge, at approximately River Mile 4.9.

In about 1910, Morgana Run was culverted, and in some places, relocated to follow Morgana Avenue. In 1960 and 1961, the Morgana Run culvert 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 Company discharge, Morgana Run has around 1,000 gallons per minute of flow.

Morgana Run is designated Warmwater Habitat and Primary Contact Recreational Use by the Ohio EPA.

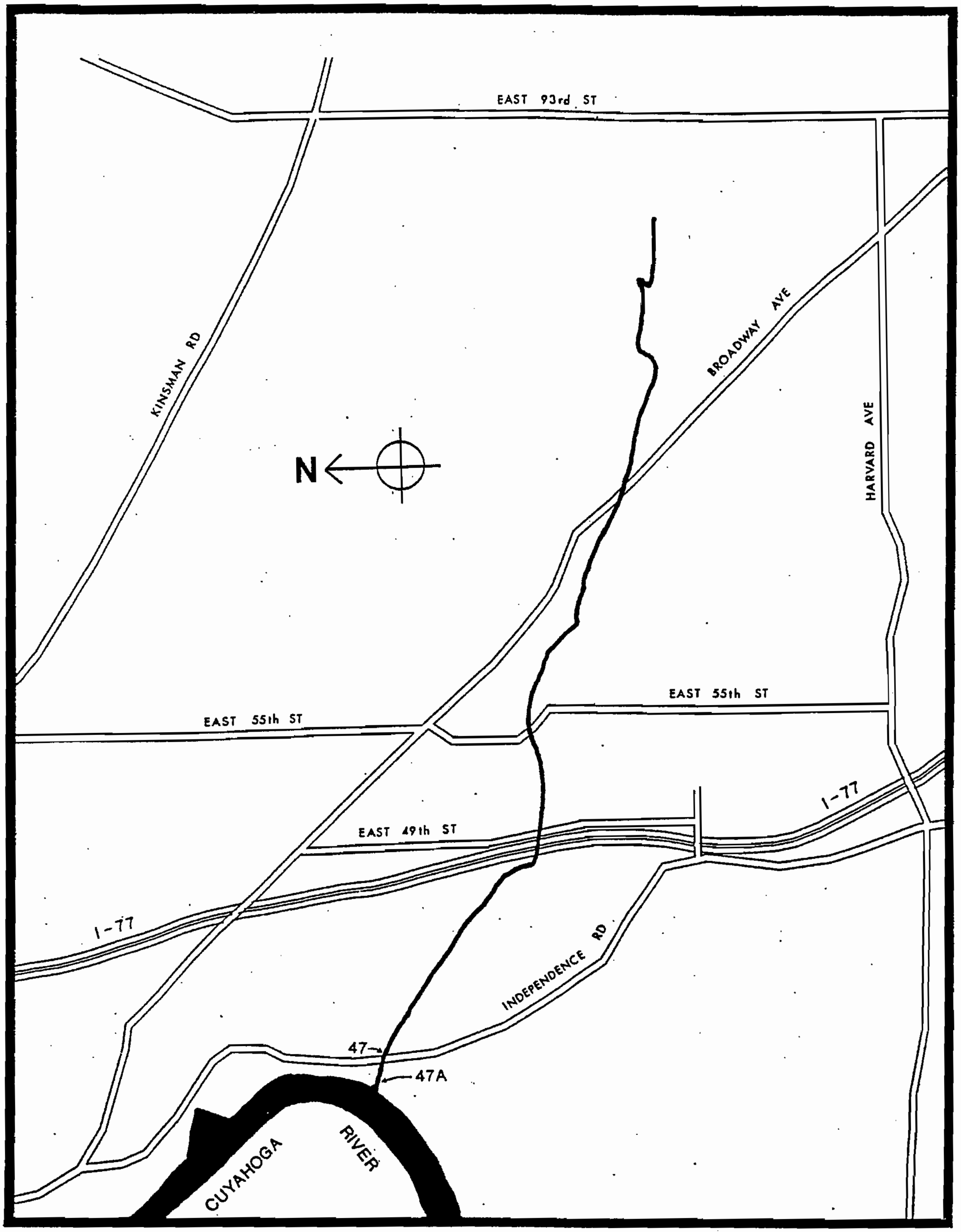
SAMPLING

Morgana Run has been assigned two sampling locations for routine chemical and bacteriological analysis (Figure 23).

Site #47-A

Site #47-A is located at the mouth of Morgana Run where it enters the Cuyahoga River. This location was selected in 1989 to include the LTV Steel Company's treated coke plant effluent into Morgana Run.

In 1989, Site #47-A was sampled twice for chemical and bacteriological analyses (Appendix II-O). The chemical analysis of the water at Site #47-A in 1989 showed three parameters (ammonia, mercury, and iron) with exceedances of the Ohio EPA numerical criteria for



Morgana Run
(NOT TO SCALE)

Figure 23

Warmwater Habitat. Ammonia was measured on August 15 at 35.5 mg/L, compared to the 5.3 mg/L criterion, and on October 31 at 15.5 mg/L, compared to the 5.8 mg/L criterion. Mercury was measured at 0.2 ug/L and 0.6 ug/L on August 15 and October 31, respectively, compared to the criterion of 0.012 ug/L. Iron was measured at 3.6 mg/L and 1.6 mg/L, on August 15 and October 31, respectively, compared to the 1.0 mg/L criterion. Also noted were elevated sulfate concentrations on August 15 (276 mg/L) and October 31 (244 mg/L). These elevated concentrations may be attributable to the LTV Steel Company's treated coke plant effluent, which constitutes most of the flow at Site #47-A in dry weather.

A single exceedance of the bacteriological criterion for fecal coliform was noted at Site #47-A in 1989 (Appendix II-O). On August 15, the fecal coliform concentration was measured at 600 organisms per 100 ml, which is below the Ohio EPA criterion for Primary Contact Recreational Use. However, on October 31, the fecal coliform concentration was measured at 23,000 organisms per 100 ml. A 1990 investigation into a possible contribution to this high bacterial concentration is discussed later in this report.

In 1990, Site #47-A was sampled once for chemical analysis, on October 2, and twice for bacteriological analysis, on January 23 and October 2 (Appendix III-O). The chemical data obtained at Site #47-A in 1990 indicated that three parameters exceeded water quality criteria for Warmwater Habitat: mercury, which was measured at 0.3 ug/L; ammonia, which was measured at 6.37 mg/L; pH, which was measured at 9.6 standard units. Also noted was a relatively high sulfate concentration (400 mg/L). These data are comparable to the previous year's sampling results and, again, may be attributable to the LTV Steel Company treated Coke Plant effluent discharge.

Bacteriological data from Site #47-A in 1990 indicated that the fecal coliform concentration (1,000 organisms per 100 ml) was below the Ohio EPA numerical criterion for Primary Contact Recreational Use and lower than the 1989 concentration of 23,000 organisms per 100 ml.

Since Morgana Run is entirely culverted, it is not conducive to sampling for benthic macroinvertebrates.

<u>Site #47</u>

Site #47 is located at a manhole on Independence Road, approximately 200 yards upstream of its confluence with the Cuyahoga River. This site is upstream of the LTV Steel Company Coke Plant effluent discharge. No sampling was performed at this location on Morgana Run in 1989.

In 1990, Site #47 was sampled once for chemical analysis and twice for bacteriological analysis (Appendix III-O). The chemical data indicated that the iron concentration and pH exceeded water quality criteria for Warmwater Habitat. On October 2, iron was measured at 1.1 mg/L and the pH was 9.3 standard units. Also noted were the chloride concentration of 356 mg/L and the sulfate concentration of 222 mg/L. Similar results had been obtained from this site in 1988. The elevated concentrations may be attributable to residual from run-off from the LTV Steel Company's bulk storage facility over Morgana Run immediately upstream of this location, which is discussed later in this report.

Bacteriological data (Appendix III-O) from Site #47 in 1990 indicated that the fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreation Use. Comparable bacteriological concentrations had been reported in 1988.

PROBLEMS AND REMEDIATION

-1-

During 1989, the NEORSD 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. 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 (2,400 ug/L); benzo(k)fluoranthene (1,950 ug/L); fluoranthene (1,850 ug/L); napthalene (900 ug/L); phenanthrene (1,500 ug/L); pyrene (1,800 ug/L); chrysene and/or benzo(a)anthracene (3,800 ug/L); benzo(b)fluoranthene and/or benzo(k)fluoranthene (5,800 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. Concentrations of several PAH's have been found at detectable levels in Cuyahoga River sediments downstream at River Mile 3.3 (Appendices V-C, VI-C, VII-M, VII-N, VII-S, VII-U, VII-V). Some PAH's have also been detected in sediments at other Cuyahoga River locations and may be attributable to additional sources. The possible relationship between these chemicals in coal pile run-off and tumors observed in bottom-feeding fishes downstream in the Cuyahoga River Shipping Channel is undergoing further study.

-2-

In January 1990, NEORSD investigators responded to several reports of oil entering the Cuyahoga River from Morgana Run. An inspection of the LTV Steel discharge "No. 090" at the intersection of Campbell Road and

Independence Road revealed the presence of an oil sheen similar in appearance to that noted in the river. This discharge is tributary to Morgana Run just upstream of its confluence with the river. These findings were reported to the LTV Steel Company's Environmental Control Department and to the U.S. Coast Guard.

-3-

Also in January 1990, Morgana Run was inspected to determine the source(s) of elevated bacteriological concentrations reported on October 31, 1989. NEORSD investigators walked the Morgana Run culvert, approximately 100 to 200 feet west of East 49th Street under Interstate 77, and obtained a sample from a 48-inch sewer tributary to the creek from the north under Interstate 77. The sample revealed a fecal coliform concentration of 200,000 organisms per 100 ml, indicating heavy contamination by sanitary sewage. A nearby combined sewer overflow structure was dye tested for leaks to the storm sewer, but the tests proved negative and the source(s) of sanitary sewage in this discharge remain unknown. The flow from this pipe was measured at approximately 100 gallons per minute but inspections have indicated that it is intermittent.

-4-

Finally, the NEORSD received a report of a 100-gallon spill of flushing liquor by the LTV Steel Company #1 Coke Plant on November 14, 1990. The majority of the spilled material reached the sanitary sewer, while a smaller portion entered the storm sewer tributary to Morgana Run. Approximately 10 gallons of this material could be seen floating on the surface of the Cuyahoga River at Morgana Run. The flushing liquor consisted of water, ammonium sulfate, sulfuric acid, and the constituents of coke oven gas (i.e., coal, coke, and tar). Clean-up measures were conducted by Samsel Services Company under contract with the LTV Steel Company.

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 sections of Cuyahoga Heights and Newburgh Heights. The total drainage area is 1,400 acres.

Tributary to Burke Brook are 13 combined sewer overflow (CSO) structures. These overflow structures receive flow from a drainage area of approximately 500 acres, which is over one third of the total drainage area of Burke Brook. Ten of these overflow structures are located on Burke Brook's main branch, east of Interstate 77. In July 1982, the NEORSD activated a diversion chamber east of Interstate 77, south of Fleet Avenue. This diversion chamber 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 Southerly Interceptor.

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 LTV Steel Company property northwest to its confluence with the Cuyahoga River at about River Mile 5.3.

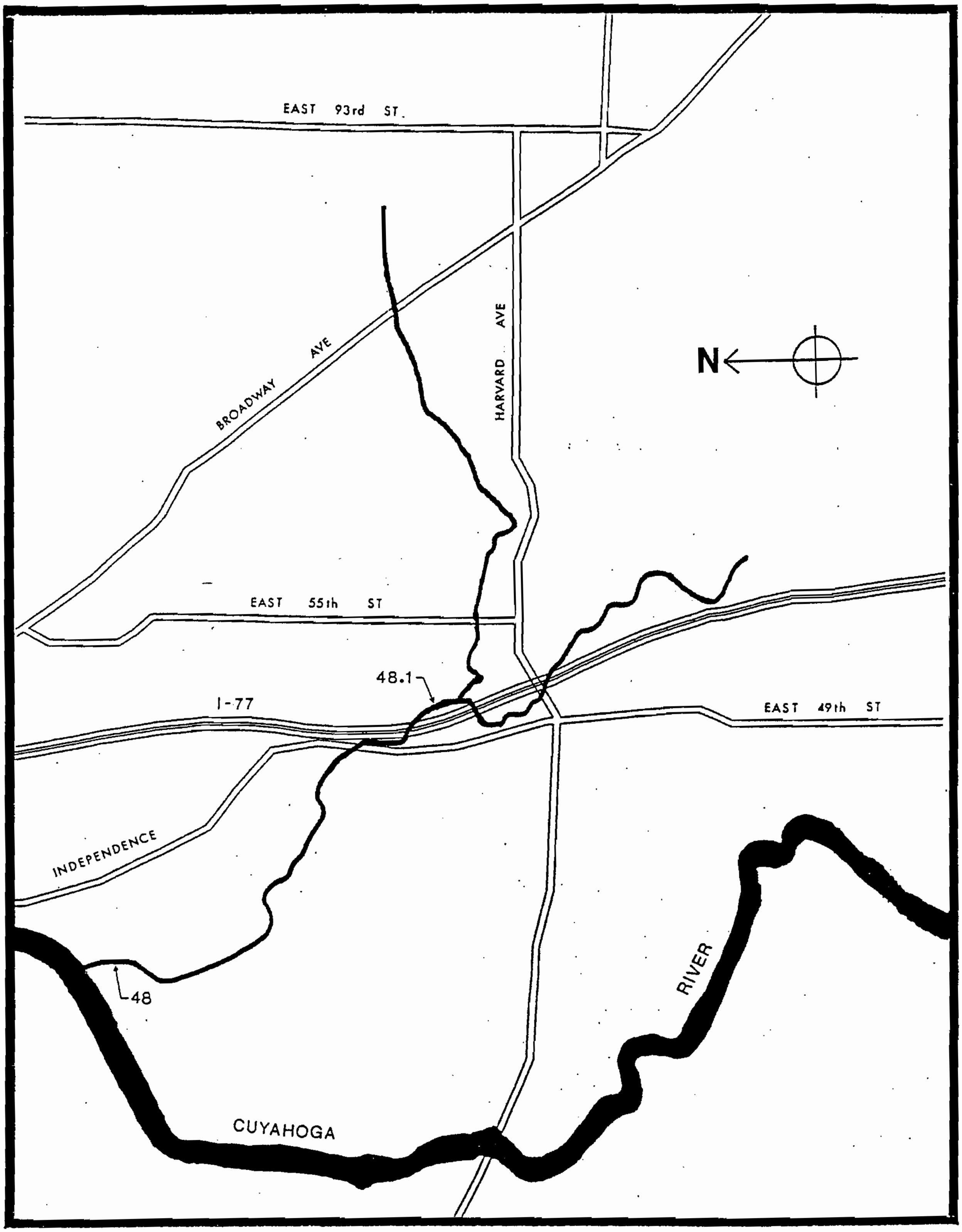
Three combined sewer overflow structures are presently not tributary to the NEORSD's diversion chamber: one on Grant Avenue east of Interstate 77 in Cuyahoga Heights, and one on Harvard Avenue west of Interstate 77 in Newburgh Heights, both of which are maintained by the NEORSD; one in the Washington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

Except for 0.3 total miles of open section on both sides of Interstate 77, the entire length of Burke Brook is culverted. In November 1988, NEORSD investigators obtained flow data near the mouth, on LTV Steel Company property, which indicated that 1.4 million gallons per day was entering the Cuyahoga River from Burke Brook in dry weather.

Burke Brook has been designated Warmwater Habitat and Primary Contact Recreational Use by the Ohio EPA.

SAMPLING

Burke Brook has been assigned two sampling locations for routine chemical and biological analysis. Site #48 (Figure 24) is located in an open chamber on the double barrel culvert on LTV Steel Company property, about 200 yards upstream of the brook's confluence with the Cuyahoga River.



Burke Brook
(NOT TO SCALE)

Figure 24

Site #48.1 (Figure 24) is located off Independence Road, south of Fleet Avenue, on the open section of Burke Brook's main stem, just east of Interstate 77, downstream from the former confluence of the main and south branches.

Site #48

Site #48 was grab sampled twice in 1989 for chemical analysis (Appendix II-P). On both occasions, the ammonia concentration (43.1 mg/L on August 15 and 17.8 mg/L on October 31) exceeded the Ohio EPA numerical criterion in Water Quality Standards for Warmwater Habitat. An exceedance of the Ohio EPA criterion for Warmwater Habitat was noted for mercury (0.4 ug/L) on October 31. All other chemical data were within water quality criteria for Warmwater Habitat. Also noted were the elevated average chloride concentration (471 mg/L) and sulfate concentration (266 mg/L). The specific conductance (2,580 umhos/cm) obtained at Site #48 on August 15 was also high. All of the chemical data are comparable to results obtained in previous years. Some of these elevated concentrations may be partly attributable to run-off from the LTV Steel Company's bulk coal and coke ore storage area, which is located adjacent to the culvert.

Site #48 was grab sampled twice in 1989 for bacteriological analysis, (Appendix II-P). The fecal coliform concentration (20,000 organisms per 100 ml) measured at Site #48 on August 15 exceeded the Ohio EPA numerical criterion for Primary Contact Recreational Use. The 1989 fecal coliform concentrations were lower than in 1988 (83,000 organisms per 100 ml). The source of this contamination is discussed later in this report.

No qualitative benthic macroinvertebrate sampling was conducted at Site #48 in 1989. Since this site is located within a culvert, the habitat is not conducive to benthic sampling.

No chemical, bacteriological, or benthic samples were collected from Site #48 in 1990.

Site #48.1

Site #48.1 (Appendix II-P) was grab sampled twice in 1989 for chemical analysis. Exceedances of the Ohio EPA numerical criterion for ammonia were noted on August 15 (207 mg/L) and October 31 (36.4 mg/L). An exceedance of the Ohio EPA criterion for Warmwater Habitat was noted for mercury. All of the other chemical data were within the Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Site #48.1 was grab sampled twice in 1989 for bacteriological analysis (Appendix II-P). The fecal coliform concentrations were below the Ohio EPA numerical criterion for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates was conducted in 1989 at Site #48.1, on September 25 (Appendix VIII-CC). Two taxa were collected and identified at this location. Both of the taxa (Physella sp. and oligochaetes) are described in literature as tolerant in their responses to organic pollution. Only a few individual organisms of each taxon were collected. This low diversity and low number of individuals indicate that the water quality of this area may be detrimentally impacted by the high ammonia concentrations, combined sewer overflows, and/or run-off from Interstate 77. While collecting macroinvertebrates, an oil sheen was visible when rocks and other debris were overturned or disturbed. This oil may be attributed to run-off from Interstate 77, which is just to the west of this location. Further investigation will be necessary to determine to what extent industrial and nonpoint source run-off may be contributing to the condition of Burke Brook.

No sampling was conducted at Site #48.1 in 1990.

PROBLEMS AND REMEDIATION

-1-

Since the construction of the NEORSD's Burke Brook diversion chamber, dry weather flow 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 due to maintenance work on the diversion chamber. In 1989, NEORSD Sewer Control Systems recorded only seven overflow events at the diversion chamber, which had a total duration through the year of three hours, 35 minutes. In 1990, there were eight overflow events recorded, with a total duration through the year of eight hours, 54 minutes.

-2-

In March of 1989, NEORSD investigators responded to a report of a surcharged manhole overflowing sewage into Burke Brook. The manhole is located where the open section of the brook becomes culverted just east of Interstate 77 and Raus Avenue. The surcharge condition was due to a blockage of the overflow structure referred to by NEORSD Sewer Maintenance & Control personnel as S-74-A. The blockage was cleared by an outside contractor, who removed debris on March 14. The dry weather overflow was eliminated by March 15. This structure (S-74-A) has been included in the Southerly Tributary Area Overflow Inspection Route Book for monitoring by NEORSD Sewer Maintenance and Repair crews.

-3-

On July 27, 1989, NEORSD Investigators responded to a reported oil spill at M. Weingold & Company Scrap Iron-Metals and Rubbish, 3920 East 91st Street. Water-soluble oil was flowing from a spill on the property into a catch basin that is tributary to Burke Brook. The spill was contained that day and clean-up was completed subsequently.

-4-

On September 19, 1989, NEORSD personnel conducted a walk-through inspection of the Burke Brook culvert. Approximately 8,400 feet of the culvert was inspected, from the mouth of the culvert near the Cuyahoga River upstream to the open section just east of Interstate 77. Fifteen connections to the culvert were noted but none of them exhibited any obvious visual evidence of contamination during the inspection. Two of these connections were from the LTV Steel Company's bulk coal and coke storage area. Wet weather run-off from coal and coke piles may enter the Burke Brook culvert upstream of Site #48 and contribute to elevated concentrations noted at this sample location.

-5-

In September and October of 1989, NEORSD investigators collected water samples from the small stream which flows through the East 29th Street Landfill north of Harvard Avenue and Bert Avenue and is tributary to the Burke Brook culvert upstream of Site #48. According to an Oak Ridge Associated Universities report (1985), this landfill is known to have been contaminated by depleted uranium-235, uranium oxide, antimony slag, and slag containing uranium and thorium decay series radionuclides. The landfill also reportedly contained materials contaminated with cadmium, chromium, lead, silver, nickel, iron, copper, zinc, cobalt, barium, and trichloroethylene. Plans for decontamination were subsequently made, and in 1990 the decontamination was in progress. The East 29th Street Landfill is now fenced off and plans to fill the ravine and culvert the stream are being considered.

During the 1989 NEORSD sampling, it was determined that an average of 90,000 gallons per day of surface water and groundwater run-off entered the Burke Brook tributary from the landfill during dry weather conditions. On September 1, a sediment sample was obtained for analysis from the bottom of the Burke Brook tributary within the landfill. The analysis indicated elevated dry-basis sediment concentrations of nickel (9,600 mg/kg), zinc (1,900 mg/kg), iron (33,000 mg/kg), mercury (1.9 mg/kg), lead (440 mg/kg), copper (290 mg/kg), and cadmium (60 mg/kg).

On September 12, grab samples for chemical analysis were obtained from the tributary water downstream of the landfill, material in a drum located in the landfill, and water from two small landfill run-off tributaries to the stream. The sample obtained from the tributary water downstream of the landfill contained elevated concentrations of nickel (0.70 mg/L), copper (0.06 mg/L), mercury (0.4 mg/L), and cadmium (0.04 mg/L). A composite grab sample of the two small run-off tributaries also had elevated metals concentrations for nickel (7.9 mg/L), copper (0.14 mg/L), zinc (1.00 mg/L), iron (12 mg/L), cadmium (0.05 mg/L), and mercury (0.5 ug/L). The elevated metals concentrations detected in the water samples are consistent with the types of materials found in the landfill. A drum in the landfill was found to contain elevated concentrations of nickel (1,630 mg/L), copper (4.2 mg/L), zinc (8.00 mg/L), iron (960 mg/L), lead (1.16 mg/L), and cadmium (0.10 mg/L). Also measured in the drum was a low pH (0.3 standard units).

Automatic samplers were installed at locations upstream of the landfill run-off and downstream just before the tributary enters a 36-inch culvert. 24-hour composite samples were obtained on September 28 and 29 and on October 2, 3, 4, and 5. On September 28, there were elevated concentrations of nickel (1.25 mg/L), copper (1.60 mg/L), zinc (0.36 mg/L), and lead (1.25 mg/L) at the upstream location. The sanitary sewer overflow at East 42nd Street and Alpha Avenue, which is discussed later in this report, is believed to have been contributory to these upstream levels.

Chemical analysis of samples obtained downstream in the tributary indicates that landfill run-off and/or sediment resuspension contributed to elevated nickel and iron concentrations. Calculations indicate that, through the landfill, average increases in loadings of 1.2 pounds of nickel per day and 1.1 pounds of iron per day were occurring in the Burke Brook tributary. No other significant metals loading increases attributable to the landfill were indicated by this sampling.

On October 4, samples were collected for priority pollutant organics and antimony from the tributary water upstream of the landfill and from landfill runoff. There were no detectable concentrations in the upstream sample except for tentatively identified non-priority pollutants. The only substances detected in the run-off sample were antimony (0.65 mg/L), and tentatively identified non-priority pollutants.

-6-

On October 3, 1989, a grab sample for bacteriological analysis was obtained from the small tributary to Burke Brook at a location upstream of the East 29th Street Landfill, and the fecal coliform concentration (greater than 60,000 organisms per 100 ml) exceeded the Ohio EPA numerical criterion for Primary Contact Recreational Use. Also noted was a low dissolved oxygen concentration (4.4 mg/L).

On October 5, 1989, NEORSD investigators discovered a dry weather sanitary sewage overflow at East 42nd Street and Alpha Avenue. This discharge had a flow rate of approximately 280,000 gallons per day and was partially caused by a blockage in the sanitary sewer. The blockage was removed that day by NEORSD investigators, but 76,000 gallons per day of sanitary sewage continued to overflow the weir because it lacked sufficient height. This condition was reported to the Village of Newburgh Heights and remediation was planned. On July 13, 1990, NEORSD investigators inspected the overflow structure at East 42nd Street and Alpha Avenue and found that due to low flow conditions, the sanitary sewage had ceased overflowing. However, at the time of the inspection the sanitary sewage was only three quarters of an inch from overflowing the weir.

EUCLID CREEK

Euclid Creek's drainage area includes the communities of Cleveland, Euclid, Highland Heights, Richmond Heights, Willoughby Hills, Lyndhurst, and South Euclid. The total drainage area is approximately 15,500 acres, and the creek has a length of 9.5 miles. The average daily flow of Euclid Creek has been about 16 million gallons per day during dry weather according to past measurements.

With the exception of a culverted section under Interstate 90, the creek is predominantly open. The section between Lake Shore Boulevard 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 Avenue Bridge.

Euclid Creek has been designated Warmwater Habitat and Primary Contact Recreational Use by the Ohio EPA.

SAMPLING

The NEORSD has selected five locations on Euclid Creek which are routinely sampled for chemical, bacteriological, and benthic analysis (Figure 25).

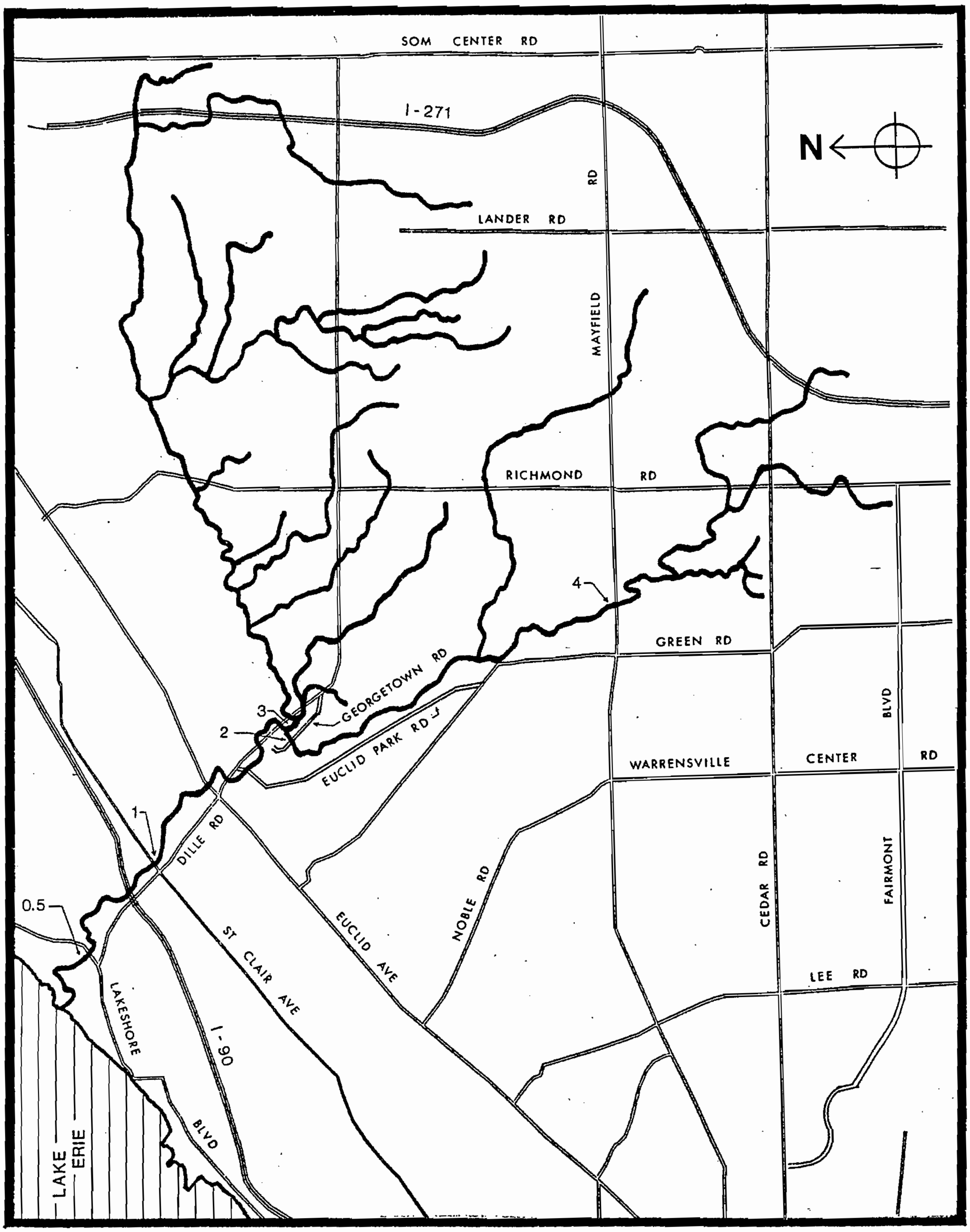
Site #0.5

Site #0.5 is located about 150 feet downstream of Lake Shore Boulevard (Figure 25). The width of the creek at this point is approximately 25 feet. The substrate consists primarily of cobble, gravel, and sand. It is surrounded by steep banks and vegetation, with no overhanging trees. Site #0.5 was selected in 1990 to reflect the environmental impact on Euclid Creek from several upstream storm sewer outfalls, and this location is the furthest downstream sampling site prior to its discharge into Lake Erie.

In 1990, Site #0.5 was sampled once for chemical and bacteriological analysis (Appendix III-P). The 1990 chemical data showed one parameter with an exceedance of the numerical criteria for Warmwater Habitat. Iron was measured at 1.2 mg/L, on October 2. All other chemical data for 1990 at Site #0.5 were within water quality criteria for Warmwater Habitat.

Bacteriological data from Site #0.5 in 1990 (Appendix III-P) showed that the fecal coliform concentration (less than 10 organisms per 100 ml on October 2) was well below the Ohio EPA criterion for Primary Contact Recreational Use. Historical City of Cleveland records indicate that the fecal coliform concentration in Euclid Creek at this location had been as high as 100,000 organisms per 100 ml (July 5, 1972).

No benthic macroinvertebrate sampling was performed in 1990 at Site #0.5.



Euclid Creek
(NOT TO SCALE)

Figure 25

Site #1

Site #1 is located about 10 feet south of the St. Clair Avenue bridge (Figure 25). The stream at Site #1 is approximately 10 feet wide and the substrate consists of boulders, cobble, gravel and sand. It is surrounded by vegetation with moderate tree overhang.

In 1989, Site #1 was sampled on three occasions for chemical analysis and twice for bacteriological analysis (Appendix II-Q). The 1989 chemical data showed zinc with one exceedance, mercury with two exceedances, and iron with three exceedances of the water quality criteria. Zinc was measured at 0.31 mg/L on July 25. Mercury was measured at 0.2 ug/L on April 20 and November 13. Iron was measured at 1.2 mg/L on July 25 and November 13, and 1.9 mg/L on April 20. All other 1989 chemical data from Site #1 were within Ohio EPA water quality criteria for Warmwater Habitat.

The exceedances may be attributable to a 42-inch storm sewer outfall, upstream of Site #1. This situation is discussed later in the report.

Bacteriological data from Site #1 in 1989 (Appendix II-Q) showed one exceedance of the Ohio EPA numerical criterion for Primary Contact Recreational Use, on July 25, when the fecal coliform concentration was measured at 2,400 organisms per 100 ml. The November 13 fecal coliform concentration (90 organisms per 100 ml) was well below the Ohio EPA criterion and was comparable to data obtained at this site in 1987. No samples had been collected for the NEORSD Stream Monitoring Program from Euclid Creek in 1988.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #1 in 1989 and 15 taxa were collected (Appendix VIII-DD). Of these, most are described in literature as facultative in their responses to organic pollution. This was an increase from the three taxa collected in 1987 and may be attributed to the elimination of backwash formerly discharged to Euclid Creek from the Nottingham Water Filtration Plant. In May 1987, this backwash had been redirected to the sanitary sewer system. The backwash discharge had been responsible for high suspended solids loadings to Euclid Creek at Site #1 in previous years. The increase in the number of taxa collected in 1989 may reflect improved water quality resulting from this remediation.

In 1990, Site #1 was sampled once for chemical and bacteriological analysis (Appendix III-P). Chemical data obtained at Site #1 in 1990 indicated that all parameters were within Ohio EPA water quality criteria for Warmwater Habitat with the exception of iron. The iron concentration was measured at 2.6 mg/L on October 2. This indicates that this section of Euclid Creek continues to be impacted by the 42-inch storm sewer outfall upstream of Site #1. This problem is discussed in detail later in this report.

Bacteriological data from Site #1 in 1990 (Appendix III-P) showed that the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use. Comparable results had been obtained in 1987.

Qualitative sampling for benthic macroinvertebrates at Site #1 in 1990 produced eleven taxa (Appendix IX-O). The majority of the taxa are described as facultative in their responses to organic pollution. One intolerant Dipteran (Pagastia sp.) was also collected. These data, especially the presence of an intolerant organism, indicate that the benthic community at Site #1 has maintained its improvement since the 1987 remediation upstream.

Site #2

Site #2 (Figure 25) is located on the South Branch of Euclid Creek in the Highland Picnic Area of the Cleveland Metroparks Euclid Creek Reservation, about 100 feet upstream of its confluence with the North Branch. The width of the creek at this point is approximately 15 feet. The substrate consists of bedrock, boulders, gravel, and sand. The banks are steep and surrounded by vegetation with moderate tree overhang.

In 1989, Site #2 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-Q). Chemical analyses of samples obtained in 1989 indicated that all parameters were within the Ohio EPA water quality criteria for Warmwater Habitat with the exception of mercury, which was measured at 0.3 ug/L on April 20. The chemical data from Site #2 in 1989 were comparable to those obtained at this site in 1987.

Bacteriological data from Site #2 in 1989 (Appendix II-Q) indicated that all fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. Bacteriological concentrations in 1989 were comparable to the levels recorded in 1987.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #2 in 1989 (Appendix VIII-EE) and 15 taxa were collected, most of which are described in literature as facultative in their responses to organic pollution. These findings are comparable to those of 1987 and indicate that Site #2 has good water quality.

In 1990, Site #2 was sampled once for chemical and bacteriological analysis (Appendix III-P). All 1990 chemical data from this location were within the Ohio EPA criteria in Water Quality Standards for Warmwater Habitat and were comparable to those obtained in the previous year.

Bacteriological analysis at Site #2 in 1990 (Appendix III-P) showed that the fecal coliform concentration (less than 10 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than in previous years.

Qualitative sampling for benthic macroinvertebrates was performed at Site #2 in 1990 (Appendix IX-P) with nine, predominantly facultative, taxa collected. These data are comparable to previous data and indicate that Site #2 has good water quality.

Site #3

Site #3 (Figure 25) is located on the North Branch of Euclid Creek in the Highland Picnic Area of the Cleveland Metroparks Euclid Creek Reservation, about 100 feet upstream of the confluence with the South Branch. The stream is about 20 feet wide and the substrate consists of bedrock, boulders, cobble, gravel, and sand. It is surrounded by steep banks with vegetation and moderate tree overhang.

In 1989, Site #3 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-Q). Chemical analyses of samples obtained at Site #3 in 1989 indicated that all parameters were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat, with the exception of zinc, which was measured at 0.80 mg/L on July 25. All other chemical data are comparable to those obtained in 1987.

Bacteriological analysis at Site #3 in 1989 (Appendix II-Q) indicated that all fecal coliform concentrations (10 to 100 organisms per 100 ml) were well below the Ohio EPA criterion for Primary Contact Recreational Use and were lower than the 1987 fecal coliform concentrations (280 to 4,200 organisms per 100 ml).

Qualitative sampling for benthic macroinvertebrates was performed twice at Site #3 in 1989 (Appendix VIII-FF). Benthic macroinvertebrates collected totaled 18 taxa on May 5 and 20 taxa on October 12. The majority of these organisms are described in literature as facultative in their responses to organic pollution. Comparable results had been obtained in 1987 at this location.

In 1990, Site #3 was sampled once for chemical and bacteriological analysis (Appendix III-Q). All 1990 chemical data from this location were within the Ohio EPA water quality criteria for Warmwater Habitat. Chemical data from Site #3 in 1990 were comparable to those obtained at this site in previous years.

Bacteriological analysis at Site #3 in 1990 (Appendix III-Q) showed that the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use. These results are comparable to the previous years' bacteriological concentrations, which were also below the Ohio EPA numerical criteria.

Qualitative sampling for benthic macroinvertebrates was performed at Site #3 in 1990 (Appendix IX-Q) and 30 taxa were collected, including one dipteran taxon (*Phaenopsectra* sp.) which is described in literature as intolerant in its response to organic pollution. This was an increase in the diversity of organisms collected compared to the benthic sampling from 1989. These findings, especially the presence of an intolerant taxon, suggest that the water quality of Euclid Creek at Site #3 was good in 1990.

Site #4

Site #4 (Figure 25) is located on the South Branch, adjacent to the South Euclid-Lyndhurst Public Library, 4645 Mayfield Road. The width of the creek at this point is approximately 15 feet. The substrate consists of boulders, cobble, gravel, and sand. The creek is surrounded by vegetation with moderate tree overhang.

In 1989, Site #4 was sampled on three occasions for chemical and bacteriological analysis (Appendix II-Q). With the exception of mercury, which exceeded the Ohio EPA criterion on two occasions, all chemical data were within water quality criteria for Warmwater Habitat. Mercury was measured at 0.2 ug/L on April 20 and July 25. All other chemical data were comparable to those obtained at this location in 1987.

Bacteriological data from Site #4 in 1989 (Appendix II-Q) showed that all fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. Similar results had been obtained from this site in 1987.

Qualitative sampling for benthic macroinvertebrates at Site #4 in 1989 produced ten taxa (Appendix VIII-GG). The majority of these taxa are described in literature as facultative in their responses to organic pollution. These data indicate that this section of Euclid Creek has fair to good water quality.

In 1990, Site #4 was sampled once for chemical and bacteriological analysis (Appendix III-Q). All 1990 chemical data from Site #4 were within water quality criteria for Warmwater Habitat and were comparable to those of the previous years.

Bacteriological data from Site #4 in 1990 (Appendix III-Q) showed that the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than in previous years.

Qualitative sampling for benthic macroinvertebrates was performed at Site #4 in 1990 with ten taxa collected (Appendix IX-R). The data continued to reflect fair to good water quality at Site #4 in 1990.

PROBLEMS AND REMEDIATION

-1-

In July, 1987, WQIS investigators inspected a 42-inch storm sewer outfall to Euclid Creek, upstream of Site #1 and behind Cleveland Metal

Cleaning Corporation at 1423 Dille Road. Intermittent discharges from this outfall have been responsible for incidents throughout the period of 1987 to 1990, during which Euclid Creek has turned an orange color downstream of the outfall. This storm sewer, which originates on the property of the Inland Division of the General Motors Corporation on Euclid Avenue, runs east past Dille Road north of Cleveland Metal Cleaning Corporation to Euclid Creek.

Numerous samples taken in 1989 and 1990 from this 42-inch storm sewer outfall indicate high concentrations of suspended solids (200 to 818 mg/L) and iron, which was especially elevated (14 to 660 mg/L). Additionally, low pH levels were noted (2.9 to 6.1 standard units). Iron solids, present in the storm sewer discharge, have accumulated, causing a build-up of iron sludge on the creek bed. A 1990 City of Euclid-contracted video inspection of this storm sewer revealed badly decomposed joints, several cracks in the top of the pipe and numerous points of infiltration in the vicinity of Cleveland Metal Cleaning Corporation, which has a steel pickling operation. Presently, this situation is being investigated by the Ohio EPA.

-2-

On September 6, 1990, NEORSD investigators sampled Euclid Creek at Richmond Road north of Ridgebury Boulevard, as requested by the Lyndhurst Engineering Department, to determine the fecal coliform concentration and source of septic odor in this pooled section of the creek. The creek was sampled downstream of a sanitary sewer overflow structure on Richmond Road. The fecal coliform concentration (5,700 organisms per 100 ml) indicated that there is a source of sanitary sewage contamination in the culvert during dry weather. The source of contamination has not been determined. There are three possible sources of the reported sanitary sewage odor at the location: first, since the flow coming from the culvert outlet evidently contains some sanitary sewage, it could emit an odor; a second possible source is the pooled area, which has sanitary sewage sludge settled on the bottom; finally, air from the sanitary sewer's atmosphere, through the overflow pipe to the culvert, is a third possible source of odor. The Lyndhurst Engineering Department has been apprised of this situation.

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. Green Creek is culverted for 2.3 miles, from Euclid Avenue to Lake Erie. The average slope is 80 feet per mile, or 1.5%. The flow to Lake Erie was measured at 1.1 million gallons per day in dry weather on October 24, 1989. Green Creek has been designated Limited Resource Water and Primary Contact Recreational Use by the Ohio EPA.

SAMPLING

Green Creek has been assigned three sample sites (Figure 26) by NEORSD Environmental Assessment for routine chemical and biological sampling: 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.

Site #5

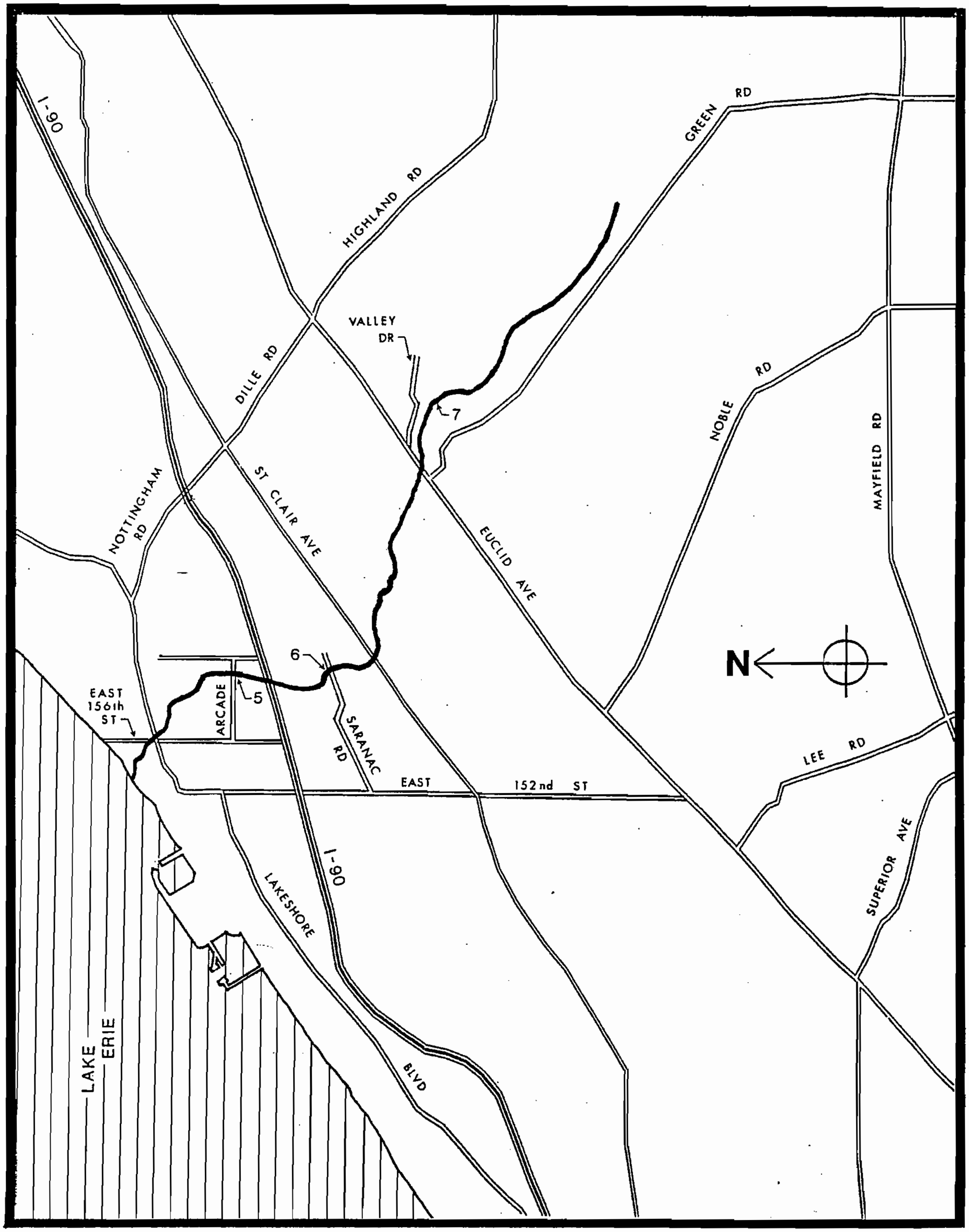
The culvert at Site #5 is 8 feet wide by 4 feet high. The average depth of the creek during dry weather is approximately 4 inches.

Site #5 was grab sampled once in 1989 for chemical analysis, on October 24 (Appendix II-R). An exceedance of the Ohio EPA water quality criterion for Limited Resource Water was noted for mercury (0.2 ug/L). All other chemical data were within the water quality criteria for Limited Resource Water. These results are comparable to chemical data obtained in 1987; no samples were collected in 1988 on Greek Creek.

Site #5 was grab sampled once in 1989 for bacteriological analysis, on October 24 (Appendix II-R). The fecal coliform concentration (7,000 organisms per 100 ml) exceeded the criterion for Primary Contact Recreational Use. The results are comparable to those obtained in 1987. The bacteriological data indicate that sanitary sewage may be tributary to the culverted portion of the creek. This problem will be discussed later in the report.

No benthic macroinvertebrate sampling was conducted at this culverted location in 1989 or 1990.

Site #5 was grab sampled once in 1990 for chemical analysis, on October 17 (Appendix III-R). All of the 1990 chemical data were within water quality criteria for Limited Resource Water. These data are comparable to results obtained in 1987 and 1989.



Green Creek
(NOT TO SCALE)

Figure 26

Site #5 was grab sampled once in 1990 for bacteriological analysis, on October 17 (Appendix III-R). The 1990 bacteriological data were below the Ohio EPA criterion for Primary Contact Recreational Use. The fecal coliform concentration (1,200 organisms per 100 ml) was lower than those measured in 1989 (7,000 organisms per 100 ml) and in 1987 (1,600 and 21,000 organisms per 100 ml). These data indicate that the water quality at Site #5 may have improved. Further sampling is required to verify this trend.

Historical City of Cleveland records indicate that the fecal coliform concentration in Green Creek near this location, at Lake Shore Boulevard, had been as high as 240,000 organisms per 100 ml (May 16, 1972).

Site #6

Site #6 is located on an open section of Green Creek. Flow data obtained at Site #6 on October 24, 1989 during dry weather was calculated to be 1.0 million gallons per day.

Site #6 was grab sampled once in 1989 for chemical analysis, on October 24 (Appendix II-R). An exceedance of the Ohio EPA water quality criterion for Limited Resource Water was noted for mercury (0.4 ug/L). All other 1989 chemical data were within Ohio EPA water quality criteria for Limited Resource Water. These results are comparable to data obtained in 1987.

Site #6 was grab sampled once in 1989 for bacteriological analysis, on October 24 (Appendix II-R). The fecal coliform concentration (5,500 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use and was comparable to data obtained at this site in 1987. A possible source of bacterial contamination at this site is discussed later in the report.

No benthic macroinvertebrate sampling was conducted at Site #6 in 1989 or 1990.

Site #6 was grab sampled once in 1990 for chemical analysis, on October 17 (Appendix III-R). All of the 1990 chemical data were within the Ohio EPA water quality criteria for Limited Resource Water. These results are comparable to results from 1987 and 1989.

Site #6 was sampled once in 1990 for bacteriological analysis, on October 17 (Appendix III-R). The fecal coliform concentration of greater than 6,000 organisms per 100 ml exceeded the Ohio EPA criterion for Primary Contact Recreational Use. This indicates that Site #6 continues to be contaminated by sanitary sewage.

Site #7

Site #7 is located south of Euclid Avenue on Upper Valley Drive. Samples and measurements are obtained at the downstream end of the open creek, before it enters the culvert. The creek is about six feet wide at this location and has an average depth of four inches during dry weather. Flow data was obtained at Site #7 on October 24, 1989, and the flow was calculated to be approximately 0.3 million gallons per day. This location has man-made walls about four feet high on both sides, and a metal grate which functions as a debris screen just upstream of the sample site. The substrate consists of small pebbles and gravel. There is no tree overhang at this site. There are no riffles, only a short waterfall from under the debris screen.

Site #7 was sampled once in 1989 for chemical analysis, on October 24 (Appendix II-R). An exceedance of the Ohio EPA criterion for Limited Resource Water was noted for mercury (0.3 ug/L). All other chemical data were within the Ohio EPA water quality criteria for Limited Resource Water. These results are comparable to those obtained in 1987.

Site #7 was grab sampled once in 1989 for bacteriological analysis, on October 24 (Appendix II-R). The fecal coliform concentration (40 organisms per 100 ml) was well below the criterion for Primary Contact Recreational Use. These results are comparable to results obtained in 1987.

Site #7 was sampled once for benthic macroinvertebrates in 1989, on November 13 (Appendix VIII-HH). Four taxa were collected from this site. Two of the taxa identified are described in literature as tolerant in their responses to organic pollution. Additionally, two large crayfish were noted but not identified. The low diversity of organisms collected may be attributable to seasonal variability. Because the 1989 sampling was conducted in November, further sampling of benthic macroinvertebrates is required before any conclusion can be made about the water quality based on the benthic community at this location.

Site #7 was grab sampled once in 1990 for chemical analysis, on October 17 (Appendix III-R). All of the 1990 chemical data were within the Ohio EPA water quality criteria for Limited Resource Water. These results are comparable to results from 1987 and 1989.

Site #7 was grab sampled once in 1990 for bacteriological analysis, on October 17 (Appendix III-R). The 1990 fecal coliform concentration (130 organisms per 100) was well below the Ohio EPA criterion for Primary Contact Recreational Use and comparable to data from 1987 and 1989.

No benthic macroinvertebrate sampling was conducted in 1990 at Site #7.

PROBLEMS AND REMEDIATION

On October 26, 1989, NEORSD investigators made an attempt to locate the source(s) of contamination by sanitary sewage in Green Creek's culverted section. Investigators inspected five combined sewer overflow (CSO) structures located upstream of Site #6. They found that all five CSO structures were in proper working order with no obstructions. The investigators did find that the leaping weir at Green Road and Euclid Avenue had small amounts of sanitary sewage entering the storm outlet due to the grade of the sewer and the velocity of the flow down the Green Road hill. This overflow site may be a possible source of minor sanitary sewage contamination in the creek. The elevated fecal coliform concentrations found at Site #6 may have been partially attributable to these conditions. Further investigation of this problem is warranted.

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. Historical measurements have indicated that Nine-Mile Creek's flow into Lake Erie is approximately 11.0 million gallons per day during dry weather.

Nine-Mile Creek is culverted from near its mouth at Lake Shore Boulevard to east of Belvoir Road 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 mainstem of Nine-Mile Creek south of Belvoir Boulevard, east of Hillside Avenue in East Cleveland, is also open.

The Ohio EPA has designated Nine-Mile Creek Warmwater Habitat and Primary Contact Recreational Use. The predominant land use around Nine-Mile Creek is residential.

SAMPLING

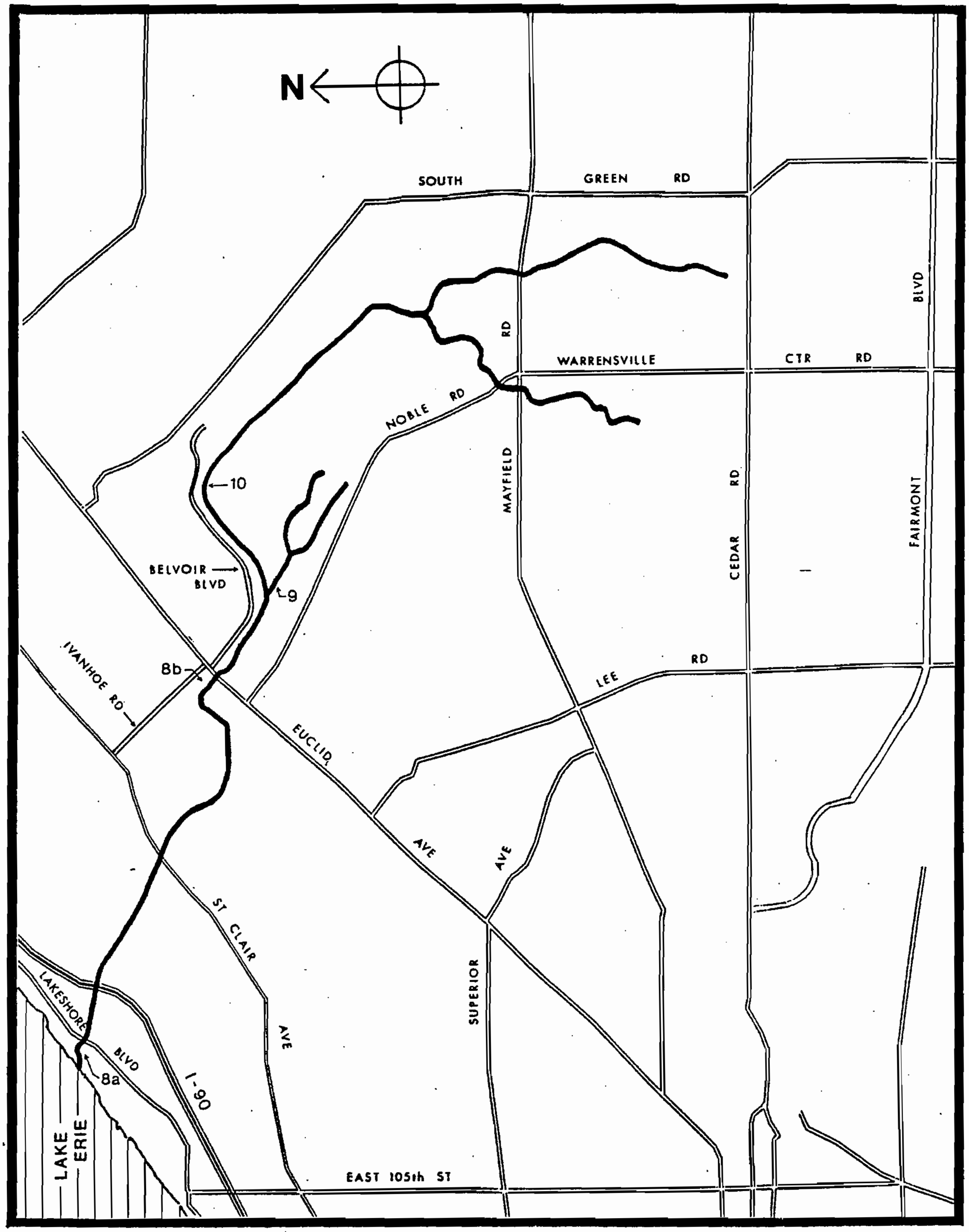
The NEORSD has selected four locations on Nine-Mile Creek which are routinely sampled for chemical, bacteriological, and benthic analysis (Figure 27).

Site #8a

Site #8a is located approximately 500 yards upstream of Nine-Mile Creek's confluence with Lake Erie. Samples are obtained about 50 feet north of the Lake Shore Boulevard bridge. The width of the creek at this location is approximately eight feet. The substrate consists primarily of gravel, silt, cobble, and septic sediment. There are steep banks on both sides of the creek with dense vegetation and some tree overhang.

Nine-Mile Creek was grab sampled on three occasions at Site #8a for chemical analysis in 1989 (Appendix II-S). Concentrations of two parameters exceeded the water quality criteria for Warmwater Habitat. Mercury was measured at 2.5 ug/L on August 18 and 0.9 ug/L on September 5, compared to the 0.012 ug/L criterion. Iron was measured at 2.2 mg/L on August 18. On that same date, the concentration of dissolved oxygen (1.0 mg/L) was lower than the minimum water quality criterion for Warmwater Habitat (4.0 mg/L). The remainder of the chemical data were within the applicable water quality criteria.

Nine-Mile Creek at Site #8a was sampled on five occasions in 1989 for bacteriological analysis (Appendix II-S). The fecal coliform concentrations ranged from 400 to 160,000 organisms per 100 ml, greatly



Nine-Mile Creek
(NOT TO SCALE)

Figure 27

exceeding the criterion for Primary Contact Recreational Use. This bacterial contamination is attributed to upstream sources of sanitary sewage, including a dry weather discharge to the creek at Site #8a which was discovered by investigators on September 5. This problem is discussed later in this report.

All of the chemical and bacteriological data obtained at Site #8a are comparable to data obtained in 1987. No water samples had been collected in 1988 at this location.

Site #8a was not sampled for benthic macroinvertebrates in 1989.

Site #8a was grab sampled once in 1990 for chemical analysis, on October 30 (Appendix III-S). All chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #8a was grab sampled once in 1990 for bacteriological analysis, on October 30 (Appendix III-S). The fecal coliform concentration (2,000 organisms per 100 ml) was at the Ohio EPA criterion for Primary Contact Recreational Use. This decrease in bacterial contamination is attributable to upstream remediation, including the elimination of the previously noted dry weather sanitary sewage discharge, which is discussed later in this report.

Historical City of Cleveland records indicate that the fecal coliform concentration in Nine-Mile Creek at this location had been as high as 1,400,000 organisms per 100 ml (June 13, 1972).

No benthic macroinvertebrates sampling was conducted at Site #8a in 1990.

Site #8b

Site #8b is located on the culverted section of the main stem of Nine-Mile Creek. This site is located at a manhole west of Ivanhoe Road and approximately 20 feet north of the railroad tracks which run perpendicular to Ivanhoe Road.

Site #8b was grab sampled twice in 1989 for chemical analysis (Appendix II-S). With the exceptions of iron and mercury, all chemical parameters were within the Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. Chemical data obtained on May 1 showed that the iron concentration (1.8 mg/L) and mercury concentration (0.2 ug/L) exceeded Ohio EPA water quality criteria.

Grab samples for bacteriological analysis were obtained twice in 1989 at Site #8b. (Appendix II-S). The bacteriological data indicate that Nine-Mile Creek at Site #8b continued to be contaminated by sanitary sewage. The fecal coliform concentrations (31,000 and 100,000 organism per 100 ml on May 1 and September 5, respectively) greatly exceeded the

Ohio EPA criterion for Primary Contact Recreational Use. These concentrations are comparable to those measured in previous years. Problems with sanitary sewage contamination upstream of Site #8b are discussed later in the report.

No benthic macroinvertebrate sampling was conducted at Site #8b in 1989, as it is culverted.

Site #8b was grab sampled once in 1990 for chemical analysis, on October 30 (Appendix III-S). All of the 1990 chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #8b was sampled once in 1990 for bacteriological analysis, on October 30 (Appendix III-S). The data indicate that this location was still heavily contaminated by sanitary sewage. The fecal coliform concentration (51,000 organisms per 100 ml) greatly exceeded the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological data are comparable to data measured in previous years.

No benthic macroinnvertebrate sampling was conducted at Site #8b in 1990.

Site #9

Site #9 on the Nine-Mile Creek "Nela Park" Branch is located one-quarter mile southeast of Euclid Avenue on the southwest side of Belvoir Boulevard. Samples are obtained just upstream of this branch's entry into the Nine-Mile Creek culvert. The width of the "Nela Park" branch at Site #9 is approximately six feet. This location is surrounded by very steep slopes with dense vegetation and tree overhang. A tributary of the "Nela Park" Branch flows from a box culvert about 300 feet upstream of the sample point. The substrate of the creek consists of boulders, cobble, rubble, and gravel. There are pools and riffles in the creek at this location.

Site #9 was grab sampled once in 1989 for chemical analysis, on September 5 (Appendix II-S). Elevated concentrations were noted for chlorides (336 mg/L), sulfates (246 mg/L), ammonia (6.19 mg/L), and total dissolved solids (1,154 mg/L). No concentrations exceeded the criteria in Ohio EPA Water Quality Standards for Warmwater Habitat, except the ammonia level would have exceeded the 30-day average criterion. Elevated levels of these parameters had also been noted at this site in 1987. The possibility that the concentrations may be related to leachate from a G.E. Nela Park landfill over the culverted tributary to the "Nela Park" Branch warrants further investigation.

Site #9 was sampled once in 1989 for bacteriological analysis, on September 5 (Appendix II-S). The fecal coliform concentration (600 organisms per 100 ml) was below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than the 1987 fecal coliform level (39,000 organisms per 100 ml). This improvement can be attributed to upstream remediation of a broken and leaking 12-inch sanitary sewer, which crosses the creek upstream of Site #9. This situation is discussed later in the report.

Site #9 was sampled once in 1989 for benthic macroinvertebrates, on September 13 (Appendix VIII-II). Only two taxa were collected and both are tolerant of organic pollution. The low diversity and presence of only tolerant organisms indicate that this site had been heavily impacted by organic pollution.

Site #9 was grab sampled for chemical analysis once in 1990 (Appendix III-S). An exceedance of the Ohio EPA water quality criterion for Warmwater Habitat was noted for mercury (0.2 ug/L) on October 30. All other 1990 chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Site #9 was grab sampled once in 1990 for bacteriological analysis on October 30 (Appendix III-S). The fecal coliform concentration (3,000 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use. The slightly elevated fecal coliform concentration may be attributable to continuing and/or recurring sewer system problems upstream in East Cleveland, which are discussed later in this report.

No benthic macroinvertebrate sampling was conducted at Site #9 in 1990.

Site #10

Site #10 is located on the main stem of Nine-Mile Creek, 10 feet upstream of its entry into the Nine-Mile Creek culvert. It is on the south side of Belvoir Boulevard about one-half mile east of Euclid Avenue. The width of the creek is approximately six feet. The substrate consists of bedrock, rubble, cobble, and man-made debris. The creek at this location is situated in a deep valley with steep slopes and banks on each side. There is extensive tree overhang with dense vegetation.

Site #10 was grab sampled on three occasions in 1989 for chemical analysis (Appendix II-S). Exceedances of the Ohio EPA Water Quality Criteria for Warmwater Habitat were noted for cadmium, mercury, and iron. Cadmium was measured at 0.06 mg/L on August 18, compared to the 0.01 mg/L criterion. Mercury was measured at 0.2 ug/L on May 1 and 1.0 ug/L on August 18. Exceedances were noted for iron on August 18 (2 mg/L) and September 5 (1.5 mg/L). The other 1989 chemical data were within the applicable numerical criteria and were comparable to 1987 data.

Site #10 was grab sampled on three occasions in 1989 for bacteriological analysis (Appendix II-S). On May 1, the fecal coliform concentration (38,000 organisms per 100 ml) greatly exceeded the Ohio EPA criterion for Primary Contact Recreational Use. This bacterial contamination is attributed to a dry weather discharge from a blocked sanitary sewer on Belvoir Boulevard. This situation is discussed later in the report. The remaining bacteriological data from August 18 (600 organisms per 100 ml) and September 5 (200 organisms per 100 ml) were well below the Ohio EPA criterion for Primary Contact Recreational Use. These results are comparable to those obtained at Site #10 in 1987.

Benthic macroinvertebrates were collected from Site #10 on September 13, 1989. Nine taxa were collected and identified (Appendix VIII-JJ). The majority of these organisms are described in literature as facultative, with several species described as tolerant, in their responses to organic pollution. This indicates that the water quality had been fair at this location.

Site #10 was grab sampled once in 1990 for chemical analysis, on October 30 (Appendix III-S). All of the 1990 chemical data were within Ohio EPA water quality criteria for Warmwater Habitat. The chemical data from 1990 are comparable to 1987 and 1989 data.

Site #10 was sampled once in 1990 for bacteriological analysis, on October 30 (Appendix III-S). The fecal coliform concentration (100 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use and was lower than any fecal coliform concentration measured at Site #10 in previous years.

No benthic macroinvertebrate sampling was conducted at Site #10 in 1990.

PROBLEMS AND REMEDIATION

-1-

On April 4, 1989, a NEORSD Sewer Maintenance & Repair crew discovered a surcharge condition in a 12-inch intercommunity sanitary sewer manhole on Belvoir Boulevard, east of Euclid Avenue, near Site #10. The City of East Cleveland Service Department was notified of this situation and agreed to remove the blockage in a sanitary sewer on Belvoir Boulevard. This manhole had previously been discovered surcharged in 1988, and a blockage was then relieved by the NEORSD's Sewer Maintenance and Repair crew. Subsequent to that remediation, the costs were billed to the communities of South Euclid and Cleveland Heights.

On May 1, 1989, water samples were obtained at Site #10, and the fecal coliform concentration was measured at 38,000 organisms per 100 ml. At the time of sampling the manhole was not surcharged, but pools of accumulated sanitary sewage debris were found in this section of Nine-Mile Creek. Although the blockage had evidently been relieved just prior to sampling, the residual sewage may have contributed to the elevated fecal coliform and metals concentrations noted on May 1. Due to the recurring nature of this problem, further monitoring of this location is warranted to ensure that the water quality in the creek is maintained.

-2-

On August 22, 1989, a NEORSD Sewer Maintenance & Repair crew discovered that the invert of a sanitary sewer located in a trench was missing and that sewage was flowing into the storm sewer below. This problem was on Hillside Avenue at Hillside Court, where the storm sewer is tributary to Nine-Mile Creek upstream of Site #8b.

The sanitary sewer was repaired but some of the sewer joints were found to be leaking. The NEORSD crew also found blockages and partial blockages in the storm sewers tributary to the culvert in this Hillside Avenue area. These blockages were causing exfiltration of stormwater and sanitary sewage. This exfiltration resulted in the formation of three sinkholes, which were approximately three feet to four feet in diameter; one sinkhole was measured at over eight feet deep. The City of East Cleveland was notified of the situation on August 29, 1989.

During the NEORSD inspection of the area, a 12-inch sanitary sewer on Hillsboro Road was found to be blocked and this situation was also reported to the City of East Cleveland.

The problems in this area were contributing to the high fecal coliform concentrations measured in Nine-Mile Creek at Site #8b from 1987 through 1990. Future sampling and investigations will be necessary to ensure remediation of these problems. The construction of NEORSD Heights-Hilltop Interceptor may aid in the relief of this heavily loaded sewer system.

-3-

On August 24, 1989, NEORSD investigators discovered a break in a 12-inch sanitary sewer, west of Atherstone Road and Langton Road, which crosses the "Nela Park" Branch of Nine-Mile Creek upstream of Site #9. The flow of sewage entering the creek from this source was measured at 0.3 million gallons per day. This break was responsible for significant contamination of the "Nela-Park" Branch of Nine-Mile Creek. Fecal coliform concentrations on this branch immediately downstream of the break were measured at greater than 300,000 organisms per 100 ml, which greatly exceeds the Ohio EPA criterion for Primary Contact Recreational Use. The City of Cleveland Heights Service Department was notified of the situation and the sewer was patched by August 28. Subsequent inspections by NEORSD investigators revealed that this source of pollution to Nine-Mile Creek had been eliminated. This remediation was reflected in the low fecal coliform concentration measured at Site #9 on September 5, 1989.

-4-

On September 5, 1989, NEORSD investigators discovered a dry weather discharge of sanitary sewage from an 18-inch storm sewer to Nine-Mile Creek, north of Lake Shore Boulevard at Site #8a. The source of this contamination was determined to be a blocked influent line to the sewage pumping station at this location. The Village of Bratenahl Service Department was informed of the situation, and on October 10, the NEORSD was informed that the problem had been corrected by bulkheading the pump station's emergency spillway.

The Village of Bratenahl has since replaced this pump station. This source of sanitary sewage had been contributed to the high fecal coliform concentration (160,000 organisms per 100 ml) and the low dissolved oxygen concentration (1.0 mg/L) measured on September 5 at Site #8a. Since replacement of the pump station, fecal coliform concentrations have been lower than in past years and even lower than the Ohio EPA criterion for Primary Contact Recreational Use, which was not exceeded in 1990. The sediment at Site #8a remains septic from deposition over the years and the low velocity of the water current. With the elimination of this and upstream sources of pollution in Nine-Mile Creek, future sampling should reflect continuing improvement in the water quality at this site.

-5-

During September 1989, NEORSD investigators attempted to trace the source of sanitary sewage and black solids accumulation in the culverted portion of Nine-Mile Creek between Lake Shore Boulevard and East 152nd Street. Three sample locations were chosen, two of which had access to both the east and the west barrels of the Nine-Mile Creek culvert. The locations were:

A) on the culvert at 955 East 140th Street (both east and west barrels);

B) on the culvert at the south end of Galewood Drive (both east and west barrels);

C) on the culvert at Woodworth Avenue and East 152nd Street.

Samples were obtained twice at each location for bacteriological analysis, on September 13 and 29. Elevated fecal coliform concentrations were noted throughout the samples, but the highest fecal coliform concentration (1,200,000 counts per 100 ml) was measured on September 13 at Location B, in the west barrel. Also noted in several samples were numerous small black particles.

During a walk-through inspection of the culvert by NEORSD investigators on November 1, a hot discharge to the east barrel, which contained a heavy concentration of black solids, was noted approximately

50 yards downstream of Location C. The flow rate of this discharge was measured at approximately 50 gallons per minute. A sample of the discharge obtained for chemical analysis contained elevated concentrations of chemical oxygen demand (416 mg/L), suspended solids (107 mg/L), and zinc (5.90 mg/L). The discharge was traced to the Goodyear Tire and Rubber Company Micron Materials Division at 1200 East 152nd Street. An inspection of the company, including dye tests, revealed that wastewater generated by the tire grinding process had been entering the culvert via storm drain piping. The small black particles were determined to be rubber. Company officials were apprised of this problem and agreed to have this water rerouted to the sanitary sewer. On July 31, 1990, NEORSD investigators verified that this source of industrial wastewater in Nine-Mile Creek was no longer tributary to the storm sewer.

NEORSD Sewer Maintenance & Repair personnel discovered blockages in combined sewer overflow structures at Noble Road and Elderwood Avenue and at Woodworth Avenue and Coit Road on September 18 and October 3, 1989, respectively. These blockages had been responsible for dry weather overflows of sanitary sewage to the Nine-Mile Creek culvert and may have contributed to the elevated fecal coliform concentrations noted during the samplings of September 13 and 29 at Locations A, B, and C. Each blockage was subsequently cleared by NEORSD personnel, eliminating these sources of contamination in Nine-Mile Creek.

-6-

On February 1, 1990, the entire flow from the Coit Road combined sewer was discovered by NEORSD investigators to be entering the Nine-Mile Creek culvert through an overflow structure at Coit Road and Kirby Avenue. The investigators also discovered deterioration of a weir in a second combined sewer overflow structure at this location, resulting in dry weather flow of sanitary sewage to the culvert. NEORSD Sewer Maintenance & Repair personnel were notified and removed a blockage of the sanitary outlet at one structure and repaired the weir at the other structure. An inspection by investigators on February 7 revealed that the dry weather flow of sanitary sewage to the Nine-Mile Creek culvert at this location had ceased. This flow may have contributed to elevated fecal coliform concentrations noted at Site #8a in 1989.

-7-

A complaint of sanitary sewage odors in Nine-Mile Creek at Site #10 was investigated on July 18, 1990. The source of the odor was determined to be the backdraft of air from the downstream culverted section of the creek. This section of the creek is located in a deep valley where odors dissipate more slowly. The odors in the culvert emanate from the sanitary sewage regulator structure that is located in the culvert. No sewage overflow to the environment was found to be occurring at the time of the investigation.

-8-

On July 18, 1990, NEORSD investigators discovered three blocked sanitary sewers that had overflows tributary to the "Nela Park" Branch. Blocked sanitary sewers were found at the following locations: between 16200 Helmsdale Road and Noble Road; between 16111 Nela View Road and Noble Road; at 16308 Greyton Road. These blockages caused overflows of sanitary sewage to storm sewers which were tributary to Nela Court and discharged to the "Nela Park" Branch culvert. During the investigation, many of the inspection plates in the sanitary sewers were found shifted or missing, and at the intersection of Nela View Road and Nela Court, an overflow weir was missing, enabling the flow of sewage to enter the storm sewer system. The City of East Cleveland Service Department was notified of these problems.

On July 23, NEORSD investigators found the sanitary sewer on Greyton Road to be unblocked. On August 8, the blockage on Nela View Road was cleared and, according to City of East Cleveland officials, repairs to the sewer on Helmsdale Road were underway.

-9-

On August 10, 1990, NEORSD investigators discovered a dry weather overflow of sanitary sewage on Ravine Drive in East Cleveland. The overflow was occurring in an excavation pit where new PVC pipe had been laid to replace the 10-inch sanitary sewer line. The flow was emanating from an open tee on the new line and flowing into a hole in an exposed storm sewer, which is tributary to Nine-Mile Creek. The flow in the sanitary sewer had backed up because of an obstruction in a downstream section. The City of East Cleveland was notified of the problem. By October 5, the overflow from the tee had ceased and repairs to the sanitary sewer were completed.

-10-

On August 9, 1990, NEORSD investigators assisted Ohio EPA personnel in sampling the abandoned G.M.C. Fisher Body Division plant property, East 140th Street and Coit Road, and storm sewers in its vicinity, including the Nine-Mile Creek culvert, for contamination by polychlorinated biphenyls (PCBs). The property had been purchased by the Ohio Department of Rehabilitation & Corrections, and concerns about possible PCB contamination of Nine-Mile Creek from a leaking transformer on the property had initiated the investigation. Analysis of soil and sediment samples at several locations showed PCBs at detectable levels (greater than 1 ppm). The highest concentration detected was 20 ppm in an algal mat from the wall directly below the facility's storm sewer outlet to the Nine-Mile Creek culvert.

Based upon the results of this sampling and a subsequent sampling on September 11, 1990, the Ohio EPA concluded that "with the restrictions placed on access to the site, the on-site PCBs, along with those in Nine-Mile Creek, pose no imminent threat to human health or the environment that would warrant a removal action at this time." The on-site levels in the storm sewers were below the USEPA action level of 50 ppm, while the off-site levels found in Nine-Mile Creek were below the remediation level for PCB spills of 10 ppm from USEPA's PCB Spill Policy in the Toxic Substances Control Act.

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 28). The area surrounding the open section from Lake Shore Boulevard to Lake Erie is being developed into a marina and harbor. This development began in 1990. The area surrounding the open section from the East Memorial Shoreway to Lake Shore Boulevard is also being developed.

Shaw Brook had originally flowed over the Easterly Interceptor between the New York Central Railroad tracks and the shoreway. At this location, a hole has been made in the top of the Easterly Interceptor to allow all dry weather flow to this point to drop into the interceptor. NEORSD Sewer Control Systems in 1987 installed a grate over the opening to capture any large pieces of debris. NEORSD Sewer Maintenance & Repair crews inspect and clean this grate on a routine basis.

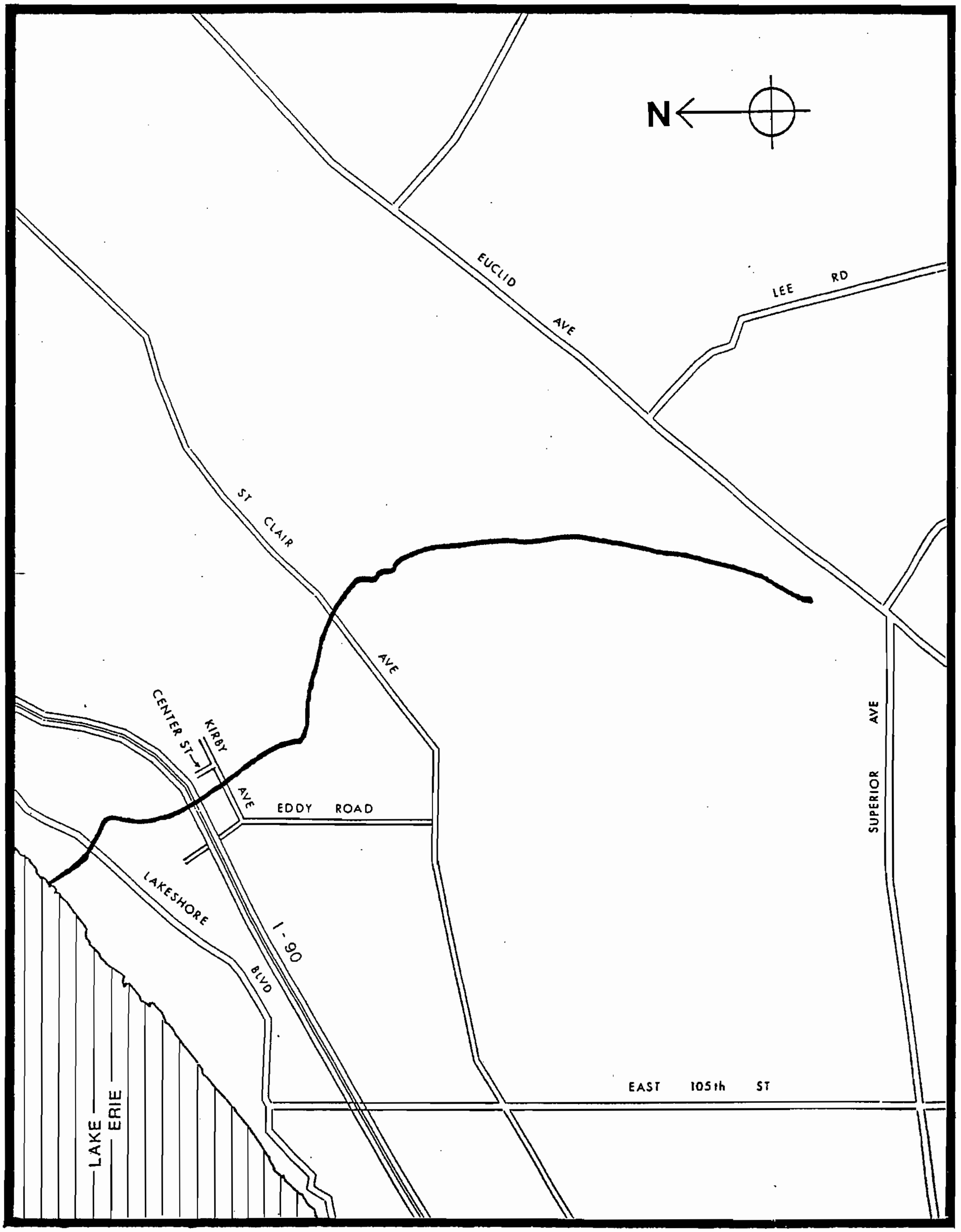
Shaw Brook's total length is 2.2 miles and its drainage area covers 1.3 square miles. Approximately 0.4 million gallons per day flow from this stream into the Easterly Interceptor during dry weather, according to measurements obtained in 1987.

Because it now acts as a combined sewer, no dry weather samples were collected on Shaw Brook by the NEORSD at former Site #11 in 1989 and 1990. Significant flow reaches Lake Erie only during wet weather conditions when dilution is likely to minimize any deleterious impact on the environment.

PROBLEMS AND REMEDIATION

The Northeast Ohio Regional Sewer District was unaware of any environmental disruptions at Shaw Brook in 1989.

In 1990 the only reported environmental disturbances were mud plumes in Lake Erie at the mouth of Shaw Brook on April 26, 1990, and October 17, 1990. The source of high turbidity was determined to be the land development in the area. The land surrounding the open section of Shaw Brook on both sides had been cleared for construction of condominiums and houses. This clearing had left the ground barren and susceptible to erosion. The construction of a harbor and marina at Shaw Brook's mouth may have also contributed to occasional mud plumes. As the construction nears completion and vegetation is returned, the amount of erosion and occurrence of mud plumes should be diminished. The U.S. Army Corps of Engineers has been made aware of residents' concerns about the mud plumes and assures the NEORSD that the appropriate permits have been obtained and are being complied with.



Shaw Brook
(NOT TO SCALE)

Figure 28

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 total drainage area of 9.5 square miles. Most of Dugway Brook is culverted, with the following exceptions which are open: near the mouth, north of Lake Shore Boulevard; on a tributary to the West Branch, between Derbyshire Road and Washington Boulevard in Cleveland Heights; on the West Branch, through Lakeview Cemetery, between Mayfield Road and Euclid Avenue; on the East Branch through Cumberland Park, between Euclid Heights Boulevard and Hampshire Road, in Cleveland Heights.

In 1987, measurements had indicated that the dry weather flow of Dugway Brook near the mouth was 0.9 million gallons per day.

The Ohio EPA has designated Dugway Brook Limited Resource Water and Secondary Contact Recreational Use.

SAMPLING

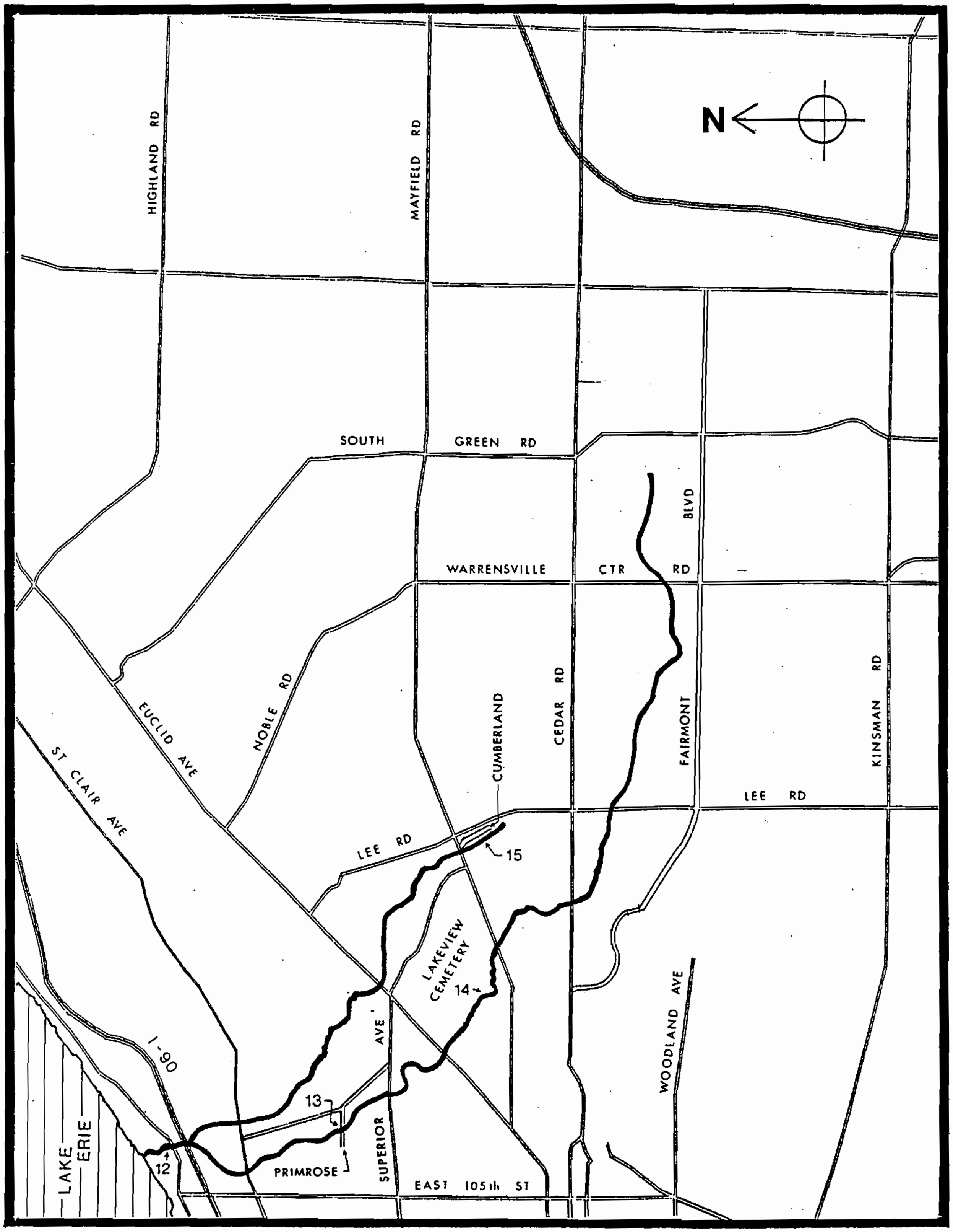
Dugway Brook has been assigned four sample sites for NEORSD monitoring (Figure 29).

Site #12

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 once at Site #12 in 1989 for chemical analysis, on July 6 (Appendix II-T). Most of the results are comparable to those obtained in 1988 at this site. However, BOD (80 mg/L), COD (196 mg/L), and chloride (830 mg/L) concentrations had been higher during the January 1988 sampling. The elevated chloride level in 1988 was attributable to roadsalt runoff. The elevated BOD and COD levels in 1988 may have been attributable to sewer overflows.

Dugway Brook was grab sampled once at Site #12 in 1989 for bacteriological analysis, on July 6 (Appendix II-T). These data indicate that Dugway Brook continued to be heavily contaminated by sanitary sewage. The fecal coliform concentration at Site #12 was 120,000 organisms per 100 ml, which greatly exceeds the Ohio EPA criterion for Secondary Contact Recreational Use. Problems contributing to this contamination are discussed later in the report.



Dugway Brook
(NOT TO SCALE)

Figure 29

Dugway Brook was sampled for benthic macroinvertebrates once at Site #12 in 1989, on October 11 (Appendix VIII-KK). The only benthic macroinvertebrates found were oligochaetes, which formed a thick carpet on the substrate. These organisms are described in literature as highly tolerant in their response to organic pollution.

Dugway Brook was grab sampled once at Site #12 in 1990 for chemical analysis, on September 26 (Appendix III-T). A low dissolved oxygen concentration of 3.0 mg/L was measured at the time of sampling and is attributable to the heavy organic pollution load on the stream at this point. All other chemical data were comparable to results obtained in 1989 from this site and were within Ohio EPA water quality criteria for Limited Resource Water.

Dugway Brook was grab sampled once at Site #12 in 1990 for bacteriological analysis, on September 26 (Appendix III-T). The results are comparable to those obtained at this site in 1989. These results further indicate that Dugway Brook continued to be heavily contaminated by sanitary sewage. The fecal coliform concentration at Site #12 in 1990 was 220,000 organisms per 100 ml, greatly exceeding the Ohio EPA criterion for Secondary Contact Recreational Use. Problems contributing to this contamination are discussed later in the report.

Historical City of Cleveland records indicate that the fecal coliform concentration in Dugway Brook at this location had been as high as 6,100,000 organisms per 100 ml (April 25, 1972).

No benthic macroinvertebrate data were obtained at Site #12 in 1990.

Site #13

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 dry weather flow depth has been about four inches in a 24-inch diameter trough.

Dugway Brook was grab sampled once at Site #13 in 1989 for chemical analysis, on July 6 (Appendix II-T). There were no exceedances of criteria in the Water Quality Standards for Limited Resource Water and the data are comparable to results obtained at this site in 1988.

Dugway Brook was grab sampled once at Site #13 in 1989 for bacteriological analysis, on July 6 (Appendix II-T). The fecal coliform concentration (640 organisms per 100 ml) was below the Ohio EPA criterion for Secondary Contact Recreational Use. This concentration is considerably lower than any concentration of fecal coliform measured at this location during previous years (11,000 organisms per 100 ml in 1987; 110,000 organisms per 100 ml in 1988).

No benthic macroinvertebrates have been collected at this site because it is within a culvert.

Dugway Brook was grab sampled once at Site #13 in 1990 for chemical analysis, on September 26 (Appendix III-T). Only the concentration of copper (0.26 mg/L) at this site exceeded the applicable criterion in Ohio EPA Water Quality Standards for Limited Resource Water (0.03 mg/L). The remainder of the data obtained are comparable to those from this site in previous years.

Dugway Brook was grab sampled once at Site #13 in 1990 for bacteriological analysis, on September 26 (Appendix III-T). The fecal coliform concentration (140,000 organisms per 100 ml) greatly exceeded the Ohio EPA criterion for Secondary Contact Recreational Use. This indicates that Dugway Brook was again heavily contaminated by sanitary sewage at this location. Possible explanations for this recurrence are discussed later in this report.

Site #14

Site #14 is located on Dugway Brook's West Branch downstream of NEORSD flood control dam at Lakeview Cemetery. The substrate consists primarily of shale, cobble and sand. The stream at this point is about eight feet wide and about four inches deep in dry weather. Relatively extensive vegetation, with some overhanging trees, surrounds the stream.

Dugway Brook was grab sampled once at Site #14 in 1989 for chemical analysis, on July 11 (Appendix II-T). All chemical data were within Ohio EPA criteria in Water Quality Standards for Limited Resource Water at this location. All chemical data are comparable to results from previous years.

Dugway Brook was sampled once at Site #14 in 1989 for bacteriological analysis, on July 11 (Appendix II-T). The fecal coliform concentration (900 organisms per 100 ml) was below the Ohio EPA criterion for Secondary Contact Recreational Use and was considerably lower than the level measured in 1988 (130,000 organisms per 100 ml).

Dugway Brook Site #14 was sampled qualitatively for benthic macroinvertebrates once in 1989. On October 11, a total of seven taxa were collected (Appendix VIII-LL). All of the benthic macroinvertebrates collected are described in literature as tolerant in their responses to organic pollution. Since benthic macroinvertebrates were not sampled during previous years at this site, these data cannot be compared with previous results. The low number of taxa and the presence of only tolerant organisms indicate that this section of Dugway Brook had been impacted by pollution.

Dugway Brook was grab sampled once at Site #14 in 1990 for chemical analysis, on September 26 (Appendix III-T). The results are comparable to those from previous years. All chemical data were within Ohio EPA criteria in Water Quality Standards for Limited Resource Water.

Dugway Brook was grab sampled once at Site #14 in 1990 for bacteriological analysis, on September 26 (Appendix III-T). The bacteriological data are comparable to data obtained in 1989. The fecal coliform concentration (430 organisms per 100 ml) was well the below the Ohio EPA criterion for Secondary Contact Recreational Use. The results obtained in 1990 and 1989 indicate that remediation of problems upstream have led to an improvement of the water quality at Site #14. The remediation is discussed later in the report.

Dugway Brook was not sampled for benthic macroinvertebrates at Site #14 in 1990.

Site #15

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, cobble, gravel, and sand. The brook at this point is about eight feet wide and averages about six inches in depth during dry weather. The stream is surrounded by dense vegetation with overhanging trees.

Dugway Brook was grab sampled once in 1989 at Site #15 for chemical analysis, on July 6 (Appendix II-T). All chemical data were within Ohio EPA Water Quality Standards for Limited Resource Water. The data are comparable to data from previous years.

Dugway Brook was grab sampled once in 1989 at Site #15 for bacteriological analysis, on July 6 (Appendix II-T). The fecal coliform concentration (2,700 organisms per 100 ml) was below the Ohio EPA criterion for Secondary Contact Recreational Use. This concentration is considerably lower than the concentrations measured at this site in 1987 (as high as 61,000 organisms per 100 ml) and 1988 (370,000 organisms per 100 ml). Remediation of problems upstream in 1988 at Redwood Road and Parkway Drive and at Superior Road between Lincoln Boulevard and Somerton Road has contributed to the improved water quality. (See NEORSD Greater Cleveland Area Stream Monitoring Program 1988 Report.)

Dugway Brook was sampled once in 1989 at Site #15 for benthic macroinvertebrates, on October 11 (Appendix VIII-MM). A total of six taxa were collected and all were midges. One taxon is described in literature as facultative in its response to organic pollution, and five taxa are tolerant in their responses to organic pollution. In comparison to data obtained in 1987, when only oligochaetes and one tolerant species of midge were found, the 1989 benthic data indicate that some improvement in water quality had occurred.

Dugway Brook was grab sampled once in 1989 at a location upstream of Site #15, west of 3534 Cummings Road for chemical and bacteriological analysis, on June 26. This sampling was conducted in response to a complaint by residents who said that, at around that time of year, the brook had been turning white and has had a foul odor. The chemical data obtained at this site were within Ohio EPA criteria in Water Quality Standards for Limited Resource Water. The fecal coliform concentration (1,400 organisms per 100 ml) was below the Ohio EPA criterion for Secondary Contact Recreational Use. A possible source of odors and coloration of the creek is discussed later in the report.

Dugway Brook was sampled once in 1990 at Site #15 for chemical analysis, on September 26 (Appendix III-T). All chemical data were within numerical criteria in Ohio EPA Water Quality Standards for Limited Resource Water and are comparable to results obtained in previous years.

Dugway Brook was sampled once in 1990 at Site #15 for bacteriological analysis, on September 26 (Appendix III-T). The bacteriological data indicated that the brook was contaminated by sanitary sewage. The fecal coliform concentration (11,000 organisms per 100 ml) exceeded Ohio EPA criteria for Secondary Contact Recreational Use. The probable source of this contamination is a heavily loaded sewerage system, which is discussed later in this report.

No benthic macroinvertebrate sampling was conducted at Site #15 in 1990.

PROBLEMS AND REMEDIATION

-1-

Dugway Brook continued to be heavily contaminated by sanitary sewage at the furthest downstream location, Site #12, in 1989 and 1990. This condition is due in part to a hydraulically heavily loaded and antiquated sewerage system. The construction of the NEORSD Heights-Hilltop Interceptor may relieve some of the load on this system and provide long-term remediation for Dugway Brook.

In 1989 and 1990 the fecal coliform concentrations were slightly lower at Site #12 than in 1988, which may be partly attributable to remediation of problems upstream. The West Branch of Dugway Brook upstream of Site #12 in the Glenville area has many overflow structures which occasionally experience dry weather overflow events. On April 11, 1989, NEORSD Sewer Maintenance and Repair personnel relieved a blockage in the Dugway Interceptor at East 106th Street and Clairdoan Avenue which had been causing dry weather discharges to the West Branch of Dugway Brook at the location of the blockage and at St. Clair Avenue and East 106th Street. The materials causing the blockage consisted of clothing, tires, concrete, lumber, etc. To help prevent a reccurence, NEORSD personnel installed locking bolts on all interceptor manholes along East 106th Street.

-2-

Dugway Brook at Site #13 in 1990 was heavily contaminated by sanitary sewage. The fecal coliform concentrations were much higher than those obtained in 1989. A source of contamination was discovered by NEORSD Sewer Maintenance and Repair personnel at a manhole on the Dugway Brook culvert behind the Glenville Commons just upstream of Site #13, on September 6th, 1990. NEORSD personnel performed investigations and obtained samples upstream, downstream, and at the manhole on November 2, 1990. Bacteriological data indicated that sewage was entering Dugway Brook through three connections of sanitary sewerage from the Glenville Commons Condominium complex. The Burke Development Corporation, who constructed the condominiums, was notified of the situation, and assured the NEORSD that corrections would be made.

-3-

In the vicinity of Dugway Brook's East Branch upstream of Site #15, many combined sewer overflow structures have sewage levels just below overflowing their weirs in dry weather. Any slight increase in flow could result in contamination of the brook. For example, on June 27, 1989, sanitary sewers at Cummings Road and Grosvenor Road were inspected by NEORSD investigators and were found to have sewage levels within one inch of overflowing.

-4-

Also in June 1989, NEORSD investigators responded to complaints from residents on Cummings Road of malodorous conditions in the brook. The residents stated that the creek routinely turns white in color and has a foul odor around that time of year. During the inspection of the creek from South Taylor Road to Cain Park, investigators found that the banks contain buried waste material. This area appears to have been used as a dump in the past and deposits of white and orange sludge, which may be from leachate, can be found in the brook.

-5-

On July 3, 1990, NEORSD investigators responded to complaints of sewage odors coming from Dugway Brook's West Branch behind 2837 East Overlook Road. The brook exhibited evidence of sanitary sewage, which was eventually traced to a blocked sanitary sewer at Corydon Road and Lamberton Road in Cleveland Heights. The Cleveland Heights Service Department was notified of the blockage on July 15, 1990. Following a second notification, the blockage was cleared, and NEORSD investigators on September 6 verified that this source of contamination in Dugway Brook had been eliminated.

-6-

During the investigation of the West Branch of Dugway Brook in Cleveland Heights, a second source of contamination by sanitary sewage was found to be coming from a blocked sanitary sewer at 3216 Silsby Road. The sanitary/storm sewer inspection plate at this location had shifted and a build-up of grease and debris was found to be blocking the sanitary sewer. The Cleveland Heights Service Department was notified of this situation on July 9 and the problem was corrected on July 10.

The remediation of the two afore-mentioned problems on the West Branch of Dugway Brook in Cleveland Heights has evidently returned the water quality of this section of the brook to good condition. Since September 6, no further complaints have been received from residents of this area. However, continued periodic inspection may be necessary to maintain the present water quality.

-7-

On July 3, 1990, an 18-inch storm pipe under the at Berkshire Road bridge over Dugway Brook had dry weather flow, which was measured at approximately 2,500 gallons per day. The flow was determined to be potable water from a leaking water main on Berkshire Road. The City of Cleveland Water Department was notified and the necessary repairs were made to eliminate this discharge to Dugway Brook.

DOAN BROOK

Doan Brook's drainage area includes the communities of Cleveland, Cleveland Heights, and Shaker Heights. Doan Brook has a total length of 8.1 miles and a drainage area of 11.7 square miles. Approximately 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 million gallons per day.

Ohio EPA has designated Doan Brook Warmwater Habitat and Primary Contact Recreational Use.

SAMPLING

Doan Brook has been assigned four sample sites for routine monitoring (Figure 30).

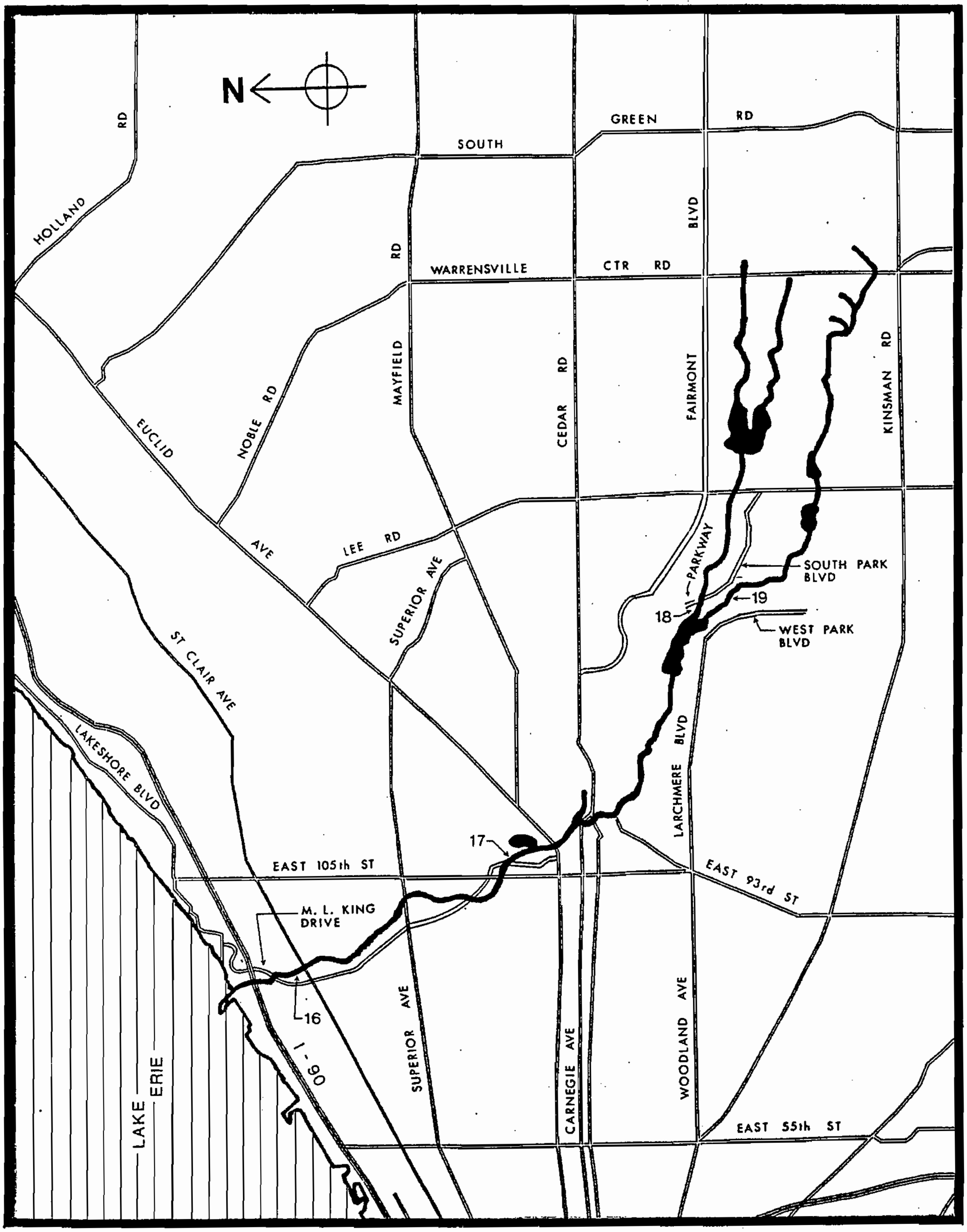
Site #16

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 cobble, gravel, sand, silt, and man-made debris. The banks are steep and wooded, with much tree overhang. Evident at this location is influence from the wave action of Lake Erie when the lake level is high and when the winds are from the north.

Doan Brook was grab sampled once in 1989 at Site #16 for chemical analysis on July 11 (Appendix II-U). At the time of sampling, wave motion from Lake Erie was evident. All chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat and were comparable to data obtained in previous years.

Doan Brook was grab sampled once in 1989 at Site #16 for bacteriological analysis, on July 11 (Appendix II-U). The results were comparable to those obtained in 1988. The fecal coliform concentration measured at Site #16 in 1989 (760 organisms per 100 ml) was below the numerical criterion for Primary Contact Recreational Use designation. This is considerably lower than the fecal coliform concentrations measured in 1987 at this site (5,200 to 300,000 organisms per 100 ml). Historical City of Cleveland records indicate that the fecal coliform concentration in Doan Brook near this location, at Gordon Park, had been as high as 560,000 organisms per 100 ml (October 25, 1972).

No benthic data were obtained at Site #16 in 1989.



Doan Brook

(NOT TO SCALE)

Figure 30

Grab samples for chemical analysis were collected at Site #16 in 1990, on September 26 (Appendix III-U). All chemical data were within numerical criteria in Water Quality Standards for Warmwater Habitat. These chemical data are comparable to data obtained at this site in previous years.

On September 26, 1990, one grab sample was obtained for bacteriological analysis at Site #16 (Appendix III-U). The fecal coliform concentration (2,500 organisms per 100 ml) slightly exceeded the Ohio EPA criterion for Primary Contact Recreational Use and was higher than in 1989. Upstream sources of sanitary sewage in the creek are discussed later in the report.

No sampling of benthic macroinvertebrates was conducted at Site #16 in 1990.

Site #17

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 (i.e. concrete slabs, bricks), cobble, gravel, and sand. The east bank is shale and soil, while the west bank is concrete, and the brook has some tree overhang. This location is approximately 100 yards downstream of the culvert opening, which originates 1.3 miles upstream at Ambler Park.

Site #17 was grab sampled once in 1989 for chemical analysis, on July 11 (Appendix II-U). All chemical data, with the exception of the dissolved oxygen concentration (3.6 mg/L) which was below the minimum criterion, were within water quality criteria for Warmwater Habitat. The chemical data obtained at this site in 1989, except for dissolved oxygen, are comparable to data obtained in previous years.

Site #17 was grab sampled twice in 1989 for bacteriological analysis (Appendix II-U). The fecal coliform concentrations on July 11 (64,000 organisms per 100 ml) and on November 7 (190,000 organisms per 100 ml) exceeded the Ohio EPA criterion for Primary Contact Recreational Use. These fecal coliform concentrations, along with the low dissolved oxygen concentration noted, indicate that this location was contaminated by sanitary sewage. The 1989 fecal coliform concentrations were higher than those measured at this location in 1988 (3,000 organisms per 100 ml). The problem of contamination by sewage in this section of Doan Brook is discussed later in this report.

Doan Brook at Site #17 was qualitatively sampled once in 1989 for benthic macroinvertebrates (Appendix VIII-NN). A total of eight taxa were collected from this location on October 9. Three of the taxa were various species of chironomids, all of which are described in literature as tolerant in their responses to organic pollution. The remainder of the taxa, with the exception of one caddisfly larva (Hydropsyche betteni), which is facultative, were tolerant of pollution. The caddisfly larva was an early instar and collected in a riffle. This is an increase from the number of taxa collected in 1987, but the predominance of tolerant organisms indicate that this site is impacted by pollution.

Doan Brook was grab sampled once in 1990 at Site #17 for chemical analysis, on September 26 (Appendix III-U). All chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. These data are comparable to data obtained at this site in previous years.

Site #17 was sampled once in 1990 for bacteriological analysis, on September 26 (Appendix III-U). The bacteriological data again indicate that this location on Doan Brook continued to be contaminated with sanitary sewage. The fecal coliform concentration (100,000 organisms per 100 ml) greatly exceeds the Ohio EPA criterion for Primary Contact Recreational Use designation.

No benthic data were obtained at Site #17 in 1990.

Site #18

Site #18 is located on the North Branch of Doan Brook, northeast of the Shaker Lakes Regional Nature Center Office, 2600 South Park Boulevard. The substrate at this location consists of sand and gravel. Vegetation and overhanging trees surround the brook. The water moves with low velocity through deep pools at this site.

Site #18 was grab sampled once in 1989 for chemical analysis, on July 11 (Appendix II-U). All chemical data were within the numerical criteria in Water Quality Standards for Warmwater Habitat. These data were comparable to those obtained in January 1988, with the exception of the chloride concentration, which was lower in July 1989 when roadsalting would not have had an impact.

In 1989, Site #18 was grab sampled once for bacteriological analysis, on July 11 (Appendix II-U). The 1989 fecal coliform concentration (160 organisms per 100 ml), was well below the Ohio EPA criterion for Primary Contact Recreational Use. This is comparable to the fecal coliform concentrations measured at this site in previous years.

Site #18 was qualitatively sampled once in 1989 for benthic macroinvertebrates, on October 9 (Appendix VIII-OO). A total of eight taxa were collected including a gastropod (Amnicola limosa), which is described in literature as intolerant in its response to organic pollution. The remaining taxa are predominantly facultative to organic pollution. The low diversity of taxa collected may be attributable to the habitat characteristics of this location: mainly deep pools with low velocity in the shallow areas. Also lacking are large rocks, cobble, and riffles which would provide a suitable habitat for a diverse macroinvertebrate community. Nevertheless, the data from Site #18, especially the presence of an intolerant organism, indicate that this section of Doan Brook has good water quality.

Doan Brook was grab sampled twice in 1990 at Site #18 for chemical analysis (Appendix III-U). All the chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Site #18 was sampled twice in 1990 for bacteriological analysis (Appendix III-U). The 1990 fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use and were comparable to those of previous years. The fecal coliform concentration were measured at 180 and 240 organisms per 100 ml on August 30 and September 26, respectively.

Benthic macroinvertebrates were collected from Site #18 on August 31, 1990 (Appendix IX-S). A total of seven taxa were collected, most of which are described in literature as facultative in their responses to organic pollution. When compared to benthic data from 1989, the same intolerant taxon was found (Amnicola limosa), and the benthic data from 1990 had only one fewer taxon. The relatively low diversity may, as previously noted, be attributable to the habitat characteristics of this location. The predominance of facultative organisms and the presence of an intolerant organism, along with the low bacteriological trations, indicate that this site remains relatively free of organic pollution.

Site #19

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, gravel, and cobble. With several small riffle/run and pooled areas. Vegetation surrounds the brook, which is completely covered by tree overhang.

Doan Brook was grab sampled once in 1989 at Site #19 for chemical analysis (Appendix II-U). An exceedance of the Ohio EPA water quality criterion for mercury (0.9 ug/L) was noted on July 11. All other chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat and were comparable to data obtained during previous years, with the exception of the chloride concentration, which was lower in 1989. The elevated chloride levels in 1988 had been attributable to roadsalt runoff.

Site #19 was sampled once in 1989 for bacteriological analysis, on July 11 (Appendix II-U). The fecal coliform level (220 organisms per 100 ml) was below the Ohio EPA criterion for Primary Contact Recreational Use, and was the same as that measured at this location in 1988. These data are also comparable to that of 1987.

Site #19 was qualitatively sampled for benthic macroinvertebrates once in 1989, on October 9 (Appendix VIII-PP). A total of nine taxa were collected including a gastropod (Amnicola limosa), which is described in literature as intolerant in its response to organic pollution. The predominance of facultative organisms and the presence of an intolerant organism indicate good water quality at Site #19 in 1989.

In 1990, Doan Brook at Site #19 was sampled twice for chemical analysis, on August 30 and September 26 (Appendix III-U). All chemical data measured at Site #19 were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat. The chemical data from 1990 are comparable to those obtained in previous years.

Site #19 was sampled twice in 1990 for bacteriological analysis (Appendix III-U). Fecal coliform concentrations at this site were below the Ohio EPA criterion for Primary Contact Recreational Use and were comparable to data from previous years.

Doan Brook was qualitatively sampled for benthic macroinvertebrates once in 1990 at Site #19, on August 31 (Appendix IX-T). A total of 15 taxa were collected, including one taxon described in literature as intolerant in its response to organic pollution (Amnicola limosa). The increased number of total taxa collected may be attributed to improved collection techniques. The overall structure of the benthic macroinvertebrate community was similar to that of previous years and indicates that Doan Brook at Site #19 has good water quality.

Shaker Lakes

In 1990, sampling of the two Shaker Lakes (Horseshoe Lake and Lower Shaker Lake), was conducted for chemical, bacteriological, and sediment analyses (Appendix XVIII). Dissolved oxygen profiles of both lakes also were obtained.

Horseshoe Lake is located on the North Branch of Doan Brook upstream of Site #18 in Shaker Heights. It is in the shape of a horseshoe with a north arm and a south arm. The average depth of the lake is approximately five feet. A grab sample for chemical analysis (Appendix XVIII-B) was obtained at the outlet of Horseshoe Lake at the west end, on August 29, 1990. All the chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Horseshoe Lake was grab sampled twice at the outlet for bacteriological analysis (Appendix XVIII-B), on August 29 and 30, 1990. All bacteriological data were well below the Ohio EPA criteria for Primary Contact Recreational Use. The fecal coliform concentrations were less than 10 organisms per 100 ml on August 29 and 30 organisms per 100 ml on August 30.

A dissolved oxygen profile was obtained from Horseshoe Lake on August 30, 1990 (Appendix XVIII-C). This profile indicated that dissolved oxygen concentrations were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Lower Shaker Lake is located northwest of Horseshoe Lake on the main stem of Doan Brook just downstream from the confluence of the North Branch and the South Branch. This lake is less than five feet deep. Lower Shaker Lake is downstream of Horseshoe Lake and Sites #18 and #19.

Lower Shaker Lake was sampled once in 1990 for chemical analysis, on August 29 (Appendix XVIII-B). The sample was obtained from the northwest end at the lake's outlet. All chemical data were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

Lower Shaker Lake was sampled twice in 1990 for bacteriological analysis (Appendix XVIII-B). The bacteriological data were well below the Ohio EPA criteria for Primary Contact Recreational Use. The fecal coliform concentrations were measured at 10 organisms per 100 ml on August 29 and at less than 10 organisms per 100 ml on August 30.

A dissolved oxygen profile was obtained from Lower Shaker Lake on August 30 (Appendix XVIII-D). This profile indicated that dissolved oxygen concentrations were within Ohio EPA criteria in Water Quality Standards for Warmwater Habitat.

A sediment sample was obtained from Horseshoe Lake on August 30, 1990 (Appendix XVIII-E). This was a composite sample collected with a Petite Ponar Dredge, from the north arm, mid-lake, and the south arm. A sediment sample was also obtained from Lower Shaker Lake, near the lake's outlet (Appendix XVIII-E). When comparing the results of the sediment analyses, most of the metal concentrations in Horseshoe Lake were slightly higher than those found in Lower Shaker Lake. Differences in metals concentrations may be attributed to differences in sediment particle size. Horseshoe Lake's sediment was finer than that in Lower Shaker Lake. Finer sediment particle size would provide more surface area for adsorption. No specific criteria for sediment concentrations exist for this type of lake. The Shaker Lakes are technically considered "upland ponds" and not "lakes," and therefore the data are not comparable to lake data or criteria for sediment disposal into Lake Erie.

PROBLEMS AND REMEDIATION

In November 1989, NEORSD investigators attempted to trace back the source of sanitary sewage entering Doan Brook upstream of Site #17. Doan Brook is culverted for 1.3 miles from Ambler Park through the University Circle area until it opens north of the Art Museum. Site #17 is located downstream of the culvert opening.

To determine where the sanitary sewage was entering the Doan Brook culvert, bacteriological samples were obtained at various locations, including: upstream of the culvert at Ambler Park; on the culvert south of the Art Museum; and at Site #17. Results of the analyses revealed fecal coliform concentrations of 100, 180,000 and 190,000 organisms per 100 ml, respectively.

While inspecting several combined sewer overflow structures located within the Doan Brook culvert, NEORSD investigators discovered a dry weather flow from overflow regulator "Doan Valley Interceptor-15" (DV-15) at Cedar Hill and East Boulevard. This flow was traced to a collapsed eight-inch sanitary sewer on Euclid Heights Boulevard. The City of Cleveland Heights was notified and repair of the collapsed sewer was planned for 1991. This source of bacterial contamination continued through 1990 and was responsible for the high fecal coliform concentrations measured at Site #17.

Past overflows at DV-15 had resulted from root intrusion and blockages of the sanitary sewer on Euclid Heights Boulevard. These blockages had been caused by excessive amounts of paper and cloth products entering the sewer from the Margaret Wagner House, 2373 Euclid Heights Boulevard. Officials from this nursing home have agreed to more closely monitor its discharges to the sewer system.

Further investigation of the 1.3 miles of the Doan Brook culvert is planned for the future.

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 Abram Creek, which joins the main stem in Cleveland, and includes the Middleburg Heights WWTP effluent.

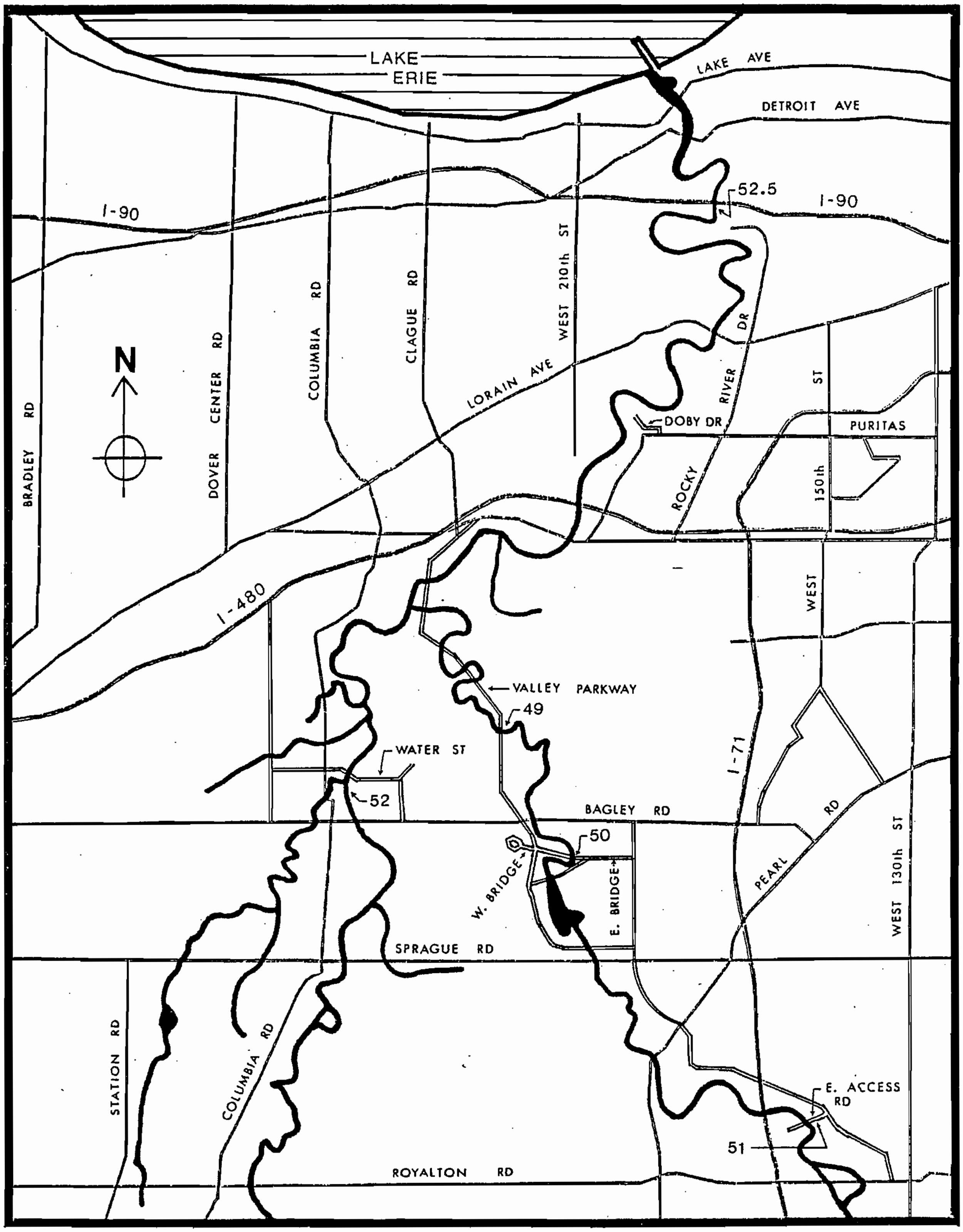
Measurements of the East Branch of Rocky River in 1987, under dry weather conditions, had indicated a flow rate of approximately 13 million gallons per day upstream of its confluence with the West Branch. No other flow measurements of the Rocky River have been obtained by the NEORSD Stream Monitoring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

SAMPLING

The NEORSD has selected five locations on the Rocky River which are routinely sampled for chemical, bacteriological, and benthic analysis (Figure 31).

Site #49

Site #49 (Figure 31) is located in Berea on the East Branch of the Rocky River, at Valley Parkway north of Falls Lane. This site is about



Rocky River
(NOT TO SCALE)

Figure 31

200 yards downstream of the Berea WWTP effluent discharge. The river at Site #49 has numerous riffles, and the substrate consists of shale, fine gravel, cobble, and boulders. The river is approximately 50 to 75 feet wide and has dense vegetation along its banks, including numerous trees.

In 1989, Site #49 (Appendix II-V) was sampled twice for chemical and bacteriological analyses. The results indicated that one chemical parameter exceeded the Ohio EPA water quality criteria, on September 5. Iron was measured at 1.4 mg/L, compared to the 1.0 mg/L criterion. All other 1989 chemical data from this site were within water quality criteria for Warmwater Habitat and were comparable to data obtained in previous years.

At Site #49 in 1989, the fecal coliform concentration exceeded the Ohio EPA criterion for Primary Contact Recreational Use of 2,000 organisms per 100 ml on one occasion (Appendix II-V). On September 5, the fecal coliform was measured at 52,000 organisms per 100 ml. This contamination may be partly attributed to a sanitary sewer overflow upstream of this site, at North Rocky River Drive in Berea, which is discussed later in the report. On September 5, NEORSD investigators noted a dry weather overflow occurring from this location at the time of sampling. The investigators also noted that on the second sampling date (October 6) no overflow was occurring and the fecal coliform concentration of the sample from that day (200 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates was performed at Site #49 in 1989 and 18 taxa were collected (Appendix VIII-QQ). Most taxa identified are described in literature as facultative in their responses to organic pollution. The diversity of benthic macroinvertebrates indicate that this section of Rocky River had at least fair water quality in 1989.

Site #49 was sampled twice for chemical analysis and once for bacteriological analysis in 1990 (Appendix III-V). With the exception of iron and mercury, which each exceeded their criteria, all other 1990 chemical data from Site #49 were within Ohio EPA Water Quality Standards for Warmwater Habitat. On August 8, the iron concentration (2.2 mg/L) exceeded the numerical criterion. Mercury was measured at 0.2 ug/L on August 8 and 0.3 ug/L on November 1, compared to the 0.012 ug/L criterion. The 1990 chemical data were comparable to those obtained from Site #49 in previous years.

In 1990, the fecal coliform concentration at Site #49 was below the Ohio EPA criterion for Primary Contact Recreational Use (Appendix III-V). Except for the high fecal coliform concentration which had been obtained at Site #49 on September 5, 1989, the bacteriological data obtained in 1989 and 1990 were generally comparable to the previous years' data.

No qualitative sampling for benthic macroinvertebrates was performed at Site #49 in 1990. However, the chemical and bacteriological data, in general, indicate that the water quality of Rocky River at this location was fair to good in 1990.

Site #50

Site #50 (Figure 31) 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 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.

In 1989, Site #50 (Appendix II-V) was sampled twice for chemical and bacteriological analyses. All chemical parameters tested in 1989 at Site #50 were within Water Quality Standards for Warmwater Habitat, with the exception of iron. Iron was measured at 3.0 mg/L on September 5 and 2.3 mg/L on October 16. All 1989 chemical data were comparable to those obtained from Site #50 in previous years.

In 1989 at Site #50 (Appendix II-V), both fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. All the 1989 bacteriological data from this location were lower than the average concentrations measured in previous years.

Qualitative sampling for benthic macroinvertebrates was performed at Site #50 in 1989 with 22 taxa collected, including an ephemeropteran (Nixe sp.) and a coleopteran (Macronychus glabratus) which are described in literature as intolerant in their responses to organic pollution (Appendix VIII-RR). These findings, especially the presence of two intolerant organisms, reflect good water quality in Rocky River at this location in 1989.

In 1990, Site #50 was sampled twice for chemical analysis and once for bacteriological analysis (Appendix III-V). With the exception of iron, which exceeded the criterion on both occasions, all chemical parameters tested in 1990 at Site #50 were within Water Quality Standards for Warmwater Habitat. Iron was measured at 4.1 mg/L on August 10 and 1.7 mg/L on November 1. All 1990 chemical data were comparable to those measured at Site #50 in previous years.

At Site #50 (Appendix III-V) in 1990, the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological data were comparable to concentrations obtained the previous year.

No qualitative sampling for benthic macroinvertebrates was performed in 1990 at Site #50. However, the chemical and bacteriological data generally continued to be indicative of good water quality in 1990.

Site #51

Site #51 (Figure 31) 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 moderate tree overhang.

In 1989, Site #51 (Appendix II-V) was sampled twice for chemical and bacteriological analysis. With the exception of iron, which exceeded its criterion on September 5, all 1989 chemical data were within Water Quality Standards for Warmwater Habitat at Site #51. Iron was measured at 1.4 mg/L. The 1989 chemical data were comparable to those at this location in previous years.

At Site #51 in 1989 (Appendix II-V), showed that the fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use. The 1989 bacteriological data were considerably lower than the average concentrations measured in previous years, which had also been below the criterion for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates was conducted at Site #51 in 1989 (Appendix VIII-SS) and 23 taxa were collected, including two ephemeropterans (Isonychia sp. and Paraleptophlebia sp.) and a plecopteran (Leuctra sp.) which are described in literature as intolerant in their responses to organic pollution. The remaining taxa are primarily facultative in their responses to organic pollution. Several tolerant taxa were also collected. The diversity of organisms, especially the presence of three intolerant taxa, are indicative of good water quality in Rocky River at this location in 1989.

In 1990, Site #51 (Appendix III-V) was sampled twice for chemical analysis and once for bacteriological analysis. All 1990 chemical data from Site #51 were within the Water Quality Standards for Warmwater Habitat. The 1990 chemical data were comparable to those obtained in previous years at this location.

At Site #51 in 1990 (Appendix III-V), the fecal coliform concentration was below the Ohio EPA criterion for Primary Contact Recreational Use. The 1990 bacteriological data were comparable to those obtained at this site in previous years.

Qualitative sampling for benthic macroinvertebrates was performed at Site #51 in 1990 (Appendix IX-U) and 34 taxa were collected, including four taxa which are described in literature as intolerant in their responses to organic pollution. The high diversity of organisms and the presence of four intolerant species indicate that the water quality of Rocky River at Site #51 was good in 1990.

Site #52

Site #52 (Figure 31) 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 deep pool, which flows over a six-foot drop at the downstream end. 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. Dense vegetation with overhanging trees surrounds the creek. The substrate consists of boulders, gravel, and sand.

In 1989, Site #52 (Appendix II-W) was sampled twice for chemical and bacteriological analysis. The results indicated that all 1989 chemical parameters tested were within Water Quality Standards for Warmwater Habitat, with the exceptions of iron and mercury. Iron was measured at 1.9 mg/L on September 6 and 32 mg/L on October 25. Mercury was measured at 0.3 ug/L on October 25. All other chemical data for 1989 at Site #52 were comparable to those obtained in previous years.

In 1989 at Site #52 (Appendix II-W), one exceedance of the Ohio EPA criterion for Primary Contact Recreational Use was noted. The fecal coliform concentration was measured at 5,300 organisms per 100 ml on September 6, which exceeded the criterion of 2,000 organisms per 100 ml. On October 25, the fecal coliform concentration (290 organisms per 100 ml) was well below the Ohio EPA criterion for Primary Contact Recreational Use. The bacteriological data show intermittent exceedances of the criterion, which had also been observed in previous years sampling data at this location. Further investigation is needed to determine the cause of such fluctuation in bacterial levels.

Qualitative sampling for benthic macroinvertebrates was performed at Site #52 in 1989 and 20 taxa were collected (Appendix VIII-TT). Although no intolerant taxa were found, the predominance of facultative taxa indicate that this section of Rocky River had at least fair water quality in 1989.

In 1990, Site #52 (Appendix III-W) was sampled twice for chemical analysis and once for bacteriological analysis. All the chemical parameters tested were within Water Quality Standards for Warmwater Habitat in 1990. All the 1990 chemical data were comparable to those obtained from Site #52 in previous years.

At Site #52 in 1990 (Appendix III-W), the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use.

No qualitative sampling for benthic macroinvertebrates was performed at Site #52 in 1990. However, the data, in general, continued to be indicative of fair to good water quality at this location.

Site #52.5

Site #52.5 (Figure 31) is located on the main stem of the Rocky River in the Cleveland 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. Site #52.5 was selected to reflect the environmental impact on the Rocky River from seven upstream storm sewer outfalls, to which numerous combined sewer overflows are known to be tributary.

In 1989, Site #52.5 was sampled twice for chemical and bacteriological analysis (Appendix II-W). Iron and mercury each had one exceedance of water quality criteria in 1989. Iron was measured at 1.6 mg/L on September 6, and mercury was measured at 0.4 ug/L on October 25. All other chemical data for 1989 at Site #52.5 were within Water Quality Standards for Warmwater Habitat. The 1989 chemical and bacteriological data were the first data obtained at this site by the NEORSD.

At Site #52.5 in 1989 (Appendix II-W), the fecal coliform concentrations were well below the Ohio EPA criterion for Primary Contact Recreational Use.

Qualitative sampling for benthic macroinvertebrates was performed at Site #52.5 in 1989 (Appendix VIII-UU) and 19 taxa were collected. Benthic sampling was also performed upstream of the storm sewer outfall at Riverside Drive and Hog's Back Lane for comparison. This upstream location produced 20 taxa (Appendix VIII-VV). Taxa at both locations consisted predominantly of organisms which are described in literature as facultative in their responses to organic pollution. One intolerant dipteran (*Tipula abdominalis*) was found at the upstream site. The results were similar in the quantity and diversity of species collected. These findings indicate no discernible impact on the water quality at Site #52.5 from the storm sewer outfall. The diversity of organisms collected and the predominance of facultative taxa indicate good water quality at Site #52.5 in 1989.

In 1990, Site #52.5 (Appendix III-W) was sampled twice for chemical analysis and once for bacteriological analysis (Appendix III-W). All chemical data were within Water Quality Standards for Warmwater Habitat at Site #52.5 in 1990. The 1990 chemical data were comparable to those obtained at this location in 1989.

At Site #52.5 in 1990 (Appendix III-W), the fecal coliform concentration was well below the Ohio EPA criterion for Primary Contact Recreational Use. The 1990 bacteriological data were comparable to those obtained at Site #52.5 in 1989.

Qualitative sampling for benthic macroinvertebrates was performed at Site #52.5 in 1990 (Appendix IX-V) and 28 taxa were collected, including an ephemeropteran (Leucrocuta sp.) and a trichopteran (Symphitopsyche sparna) which are described in literature as intolerant in their responses to organic pollution. Comparable results had been obtained in 1989, reflecting good water quality in this section of Rocky River.

PROBLEMS AND REMEDIATION

-1-

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 removed 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. 1989 inspections revealed that this situation remained a problem and was probably responsible for elevated bacteriological concentrations found downstream in the Rocky River at Site #49.

-2-

In 1989, NEORSD Sewer Control Systems crews discovered and reported two storm sewer outfalls with dry weather flows into Rocky River:

Outfall No. 064 is located at Larchwood Avenue in Cleveland. Measurements indicated that the flow rate was approximately 173,000 gallons per day under dry weather conditions in 1989. The 1990 bacteriological analysis of this discharge showed a fecal coliform concentration of 69,000 counts per 100 ml on January 9, indicating contamination by sanitary sewage. The 1990 bacteriological analysis of Site (#52.5), located downstream of the outfall, indicated that this section of Rocky River was relatively unimpacted from the outfall. The fecal coliform was measured at 130 organisms per 100 ml at Site #52.5. The discharge's contamination of the Rocky River is evidently minimized by the dilution as it enters the river.

Outfall No. 068 is located at Hog's Back Lane and Rocky River Drive in Cleveland. According to 1989 measurements, the flow entering the river was at a constant rate of approximately 144,000 gallons per day under dry weather conditions. The sample obtained at this outfall in 1990 showed relatively little contamination by sanitary sewage. The fecal coliform concentration was measured at 740 organisms per 100 ml.

The sources of the dry weather flows to the two outfalls remain undetermined. There are two combined sewer overflows (CSO's) tributary to Outfall No. 064 and one CSO tributary to Outfall No. 068 during high flow periods. These CSO's are inspected and maintained on a regular basis by NEORSD Sewer Maintenance and Repair crews. These crews' past investigations had revealed that inspection plates in area sewers were either missing or shifted due to high flow conditions and/or blockages in the sanitary sewers. These types of problems may be contributing to contamination of the outfalls and warrant further investigation.

-3-

In 1989, the NEORSD was notified that Sundorph Aeronautical Corporation, located at Cleveland Hopkins International Airport, did not have a sanitary sewer system. The company's sanitary wastewater has been tributary to a 30-inch storm sewer which discharges into Abram Creek. As of the date of this report, Sundorph Aeronautical Corporation is in litigation with the Ohio EPA over this matter.

-4-

Currently, a wastewater system/water pollution control study is being conducted for Hopkins International Airport to examine several alternatives for the elimination or reduction of pollutants being discharged from the airport's storm sewer system to Abram Creek and the Rocky River. The major pollutants in the stormwater are the deicing chemicals used by the airport. The primary deicing agents utilized are urea and UCAR (a combination of urea and ethylene glycol) on the runways and ethylene and propylene glycol on the airplanes. Calcium magnesium acetate may also be used at times as a runway deicing agent.

Samples obtained from the airport's storm sewers in 1990 showed high biochemical oxygen demand concentrations (200 to 1,000 mg/L). Any impact of this discharge on the water quality of Rocky River has not been evident in the NEORSD sampling since the use of these chemicals is seasonal and weather-dependent.

-5-

A white substance entering Rocky River from a storm sewer outfall approximately 1,000 feet upstream of Brookpark Road, on NASA and Cleveland Hopkins International Airport property, continued to occur throughout 1990. The discharge was discovered by NEORSD investigators in 1985. A sample obtained from this discharge in 1985 had shown elevated sulfate (227 mg/L) and ammonia (16.8 mg/L) concentrations. An inspection indicated that this intermittent flow consists primarily of groundwater contaminated with substances typical of landfill leachate.

The installation of a new sewer system at Cleveland Hopkins International Airport, which is presently under consideration, could eliminate the discharges of both the deicing agents and white-colored substance currently entering Abram Creek and Rocky River if the storm sewers are redirected to the sanitary sewer system.

CHAGRIN RIVER

The Chagrin River has a total length of 48 miles, with a drainage area of 267 square miles. The land use is primarily rural with a low density of residential housing. Communities located in the Chagrin River drainage area include: Aurora, Chagrin Falls, Chesterland, Eastlake, Mayfield Heights, The Village of Mayfield, Newbury, Solon, Willoughby, Willoughby Hills, and several other eastern suburbs of Cleveland. Development pressures in the drainage area are potential causes of degradation of the habitat. However the majority of the Chagrin River has good to exceptional water quality with a healthy biological community. In 1986, Invertebrate Community Index scores in the Chagrin River Basin ranged from "Fair" to "Exceptional" with the majority of sites sampled "Very Good" (Ohio EPA, 1987). The fish community also reflected very good conditions in the Chagrin River basin (Ohio EPA, 1987).

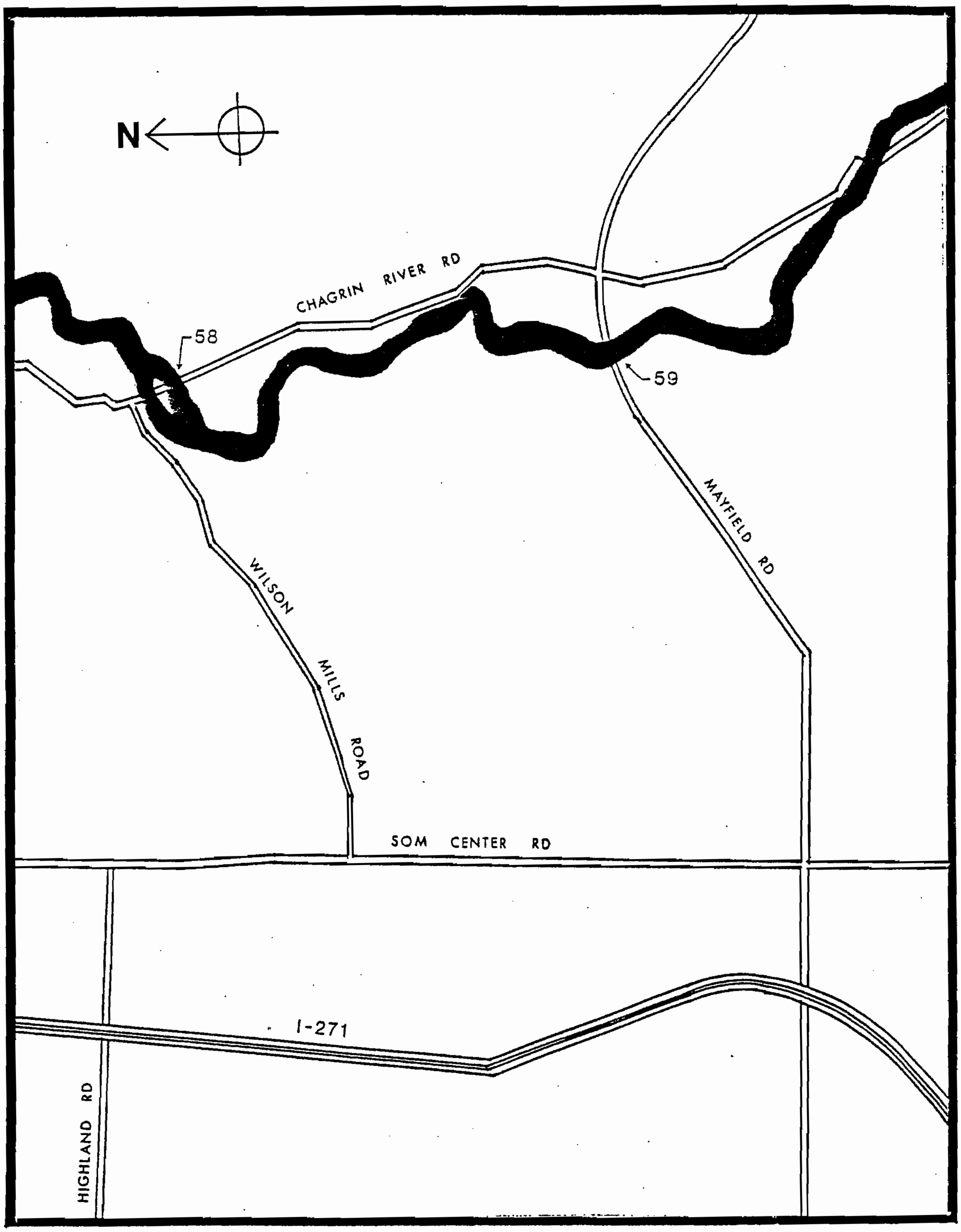
The entire Chagrin River basin is considered a State Resource Water. The main stem of the Chagrin River from the headwaters to River Mile 4.8 has been designated by the Ohio EPA Warmwater Habitat and Primary Contact Recreational Use. From River Mile 4.8 to the mouth, the river has been designated Exceptional Warmwater and Seasonal Salmonid Habitat, and Primary Contact Recreational Use. The Ohio EPA has designated the following tributaries of the Chagrin River as Exceptional Warmwater Habitat and Primary Contact Recreational Use: Griswald Creek, Willey Creek, McFarland Creek, and Beaver Creek. Coldwater Habitat and Primary Contact Recreational Use designations apply to Silver Creek and the East Branch along with its tributaries.

SAMPLING

The Chagrin River has been assigned two sites for routine sampling by the NEORSD. These sites were chosen to evaluate the potential impact on Chagrin River water quality from the NEORSD-owned and -operated Beech Hill Pump Station at 6830 Wilson Mills Road and Bonnieview Pump Station at Beech Hill Road and Bonnieview Road. One site is located upstream of the sewage pumping stations' bypass effluents (Site #59) and the other is located downstream of the effluents (Site #58).

Site #58

Site #58 (Figure 32) is located on the main stem of the Chagrin River at River Mile 15.1, approximately 3,500 feet downstream of the confluence with Beech Hill/Bonnieview Creek and 1,500 feet east of the Chagrin River Road bridge. Beech Hill/Bonnieview Creek receives flow from the Beech Hill and Bonnieview Pump Stations during bypass events. The river at Site #58 is approximately 65 feet wide and is divided into two channels by a small island during dry weather. Just upstream of this location,



Chagrin River

(NOT TO SCALE)

Figure 32

the banks have cement walls to prevent erosion. This upstream location is a deep pool-run habitat. A long riffle-run, free flowing stream habitat is found at the sampling location. The substrate consists of cobble, boulders, gravel, sand, and manmade as well as natural debris.

Site #58 was sampled twice in 1989 for chemical analysis (Appendix II-X). Single exceedances of the numerical criteria for Warmwater Habitat were noted for copper (0.15 mg/L) and iron (1.4 mg/L), on September 20. All other 1989 chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #58 was sampled twice in 1989 for bacteriological analysis (Appendix II-X). The fecal coliform concentrations were below the Ohio EPA criterion for Primary Contact Recreational Use.

No qualitative benthic macroinvertebrate sampling was conducted at Site #58 in 1989.

Site #58 was grab sampled once in 1990 for chemical analysis (Appendix III-X). All of the chemical data were within the Ohio EPA numerical criteria in Water Quality Standards for Warmwater Habitat. These results were generally comparable to those obtained in 1989.

Site #58 was sampled once in 1990 for bacteriological analysis (Appendix III-X). The fecal coliform concentration was below the Ohio EPA criterion for Primary Recreational Use. The bacteriological data are comparable to results obtained in 1989.

Site #58 was not sampled for benthic macroninvertebrates in 1990. Benthic macroinvertebrate sampling at Site #58 is planned for 1991.

Site #59

Site #59 (River Mile 17.4) is located on the main stem of the Chagrin River approximately 1.6 miles upstream of the confluence with Beech Hill/Bonnieview Creek (Figure 32). Samples are obtained from the south side of the Mayfield Road bridge. The river at this location is approximately 65 feet wide. A pool-run stream habitat exists from 300 feet upstream to the bridge, with a dry weather depth of 6 feet midstream to 3 feet near shore. Riffle-run habitats are found both upstream and downstream of the pool-run habitat. The substrate consists of large boulders, cobble, gravel, and sand. Limestone sidewalls have been installed along the banks upstream of the bridge to prevent erosion.

Site #59 was grab sampled twice for chemical analysis in 1989 (Appendix II-X). An exceedance of the Ohio EPA numerical criterion for Warmwater Habitat was noted for iron (1.4 mg/L), on September 20. All other chemical data were within the numerical criteria in Water Quality Standards for Warmwater Habitat.

Site #59 was sampled twice in 1989 for bacteriological analysis (Appendix II-X). The fecal coliform data were well below the Ohio EPA criterion for Primary Contact Recreational Use.

No qualitative benthic macroinvertebrate sampling was conducted at Site #59 in 1989.

Site #59 was grab sampled once in 1990 for chemical analysis (Appendix III-X). All of the chemical parameters were within the numerical criteria in Water Quality Standards for Warmwater Habitat. These results were comparable to those obtained in 1989.

Site #59 was sampled once in 1990 for bacteriological analysis (Appendix III-X). The fecal coliform concentration was well below the Ohio EPA numerical criterion for Primary Contact Recreational Use. The bacteriological data are comparable to concentrations measured in 1989 at this location.

No benthic macroinvertebrate sampling was conducted at Site #59 in 1990, although sampling is planned for in 1991.

The chemical and bacteriological data collected from both locations on the Chagrin River indicate no measurable impact on water quality downstream of the Beech Hill and Bonnieview Pump Stations during dry weather. The use of quantitative benthic macroinvertebrate sampling, planned for both sample sites on the Chagrin River in 1991, will allow a more comprehensive evaluation of the potential impact on Chagrin River water quality from the pump stations. Future investigations to identify other potential sources, such as other area pump stations and sewerage facilities, which may be tributary to this section of the Chagrin River and could impact water quality, are planned.

PROBLEMS AND REMEDIATION

In 1989 and 1990, there were occasional bypasses of sewage from the NEORSD's Beech Hill and Bonnieview Pump Stations. These bypasses were the result of heavy rains, equipment malfunctions, and power failures. The Bonnieview Pump Station is tributary to the Beech Hill Pump Station which, in turn, is tributary to the Cuyahoga County Sanitary Engineers-owned and -operated Wilson Mills Pump Station.

The Beech Hill Pump Station had ten reported bypass events in 1989 and two reported bypass events in 1990 (Table 3).

The Bonnieview Pump Station had seven bypass events in 1989 and one bypass event in 1990 (Table 4). The Bonnieview Pump Station has a one million-gallon retention tank, which allows settling of sewage. Additionally, the effluent from this tank is treated with chlorine. If a bypass occurs at the Bonnieview Pump Station, the sewage which is

TABLE 3. BEECH HILL PUMP STATION BYPASSES
(From NEORSD Records)

Date	Duration	Quantity	Reason
2/24/89	Approx. 2.5 hours	Under 5,000 gallons	Force main break. Cuy. County Sanitary Engineers repaired it.
4/3/89	Approx. 6.5 hours	Intermittent - Unknown quantity	Wet weather, heavy rain. Wilson Mills Pump Station shut down.
4/15/89 4/16/89	20 to 30 minutes each day	Less than 1,000 gallons	Bubbler tube malfunction. Overfilling of wet well.
5/8/89	Approx. 15 minutes (11:30 - 11:45 a.m.)	Less than 1,000 gallons	Power failure at Wilson Mills Pump Station.
5/26/89	Approx. 2 hours (2:15 - 4:20 p.m.)	100,000 gallons	Wet weather, heavy rains. Wilson Mills Pump Station shut down.
5/31/89	Approx. 45 minutes	Under 2,000 gallons	Heavy rain; Wilson Mills Pump Station shut down.
8/3/89	Approx. 4 - 5 hours	--	Sluice gate closed. Overflow occurred at Bonnieview Pump Station. Central Failure at Beech Hill Pump Station.
9/1/89	2 hours 45 minutes	200,000 gallons	Crack in discharge line of Pump #1.
9/3/89	10 hours	1,000,000 gallons	Crack in elbow of 12-inch discharge pipe of Pump #3.
9/5/89	1 hour 50 minutes	5,000 gallons	CEI power failure. Beech Hill emergency generator also failed.
1/9/90	1 hour	2,000 gallons	Expansion joint failure on Pump #1.
2/5/90	27 hours	Approx. 750,000 gallons	Force main failure in discharge from Beech Hill. Cuy. County Sanitary Engineers repaired.

TABLE 4. BONNIEVIEW PUMP STATION BYPASSES
(From NEORSD Records)

All bypasses from 1,000,000-gallon storage tank.
Sewage is settled and chlorine treated.

Date	Duration	Quantity	Reason
4/2/89 4/4/89	48 hours	Unknown	Heavy rains. Beech Hill and Wilson Mills Pump Stations overloaded.
5/8/89	Intermittent	Unknown	Heavy rain
5/24/89	Intermittent	Approx. 300,000 gallons of chlorine-treated settled sewage	Heavy rain
5/26/89 5/27/89	24 hours	Approx. 1,000,000 gallons	Storage tank full from heavy rains.
5/31/89 6/2/89	72 hours	Approx. 1,000,000 gallons	Heavy rains. Beech Hill and Wilson Mills Pump Stations shut down.
8/3/89	4 to 5 hours	440,000 gallons	Pump control failure at Beech Hill Pump Station. Sluice gate closed there.
9/3/89	10 hours	300,000 gallons	Crack in elbow of 12-inch pipe from pump #3 at the Beech Hill Pump Station.
2/5/90	27 hours	1,000,000 gallons	Force main failure in discharge from Beech Hill Pump Station which shut down.

diverted to Beech Hill/Bonnieview Creek has undergone primary treatment and disinfection.

Hopefully, the completion of the NEORSD Heights/Hilltop Interceptor will in the future alleviate any impact from bypasses. This interceptor will be a gravity line, which should minimize the number of environmental discharges due to equipment (i.e., pump) failures. The communities in this drainage area are growing rapidly, and the Heights/Hilltop Interceptor should help to relieve the increasing burden on the pump stations and sewers in this area.

LAKE ERIE

In 1990, the NEORSD initiated sampling of Lake Erie water quality in the vicinity of Greater Cleveland. The NEORSD's jurisdictional area is located entirely within the Lake Erie basin, and therefore all waters from NEORSD facilities are ultimately tributary to Lake Erie.

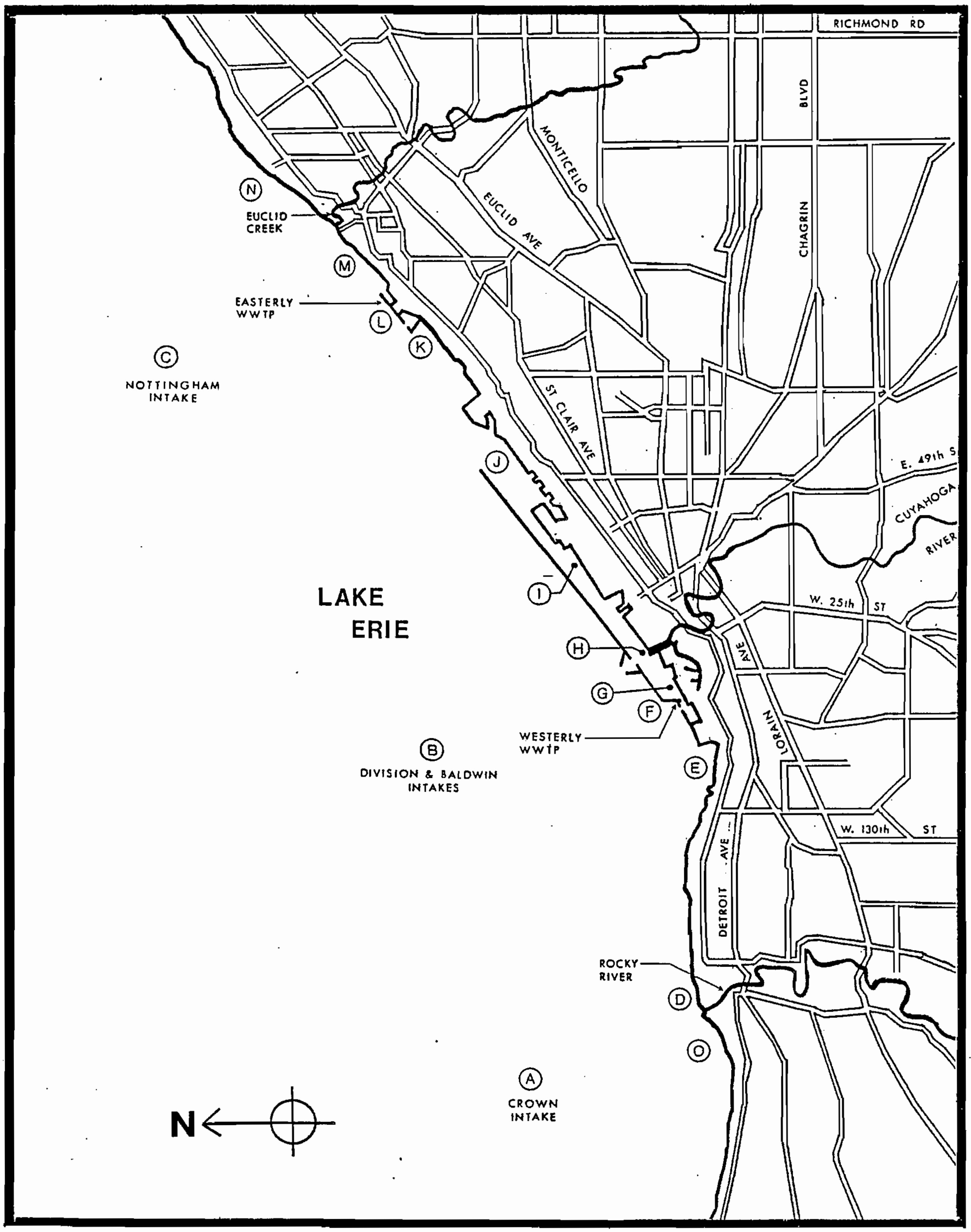
The lake is the site of the area's heaviest recreational water use, including bathing, boating, and fishing. Additionally, the City of Cleveland uses Lake Erie as its public water supply, pumping water for domestic, commercial, and industrial uses from intakes located offshore.

The 15 NEORSD Lake Erie sampling sites were selected to evaluate the impact of potential sources of pollution on ambient water quality, at sites where it is most critical to the uses to be protected and where the impact is likely to be most severe. All chemical and bacteriological parameters measured by the NEORSD on area streams were also measured at the Lake Erie sites. Samples were collected from a NEORSD-rented boat between May 1990 and October 1990, using a Kemmerer-style Vertical Sampling Bottle. Samples were collected from near the lake surface at each site for chemical and bacteriological analysis and also near the lake bottom for chemical analysis at three sites. Several parameters were measured with portable meters at the time of sampling, including turbidity, specific conductance, dissolved oxygen, temperature, and pH. Water clarity was measured at each site using a Secchi disk.

No attempt was made by the NEORSD to limit the lake sampling to conditions of dry weather pollution impacts. Wet weather sources may affect lake water quality for a much longer period of time than they affect stream water quality, although the impact is diminished by greater dilution in the lake. Water quality is less subject to variability in a large water body's lentic environment than in a stream's lotic environment.

The Ohio EPA has designated Lake Erie Exceptional Warmwater Habitat, State Resource Water, Public Water Supply, Agricultural Water Supply, Industrial Water Supply, and Bathing Waters for Recreational Use. Public Water Supply criteria apply within 500 yards of surface water intakes.

Except at the Cuyahoga River mouth (Site H), the only chemical parameter to exceed applicable Ohio EPA criteria in the surface samples from the NEORSD Lake Erie sites was mercury, which exhibited at least one exceedance at each lake site in 1990. Numerous exceedances of the mercury criterion had also been noted at NEORSD stream sites throughout the sampling area. Studies have identified atmospheric deposition as a significant route of environmental mercury contamination in the Great Lakes (IJC Virtual Elimination Task Force, 1991). Sources of mercury in the atmosphere include paint application and combustion of fossil fuels.



Lake Erie

(NOT TO SCALE)

Figure 33

The Ohio EPA mercury criterion of 0.012 micrograms per liter was developed for the protection of human health from toxicity through fish consumption. Several conservative assumptions about mercury's bioavailability in the environment and bioaccumulative properties in the food chain are made in the derivation of this value (Ohio EPA, 1989). The criterion's purpose is to prevent concentrations in fish tissue from exceeding the U.S. Food & Drug Administration's Action Level for mercury of 1.0 mg/kg. However, in support of the Cuyahoga River Remedial Action Plan, the NEORSD analyzed mercury in the fillet tissue of seven fish species (42 individuals) collected from the Lake Erie nearshore area between Lakewood and Eastlake in 1990, and mercury concentrations no greater than 0.28 mg/kg were measured. These data indicate that mercury is not an environmental water quality problem in Lake Erie in the vicinity of Greater Cleveland.

Site A

Site A is located near the submerged Crown Water Intake, at 81°52'48"/41°31'10" (Figure 33). The site is about 2.6 miles offshore on a heading of 310 degrees northwest from the east side of the mouth of the Rocky River. The average water depth at Site A was measured at 46 feet. Water clarity varied during 1990 sampling from 4 feet on July 18 to 13 feet on July 5.

Site A was sampled at the water surface on six occasions in 1990 for chemical analysis (Appendix IV-A). One exceedance of the Ohio EPA criterion for mercury was noted, on July 5 (0.3 ug/L). All of the other chemical data from the surface at Site A were within the Ohio EPA criteria for Exceptional Warmwater Habitat, Public Water Supply, and Agricultural Water Supply.

Site A was sampled at the surface on two occasions for bacteriological analysis (Appendix IV-A). The fecal coliform concentrations (5 and 30 organisms per 100 ml on July 9 and August 20, respectively) were well within the Ohio EPA Recreational Use criterion for Bathing Waters of 400 organisms per 100 ml.

Site A was sampled on four occasions near the lake bottom, at a depth of about 40 feet, in 1990 (Appendix IV-A) for a comparison with the surface sample data. Elevated concentrations of iron (5.8 mg/L), nickel (0.02 mg/L), chromium (0.08 mg/L), and zinc (0.07 mg/L) were noted in the bottom sample obtained on July 27. Of these, only iron exceeded the Ohio EPA criterion for Exceptional Warmwater Habitat, Public Water Supply, and Agricultural Water Supply. The elevated concentrations were attributed to suspended sediments and are reflected in the elevated suspended solids concentration of 132 mg/L in this sample. Such metals concentrations associated with solids are not of significant concern with regard to Public Water Supply, because if the solids were to be suspended to where they could enter the water intakes, they would be removed through filtration.

Site B

Site B is located within 500 yards west of the visible Baldwin Water Intake Crib at 81°45'00"/41°32'54" (Figure 33). Also in this vicinity is the submerged Garret A. Morgan (Division) Water Intake at 81°45'50"/41°32'50". The average water depth at Site B was measured at 48 feet. Water clarity varied during 1990 sampling from 6 feet on May 23 to 20 feet on July 5.

Site B was sampled on five occasions in 1990 for chemical analysis (Appendix IV-B). Exceedances of the Ohio EPA water quality criterion for mercury were noted in the surface samples on two occasions (0.3 ug/L and 0.2 ug/L on June 28 and July 5, respectively). Mercury also exceeded its criterion in one lake bottom sample collected at a depth of 45 feet (0.2 ug/L on June 28). All other chemical data in both surface and bottom samples were within the Ohio EPA criteria for Exceptional Warmwater Habitat, Public Water Supply, and Agricultural Water Supply.

Site B was sampled on three occasions for bacteriological analysis at the surface in 1990 (Appendix IV-B). All fecal coliform concentrations were less than 5 organisms per 100 ml and well within the Ohio EPA Recreational Use criterion for Bathing Waters.

Site C

Site C is located near the submerged Nottingham Water Intake, at 81°37'03"/41°37'05" (Figure 33). The site is about 3.5 miles offshore on a heading of 315 degrees northwest of the mouth of Euclid Creek. The average water depth at Site C was measured at 48 feet. Water clarity varied during 1990 sampling from 8 feet on May 31 to 16 feet on July 3.

Site C was sampled at the surface on five occasions in 1990 for chemical analysis (Appendix IV-C). Exceedances of the Ohio EPA criterion for mercury (0.2 ug/L on May 31 and July 3) were noted. Mercury also exceeded its criterion in two lake bottom samples collected at an average depth of 41 feet (0.4 ug/L and 0.2 ug/L on May 31 and July 3, respectively). All other parameters analyzed in both surface and bottom samples were within Ohio EPA criteria for Exceptional Warmwater Habitat, Public Water Supply, and Agricultural Water Supply.

Site C was sampled at the surface on three occasions for bacteriological analysis in 1990 (Appendix IV-C). All fecal coliform concentrations were less than 5 organisms per 100 ml and well within the Ohio EPA Recreational Use criterion for Bathing Waters.

Site D

Site D is located approximately 300 feet offshore and 200 feet east of the Rocky River mouth (Figure 33). Site D was selected to evaluate the impact of flow from the Rocky River on water quality in Lake Erie. The average depth at Site D was measured at 12 feet. Water clarity varied during 1990 sampling from 2 feet on May 23 to 11 feet on July 5.

Site D was sampled at the surface on six occasions in 1990 for chemical analysis (Appendix IV-D). Mercury concentrations (0.7 ug/L, 0.3 ug/L, and 0.2 ug/L on June 27, July 5, and September 18, respectively) exceeded the Ohio EPA criterion. All other chemical parameters were within Ohio EPA criteria for Exceptional Warmwater Habitat at this site in 1990.

Site D was sampled on two occasions in 1990 for bacteriological analysis (Appendix IV-D). On August 20, the fecal coliform concentration was measured at 900 organisms per 100 ml, which exceeds the Ohio EPA Recreational Use criterion for Bathing Waters. A comparison with the fecal coliform concentration at Site O, west of the Rocky River mouth, on August 20 (90 organisms per 100 ml) indicates that the elevated level at Site D is attributable to flow from the Rocky River. Significant rainfall had preceded this sampling date. Wet weather sources of bacterial contamination in the Rocky River include combined sewer overflows and storm sewers. A dry weather sample for bacteriological analysis collected on July 9 at Site D produced a fecal coliform concentration of 10 organisms per 100 ml, which is well within the Ohio EPA Recreational Use criteria for Bathing Waters.

Site E

Site E is located approximately 300 feet offshore of Edgewater Beach (Figure 33). This site was selected to evaluate the water quality of Lake Erie in this area of heavy recreational use. The average water depth at Site E was measured at 10 feet. Water clarity varied during 1990 sampling from 3 feet on May 23 to 13 feet on July 5.

Site E was sampled at the surface on nine occasions in 1990 for chemical analysis (Appendix IV-E). The Ohio EPA criterion for mercury was exceeded on three occasions at Site E (0.5 ug/L, 0.2 ug/L, and 0.2 ug/L on June 27, August 3, and October 3, respectively). All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat.

Site E was sampled on eleven occasions by the NEORSD in 1990 for bacteriological analysis (Appendix IV-E). All fecal coliform concentrations measured in 1990 were no higher than 20 organisms per 100 ml and were well within the Ohio EPA Recreational Use criterion for Bathing Waters.

A major combined sewer overflow (CSO) at Edgewater Park has been tributary to Lake Erie west of Edgewater Beach. Following construction of the NEORSD Northwest Interceptor, an automated regulator was officially activated by the NEORSD at the Edgewater Park CSO structure on February 28, 1984. Subsequently, overflows from this structure during all but the most severe rain events have been intercepted by the Northwest Interceptor for treatment at the NEORSD Westerly Wastewater Treatment Plant (WWTP).

Bacterial levels in Lake Erie at Edgewater Beach reflecting the remediation provided by this CSO control are presented in Appendix XVI. Prior to 1984, fecal coliform concentrations measured by the City of Cleveland (Weber, 1973) and the Ohio Department of Health (unpublished raw data) frequently exceeded Recreational Use criteria for Bathing Waters at Edgewater Beach. In the late 1960's contamination at the beach had been so serious that efforts had been undertaken to minimize it using beach enclosures and chlorination. However, following the automated regulator activation in 1984, fecal coliform concentrations have been substantially reduced and have more consistently met the Bathing Waters standards at Edgewater Beach (Appendix XVI-E).

Site F

Site F is located near the NEORSD Westerly WWTP treated effluent discharge to Lake Erie, which is submerged 185 feet north of the northwest corner of the Cleveland Harbor breakwall (Figure 33). This site was selected to evaluate the water quality of Lake Erie within the plant's effluent mixing zone. The average water depth measured at this location was 30 feet. Water clarity varied during 1990 sampling from 4 feet on June 27 to 14 feet on July 3.

Site F was sampled at the surface on nine occasions in 1990 for chemical analysis (Appendix IV-F). Mercury concentrations exceeded the Ohio EPA criterion twice (0.6 ug/L and 0.2 ug/L on July 3 and October 3, respectively). All other chemical parameters analyzed were within the Ohio EPA criteria for Exceptional Warmwater Habitat at Site F in 1990.

Site F was sampled on 13 occasions in 1990 for bacteriological analysis (Appendix IV-F). The fecal coliform concentration of 1,900 organisms at Site F on September 20 exceeded the Ohio EPA Recreational Use criteria for Bathing Waters and may be associated with a storm event which had occurred on the previous day. Another elevated fecal coliform concentration (180 organisms per 100 ml) was noted on July 20, but this level did not exceed the Bathing Waters criterion. All other fecal coliform concentrations at Site F in 1990 were no higher than 70 organisms per 100 ml and were well within the Bathing Waters criterion.

In 1978-1979 and in 1988-1989, studies of the benthic macroinvertebrate community in the vicinity of the Westerly WWTP effluent and the Cleveland Harbor were conducted by the Heidelberg College Water Quality Laboratory (Krieger, 1990). The relatively high abundance of oligochaetes found in these studies indicated that the entire Cleveland Harbor vicinity would be classified as highly organically enriched. Furthermore, most of the locations sampled within the Cleveland Harbor and near the Westerly WWTP effluent exhibited higher percentage contribution of oligochaetes than the open water locations sampled. The greater abundance of intolerant oligochaetes, midges, and snails at the open water locations also indicated higher benthic habitat quality than at the Westerly WWTP and Cleveland Harbor locations.

However, in a comparison between the 1978-1979 study and the 1988-1989 study, a temporal improvement in environmental quality of the Cleveland area was evident. A dramatic increase in the number of taxa at all locations, along with a reduction in the proportion of oligochaetes and a large increase in the abundance of clams and midges, contributed to this conclusion. Additionally, the increase in the abundance of oligochaetes may be indicative of declining concentrations of toxic pollutants in this area. The results of these studies have been included in the Cuyahoga River Remedial Action Plan Stage One Report.

Site G

Site G is located inside the Cleveland Harbor, approximately 200 feet offshore and 50 feet east of the location of the NEORSD Westerly Combined Sewer Overflow Treatment Facility (CSOTF) discharge to the harbor (Figure 33). This site was selected to evaluate the water quality in the west end of Cleveland Harbor, which is potentially impacted by flows from both the Westerly CSOTF discharge and the Cuyahoga River. The average water depth at this location was measured at 29 feet. The water clarity varied during 1990 sampling from 1.5 feet on July 27 to 4 feet on July 3.

Site G was sampled at the surface on nine occasions in 1990 for chemical analysis (Appendix IV-G). Mercury concentrations exceeded the Ohio EPA criterion twice (0.3 ug/L and 0.2 ug/L on June 28 and July 3, respectively). All other chemical parameters analyzed at Site G in 1990 were within Ohio EPA criteria for Exceptional Warmwater Habitat. Elevated turbidity levels measured at Site G in comparison to other lake sites are attributable to the location inside the breakwall, where solids from the Cuyahoga River are restricted from dispersion into Lake Erie.

Site G was sampled by the NEORSD on three occasions in 1990 for bacteriological analysis (Appendix IV-G). These data indicated that all fecal coliform concentrations at Site G were no greater than 23 organisms per 100 ml and were well within the Ohio EPA Recreational Use criterion for Bathing Waters.

Data collected in 1990 by the Ohio EPA, NOACA, and the NEORSD in support of the Cuyahoga River Remedial Action Plan, however, revealed that, following rain events, fecal coliform concentrations in the Cleveland Harbor near this location exceeded the Bathing Waters criterion. A geometric mean fecal coliform concentration of over 200 organisms per 100 ml was measured during wet weather periods at the west entrance of the harbor. Contributing to these elevated bacterial levels were combined sewer overflows and storm sewers in the Cuyahoga River basin and the Westerly CSOTF discharge. Data from several locations within the Cleveland Harbor east of Site G exhibited comparable wet weather levels.

Site H

Site H is located within the Cleveland Harbor, approximately 50 feet northwest of the mouth of the Cuyahoga River (Figure 33). This site was selected to evaluate the influence of the Cuyahoga River on the water quality of Lake Erie within the Cleveland Harbor. This location is in a high-traffic area during the commercial shipping and recreational boating season. The average water depth at Site H was measured at 33 feet. Water clarity varied during 1990 sampling at Site H from 4 inches on May 30 to 3 feet on June 28.

Site H was sampled by the NEORSD at the water surface on nine occasions in 1990 for chemical analysis (Appendix IV-H). Exceedances of the Ohio EPA Exceptional Warmwater Habitat criteria were noted at Site H for iron (1.4 mg/L on August 2 and August 21), zinc (0.31 mg/L on July 3), and mercury (0.2 ug/L to 0.4 ug/L on six occasions). Dissolved oxygen concentrations as low as 5.0 mg/L failed to meet the Ohio EPA minimum criterion for Exceptional Warmwater Habitat of 6.0 mg/L on six occasions. All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat at Site H. The exceedances, along with slightly elevated concentrations of several other parameters such as turbidity, are attributable to numerous point and nonpoint sources in the Cuyahoga River basin. The low dissolved oxygen concentrations are associated with the low-velocity flow conditions of the Cuyahoga River shipping channel upstream of Site H.

Site H was sampled by the NEORSD on three occasions in 1990 for bacteriological analysis (Appendix IV-H). On August 20, the fecal coliform concentration at Site H (2,000 organisms per 100 ml) exceeded the Ohio EPA Recreational Use criterion for Bathing Waters. This sampling followed a rain event on the previous day, and the exceedance is attributable to combined sewer overflows and/or storm sewers in the Cuyahoga River basin. The other fecal coliform concentrations measured at Site H in 1990 were within the Bathing Water criterion, although they were slightly elevated in comparison to data from other Lake Erie sites within the Cleveland Harbor.

Site I

Site I is located inside the Cleveland Harbor breakwall offshore from Burke Lakefront Airport, just east of Channel Marker #9 (Figure 33). This site was selected to evaluate the water quality of Lake Erie within the eastern Cleveland Harbor and potential impacts on it, including five combined sewer overflows along the lakefront between East 20th Street and East 38th Street. The average water depth at Site I was measured at 25 feet. Water clarity varied during 1990 sampling from 2.2 feet on June 21 to 9 feet on July 5.

Site I was sampled at the water surface on seven occasions in 1990 for chemical analysis (Appendix IV-I). The Ohio EPA criterion for mercury was exceeded on one occasion (0.2 ug/L on June 28). All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat.

Site I was sampled by the NEORSD on three occasions in 1990 for bacteriological analysis (Appendix IV-I). On August 20, the fecal coliform concentration at Site I (680 organisms per 100 ml) exceeded the Ohio EPA Recreational Use criterion for Bathing Waters. This sampling followed a rain event on the previous day, and the exceedance is attributable to combined sewer overflows and/or storm sewers in the Cuyahoga River basin and along the lakeshore. The other fecal coliform concentrations measured at Site I in 1990 were within the Bathing Waters criterion.

Site J

Site J is located approximately 200 feet offshore from Gordon Park, at the east end of the Cleveland Harbor (Figure 33). This site was selected to evaluate the water quality inside the harbor as it enters the open area of Lake Erie. The average water depth at Site J was measured at 27 feet. Water clarity varied during 1990 sampling from 3 feet on May 30, July 24, and September 18 to 9 feet on July 5.

Site J was sampled at the surface on seven occasions in 1990 for chemical analysis (Appendix IV-J). The Ohio EPA criterion for mercury was exceeded on two occasions (0.5 ug/L and 0.2 ug/L on June 28 and July 24, respectively). All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat.

Site J was sampled on three occasions in 1990 for bacteriological analysis (Appendix IV-J). All fecal coliform concentrations were no greater than 44 organisms per 100 ml and were well within the Ohio EPA Recreational Use criterion for Bathing Waters. The post-rainfall fecal coliform concentration at Site J on August 20 was 30 organisms per 100 ml, which was considerably lower than the elevated concentrations noted at the other Lake Erie sites within the Cleveland Harbor on that date. Greater distance from sources and dilution by open lake waters are probable reasons for this difference.

Site K

Site K is located between Nine-Mile Creek to the west and the NEORSD Easterly WWTP to the east, approximately 200 feet offshore from White City Beach, west of its breakwall. This site was selected to evaluate the potential impact on Lake Erie water quality from several Cleveland East Side streams, including the severely polluted Dugway Brook and Nine-Mile Creek, and a major combined sewer overflow outlet located at the end of a pier between White City Beach and the Easterly WWTP. The average water depth at Site K was measured at 10 feet. Water clarity varied during 1990 sampling from 2 feet on July 16 to 8 feet on June 22.

Site K was sampled at the water surface on nine occasions in 1990 for chemical analysis (Appendix IV-K). The Ohio EPA criterion for mercury was exceeded on three occasions (0.2 ug/L on July 3 and July 24, and 0.3 ug/L on October 3). All other chemical parameters analyzed were within the Ohio EPA criteria for Exceptional Warmwater Habitat.

Site K was sampled on 14 occasions in 1990 for bacteriological analysis (Appendix IV-K). Fecal coliform concentrations ranged from less than 2 organisms per 100 ml on October 3 to 188 organisms per 100 ml on June 29 but were all within the Ohio EPA Recreational Use criterion for Bathing Waters.

A sampling of Lake Erie at White City Beach closer to the shore evaluating the water quality impact during wet weather conditions was performed by the NEORSD in 1989 and is presented in detail in Appendix XVII.

Site L

Site L is located approximately 50 feet north of the Easterly WWTP discharge to Lake Erie (Figure 33). This site was selected to evaluate the water quality of Lake Erie within the Easterly WWTP effluent mixing zone. The average water depth at Site L was measured at 19 feet. Water clarity varied during 1990 sampling from 4 feet on July 16 to 13 feet on July 3.

Site L was sampled at the surface on nine occasions in 1990 for chemical analysis (Appendix IV-L). The Ohio EPA criterion for mercury was exceeded on three occasions (0.4 ug/L on June 28, and 0.2 ug/L on July 3 and October 3). The mercury levels are consistent with concentrations measured by the NEORSD in 1990 at most of the Lake Erie sites. All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat at Site L.

Site L was sampled on 14 occasions in 1990 for bacteriological analysis (Appendix IV-L). The fecal coliform concentrations ranged from less than 2 organisms per 100 ml on August 3 to 340 organisms per 100 ml on July 18 but were all within the Ohio EPA Recreational Use criterion for Bathing Waters.

In cooperation with the NASA Lewis Research Center, aerial infrared photography had been employed to aid in determining the location of the plume and flow pattern of the Easterly WWTP effluent. The February 8 and May 31, 1990 infrared photographs revealed the plant effluent extending more than 100 feet northward into Lake Erie and clinging to the entire length of the breakwall northeast of the plant before dissipating further eastward.

Site M

Site M is located approximately 300 feet offshore from Euclid Beach and one mile northeast of the Easterly WWTP (Figure 33). This site was selected to evaluate the water quality of Lake Erie in the vicinity of the beach, where recreational use is relatively heavy. The average water depth at Site M was measured at 16 feet. Water clarity varied during 1990 sampling from 4 feet on July 16 to 10 feet on July 3.

Site M was sampled at the water surface on eight occasions in 1990 (Appendix IV-M). The Ohio EPA criterion for mercury was exceeded on one occasion (0.2 ug/L on July 3). All other chemical parameters analyzed were within Ohio EPA criteria for Exceptional Warmwater Habitat at Site M.

Site M was sampled on 14 occasions in 1990 for bacteriological analysis (Appendix IV-M). The fecal coliform concentrations at Site M ranged from less than 2 organisms per 100 ml on August 3 and September 18 to 230 organisms per 100 ml on August 20 but were all within the Ohio EPA Recreational Use criterion for Bathing Waters.

Site N

Site N is located approximately 300 feet offshore from Euclid General Hospital, about one mile northeast of the mouth of Euclid Creek (Figure 33). This site was selected to evaluate the water quality of Lake Erie entirely "down-lake" from the NEORSD jurisdictional area. The average water depth at Site N was measured at 17 feet. Water clarity varied during 1990 sampling from 5 feet on July 16 and September 18 to 11 feet on July 3.

Site N was sampled at the water surface on six occasions in 1990 for chemical analysis (Appendix IV-N). The Ohio EPA criterion for mercury was exceeded on one occasion (0.6 ug/L on July 3). All other chemical parameters were within the Ohio EPA criteria for Exceptional Warmwater Habitat.

Site N was sampled on three occasions in 1990 for bacteriological analysis (Appendix IV-N). The fecal coliform concentrations ranged from less than 2 organisms per 100 ml on June 29 to 180 organisms per 100 ml on August 20 but were all within the Ohio EPA Recreational Use criterion for Bathing Waters.

Site O

Site O is located approximately 200 feet offshore and 1,000 feet west of the mouth of the Rocky River (Figure 33). This site was selected to evaluate the water quality of Lake Erie entirely "up-lake" and outside of any expected influence from the NEORSD jurisdictional area. The average water depth at Site O was measured at 11 feet. Water clarity varied during 1990 sampling from 3 feet on September 15 to 11 feet on July 5.

Site O was sampled at the water surface on six occasions in 1990 for chemical analysis (Appendix IV-O). The Ohio EPA criterion for mercury was exceeded on one occasion (0.2 ug/L on June 27). All other chemical parameters analyzed were within the Ohio EPA criteria for Exceptional Warmwater Habitat.

Site O was sampled on two occasions in 1990 for bacteriological analysis (Appendix IV-O). The fecal coliform concentrations of less than 5 organisms per 100 ml on July 9 and 90 organisms per 100 ml on August 20 were both within the Ohio EPA Recreational Use criterion for Bathing Waters.

The NEORSD chemical and bacteriological data from Site O in 1990 were generally comparable to the data from "down-lake" at Site N in 1990.

GREATER CLEVELAND AREA

ENVIRONMENTAL WATER QUALITY ASSESSMENT

1989-1990 REPORT

APPENDICES

APPENDIX I

BIBLIOGRAPHY

APPENDIX I

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APPENDIX II

CLEVELAND AREA STREAMS
1989 CHEMICAL AND BACTERIOLOGICAL DATA*

*NOTE: Data presented are from analyses of surface grab samples obtained under dry weather conditions (following at least three days of no significant rainfall). Bacteriological data presented are geometric means in organisms/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. pH data are expressed as ranges. Not all parameters listed were analyzed in all samples collected. Individual data are on file by date of sampling and are available for review upon request at the NEORSD Water Quality and Industrial Surveillance offices.

Appendix II-A: Cuyahoga River

Sample Dates: 9/21, 10/26/89

Site No.	20	21	22
Number of Samples	2	2	2
Temperature (°C)	18.1	18.3	19.5
Dissolved Oxygen	5.6	5.7	7.0
BOD	2	4	3
COD	20	20	23
Suspended Solids	31	26	21
Total Solids	574	567	604
Dissolved Solids	490	542	548
Sp. Con. (umhos/cm)	740	750	798
Turbidity (NTU)	---	---	---
Ammonia	1.04	1.35	2.69
Phosphorus	0.24	0.24	0.26
Soluble P	0.16	0.18	0.21
Nitrates	3.62	3.61	3.92
Nitrites	0.07	0.06	0.07
TKN	2.21	0.94	3.64
Chlorides	116	112	120
Sulfates	74	78	85
Alkalinity	137	135	140
Hardness	218	228	229
Nickel	0.02	0.03	0.03
Copper	0.02	0.01	0.02
Chromium (Total)	<0.01	<0.01	0.02
Chromium (Hex.)	<0.01	0.01	0.01
Zinc	0.18	0.17	0.16
Iron	1.4	2.3	1.0
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	2,100	1,700	2,300
Fecal Coliform	390	360	220
Fecal Streptococcus	89	150	97
pH (standard units)	7.3 - 7.5	7.4 - 7.6	6.8 - 7.6

Appendix II-B: Cuyahoga River (Continued)

Sample Dates: 5/15, 9/21, 9/26, 10/26/89

Site No.	22.5	22.51	22.6
Number of Samples	1	2	3
Temperature (°C)	20.5	16.8	13.6
Dissolved Oxygen	8.2	8.7	9.7
BOD	1	2	16
COD	23	18	27
Suspended Solids	54	18	40
Total Solids	664	594	541
Dissolved Solids	610	564	528
Sp. Con. (umhos/cm)	850	768	661
Turbidity (NTU)	--	--	--
Ammonia	0.15	0.08	0.05
Phosphorus	0.42	0.36	0.24
Soluble P	0.38	0.24	0.18
Nitrates	6.87	5.22	4.44
Nitrites	0.05	0.04	0.03
TKN	1.12	0.96	1.40
Chlorides	138	123	111
Sulfates	115	71	83
Alkalinity	138	142	131
Hardness	255	222	178
Nickel	0.10	0.02	0.41
Copper	0.27	0.02	0.02
Chromium (Total)	0.02	<0.01	0.02
Chromium (Hex.)	--	<0.01	<0.01
Zinc	0.21	0.06	0.05
Iron	2.4	1.0	1.6
Cadmium	<0.01	<0.01	<0.01
Lead	0.08	<0.01	0.01
Mercury (ug/L)	--	1.0	<0.2
Total Coliform	3,000	3,500	2,500
Fecal Coliform	760	130	230
Fecal Streptococcus	280	71	92
pH (standard units)	7.5	7.6 - 7.7	7.4 - 7.6

Appendix II-C: Cuyahoga River (Continued)

Sample Dates: 9/21, 9/26, 10/26/89

Site No.	22.7	22.8	22.9
Number of Samples	2	3	2
Temperature (°C)	14.3	14.8	12.8
Dissolved Oxygen	9.4	9.3	9.6
BOD	6	6	6
COD	20	19	16
Suspended Solids	13	13	18
Total Solids	582	549	544
Dissolved Solids	554	502	499
Sp. Con. (umhos/cm)	705	673	620
Turbidity (NTU)	—	—	—
Ammonia	0.06	0.07	0.04
Phosphorus	0.26	0.13	0.14
Soluble P	0.24	0.11	0.11
Nitrates	6.00	3.07	3.03
Nitrites	0.03	0.04	0.04
TKN	1.29	1.21	1.96
Chlorides	119	108	100
Sulfates	74	68	62
Alkalinity	142	151	151
Hardness	220	236	222
Nickel	0.02	0.02	0.01
Copper	0.02	0.01	<0.01
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.04	0.02	0.02
Iron	0.8	0.8	1.1
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	3,900	6,900	3,600
Fecal Coliform	130	370	250
Fecal Streptococcus	130	470	160
pH (standard units)	7.3 - 7.6	7.8 - 7.9	7.9 - 8.0

Appendix II-D: Cuyahoga River (Continued)

Sample Dates: 9/26, 10/26/89

Site No.	23	24
Number of Samples	2	2
Temperature (°C)	13.4	13.9
Dissolved Oxygen	9.5	9.3
BOD	7	6
COD	14	14
Suspended Solids	18	7
Total Solids	496	485
Dissolved Solids	475	464
Sp. Con. (umhos/cm)	600	580
Turbidity (NTU)	--	--
Ammonia	0.03	0.20
Phosphorus	0.15	0.17
Soluble P	0.12	0.13
Nitrates	2.98	3.02
Nitrites	0.04	0.02
TKN	1.23	1.03
Chlorides	95	43
Sulfates	78	62
Alkalinity	150	149
Hardness	214	214
Nickel	0.02	0.02
Copper	0.01	0.02
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	0.01	<0.01
Zinc	0.02	0.03
Iron	0.7	0.6
Cadmium	<0.01	<0.01
Lead	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	7,400	3,700
Fecal Coliform	170	110
Fecal Streptococcus	110	200
pH (standard units)	7.9	7.9

Appendix II-E: Big Creek

Sample Dates: 5/19, 5/22, 10/5/89

Site No.	25	26	27
Number of Samples	2	2	2
Temperature (°C)	14.2	14.2	15.4
Dissolved Oxygen	8.6	11.0	9.2
BOD	2	11	4
COD	16	28	24
Suspended Solids	16	16	2
Total Solids	741	523	630
Dissolved Solids	722	517	606
Sp. Con. (umhos/cm)	910	690	820
Turbidity (NTU)	—	2.8	8.0
Ammonia	0.70	0.03	0.92
Phosphorus	0.24	0.08	0.22
Soluble P	0.20	0.06	0.17
Nitrates	0.78	0.94	1.01
Nitrites	0.06	0.05	0.22
TKN	1.68	1.12	3.78
Chlorides	202	116	162
Sulfates	120	104	112
Alkalinity	144	123	143
Hardness	221	197	181
Nickel	0.20	0.02	0.1
Copper	<0.01	<0.01	0.01
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.04	0.04	0.06
Iron	1.2	0.2	1.4
Cadmium	<0.01	<0.01	<0.01
Lead	0.02	<0.01	<0.01
Mercury (ug/L)	0.2	<0.2	<0.2
Total Coliform	19,000	31,000	50,000
Fecal Coliform	680	520	1,200
Fecal Streptococcus	80	420	420
pH (standard units)	7.7 - 7.9	7.9 - 8.6	7.4 - 7.5

Appendix II-F: Big Creek (Continued)

Sample Dates: 5/19, 5/22, 10/5/89

Site No.	28	29	30
Number of Samples	1	1	2
Temperature (°C)	10.3	10.3	15.7
Dissolved Oxygen	7.4	9.9	10.5
BOD	2	2	2
COD	18	16	20
Suspended Solids	2	2	6
Total Solids	468	403	605
Dissolved Solids	451	373	599
Sp. Con. (umhos/cm)	465	380	864
Turbidity (NTU)	--	--	1.5
Ammonia	0.69	0.02	0.03
Phosphorus	0.18	0.06	0.12
Soluble P	0.16	0.05	0.12
Nitrates	0.60	0.61	1.06
Nitrites	0.08	0.02	0.04
TKN	1.12	0.84	0.98
Chlorides	102	60	185
Sulfates	72	83	86
Alkalinity	127	110	142
Hardness	207	187	188
Nickel	0.02	<0.01	0.12
Copper	<0.01	0.01	<0.01
Chromium (Total)	0.01	0.01	0.02
Chromium (Hex.)	0.01	0.01	<0.01
Zinc	0.08	0.02	0.04
Iron	0.2	0.2	1.0
Cadmium	<0.01	<0.01	<0.01
Lead	0.01	0.01	0.02
Mercury (ug/L)	<0.2	<0.2	0.3
Total Coliform	12,000	28,000	54,000
Fecal Coliform	2,100	3,500	9,000
Fecal Streptococcus	<20	960	1,800
pH (standard units)	7.5	7.6	7.4 - 7.8

Appendix II-G: Mill Creek

Sample Dates: 6/27, 9/19/89

Site No.	31	32	33
Number of Samples	2	2	2
Temperature (°C)	21.3	23.3	21.0
Dissolved Oxygen	7.4	0.3	8.1
BOD	4	4	4
COD	25	22	12
Suspended Solids	8	14	12
Total Solids	939	1,003	679
Dissolved Solids	912	989	667
Sp. Con. (umhos/cm)	1,408	1,246	892
Turbidity (NTU)	25.0	4.5	2.2
Ammonia	2.34	0.39	0.07
Phosphorus	0.06	0.14	0.20
Soluble P	0.04	0.14	0.14
Nitrates	1.53	0.50	0.77
Nitrites	0.24	<0.01	0.01
TKN	4.76	2.80	2.02
Chlorides	237	143	150
Sulfates	180	436	124
Alkalinity	220	206	150
Hardness	400	135	252
Nickel	0.03	0.01	<0.01
Copper	0.01	<0.01	0.01
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	--	--	--
Zinc	0.10	0.04	0.06
Iron	2.6	0.2	0.3
Cadmium	<0.01	<0.01	<0.01
Lead	0.02	0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	0.2
Total Coliform	13,000	2,900	2,700
Fecal Coliform	2,600	470	270
Fecal Streptococcus	390	1,200	170
pH (standard units)	6.8 - 8.0	9.1 - 9.3	7.2 - 7.7

Appendix II-H: Mill Creek (Continued)

Sample Dates: 6/27, 9/19/89

Site No.	33.5	34	35
Number of Samples	2	2	2
Temperature (°C)	20.6	20.2	20.0
Dissolved Oxygen	6.8	10.8	8.2
BOD	6	6	3
COD	16	46	16
Suspended Solids	9	8	4
Total Solids	614	597	999
Dissolved Solids	606	590	996
Sp. Con. (umhos/cm)	779	764	1,455
Turbidity (NTU)	—	—	4.0
Ammonia	1.50	1.27	<0.01
Phosphorus	0.17	0.60	0.02
Soluble P	0.10	0.26	0.02
Nitrates	1.30	0.62	0.35
Nitrites	0.37	0.11	<0.01
TKN	3.78	4.03	1.68
Chlorides	132	182	392
Sulfates	156	66	72
Alkalinity	118	158	162
Hardness	242	204	237
Nickel	<0.01	<0.01	0.01
Copper	0.01	0.01	0.02
Chromium (Total)	<0.01	<0.01	0.04
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.04	0.06	0.04
Iron	0.6	0.5	0.4
Cadmium	<0.01	<0.01	0.01
Lead	<0.01	0.02	<0.01
Mercury (ug/L)	<0.2	<0.2	0.2
Total Coliform	10,000	29,000	2,500
Fecal Coliform	1,700	13,000	140
Fecal Streptococcus	580	530	130
pH (standard units)	7.3 - 7.6	7.5 - 8.0	7.6

Appendix II-I: West Creek

Sample Dates: 10/25/89

Site No.	36	37	38
Number of Samples	1	1	1
Temperature (°C)	10.7	11.1	10.0
Dissolved Oxygen	8.5	8.9	9.1
BOD	6	1	1
COD	7	8	12
Suspended Solids	7	11	2
Total Solids	630	501	675
Dissolved Solids	623	490	663
Sp. Con. (umhos/cm)	1,080	860	1,110
Turbidity (NTU)	--	--	--
Ammonia	0.03	<0.01	0.35
Phosphorus	0.05	0.05	0.10
Soluble P	0.04	0.05	0.10
Nitrates	1.17	1.85	2.69
Nitrites	0.03	0.02	0.03
TKN	0.84	0.84	1.12
Chlorides	162	106	136
Sulfates	104	106	190
Alkalinity	134	129	174
Hardness	202	193	279
Nickel	<0.01	0.01	0.02
Copper	<0.01	<0.01	0.01
Chromium (Total)	0.01	<0.01	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.02	0.02
Iron	0.2	0.2	0.2
Cadmium	<0.01	<0.01	<0.01
Lead	0.02	0.04	0.02
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	4,100	2,700	1,200
Fecal Coliform	<20	20	20
Fecal Streptococcus	220	100	40
pH (standard units)	6.0	7.8	7.7

Appendix II-J: Tinkers Creek

Sample Dates: 7/12, 8/10, 9/20/89

Site No.	39	40	41	42
Number of Samples	3	3	3	3
Temperature (°C)	20.4	21.1	20.8	20.5
Dissolved Oxygen	8.8	9.4	8.8	8.9
BOD	5	5	7	8
COD	23	28	32	31
Suspended Solids	13	29	35	52
Total Solids	502	499	540	517
Dissolved Solids	489	471	505	465
Sp. Con. (umhos/cm)	751	899	867	757
Turbidity (NTU)	---	---	---	---
Ammonia	0.04	0.12	0.14	0.09
Phosphorus	0.19	0.27	0.35	0.46
Soluble P	0.15	0.19	0.21	0.30
Nitrates	3.56	3.01	2.81	0.94
Nitrites	0.04	0.03	0.06	0.03
TKN	1.20	1.70	1.85	1.75
Chlorides	121	118	120	97
Sulfates	68	64	60	63
Alkalinity	147	150	157	167
Hardness	223	236	238	216
Nickel	0.18	0.02	0.03	0.06
Copper	0.06	0.02	0.01	0.01
Chromium (Total)	<0.01	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.03	0.03	0.03
Iron	0.6	1.3	1.5	2.2
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	0.06	0.08	0.05	0.07
Mercury (ug/L)	<0.2	<0.2	<0.2	<0.2
Total Coliform	2,200	1,600	3,800	2,300
Fecal Coliform	910	650	420	450
Fecal Streptococcus	120	78	190	180
pH (standard units)	7.0 - 7.4	7.6 - 7.8	7.3 - 7.8	7.1 - 8.0

Appendix II-K: Chippewa Creek

Sample Dates: 7/27, 8/24, 10/6/89

Site No.	43	43.5	44
Number of Samples	3	3	3
Temperature (°C)	17.8	15.2	18.2
Dissolved Oxygen	8.9	9.2	8.8
BOD	2	2	2
COD	10	5	7
Suspended Solids	4	8	9
Total Solids	625	995	818
Dissolved Solids	619	982	797
Sp. Con. (umhos/cm)	778	1,207	718
Turbidity (NTU)	—	—	—
Ammonia	0.01	<0.01	0.04
Phosphorus	0.02	0.03	0.08
Soluble P	0.02	0.03	0.08
Nitrates	0.62	0.53	0.51
Nitrites	0.02	0.01	0.03
TKN	2.13	1.59	1.68
Chlorides	96	76	70
Sulfates	183	387	258
Alkalinity	152	259	236
Hardness	365	657	505
Nickel	0.01	<0.01	0.02
Copper	0.01	<0.01	0.01
Chromium (Total)	0.02	<0.01	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.03	0.03
Iron	0.3	0.2	0.4
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	0.2	0.2	<0.2
Total Coliform	1,000	790	880
Fecal Coliform	210	78	410
Fecal Streptococcus	350	330	280
pH (standard units)	7.0 - 8.1	7.3 - 8.2	7.5 - 8.0

Appendix II-L: Sagamore Creek

Sample Dates: 8/2, 9/7/89

Site No.	57
Number of Samples	2
Temperature (°C)	18.8
Dissolved Oxygen	8.8
BOD	1
COD	9
Suspended Solids	8
Total Solids	516
Dissolved Solids	511
Sp. Con. (umhos/cm)	749
Turbidity (NTU)	--
Ammonia	<0.01
Phosphorus	0.17
Soluble P	0.17
Nitrates	0.20
Nitrites	0.02
TKN	0.98
Chlorides	129
Sulfates	75
Alkalinity	164
Hardness	278
Nickel	0.02
Copper	<0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.04
Iron	0.2
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	1,000
Fecal Coliform	40
Fecal Streptococcus	340
pH (standard units)	7.3 - 9.9

Appendix II-M: Kingsbury Run

Sample Dates: 8/17, 10/30/89

Site No.	46	46.1	46-A
Number of Samples	2	2	2
Temperature (°C)	16.4	15.8	15.8
Dissolved Oxygen	8.7	8.8	8.4
BOD	5	7	6
COD	23	16	20
Suspended Solids	4	17	12
Total Solids	994	1,176	1,104
Dissolved Solids	983	1,156	1,082
Sp. Con. (umhos/cm)	1,130	1,450	1,425
Turbidity (NTU)	--	--	--
Ammonia	2.17	0.84	1.76
Phosphorus	0.17	0.16	0.31
Soluble P	0.10	0.07	0.17
Nitrates	1.56	2.70	1.05
Nitrites	0.55	0.22	0.32
TKN	2.94	3.41	4.37
Chlorides	194	258	268
Sulfates	200	243	195
Alkalinity	334	364	639
Hardness	456	610	597
Nickel	0.06	0.02	0.02
Copper	0.01	0.02	0.02
Chromium (Total)	0.14	0.34	1.00
Chromium (Hex.)	0.04	0.12	0.24
Zinc	0.02	0.06	0.08
Iron	3.5	1.9	2.0
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	0.01
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	>11,000	740	860
Fecal Coliform	1,400	20	180
Fecal Streptococcus	660	5,700	420
pH (standard units)	7.5 - 7.6	7.4 - 7.6	7.3 - 7.6

Appendix II-N: Kingsbury Run (Continued)

Sample Dates: 8/17, 10/30/89

Site No.	46-B	46-C
Number of Samples	2	2
Temperature (°C)	17.4	15.5
Dissolved Oxygen	8.6	8.9
BOD	10	2
COD	36	8
Suspended Solids	61	6
Total Solids	831	770
Dissolved Solids	720	726
Sp. Con. (umhos/cm)	935	995
Turbidity (NTU)	--	--
Ammonia	0.21	0.05
Phosphorus	0.30	0.12
Soluble P	0.03	0.11
Nitrates	0.76	1.22
Nitrites	0.04	0.02
TKN	1.68	2.74
Chlorides	126	137
Sulfates	193	100
Alkalinity	322	416
Hardness	461	164
Nickel	0.04	0.01
Copper	0.05	<0.01
Chromium (Total)	0.14	0.02
Chromium (Hex.)	<0.01	<0.01
Zinc	0.20	0.02
Iron	14.0	0.4
Cadmium	<0.01	<0.01
Lead	0.02	0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	1,600	2,300
Fecal Coliform	420	120
Fecal Streptococcus	1,800	160
pH (standard units)	7.3 - 7.5	8.0 - 8.2

Appendix II-O: Morgana Run

Sample Dates: 8/15, 10/31/89

Site No.	47-A
Number of Samples	2
Temperature (°C)	25.5
Dissolved Oxygen	8.0
BOD	12
COD	59
Suspended Solids	44
Total Solids	870
Dissolved Solids	820
Sp. Con. (umhos/cm)	1,438
Turbidity (NTU)	—
Ammonia	25.50
Phosphorus	0.38
Soluble P	0.26
Nitrates	4.65
Nitrites	0.02
TKN	27.75
Chlorides	216
Sulfates	260
Alkalinity	140
Hardness	214
Nickel	0.03
Copper	0.02
Chromium (Total)	0.05
Chromium (Hex.)	0.01
Zinc	0.06
Iron	2.6
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	0.4
Total Coliform	80,000
Fecal Coliform	3,700
Fecal Streptococcus	590
pH (standard units)	8.1 - 8.2

Appendix II-P: Burke Brook

Sample Dates: 8/15, 10/31/89

Site No.	48	48.1
Number of Samples	2	2
Temperature (°C)	18.2	18.8
Dissolved Oxygen	8.1	8.5
BOD	7	4
COD	38	12
Suspended Solids	12	23
Total Solids	1,380	664
Dissolved Solids	1,364	620
Sp. Con. (umhos/cm)	2,040	1,750
Turbidity (NTU)	--	--
Ammonia	30.45	122.00
Phosphorus	0.18	0.14
Soluble P	0.15	0.06
Nitrates	1.86	2.40
Nitrites	0.41	0.57
TKN	31.65	123.05
Chlorides	471	209
Sulfates	266	177
Alkalinity	187	234
Hardness	338	190
Nickel	0.07	0.04
Copper	0.02	0.02
Chromium (Total)	0.02	0.02
Chromium (Hex.)	<0.01	<0.01
Zinc	0.06	0.06
Iron	0.6	0.5
Cadmium	<0.01	0.02
Lead	<0.01	0.02
Mercury (ug/L)	0.2	0.6
Total Coliform	29,000	6,000
Fecal Coliform	6,200	690
Fecal Streptococcus	1,500	2,000
pH (standard units)	8.6 - 8.7	7.9 - 8.9

Appendix II-Q: Euclid Creek

Sample Dates: 4/20, 7/25, 11/13/89

Site No.	1	2	3	4
Number of Samples	3	3	3	3
Temperature (°C)	14.0	12.2	12.0	13.4
Dissolved Oxygen	9.6	9.9	10.6	10.3
BOD	2	1	12	3
COD	17	15	12	15
Suspended Solids	7	4	4	5
Total Solids	478	592	404	601
Dissolved Solids	439	564	236	574
Sp. Con. (umhos/cm)	747	1,185	639	1,028
Turbidity (NTU)	--	1.5	1.6	3
Ammonia	0.08	0.10	0.05	0.07
Phosphorus	0.08	0.04	0.17	0.02
Soluble P	0.05	0.01	0.16	0.02
Nitrates	0.84	0.62	1.04	0.45
Nitrites	0.02	0.01	0.23	0.17
TKN	3.69	0.93	1.12	0.84
Chlorides	142	205	358	192
Sulfates	90	94	75	92
Alkalinity	105	116	104	111
Hardness	223	186	151	191
Nickel	0.03	0.02	0.02	0.01
Copper	0.01	<0.01	<0.01	0.01
Chromium (Total)	0.01	<0.01	<0.01	0.01
Chromium (Hex.)	--	--	--	--
Zinc	0.18	0.03	0.27	0.07
Iron	1.4	0.2	0.2	0.4
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	0.02	0.03	0.02
Mercury (ug/L)	0.2	0.2	<0.2	0.2
Total Coliform	2,300	520	110	370
Fecal Coliform	460	150	39	89
Fecal Streptococcus	190	67	81	120
pH (standard units)	7.2 - 8.0	7.2 - 7.9	7.5 - 8.2	7.7 - 8.1

Appendix II-R: Green Creek

Sample Dates: 10/24/89

Site No.	5	6	7
Number of Samples	1	1	1
Temperature (°C)	13.6	13.6	17.8
Dissolved Oxygen	8.3	8.9	9.3
BOD	4	8	2
COD	32	39	23
Suspended Solids	4	8	1
Total Solids	329	280	264
Dissolved Solids	322	266	263
Sp. Con. (umhos/cm)	540	477	452
Turbidity (NTU)	--	--	--
Ammonia	0.76	0.67	0.19
Phosphorus	0.27	0.48	0.04
Soluble P	0.25	0.44	0.03
Nitrates	0.85	0.51	0.51
Nitrites	0.09	0.08	0.01
TKN	3.36	2.91	1.34
Chlorides	58	62	54
Sulfates	66	54	66
Alkalinity	125	94	94
Hardness	174	167	138
Nickel	<0.01	<0.01	<0.01
Copper	<0.01	0.01	<0.01
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.02	0.01
Iron	0.3	0.4	0.2
Cadmium	<0.01	<0.01	<0.01
Lead	0.01	<0.01	<0.01
Mercury (ug/L)	0.2	0.4	0.3
Total Coliform	>80,000	>80,000	460
Fecal Coliform	7,000	5,500	40
Fecal Streptococcus	12,000	61,000	200
pH (standard units)	7.4	7.5	--

Appendix II-S: Nine-Mile Creek

Sample Dates: 5/1, 8/18, 8/24, 9/5, 9/13, 9/29/89

Site No.	8a	8b	9	10
Number of Samples	5	2	1	3
Temperature (°C)	15.6	10.3	19.7	16.2
Dissolved Oxygen	3.0	9.7	5.9	7.9
BOD	8	4	5	5
COD	56	37	26	15
Suspended Solids	18	12	3	6
Total Solids	552	461	1,157	354
Dissolved Solids	492	460	1,154	331
Sp. Con. (umhos/cm)	794	782	1,737	568
Turbidity (NTU)	6.2	60.0	—	—
Ammonia	1.68	0.34	6.19	0.05
Phosphorus	0.83	0.24	0.34	0.12
Soluble P	0.72	0.18	0.26	0.12
Nitrates	0.40	0.78	0.14	0.52
Nitrites	0.12	0.08	0.15	0.02
TKN	3.38	0.84	7.45	0.84
Chlorides	118	128	336	91
Sulfates	77	74	246	52
Alkalinity	150	111	176	118
Hardness	183	130	353	160
Nickel	0.05	0.04	0.26	0.18
Copper	0.08	0.02	<0.01	0.01
Chromium (Total)	0.04	<0.01	<0.01	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.09	0.04	0.03	0.04
Iron	1.2	1.1	2.4	1.8
Cadmium	<0.01	<0.01	<0.01	0.03
Lead	0.01	0. 01	<0.01	0.01
Mercury (ug/L)	1.2	<0.2	<0.2	0.4
Total Coliform	>210,000	92,000	4,500	1,600
Fecal Coliform	89,000	56,000	600	350
Fecal Streptococcus	34,000	5,300	540	680
pH (standard units)	7.5 - 8.0	7.7 - 8.1	7.9	7.3 - 8.5

Appendix II-T: Dugway Brook

Sample Dates: 7/6, 7/11/89

Site No.	12	13	14	15
Number of Samples	1	1	1	1
Temperature (°C)	16.9	20.7	24.0	17.9
Dissolved Oxygen	6.2	8.7	11.4	6.9
BOD	7	3	9	4
COD	29	19	17	17
Suspended Solids	6	20	3	14
Total Solids	1,012	486	--	718
Dissolved Solids	1,006	466	601	704
Sp. Con. (umhos/cm)	1,300	655	900	1,100
Turbidity (NTU)	--	--	--	--
Ammonia	1.86	0.33	0.89	0.25
Phosphorus	0.50	0.48	0.90	0.03
Soluble P	0.42	0.46	0.87	0.01
Nitrates	1.25	1.56	1.06	0.71
Nitrites	0.12	0.20	0.26	0.03
TKN	3.25	2.24	1.74	1.12
Chlorides	288	116	135	202
Sulfates	142	58	68	111
Alkalinity	220	121	165	198
Hardness	317	169	184	279
Nickel	<0.01	<0.01	0.02	<0.01
Copper	0.02	0.02	0.01	0.02
Chromium (Total)	<0.01	<0.01	<0.01	<0.01
Chromium (Hex.)	--	--	--	--
Zinc	0.15	0.04	0.02	0.08
Iron	1.0	0.5	0.4	0.7
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	0.13	0.12	0.12	0.14
Mercury (ug/L)	--	--	<0.2	--
Total Coliform	180,000	3,000	6,800	2,900
Fecal Coliform	120,000	640	900	2,700
Fecal Streptococcus	90,000	320	300	2,800
pH (standard units)	7.35	7.65	8.35	7.0

Appendix II-U: Doan Brook

Sample Dates: 7/11, 11/7/89

Site No.	16	17	18	17
Number of Samples	1	2	1	1
Temperature (°C)	23.5	22.2	23.3	22.9
Dissolved Oxygen	--	3.6	7.9	7.7
BOD	4	9	1	<1
COD	10	21	7	12
Suspended Solids	--	22	7	12
Total Solids	--	--	--	--
Dissolved Solids	--	505	343	398
Sp. Con. (umhos/cm)	720	700	700	550
Turbidity (NTU)	--	--	--	--
Ammonia	0.20	2.17	0.09	0.04
Phosphorus	0.24	0.75	0.13	0.08
Soluble P	0.20	0.73	0.12	0.06
Nitrates	1.01	0.24	0.39	0.43
Nitrites	0.08	0.03	0.01	0.01
TKN	2.74	3.25	1.01	1.51
Chlorides	112	118	73	78
Sulfates	66	59	36	52
Alkalinity	138	135	139	113
Hardness	198	189	141	124
Nickel	0.02	0.02	0.02	0.02
Copper	0.02	0.02	0.02	0.02
Chromium (Total)	<0.01	<0.01	0.01	<0.01
Chromium (Hex.)	--	--	--	--
Zinc	0.01	0.01	<0.01	<0.01
Iron	0.4	0.2	0.2	0.2
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	0.12	0.07	0.07	0.14
Mercury (ug/L)	--	<0.2	<0.2	0.9
Total Coliform	5,100	>180,000	2,500	1,200
Fecal Coliform	760	110,000	160	220
Fecal Streptococcus	360	35,000	20	60
pH (standard units)	7.3	7.3	7.3	7.7

Appendix II-V: Rocky River

Sample Dates: 9/5, 9/6, 10/16/89

Site No.	49	50	51
Number of Samples	2	2	2
Temperature (°C)	18.3	18.1	16.9
Dissolved Oxygen	8.9	8.6	8.8
BOD	7	3	2
COD	18	18	16
Suspended Solids	8	44	7
Total Solids	488	464	424
Dissolved Solids	460	392	418
Sp. Con. (umhos/cm)	695	570	575
Turbidity (NTU)	—	—	—
Ammonia	1.58	0.12	<0.01
Phosphorus	0.24	0.21	0.13
Soluble P	0.19	0.13	0.10
Nitrates	4.73	2.91	7.52
Nitrites	0.44	0.03	0.02
TKN	2.46	1.12	1.26
Chlorides	141	105	86
Sulfates	102	93	92
Alkalinity	93	112	114
Hardness	170	223	186
Nickel	0.08	0.06	0.07
Copper	<0.01	<0.01	0.01
Chromium (Total)	0.01	<0.01	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.03	0.01
Iron	1.1	2.7	0.8
Cadmium	<0.01	<0.01	<0.01
Lead	0.01	0.02	0.02
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	9,800	730	790
Fecal Coliform	3,200	260	170
Fecal Streptococcus	424	140	40
pH (standard units)	7.5	7.2 - 7.5	7.7 - 8.0

Appendix II-W: Rocky River (Continued)

Sample Dates: 9/5, 9/6, 10/16/89

Site No.	52	52.5
Number of Samples	2	2
Temperature (°C)	15.2	16.2
Dissolved Oxygen	9.2	9.1
BOD	6	3
COD	22	19
Suspended Solids	12	14
Total Solids	458	505
Dissolved Solids	447	491
Sp. Con. (umhos/cm)	752	747
Turbidity (NTU)	--	--
Ammonia	0.86	0.07
Phosphorus	0.24	0.20
Soluble P	0.18	0.18
Nitrates	4.90	5.18
Nitrites	0.36	0.08
TKN	2.10	1.51
Chlorides	92	100
Sulfates	85	70
Alkalinity	74	123
Hardness	200	191
Nickel	0.05	0.05
Copper	0.01	0.02
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	0.02	0.04
Iron	1.2	1.0
Cadmium	<0.01	<0.01
Lead	0.01	0.01
Mercury (ug/L)	0.3	0.2
Total Coliform	4,600	2,200
Fecal Coliform	1,200	130
Fecal Streptococcus	240	160
pH (standard units)	7.5	7.4 - 8.4

Appendix II-X: Chagrin River

Sample Dates: 9/20, 11/13/89

Site No.	58	59
Number of Samples	2	2
Temperature (°C)	10.6	10.6
Dissolved Oxygen	11.2	11.0
BOD	2	2
COD	17	16
Suspended Solids	12	9
Total Solids	318	324
Dissolved Solids	303	315
Sp. Con. (umhos/cm)	580	583
Turbidity (NTU)	---	---
Ammonia	0.05	0.06
Phosphorus	0.10	0.10
Soluble P	0.08	0.09
Nitrates	0.62	0.75
Nitrites	<0.01	0.38
TKN	0.70	1.06
Chlorides	58	52
Sulfates	58	59
Alkalinity	152	151
Hardness	179	179
Nickel	0.38	0.08
Copper	0.08	<0.01
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	---	---
Zinc	0.03	0.02
Iron	1.0	0.9
Cadmium	<0.01	<0.01
Lead	0.04	0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	880	900
Fecal Coliform	120	100
Fecal Streptococcus	<220	<170
pH (standard units)	7.6	7.9 - 8.5

APPENDIX III

CLEVELAND AREA STREAMS
1990 CHEMICAL AND BACTERIOLOGICAL DATA*

*NOTE: Data presented are from analyses of surface grab samples obtained under dry weather conditions (following at least three days of no significant rainfall). Bacteriological data presented are geometric means in organisms/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. pH data are expressed as ranges. Not all parameters listed were analyzed in all samples collected. Individual data are on file by date of sampling and are available for review upon request at the NEORSD Water Quality and Industrial Surveillance offices.

Appendix III-A: Cuyahoga River

Sample Dates: 7/25, 9/14/90

Site No.	20	21	22
Number of Samples	2	2	2
Temperature (°C)	22.8	22.5	22.9
Dissolved Oxygen	5.4	5.6	6.0
BOD	2	4	5
COD	24	27	25
Suspended Solids	54	66	56
Total Solids	475	488	504
Dissolved Solids	339	316	330
Sp. Con. (umhos/cm)	550	555	580
Turbidity (NTU)	26.0	34.0	24.5
Ammonia	0.99	0.89	0.70
Phosphorus	0.17	0.19	0.17
Soluble P	0.12	0.12	0.11
Nitrates	2.00	2.35	2.09
Nitrites	<0.01	<0.01	<0.01
TKN	1.96	2.02	1.96
Chlorides	66	66	75
Sulfates	78	66	78
Alkalinity	108	108	107
Hardness	185	166	150
Nickel	<0.01	<0.01	<0.01
Copper	0.04	0.02	0.02
Chromium (Total)	0.02	0.02	0.02
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.05	0.07	0.06
Iron	2.2	3.0	2.4
Cadmium	<0.01	<0.01	<0.01
Lead	0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	0.4	0.6
Total Coliform	7,200	5,800	6,600
Fecal Coliform	480	1,400	2,000
Fecal Streptococcus	260	75	180
pH (standard units)	7.4 - 7.6	7.3 - 7.5	7.3 - 7.6

Appendix III-B: Cuyahoga River (continued)

Sample Dates: 7/25, 9/13, 9/14/90

Site No.	22.5	22.51	22.6
Number of Samples	2	2	2
Temperature (°C)	22.0	21.2	21.8
Dissolved Oxygen	6.5	7.5	6.9
BOD	4	3	8
COD	28	28	31
Suspended Solids	32	84	68
Total Solids	426	501	478
Dissolved Solids	312	324	311
Sp. Con. (umhos/cm)	540	525	520
Turbidity (NTU)	26.0	40	25
Ammonia	0.05	0.06	0.03
Phosphorus	0.16	0.20	0.20
Soluble P	0.10	0.12	0.12
Nitrates	1.90	1.99	2.00
Nitrites	<0.01	<0.01	<0.01
TKN	1.96	1.68	0.84
Chlorides	64	67	64
Sulfates	72	62	69
Alkalinity	108	107	106
Hardness	146	154	175
Nickel	<0.01	<0.01	<0.01
Copper	0.01	0.04	0.04
Chromium (Total)	0.03	0.02	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.04	0.04	0.04
Iron	1.5	3.0	2.4
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	0.3	<0.2	0.2
Total Coliform	8,000	4,500	7,700
Fecal Coliform	1,500	1,000	2,900
Fecal Streptococcus	300	480	480
pH (standard units)	7.2 - 7.4	7.3 - 7.6	7.2 - 7.4

Appendix III-C: Cuyahoga River (continued)

Sample Dates: 7/25, 9/13/90

Site No.	22.7	22.8	22.9
Number of Samples	2	2	2
Temperature (°C)	20.8	21.0	20.2
Dissolved Oxygen	6	7.2	7.9
BOD	3	5	3
COD	29	26	29
Suspended Solids	86	81	81
Total Solids	420	446	438
Dissolved Solids	322	291	328
Sp. Con. (umhos/cm)	518	468	462
Turbidity (NTU)	22.5	28.5	27
Ammonia	0.04	<0.01	<0.01
Phosphorus	0.21	0.20	0.20
Soluble P	0.12	0.10	0.10
Nitrates	2.35	1.46	1.28
Nitrites	<0.01	<0.01	<0.01
TKN	1.12	59	0.84
Chlorides	77	60	57
Sulfates	61	59	54
Alkalinity	107	104	104
Hardness	175	160	146
Nickel	0.01	<0.01	<0.01
Copper	0.04	0.02	0.03
Chromium (Total)	<0.01	0.01	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.05	0.02	0.04
Iron	2.5	3.0	3.0
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	0.03	0.02
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	2,900	16,000	16,000
Fecal Coliform	2,600	4,000	3,400
Fecal Streptococcus	620	820	760
pH (standard units)	7.3 - 7.5	7.3 - 7.6	7.3 - 7.6

Appendix III-D: Cuyahoga River (continued)

Sample Dates: 7/25, 9/13/90

Site No.	23	24	24.5
Number of Samples	2	2	1
Temperature (°C)	20.0	20.4	20.0
Dissolved Oxygen	7.0	7.1	8.4
BOD	3	2	2
COD	31	25	29
Suspended Solids	76	56	38
Total Solids	432	440	314
Dissolved Solids	296	320	243
Sp. Con. (umhos/cm)	460	455	380
Turbidity (NTU)	22.0	18.0	13
Ammonia	<0.01	<0.01	0.05
Phosphorus	0.18	0.16	0.16
Soluble P	0.20	0.09	0.07
Nitrates	1.33	1.19	1.29
Nitrites	0.01	0.01	<0.01
TKN	2.10	0.56	1.40
Chlorides	64	66	57
Sulfates	58	54	50
Alkalinity	102	104	95
Hardness	143	142	162
Nickel	<0.01	<0.01	<0.01
Copper	0.02	0.02	0.02
Chromium (Total)	0.02	0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.02	0.02
Iron	2.4	2.0	1.4
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	0.01
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	4,500	3,700	2,100
Fecal Coliform	2,600	2,400	1,700
Fecal Streptococcus	520	620	240
pH (standard units)	7.2 - 7.5	7.3 - 7.6	7.5

Appendix III-E: Ohio Canal

Sample Dates: 8/1/90

Site No.	53	54	55	56
Number of Samples	1	1	1	1
Temperature (°C)	23.6	21.3	20.2	19.9
Dissolved Oxygen	7.8	8.2	8.5	8.5
BOD	12	7	6	8
COD	16	23	21	14
Suspended Solids	50	66	64	65
Total Solids	483	434	385	452
Dissolved Solids	433	167	306	360
Sp. Con. (umhos/cm)	630	600	440	545
Turbidity (NTU)	35.0	40.0	38.0	25.0
Ammonia	<0.01	<0.01	<0.01	<0.01
Phosphorus	0.18	0.25	0.22	0.19
Soluble P	0.08	0.16	0.13	0.12
Nitrates	--	--	--	--
Nitrites	--	--	--	--
TKN	--	--	--	--
Chlorides	100	85	65	80
Sulfates	92	90	75	90
Alkalinity	104	125	98	121
Hardness	167	--	109	140
Nickel	0.01	0.01	0.01	0.01
Copper	0.02	0.01	0.02	<0.01
Chromium (Total)	0.01	<0.01	0.02	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.04	0.04	0.06	0.03
Iron	2.3	2.6	2.1	1.5
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	0.2	<0.2
Total Coliform	3,300	3,300	36,000	66,000
Fecal Coliform	<10	<10	120	310
Fecal Streptococcus	130	490	310	1,900
pH (standard units)	--	--	7.6	7.6

Appendix III-F: Big Creek

Sample Dates: 6/20, 7/19, 10/16/90

Site No.	25	26	27
Number of Samples	2	3	3
Temperature (°C)	13.4	17.4	17.2
Dissolved Oxygen	9.0	9.1	8.0
BOD	2	1	2
COD	14	12	20
Suspended Solids	5	4	4
Total Solids	600	502	700
Dissolved Solids	552	462	645
Sp. Con. (umhos/cm)	790	697	926
Turbidity (NTU)	6.0	2.0	4.0
Ammonia	0.56	0.30	0.48
Phosphorus	0.10	0.08	0.18
Soluble P	0.08	0.08	0.16
Nitrates	1.02	1.04	0.88
Nitrites	0.06	0.05	0.07
TKN	3.22	2.66	4.48
Chlorides	186	158	219
Sulfates	104	125	119
Alkalinity	176	144	179
Hardness	223	210	238
Nickel	0.02	0.03	0.01
Copper	0.02	0.02	0.02
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.01	0.02
Iron	0.5	0.4	0.6
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	0.01	<0.01
Mercury (ug/L)	1.2	0.8	0.2
Total Coliform	8,000	28,000	22,000
Fecal Coliform	20	20	<20
Fecal Streptococcus	420	640	800
pH (standard units)	7.8 - 8.0	8.2 - 8.9	7.5 - 8.0

Appendix III-G: Big Creek (Continued)

Sample Dates: 6/20, 10/16/90

Site No.	28	29	30
Number of Samples	2	2	2
Temperature (°C)	14.6	14.2	13.8
Dissolved Oxygen	8.2	9.3	9.8
BOD	2	4	2
COD	22	16	13
Suspended Solids	4	32	2
Total Solids	770	660	384
Dissolved Solids	660	602	346
Sp. Con. (umhos/cm)	988	622	512
Turbidity (NTU)	4.0	26.0	1.0
Ammonia	0.22	0.55	0.23
Phosphorus	0.13	0.16	0.10
Soluble P	0.10	0.14	0.10
Nitrates	1.04	0.84	1.04
Nitrites	0.09	0.06	0.05
TKN	2.02	2.04	1.60
Chlorides	294	144	124
Sulfates	105	92	58
Alkalinity	188	148	130
Hardness	244	200	154
Nickel	0.02	0.02	0.01
Copper	0.02	0.02	0.02
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.05	0.02	0.02
Iron	0.3	1.0	0.1
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	0.01	<0.01
Mercury (ug/L)	0.4	0.6	0.3
Total Coliform	67,000	78,000	49,000
Fecal Coliform	<20	580	20
Fecal Streptococcus	340	16,000	260
pH (standard units)	7.7 - 8.5	8.0 - 8.2	7.9 - 8.1

Appendix III-H: Mill Creek

Sample Dates: 3/20, 3/21, 3/22, 3/26, 9/6, 12/7/90

Site No.	31	32	33
Number of Samples	1	1	6
Temperature (°C)	1.0	1.5	14
Dissolved Oxygen	8.2	8.2	11.1
BOD	13	2	4
COD	43	28	11
Suspended Solids	18	5	24
Total Solids	182	1,080	788
Dissolved Solids	144	1,090	742
Sp. Con. (umhos/cm)	1,150	880	940
Turbidity (NTU)	15.0	3.0	2.0
Ammonia	3.52	1.28	0.80
Phosphorus	0.07	0.05	0.15
Soluble P	0.02	0.02	0.15
Nitrates	1.50	0.97	69.4
Nitrites	0.27	0.07	0.008
TKN	5.37	1.96	2.38
Chlorides	429	300	138
Sulfates	175	280	126
Alkalinity	244	180	155
Hardness	364	430	266
Nickel	<0.01	0.04	0.01
Copper	<0.01	0.02	0.02
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.12	0.04	0.04
Iron	2.0	0.8	0.4
Cadmium	<0.01	<0.01	<0.01
Lead	0.02	0.01	0.008
Mercury (ug/L)	<0.2	<0.2	0.2
Total Coliform	55,000	3,400	38,000
Fecal Coliform	12,000	200	5,100
Fecal Streptococcus	9,500	<100	570
pH (standard units)	7.5	--	8.0

Appendix III-I: Mill Creek (continued)

Sample Dates: 9/6, 12/7/90

Site No.	33.5	34	35
Number of Samples	2	2	2
Temperature (°C)	12	14.2	11
Dissolved Oxygen	10.0	11.7	13.3
BOD	2	4	2
COD	9	12	18
Suspended Solids	24	29	28
Total Solids	596	623	874
Dissolved Solids	562	593	832
Sp. Con. (umhos/cm)	720	800	1,080
Turbidity (NTU)	2.2	3.4	2.5
Ammonia	0.06	0.37	0.04
Phosphorus	0.11	0.20	0.06
Soluble P	0.08	0.16	0.04
Nitrates	1.16	0.78	0.67
Nitrites	<0.01	0.08	<0.01
TKN	0.94	2.02	1.77
Chlorides	67	105	251
Sulfates	89	80	82
Alkalinity	149	168	170
Hardness	240	253	280
Nickel	<0.01	<0.01	0.02
Copper	0.008	0.008	0.008
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.02	0.02
Iron	0.2	0.2	0.3
Cadmium	<0.01	<0.01	<0.01
Lead	0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	0.2
Total Coliform	36,000	1,800,000	3,400
Fecal Coliform	4,300	1,400,000	720
Fecal Streptococcus	810	370,000	1,600
pH (standard units)	7.8	8.2	7.7

Appendix III-J: West Creek

Sample Dates: 3/16, 8/1/90

Site No.	36	37	38
Number of Samples	2	1	1
Temperature (°C)	18.8	17.4	18.7
Dissolved Oxygen	8.3	9.0	8.1
BOD	4	4	4
COD	17	10	10
Suspended Solids	11	5	5
Total Solids	789	579	734
Dissolved Solids	727	567	690
Sp. Con. (umhos/cm)	850	750	970
Turbidity (NTU)	4.6	2.7	2.2
Ammonia	0.29	<0.01	<0.08
Phosphorus	0.11	0.05	0.06
Soluble P	0.06	0.05	0.06
Nitrates	0.88	--	--
Nitrites	0.05	--	--
TKN	1.34	--	--
Chlorides	224	134	194
Sulfates	129	136	195
Alkalinity	120	107	127
Hardness	213	192	--
Nickel	0.02	<0.01	<0.01
Copper	0.04	0.01	0.02
Chromium (Total)	0.02	0.02	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.08	0.04	0.03
Iron	1.3	0.2	0.1
Cadmium	<0.01	<0.01	<0.01
Lead	0.04	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	0.4
Total Coliform	940	4,500	650
Fecal Coliform	10	<10	<10
Fecal Streptococcus	550	610	240
pH (standard units)	7.8 - 8.6	7.6	7.7

Appendix III-K: Tinkers Creek

Sample Dates: 3/15, 6/18/90

Site No.	39	40
Number of Samples	2	1
Temperature (°C)	--	--
Dissolved Oxygen	--	--
BOD	5	7
COD	12	23
Suspended Solids	14	9
Total Solids	554	518
Dissolved Solids	517	504
Sp. Con. (umhos/cm)	690	700
Turbidity (NTU)	--	--
Ammonia	0.14	0.11
Phosphorus	0.13	0.13
Soluble P	0.10	0.11
Nitrates	2.77	1.55
Nitrites	0.06	0.11
TKN	1.24	2.24
Chlorides	142	156
Sulfates	62	60
Alkalinity	135	123
Hardness	192	171
Nickel	0.06	0.03
Copper	0.03	0.02
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	<0.01	--
Zinc	0.10	0.04
Iron	1.1	0.6
Cadmium	<0.01	<0.01
Lead	0.02	0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	2,600	21,000
Fecal Coliform	80	460
Fecal Streptococcus	60	260
pH (standard units)	9.1	7.85

Appendix III-L: Tinkers Creek (Continued)

Sample Dates: 3/15/90

Site No.	41	42
Number of Samples	1	1
Temperature (°C)	—	—
Dissolved Oxygen	--	--
BOD	8	6
COD	23	22
Suspended Solids	10	10
Total Solids	481	445
Dissolved Solids	432	375
Sp. Con. (umhos/cm)	612	560
Turbidity (NTU)	—	—
Ammonia	0.46	0.20
Phosphorus	0.14	0.12
Soluble P	0.12	0.09
Nitrates	1.62	1.12
Nitrites	0.09	0.01
TKN	5.32	3.92
Chlorides	126	104
Sulfates	50	50
Alkalinity	122	114
Hardness	172	159
Nickel	0.04	0.04
Copper	0.02	0.01
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	—	—
Zinc	0.01	<0.01
Iron	1.0	0.9
Cadmium	<0.01	<0.01
Lead	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	44,000	1,500
Fecal Coliform	820	<20
Fecal Streptococcus	340	<20
pH (standard units)	7.45	7.7

Appendix III-M: Chippewa Creek

Sample Dates: 6/25, 7/2/90

Site No.	43	43.5	44
Number of Samples	2	2	2
Temperature (°C)	18.6	20.4	17.9
Dissolved Oxygen	8.4	7.8	8.4
BOD	2	2	2
COD	32	22	10
Suspended Solids	5	6	16
Total Solids	686	844	642
Dissolved Solids	590	710	547
Sp. Con. (umhos/cm)	958	1,134	946
Turbidity (NTU)	3.0	3.0	6.0
Ammonia	0.03	0.11	0.09
Phosphorus	0.04	0.04	0.07
Soluble P	0.02	0.02	0.04
Nitrates	0.46	0.58	0.35
Nitrites	0.02	0.04	0.01
TKN	1.26	3.64	0.70
Chlorides	126	121	100
Sulfates	302	304	84
Alkalinity	153	198	188
Hardness	209	360	194
Nickel	<0.01	0.02	0.04
Copper	0.02	0.02	0.03
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	<0.01	0.02	0.17
Iron	0.3	0.2	0.4
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	0.01	0.01
Mercury (ug/L)	0.2	0.2	0.2
Total Coliform	2,900	2,600	5,100
Fecal Coliform	120	180	120
Fecal Streptococcus	100	280	480
pH (standard units)	7.6 - 7.8	8.0 - 8.2	7.6 - 7.8

Appendix III-N: Sagamore Creek

Sample Dates: 10/31/90

Site No.	57
Number of Samples	1
Temperature (°C)	9.0
Dissolved Oxygen	13.2
BOD	2
COD	13
Suspended Solids	2
Total Solids	437
Dissolved Solids	393
Sp. Con. (umhos/cm)	480
Turbidity (NTU)	0.7
Ammonia	0.14
Phosphorus	0.06
Soluble P	0.06
Nitrates	0.24
Nitrites	0.20
TKN	0.14
Chlorides	144
Sulfates	95
Alkalinity	175
Hardness	220
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.02
Iron	0.1
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	120
Fecal Coliform	40
Fecal Streptococcus	20
pH (standard units)	8.0

Appendix III-O: Morgana Run

Sample Dates: 1/23, 10/2/90

Site No.	47	47-A
Number of Samples	2	2
Temperature (°C)	--	--
Dissolved Oxygen	--	--
BOD	8	28
COD	42	69
Suspended Solids	186	48
Total Solids	1,288	1,283
Dissolved Solids	--	1,137
Sp. Con. (umhos/cm)	210	236
Turbidity (NTU)	18.0	14.0
Ammonia	1.26	6.37
Phosphorus	0.17	0.17
Soluble P	0.04	0.09
Nitrates	1.06	3.41
Nitrites	0.23	<0.01
TKN	5.60	14.8
Chlorides	356	269
Sulfates	222	400
Alkalinity	58	161
Hardness	380	160
Nickel	0.01	0.01
Copper	0.02	0.02
Chromium (Total)	0.02	0.04
Chromium (Hex.)	<0.01	<0.01
Zinc	0.09	0.02
Iron	1.1	1.0
Cadmium	<0.01	<0.01
Lead	0.03	<0.01
Mercury (ug/L)	<0.2	0.3
Total Coliform	4,800	12,000
Fecal Coliform	<100	1,000
Fecal Streptococcus	4,300	820
pH (standard units)	9.3	9.6

Appendix III-P: Euclid Creek

Sample Dates: 10/2/90

Site No.	0.5	1	2
Number of Samples	1	1	1
Temperature (°C)	13.0	12.5	12.0
Dissolved Oxygen	11.0	11.0	9.8
BOD	2	1	2
COD	19	18	12
Suspended Solids	3	13	2
Total Solids	484	481	506
Dissolved Solids	462	449	497
Sp. Con. (umhos/cm)	540	510	966
Turbidity (NTU)	6.7	15.0	0.6
Ammonia	<0.01	0.03	<0.01
Phosphorus	0.04	0.07	<0.01
Soluble P	0.02	0.02	<0.01
Nitrates	1.16	1.33	0.87
Nitrites	<0.01	<0.01	<0.01
TKN	2.52	2.80	3.36
Chlorides	114	94	120
Sulfates	93	96	100
Alkalinity	123	123	112
Hardness	170	160	160
Nickel	0.01	<0.01	0.01
Copper	0.02	0.01	0.02
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.01	<0.01	<0.01
Iron	1.2	2.6	<0.01
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	620	460	450
Fecal Coliform	<10	240	<10
Fecal Streptococcus	180	80	30
pH (standard units)	8.1	7.7	7.7

Appendix III-Q: Euclid Creek (continued)

Sample Dates: 10/2/90

Site No.	3	4
Number of Samples	1	1
Temperature (°C)	13.0	13.0
Dissolved Oxygen	12.0	12.0
BOD	2	2
COD	13	24
Suspended Solids	2	2
Total Solids	478	510
Dissolved Solids	421	493
Sp. Con. (umhos/cm)	690	853
Turbidity (NTU)	1.0	1.7
Ammonia	<0.01	<0.01
Phosphorus	0.13	0.04
Soluble P	0.13	0.03
Nitrates	1.83	0.75
Nitrites	<0.01	<0.01
TKN	4.20	4.03
Chlorides	86	124
Sulfates	71	95
Alkalinity	122	2,470
Hardness	150	160
Nickel	<0.01	<0.01
Copper	0.01	0.01
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	<0.01	0.01
Iron	<0.1	0.2
Cadmium	<0.01	<0.01
Lead	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	390	290
Fecal Coliform	40	<10
Fecal Streptococcus	50	140
pH (standard units)	7.8	8.0

Appendix III-R: Green Creek

Sample Dates: 10/17/90

Site No.	5	6	7
Number of Samples	1	1	1
Temperature (°C)	14.0	13.0	12.0
Dissolved Oxygen	9.6	8.8	10.1
BOD	2	2	2
COD	13	11	8
Suspended Solids	5	4	4
Total Solids	451	370	277
Dissolved Solids	371	298	232
Sp. Con. (umhos/cm)	505	405	295
Turbidity (NTU)	1.8	1.4	2.0
Ammonia	0.16	0.32	0.03
Phosphorus	0.08	0.16	0.02
Soluble P	0.07	0.15	0.01
Nitrates	1.10	0.93	0.45
Nitrites	<0.01	0.04	<0.01
TKN	3.08	4.48	2.24
Chlorides	56	52	26
Sulfates	92	83	68
Alkalinity	168	110	98
Hardness	210	180	170
Nickel	<0.01	<0.01	<0.01
Copper	0.01	0.02	0.02
Chromium (Total)	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.04	0.04	0.01
Iron	0.3	0.2	0.2
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	--	--	--
Total Coliform	9,700	>8,000	620
Fecal Coliform	1,200	>6,000	130
Fecal Streptococcus	84	410	200
pH (standard units)	7.6	7.7	7.6

Appendix III-S: Nine-Mile Creek

Sample Dates: 10/30/90

Site No.	8a	8b	9	10
Number of Samples	1	1	1	1
Temperature (°C)	9.0	9.0	7.0	5.0
Dissolved Oxygen	5.4	8.5	8.8	10.8
BOD	3	4	2	1
COD	14	18	<10	11
Suspended Solids	4	5	2	2
Total Solids	525	497	633	487
Dissolved Solids	461	442	596	430
Sp. Con. (umhos/cm)	591	560	710	500
Turbidity (NTU)	3.0	1.4	0.85	0.5
Ammonia	0.71	0.84	0.20	0.10
Phosphorus	0.29	0.21	0.04	0.08
Soluble P	0.20	0.19	0.04	0.08
Nitrates	1.03	1.58	2.90	1.86
Nitrites	0.34	0.03	0.06	0.04
TKN	1.89	1.77	0.53	0.42
Chlorides	99	112	159	115
Sulfates	110	122	153	99
Alkalinity	153	121	136	125
Hardness	220	190	240	190
Nickel	<0.01	0.01	0.03	<0.01
Copper	0.01	0.01	0.02	<0.01
Chromium (Total)	0.06	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.04	0.10	0.02
Iron	0.5	0.2	0.2	<0.1
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	0.01
Mercury (ug/L)	<0.2	<0.2	0.2	<0.2
Total Coliform	11,000	87,000	27,000	1,600
Fecal Coliform	2,000	51,000	3,000	100
Fecal Streptococcus	800	11,000	1,200	<100
pH (standard units)	7.1	7.4	7.3	7.2

Appendix III-T: Dugway Brook

Sample Dates: 9/26/90

Site No.	12	13	14	15
Number of Samples	1	1	1	1
Temperature (°C)	17.0	15.0	15.0	14.0
Dissolved Oxygen	3.0	8.6	11.2	6.4
BOD	11	7	1	2
COD	24	18	20	<10
Suspended Solids	10	11	6	14
Total Solids	953	532	600	716
Dissolved Solids	868	500	564	657
Sp. Con. (umhos/cm)	1,325	660	750	810
Turbidity (NTU)	5.0	4.7	1.5	2.0
Ammonia	3.83	0.65	0.42	0.44
Phosphorus	0.42	0.34	0.24	0.10
Soluble P	0.32	0.31	0.25	0.10
Nitrates	0.71	0.95	0.23	1.17
Nitrites	0.15	0.16	0.12	0.13
TKN	5.88	2.02	1.85	2.24
Chlorides	288	118	148	156
Sulfates	97	78	94	23
Alkalinity	215	148	160	202
Hardness	270	180	210	240
Nickel	<0.01	<0.01	<0.01	0.01
Copper	0.02	0.26	<0.01	0.01
Chromium (Total)	<0.01	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.04	0.01	0.01
Iron	0.8	0.6	0.2	<0.4
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	0.02	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	<0.2	<0.2
Total Coliform	>200,000	>200,000	4,800	30,000
Fecal Coliform	220,000	140,000	430	11,000
Fecal Streptococcus	40,000	7,700	180	590
pH (standard units)	7.3	7.6	7.3	7.6

Appendix III-U: Doan Brook

Sample Dates: 8/30, 9/26/90

Site No.	16	17	18	19
Number of Samples	1	1	2	2
Temperature (°C)	—	—	—	—
Dissolved Oxygen	8.8	8.3	8.3	7.6
BOD	2	3	1	2
COD	11	<10	<10	11
Suspended Solids	4	9	4	5
Total Solids	380	310	369	424
Dissolved Solids	333	265	340	390
Sp. Con. (umhos/cm)	542	428	498	482
Turbidity (NTU)	2	3	2	2
Ammonia	0.24	0.41	0.20	0.26
Phosphorus	0.14	0.20	0.06	0.06
Soluble P	0.12	0.18	0.03	0.04
Nitrates	0.84	0.57	0.22	0.44
Nitrites	0.02	<0.01	<0.01	<0.01
TKN	2.35	2.58	2.00	1.96
Chlorides	78	68	76	88
Sulfates	51	39	46	48
Alkalinity	110	109	129	128
Hardness	140	90	97	104
Nickel	<0.01	<0.01	<0.01	0.01
Copper	0.01	<0.01	<0.01	0.02
Chromium (Total)	0.01	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.01	0.01	<0.01
Iron	0.2	0.1	0.2	0.2
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2	<0.2	<0.2
Total Coliform	5,800	>200,000	2,000	1,100
Fecal Coliform	2,500	100,000	210	340
Fecal Streptococcus	380	39,000	160	150
pH (standard units)	7.5	7.6	7.5	7.4 - 7.6

Appendix III-V: Rocky River

Sample Dates: 8/10, 11/1/90

Site No.	49	50	51
Number of Samples	2	2	2
Temperature (°C)	17.0	15.0	15.0
Dissolved Oxygen	11	10	12
BOD	4	4	4
COD	18	14	10
Suspended Solids	30	27	18
Total Solids	423	408	360
Dissolved Solids	378	367	330
Sp. Con. (umhos/cm)	520	488	462
Turbidity (NTU)	8.0	17.0	3.8
Ammonia	1.4	0.13	0.09
Phosphorus	0.18	0.16	0.10
Soluble P	0.14	0.10	0.08
Nitrates	2.53	2.15	2.65
Nitrites	0.08	0.05	0.05
TKN	2.94	2.07	4.22
Chlorides	83	86	79
Sulfates	83	76	66
Alkalinity	135	138	153
Hardness	195	178	184
Nickel	<0.01	0.01	<0.01
Copper	0.01	<0.01	0.02
Chromium (Total)	0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.03	0.05	0.04
Iron	1.6	2.9	0.1
Cadmium	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	<0.01
Mercury (ug/L)	0.2	<0.2	<0.2
Total Coliform	7,600	2,500	1,500
Fecal Coliform	1,000	100	1,200
Fecal Streptococcus	190	200	20
pH (standard units)	8.0	7.7	8.1

Appendix III-W: Rocky River (Continued)

Sample Dates: 8/10, 11/1/90

Site No.	52	52.5
Number of Samples	2	2
Temperature (°C)	17.0	18.0
Dissolved Oxygen	9	10
BOD	2	2
COD	15	13
Suspended Solids	7	8
Total Solids	391	428
Dissolved Solids	358	388
Sp. Con. (umhos/cm)	510	520
Turbidity (NTU)	3.0	2.2
Ammonia	0.24	0.33
Phosphorus	0.14	0.13
Soluble P	0.13	0.11
Nitrates	2.00	3.45
Nitrites	0.08	0.20
TKN	6.40	2.46
Chlorides	82	91
Sulfates	83	84
Alkalinity	166	149
Hardness	223	198
Nickel	<0.01	<0.01
Copper	0.02	0.01
Chromium (Total)	0.01	0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	0.01	0.03
Iron	0.5	0.6
Cadmium	<0.01	<0.01
Lead	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	2,400	360
Fecal Coliform	170	130
Fecal Streptococcus	70	50
pH (standard units)	8.2	8.0

Appendix III-X: Chagrin River

Sample Dates: 10/31/90

Site No.	58	59
Number of Samples	1	1
Temperature (°C)	7	7
Dissolved Oxygen	13.4	13.0
BOD	2	2
COD	14	12
Suspended Solids	2	2
Total Solids	299	294
Dissolved Solids	260	258
Sp. Con. (umhos/cm)	330	328
Turbidity (NTU)	2.8	3.0
Ammonia	0.08	0.36
Phosphorus	0.02	0.03
Soluble P	0.02	0.02
Nitrates	0.60	0.60
Nitrites	0.18	<0.01
TKN	1.21	1.35
Chlorides	110	154
Sulfates	71	134
Alkalinity	152	149
Hardness	150	150
Nickel	<0.01	<0.01
Copper	<0.01	0.03
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	0.02	0.02
Iron	0.4	0.4
Cadmium	<0.01	<0.01
Lead	<0.01	<0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	660	400
Fecal Coliform	30	110
Fecal Streptococcus	70	<10
pH (standard units)	7.8	7.7

APPENDIX IV

LAKE ERIE
1990 CHEMICAL AND BACTERIOLOGICAL DATA*

*Note: Data presented are from analyses of grab samples obtained under various weather conditions. Bacteriological data presented are geometric means in organisms/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 data at a site were lower than detection limits. pH data are expressed as ranges. Not all parameters listed were analyzed in all samples collected. Individual data are on file by date of sampling and are available for review upon request at the NEORSD Water Quality & Industrial Surveillance offices.

Appendix IV-A: Site A, Lake Erie near Crown Water Intake

Sample Dates: 6/27, 7/5, 7/9, 7/18, 7/20, 7/27, 8/20, 9/20/90

	Surface	Bottom
Number of Samples	8	4
Temperature (°C)	21.4	19.6
Dissolved Oxygen	8.5	8.5
BOD	2	8
COD	<10	<10
Suspended Solids	5	69
Total Solids	180	230
Dissolved Solids	135	138
Sp. Con. (umhos/cm)	264	268
Turbidity (NTU)	2.8	18.5
Clarity (ft.)	8	--
Ammonia	<0.01	<0.01
Phosphorus	0.03	0.16
Soluble P	0.02	0.07
Nitrates	0.41	--
Nitrites	<0.01	--
TKN	1.27	0.06
Chlorides	24	20
Sulfates	36	38
Alkalinity	84	90
Hardness	94	96
Nickel	<0.01	0.01
Copper	0.01	0.03
Chromium (Total)	<0.01	0.04
Chromium (Hex.)	<0.01	<0.01
Zinc	0.01	0.04
Iron	<0.1	3
Cadmium	<0.01	<0.01
Lead	<0.01	0.06
Mercury (ug/L)	<0.2	<0.2
Total Coliform	--	--
Fecal Coliform	9	--
pH (standard units)	7.5 - 8.2	7.2 - 7.5

Appendix IV-B: Site B, Lake Erie near Division & Baldwin Water Intakes

Sample Dates: 6/28, 6/29, 7/5, 7/9, 7/18, 8/20, 8/21, 9/20/90

	Surface	Bottom
Number of Samples	8	4
Temperature (°C)	20	19.2
Dissolved Oxygen	8.6	8.7
BOD	2	2
COD	11	<10
Suspended Solids	5	4
Total Solids	196	188
Dissolved Solids	158	153
Sp. Con. (umhos/cm)	254	253
Turbidity (NTU)	2.2	2.1
Clarity (ft.)	11	--
Ammonia	0.10	0.08
Phosphorus	0.02	0.03
Soluble P	0.02	0.02
Nitrates	0.32	0.37
Nitrites	0.02	0.06
TKN	1.37	2.80
Chlorides	25	25
Sulfates	31	29
Alkalinity	96	82
Hardness	82	76
Nickel	<0.01	<0.01
Copper	0.01	<0.01
Chromium (Total)	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	0.02	0.02
Iron	0.1	0.1
Cadmium	<0.01	<0.01
Lead	0.01	0.01
Mercury (ug/L)	<0.2	<0.2
Total Coliform	52	--
Fecal Coliform	<3	--
Fecal Streptococcus	<2	--
pH (standard units)	7.6 - 7.8	7.6 - 8.2

Appendix IV-C: Site C, Lake Erie near Nottingham Water Intake

Sample Dates: 5/31, 6/22, 6/29, 7/3, 7/9, 7/17, 8/20, 9/20/90

	Surface	Bottom
Number of Samples	8	3
Temperature (°C)	19.3	16.3
Dissolved Oxygen	8.4	9.5
BOD	2	2
COD	23	16
Suspended Solids	5	2
Total Solids	214	208
Dissolved Solids	197	136
Sp. Con. (umhos/cm)	257	233
Turbidity (NTU)	1.2	1.4
Clarity (ft.)	11	—
Ammonia	0.49	<0.01
Phosphorus	0.01	0.01
Soluble P	0.01	<0.01
Nitrates	0.43	0.35
Nitrites	<0.01	0.02
TKN	0.49	0.44
Chlorides	19	18
Sulfates	34	35
Alkalinity	88	90
Hardness	136	152
Nickel	0.01	0.02
Copper	0.02	0.01
Chromium (Total)	0.01	<0.01
Chromium (Hex.)	<0.01	<0.01
Zinc	0.02	<0.01
Iron	<0.1	<0.1
Cadmium	<0.01	<0.01
Lead	0.01	<0.01
Mercury (ug/L)	<0.2	0.3
Total Coliform	80	—
Fecal Coliform	<2	—
Fecal Streptococcus	<5	—
pH (standard units)	7.4 - 8.0	7.6 - 8.0

Appendix IV-D: Site D, Lake Erie east of Rocky River mouth

Sample Dates: 6/27, 7/5, 7/9, 7/18, 7/20, 7/27, 8/20, 9/18/90

	Surface
Number of Samples	8
Temperature (°C)	22.0
Dissolved Oxygen	8.0
BOD	2.0
COD	7
Suspended Solids	6
Total Solids	215
Dissolved Solids	148
Sp. Con. (umhos/cm)	278
Turbidity (NTU)	3.6
Clarity (ft.)	6
Ammonia	0.03
Phosphorus	0.03
Soluble P	0.02
Nitrates	0.66
Nitrites	<0.01
TKN	1.12
Chlorides	27
Sulfates	38
Alkalinity	86
Hardness	121
Nickel	<0.01
Copper	0.02
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.02
Iron	0.2
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	0.3
Total Coliform	--
Fecal Coliform	95
Fecal Streptococcus	--
pH (standard units)	7.4 - 8.2

Appendix IV-E: Site E, Lake Erie off Edgewater Beach

Sample Dates: 6/22, 6/27, 7/5, 7/9, 7/16, 7/17, 7/18, 7/20, 7/24, 8/2, 8/3, 8/20, 8/21, 9/18, 9/20, 10/3/90

	Surface
Number of samples	16
Temperature (°C)	22.2
Dissolved Oxygen	8.4
BOD	3
COD	8
Suspended Solids	6
Total Solids	204
Dissolved Solids	179
Sp. Con. (umhos/cm)	307
Turbidity (NTU)	2.6
Clarity (ft.)	7
Ammonia	0.11
Phosphorus	0.03
Soluble P	0.01
Nitrates	0.59
Nitrites	<0.03
TKN	2.1
Chlorides	35
Sulfates	36
Alkalinity	93
Hardness	113
Nickel	0.02
Copper	<0.01
Chromium (Total)	0.02
Chromium (Hex.)	<0.01
Zinc	<0.02
Iron	<0.2
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	0.2
Total Coliform	99
Fecal Coliform	4
Fecal Streptococcus	2
pH (standard units)	7.3 - 7.8

Appendix IV-F: Site F, Lake Erie outside Breakwall, near Westerly WWTP effluent

Sample Dates: 6/22, 6/27, 7/3, 7/9, 7/16, 7/17, 7/18, 7/20, 7/24 8/2, 8/3, 8/20, 8/21, 9/18, 9/20, 10/3/90

	Surface
Number of samples	16
Temperature (°C)	20.6
Dissolved Oxygen	8.3
BOD	4
COD	11
Suspended Solids	6
Total Solids	209
Dissolved Solids	216
Sp. Con. (umhos/cm)	337
Turbidity (NTU)	2.8
Clarity (ft.)	6
Ammonia	0.95
Phosphorus	0.05
Soluble P	0.03
Nitrates	0.43
Nitrites	0.02
TKN	2.59
Chlorides	43
Sulfates	41
Alkalinity	103
Hardness	101
Nickel	0.04
Copper	0.01
Chromium (Total)	0.02
Chromium (Hex.)	<0.01
Zinc	0.03
Iron	0.2
Cadmium	<0.01
Lead	0.01
Mercury (ug/L)	0.2
Total Coliform	520
Fecal Coliform	9
Fecal Streptococcus	12
pH (standard units)	6.8 - 8.2

Appendix IV-G: Site G, Lake Erie inside Breakwall, at west end of Cleveland Harbor

Sample Dates: 6/28, 6/29, 7/3, 7/9, 7/18, 7/20, 7/27, 8/2, 8/20, 8/21, 9/18, 10/10/90

	Surface
Number of samples	12
Temperature (°C)	22.5
Dissolved Oxygen	8.0
BOD	3
COD	12
Suspended Solids	8
Total Solids	390
Dissolved Solids	287
Sp. Con. (umhos/cm)	402
Turbidity (NTU)	6.4
Clarity (ft.)	3
Ammonia	0.39
Phosphorus	0.06
Soluble P	0.05
Nitrates	1.4
Nitrites	0.06
TKN	1.0
Chlorides	46
Sulfates	43
Alkalinity	98
Hardness	108
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.04
Iron	0.43
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	250
Fecal Coliform	7
Fecal Streptococcus	21
pH (standard units)	6.9 - 7.8

Appendix IV-H: Site H, Lake Erie at Cuyahoga River mouth

Sample Dates: 6/27, 6/28, 6/29, 7/3, 7/9, 7/17, 7/24, 8/2, 8/20, 8/21, 9/18, 10/3/90

	Surface
Number of samples	12
Temperature (°C)	22.5
Dissolved Oxygen	6.6
BOD	2
COD	15
Suspended Solids	20
Total Solids	395
Dissolved Solids	320
Sp. Con. (umhos/cm)	488
Turbidity (NTU)	10.6
Clarity (ft.)	2
Ammonia	0.66
Phosphorus	0.11
Soluble P	0.08
Nitrates	1.96
Nitrites	0.04
TKN	2.13
Chlorides	81
Sulfates	52
Alkalinity	109
Hardness	130
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.07
Iron	0.85
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	490
Fecal Coliform	210
Fecal Streptococcus	78
pH (standard units)	7.2 - 7.8

Appendix IV-I: Site I, Lake Erie inside Breakwall, off Burke Lakefront Airport

Sample Dates: 6/28, 6/29, 7/5, 7/9, 7/17, 8/2, 8/20, 8/21, 9/18, 10/3/90

	Surface
Number of samples	10
Temperature (°C)	21.6
Dissolved Oxygen	8.0
BOD	3
COD	6
Suspended Solids	8
Total Solids	236
Dissolved Solids	200
Sp. Con. (umhos/cm)	379
Turbidity (NTU)	4.3
Clarity (ft.)	5
Ammonia	0.22
Phosphorus	0.04
Soluble P	0.03
Nitrates	0.92
Nitrites	0.03
TKN	23
Chlorides	66
Sulfates	40
Alkalinity	100
Hardness	119
Nickel	<0.01
Copper	<0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.01
Iron	0.3
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	580
Fecal Coliform	90
Fecal Streptococcus	16
pH (standard units)	7.3 - 7.8

Appendix IV-J: Site J, Lake Erie inside Breakwall, at east end of Cleveland Harbor

Sample Dates: 6/28, 6/29, 7/5, 7/9, 7/17, 7/24, 8/2, 8/20, 8/21, 9/18/90

	Surface
Number of samples	10
Temperature (°C)	21.8
Dissolved Oxygen	8.1
BOD	2
COD	14
Suspended Solids	7
Total Solids	229
Dissolved Solids	201
Sp. Con. (umhos/cm)	324
Turbidity (NTU)	3.6
Clarity (ft.)	6
Ammonia	0.10
Phosphorus	0.04
Soluble P	0.03
Nitrates	0.65
Nitrites	0.03
TKN	1.65
Chlorides	33
Sulfates	35
Alkalinity	88
Hardness	112
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.03
Iron	0.3
Cadmium	<0.01
Lead	0.01
Mercury (ug/L)	0.2
Total Coliform	5,000
Fecal Coliform	26
Fecal Streptococcus	40
pH (standard units)	7.1 - 7.9

Appendix IV-K: Site K, Lake Erie off White City Beach

Sample Dates: 6/22, 6/27, 6/28, 6/29, 7/3, 7/9, 7/16, 7/17, 7/18, 7/20, 7/24, 8/2, 8/3, 8/20, 8/21, 9/18, 9/20, 10/3/90

	Surface
Number of samples	22
Temperature (°C)	20.4
Dissolved Oxygen	8.26
BOD	2
COD	10
Suspended Solids	6
Total Solids	214
Dissolved Solids	163
Sp. Con. (umhos/cm)	291
Turbidity (NTU)	3.7
Clarity (ft.)	5
Ammonia	0.03
Phosphorus	0.03
Soluble P	0.02
Nitrates	0.53
Nitrites	0.04
TKN	1.23
Chlorides	26
Sulfates	33
Alkalinity	89
Hardness	102
Nickel	<0.01
Copper	0.01
Chromium (Total)	0.02
Chromium (Hex.)	<0.01
Zinc	0.02
Iron	0.3
Cadmium	<0.01
Lead	0.01
Mercury (ug/L)	<0.2
Total Coliform	910
Fecal Coliform	24
Fecal Streptococcus	14
pH (standard units)	7.0 - 8.2

Appendix IV-L: Site L, Lake Erie near Easterly WWTP effluent

Sample Dates: 6/22, 6/27, 6/28, 6/29, 7/3, 7/9, 7/16, 7/17, 7/18, 7/20, 7/24, 8/2, 8/3, 8/20, 8/21, 9/18, 9/20, 10/3/90

	Surface
Number of samples	22
Temperature (°C)	19.7
Dissolved Oxygen	8.3
BOD	3
COD	11
Suspended Solids	6
Total Solids	284
Dissolved Solids	230
Sp. Con. (umhos/cm)	389
Turbidity (NTU)	2.5
Clarity (ft.)	6
Ammonia	0.96
Phosphorus	0.06
Soluble P	0.05
Nitrates	1.32
Nitrites	0.22
TKN	2.31
Chlorides	49
Sulfates	43
Alkalinity	100
Hardness	114
Nickel	0.01
Copper	<0.01
Chromium (Total)	0.02
Chromium (Hex.)	<0.01
Zinc	0.04
Iron	0.2
Cadmium	<0.01
Lead	0.01
Mercury (ug/L)	<0.2
Total Coliform	1,000
Fecal Coliform	30
Fecal Streptococcus	27
pH (standard units)	7.1 - 7.8

Appendix IV-M: Site M, Lake Erie off Euclid Beach

Sample Dates: 6/22, 6/27, 6/29, 7/3, 7/9, 7/16, 7/17, 7/18, 7/20, 7/24, 8/2, 8/3, 8/20, 8/21, 9/18, 9/20, 10/3/90

	Surface
Number of samples	21
Temperature (°C)	20.2
Dissolved Oxygen	8.4
BOD	2
COD	12
Suspended Solids	6
Total Solids	262
Dissolved Solids	189
Sp. Con. (umhos/cm)	283
Turbidity (NTU)	3.5
Clarity (ft.)	6
Ammonia	0.05
Phosphorus	0.02
Soluble P	0.02
Nitrates	0.38
Nitrites	0.03
TKN	1.25
Chlorides	22
Sulfates	35
Alkalinity	92
Hardness	103
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.03
Iron	0.2
Cadmium	<0.01
Lead	0.02
Mercury (ug/L)	<0.2
Total Coliform	400
Fecal Coliform	15
Fecal Streptococcus	5
pH (standard units)	6.7 - 8.4

Appendix IV-N: Site N, Lake Erie northeast of Euclid Creek mouth

Sample Dates: 6/29, 7/3, 7/9, 7/16, 7/24, 8/2, 8/20, 9/18, 10/3/90

	Surface
Number of samples	9
Temperature (°C)	20.4
Dissolved Oxygen	8.3
BOD	4
COD	10
Suspended Solids	4
Total Solids	203
Dissolved Solids	161
Sp. Con. (umhos/cm)	275
Turbidity (NTU)	2.1
Clarity (ft.)	7
Ammonia	0.01
Phosphorus	0.02
Soluble P	0.02
Nitrates	0.27
Nitrites	<0.01
TKN	3.17
Chlorides	26
Sulfates	35
Alkalinity	95
Hardness	104
Nickel	<0.01
Copper	0.01
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.04
Iron	0.1
Cadmium	<0.01
Lead	0.01
Mercury (ug/L)	0.2
Total Coliform	80
Fecal Coliform	11
Fecal Streptococcus	<2
pH (standard units)	7.3 - 8.0

Appendix IV-O: Site O, Lake Erie west of Rocky River mouth

Sample Dates: 6/27, 7/5, 7/9, 7/18, 7/20, 7/27, 8/20, 9/18/90

	Surface
Number of samples	8
Temperature (°C)	22.3
Dissolved Oxygen	8.1
BOD	2
COD	7
Suspended Solids	4
Total Solids	191
Dissolved Solids	143
Sp. Con. (umhos/cm)	265
Turbidity (NTU)	3.1
Clarity (ft.)	7
Ammonia	0.02
Phosphorus	0.04
Soluble P	0.02
Nitrates	0.44
Nitrites	<0.01
TKN	2.39
Chlorides	32
Sulfates	34
Alkalinity	97
Hardness	95
Nickel	<0.01
Copper	0.03
Chromium (Total)	<0.01
Chromium (Hex.)	<0.01
Zinc	0.02
Iron	0.2
Cadmium	<0.01
Lead	<0.01
Mercury (ug/L)	<0.2
Total Coliform	---
Fecal Coliform	15
Fecal Streptococcus	---
pH (standard units)	7.2 - 8.1

APPENDIX V

1989 CUYAHOGA AND CHAGRIN RIVER SEDIMENT ANALYSIS

Appendix V-A: Sediment particle size determinations (9/28/89)

	mm, Pore Diameter	Cuyahoga River RM 11.3	Cuyahoga River RM 7.2	Cuyahoga River RM 5.6	Cuyahoga River RM 3.3	Chagrin River RM 4.5	Chagrin River RM 1.0
Sample weight, grams		450.2	394.4	298.0	141.5	489.0	206.1
Grams retained by:		Coarse sand.	Fine sand.	Fine sand.	Muck.	Coarse sand.	Muck.
Sieve #4	4.76	57.4	0	2.4	0	15.9	0
Sieve #12	1.68	81.8	0.1	3.4	0	88.3	1.8
Sieve #60	0.250	272.7	177.8	233.6	0.7	381.2	16.6
Sieve #100	0.149	32.9	124.8	36.5	42.8	2.2	72.3
Sieve #200	0.074	3.4	64.4	13.7	26.7	0.2	52.8
Pan	0	1.6	20.8	7.0	70.1	0.2	59.9

Appendix V-B: Concentrations of metals in sediments (9/28/89)

		Cuyahoga River				Chagrin River	
mg/kg	MDL	RM 11.3	RM 7.1	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Arsenic	0.2	4	4	5	9	ND	ND
Chromium	0.7	5	6	5	21	ND	ND
Lead	2.5	15	43	34	55	5	6.5
Copper	0.5	13	90	100	40	7.6	9.3
Nickel	0.7	5	14	14	19	6.8	7.0
Zinc	0.5	50	230	165	330	50	30
Antimony	2.5	7.8	8	6	16	14	12
Thallium	5.0	20	40	22	27	22	25

(ND = not detected. MDL = Method Detection Limit.)

Appendix V-C: Concentrations of priority pollutant organics in sediments (9/28/89)

		Cuyahoga River				Chagrin River	
ug/g	MDL	RM 11.3	RM 7.1	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Bis(2-ethylhexyl) phthalate	0.33	0.89	0.69	1.0	1.4	0.99	0.73
Benzo(a)anthracene	0.33	ND	ND	ND	0.34	ND	ND
3,4-Benzofluoranthene	0.33	ND	ND	ND	0.58	ND	ND
Chrysene	0.33	ND	ND	ND	0.33	ND	ND
Fluoranthene	0.33	ND	ND	ND	0.58	ND	ND
Phenanthrene	0.33	ND	ND	ND	0.44	ND	ND
Pyrene	0.33	0.38	0.39	ND	0.85	ND	ND

(ND = not detected. MDL = Method Detection Limit.)

Appendix V-D: Priority pollutants not detected in Cuyahoga or Chagrin River sediments (9/28/89).

Parameter	MDL (ppm)	Parameter	MDL (ppm)
Cyanide	0.2	Heptachlor epoxide	0.3
Cadmium	0.25	PCB(as Arochlor 1242)	0.5
Selinium	2.5	PCB(as Arochlor 1254)	0.5
Silver	0.2	PCB(as Arochlor 1221)	0.5
Beryllium	0.1	PCB(as Arochlor 1232)	0.5
Mercury	0.0005	PCB(as Arochlor 1248)	0.5
Acrolein	6.3	PCB(as Arochlor 1260)	0.5
Acrylonitrile	6.3	PCB(as Arochlor 1016)	0.5
Benzene	0.63	Toxaphene	1.5
Bromoform	0.63	2-Chlorophenol	0.33
Carbon tetrachloride	0.63	2,4-Dichlorophenol	0.33
Chlorobenzene	0.63	2,4-Dimethylphenol	0.33
Chlorodibromomethane	0.63	4,6-Dinitro-o-cresol	1.7
Chloroethane	0.63	2,4-Dinitrophenol	1.7
2-Chloroethyl vinyl ether	1.3	2-Nitrophenol	0.33
Chloroform	0.63	4-Nitrophenol	1.7
Dichlorobromomethane	0.63	p-Chloro-m-cresol	0.33
1,1-Dichloroethane	0.63	Pentachlorophenol	1.7
1,2-Dichloroethane	0.63	Phenol	0.33
1,1-Dichlorethylene	0.63	2,4,6-Trichlorophenol	0.33
1,2-Dichloropropane	0.63	Acenaphthene	0.33
1,3-Dichlopropylene	0.63	Acenaphthalene	0.33
Ethlybenzene	0.63	Anthracene	0.33
Methyl bromide	0.63	Benzidine	1.7
Methyl chloride	0.63	Benzo(a)pyrene	0.33
Methylene chloride	0.63	Benzo(ghi)perylene	0.67
1,1,2,2-Tetrachloroethane	0.63	Benzo(k)fluoranthene	0.33
Tetrachloroethylene	0.63	Bis(2-chloroethoxy)methane	0.33
Toluene	0.63	Bis(2-chloroethyl)ether	0.33
1,2-trans-Dichloroethylene	0.63	Bis(2-chloroisopropyl)ether	0.33
1,1,1-Trichloroethane	0.63	4-Bromophenol phenyl ether	0.33
1,1,2-Trichloroethane	0.63	Butyl benzyl phthalate	0.33
Trichloroethylene	0.63	2-Chloronapthalene	0.33
Vinyl chloride	0.63	4-Chlorophenyl phenyl ether	0.33
Aldrin	0.3	Dibenzo(a,h)anthracene	0.67
Alpha-BHC	0.3	1,2-Dichlorobenzene	0.33
Beta-BHC	0.3	1,3-Dichlorobenzene	0.33
Delta-BHC	0.3	1,4-Dichlorobenzene	0.33
Gamma-BHC	0.3	3,3-Dichlorobenzidene	1.7
Chlordane	0.5	Diethyl phthalate	0.33
4,4-DDT	0.3	Dimethyl phthalate	0.33
4,4-DDE	0.3	Di-n-butyl phthalate	0.33
4,4-DDD	0.3	2,4-Dinitrotoluene	0.33
Dieldrin	0.3	2,6-Dinitrotoluene	0.33
Alpha endosulfan	0.3	Di-n-octyl phthalate	0.33
Beta endosulfan	0.3	1,2-Diphenylhydrazine	0.33
Endosulfan sulfate	0.5	Fluorene	0.33
Endrin	0.3	Hexachlorobenzene	0.33
Endrin aldehyde	1.0	Hexachlorobutadiene	0.33
Heptachlor	0.3	Hexachlorocyclopentadiene	0.33

(Continued on following page.)

Appendix V-D (continued): Priority pollutants not detected in Cuyahoga or Chagrin River sediments (9/28/89).

Parameter	MDL (ppm)
Hexachloroethane	0.33
Indeno(1,2,3-cd)pyrene	0.67
Isophorone	0.33
Naphthalene	0.33
Nitrobenzene	0.33
N-nitrosodimethylamine	1.7
N-mitrosodi-n-propylamine	0.67
N-nitrosodiphenylamine	1.7
1,2,4-Trichlorobenzene	0.33

Appendix V-E: Concentrations of non-priority pollutants tentatively identified in sediments (9/28/89).

	Cuyahoga River				Chagrin River	
ug/g (estimated)	RM 11.3	RM 7.2	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Anthracene, 1-methyl-	0.027	-	-	-	-	-
t-Butyl hydroxyanisole	-	0.028	-	-	0.030	-
Cyclohexane, methyl-	0.11	0.14	-	-	0.15	0.16
Cyclohexane, pentyl-	-	-	-	0.21	-	-
Cyclohexanol	0.14	0.17	0.25	-	0.17	0.17
Cyclohexanone	0.12	0.12	0.20	-	0.097	0.12
4,4-Cyclopenta[def] phenanthrene	0.060	-	-	-	-	-
Decane	0.11	-	-	0.51	-	-
Decane, 4-methyl-	-	-	-	0.66	-	-
Dodecane	0.11	0.11	-	0.74	0.14	0.083
Dodecane, 2,6,10-trimethyl-	-	-	-	0.63	0.031	0.039
Eicosane	0.061	-	-	0.79	0.079	0.11
Ethane, pentachloro-	0.049	0.045	0.034	0.12	0.058	-
Heptadecane	0.068	0.096	0.054	1.0	0.095	0.17
Hexadecane	0.13	-	0.078	0.71	0.11	0.12
Napthalene, decahydro-2-methyl-	-	-	-	0.14	-	-
Nonadecane	0.078	0.076	0.083	-	0.10	0.10
Nonane	0.049	-	-	0.13	0.036	-
Octane, 2-methyl-	-	-	-	0.22	-	-
Octane, 2,3-dimethyl-	-	-	-	0.60	-	-
Octane, 2,7-dimethyl-	-	-	-	-	-	0.060
Octane, 3,5-dimethyl-	-	-	-	-	0.089	-
Pentadecane,	0.11	0.14	0.11	0.32	0.13	0.19
Pentadecane, 2,6,10,14-tetramethyl-	0.081	0.12	0.073	1.1	-	-
2-Pentanone,4-hydroxy-4-methyl-	0.13	0.10	0.18	0.19	0.18	0.23
4-Penten-2-ol	-	0.036	-	-	0.046	-
Phenol, 2,4-bis (1,1-dimethylethyl)-	-	0.045	0.19	-	-	0.28
Phenol, 4-methyl-	-	-	-	-	-	0.14
Sulfur, mol. (S_8)	-	-	0.035	-	-	0.074
Tetradecane	0.11	0.13	0.67	0.80	0.12	0.13
Tetradecane, 4,11-dimethyl-	-	-	-	0.28	-	0.10
Tridecane	0.16	0.17	-	0.34	0.19	0.12
Tridecane, 4,8-dimethyl-	-	0.058	-	-	-	-
Undecane	0.081	0.077	0.11	0.66	0.071	0.060
Undecane,2,6-dimethyl-	0.055	0.048	-	0.57	0.076	0.040
C_{16} aliphatic acid, methyl ester	-	-	0.029	-	-	-
C_{13} hydrocarbon	-	-	0.064	-	-	-
C_{14} hydrocarbon	-	-	0.098	-	-	-
C_{19} hydrocarbon	-	-	0.087	-	-	-
C_{21} hydrocarbon	-	-	0.043	-	-	-
C_{24} hydrocarbon	-	-	0.11	-	-	-

APPENDIX VI

1990 CUYAHOGA AND CHAGRIN RIVER SEDIMENT ANALYSIS

Appendix VI-A: Sediment particle size determinations (7/24/90 & 7/25/90)

		Cuyahoga River					Chagrin River	
	mm, Pore Diameter	RM 11.3	RM 10.0	RM 7.1	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Percentage (weight) retained by:		Coarse sand.	Fine sand.	Fine sand.	Coarse sand.	Muck.	Coarse sand.	Coarse sand.
Sieve #4	4.76	10.8	0	2.2	14.7	0.1	20.4	19.9
Sieve #10	2.00	22.8	0	6.7	26.4	0.3	23.2	27.2
Sieve #20	0.84	30.8	0	13.1	26.4	0.9	24.1	25.0
Sieve #40	0.42	25.7	0	22.6	16.9	1.6	26.6	17.2
Sieve #60	0.250	5.7	24.5	30.6	8.5	2.2	5.6	8.0
Sieve #100	0.149	4.2	60.2	17.7	4.6	2.6	0.1	2.3
Sieve #200	0.074	0	14.6	6.1	2.1	3.8	0	0.4
Pan	0	0	0.7	1.0	0.4	88.5	0	0

Appendix VI-B: Concentrations of metals in sediments (7/24/90 & 7/25/90)

		Cuyahoga River					Chagrin River	
mg/kg	MDL	RM 11.3	RM 10.5	RM 7.1	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Chromium	3.0	9.6	7.0	12	8.2	19	6.4	6.6
Lead	20	51	ND	28	22	38	ND	ND
Copper	2.5	15	12	30	22	34	11	14
Nickel	3.5	17	8.3	26	11	18	11	12
Zinc	0.8	100	61	130	89	260	45	57
Beryllium	0.2	0.3	ND	0.3	ND	0.3	ND	ND
Mercury	0.05	ND	ND	0.08	0.08	0.16	ND	ND

(ND = not detected. MDL = Method Detection Limit)

Appendix VI-C: Concentrations of priority pollutant organics in sediments (7/24/90 & 7/25/90)

		Cuyahoga River					Chagrin River	
mg/kg	MDL	RM 11.3	RM 10.5	RM 7.1	RM 5.6	RM 3.3	RM 4.5	RM 1.0
Pyrene	0.33	0.82	ND	1.4	2.0	1.0	ND	ND
Phenanthrene	0.33	0.33	ND	0.81	1.3	0.79	ND	ND
Fluoranthene	0.33	1.0	ND	1.7	ND	1.3	ND	ND
Chrysene	0.67	ND	ND	ND	0.73	ND	ND	ND
3,4-Benzofluoranthene	0.33	0.34	ND	0.83	1.1	0.82	ND	ND
Benzo(a)pyrene	0.33	ND	ND	0.47	0.60	0.36	ND	ND
Benzo(a)anthracene	0.33	ND	ND	0.58	0.72	0.62	ND	ND
Benzene	0.63	ND	ND	ND	1.1	ND	ND	ND
Anthracene	0.33	ND	ND	ND	0.41	ND	ND	ND
Bis(2-ethylhexyl) phthalate	0.33	ND	ND	ND	0.36	ND	ND	ND
Chloroform	0.63	ND	1.0	ND	ND	ND	0.88	ND
Methyl chloride	0.63	ND	ND	ND	ND	ND	1.4	ND

(ND = not detected. MDL = Method Detection Limit.)

Appendix VI-D: Priority pollutants not detected in Cuyahoga or Chagrin River sediments (7/24/90 & 7/25/90).

Parameter	MDL (ppm)	Parameter	MDL (ppm)
Cyanide	2	Beta-BHC	0.06
Antimony	20	Delta-BHC	0.06
Arsenic	20	Gamma-BHC	0.06
Cadmium	2.5	Chlordane	0.10
Selenium	2.0	4,4-DDT	0.06
Silver	1.0	4,4-DDE	0.06
Thallium	50	4,4-DDD	0.06
Acrolein	6.3	Dieldrin	0.06
Acrylonitrile	6.3	Alpha endosulfan	0.06
Bromoform	0.63	Beta endosulfan	0.06
Carbon tetrachloride	0.63	Endosulfan sulfate	0.10
Chlorobenzene	0.63	Endrin	0.06
Chlorodibromomethane	0.63	Endrin aldehyde	0.20
Chloroethane	0.63	Heptachlor	0.06
2-Chloroethyl vinyl ether	1.3	Heptachlor epoxide	0.06
Dichlorobromomethane	0.63	PCB(as Arochlor 1242)	0.10
1,1-Dichloroethane	0.63	PCB(as Arochlor 1254)	0.10
1,2-Dichloroethane	0.63	PCB(as Arochlor 1221)	0.10
1,1-Dichloroethylene	0.63	PCB(as Arochlor 1232)	0.10
1,2-Dichloropropane	0.63	PCB(as Arochlor 1248)	0.10
1,3-Dichloropropylene	0.63	PCB(as Arochlor 1260)	0.10
Ethylbenzene	0.63	PCB(as Arochlor 1016)	0.10
Methyl bromide	0.63	Toxaphene	0.25
Methylene chloride	0.63	2-Chlorophenol	0.33
1,1,2,2-tetrachloroethane	0.63	2,4-Dichlorophenol	0.33
Tetrachloroethylene	0.63	2,4-Dimethylphenol	0.33
Toluene	0.63	4,6-Dinitro-o-cresol	1.7
1,2-trans-Dichloroethylene	0.63	2,4-Dinitrophenol	1.7
1,1,1-Trichloroethane	0.63	2-Nitrophenol	0.33
1,1,2-Trichloroethane	0.63	4-Nitrophenol	1.7
Trichloroethylene	0.63	p-Chloro-m-cresol	0.33
Vinyl chloride	0.63	Pentachlorophenol	1.7
Aldrin	0.06	Phenol	0.33
Alpha-BHC	0.06	Nitrobenzene	0.33
2,4,6-Trichlorophenol	0.33	N-nitrosodimethylamine	1.7
Acenaphthene	0.33	N-nitrosodi-n-propylamine	0.67
Acenaphthylene	0.33	N-nitrosodiphenylamine	1.7
Benzidine	1.7	1,2,4-Trichlorobenzene	0.33
Benzo(ghi)perylene	0.67	Bis(2-chloroethoxy)methane	0.33
Benzo(k)fluoranthene	0.33	Bis(2-chloroisopropyl)ether	0.33
Bis(2-chloroethyl)ether	0.33	Butyl benzyl phthalate	0.33
4-Bromophenyl phenyl ether	0.33	4-Chlorophenyl phenyl ether	0.33
2-Chloronapthalene	0.33	1,2-Dichlorobenzene	0.33
Dibenzo(a,h)anthracene	0.33		

(Continued on following page.)

Appendix VI-D (continued): Priority pollutants not detected in Cuyahoga or Chagrin River sediments (7/24/90 & 7/25/90)

Parameter	MDL (ppm)	Parameter	MDL (ppm)
1,3-Dichlorobenzene	0.33	1,4-Dichlorobenzene	0.33
3,3-Dichlorobenzidine	1.7	Diethyl phthalate	0.33
Dimethyl phthalate	0.33	Di-n-butyl phthalate	0.33
2,4-Dinitrotoluene	0.33	2,6-Dinitrotoluene	0.33
Di-n-octyl phthalate	0.33	1,2-Diphenylhydrazine	0.33
Fluorene	0.33	Hexachlorobenzene	0.33
Hexachlorobutadiene	0.33	Hexachlorocyclopentadiene	0.33
Hexachloroethane	0.33	Indeno(1,2,3-cd)pyrene	0.67
Isophorone	0.33	Naphthalene	0.33

Appendix VI-E: Concentrations of non-priority pollutants tentatively identified in sediments (7/24/90 & 7/25/90).

ug/g (estimated)	Cuyahoga River RM 11.3	Cuyahoga River RM 10.0	Cuyahoga River RM 7.1	Cuyahoga River RM 5.6	Cuyahoga River RM 3.3	Chagrin River RM 4.5	Chagrin River RM 1.0
Acenaphthylene, 1,2-dihydro-	-	-	0.08	0.18	-	-	-
Acetic acid, butylester	-	3.7	-	-	-	-	-
Acetone	-		-	-	1.5	-	-
Anthracene, 2-ethyl-	-	-	0.06	-	-	-	-
Anthracene, 2-methyl-	-	-	0.12	0.22	-	-	-
7H-Benzo[c]fluorene	-	0.091	0.22	1.0	-	-	-
11H-Benzo[alpha] fluorene	-	-	-	0.47	-	-	-
Benzo[c]phenanthrene	-	-	0.09	-	-	-	-
Benzo[b]thiophene, 3-phenyl-	-	-	-	-	-	-	0.13
Butane,1,1'-oxybis-	-	8.2	-	1.2	-	-	-
1,3-Butanediol	-	-	-	-	-	-	0.92
2-Butanoic acid	-	89	-	-	-	-	-
Butanoic acid, 1-methyl propylester	-	2.2	-	-	-	-	-
1-Butanol		-	-	20	-	-	-
9H-Carbazole	-	-	0.10	-	-	-	-
Carbonic acid, dibutyl ester	2.6	-	-	13	-	-	-
Cholan-24-oic acid, 3-oxo-methyl ester	-	-	-	-	1.0	-	-
Cholestan-3-ol, (3-alpha, 5-alpha)	-	-	-	-	0.36	-	-
Cyclobutanol, 2-ethyl-	-	0.78	-	-	-	-	-
Cyclohexane, nonyl-	-	-	-	-	1.5	-	-
Cyclohexane, octyl-	-	-	-	-	0.94	-	-
(Substituted) Cyclohexane	-	-	-	-	0.53	-	-
Cyclohexyl ethyl ether	-	40	-	-	-	-	-
4H-Cyclopenta[def] phenanthrene	-	-	0.20	0.30	-	-	-
Docosane	-	-	-	-	-	-	0.16
Dodecane, 2,6,11-trimethyl-	-	-	-	-	1.0	-	-
Eicosane	-	-	-	-	-	-	0.062
Ethanone, 1-(2-hydroxy-5-methoxy-4-methyl phenyl)-	-	-	-	-	-	-	0.67
9H-Fluorene-9-methyl-	-	-	-	0.24	-	-	-
D-Galactitol, 2-(acetylmethyl-amino) 2-deoxy-3,4,6-tri-o-methyl, 1,5-diacetate	-	-	-	0.19	-	-	-

(Continued on following page.)

Appendix VI-E (continued): Concentrations of non-priority pollutants tentatively identified in sediments (7/24/90 & 7/25/90).

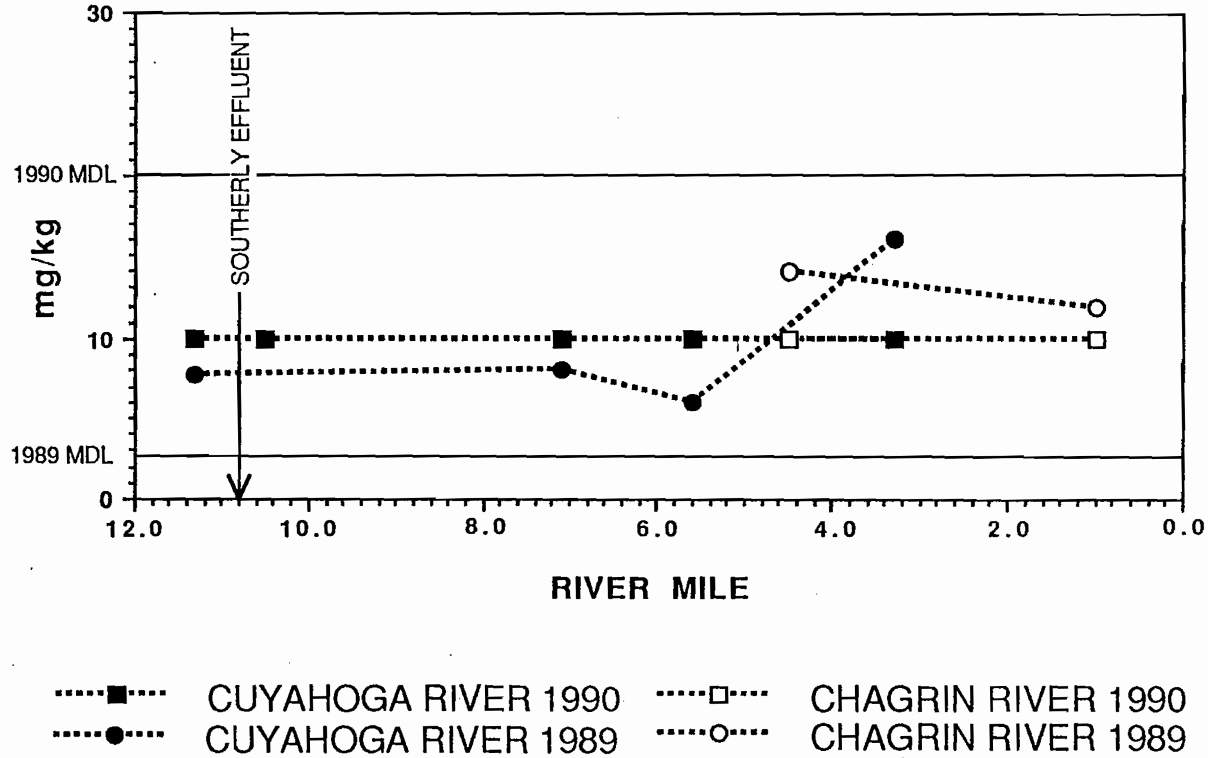
ug/g (estimated)	Cuyahoga River RM 11.3	RM 10.0	RM 7.1	RM 5.6	RM 3.3	Chagrin River RM 4.5	RM 1.0
Heptane, 3-ethyl-5-methyl-	-	-	-	-	0.70	-	-
Heptadecane	-	-	0.08	-	-	-	0.083
Hexadecane	-	-	0.13	0.15	0.56	-	0.12
Hexadencanoic acid, methyl ester	-	-	-	-	-	-	0.060
9-Hexadecenoic acid, methyl ester	-	-	-	-	-	-	0.15
1-Hexanol	-	91	-	-	-	-	-
1H-Indene, 1-phenyl-	-	-	0.08	-	-	-	-
1H-Indene, 2-phenyl-	-	-	0.08	-	-	-	-
Napthalene, 2-phenyl-	-	-	0.20	0.30	-	-	-
Nonadecane	-	-	0.09	-	-	-	-
Pentadecane	-	-	0.14	-	-	-	0.10
Pentadecane, 2,6-10,14-tetramethyl-	-	0.062	-	-	-	-	-
2-Pentanone, 4-hydroxy-4-methyl-	0.96	-	1.2	0.65	1.1	-	1.1
Phenanthrene, 2,5-dimethyl-	-	-	-	-	0.31	-	-
Phenanthrene, 2-ethyl-	-	-	0.05	-	-	-	-
Phenanthrene, 2-methyl-	-	-	0.10	0.16	-	-	-
Phenol,2,6-bis(1,1-dimethylethyl)-4-methyl	-	-	-	-	-	-	0.26
Propanoic acid, butylester	-	6.0	-	-	-	-	-
2-Propenoic acid, butylester	6.5	-	-	38	-	-	-
2-Propenoic acid, methyl ester	13	-	-	11	-	-	-
Sulfur, molecular (S_8)	0.27	0.083	0.48	0.35	-	-	0.20
Tetracosane	-	-	-	-	-	-	0.13
Tetradecane	-	-	0.14	-	0.84	-	0.061
Undecane	-	-	-	-	0.62	-	-
C_{11} hydrocarbon	-	-	-	-	0.46	-	-
C_{13} hydrocarbon	-	-	-	-	1.0	-	-
C_{14} hydrocarbon	-	-	-	-	0.88	-	-
C_{14} hydrocarbon	-	-	-	-	0.68	-	-
C_{15} hydrocarbon	-	-	-	-	1.6	-	-
C_{15} hydrocarbon	-	0.062	-	-	0.96	-	-
C_{18} hydrocarbon	-	0.040	-	0.22	-	-	0.10
C_{19} hydrocarbon	-	0.072	-	-	1.6	-	0.071
C_{20} hydrocarbon	-	-	0.11	-	0.77	-	-
C_{24} hydrocarbon	-	---	-	-	-	-	0.12
C_{26} hydrocarbon	-	-	-	-	-	-	0.26
C_{26} hydrocarbon	-	-	-	-	-	-	0.12

APPENDIX VII

GRAPHIC COMPARISON OF
CUYAHOGA AND CHAGRIN RIVER
1989-1990 SEDIMENT DATA

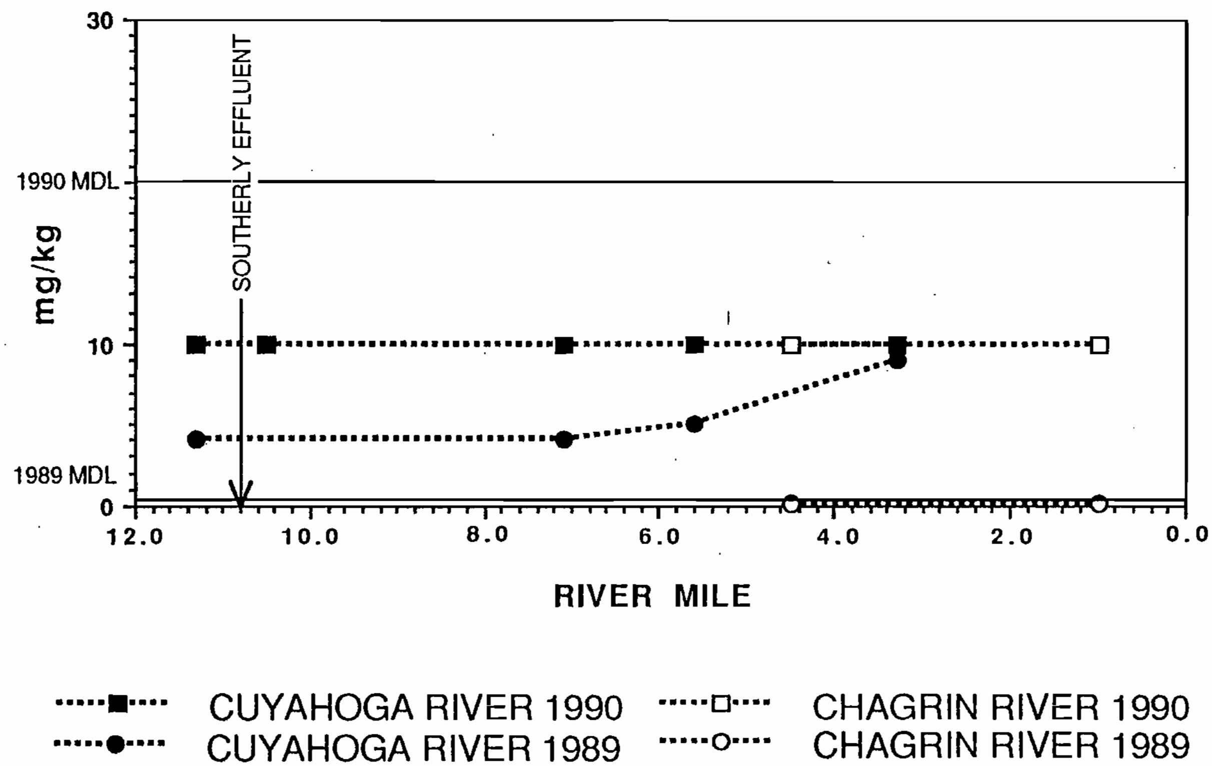
Appendix VII-A

SEDIMENT ANTIMONY CONCENTRATIONS



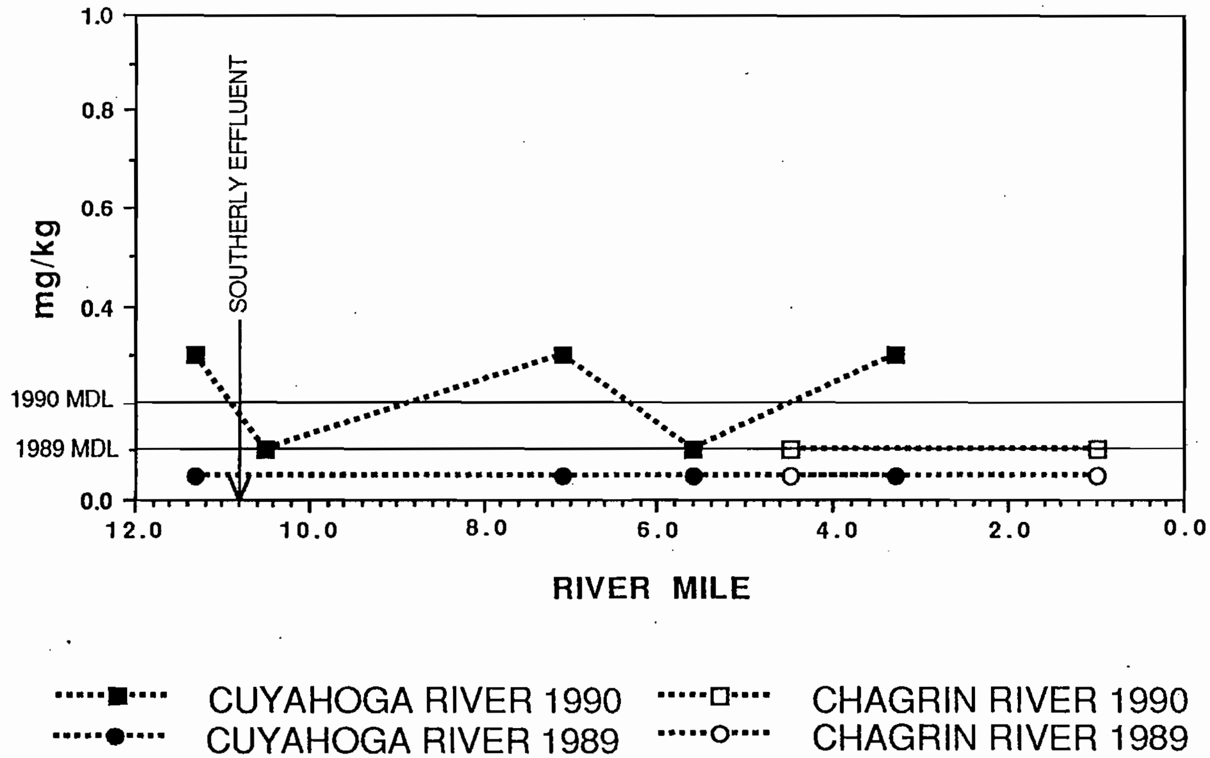
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT ARSENIC CONCENTRATIONS

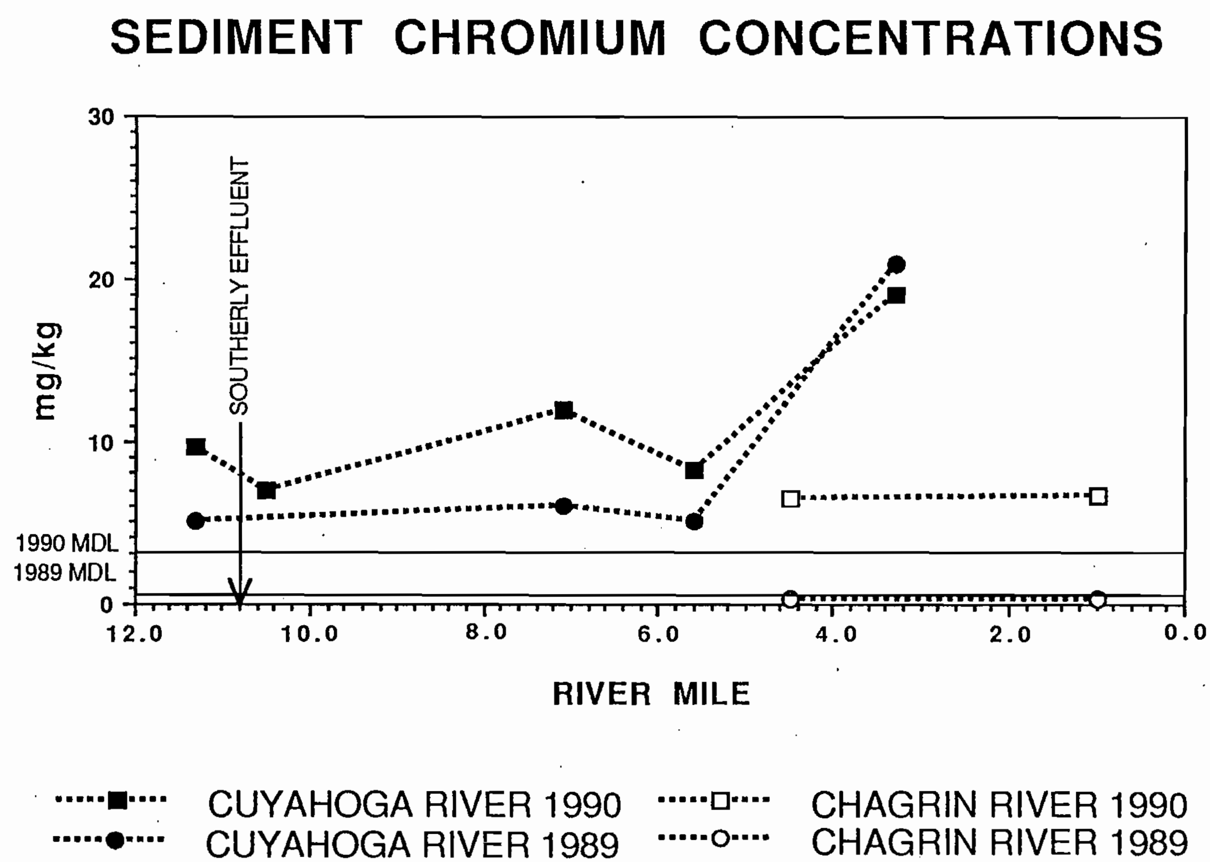


MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BERYLLIUM CONCENTRATIONS

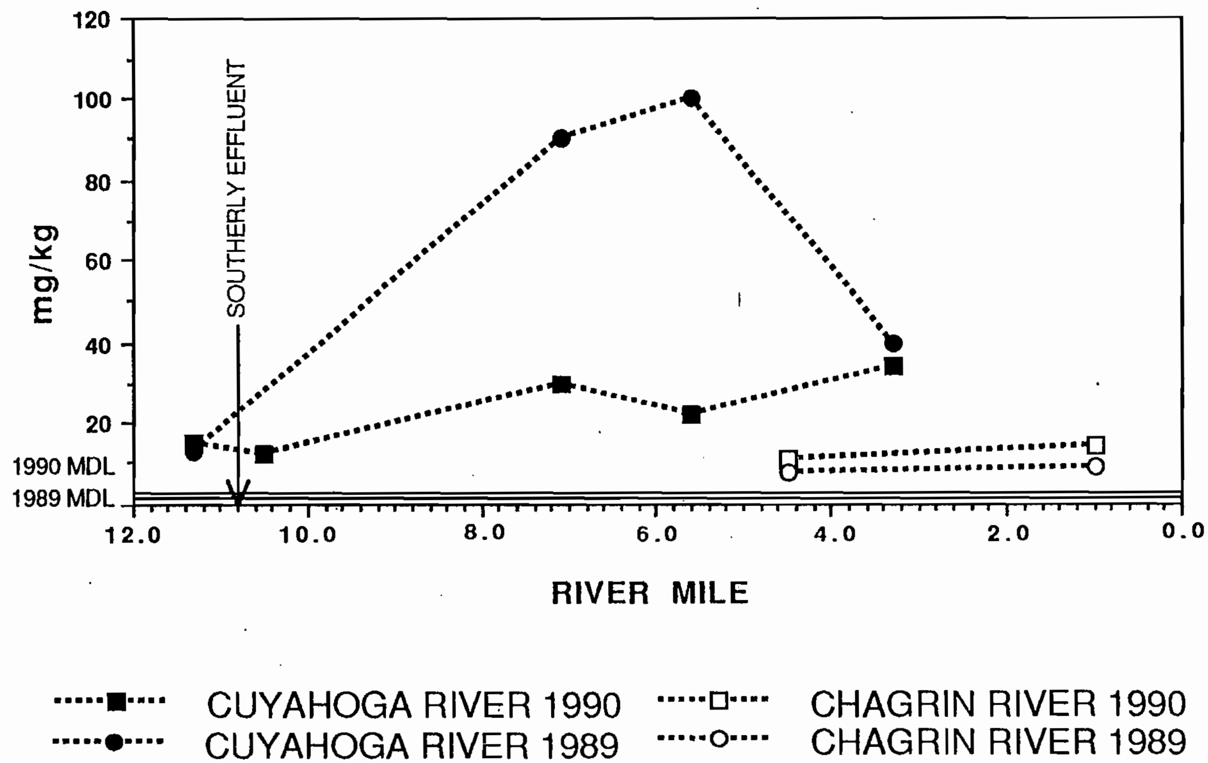


MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.



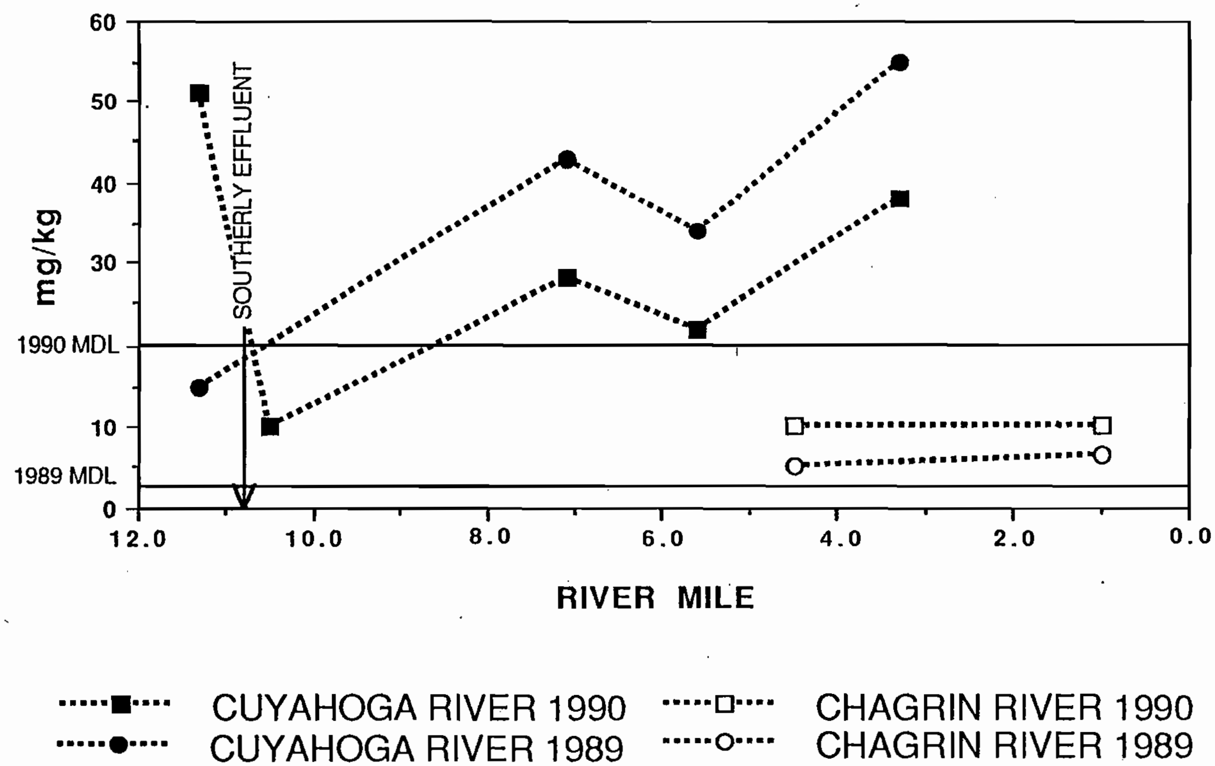
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT COPPER CONCENTRATIONS



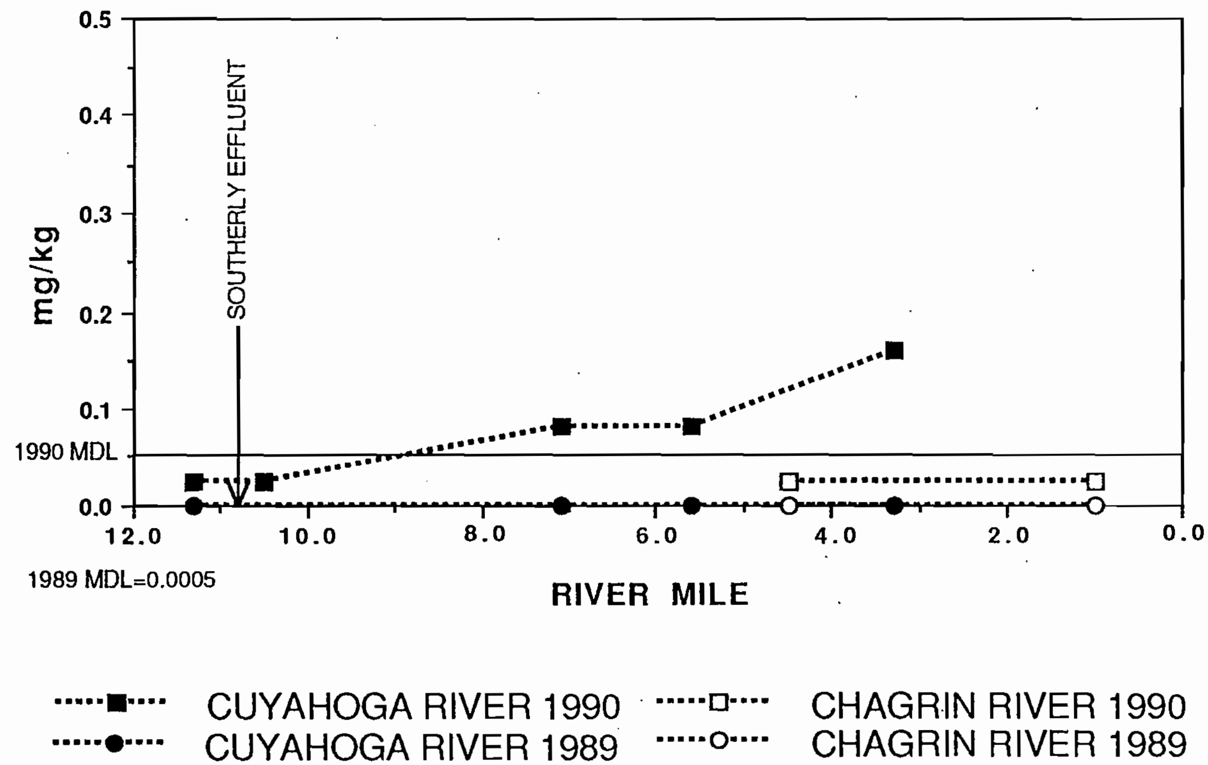
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT LEAD CONCENTRATIONS



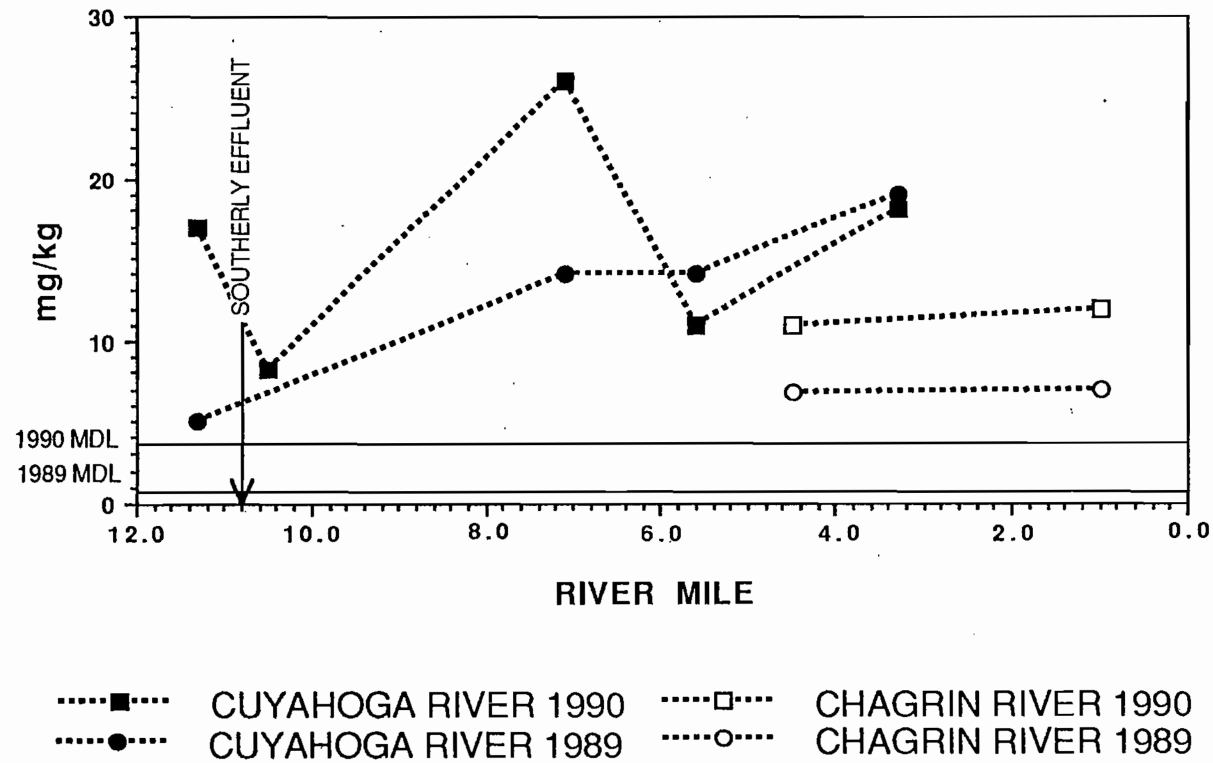
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT MERCURY CONCENTRATIONS



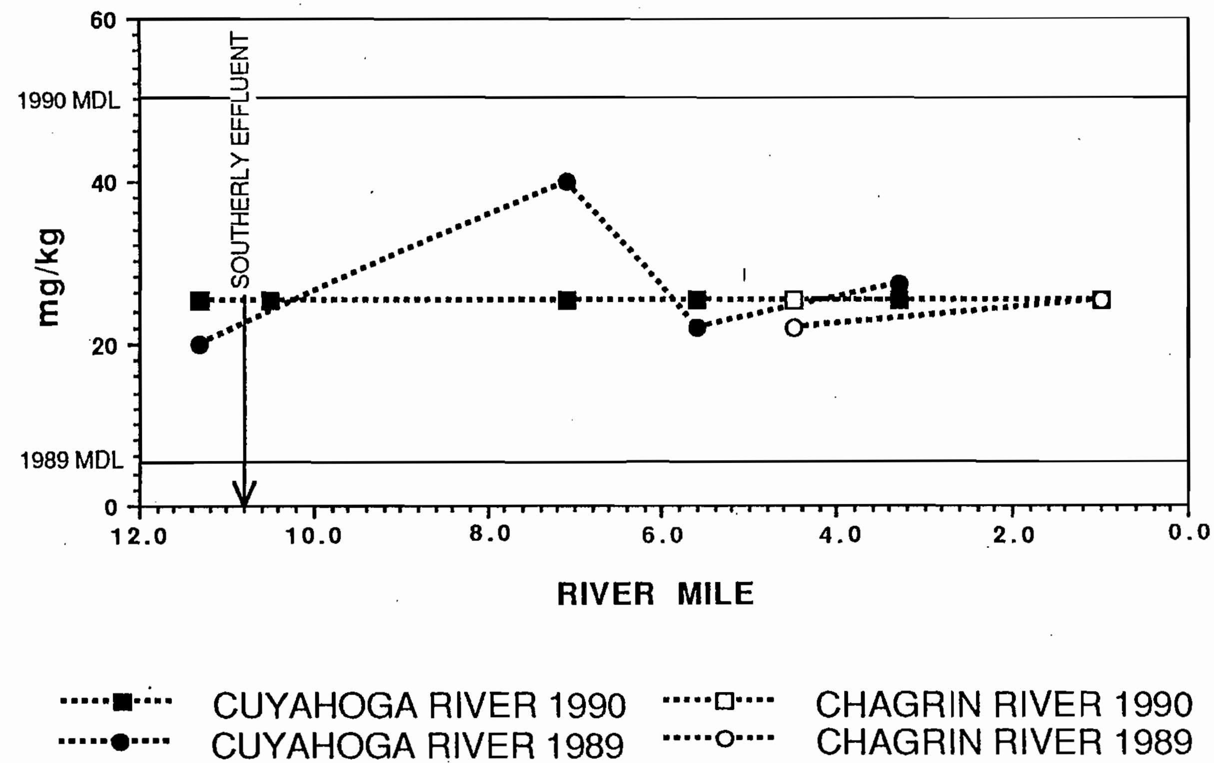
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT NICKEL CONCENTRATIONS



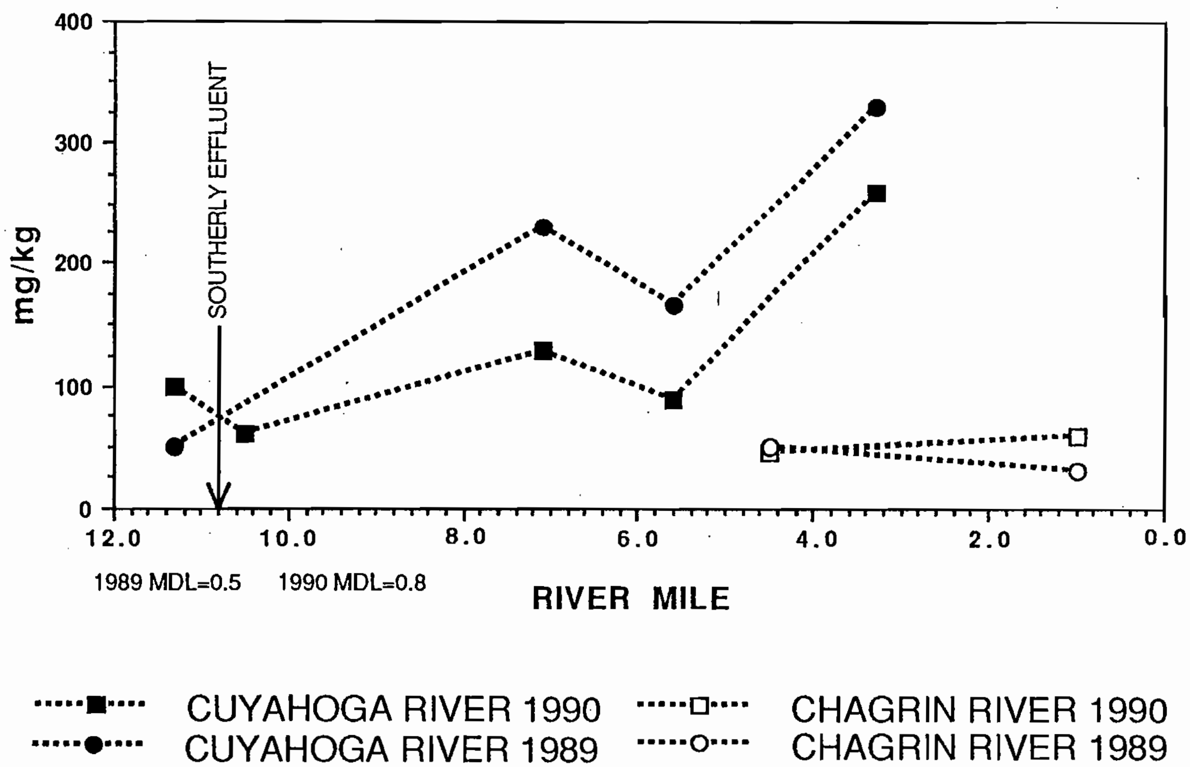
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT THALLIUM CONCENTRATIONS



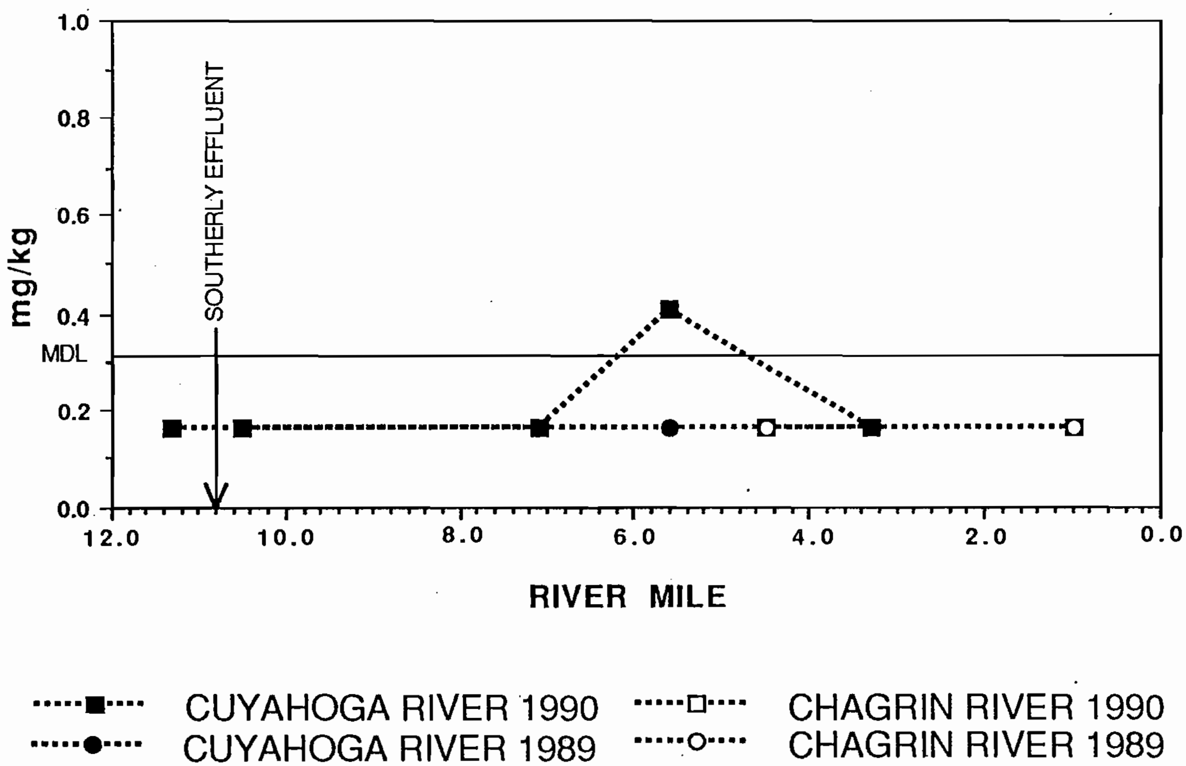
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT ZINC CONCENTRATIONS



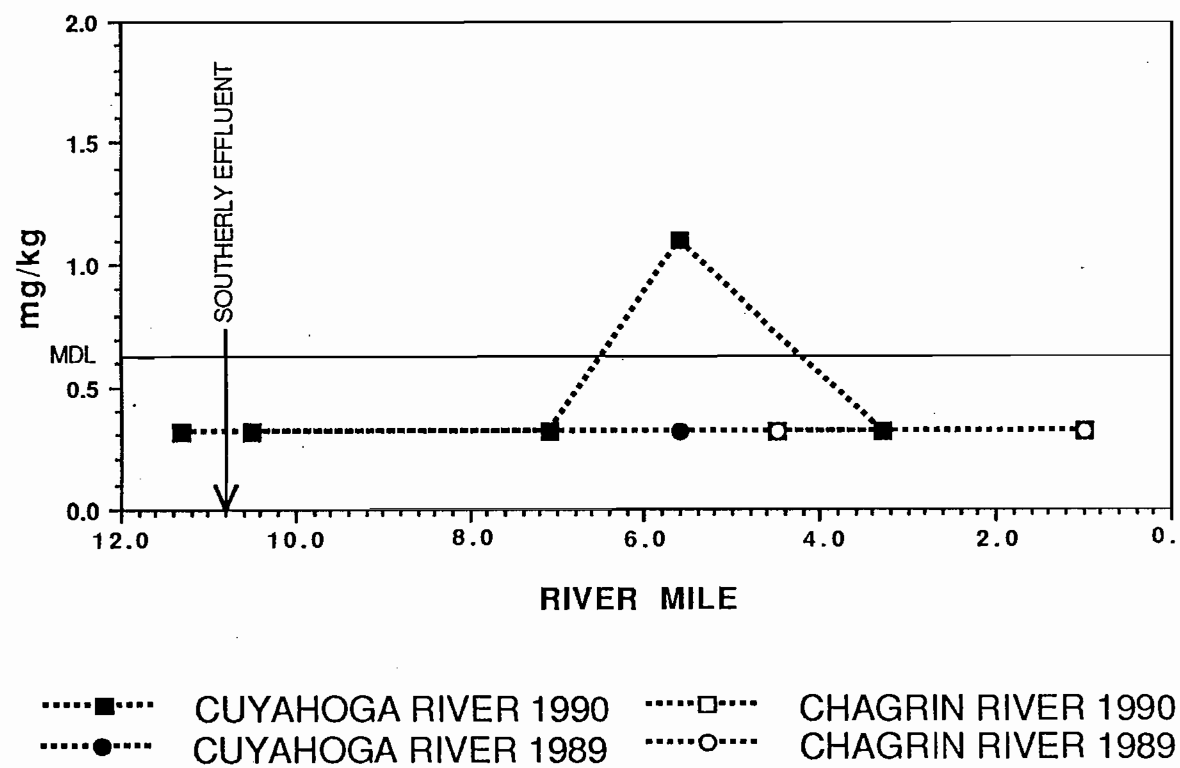
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT ANTHRACENE CONCENTRATIONS



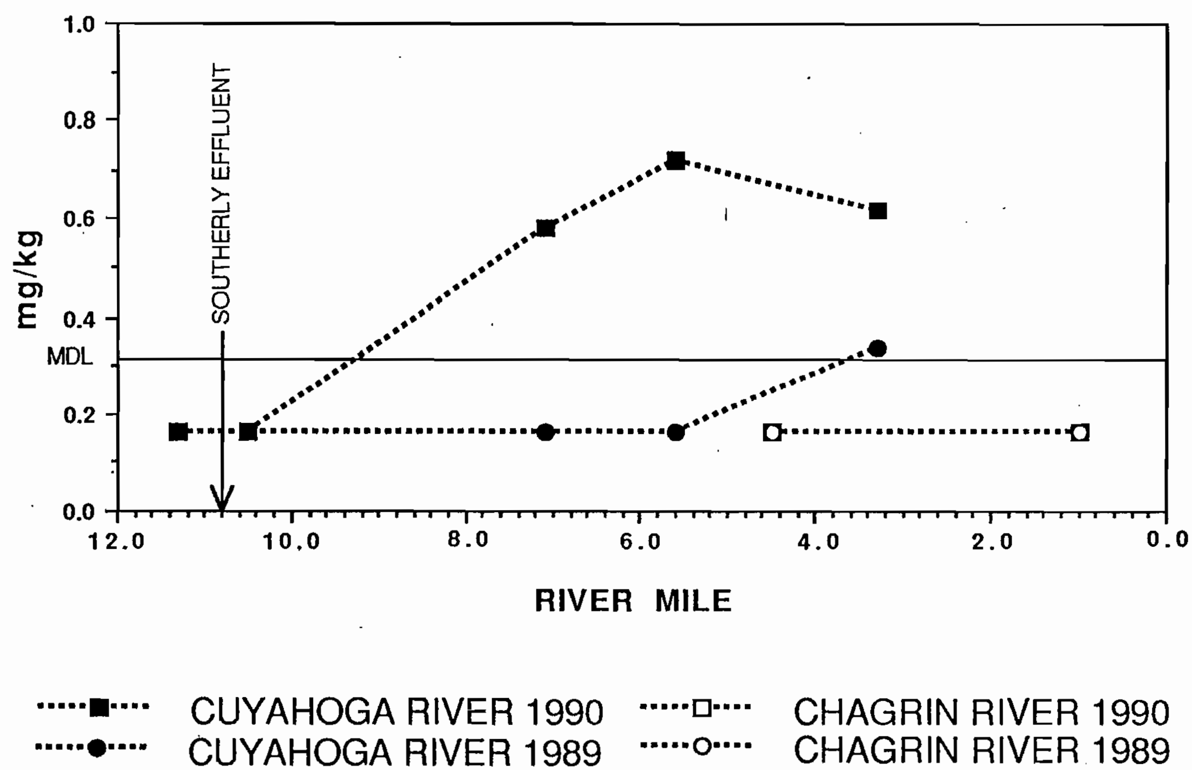
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BENZENE CONCENTRATIONS



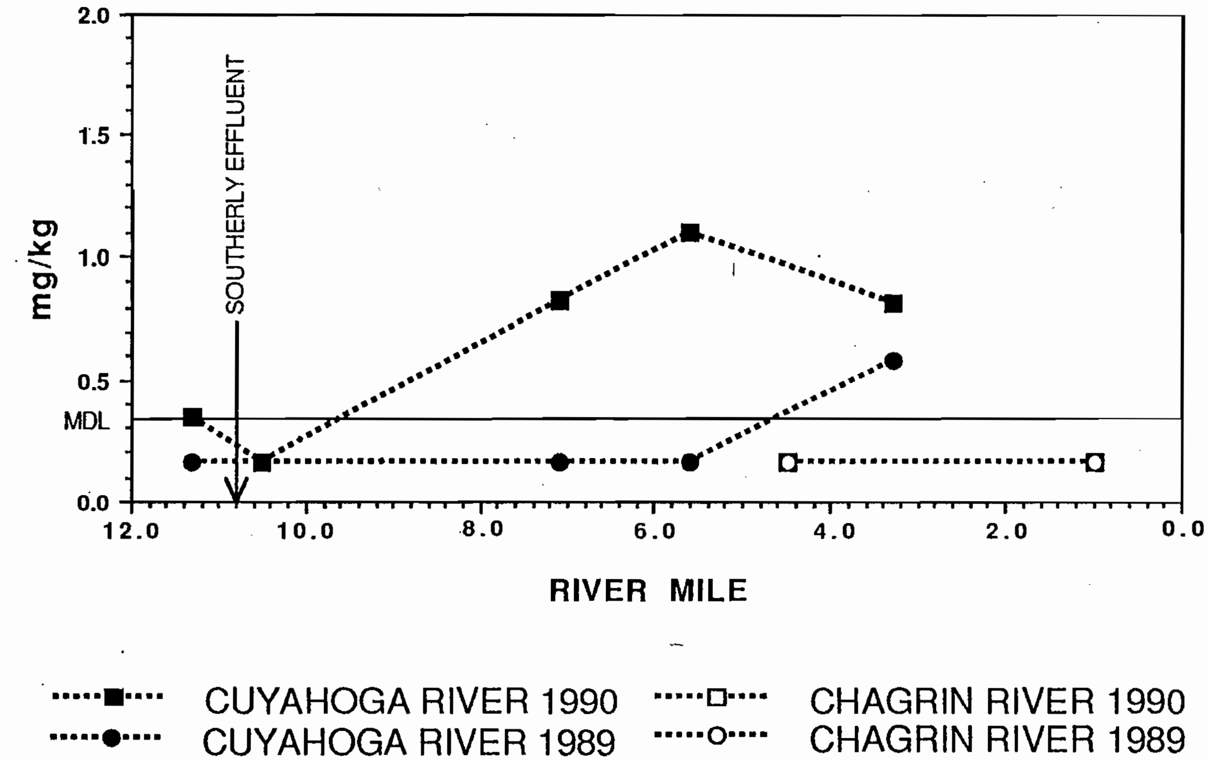
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BENZO(a)ANTHRACENE CONCENTRATIONS



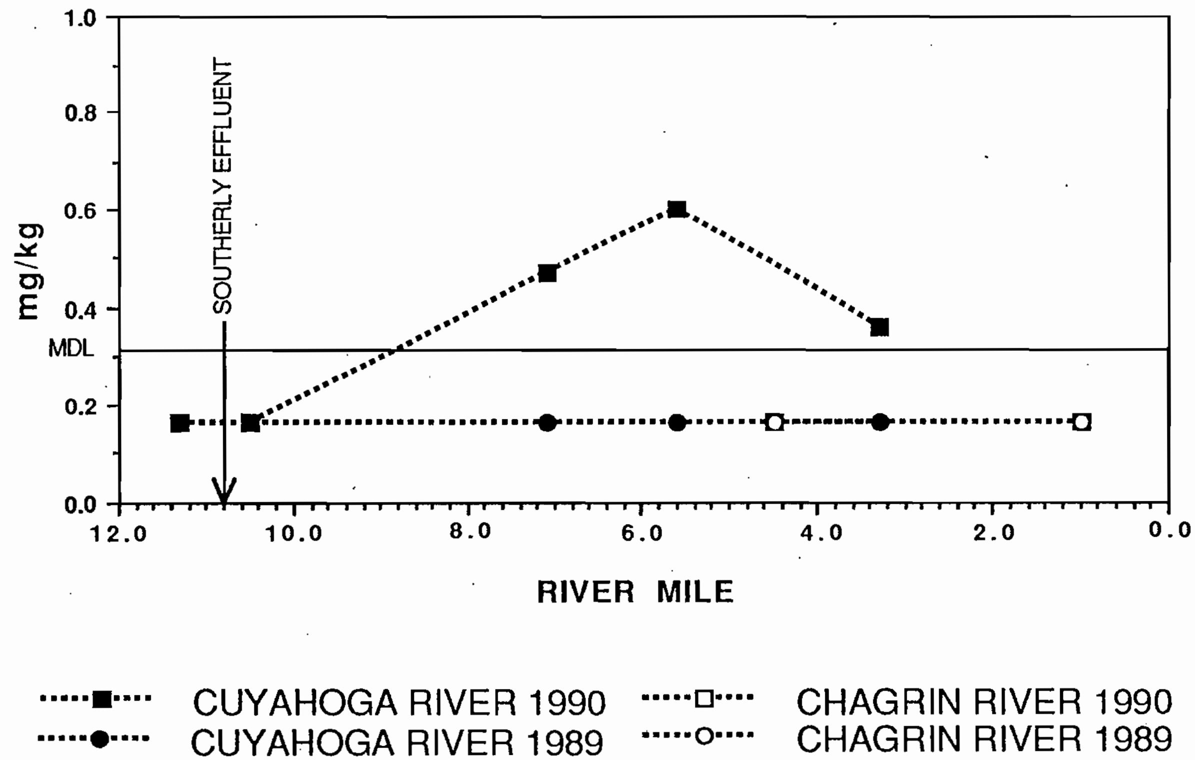
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BENZOFLUORANTHENE CONCENTRATIONS



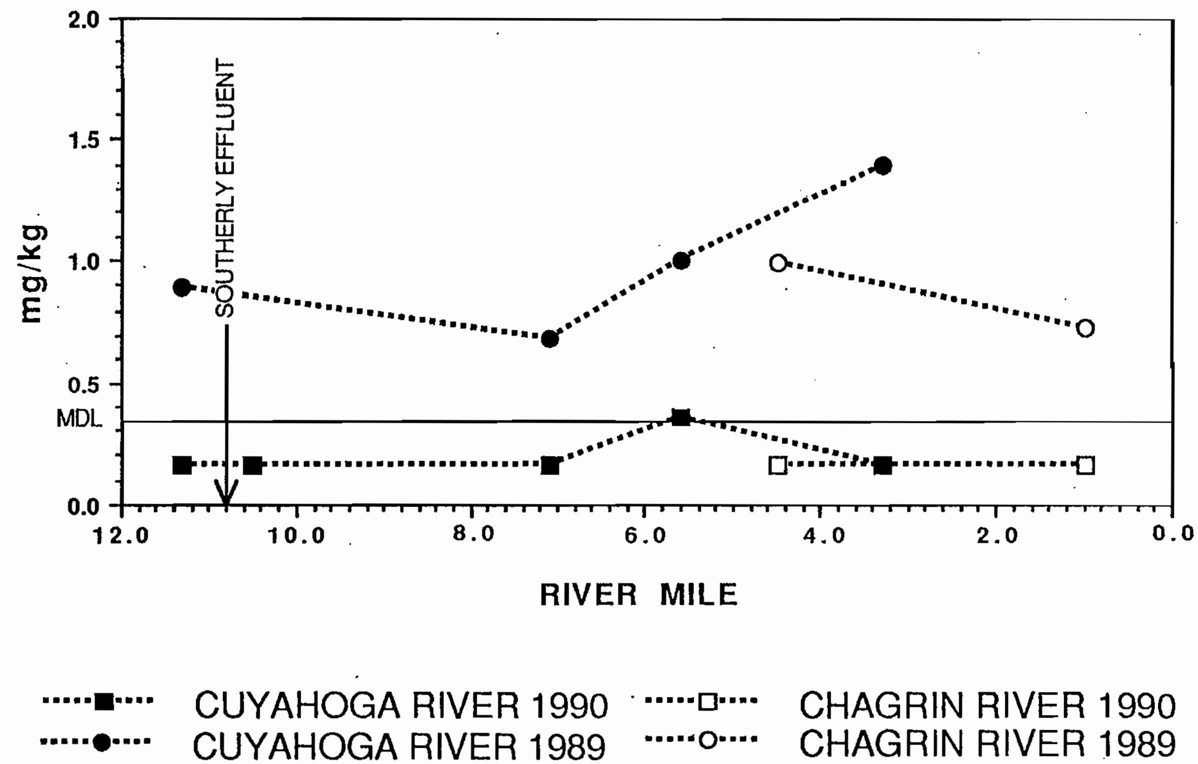
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BENZO(a)PYRENE CONCENTRATIONS



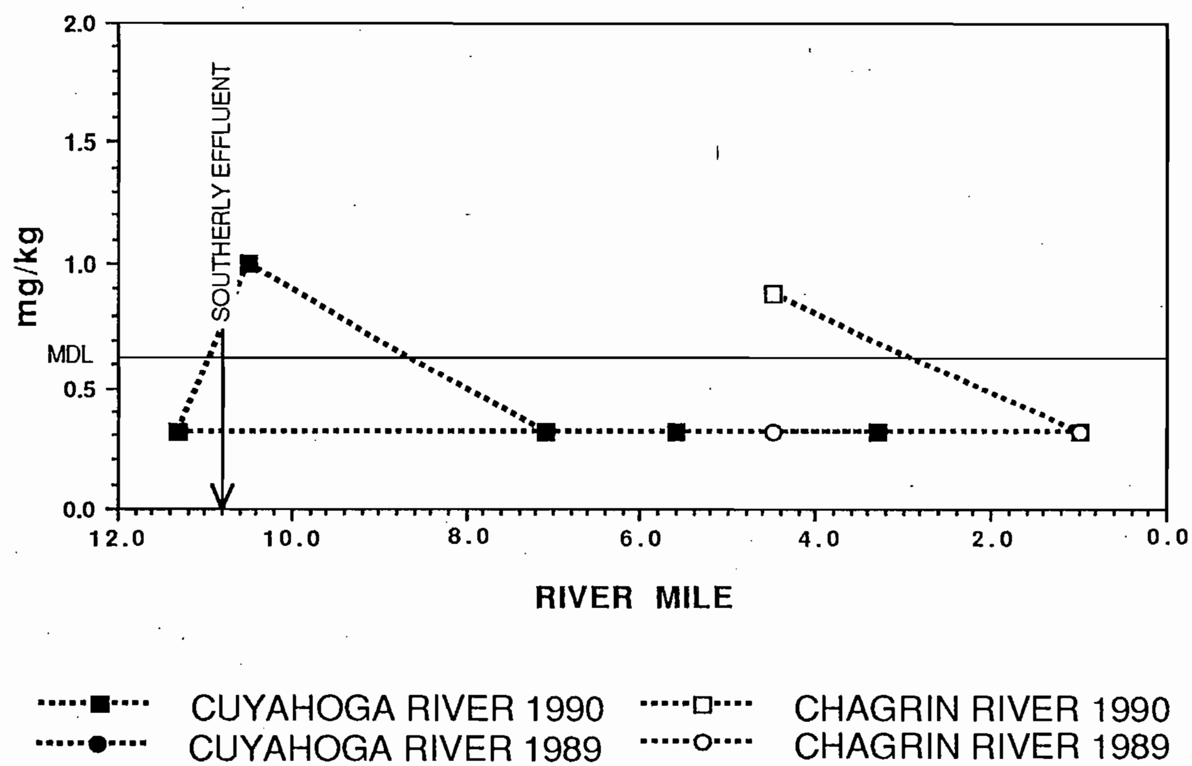
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT BIS(2-ETHYLHEXYL)PHTHALATE CONCENTRATIONS



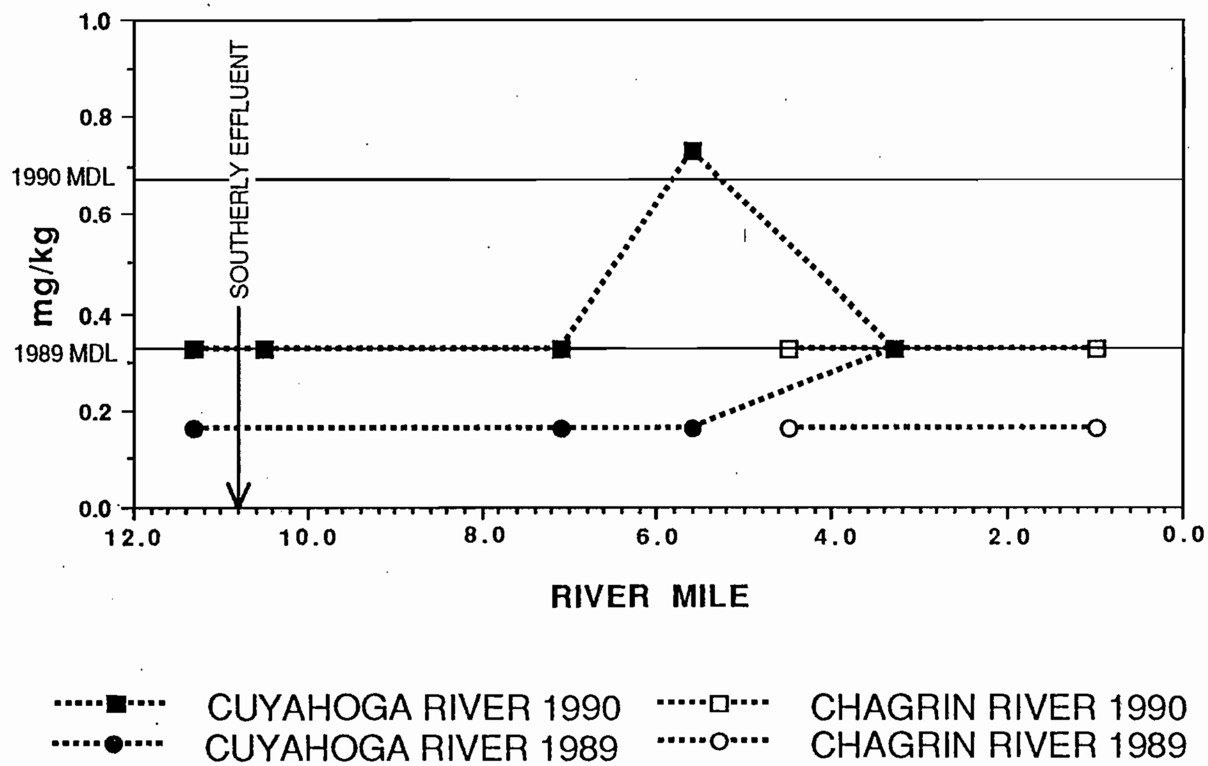
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT CHLOROFORM CONCENTRATIONS



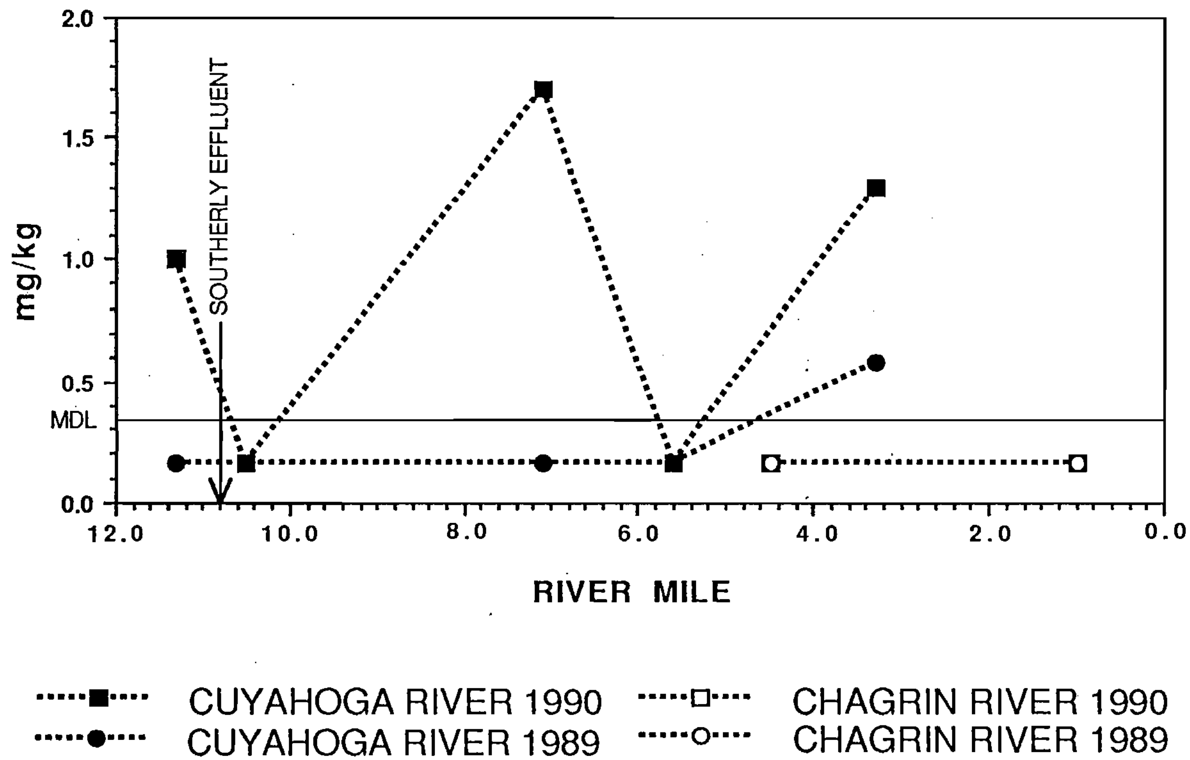
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT CHRYSENE CONCENTRATIONS



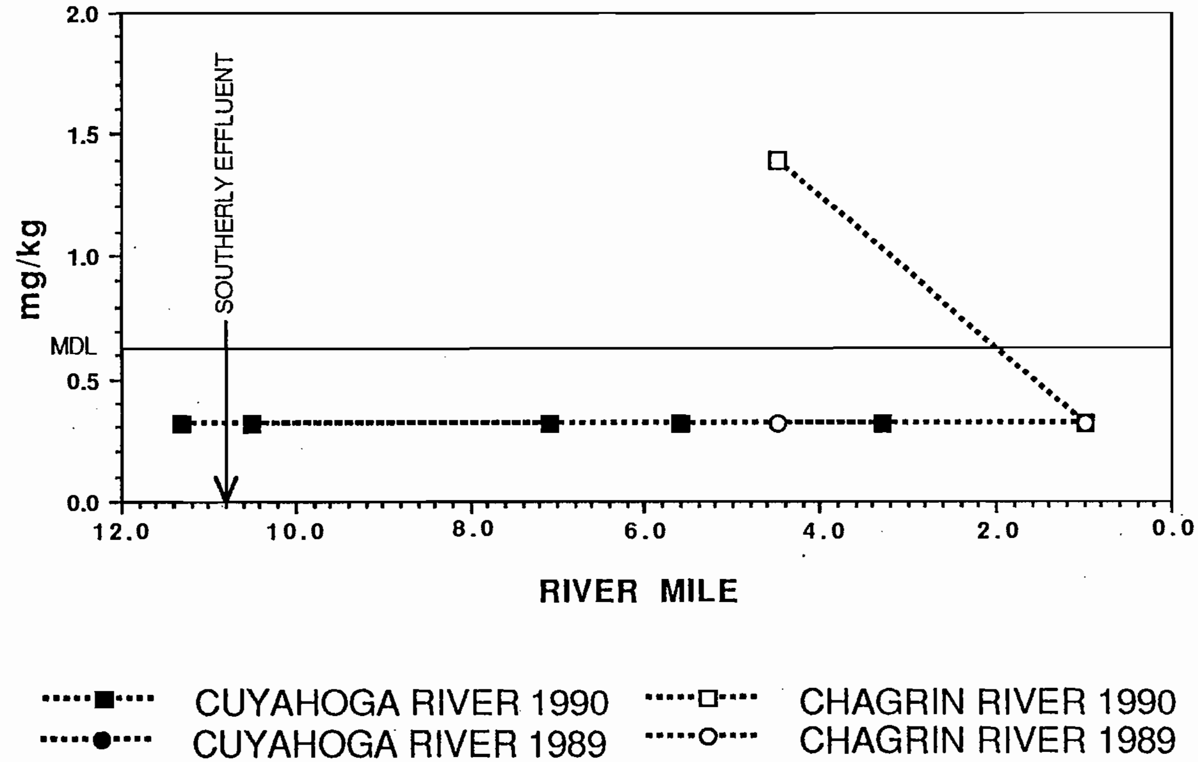
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT FLUORANTHENE CONCENTRATIONS



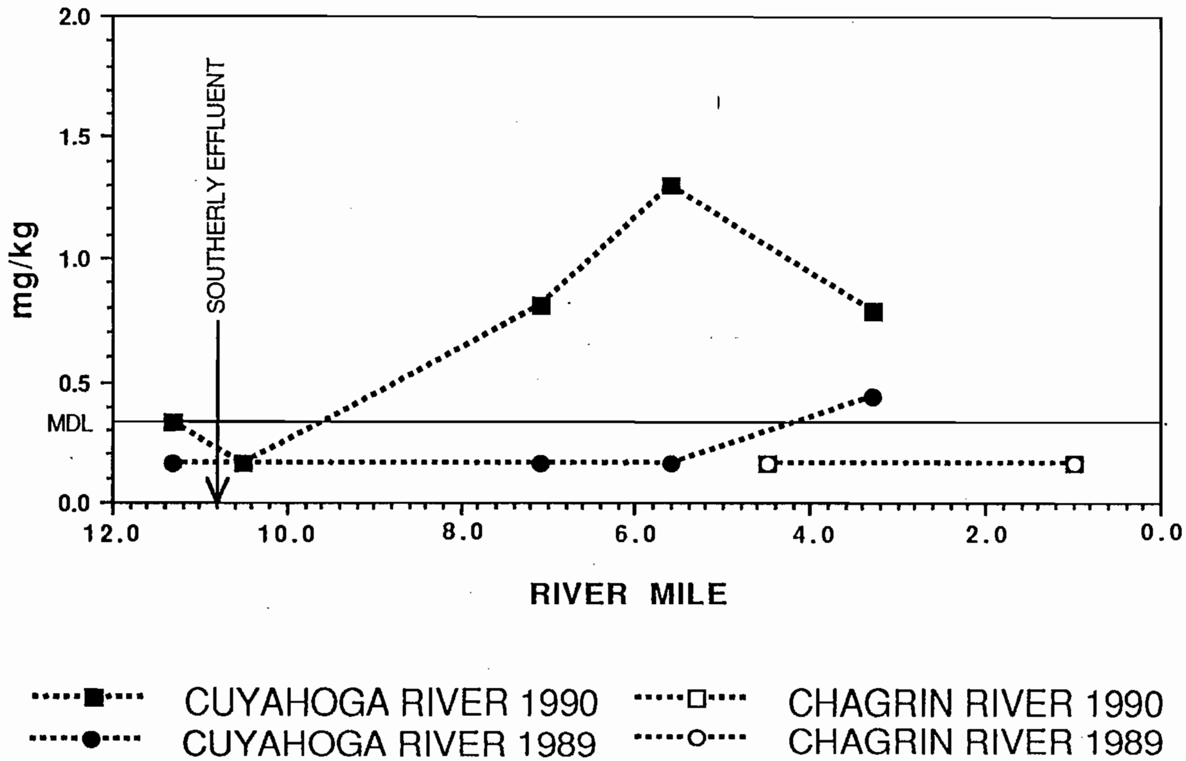
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT METHYLCHLORIDE CONCENTRATIONS



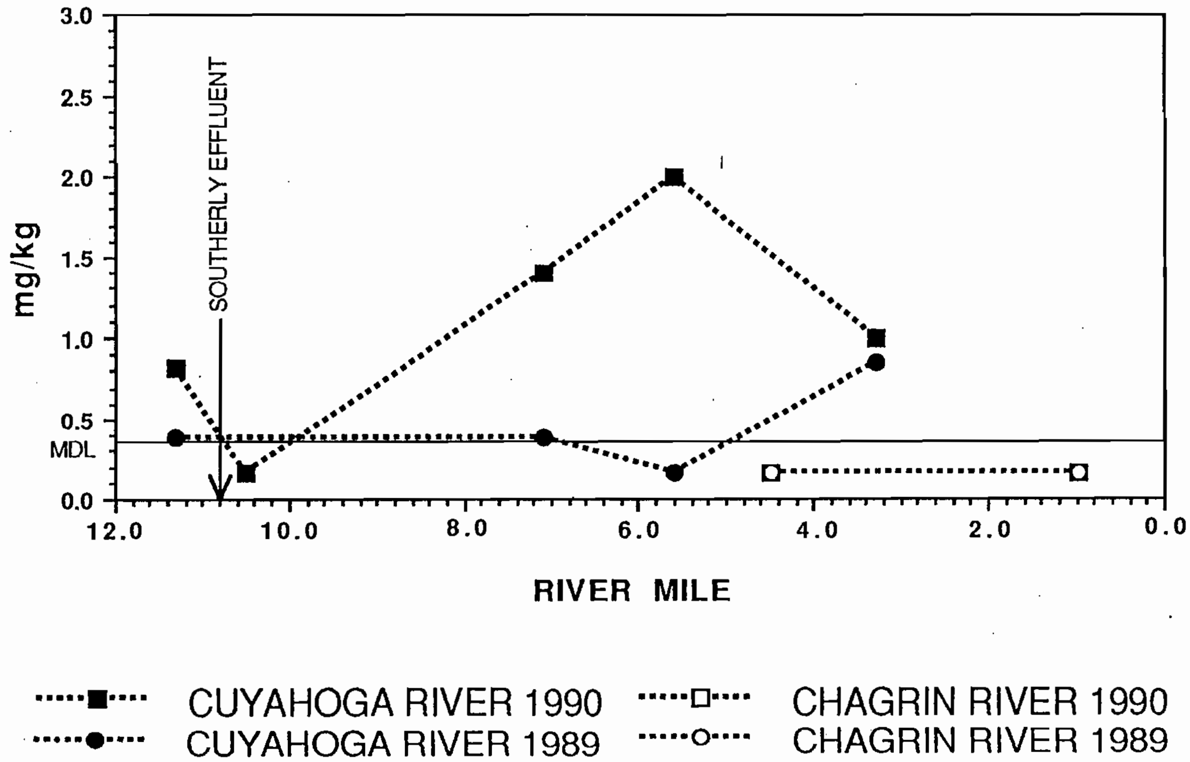
MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT PHENANTHRENE CONCENTRATIONS



MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

SEDIMENT PYRENE CONCENTRATIONS



MDL = METHOD DETECTION LIMIT.
CONCENTRATIONS NOT DETECTED ARE DISPLAYED AS 1/2 MDL.

APPENDIX VIII

1989 QUALITATIVE RESULTS OF SAMPLING FOR BENTHIC MACROINVERTEBRATES

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

Appendix VIII-A: Site #20, Cuyahoga River (8/31/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina (*Mooreobdella*) *microstoma*	Tolerant	Mason, et al., 1971
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987
Amnicola limosa	--	--
Gyraulus parvus	Facultative	Sinclair, 1957
Valvata sincera	--	--
Pisidium amnicum	Facultative	Sinclair, 1957

Appendix VIII-B: Site #22.5, Cuyahoga River (8/29/89)

Taxon	Tolerance	Source
Odonata		
Argia violacea	--	--
Enallagma sp.	Facultative	Hilsenhoff, 1982
Diptera		
Polypedilum sp."B"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Helisoma anceps	Facultative	Ingram, 1957

Appendix VIII-C: Site #22.51, Cuyahoga River (8/14/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Dina (Mooreobdella) microstoma	Tolerant	Mason, et al., 1971
Crustacea		
Asellus sp.	---	---
Ephemeroptera		
Leucrocuta sp.	Intolerant	Hilsenhoff, 1987
Stenonema integrum	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Stenonema interpunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Lewis, 1974
Odonota		
Hetaerina sp.	---	---
Argia sp.	---	---
Hemiptera		
Saldidae	---	---
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Hydropsyche sp. (pupa)		
Coleoptera		
Lampyridae (adult)	---	---
Tenebrionidae	---	---
Stenelmis crenata (adult)	Facultative	Brown, 1972
Stenelmis sp. (larvae)	Facultative	Brown, 1972

(Continued on following page.)

Appendix VIII-C (continued): Site #22.51, Cuyahoga River (8/14/89)

Taxon	Tolerance	Source
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Facultative	Hilsenhoff, 1982
Ablabesmyia sp.(pupae)	Facultative	Hilsenhoff, 1982
Larsia sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp. "C"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-D: Site #22.7, Cuyahoga River (8/29/89)

Taxon	Tolerance	Source
Odonata		
Argia violacea	--	--
Diptera		
Polypedilum sp."B"	Tolerant	OEPA, 1987
Mollusca		
Gyraulus parvus	Facultative	Ingram, 1957

Appendix VIII-E: Site #22.8, Cuyahoga River (8/14/89)

Taxon	Tolerance	Source
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Gammarus fasciatus	Facultative	Mason, et al., 1971
Ephemeroptera		
Leucrocuta sp.	Intolerant	Hilsenhoff, 1987
Stenonema integrum	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Megaloptera		
Corydalus sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenelmis sp.	Facultative	Brown, 1972
Hydrochus sp.	--	--
Diptera		
Hemerodromia sp.	Facultative	Mason, et al., 1971
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Ablabesmyia sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-F: Site #22.9, Cuyahoga River (8/4/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdella punctata	Tolerant	Mason, et al., 1971
Crustacea		
Asellus sp.	--	--
Gammarus fasciatus	Facultative	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Leucrocuta sp.	Intolerant	Hilsenhoff, 1987
Stenonema terminatum	Facultative	Lewis, 1974
Stenonema integrum	Facultative	Lewis, 1974
Stenonema interpunctatum	Facultative	Lewis, 1974
Tricorythodes sp.	Facultative	Mason, et al., 1971
Odonata		
Hetaerina sp.		
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Ancyronyx variegata (adults)	Intolerant	Sinclair, 1964
Macronychus glabratus (adults)	Intolerant	Sinclair, 1964
Ancyronyx variegata (larvae)	Intolerant	Sinclair, 1964
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenus sp. (adult)	Facultative	Brown, 1972
Diptera		
Hemerodromia sp.	Facultative	Mason, et al., 1971
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982

(Continued on following page.)

Appendix VIII-F (continued): Site #22.9, Cuyahoga River (8/4/89)

Taxon	Tolerance	Source
Polypedilum sp."B"	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Bithynia tentaculata	--	--

Appendix VIII-G: Site #23, Cuyahoga River (8/29/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Erpobdellidae	--	--
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Amphipoda		
Gammarus fasciatus	Facultative	Mason, et al., 1971
Ephemeroptera		
Tricorythodes sp.	Facultative	Mason et al., 1971
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Stenonema integrum	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Odonata		
Argia violacea	--	--
Megaloptera		
Corydalus cornutus	Facultative	Mason, et al., 1971
Trichoptera		
Agraylea sp.	Facultative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1987

(Continued on following page.)

Appendix VIII-G (continued): Site #23, Cuyahoga River (8/29/89)

Taxon	Tolerance	Source
Coleoptera		
Stenelmis crenata (adult)	Facultative	Brown, 1972
Stenelmis sp.	Facultative	Brown, 1972
Ancyronyx variegata	Intolerant	Sinclair, 1964
Macronychus glabratus	Intolerant	Sinclair, 1964
Psephenus sp.	Facultative	Hilsenhoff, 1982
Ectopria sp.	Facultative	Hilsenhoff, 1982
Enochrus sp.	--	--
Diptera		
Hemerodromia sp.	Facultative	Mason, et al., 1971
Tipula sp.	Facultative	Hilsenhoff, 1987
Antocha sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Conchapelopia sp.	Facultative	Mason, et al., 1971
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Rheotanytarsus sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp. "B"	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Atherix sp.	Facultative	Mason, et al., 1971
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Ferrissia sp.	Tolerant	OEPA, 1987
Sphaerium sp.	--	--

Appendix VIII-H: Site #24, Cuyahoga River (8/4/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdelidae	--	--
Plecoptera		
Acroneuria sp.	Intolerant	Hilsenhoff, 1987
Ephemeroptera		
Isonychia sp.	Facultative	Hilsenhoff, 1982
Tricorythodes sp.	Facultative	Mason, et al., 1971
Leucrocuta sp.	Intolerant	Hilsenhoff, 1987
Stenonema terminatum	Facultative	Lewis, 1974
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema integrum	Facultative	Lewis, 1974
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Hemiptera		
Gelastocoris sp.	--	--
Corisella sp.	--	--
Magaloptera		
Corydalus cornutus	Facultative	Mason, et al., 1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1987
Coleoptera		
Laccophilus sp.	--	--
Tropisternus sp.	--	--
Psephenus sp.	Facultative	Hilsenhoff, 1982
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenelmis sp. (larvae)	Facultative	Brown, 1972
Berosus sp.	Tolerant	Mason, et al., 1971

(Continued on following page.)

Appendix VIII-H (continued): Site #24, Cuyahoga River (8/4/89)

Taxon	Tolerance	Source
Diptera		
Simulium sp.	--	--
Guttipelopia sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Paratanytarsus sp.	Facultative	Hilsenhoff, 1982
Cryptochironomus sp.	Tolerant	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Dicrotendipes sp."A"	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Facultative	Hilsenhoff, 1987
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Stenochironomus sp.	Facultative	Hilsenhoff, 1982
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia grp.	Facultative	Mason, et al., 1971
Atherix sp.	Facultative	Mason, et al., 1971
Mollusca		
Physella vinosa	Tolerant	OEPA, 1987

Appendix VIII-I: Site #25, Big Creek (10/6/89)

Taxon	Tolerance	Source
Annelida		
Erpobdella punctata	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Diptera		
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987

Appendix VIII-J: Site #27, Big Creek (5/22/89)

Taxon	Tolerance	Source
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-K: Site #28, Big Creek (5/24/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Odonata		
Coenagrion sp.	Tolerant	Hilsenhoff, 1987
Coleoptera		
Staphylinidae (adult)	--	--
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-L: Site #29, Big Creek (5/24, 6/21/89)

Taxon	Tolerance	Source
Annelida		
Erpobdellidae	--	--
Oligochaeta	Tolerant	OEPA, 1987
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Cnephia sp.	--	--
Simulium sp.	--	--
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Tipula sp.	Facultative	Hilsenhoff, 1982
Glyptotendipes sp.	Tolerant	Hilsenhoff, 1982
Eukiefferiella pseudomontana	Tolerant	Hilsenhoff, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Sympotthastia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-M: Site #30, Big Creek (3/29/89, 5/22/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Cricotopus sp.	Tolerant	OEPA, 1987
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Fossaria sp.	--	--

Appendix VIII-N: Site #31, Mill Creek (6/28/89, 7/5/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina lateralis	Tolerant	Mason, et al., 1971
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Diptera		
Smittia sp.	Tolerant	Hilsenhoff, 1982
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
- *Gyraulus parvus*	Facultative	Ingram, 1957
Marstonia sp.	--	--

Appendix VIII-O: Site #33, Wolf Creek (6/23/89)

Taxon	Tolerance	Source
Annelida		
Mollibdella grandis	--	--
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Diptera		
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-P: Site #33.5, Mill Creek (6/26/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Odonata		
Lestes sp.	Tolerant	Hilsenhoff, 1987
Lepidoptera		
Sphyngidae family (larvae)	--	--
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-Q: Site #34, Mill Creek (6/26/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina (_Moorebdella_) _microstoma_	Tolerant	Mason, et al., 1971
Odonata		
Aeshna sp.	Facultative	Hilsenhoff, 1982
Diptera		
Chironomus sp.	Tolerant	OEPA, 1987
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus sp. "C"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-R: Site #35, Mill Creek (6/26/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Crangonyx sp.	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis sp. (adults)	--	--
Baetis sp. (nymphs)	--	--
Odonata		
Argia violacea	--	--
Coleoptera		
Stenopelmus sp. (adult)	--	--
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Cricotopus sp. "C"	Tolerant	OEPA, 1987
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Ablabesmyia sp.	Facultative	Hilsenhoff, 1982
Guttipelopia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-S: Site #36, West Creek (6/30/89)

Taxon	Tolerance	Source
Annelida		
Erpobdellidae	--	--
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Argia sp.	Facultative	Mason, et al., 1971
Coleoptera		
Cyphon sp. (adult)	--	--
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-T: Site #37, West Creek (7/7/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason et al., 1971
Annelida		
Erpobdella sp.	Tolerant	Mason et al., 1971
Crustacea		
Asellus sp.	--	--
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydroptila sp.	Facultative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Bledius sp.	--	--
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-U: Site #38, West Creek (7/7/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Somatochlora sp.	Intolerant	Hilsenhoff, 1982
Lanthus sp.	--	--
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Pentaneura sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Cricotopus sp."C"	Tolerant	OEPA, 1987
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987

Appendix VIII-V: Site #39, Tinkers Creek (8/28/89)

Taxon	Tolerance	Source
Annelida		
Erpobdellidae	--	--
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Stenonema interpunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis sp."C"	--	--
Hemiptera		
Sigara sp.	--	--
Megaloptera		
Corydalus sp.	Facultative	Mason, et al., 1971
Trichoptera		
Hydroptila sp.	Facultative	Hilsenhoff, 1982
Agraylea sp.	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Coleoptera		
Peltodytes sp.	--	--
Tropisternus sp. (adults)	--	--
Stenus sp.	--	--
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Dicrotendipes sp."A"	Tolerant	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987

(Continued on following page.)

Appendix VIII-V (continued): Site #39, Tinkers Creek (8/28/89)

Taxon	Tolerance	Source
Cricotopus trifascia	--	--
Cricotopus sp."C"	Tolerant	OEPA, 1987
Atherix sp.	Facultative	Mason, et al., 1971
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-W: Site #40, Tinkers Creek (8/28/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Stenonema interpunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Argia sp.	--	--
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Hemiptera		
Mesovelia sp.	--	--
Megaloptera		
Corydalus sp.	Facultative	Mason, et al., 1971
Trichoptera		
Hydroptila sp.	Facultative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche sp. (Pupae)	--	--
Coleoptera		
Stenelmis crenata (adults)	Facultative	Hilsenhoff, 1982
Cyphon sp.	--	--
Diptera		
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Sphaerium sp.	Facultative	Mason, et al., 1971

Appendix VIII-X: Site #41, Tinkers Creek (8/28/89)

Taxon	Tolerance	Source
Annelida		
Dina (Mooreobdella) Microstoma	Tolerant	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Ephemeroptera		
Stenonema interpunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Baetis sp.	--	--
Odonata		
Argia violacea	--	--
Megaloptera		
Nigronia sp.	--	--
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adult)	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Pentaneura sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Theinimanniella sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-Y: Site #42, Tinkers Creek (8/28, 8/30/89)

Taxon	Tolerance	Source
Annelida		
Placobdella ornata	Facultative	Mason, et al., 1971
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Dina (Mooreobdella) microstoma	Tolerant	Mason, et al., 1971
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Orconectes sp.	--	--
Ephemeroptera		
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema pulchellum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis propinquus	Facultative	Hilsenhoff, 1982
Odonata		
Cordulegaster sp.		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Argia violacea	--	--
Argia sp.	Facultative	Mason, et al., 1971
Hemiptera		
Gelastocoris sp.	--	--
Megaloptera		
Nigronia sp.	--	--
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Polycentropodidae (larvae)	--	--
Coleoptera		
Tropisternus sp. (adult)		
Ancyronyx variegata	Intolerant	Sinclair, 1964
Macronychus glabratus (adults)	Intolerant	Sinclair, 1964
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenelmis sp. (larvae)	Facultative	Brown, 1972

(Continued on following page.)

Appendix VIII-Y (continued): Site #42, Tinkers Creek (8/28, 8/30/89)

Taxon	Tolerance	Source
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Conchapelopia sp.	Facultative	Mason, et al., 1971
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Cryptochironomus sp.	Tolerant	Hilsenhoff, 1982
Polypedilum sp."A"	Tolerant	OEPA, 1987
Polypedilum sp."B"	Tolerant	OEPA, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Orthocladius dorenus	Facultative	Hilsenhoff, 1982
Cricotopus sp."C"	Tolerant	OEPA, 1987
Mollusca		
Sphaeriidae	--	--

Appendix VIII-Z: Site #43, Chippewa Creek (4/17/89)

Taxon	Tolerance	Source
Collembola		
Isotoma sp.	--	--
Ephemeroptera		
Baetis sp.	--	--
Tricorythodes sp.	Facultative	Mason, et al., 1971
Stenonema tripunctatum	Facultative	Lewis, 1974
Hemiptera		
Gerris sp.	Tolerant	Gaufin, et al., 1956
Trichoptera		
Neophylax sp.	Facultative	Hilsenhoff, 1982
Diplectrona sp.	--	--
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Symphitopsyche bifida grp.	Facultative	Mason, et al., 1971
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Symphitopsche alhedra	Facultative	Hilsenhoff, 1987
Coleoptera		
Stenelmis sp.	Facultative	Brown, 1971
Ectopria sp.	Facultative	Hilsenhoff, 1982
Psephenus sp.	Facultative	Hilsenhoff, 1982
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Antocha sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Tanytarsus sp.	Facultative	Hilsenhoff, 1982
Paratendipes sp.	Facultative	Hilsenhoff, 1982
Glyptotendipes sp.	Tolerant	OEPA, 1987
Chaetocladius sp.	Facultative	Hilsenhoff, 1982
Nanocladius sp.	Tolerant	OEPA, 1987
Parametriocnemus sp.	Facultative	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Parametriochemus sp.	Facultative	Hilsenhoff, 1982
Tvetenia bavarica	Facultative	Hilsenhoff, 1982

(Continued on following page.)

Appendix VIII-Z (continued): Site #43, Chippewa Creek (4/17/89)

Taxon	Tolerance	Source
Eukiefferiella pseudomontana	Tolerant	Hilsenhoff, 1987
Cricotopus sp."A"	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp."C"	Facultative	OEPA, 1987
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus sp."B"	Tolerant	OEPA, 1987
Diamesa sp.	Facultative	Hilsenhoff, 1982
Sympotthastia sp.	Facultative	Hilsenhoff, 1982
Caloparyphus sp.	Tolerant	Paine, et al., 1956
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-AA: Site #43.5, Chippewa Creek (10/12/89)

Taxon	Tolerance	Source
Ephemeroptera		
Stenonema tripunctatum	Facultative	Lewis, 1974
Baetis brunneicolor	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982

Appendix VIII-BB: Site #44, Chippewa Creek (10/11/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdella punctata	Tolerant	Mason, et al., 1971
Ephemeroptera		
Stenonema vicarium	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Baetis brunneicolor	Facultative	Hilsenhoff, 1982
Baetis vagans	Intolerant	Mason, et al., 1971
Odonata		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Ectopria sp.	Facultative	Hilsenhoff, 1982
Psephenus sp.	Facultative	Hilsenhoff, 1982
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenelmis sp.	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Tabanus sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-CC: Site #48.1, Burke Brook (9/25/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-DD: Site #1, Euclid Creek (10/12, 10/14/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Dina (Mooreobdella) microstoma	Tolerant	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Stenonema tripunctatum	Facultative	Lewis, 1974
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al.,1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Diptera		
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus/Othocladius sp.	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	HIlsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Bithynia tentaculata	--	--

Appendix VIII-EE: Site #2, Euclid Creek (4/20, 5/1, 10/13/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Stenonema tripunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Caenis sp.	Facultative	Mason, et al., 1971
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche bifida grp.	Facultative	Mason, et al., 1971
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Diptera		
Thienemannimyia sp. grp.	Facultative	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus sp."C"	--	--
Mollusca		
Bithynia tentaculata	--	--

Appendix VIII-FF: Site #3, Euclid Creek (5/10, 10/12/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Stenonema tripunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Chromagrion canditum	Facultative	Hilsenhoff, 1982
Hemiptera		
Sigara sp.	--	--
Trichoptera		
Hydroptila sp.	Facultative	Hilsenhoff, 1982
Phylocentropus sp.	--	--
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche bifida grp.	Facultative	Mason, et al., 1971
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis sp. (larvae)	Facultative	Brown, 1972
Stenelmis crenata (adults)	Facultative	Brown, 1972
Diptera		
Antocha sp.	Facultative	Hilsenhoff, 1987
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987

(Continued on following page.)

Appendix VIII-FF (continued): Site #3, Euclid Creek (5/10, 10/12/89)

Taxon	Tolerance	Source
Tipula abdominalis	Facultative	Hilsenhoff, 1982
Pentaneura sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Hydrobaenus sp.	Tolerant	Hilsenhoff, 1987
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987
Paracricotapus sp.	Facultative	--
Potthastia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Ferrissia paralella	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-GG: Site #4, Euclid Creek (10/13/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp. grp.	Facultative	Hilsenhoff, 1982
Nanocladius sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Gyraulus parvus	Facultative	Sinclair, 1957
Bithynia tentaculata	--	--

Appendix VIII-HH: Site #7, Green Creek (11/13/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Trichoptera		
*<u>Hydropsyche</u> sp.	--	--
Coleoptera		
<u>Helophorus</u> sp.	--	--
Mollusca		
<u>Physella gyrina sayi</u>	Tolerant	OEPA, 1987

*Cases found with remains;
no living specimens collected.

Appendix VIII-II: Site #9, Nine-Mile Creek (9/13/89)

Taxon	Tolerance	Source
Diptera		
Chironomus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-JJ: Site #10, Nine-Mile Creek (9/13/89)

Taxon	Tolerance	Source
Platyhelminthes		
Planariidae	Facultative	Mason, et al., 1971
Annelida		
Placobdella sp.	Facultative	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Ablabesmyia sp.	Facultative	Hilsenhoff, 1982
Paramerina sp.	--	--
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-KK: Site #12, Dugway Brook (10/11/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987

Appendix VIII-LL: Site #14, Dugway Brook (10/11/89)

Taxon	Tolerance	Source
Annelida		
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Coleoptera		
Curculionidae	--	--
Diptera		
Psychoda sp.	Tolerant	Mason, et al., 1971
Chironomus sp.	Tolerant	OEPA, 1987
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-MM: Site #15, Dugway Brook (10/11/89)

Taxon	Tolerance	Source
Diptera		
Chironomus sp.	Tolerant	OEPA, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Eukiefferiella pseudomontana group	Tolerant	Hilsenhoff, 1987
Natarsia sp.	Tolerant	Hilsenhoff, 1987

Appendix VIII-NN: Site #17, Doan Brook (10/9/89)

Taxon	Tolerance	Source
Crustacea		
Crangonyx gracilis	Tolerant	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Simulium sp.	--	--
Psychodidae (pupa)	Tolerant	Mason, et al., 1971
Chironomus sp.	Tolerant	OEPA, 1987
Glypototendipes sp.	Tolerant	Hilsenhoff, 1987
Cricotopus sp.	--	--
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-OO: Site #18, Doan Brook (10/9/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdella sp.	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Argia violacea	--	--
Coenagrion/Enallagma sp. grp.	Facultative	Hilsenhoff, 1982
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Mollusca		
Amnicola limnosa	Intolerant	Richardson, 1928
Sphaerium sp.	--	--

Appendix VIII-PP: Site #19, Doan Brook (10/9/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, 1986
Annelida		
Erpobdella sp.	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Argia violacea	--	--
Enallagma sp.	Facultative	Hilsenhoff, 1982
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Amnicola limnosa	Intolerant	Richardson, 1928

Appendix VIII-QQ: Site #49, Rocky River (10/16/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Helobdella sp.	Tolerant	Richardson, 1928
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Stenonema tripunctatum	Facultative	Lewis, 1974
Stenonema interpunctatum	Facultative	Lewis, 1974
Megaloptera		
Sialis sp.	Facultative	Mason, et al., 1971
Nigronia sp.	--	--
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenus sp.	--	--
Diptera		
Tipula furca	Facultative	Hilsenhoff, 1982
Hemerodromia sp.	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Eukiefferiella pseudomontana	Tolerant	Hilsenhoff, 1987
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987

Appendix VIII-RR: Site #50, Rocky River (6/7/89)

Taxon	Tolerance	Source
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Nixe sp.	Intolerant	Hilsenhoff, 1982
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema pulchellum	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Odonata		
Argia violacea	--	--
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydrospyche dicantha	Facultative	Hilsenhoff, 1982
Hydrospyche simulans	Facultative	Hilsenhoff, 1982
Coleoptera		
Macronychus glabratus	Intolerant	Sinclair, 1964
Stenelmis crenata (adults)	Facultative	Brown, 1972
Psephenus sp.	Facultative	Hilsenhoff, 1982
Diptera		
Procladius sp.	Tolerant	Curry, 1962
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1982
Tanytarsus sp.	Facultative	Curry, 1962
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Mollusca		
Ferrissia tarda	Tolerant	OEPA, 1987
Sphaeriinae	--	--

Appendix VIII-SS: Site #51, Rocky River (6/8/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Plecoptera		
Leuctra sp.	Intolerant	Hilsenhoff, 1982
Ephemeroptera		
Isonychia sp.	Intolerant	Mason, et al., 1971
Baetis sp.	--	--
Paraleptophlebia sp.	Intolerant	Hilsenhoff, 1982
Caenis sp.	Facultative	Mason, et al., 1971
Stenonema tripunctatum	Facultative	Lewis, 1974
Stenonema pulchellum	Facultative	Lewis, 1974
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Odonata		
Boyeria sp.	--	--
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Psephenus sp.	Facultative	Hilsenhoff, 1982
Stenelmis sp.	Facultative	Brown, 1972

(Continued on following page.)

Appendix VIII-SS (continued): Site #51, Rocky River (6/8/89)

Taxon	Tolerance	Source
Diptera		
Brillia sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-TT: Site #52, Rocky River (6/8/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Dina (Mooreobdella) microstoma	Tolerant	Richardson, 1928
Placobdella parasitica	Facultative	Mason, et al., 1971
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Orconectes virilis	--	--
Ephemeroptera		
Caenis sp.	Facultative	Mason, et al., 1971
Stenonema interpunctatum	Facultative	Lewis, 1974
Odonata		
Argia apicalis	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis crenata (adult)	Facultative	Brown, 1972
Diptera		
Limonia sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Orthocladius sp.	Tolerant	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Goniobasis livescens	Facultative	Ingram, 1957
Pisidium amnicum	--	--

Appendix VIII-UU: Site #52.5, Rocky River (10/16/89)

Taxon	Tolerance	Source
Annelida		
Helobdella sp.	Tolerant	Mason, et al., 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Ephemeroptera		
Caenis sp.	Facultative	Mason, et. al, 1971
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema minnetonka	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Odonata		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Argia moesta	Facultative	Hilsenhoff, 1982
Coenagrion sp.	Tolerant	Hilsenhoff, 1982
Trichoptera		
Symphitopsyche bifida group	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Berosus sp.	Tolerant	Mason, et al., 1971
Diptera		
Hemerodromia sp.	Facultative	Mason, et al., 1971
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix VIII-VV: 250 Yards Upstream of Site #52.5, Rocky River (10/16/89)

Taxon	Tolerance	Source
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis complex	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Caenis sp.	Facultative	Mason, et al., 1971
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Stenonema intepunctatum	Facultative	Lewis, 1974
Stenonema pulchellum	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Odonata		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Argia violacea	--	--
Argia moesta	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Berosus sp.	Tolerant	Mason, et al., 1971
Diptera		
Tipula abdominalis	Intolerant	Paine, et al., 1956
Tipula furca	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Mollusca		
Ferrissia paralella	Tolerant	OEPA, 1987
Goniobasis livescens	Facultative	Ingram, 1957

Appendix VIII-WW: Site #57, Sagamore Creek (9/6, 9/18/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Ephemera sp.	--	--
Caenis sp.	Facultative	Mason, et al., 1971
Stenonema tripunctatum	Facultative	Lewis, 1974
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis brunneicolor	Facultative	Hilsenhoff, 1982
Odonata		
Aeshna sp.	Facultative	Hilsenhoff, 1982
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Megaloptera		
Sialis sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Chimarra sp.	--	--
Cernotina sp.	--	--
Cyrnellus sp.	--	--
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Symphitopsyche bifida group	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis crenata (adult)	Facultative	Brown, 1972
Stenelmis sp.	Facultative	Brown, 1972
Ectopria sp.	Facultative	Hilsenhoff, 1982
Psephenus sp.	--	--

(Continued on following page.)

Appendix VIII-WW (continued): Site #57, Sagamore Creek (9/6, 9/18/89)

Taxon	Tolerance	Source
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Simulium corbis	Intolerant	Hilsenhoff, 1982
Thienemannimyia sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Atherix sp.	Facultative	Mason, et al., 1971
Mollusca		
Valvata sincera	--	--
Limnaedae	--	--

APPENDIX IX

1990 QUALITATIVE RESULTS OF SAMPLING FOR
BENTHIC MACROINVERTEBRATES

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

Appendix IX-A: Site #24, Cuyahoga River (7/16/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Gammarus fasciatus	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis sp. "C"	--	--
Leucrocuta sp.	Intolerant	Hilsenhoff, 1982
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema integrum	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Megaloptera		
Sialis sp.	Facultative	Mason, et al., 1971
Corydalus sp.	Facultative	Mason, et al., 1971
Trichoptera		
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis sp. (larvae)	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Polypedilum sp."B"	Tolerant	OEPA, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Mollusca		
Ferrissia tarda	Tolerant	OEPA, 1987
Fossaria humilis	Tolerant	Ingram, 1957

Appendix IX-B: Site #25, Big Creek (11/1/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Diptera		
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-C: Site #26, Big Creek (7/19/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdella sp.	Tolerant	Richardson, 1928
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Tipula abdominalis	Intolerant	Paine, et al., 1954
Tipula furca	Facultative	Hilsenhoff, 1982
Ephydridae	Tolerant	Paine, et al., 1954
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Musculium transversum	Tolerant	Richardson, 1928

Appendix IX-D: Site #27, Big Creek (7/19/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987

Appendix IX-E: Site #29, Big Creek (10/19/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Erpobdella punctata	Tolerant	Richardson, 1928
Crustacea		
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Stenonema tripunctatum	Facultative	Lewis, 1974
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Tipula furca	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Ferrissia parallela	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-F: Site #30, Big Creek (10/19/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus sp.	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Cryptochironomus sp.	Tolerant	Beck, 1954
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971

Appendix IX-G: Site #33, Mill Creek (Wolf Creek) (10/19/90)

Taxon	Tolerance	Source
Annelida		
Hirudinea	—	--
Crustacea		
Asellus racovitzai racovitzai	Tolerant	Hilsenhoff, 1987
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Pericoma sp.	Facultative	Hilsenhoff, 1987
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Chironomus sp.	Tolerant	OEPA, 1987
Polypedilum sp. "B"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-H: Site #33.5, Mill Creek (9/13/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Odonata		
Boyeria sp.	--	--
Diptera		
Stratiomys sp.	Tolerant	Paine, et al., 1956
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Tiputa furca	Facultative	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-I: Site #35, Mill Creek (9/24/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Erpobdellidae	--	--
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Hemiptera		
Beunoa sp.	--	--
Trichoptera		
Hydroptila sp.	Facultative	Hilsenhoff, 1987
Diptera		
Tipula furca	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Polypedilum sp. "B"	Tolerant	OEPA, 1987
Cricotopus trifascia gr.	Facultative	Mason, et al., 1971

Appendix IX-J: Site #36, West Creek (11/1/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Diptera		
Eukiefferiella pseudomontana gr.	Tolerant	Hilsenhoff, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971

Appendix IX-K: Site #39, Tinkers Creek (6/18/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus sp.	---	---
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydroptila sp.	Facultative	Hilsenhoff, 1982
Coleoptera		
Staphylinidae (adult)	---	---
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Conchapelopia (pupae)	Facultative	Mason, et al., 1971
Thienemannimyia sp. (pupae)	---	---
Chironomus sp.	Tolerant	OEPA, 1987
Polypedilum sp."B"	Tolerant	OEPA, 1987
Nanocladius sp.	Tolerant	OEPA, 1987
Eukiefferiella sp.	Tolerant	OEPA, 1987
Rheocricotopus sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia gr.	Facultative	Mason, et al., 1971
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Isocladius sp.	Tolerant	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-L: Site #43, Chippewa Creek (7/2/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis sp. "C"	--	--
Paraleptophlebia sp.	Intolerant	Hilsenhoff, 1982
Odonata		
Aeshna sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Diplectrona sp.	--	--
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Symphitopsyche cheilonis	Facultative	Mason, et al., 1971
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Coleoptera		
Staphylinidae (adult)	--	--
Stenelmis crenata (adults)	Facultative	Brown, 1972
Tropisternus sp.	Tolerant	Mason, et al., 1971
Diptera		
Tipula furca	Facultative	Hilsenhoff, 1982
Atherix sp.	Facultative	Mason, et al., 1971
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Cryptochironomus sp.	Tolerant	Beck, 1954
Demicryptochironomus sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix IX-M: Site #43.5, Chippewa Creek (7/2/90)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Plecoptera		
Leuctra sp.	Intolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Paraleptophlebia sp.	Intolerant	Hilsenhoff, 1982
Trichoptera		
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Coleoptera		
Stenelmis crenata (adult)	Facultative	Brown, 1972
Helophorus sp. (adult)	--	--
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Limnophora sp.	Facultative	Mason, et al., 1971
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Tanytarsus sp.	Facultative	Hilsenhoff, 1982
Chironomus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Eukiefferiella pseudomontana	Tolerant	Hilsenhoff, 1987
Brillia sp.	Facultative	Hilsenhoff, 1982
Diamesa sp.	Intolerant	Wurtz, 1955
Mollusca		
Gyraulus parvus	Facultative	Ingram, 1957

Appendix IX-N: Site #44, Chippewa Creek (7/2/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Erpobdella sp.	Tolerant	Richardson, 1928
Crustacea		
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Plecoptera		
Leuctra sp.	Intolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Baetis vagans	Intolerant	Mason, et al., 1971
Paraleptophlebia sp.	Intolerant	Hilsenhoff, 1982
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Stenonema integrum	Facultative	Lewis, 1974
Odonata		
Boyeria sp.	--	--
Trichoptera		
Hydropsychidae (pupae)	--	--
Symphitopsyche slossonae	Facultative	Hilsenhoff, 1982
Symphitopsyche cheilonis	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1972
Coleoptera		
Oreodytes sp.	--	--
Brachyvatus sp. (adult)	--	--
Tropisternus sp.	Tolerant	Mason, et al., 1971
Psephenus sp.	Facultative	Hilsenhoff, 1982
Stenelmis crenata	Facultative	Brown, 1972

(Continued on following page.)

Appendix IX-O: Site #1, Euclid Creek (8/9/90)

Taxon	Tolerance	Source
Platyhelminthes	Facultative	Mason, et al, 1971
Annelida		
Erpobdella sp.	Tolerant	Richardson, 1928
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche cheilonis	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis sp.	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Thienemannimyia sp. gr.	Facultative	Mason, et al., 1971
Pagastia sp.	Intolerant	Hilsenhoff, 1987

Appendix IX-N (continued): Site #44, Chippewa Creek (7/2/90)

Taxon	Tolerance	Source
Diptera		
Limnophora sp.	Facultative	Mason, et al., 1971
Antocha sp.	Facultative	Hilsenhoff, 1982
Limonia sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Simulium pictipes	Facultative	Hilsenhoff, 1987
Twinnia sp.	--	--
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Paratendipes sp.	Intolerant	Curry, 1962
Cryptochironomus sp.	Tolerant	Beck, 1954
Stictochironomus sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."A"	Tolerant	OEPA, 1987
Polypedilum sp."B"	Tolerant	OEPA, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus (Isocladius) sp.	Tolerant	Hilsenhoff, 1982
Glyptotendipes sp.	Tolerant	Curry, 1962

Appendix IX-P: Site #2, Euclid Creek (8/9/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx pseudogracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Ablabesmyia sp.	Facultative	Mason, et al, 1971
Cardiocladius sp.	Facultative	Hilsenhoff, 1982

Appendix IX-Q: Site #3, Euclid Creek (8/9/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx pseudogracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Caenis sp.	Facultative	Mason, et al., 1971
Stenonema tripunctatum	Facultative	Lewis, 1974
Trichoptera		
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche slossanae	Facultative	Hilsenhoff, 1982
Symphitopsyche cheilonis	Facultative	Mason, et al., 1971
Hydropsychidae (pupae)	--	--
Cernotina sp.	--	--
Coleoptera		
Stenelmis crenata (adults)	Facultative	Brown, 1972
Stenelmis sp. (larvae)	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Simulium sp. (pupae)	--	--
Hemerodromia sp.	Facultative	Mason, et al., 1971
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1982
Tanytarsus sp.	Facultative	Hilsenhoff, 1982
Microspectra/Tanytarsus sp.	Facultative	Hilsenhoff, 1982
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Endochironomus sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987

(Continued on following page.)

Appendix IX-Q (continued): Site #3, Euclid Creek (8/9/90)

Taxon	Tolerance	Source
Phaenopsectra sp.	Intolerant	Mason, et al, 1971
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp."A"	Tolerant	OEPA, 1987
Cricotopus sp."B"	Tolerant	OEPA, 1987
Mollusca		
Physella sp.	Tolerant	OEPA, 1987
Ferrissia sp.	Tolerant	OEPA, 1987

Appendix IX-R: Site #4, Euclid Creek (10/17/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Eurylophella temporalis	Tolerant	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Diptera		
Tipula sp.	Facultative	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Eukiefferiella sp.	Tolerant	Hilsenhoff, 1987

Appendix IX-S: Site #18, Doan Brook (8/31/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Odonata		
Argia violacea	--	--
Enallagma sp.	Facultative	Mason, et al., 1971
Mollusca		
Gyraulus circumstriatus	Facultative	Ingram, 1957
Amnicola limosa	Intolerant	Richardson, 1928
Sphaerium sp.	Facultative	Mason, et al., 1971

Appendix IX-T: Site #19, Doan Brook (8/31/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina (Mooreobdella) sp.	Tolerant	Mason, et al., 1982
Odonata		
Enallagma sp.	Facultative	Mason, et al., 1971
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Abalbesmyia sp.	Facultative	Hilsenhoff, 1982
Polypedilum sp."B"	Tolerant	OEPA, 1987
Dicrotendipes sp.	Tolerant	Hilsenhoff, 1982
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987
Gyraulus parvus	Facultative	Ingram, 1957
Helisoma anceps	Facultative	Ingram, 1957
Amnicola limosa	Intolerant	Richardson, 1928
Sphaerium sp.	Facultative	Mason, et al., 1971

Appendix IX-U: Site #51, Rocky River (7/26/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Plecoptera		
Leuctra sp.	Intolerant	Hilsenhoff, 1982
Ephemeroptera		
Isonychia sp.	Intolerant	Mason, et al., 1971
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Baetis sp."C"	--	---
Baetis favistriga	Facultative	Hilsenhoff, 1982
Stenonema pulchellum	Facultative	Lewis, 1969
Stenonema tripunctatum	Facultative	Lewis, 1974
Stenonema vicarium	Facultative	Lewis, 1974
Stenonema terminatum	Facultative	Lewis, 1974
Leucrocuta sp.	Intolerant	Hilsenhoff, 1982
Megaloptera		
Sialis sp.	Facultative	Mason, et al., 1971
Trichoptera		
Symphitopsyche cheilonis	Facultative	Mason, et al., 1971
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Symphitopsyche slossanae	Facultative	Hilsenhoff, 1982
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Stenelmis sp.	Facultative	Brown, 1982
Stenelmis crenata (adults)	Facultative	Brown, 1982
Psephenus sp.	Facultative	Hilsenhoff, 1982

(Continued on following page.)

Appendix IX-U (continued): Site #51, Rocky River (7/26/90)

Taxon	Tolerance	Source
Diptera		
Atherix sp.	Facultative	Mason, et al., 1971
Hemerodromia sp.	Facultative	Mason, et al., 1971
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Facultative	Hilsenhoff, 1982
Thienemannimyia sp. gr.	Facultative	Hilsenhoff, 1987
Polypedilum sp."B"	Tolerant	OEPA, 1987
Dicrotendipes sp.	Tolerant	Hilsenhoff, 1982
Microtendipes sp.	Facultative	Hilsenhoff, 1982
Cryptochironomus sp.	Tolerant	Beck, 1954
Lopescladius sp.	--	--
Cricotopus sp.	Tolerant	Hilsenhoff, 1982
Mollusca		
Ferrissia parallela	Tolerant	OEPA, 1987

Appendix IX-V: Site #52.5, Rocky River (8/10/90)

Taxon	Tolerance	Source
Annelida		
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Erpobdella triannulata	Tolerant	Richardson, 1928
Crustacea		
Asellus communis	Facultative	Mason, et al., 1971
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Ephemeroptera		
Caenis sp.	Facultative	Mason, et al., 1971
Baetis intercalaris	Facultative	Hilsenhoff, 1982
Baetis falvistriga	Facultative	Hilsenhoff, 1982
Baetis sp. "C"	--	--
Leucrocuta sp.	Intolerant	Hilsenhoff, 1982
Stenonema interpunctatum	Facultative	Lewis, 1974
Stenonema tripunctatum	Facultative	Lewis, 1974
Stenonema pulchellum	Facultative	Lewis, 1974
Odonata		
Calopteryx sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche dicantha	Facultative	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Laccophilus sp.	Tolerant	Gaufin, 1956
Stenelmis sexlineata	Facultative	Brown, 1972
Stenelmis sp.	Facultative	Brown, 1972
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Polypedilum sp."B"	Tolerant	OEPA, 1987
Chironomus sp.	Tolerant	OEPA, 1987
Cardiocladius sp.	Facultative	Hilsenhoff, 1982

(Continued on following page.)

Appendix IX-V (continued): Site #52.5, Rocky River (8/10/90)

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

Appendix IX-W: Site #57, Sagamore Creek (6/5, 7/26/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Crustacea		
Asellus scrupulosus	--	--
Crangonyx gracilis	Tolerant	Hilsenhoff, 1987
Cambaridae	--	--
Plecoptera		
Acroneuria sp.	Intolerant	Hilsenhoff, 1982
Bolotoperla sp.	Intolerant	Mason, et al., 1971
Leuctra sp.	Intolerant	Hilsenhoff, 1982
Ephemeroptera		
Baetis vagans	Intolerant	Mason, et al., 1971
Euryolphella temporalis	Tolerant	Hilsenhoff, 1982
Nixe sp.	Intolerant	Hilsenhoff, 1982
Stenonema tripunctatum	Facultative	Lewis, 1974
Odonata		
Ophiogomphus sp.	Intolerant	Hilsenhoff, 1987
Megaloptera		
Sialis sp.	Facultative	Mason, et al., 1971
Trichoptera		
Cernotina sp.	--	--
Diplectrona sp.	--	--
Symphitopsyche slossonae	Faculative	Hilsenhoff, 1982
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Symphitopsyche sparna	Intolerant	Hilsenhoff, 1982
Cheumatopsyche sp.	Facultative	Mason, et al., 1971
Coleoptera		
Agabus sp.	--	--
Stenelmis crenata (adults)	Facultative	Brown, 1972
Psephenus sp.	Facultative	Hilsenhoff, 1982

(Continued on following page.)

Appendix IX-W (continued): Site #57, Sagamore Creek (6/5, 7/26/90)

Taxon	Tolerance	Source
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Conchapelopia sp. (pupa)	Facultative	Mason, et al., 1971
Parametriochemus sp.	Facultative	Hilsenhoff, 1982
Tanytarsus sp.	Facultative	Curry, 1962
Conchapelopia sp.	Facultative	Mason, et al., 1971
Macropelopia sp.	Facultative	Paine, et al, 1956
Polypedilum sp."B"	Tolerant	OEPA, 1987
Parametriochemus sp.	Facultative	Hilsenhoff, 1982
Cricotopus sp."A"	Tolerant	OEPA, 1987
Eukiefferiella pseudomontana	Tolerant	Hilsenhoff, 1987
Phaenopsectra sp.	Intolerant	Mason, et al., 1971
Chironomus sp.	Tolerant	OEPA, 1987
Tvetenia bavarica gr.	--	--
Rheotanytarsus sp.	Facultative	Mason, et al., 1971
Cricotopus sp."B"	Tolerant	OEPA, 1987
Hemerodromia sp.	Facultative	Mason, et al., 1971
Limnophora sp.	Facultative	Hilsenhoff, 1982
Simulium corbis	Intolerant	Hilsenhoff, 1982
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Tribelos sp.	Intolerant	Mason, et al., 1971

APPENDIX X

1990 NEORSD CUYAHOGA RIVER
QUANTITATIVE FISH SURVEYS

Appendix X-A: Cuyahoga River Upstream of Southerly WWTP Effluent

Survey Date: 8/3/90

Collection Method: Boat electroshocking

Collection Distance: 0.6 km

Location: River Mile 11.3

Species	Number	Weight (kg)	Pollution Tolerance	DELT Anomalies
Cyprinus carpio (Common carp)	8	15.300	Highly Tolerant	Dorsal, caudal lesions
Aplodinotus grunniens (Freshwater drum)	1	0.212	Moderately Tolerant	--
Dorosoma cepedianum (Gizzard shad)	10	0.312	--	--
Notropis spilopterus (Spotfin shiner)	16	0.075	--	--
Percopsis omiscomaycus (Trout-perch)	1	0.012	--	--
Catostomus commersoni (Common white sucker)	13	2.176	Highly Tolerant	Caudal fin lesions
Ictalurus natalis (Yellow bullhead)	1	0.206	Highly Tolerant	Eye lesion
TOTAL:	50	18.293 kg		Greater than 3.0%

Index of Biotic Integrity (IBI) = 16 ("Very poor - Poor")

Modified Index of Well Being (MIwb) = 4.1 ("Very Poor")

Appendix X-B: Cuyahoga River Downstream of Southerly WWTP Effluent

Survey Date: 8/3/90

Collection Method: Boat electroshocking

Collection Distance: 0.5 km

Location: River Mile 10.5

Species	Number	Weight (kg)	Pollution Tolerance	DELT Anomalies
Pimephales notatus (Bluntnose minnow)	1	0.001	Highly Tolerant	--
Ictalurus nebulosus (Brown bullhead)	1	0.158	Highly Tolerant	--
Ictalurus natalis (Yellow bullhead)	2	0.396	Highly Tolerant	Lip lesion
Lepomis macrochirus (Bluegill sunfish)	1	0.006	Moderately Tolerant	--
Cyprinus carpio (Common carp)	36	59.500	Highly Tolerant	Eroded fins; anal, caudal, pectoral fin lesions
Semotilus atromaculatus (Northern creek chub)	1	0.001	Highly Tolerant	--
Aplodinotus grunniens (Freshwater drum)	1	0.001	Moderately Tolerant	--
Dorosoma cepedianum (Gizzard shad)	9	0.518	--	Mouth lesions; deformed nose
Esox americanus (Grass pickerel)	1	0.725	Moderately Tolerant	Slight caudal lesion
Notropis spilopterus (Spotfin shiner)	47	0.161	--	--
Catostomus commersoni (Common white sucker)	11	1.739	Highly Tolerant	Gill, pectoral lesions
TOTAL:	111	63.206 kg		Greater than 3.0%

Index of Biotic Integrity (IBI) = 18 ("Poor")

Modified Index of Well Being (MIwb) = 4.7 ("Very Poor")

Appendix X-C: Cuyahoga River Upstream of Southerly WWWTP Effluent

Survey Date: 9/28/90

Collection Method: Boat electroshocking

Collection Distance: 0.6 km

Location: River Mile 11.3

Species	Number	Weight (kg)	Pollution Tolerance	DELT Anomalies
Ictalurus hatalis (Yellow bullhead)	1	0.318	Highly Tolerant	--
Cyprinus carpio (Common carp)	5	8.650	Highly Tolerant	Slight dorsal fin lesions
Ictalurus punctatus (Channel catfish)	1	0.204	--	Slight pectoral & anal fin serrations
Dorosoma cepedianum (Gizzard shad)	31	0.858	--	--
Notropis spilopterus (Spotfin shiner)	1	0.009	--	--
Campostoma anomalum (Ohio stoneroller minnow)	1	0.003	--	Caudal fin lesions
Catostomus commersoni (Common white sucker)	20	3.350	Highly Tolerant	Anal, dorsal lesions
TOTAL:	60	13.392 kg		Greater than 3.0%

Index of Biotic Integrity (IBI) = 14 ("Very Poor")

Modified Index of Well Being (MIwb) = 4.6 ("Very Poor")

Appendix X-D: Cuyahoga River Downstream of Southerly WWTP Effluent

Survey Date: 9/28/90

Collection Method: Boat electroshocking

Collection Distance: 0.5 km

Location: River Mile 10.5

Species	Number	Weight (kg)	Pollution Tolerance	DELT Anomalies
Lepomis macrochirus (Bluegill sunfish)	1	0.070	Moderately Tolerant	--
Pimephales notatus (Bluntnose minnow)	3	0.004	Highly Tolerant	--
Ictalurus nebulosus (Brown bullhead)	2	0.350	Highly Tolerant	Lower lip lesion
Ictalurus natalis (Yellow bullhead)	7	1.370	Highly Tolerant	Dorsal, caudal, pectoral & lip lesions
Cyprinus carpio (Common carp)	20	37.800	Highly Tolerant	Dorsal & caudal fin lesions; body lesions
Dorosoma cepedianum (Gizzard shad)	18	0.720	--	--
Notropis spilopterus (Spotfin shiner)	2	0.012	--	--
Morone chrysops (White bass)	1	0.019	--	--
Catostomus commersoni (Common white sucker)	25	4.868	Highly Tolerant	Dorsal & anal fin lesions; body lesions
TOTAL:	79	45.213 kg		Greater than 3.0%

Index of Biotic Integrity (IBI) = 14 ("Very Poor")

Modified Index of Well Being (MIwb) = 4.8 ("Very Poor")

Appendix X-E: Index of Biotic Integrity (IBI) and Modified Index of Well Being (MIwb) for the Cuyahoga River (RM 7.1 - 13.1)

1984 to 1990 Data

Survey Date	River Mile	IBI	MIwb	Source
08/03/90	11.3	16	4.1	NEORSD, 1990
09/28/90	11.3	14	4.6	NEORSD, 1990
08/03/90	10.5	18	4.7	NEORSD, 1990
09/28/90	10.5	14	4.8	NEORSD, 1990
08/16/90	11.3	--	5.68	Battelle, 1990
09/06/89	11.3	--	4.66	Battelle, 1990
10/18/89	11.3	--	5.65	Battelle, 1990
11/08/89	11.3	--	5.68	Battelle, 1990
08/16/89	10.5	--	5.53	Battelle, 1990
09/06/89	10.5	--	3.76	Battelle, 1990
10/19/89	10.5	--	5.41	Battelle, 1990
11/08/89	10.5	--	5.72	Battelle, 1990
1988	13.1	22	6.1	OEPA, 1989
08/02/88	12.2	12	5.7	EA Science, 1988
1988	12.1	20	5.5	OEPA, 1989
1988	11.5	21	5.9	OEPA, 1989
08/02/88	11.3	14	3.3	EA Science, 1988
08/02/88	10.5	14	5.0	EA Science, 1988
1988	9.8	22	6.2	OEPA, 1989
08/02/88	7.8	14	3.9	EA Science, 1988
1988	7.5	18	4.8	OEPA, 1989
1988	7.1	16	5.5	OEPA, 1989
1987	13.1	20	5.4	OEPA, 1989
1987	12.2	17	5.1	OEPA, 1989
1987	11.5	17	4.2	OEPA, 1989
1987	9.8	19	4.8	OEPA, 1989
1987	7.5	20	3.4	OEPA, 1989
1987	7.1	17	4.4	OEPA, 1989
1985	13.1	20	6.3	OEPA, 1989
1985	11.5	18	6.5	OEPA, 1989
1985	9.8	16	5.1	OEPA, 1989
1985	7.5	16	3.6	OEPA, 1989
1985	7.1	14	5.9	OEPA, 1989
1984	13.1	16	4.2	OEPA, 1989
1984	11.5	14	4.0	OEPA, 1989
1984	9.8	13	4.0	OEPA, 1989
1984	7.5	14	4.7	OEPA, 1989
1984	7.1	15	3.8	OEPA, 1989

Appendix X-E (continued): Index of Biotic Integrity (IBI) and Modified Index of Well Being (MIwb) for the Cuyahoga River (RM 7.1 - 13.1)

1984 to 1990 Data Sources

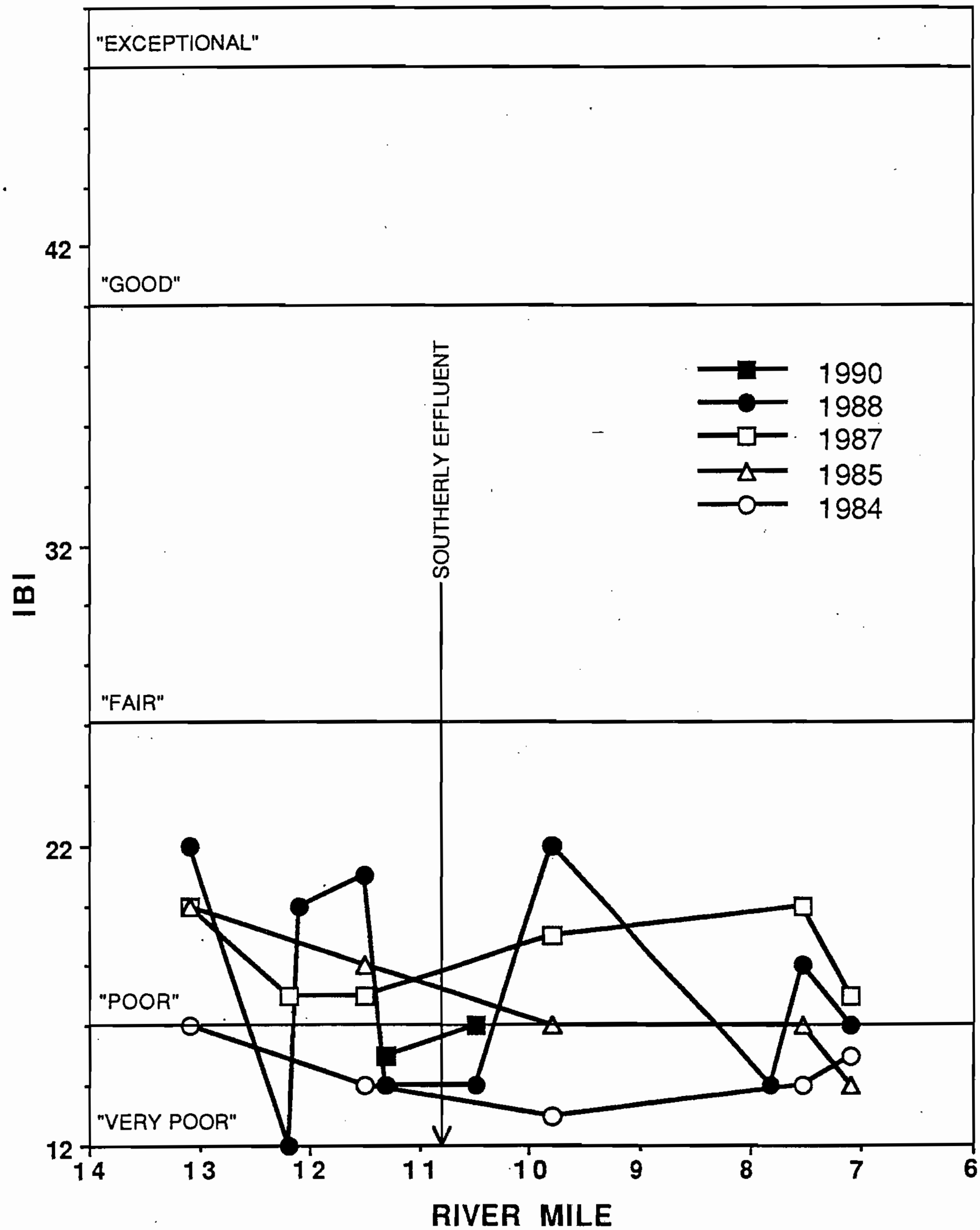
Battelle, Columbus Division, March 1990. A Field and Laboratory Site-Specific Evaluation of Cadmium, Copper, and Zinc for the Cuyahoga River in the Vicinity of the Northeast Ohio Regional Sewer District's Southerly Effluent Discharge.

EA Science and Technology, 1988. Results of a Fish Survey of the Cuyahoga River, August 1988. Northbrook, Illinois.

Northeast Ohio Regional Sewer District, 1990. Calculations of IBI and MIwb from 1990 surveys. Water Quality and Industrial Surveillance. 1990.

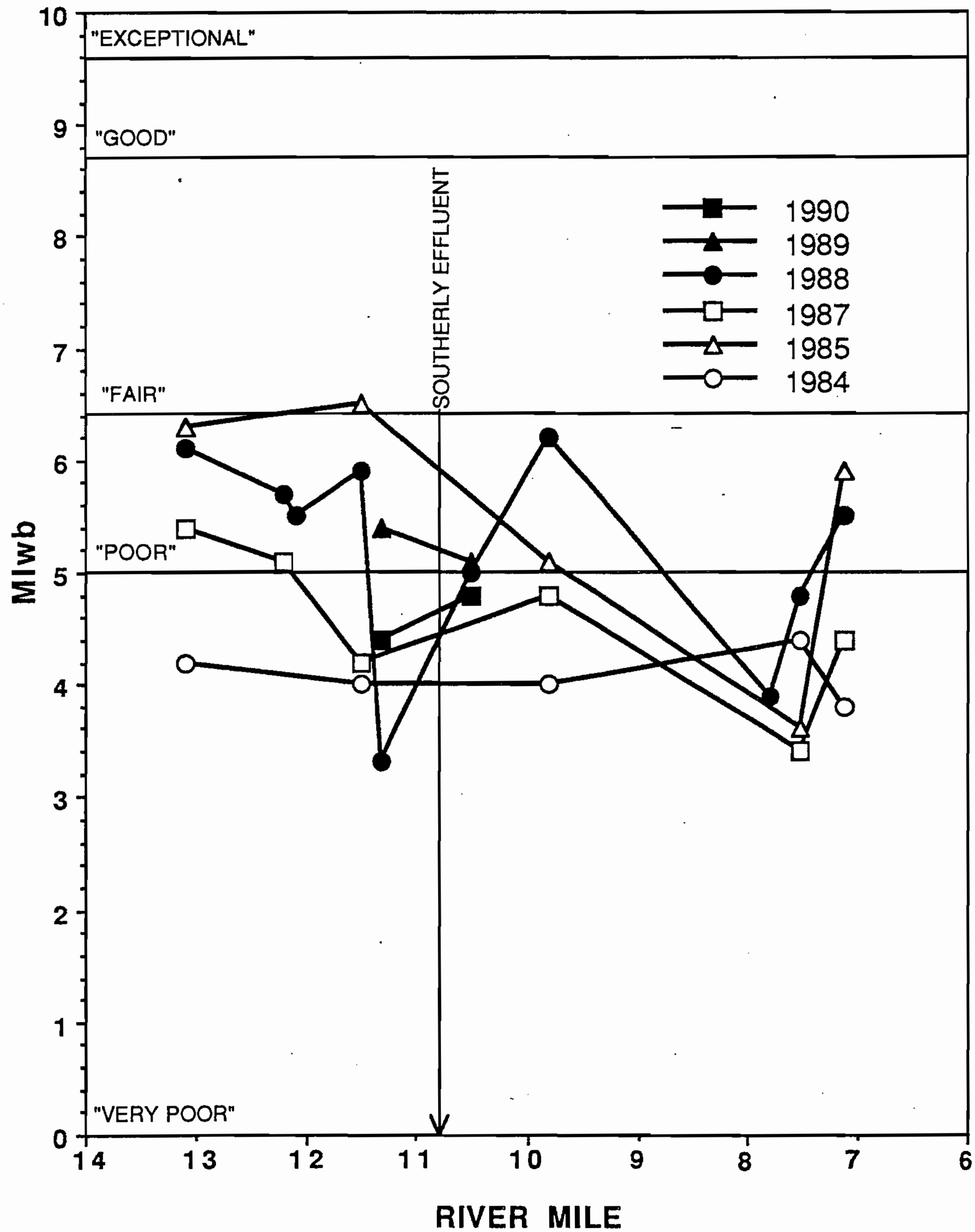
Ohio Environmental Protection Agency, 1989. Compendium of Biological Results from Ohio Rivers, Streams and Lakes: 1989 Edition. Ecological Assessment Section, Columbus, Ohio.

CUYAHOGA RIVER
INDEX OF BIOTIC INTEGRITY (IBI)
(FROM NEORSD AND OEPA DATA)



(NEORSD data are from surveys by NEORSD, Battelle, and EA Science & Technology.)

CUYAHOGA RIVER
MODIFIED INDEX OF WELL BEING (MIwb)
(FROM NEORSD AND OEPA DATA)



(NEORSD data are from surveys by NEORSD, Battelle, and EA Science & Technology.)

APPENDIX XI

HISTORICAL COMPARISON OF FISH SPECIES COLLECTED FROM THE CUYAHOGA RIVER WITHIN CUYAHOGA COUNTY

APPENDIX XI-A

Fish Species Collected From the Cuyahoga River in Cuyahoga County
Between River Mile 20.8 and River Mile 0.0
(excluding hybrids) Before 1955

Source: Trautman, M.B. 1981. The Fishes of Ohio. Ohio State University Press, Columbus, Ohio.

Collection Methods: Seining, others unknown.

Species Collected Before 1955	Pollution Tolerance*
1. Silver lamprey (Ichthyomyzon unicuspis)	--
2. Spotted gar (Lepisosteus oculatus), before 1901	--
3. Longnose gar (Lepisosteus osseus), before 1901	--
4. Bowfin (Amia calva), before 1901	--
5. American eel (Anguilla rostrata)	--
6. Mooneye (Hiodon tergisus)	Rare Intolerant
7. Eastern gizzard shad (Dorosoma cepedianum)	--
8. Grass pickerel (Esox americanus), before 1901	Moderately Tolerant
9. Northern pike (Esox lucius), before 1910	--
10. Great Lakes muskellunge (Esox masquinongy), before 1900	--
11. Northern hog sucker (Hypentelium nigricans)	Moderately Intolerant
12. Common white sucker (Catostomus commersoni)	Highly Tolerant
13. Spotted sucker (Minytrema melanops), before 1925	--
14. Common carp (Cyprinus carpio)	Highly Tolerant
15. Golden shiner (Notemigonus crysoleucas)	Highly Tolerant
16. Northern bigeye chub (Hybopsis amblops), before 1924	Common Intolerant
17. Western blacknose dace (Rhinichthys atratulus)	Highly Tolerant
18. Northern creek chub (Semotilis atromaculatus)	Highly Tolerant
19. Southern redbelly dace (Phoxinus erythrogaster)	--
20. Redside dace (Clinostomus elongatus)	Common Intolerant
21. Common emerald shiner (Notropis atherinoides)	--
22. Rosyface shiner (Notropis rubellus), before 1924	Common Intolerant
23. Central striped shiner (Notropis chrysocephalus)	--
24. Common shiner (Notropis cornutus)	--
25. Spottail shiner Notropis hudsonius)	Moderately Tolerant
26. Spotfin shiner (Notropis spilopterus)	--
27. Northern fathead minnow (Pimephales promelas)	Highly Tolerant
28. Bluntnose minnow (Pimephales notatus)	Highly Tolerant
29. Central quillback carpsucker (Carpiodes Cyprinus), after 1880	--
30. Channel catfish (Ictalurus punctatus)	--
31. Yellow bullhead (Ictalurus natalis), 1901-37	Highly Tolerant

(Continued on following page.)

APPENDIX XI-A (continued)

Species Collected Before 1955	Pollution Tolerance*
32. Black bullhead (*Ictalurus melas*), before 1901	Moderately Tolerant
33. Eastern burbot (*Lota lota*)	--
34. White bass (*Morone chrysops*)	--
35. Black crappie (*Pomoxis nigromaculatus*)	--
36. Northern rockbass (*Ambloplites rupestris*)	--
37. Northern smallmouth bass (*Micropterus dolomieui*)	Moderately Intolerant
38. Green sunfish (*Lepomis cyanellus*)	Highly Tolerant
39. Northern bluegill sunfish (*Lepomis macrochirus*)	Moderately Tolerant
40. Pumpkinseed sunfish (*Lepomis gibbosus*), before 1926	Moderately Tolerant
41. Northern longear sunfish (*Lepomis megalotis*)	Moderately Intolerant
42. Yellow perch (*Perca flavescens*)	--
43. Blackside darter (*Percina maculata*)	--
44. Eastern sand darter (*Ammoncrypta pellucida*), before 1924	Rare Intolerant
45. Central johnny darter (*Etheostoma nigrum*)	--
46. Freshwater drum (*Aplodinotus grunniens*)	Moderately Tolerant

*Pollution Tolerances from: Ohio Environmental Protection Agency. 1989. *Biological Protection of Aquatic Life*, Volume III. Columbus, Ohio.

APPENDIX XI-B

Fish Species Collected From the Cuyahoga River
in Cuyahoga County Between River Mile 20.8 and River Mile 0.0
(excluding hybrids) 1955-1980

Sources: Trautman, M.B. 1981. The Fishes of Ohio. Ohio State University Press, Columbus, Ohio.

White, A.M., et al. 1975. Water Quality Baseline Assessment for the Cleveland Area - Lake Erie, Vol. II: The Fishes of the Cleveland Metropolitan Area Including the Lake Erie Shoreline. EPA-905/9-75-001.

Northeast Ohio Areawide Coordinating Agency. 1978. Analysis of Stream Habitats: Technical Appendix A21. Cleveland, Ohio.

Collection Methods: Experimental gill netting, trawling, trap netting, seining.

Species Collected From 1955 to 1980	Pollution Tolerance*
1. Longnose gar (Lepisosteus asseus)	--
2. Eastern gizzard shad (Dorosoma cepedianum)	--
3. Alewife (Alosa pseudoharengus)	--
4. Chain pickerel (Esox niger), stocked by Div. of Wildlife since 1954	--
5. Common carp (Cyprinus carpio)	Highly Tolerant
6. Goldfish (Carassius auratus)	Highly Tolerant
7. Golden shiner (Notemigonus chrysoleucas)	Highly Tolerant
8. Creek chub (Semotilus atromaculatus)	Highly Tolerant
9. Common emerald shiner (Notropis atherinoides)	--
10. Central striped shiner (Notropis chrysocephalus)	--
11. Spottail shiner (Notropis hudsonius)	Moderately Tolerant
12. Spotfin shiner (Notropis spilopterus)	--
13. Sand shiner (Notropis stramineus)	Moderately Intolerant
14. Northern mimic shiner (Notropis volucellus)	Common Intolerant
15. Fathead minnow (Pimephales promelas)	Highly Tolerant
16. Bluntnose minnow (Pimephales notatus)	Highly Tolerant
17. Central stoneroller minnow (Campostoma anomalum)	--
18. Common white sucker (Catostomus commersoni)	Highly Tolerant
19. Brown bullhead (Ictalurus nebulosus)	Highly Tolerant
20. Black bullhead (Ictalurus melas)	Moderately Tolerant
21. Trout-perch (Percopsis omiscomaycus)	--
22. Brook stickleback (Culaea inconstans)	--
23. White bass (Morone chrysops)	--

(Continued on following page.)

APPENDIX XI-B (continued)

Species Collected From 1955 to 1980	Pollution Tolerance*
24. Pumpkinseed sunfish (*Lepomis gibbosus*)	Moderately Tolerant
25. Yellow perch (*Perca flavescens*)	--
26. Northern logperch darter (*Percina caprodes*)	Moderately Intolerant
27. Freshwater drum (*Aplodinotus grunniens*)	Moderately Tolerant

*Pollution Tolerances from: Ohio Environmental Protection Agency. 1989. Biological Protection of Aquatic Life, Volume III. Columbus, Ohio.

APPENDIX XI-C

Fish Species Collected From the Cuyahoga River in Cuyahoga County
Between River Mile 20.8 and River Mile 0.0
(excluding hybrids) 1988-1991

Sources: Ohio EPA. Water Quality Monitoring & Assessment Fish Information System, 1988-1991.

Northeast Ohio Regional Sewer District Survey Data, 1988-1991.

Collection Methods: Electroshocking and seining.

Species Collected From 1988 to 1991	Pollution Tolerance*
1. Alewife (*Alosa pseudoharengus*)	--
2. Eastern gizzard shad (*Dorosoma cepedianum*)	--
3. Grass pickerel (*Esox americanus*)	Moderately Tolerant
4. Northern pike (*Esox lucius*)	--
5. Bigmouth buffalo (*Ictiobus cyprinellus*)	--
6. Smallmouth buffalo (*Ictiobus bubalus*)	--
7. Central quillback carpsucker (*Carpiodes cyprinus*)	--
8. Black redhorse (*Moxostoma duquesnei*)	Common Intolerant
9. Golden redhorse (*Moxostoma erythrurum*)	Moderately Intolerant
10. Shorthead redhorse (*Moxostoma macrolepidotum*)	Moderately Intolerant
11. Northern hog sucker (*Hypentelium nigricans*)	Moderately Intolerant
12. Common white sucker (*Catostomus commersoni*)	Highly Tolerant
13. Common carp (*Cyprinus carpio*)	Highly Tolerant
14. Goldfish (*Carassius auratus*)	Highly tolerant
15. Golden shiner (*Notemigonus crysoleucas*)	Highly Tolerant
16. Blacknose dace (*Rhinicthys atratulus*)	Highly Tolerant
17. Creek chub (*Semotilus atromaculatus*)	Highly Tolerant
18. Common emerald shiner (*Notropis atherinoides*)	--
19. Silver shiner (*Notropis photogenis*)	Common Intolerant
20. Common shiner (*Notropis cornutus*)	--
21. Spottail shiner (*Notropis hudsonius*)	Moderately Tolerant
22. Spotfin shiner (*Notropis spilopterus*)	--
23. Sand shiner (*Notropis stramineus*)	Moderately Intolerant
24. Silverjaw minnow (*Ericymba buccata*)	--
25. Northern fathead minnow (*Pimephales promelas*)	Highly Tolerant
26. Bluntnose minnow (*Pimephales notatus*)	Highly Tolerant
27. Central stoneroller minnow (*Campostoma anomalum*)	--
28. Grass carp (*Ctenophargngodon idella*)	--
29. Channel catfish (*Ictalurus punctatus*)	--
30. Yellow bullhead (*Ictalurus natalis*)	Highly Tolerant
31. Brown bullhead (*Ictalurus nebulosus*)	Highly Tolerant
32. Black bullhead (*Ictalurus melas*)	Moderately Tolerant
33. Trout-perch (*Percopsis omiscomaycus*)	--

(Continued on following page.)

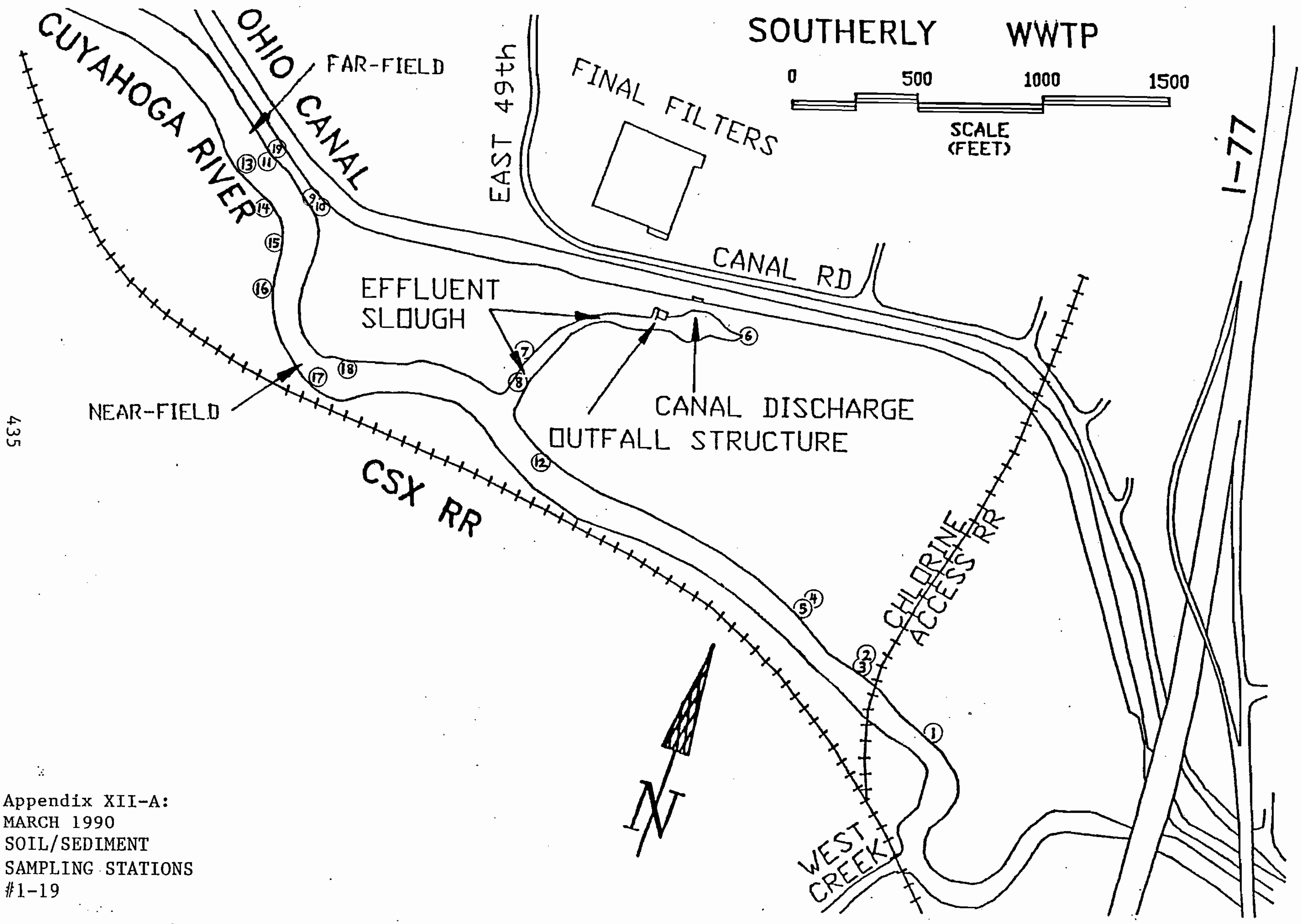
APPENDIX XI-C (continued)

Species Collected From 1988 to 1991	Pollution Tolerance*
34. White bass (*Morone chrysops*)	--
35. White perch (*Morone americana*)	--
36. White crappie (*Pomoxis annularis*)	--
37. Black crappie (*Pomoxis nigromaculatus*)	--
38. Northern rockbass (*Ambloplites rupestris*)	--
39. Northern smallmouth bass (*Micropterus dolomieui*)	Moderately Intolerant
40. Northern largemouth bass (*Micropterus salmoides*)	--
41. Warmouth sunfish (*Lepomis gulosus*)	--
42. Green sunfish (*Lepomis cyanellus*)	Highly tolerant
43. Northern bluegill sunfish (*Lepomis macrochirus*)	Moderately Tolerant
44. Northern longear sunfish (*Lepomis megalotis*)	Moderately Intolerant
45. Pumpkinseed sunfish (*Lepomis gibbosus*)	Moderately Tolerant
46. Yellow perch (*Perca flavescens*)	--
47. Northern logperch darter (*Percina caprodes*)	Moderately Intolerant
48. Greenside darter (*Etheostoma blennioides*)	Moderately Intolerant
49. Freshwater drum (*Aplodinotus grunniens*)	Moderately Tolerant

*Pollution Tolerances from: Ohio Environmental Protection Agency. 1989. *Biological Protection of Aquatic Life*, Volume III. Columbus, Ohio.

APPENDIX XII

MARCH-APRIL 1990 ASSESSMENT OF POTENTIAL IMPACTS ON CUYAHOGA RIVER WATER QUALITY NEAR THE SOUTHERLY WWTP EFFLUENT



Appendix XII-A:
MARCH 1990
SOIL/SEDIMENT
SAMPLING STATIONS
#1-19

Appendix XII-B:
3/90 Concentrations of Metals in Soil/Sediment (mg/kg)

Station #	Sample	Cadmium	Chromium	Lead	Copper	Nickel	Zinc	Mercury	Percent Solids	Total Metals, mg/kg	Total Metals (mg) per kg Solids
1	Soil at waterline upstream of chlorine-access RR bridge	0.6	6.0	17.0	12.0	5.0	54.0	0.065	80%	94.7	120
2	Soil at crest of bank down-stream of chlorine-access RR bridge	25.0	380.0	550.0	440.0	120.0	1200.0	0.02	59%	2715.0	4600
3	Soil at water-line downstream of chlorine-access RR Bridge	0.3	4.0	10.0	5.0	4.0	34.0	0.039	79%	57.3	72
4	Soil at crest of bank 150 yards downstream of chlorine-access RR bridge	40.0	620.0	660.0	510.0	150.0	1400.0	0.074	61%	3380.1	5500
5	Soil at water-Line 150 yards downstream of chlorine-access RR bridge	1.0	4.0	10.0	7.0	5.0	41.0	0.034	75%	68.0	91
6	Soil at east end of Southerly former effluent channel	4.0	8.0	5.0	14.0	30.0	77.0	0.067	75%	138.1	180
7	Gray material at crest of effluent channel northwest bank	14.0	190.0	190.0	110.0	38.0	1300.0	0.02	98%	1842.0	1900

Appendix XII-B (continued)

Station #	Sample	Cadmium	Chromium	Lead	Copper	Nickel	Zinc	Mercury	Percent Solids	Total Metals, mg/kg	Total Metals (mg) per kg Solids
8	Sediment in Southerly effluent channel	31.0	120.0	490.0	110.0	60.0	1300.0	0.37	55%	2111.4	3800
9	Gray material at crest of east bank upstream of far-field site	6.0	10.0	13.0	17.0	21.0	67.0	0.02	94%	134.0	140
10	Red material at crest of east bank upstream of far-field site	20.0	140.0	280.0	33.0	19.0	710.0	0.047	93%	1202.0	1300
11	River sediment at east side of far-field site	0.4	5.0	10.0	4.0	4.0	36.0	0.02	80%	59.4	74
12	River sediment upstream of Southerly effluent at east side of site	0.3	8.0	25.0	16.0	8.0	81.0	0.056	60%	138.4	230
13	River sediment at west side of far-field site	0.9	17.0	51.0	25.0	15.0	110.0	0.072	70%	219.0	310
14	Material at waterline at north end of Amser Corp. property	1.0	4.0	8.0	6.0	5.0	36.0	0.02	78%	60.0	86

Appendix XII-B (continued)

Station #	Sample	Cadmium	Chromium	Lead	Copper	Nickel	Zinc	Mercury	Percent Solids	Total Metals, mg/kg	Total Metals (mg) per kg Solids
15	Material at waterline 200 feet upstream of north end of Amser Corp. property	1.0	3.0	8.0	6.0	4.0	40.0	0.02	77%	62.0	80
16	Material at waterline 400 feet upstream of north end of Amser Corp. property	1.0	3.0	10.0	6.0	6.0	45.0	0.031	79%	71.0	90
17	River sediment at west side of near-field site	1.0	4.0	10.0	7.0	5.0	47.0	0.027	72%	74.0	100
18	River sediment at east side of far-field site	0.9	19.0	20.0	18.0	11.0	89.0	0.035	73%	157.9	220
19	Sand at east bank of far-field site	1.0	4.0	10.0	7.0	5.0	46.0	0.038	78%	73.0	94

Metals Not Detected	Method Detection Limit, mg/kg
Antimony	2.0
Arsenic	2.5
Beryllium	0.02
Selenium	5.0
Silver	0.25
Thallium	6.5

APPENDIX XII-C: FIELD MEASUREMENT OF SPECIFIC CONDUCTANCE (umhos/cm)

TABLE 1: Dry Weather Conditions

Date	Cuyahoga River Flow*	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
3/19/90	666	490	820	780	580
3/20/90	635	490	820	750	560
3/21/90	602	500	950	790	540
3/26/90	374	550	920	820	700

TABLE 2: Wet Weather Conditions

Date	Cuyahoga River Flow*	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
4/04/90	1,420	1,220	920	1,000	790
4/05/90	1,230	580	890	780	630
4/10/90	2,570	575	980	900	--

*Flow = Cubic feet per second at USGS Independence Gauge

APPENDIX XII-D: FIELD MEASUREMENT OF TURBIDITY (NTU)

TABLE 1: Dry Weather Conditions

Date	Cuyahoga River Flow*	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
3/19/90	666	5.5	2.5	3.0	4.0
3/20/90	635	4.0	1.9	2.1	3.1
3/21/90	602	3.5	2.0	2.2	3.2
3/26/90	374	3.0	2.9	3.2	3.0

TABLE 2: Wet Weather Conditions

Date	Cuyahoga River Flow*	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
4/04/90	1,420	35.0	3.5	8.5	20.0
4/05/90	1,230	20.0	5.5	12.0	20.0
4/10/90	2,570	150.0	15.0	12.0	33.0

*Flow = Cubic feet per second at USGS Independence Gauge

APPENDIX XII-E: CHEMICAL DATA FROM 3/26/90

(Dry Weather Conditions)

	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
BOD	3	4	4	4
COD	17	42	35	26
Suspended Solids	9	10	12	4
Total Solids	558	881	720	652
Dissolved Solids	505	838	703	647
Ammonia	0.61	0.26	0.38	0.55
Phosphorus	0.06	0.33	0.28	0.18
Soluble P	0.05	0.31	0.24	0.15
Nitrates	1.51	14.1	6.90	0.55
Nitrites	0.11	0.04	0.52	6.91
TKN	1.68	0.56	1.68	1.12
Chlorides	134	224	218	168
Sulfates	75	92	90	84
Alkalinity	149	129	122	130
Hardness	221	276	264	248
Nickel	0.02	0.08	0.06	0.06
Copper	0.01	0.02	0.02	0.01
Chromium (Total)	<0.01	0.02	0.02	0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.01	0.09	0.07	0.04
Iron	0.9	0.4	0.6	0.6
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	0.01	0.01	0.01
Mercury (ug/L)	<0.01	0.1	0.4	<0.1
pH (Standard Units)	7.8	7.4	7.5	7.7

(All data in mg/L unless otherwise noted.)

APPENDIX XII-F: CHEMICAL DATA FROM 4/04/90

(Wet Weather Conditions)

	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
BOD	5	6	6	6
COD	20	37	33	23
Suspended Solids	50	6	12	39
Total Solids	740	874	838	743
Dissolved Solids	—	—	—	—
Ammonia	0.25	0.03	0.07	0.15
Phosphorus	0.13	0.19	0.16	0.14
Soluble P	0.08	0.17	0.13	0.09
Nitrates	1.16	7.49	6.64	2.82
Nitrites	0.09	0.02	0.03	0.07
TKN	1.12	1.68	1.68	1.79
Chlorides	274	320	320	244
Sulfates	78	83	87	76
Alkalinity	124	126	126	135
Hardness	255	273	273	303
Nickel	0.04	0.07	0.09	0.05
Copper	0.02	0.02	0.02	0.02
Chromium (Total)	0.02	0.02	0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.06	0.12	0.09	0.06
Iron	2.3	1.0	1.1	1.8
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	<0.01	0.02	<0.01
Mercury (ug/L)	0.2	0.1	0.1	0.2
pH (Standard Units)	7.6	7.2	7.4	7.5

(All data in mg/L unless otherwise noted.)

APPENDIX XII-G: CHEMICAL DATA FROM 4/10/90

(Wet Weather Conditions)

	Cuyahoga River Upstream of Southerly WWTP	Southerly Effluent Channel	Cuyahoga River Near-Field Site	Cuyahoga River Far-Field Site
BOD	10	10	10	10
COD	45	44	32	26
Suspended Solids	176	9	15	15
Total Solids	675	805	727	616
Dissolved Solids	499	792	705	599
Ammonia	0.48	0.15	0.24	0.33
Phosphorus	0.64	0.38	0.31	0.28
Soluble P	0.08	0.39	0.26	0.14
Nitrates	1.26	11.8	9.85	5.14
Nitrites	0.09	0.03	0.04	0.07
TKN	0.84	0.67	1.96	2.24
Chlorides	156	244	225	184
Sulfates	68	87	88	84
Alkalinity	116	120	122	123
Hardness	204	261	240	221
Nickel	0.04	0.08	0.06	0.04
Copper	0.02	0.01	0.01	0.01
Chromium (Total)	<0.01	<0.01	<0.01	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.06	0.12	0.10	0.06
Iron	5.1	0.6	0.8	1.4
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	0.02	<0.01	0.02	<0.01
Mercury (ug/L)	0.1	0.1	0.1	0.1
pH (Standard Units)	7.6	6.8	6.9	7.0

(All data in mg/L unless otherwise noted.)

APPENDIX XIII

1989 BIG CREEK INTERCEPTOR DIVERSION
IMPACT ASSESSMENT

Appendix XIII

1989 Big Creek Interceptor Diversion to Big Creek: Biotic Impact

Introduction

On May 15, 1989, the NEORSD diverted the flow of the Big Creek Interceptor to the main stem of Big Creek, approximately 750 feet downstream of the confluence of the East and West Branches. This Ohio EPA-approved diversion allowed for the inspection and maintenance of the interceptor. The diversion of approximately 13.6 million gallons per day continued until May 18, 1989. Five locations were sampled for chemical and bacteriological analysis to evaluate the influence of the diversion on water quality, including one upstream location and two downstream locations on Big Creek. Additionally, two Cuyahoga River locations were sampled, one upstream of the confluence with Big Creek and the other downstream of the confluence.

Flow measurements were obtained on Big Creek upstream and downstream during the diversion using a Marsh-McBirney Model 201D portable water current meter and measurements of cross-sectional area.

Qualitative benthic macroinvertebrate sampling was conducted at one location upstream and three locations downstream of the diversion. The benthic macroinvertebrate samples were used to evaluate the magnitude and extent of the diversion's impact on the benthic macroinvertebrate community of Big Creek. Benthic macroinvertebrate samples were collected with a long-handled D-frame Kicknet.

On October 30, 1989, a second Ohio EPA-approved diversion of the Big Creek Interceptor occurred. This second diversion of approximately 4.6 million gallons per day, according to a NEORSD Sewer Control Systems estimate, took place 50 feet east of Ridge Road, about one mile downstream of the May 1989 diversion, and continued until November 1, 1989.

Three locations, including one location upstream and two locations downstream of the October-November 1989 diversion, were sampled for benthic macroinvertebrates before and after the diversion to evaluate the impact on the benthic macroinvertebrate community.

Big Creek Location A

Location A is approximately 50 feet upstream of the May 1989 diversion outfall to Big Creek and about 700 feet downstream of the confluence of the Big Creek East and West Branches in the Cleveland Metroparks Big Creek Reservation north of Memphis Avenue and Tiedeman Road. The creek at this location is about 30 feet wide with an average dry weather water depth of about 0.5 feet. The location has a riffle/run/pool habitat. The substrate consists mostly of shale and shale bits, with some cobble, gravel, and sand. Manmade debris (i.e., bricks, concrete, pipe, etc.) also litter the area. The flow at this location was measured at approximately 10.6 million gallons per day (MGD) on May 16, 1989 (Appendix XIII-C).

Big Creek Location B

Location B is approximately 300 feet downstream of the May 1989 diversion outfall. The creek at this location is approximately 40 feet wide with an average depth during the diversion of 0.7 feet. The average flow rate during the diversion was measured at approximately 24 MGD on May 16, 1989 (Appendix XIII-D).

Location B has a substrate similar to that of Location A, with equal amounts of natural and manmade debris, cobble, and rubble. Location B also has a riffle/run/pool habitat.

Big Creek Location C

Location C is approximately 4,500 feet east of Ridge Road near Rose Field in Brookside Park. This site was chosen because it is less than one mile downstream from the October-November 1989 diversion at Ridge Road, and approximately two miles downstream of Location B. Location C has a long riffle/run habitat with a large pool under a pedestrian bridge. The substrate consists of cobble, concrete rubble, sand, and gravel. Many logs and other debris have accumulated on the upstream side of the pedestrian bridge. The creek at this site is approximately 30 feet wide with an average dry weather water depth of 0.5 feet. Concrete walls for erosion prevention are located on both banks. This site was only sampled for benthic macroinvertebrates.

Big Creek Location D

Location D is on Big Creek at the downstream side of Jennings Road. It is about four miles downstream of the May 1989 diversion outfall and about three miles downstream of the October-November 1989 diversion outfall. Samples were obtained approximately 900 feet upstream of the confluence with the Cuyahoga River. The creek is about 25 feet wide, with an average dry weather water depth of 0.6 feet. Location D has a riffle/run/pool habitat. The long riffle area has many large concrete slabs in the substrate, which consists of boulders, cobble, gravel, and miscellaneous debris. This location is routinely sampled by the NEORSD as Site #25.

Cuyahoga River Location E

Location E is at River Mile 7.9 on the Cuyahoga River approximately 0.6 miles upstream from the confluence with Big Creek. Samples were collected from the west bank of the river adjacent to the River Smelting and Refining Company, 4195 Bradley Road. This location is also routinely sampled by the NEORSD as Site #22.6.

Chemical and bacteriological samples were obtained at this upstream location for comparison with samples collected downstream of the Big Creek confluence at Location F.

Cuyahoga River Location F

Location F is at River Mile 7.1 on the Cuyahoga River at the Lower Harvard bridge. This location is 0.2 miles downstream of the Big Creek confluence. This location is also routinely sampled by the NEORSD as Site #22.51.

Discussion

Chemical, bacteriological, and benthic sampling produced data which indicated that the Big Creek Interceptor diversion from May 15 to May 18, 1989 had a significant impact on the water quality of Big Creek and the Cuyahoga River downstream of the diversion.

An elevated fecal coliform concentration of 210,000 organisms per 100 ml, which greatly exceeded the Ohio EPA Primary Contact Recreational Use criterion of 2,000 organisms, was noted at Location B on May 15 (Appendix XIII-A). For comparison, a fecal coliform concentration of 1,500 organisms had been measured upstream of the diversion at Location A on May 15.

The fecal coliform concentration in the Cuyahoga River on May 15 increased from 520 organisms per 100 ml at Location E upstream of the Big Creek confluence to 16,000 organisms per 100 ml at Location F downstream of the Big Creek confluence, where the Primary Contact Recreational Use criterion was exceeded. Both of the May 15 bacteriological criterion exceedances, at Locations B and F, were attributable to the diversion.

Chemical exceedances of the Ohio EPA water quality criteria for Warmwater Habitat attributable to the diversion, were noted for copper, zinc, iron, cadmium, and mercury on May 15 and May 16 at Location B (Appendices XIII-A, XIII-B). Significant increases in loadings to Big Creek of these and other parameters were measured on May 16 and are attributable to the diversion (Appendix XIII-E).

Chemical exceedances of the criteria for Warmwater Habitat attributable to the diversion were also noted in the Cuyahoga River at Site F for copper and zinc on May 16 (Appendix XIII-B).

Although the diversion had ceased by May 19, a flow of about five gallons per minute was observed to be continuing from the Big Creek

Interceptor diversion outfall pipe and, along with residual contamination, was probably responsible for a criterion exceedance for ammonia noted on that date at Location B (Appendix XIII-F). Concentrations measured further downstream on Big Creek at Location D on May 16 were very similar to the concentrations upstream of the diversion outfall location at Location A and indicated that the diversion had ceased to impact water quality at Location D one day after its cessation.

Site A was sampled twice for benthic macroinvertebrates in 1989 (Appendices XIII-G, XIII-H). Six taxa were collected at Location A on May 19, including two taxa described in literature as facultative and four taxa described as tolerant in their responses to organic pollution (Appendix XIII-G). This low diversity reflects an impact at this location attributable to water quality problems upstream on the West Branch of Big Creek.

On October 6, 1989, an increased diversity in the benthic macroinvertebrate community was noted at Location A (Appendix XIII-H), when compared to the May 19 sample. Eight taxa were collected, including four taxa described in literature as facultative and four taxa described as tolerant in their responses to organic pollution. This increase may be attributable to seasonal variability (Robinson, Minshall and Rushforth, 1990) and/or improved water quality upstream in the West Branch of Big Creek. Noted were two benthic macroinvertebrate taxa (Baetis flavistriga and Hydropsyche betteni) which had been absent in the May 19 sample. These two taxa are commonly found 900 feet upstream in the East Branch of Big Creek. With improved water quality from the West Branch, the successful colonization of Location A by these species, which have a high propensity to drift (Shaw and Minshall, 1980), was possible.

Benthic macroinvertebrate samples were collected on three occasions at Location B in 1989 (Appendixes XIII-I, XIII-J, XIII-K). On May 19, two benthic macroinvertebrate taxa were collected, both of which are described in literature as tolerant in their responses to organic pollution (Appendix XIII-I). When compared to the May 19 diversity noted immediately upstream at Location A which has a similar habitat (Appendix XIII-G), these data reflect the impact that the May 1989 diversion had on the benthic community immediately downstream of the diversion outfall.

Following a period of about five months, a recovery of the benthic macroinvertebrate community at Location B was noted, on October 6 (Appendix XIII-J). Seven taxa were collected, including five taxa described in literature as facultative and two taxa described as tolerant in their responses to organic pollution. Noted was the presence of two benthic macroinvertebrate taxa (Baetis flavistriga and Hydropsyche betteni), which are commonly found approximately 1,200 feet upstream in the East Branch of Big Creek. As the water quality improved following cessation of the May 1989 diversion, successful colonization of Location B by these species, which have a high propensity to drift (Shaw and Minshall, 1980), was possible. A slight decrease in the number of taxa was noted at Location B on November 20 (Appendix XIII-K), when compared to October 6, but is attributable to seasonal variability.

Location C was sampled for benthic macroinvertebrates on two occasions in 1989 (Appendices XIII-L, XIII-M). On October 6, fourteen taxa were collected, including six taxa described as facultative and six taxa described as tolerant in their responses to organic pollution (Appendix XIII-L). No detrimental impact from the May 1989 diversion was evident at this location on this date.

The benthic macroinvertebrate sample collected at Location C on November 13, 1989 reflects the impact of the October-November 1989 diversion with a decrease in the number of taxa collected (Appendix XIII-M), when compared to the October 6 sample. Five taxa were collected on November 13, compared to fourteen taxa on October 6.

Location D was sampled for benthic macroinvertebrates on three occasions in 1989 (Appendices XIII-N, XIII-O, XIII-P) and once in 1990 (Appendix XIII-Q). On May 19, five taxa were collected, all of which are described in literature as tolerant in their responses to organic pollution (Appendix XIII-N). Also noted at Location D on this date were several fish and decapod carcasses along the margins and in pooled areas of the creek. These observations reflect the impact that the May 1989 diversion had on the water quality and the benthic community of Big Creek.

On October 6, five benthic macroinvertebrate taxa were collected at Location D, including two taxa described in literature as facultative and three taxa described as tolerant in their responses to organic pollution (Appendix XIII-O). This indicates that a recovery of the benthic community occurred at Location D between May 19 and October 6, 1989.

On November 13, the benthic community appeared to have been degraded at Location D by the October-November 1989 diversion, with two taxa collected, both of which are described in literature as tolerant in their responses to organic pollution (Appendix XIII-P).

Finally, on November 1, 1990, routine benthic macroinvertebrate sampling was conducted at Location D (Appendix XIII-Q). Six taxa were collected, including two taxa described in literature as facultative and four taxa described as tolerant in their responses to organic pollution. This increase in the number of taxa, when compared to the November 13, 1989 sample, along with the presence of facultative organisms, indicates that a recovery of the benthic macroinvertebrate community occurred between November 13, 1989 and November 1, 1990.

In conclusion, the May 1989 and October-November 1989 Big Creek Interceptor diversions had a significant downstream impact on the benthic macroinvertebrate communities in Big Creek. However, recovery of the benthic communities was noted within the year following each of these environmental disruptions.

Appendix XIII-A: Chemical and Bacteriological Data during the Big Creek Interceptor Diversion, May 15, 1989 at Big Creek and Cuyahoga River Locations. (All data in mg/L unless otherwise stated.)

	Big Creek		Cuyahoga River	
	Upstream of Diversion	Downstream of Diversion	Upstream of Big Creek Confluence	Downstream of Big Creek Confluence
Sample Locations	A	B	E	F
Temperature (°C)	10.7	11.9	11.9	11.6
Dissolved Oxygen	12.7	12.0	9.9	10.0
BOD	10	12	38	36
COD	24	58	41	23
Suspended Solids	5	24	40	50
Total Solids	640	660	450	520
Dissolved Solids	630	640	440	480
Sp. Con. (umhos/cm)	1,022	1,016	622	667
Turbidity (NTU)	--	--	--	--
Ammonia	0.09	1.96	0.10	0.39
Phosphorus	0.09	0.98	0.19	0.30
Soluble P	0.08	0.89	0.13	0.23
Nitrates	0.60	0.67	2.01	1.87
Nitrites	0.04	0.08	0.03	0.04
TKN	1.40	5.60	1.68	2.35
Chlorides	155	162	86	92
Sulfates	121	113	72	66
Alkalinity	134	147	108	110
Hardness	243	218	104	115
Nickel	0.40	0.29	1.2	0.22
Copper	0.01	0.54*	0.02	0.02
Chromium (Total)	0.03	0.05	0.04	0.03
Chromium (Hex.)	<0.01	<0.01	<0.01	<0.01
Zinc	0.02	0.36*	0.04	0.03
Iron	0.85	1.2*	2.8*	1.7*
Cadmium	<0.01	<0.01	<0.01	<0.01
Lead	0.02	0.11	0.03	0.03
Mercury (ug/L)	0.2*	0.2*	0.2*	0.3*
Total Coliform	7,100	810,000	1,200	61,000
Fecal Coliform	1,500	210,000*	520	16,000*
Fecal Streptococcus	600	65,000	200	5,900
pH (standard units)	8.30	8.40	7.55	7.75

*Exceedances of Ohio EPA water quality criteria for Warmwater Habitat and Primary Contact Recreational Use.

Appendix XIII-B: Chemical Data during the Big Creek Interceptor Diversion, May 16, 1989 at Big Creek and Cuyahoga River Locations. (All data in mg/L unless otherwise stated.)

	Big Creek		Cuyahoga River	
	Upstream of Diversion	Downstream of Diversion	Upstream of Big Creek Confluence	Downstream of Big Creek Confluence
Sample Locations	A	B	E	F
Temperature (°C)	10.8	12.2	12.4	12.7
Dissolved Oxygen	13.0	13.0	9.3	9.2
BOD	5	40	5	--
COD	15	172	25	23
Suspended Solids	10	120	70	40
Total Solids	600	800	540	580
Dissolved Solids	590	680	470	540
Sp. Con. (umhos/cm)	863	1,041	622	655
Turbidity (NTU)	3.5	165	160	165
Ammonia	0.20	7.03	0.17	0.43
Phosphorus	0.20	1.62	0.33	0.18
Soluble P	0.19	1.34	0.13	0.17
Nitrates	0.75	0.03	2.69	2.37
Nitrites	0.03	0.02	0.05	0.07
TKN	3.14	18.48	8.96	1.68
Chlorides	146	198	86	114
Sulfates	98	63	58	74
Alkalinity	120	164	102	112
Hardness	134	140	90	133
Nickel	0.06	0.25	0.44	0.16
Copper	<0.01	0.14*	0.01	0.03*
Chromium (Total)	0.03	0.02	<0.01	0.02
Chromium (Hex.)	<0.01	0.02	<0.01	<0.01
Zinc	0.04	0.34*	0.04	0.16*
Iron	0.4	1.8*	4.3*	3.2*
Cadmium	<0.01	0.02*	<0.01	<0.01
Lead	0.02	0.04	0.04	0.02
Mercury (ug/L)	<0.2	0.3*	0.2*	--
Total Coliform	--	--	--	--
Fecal Coliform	--	--	--	--
Fecal Streptococcus	--	--	--	--
pH (standard units)	8.55	8.05	7.56	7.55

*Exceedances of Ohio EPA water quality criteria for Warmwater Habitat.

Appendix XIII-C

Flow Data (5/16/89) from Big Creek
50 Feet Upstream of Big Creek Interceptor Diversion
(Location A)

ZONE	WIDTH (ft)	DEPTH (ft)	VELOCITY (ft/sec)	FLOW (CFS)	FLOW (MGD)
1	2.00	0.21	0.28	0.12	0.08
2	2.00	0.21	0.28	0.12	0.08
3	2.00	0.23	0.42	0.19	0.12
4	2.00	0.25	0.43	0.21	0.14
5	2.00	0.33	0.57	0.38	0.25
6	2.00	0.58	0.53	0.61	0.39
7	2.00	0.54	0.58	0.63	0.41
8	2.00	0.58	0.80	0.93	0.60
9	2.00	0.63	0.92	1.16	0.75
10	2.00	0.75	1.18	1.77	1.14
11	2.00	0.92	1.18	2.17	1.40
12	2.00	1.17	1.20	2.81	1.82
13	2.00	0.81	1.42	2.30	1.49
14	2.00	0.65	1.33	1.73	1.12
15	2.00	0.50	1.20	1.20	0.77
16	0.75	0.08	0.30	0.02	0.01
Total					10.57

Appendix XIII-D

Flow Data (5/16/89) from Big Creek
300 Feet Downstream of Big Creek Interceptor Diversion
(Location B)

ZONE	WIDTH (ft)	DEPTH (ft)	VELOCITY (ft/sec)	FLOW (CFS)	FLOW (MGD)
1	1.75	0.67	0.84	0.98	0.63
2	2.00	0.67	1.01	1.35	0.87
3	2.00	0.71	1.50	2.13	1.38
4	2.00	0.79	1.53	2.42	1.56
6	2.00	0.87	1.54	2.68	1.73
7	2.00	0.92	1.36	2.50	1.61
8	2.00	0.83	1.27	2.11	1.36
9	2.00	0.87	1.24	2.16	1.40
10	2.00	0.75	1.27	1.91	1.23
11	2.00	0.79	1.27	2.01	1.30
12	2.00	0.67	1.23	1.65	1.07
13	2.00	0.63	0.96	1.21	0.78
14	2.00	0.67	1.02	1.37	0.89
15	2.00	0.67	0.88	1.18	0.76
16	2.00	0.58	1.03	1.19	0.77
17	2.00	0.46	0.95	0.87	0.56
18	2.00	0.73	0.98	1.43	0.92
19	2.00	0.75	1.02	1.53	0.99
20	2.00	0.71	1.40	1.99	1.29
21	2.00	0.63	1.44	1.81	1.17
22	1.00	0.42	1.25	0.53	0.34
Total					24.13

Downstream	24.13 MGD
Upstream	-10.57 MGD
Diversion Flow	13.56 MGD

Appendix XIII-E: Elevated Loadings Attributable to Big Creek Interceptor Diversion on May 16, 1989

Loadings in Pounds per Day

Parameter	Location A (upstream)	Location B (downstream)	Attributable to Diversion
BOD	400	8,000	7,600
COD	1,300	34,600	33,300
Suspended Solids	880	24,100	23,200
Dissolved Solids	52,000	137,000	85,000
Ammonia	18	1,410	1,390
TKN	277	3,720	3,440
Phosphorus	18	326	308
Nickel	5	50	40
Copper	<0.9	28	28
Zinc	4	68	64
Iron	40	360	320
Cadmium	<0.9	4	4
Lead	2	8	6
Mercury	<0.02	0.06	0.05

Appendix XIII-F: Chemical Data Obtained following Big Creek Interceptor Diversion, May 19, 1989 at Big Creek Locations. (All data in mg/L unless otherwise stated.)

Sample Locations	Upstream of Diversion A	Downstream of Diversion B	Downstream at Jennings Road D
Temperature (°C)	17.5	19.0	18.5
Dissolved Oxygen	12.9	11.9	7.2
BOD	5	3	3
COD	13	12	17
Suspended Solids	80	10	28
Total Solids	770	790	890
Dissolved Solids	690	780	860
Sp. Con. (umhos/cm)	1,072	2,310	1,180
Turbidity (NTU)	--	--	--
Ammonia	0.09	10.30*	1.03
Phosphorus	0.08	1.08	0.43
Soluble P	0.06	0.23	0.35
Nitrates	0.30	0.20	0.47
Nitrites	0.05	0.20	0.06
TKN	1.40	16.91	2.24
Chlorides	220	369	251
Sulfates	135	710	140
Alkalinity	119	57	147
Hardness	197	340	199
Nickel	0.17	0.20	0.38
Copper	0.01	0.03	<0.01
Chromium (Total)	<0.01	0.10	<0.01
Chromium (Hex.)	<0.01	<0.01	<0.01
Zinc	0.02	0.06	0.04
Iron	1.7*	--	1.8*
Cadmium	<0.01	<0.01	<0.01
Lead	0.03	0.04	0.03
Mercury (ug/L)	0.3*	--	0.3*
Total Coliform	--	--	--
Fecal Coliform	--	--	--
Fecal Streptococcus	--	--	--
pH (standard units)	8.4	8.1	7.7

*Exceedances of Ohio EPA water quality criteria for Warmwater Habitat.

Appendix XIII-G

Location A

Big Creek Upstream of
5/89 Big Creek Interceptor Diversion
(5/19/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina (Mooreobdella) sp.	Tolerant	Mason, et al., 1971
Diptera		
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Thienemannimyia sp. group	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix XIII-H

Location A

Big Creek Upstream of
5/89 Big Creek Interceptor Diversion
(10/6/89)

Taxon	Tolerance	Source
Annelida		
Erpobdella sp.	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1986
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1986
Diptera		
Hemerodromia sp.	Facultative	Mason, et al., 1971
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Crictotopus/Orthocladius sp.	Tolerant	OEPA, 1987
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987

Appendix XIII-I

Location B

Big Creek Downstream of
5/89 Big Creek Interceptor Diversion
(After Diversion, 5/19/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Erpobdella sp.	Tolerant	Mason, et al., 1971

Appendix XIII-J

Location B

Big Creek Downstream of
5/89 Big Creek Interceptor Diversion
(10/6/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1986
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1986
Diptera		
Thienemannimyia sp. group	Facultative	Hilsenhoff, 1982
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix XIII-K

Location B

Big Creek Downstream of
5/89 Big Creek Interceptor Diversion
(11/20/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Dina (*Mooreobdella*) sp.	Tolerant	Mason, et al, 1971
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1986
Coleoptera		
Stenelmis crenata	Facultative	Brown, 1972
Diptera		
Thienemannimyia sp. group	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix XIII-L

Location C

Big Creek at Rose Field,
Downstream of 11/89 BCI Diversion
(10/6/89)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al, 1971
Annelida		
Helobdella stagnalis	Tolerant	Mason, et al., 1971
Placobdella papilliform	-	-
Erpobdella punctata	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Tricoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1982
Hydropsyche simulans	Facultative	Hilsenhoff, 1982
Coleoptera		
Bledius sp.	-	-
Diptera		
Simulium vittatum	Tolerant	Hilsenhoff, 1982
Cardiocladius sp.	Facultative	Hilsenhoff, 1982
Cricotopus trifascia	Facultative	Mason, et al., 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Mollusca		
Ferrissia sp.	Tolerant	OEPA, 1987
Physella sp.	Tolerant	OEPA, 1987

Appendix XIII-M

Location C

Big Creek at Rose Field,
Downstream of 11/89 BCI Diversion
(After Diversion, 11/13/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Odonata		
Enallagma sp.	Facultative	Hilsenhoff, 1982
Trichoptera		
Hydropsyche betteni	Facultative	Hilsenhoff, 1986
Diptera		
Larsia sp.	Facultative	Hilsenhoff, 1982
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

Appendix XIII-N

Location D

Big Creek at Jennings Road
(After 5/89 BCI Diversion, 5/19/89)

Taxon	Tolerance	Source
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Erpobdella sp.	Tolerant	OEPA, 1987
Diptera		
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus/*Orthocladius* sp.	Tolerant	OEPA, 1987
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987

Appendix XIII-O

Location D

Big Creek at Jennings Road (10/6/89)

Taxon	Tolerance	Source
Annelida		
Erpobdella punctata	Tolerant	Mason, et al., 1971
Ephemeroptera		
Baetis flavistriga	Facultative	Hilsenhoff, 1982
Diptera		
Cricotopus trifascia	Facultative	Mason, et al., 1971
Cricotopus sp.	Tolerant	OEPA, 1987
Mollusca		
Physella gyrina	Tolerant	OEPA, 1987

Appendix XIII-P

Location D

Big Creek at Jennings Road
(After 11/89 BCI Diversion, 11/13/89)

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

Appendix XIII-Q

Location D

Big Creek at Jennings Road (11/1/90)

Taxon	Tolerance	Source
Platyhelminthes		
Dugesia tigrina	Facultative	Mason, et al., 1971
Annelida		
Oligochaeta	Tolerant	OEPA, 1987
Diptera		
Natarsia sp.	Tolerant	Hilsenhoff, 1987
Cricotopus sp.	Tolerant	OEPA, 1987
Cricotopus trifascia	Facultative	Mason, et al., 1971
Mollusca		
Physella sp.	Tolerant	OEPA, 1987

APPENDIX XIV

COMPARISON OF CUYAHOGA RIVER REMEDIAL ACTION PLAN 1990 FECAL COLIFORM DATA WITH HISTORICAL CITY OF CLEVELAND DATA

NOTE: The 1990 data, which were collected by the NEORSD in support of the Remedial Action Plan, were accompanied by measurements of dissolved oxygen, water temperature, specific conductance, and turbidity. This additional information is available upon request at the NEORSD Water Quality & Industrial Surveillance offices. The complete 1990 Lower Cuyahoga River Fecal Coliform Study, which was accomplished in cooperation with the Ohio Environmental Protection Agency, the Northeast Ohio Areawide Coordinating Agency, and the Ohio Department of Health, is to be presented in the Cuyahoga River Remedial Action Plan Stage One Report.

APPENDIX XIV-A

CUYAHOGA RIVER REMEDIAL ACTION PLAN FECAL COLIFORM STUDY
DATA FROM JUNE 1990
(Samples collected and analyzed by NEORSD)

Fecal Coliform, Organisms per 100 ml

Sample Site	River Mile	6/7**	6/13	6/14	6/20**	6/21	6/27	6/28	GEOMETRIC MEANS QA/QC-Validated Data	GEOMETRIC MEANS Total Data
Old Rockside Rd.	13.2	120*	280	110	200	820	400*	140	270	230
E. 71 St. & Canal Rd.	11.4	260	-	230	-	580	-	120*	250	250
Chlorine-Access Bridge	11.3	260	-	1,200	-	1,400*	-	100	550	460
Southwest Interceptor	9.7	460	420	330*	240*	800	570	40	300	310
River Smelting	7.9	380	-	170	-	640	-	90	210	250
Lower Harvard	7.1	320	340*	260	6,700	980	380	160	350	530
Newburgh & S.S. Railroad	5.6	600	-	370	-	7,400	-	290	920	830
Blank (QA/QC)	-	20	<5	<5	440	<10	<2	<2	-	-
Duplicate (QA/QC)	-	100	240	400	560	1,700	530	50	-	-

*Duplicate location
**Discard for QA/QC-validated data mean.

APPENDIX XIV-B

CUYAHOGA RIVER REMEDIAL ACTION PLAN FECAL COLIFORM STUDY
DATA FROM JULY 1990
(Samples collected and analyzed by NEORSD)

Fecal Coliform, Organisms per 100 ml

Sample Site	River Mile	7/5	7/12	7/19	7/25	7/26	Geometric Mean
Old Rockside Rd.	13.2	75	21,000*	80	150	130	300
E. 71 St. & Canal Rd.	11.4	60	20,000	160*	-	64	330
Chlorine-Access Bridge	11.3	100	18,000	220	-	120	540
Southwest Interceptor	9.7	60	11,000	170	-	80	310
River Smelting	7.9	90	14,000	250	110	140	340
Lower Harvard	7.1	90	19,000	240	180*	84	360
Newburgh & S.S. Railroad	5.6	55*	18,000	740	-	78*	490
Blank (QA/QC)	-	<2	<5	<4	<2	<2	-
Duplicate (QA/QC)	-	55	24,000	100	290	26	-

*Duplicate location

APPENDIX XIV-C

CUYAHOGA RIVER REMEDIAL ACTION PLAN FECAL COLIFORM STUDY
DATA FROM AUGUST 1990
(Samples collected and analyzed by NEORSD)

Fecal Coliform, Organisms per 100 ml

Sample Site	River Mile	8/2	8/7	8/8	8/9	8/16	8/22	8/23	Geometric Mean
Old Rockside Rd.	13.2	30*	2,300*	1,300	310	740*	16,000*	1,300*	890
E. 71 St. & Canal Rd.	11.4	45	1,800	1,200	190*	740	-	880	480
Chlorine-Access Bridge	11.3	35	6,300	2,100	230	920	-	1,800	750
Southwest Interceptor	9.7	10	2,000	1,500	200	1,020	8,800	4,400	810
River Smelting	7.9	75	620	650	64	860	-	2,200	390
Lower Harvard	7.1	35	2,300	1,600*	270	960	7,600	2,800	950
Newburgh & S.S. Railroad	5.6	45	4,100	1,200	142	3,000	-	3,600	840
Blank (QA/QC)	-	<5	<2	<2	<2	<1	<2	<2	-
Duplicate (QA/QC)	-	45	2,400	1,200	180	520	13,000	1,000	-

*Duplicate location

APPENDIX XIV-D

HISTORICAL CITY OF CLEVELAND CUYAHOGA RIVER
FECAL COLIFORM DATA
Organisms per 100 ml

ABOVE SOUTHERLY (RM 11.3)

Year	Month	FC Geometric Mean	Number of Days Sampled
1972	February	57,000	3
"	March	4,800	22
"	April	4,600	18
"	May	2,100	22
"	June	5,100	21
"	July	3,200	20
"	August	5,000	23
"	September	5,100	16
"	October	4,300	19
"	November	4,400	19
"	December	4,400	15

BELOW SOUTHERLY (RM 7.9)

Year	Month	FC Geometric Mean	Number of Days Sampled
1972	February	72,000	3
"	March	8,700	21
"	April	1,500	18
"	May	1,300	22
"	June	5,000	20
"	July	4,800	20
"	August	4,400	23
"	September	25,000	16
"	October	4,300	19
"	November	3,200	19
"	December	840	15

APPENDIX XIV-E

HISTORICAL CITY OF CLEVELAND CUYAHOGA RIVER
FECAL COLIFORM DATA
Organisms per 100 ml

LOWER HARVARD BRIDGE (RM 7.1)

Year	Month	FC Geometric Mean	Number of Days Sampled
1970	June	1,800,000	2
1972	March	8,400	4
"	April	2,000	2
"	May	5,300	5
"	June	8,000	5
"	July	5,900	4
"	August	4,600	5
"	September	20,000	3
"	October	570	4
"	November	5,900	5
"	December	24,000	3
1973	January	93	5
"	February	420	4
"	March	740	4
"	April	5,800	4
"	May	4,800	5
"	June	9,000	4
"	July	1,200	2
"	August	5,800	5
"	September	7,900	4
"	October	950	5
"	November	5,200	4
"	December	2,800	4

APPENDIX XIV-F

HISTORICAL CITY OF CLEVELAND CUYAHOGA RIVER
FECAL COLIFORM DATA
Organisms per 100 ml

CENTER STREET (RM 1.0)

Year	Month	FC Geometric Mean	Number of Days Sampled
1972	February	150	1
"	March	7,600	4
"	April	3,500	2
"	May	9,100	5
"	June	6,400	4
"	July	3,900	4
"	August	7,800	5
"	September	5,300	3
"	October	6,500	4
"	November	6,200	4
"	December	7,800	3

WEST 3RD STREET (RM 3.3)

Year	Month	FC Geometric Mean	Number of Days Sampled
1970	June	430,000	2

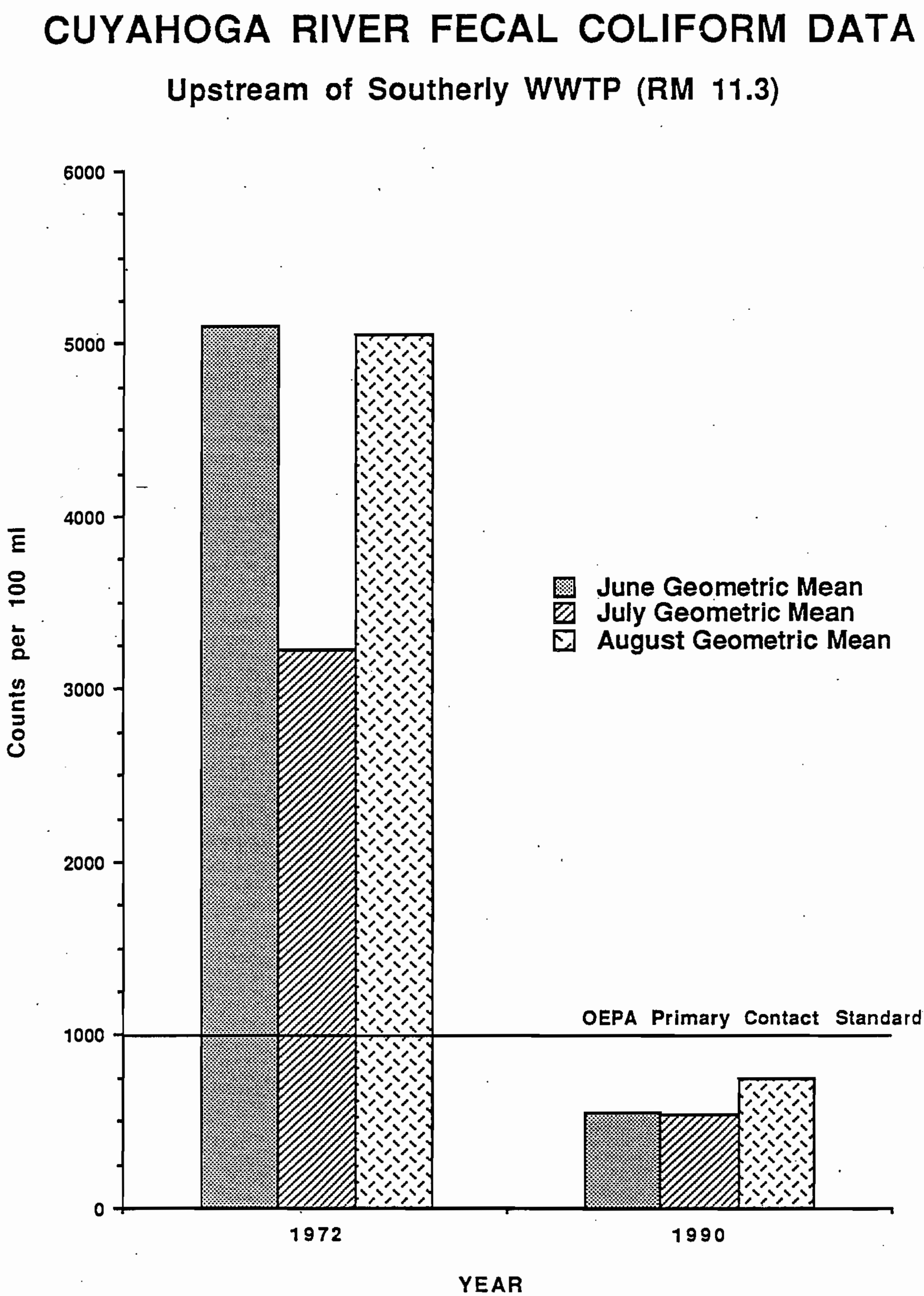
ROCKSIDE ROAD (RM 13.2)

Year	Month	FC Geometric Mean	Number of Days Sampled
1970	June	41,000	2

STATION ROAD (RM 20.8)

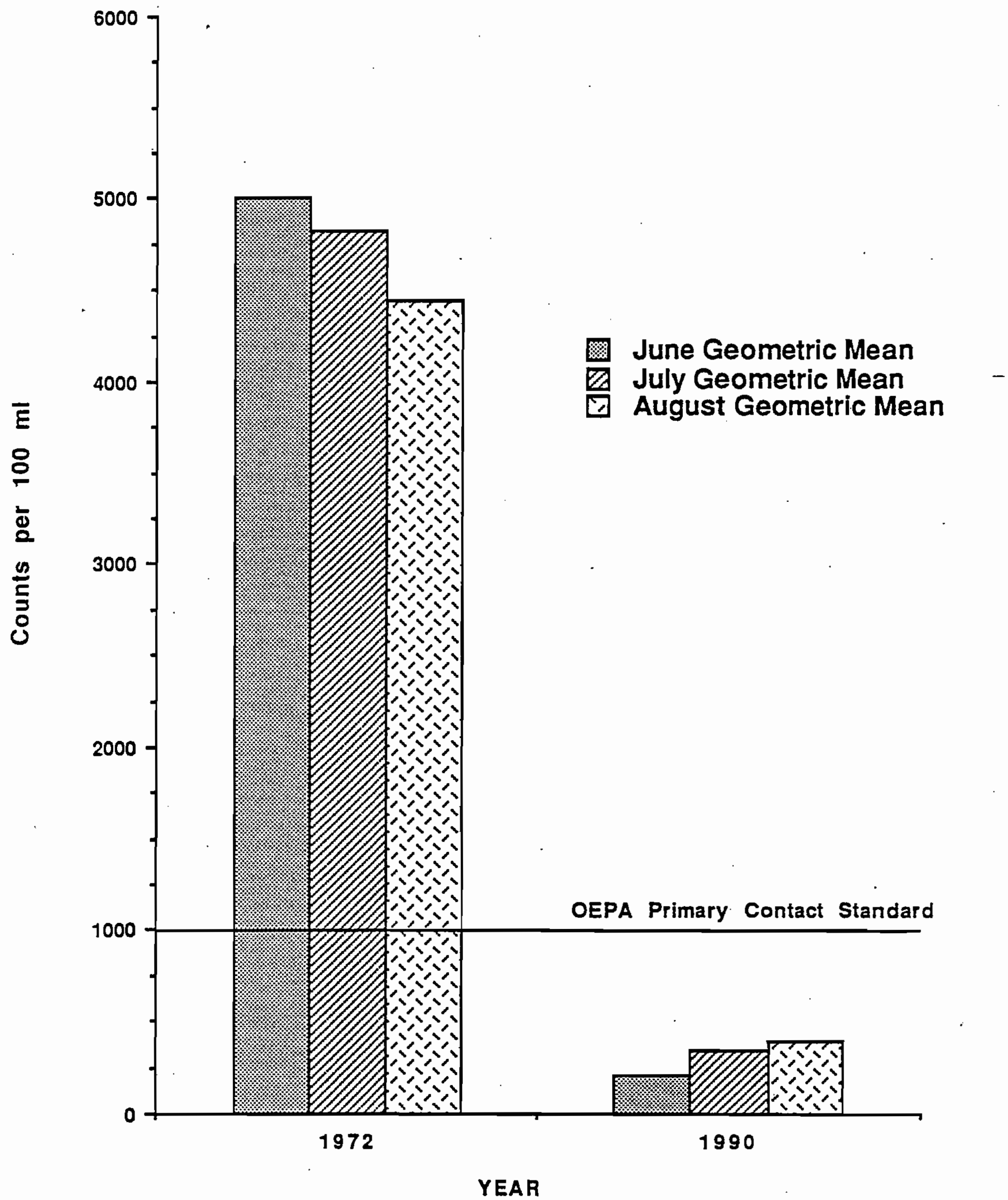
Year	Month	FC Geometric Mean	Number of Days Sampled
1970	June	220,000	2

APPENDIX XIV-G



CUYAHOGA RIVER FECAL COLIFORM DATA

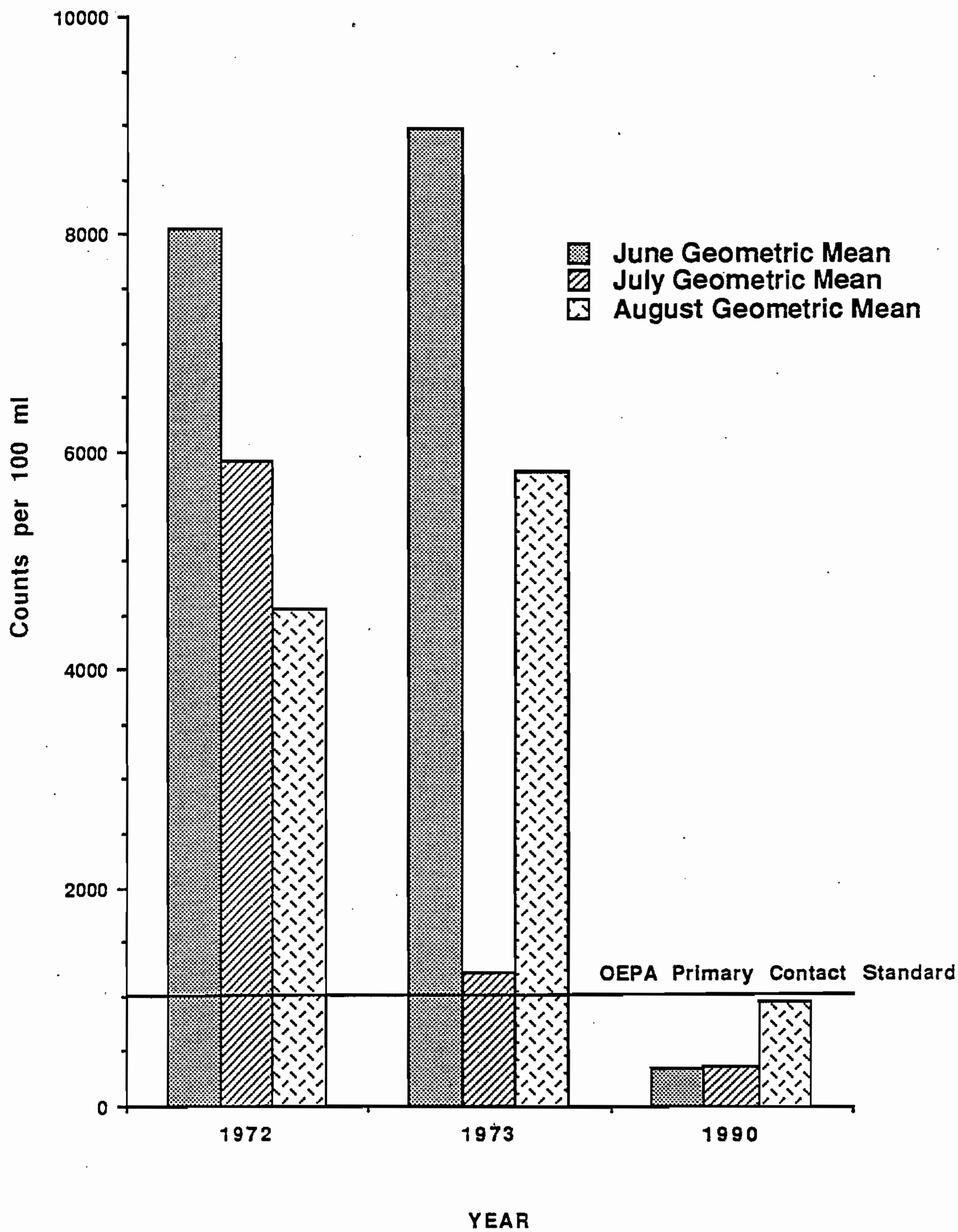
Downstream of Southerly WWTP (RM 7.9)



APPENDIX XIV-I

CUYAHOGA RIVER FECAL COLIFORM DATA

Lower Harvard Bridge (RM 7.1)



APPENDIX XV

HISTORICAL NEORSD MONITORING OF CUYAHOGA RIVER
FECAL COLIFORM AND AMMONIA
ABOVE AND BELOW SOUTHERLY WWTP

APPENDIX XV-A

MONTHLY CUYAHOGA RIVER FECAL COLIFORM CONCENTRATIONS
UPSTREAM OF SOUTHERLY WWTP (RM 11.3)
REPORTED BY NEORSD 1977-1990
(Organisms per 100 ml)

YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	AVERAGE
1977	4,900	7,600	18,000	24,000	44,000	13,000	18,000
1978	16,000	12,500	23,300	29,900	16,200	50,500	25,000
1979	11,900	22,000	5,700	15,200	10,300	24,500	15,000
1980	14,100	23,500	13,100	92,600	16,000	19,700	30,000
1981	8,825	12,200	<8,796	5,100	15,900	18,300	11,000
1982	1,600	11,600	3,600	25,500	5,660	10,800	9,800
1983	4,750	3,950	1,100	850	3,600	4,560	3,100
1984	2,250	218	420	1,240	1,380	3,120	1,400
1985	767	2,051	3,641	5,391	4,509	4,012	3,400
1986	2,133	7,622	1,060	944	668	2,055	2,400
1987	2,330	3,387	1,431	3,853	2,536	2,539	2,700
1988	857	126	3,631	3,415	3,301	2,031	2,200
1989	1,565	5,736	384	1,512	495	284	1,700
1990	436	665	266	1,681	2,170	1,792	1,200

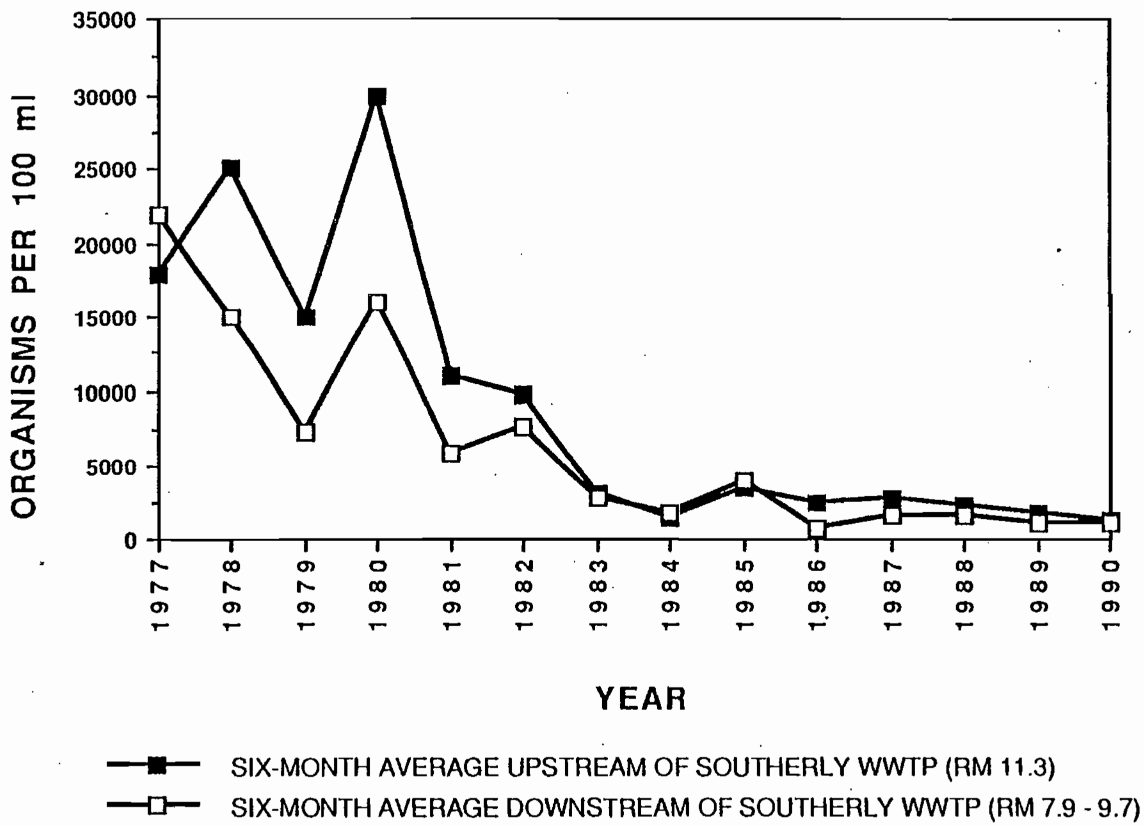
APPENDIX XV-B

MONTHLY CUYAHOGA RIVER FECAL COLIFORM CONCENTRATIONS
DOWNSTREAM OF SOUTHERLY WWTP (RM 7.9 - 9.7)
REPORTED BY NEORSD 1977-1990
(Organisms per 100 ml)

YEAR	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	AVERAGE
1977	26,000	74,000	15,000	6,700	8,500	130	22,000
1978	8,500	3,800	2,200	9,700	9,600	56,100	15,000
1979	4,400	10,200	2,800	990	5,000	21,200	7,400
1980	4,400	22,200	9,100	47,600	15,400	1,400	16,000
1981	733	6,510	8,504	6,100	10,200	3,450	5,900
1982	1,930	13,200	6,970	4,080	18,000	2,220	7,700
1983	4,950	1,340	610	2,300	4,100	3,870	2,800
1984	5,180	307	610	680	1,320	2,480	1,800
1985	1,467	6,122	4,222	5,469	3,952	2,706	4,000
1986	897	722	724	482	396	1,209	740
1987	708	2,088	1,186	1,713	1,626	1,803	1,500
1988	920	276	2,691	651	3,038	1,290	1,500
1989	946	1,608	373	2,569	317	208	1,000
1990	393	604	327	2,150	1,586	843	980

CUYAHOGA RIVER

MAY-TO-OCTOBER FECAL COLIFORM CONCENTRATIONS



APPENDIX XV-D

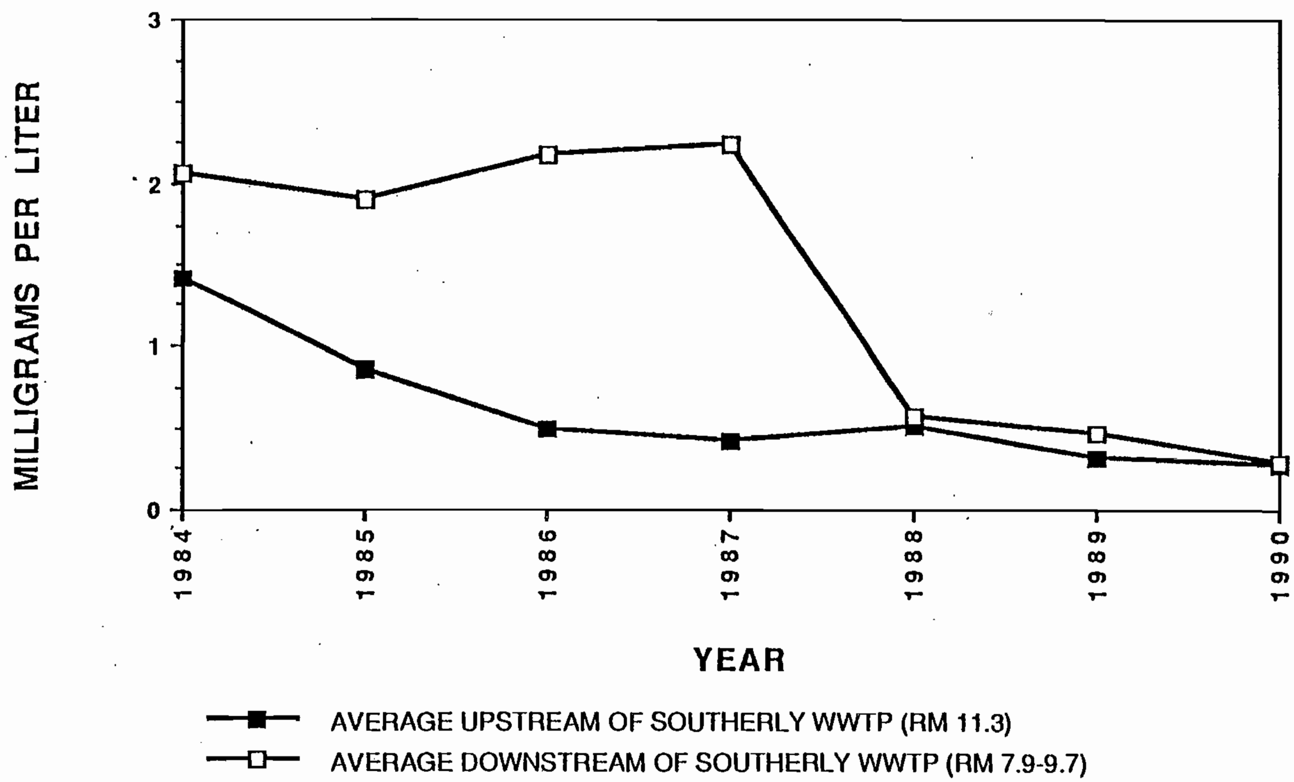
ANNUAL AVERAGE CUYAHOGA RIVER AMMONIA CONCENTRATIONS
UPSTREAM AND DOWNSTREAM OF SOUTHERLY WWTP
REPORTED BY NEORSD 1984-1990 (mg/L)

YEAR	UPSTREAM	DOWNSTREAM
1984	1.42	2.06
1985	0.86	1.90
1986	0.50	2.16
1987	0.42	2.23
1988	0.52	0.58
1989	0.32	0.47
1990	0.26	0.29

APPENDIX XV-E

CUYAHOGA RIVER

ANNUAL AVERAGE AMMONIA CONCENTRATIONS



APPENDIX XVI

EDGEWATER BEACH FECAL COLIFORM LEVELS
COMPARISON OF HISTORICAL DATA

APPENDIX XVI-A

SUMMARY OF CITY OF CLEVELAND/ODH EDGEWATER BEACH
FECAL COLIFORM DATA PRESENTED IN FOLLOWING TABLES
("No enclosure"/"outside curtain" data only.)
(Counts/100 ml)

Year	Number of Samples	Arithmetic Mean	Geometric Mean
1968	48	3,700	700
1969	102	4,300	640
1983	30	960	250
1984	24	500	70
1988	24	340	160
1989	32	51	25

APPENDIX XVI-B

EDGEWATER BEACH
CITY OF CLEVELAND FECAL COLIFORM DATA
(Counts/100 ml)

6/20/68 to 9/4/68 (Beach not enclosed; no chlorination.)

Number of Samples	Arithmetic Mean	Geometric Mean
48	3,700	700

5/19/69 to 7/2/69 (Beach not enclosed; no chlorination.)

Number of Samples	Arithmetic Mean	Geometric Mean
31	9,200	1,500

7/9/69 to 8/5/69 (Beach enclosed; manual chlorination.)

	Number of Samples	Arithmetic Mean	Geometric Mean
Inside Curtain	35	3,100	1,600
Outside Curtain	35	2,600	600

8/6/69 to 8/29/69 (Beach enclosed; automatic chlorination.)

	Number of Samples	Arithmetic Mean	Geometric Mean
Inside Curtain	36	1,500	140
Outside Curtain	36	1,800	320

APPENDIX XVI-C

EDGEWATER BEACH
OHIO DEPARTMENT OF HEALTH FECAL COLIFORM DATA
(Counts/100 ml)

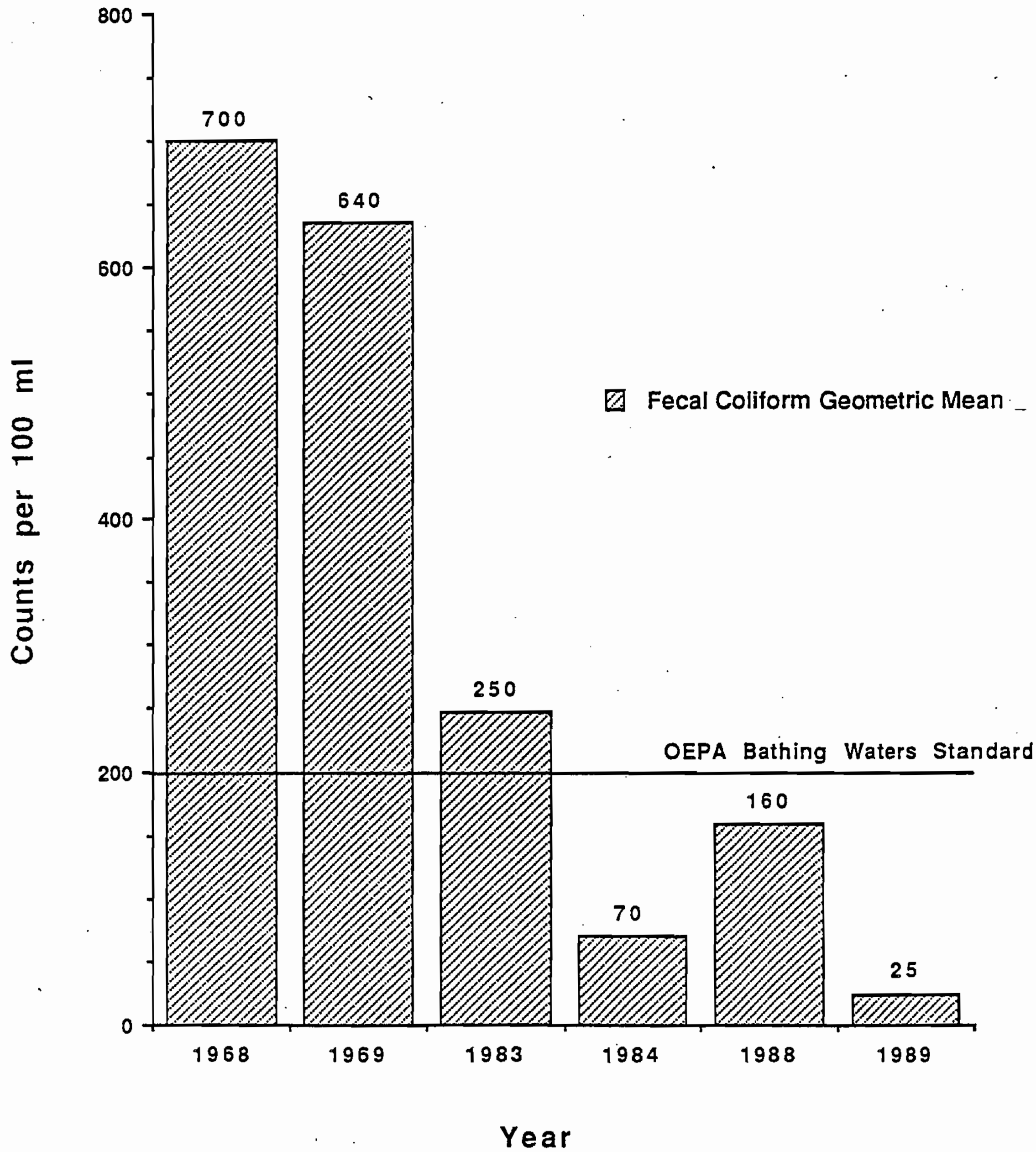
DATE	"EDGEWATER EAST"	"EDGEWATER WEST"	"EDGEWATER CSO"
5/23/83	2,800	4,700	-
5/31/83	2,600	56	580
6/06/83	8,000	520	580
6/13/83	120	15	110
6/21/83	90	30	45
7/06/83	510	750	630
7/11/83	120	100	160
7/19/83	80	200	-
8/11/83	690	1,100	3,700
8/19/83	92	36	-
8/25/83	320	-	-
8/30/83	-	10	45
5/15/84	400	280	-
5/22/84	100	240	-
6/07/84	110	10	-
6/12/84	38	19	-
6/19/84	480	350	-
6/28/84	80	<3.8	-
7/05/84	1,000	8,400	-
7/26/84	15	5	-
7/31/84	85	<3.8	-
8/07/84	170	45	-
8/16/84	110	15	-
9/06/84	35	25	-

APPENDIX XVI-D

EDGEWATER BEACH
OHIO DEPARTMENT OF HEALTH FECAL COLIFORM DATA
(Counts/100 ml)

DATE	"EDGEWATER EAST"	"EDGEWATER WEST"	"EDGEWATER OUTFALL"
5/26/88	150	20	--
6/02/88	69	48	52
6/06/88	69	44	--
6/16/88	210	380	--
6/23/88	250	250	--
6/30/88	140	160	--
7/05/88	7.7	19	--
7/14/88	130	200	--
7/21/88	960	1,000/880	--
7/28/88	660	1,700	--
8/01/88	520	240	--
5/15/89	15	<3.8	--
5/22/89	3.8	<3.8	--
5/30/89	260	35	--
6/05/89	290	220	--
6/12/89	46	42	--
6/19/89	31	15	--
6/26/89	7.7	7.7	--
7/05/89	55	<3.8	--
7/10/89	52	16	--
7/17/89	8.9	6.3	--
7/24/89	29	36	--
7/31/89	13	8.3	--
8/07/89	97	100	--
8/14/89	42	14	--
8/21/89	70	42	--
8/28/89	54	16	--

EDGEWATER BEACH FECAL COLIFORM DATA
From City of Cleveland / ODH Sampling



APPENDIX XVII

1989 NEORSD SAMPLING OF WHITE CITY BEACH

APPENDIX XVII

1989 Sampling of White City Beach
Robert Kleinhenz, Investigator
Northeast Ohio Regional Sewer District
December 22, 1989

Because of concerns over water quality at White City Beach, which is located on NEORSD property adjacent to the Easterly Wastewater Treatment Plant, the NEORSD Industrial Waste Section obtained water samples at locations around the beach for chemical and bacteriological testing. The results of the water quality sampling performed should provide a basis on which to consider future possible use of the area, or more specifically, to assess the potential human health hazard that may be associated with any activities at the beach involving frequent body contact with the water.

Industrial Waste Section personnel obtained a grab sample at each of the beach area locations shown in Appendix XVII-A on seven separate occasions from July to October, 1989. Measurements of temperature, dissolved oxygen, pH and specific conductance were obtained and a bacteriological quality analysis was performed on all the samples collected. On four of the seven sets of samples, additional parameters were analyzed for including BOD, COD, solids, ammonia, dissolved salts, nutrients and metals. The sampling was performed under both dry and wet weather conditions.

Appendices XVII-B (dry weather) and XVII-C (wet weather) present the averages of the data for the water quality parameters measured on the samples collected at each location. Dry weather samples were obtained five days or longer after the last recorded rain event for the area. Rain event data can be obtained from the District's precipitation gauge located at the Easterly Wastewater Treatment Plant. Wet weather sampling events occurred within three days of the last recorded precipitation at the gauge.

Physical Observations

The highly variable nature of the wind direction and wind strength over the lake's nearshore waters results in variable wave action in the same. Because White City Beach is partly protected by rock piers which act as a barrier to strong water movement inland, under most wind conditions, the wave heights established inside the breakwall are diminished along the beach shore. This barrier is especially effective in front of the east sampling location where the water is quiescent most of the time. Conversely, the beach area west of White City Beach is unprotected by piers and the shoreline waves there are of similar height and strength to those established inside the breakwall.

White City Beach is not being used for recreational purposes, and therefore it is not routinely maintained. Floatable wood and manmade debris carried by the lake and its nearby tributaries to the west, including the Cuyahoga River, has been deposited and is accumulating on the sandy beach. This material is generated during rain events from storm sewer discharges, combined sewer overflows and land surface runoff. Approximately 30 percent of the shoreline debris includes, but is not limited to, an array of small plastic items and some old tires. The remainder of the floatable material is driftwood.

Under wet weather conditions, debris usually accumulates near the east sampling location, though not nearly to the extent as along the shoreline. Also, at the north sampling location near NEORSD CSO No. 001 there is typically a thin patchy scum layer on the water surface and a negligible amount of floatables as evidence of a current or very recent CSO discharge during wet weather. Under dry weather conditions the water in front of the beach and immediately out in the lake visibly appears "clean" and lacks any evidence of nuisance algal growths.

Sampling Results

The sample analyses will be discussed in light of the fact that the current designation of the lake's nearshore waters in the Cleveland area, including White City Beach, is Warmwater Habitat for aquatic life and Primary Contact Recreational Use. The area is so designated because it lies within an "excepted" area of the lake as described in Ohio EPA Water Quality Standards. However, under proposed rule changes in the standards, the nearshore excepted areas will no longer apply and the entire lake will be designated Exceptional Warmwater Habitat for aquatic life and will include the Recreational Use Designation of Bathing Waters.

The results of the dry weather sampling (Appendix XVII-B) indicate no major differences between sample locations for the parameters analyzed. Though only one set of samples collected during dry weather had been analyzed for metals, lead at each location was at a concentration above the current Warmwater Habitat 30-day average water quality criterion. The measured lead concentration is also above the 30-day average criterion expressed in the proposed Warmwater Habitat and Exceptional Warmwater Habitat standards. All other measured parameters, including the bacteria concentrations, are below current and proposed criteria.

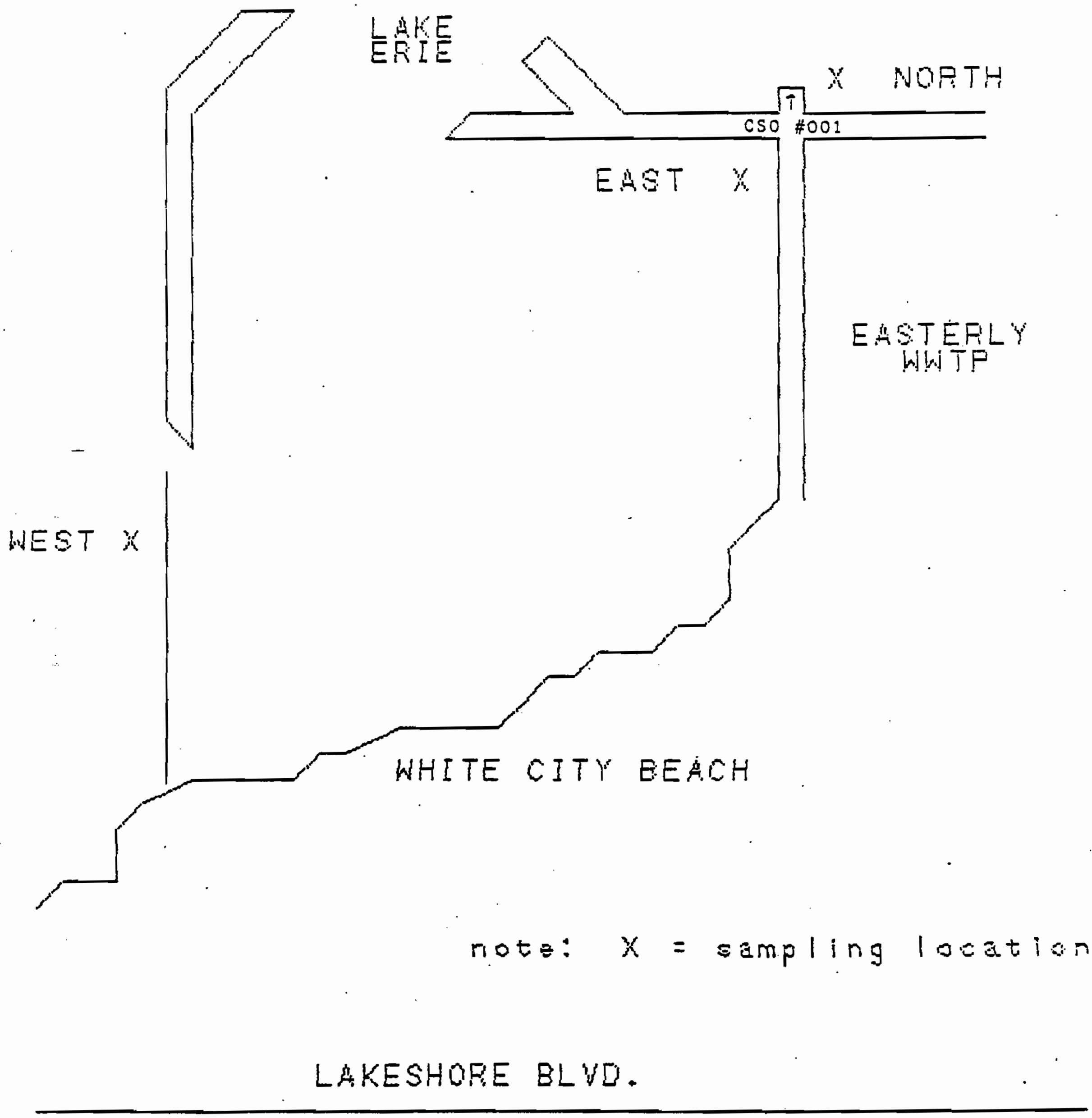
The results of the wet weather sampling (Appendix XVII-C) indicate that lead is not in exceedence of the current Warmwater Habitat 30-day average water quality criterion, though it is in minor exceedence of the proposed Warmwater Habitat and Exceptional Warmwater Habitat criteria at all three locations. Mercury is in exceedence of the proposed 30-day average human health criterion [for exposure through fish consumption] at all three locations. Excluding the bacteria concentrations, there are no major differences between sample locations for the parameters analyzed during wet weather.

The lead concentrations measured in the samples collected under both dry and wet weather conditions are higher than expected for Lake Erie's nearshore waters. The wet weather mercury concentrations appear elevated as well. Further testing of ambient water quality in the vicinity of White City Beach and elsewhere inside the breakwall will show whether or not these parameter concentrations are the norm. [See data from NEORSD 1990 sampling at Lake Erie Site K, Appendix IV-K.]

Appendix XVII-D depicts the fecal coliform concentrations measured in the samples collected at each location during each of four sampling events under wet weather conditions. The samples were obtained at the indicated time frame after four separate rain events, each of which were of different duration and resulted in different rain accumulations. An overflow had occurred through NEORSD CSO No. 001 from the Easterly Wastewater Treatment Plant during each rain event.

As expected, the graph shows a decline in fecal coliform concentrations with time after a rain event. Based on the bacteria die-off rate depicted, dry weather fecal coliform concentrations within the range indicated in Appendix XVII-B should be achievable at least three days after a rain event and would fall within the water quality standards established for Bathing Water Recreational Use (200 and 400 counts/100 ml). From a human health standpoint, the waters would be safe for all-purpose recreational needs after this time frame. Furthermore, the graph shows that the criteria for Primary Contact Recreational Use (1,000 and 2,000 counts/100 ml) would probably be routinely met two days after a rain event.

APPENDIX XVII-A



Appendix XVII-B: White City Beach

Sample Dates: 7/13, 7/26, 8/9/89 (dry weather)

Location	North	East	West
Temperature (°C)	23.7	23.6	23.1
Dissolved Oxygen	8.4	8.0	8.3
BOD	1	2	2
COD	8	9	11
Suspended Solids	7	7	4
Total Solids	192	<100	221
Dissolved Solids	185	-	217
Sp. Con. (umhos/cm)	278	278	313
Ammonia	0.30	0.19	0.30
Phosphorus	0.06	0.04	0.14
Ortho P	0.05	0.02	0.04
Nitrates	0.49	0.51	0.61
Nitrites	0.02	0.02	0.03
TKN	1.01	0.73	0.67
Chlorides	33	35	33
Sulfates	32	33	29
Alkalinity	97	96	99
Hardness	129	129	127
Nickel	0.01	0.01	0.01
Copper	<0.01	0.01	<0.01
Chromium (Total)	<0.01	<0.01	<0.01
Zinc	0.03	0.02	<0.01
Iron	0.3	0.2	0.6
Cadmium	<0.01	<0.01	<0.01
Lead	0.06	0.06	0.06
Mercury (ug/L)	<0.2	<0.2	<0.2
Total Coliform	710	520	1,200
Fecal Coliform	110	45	130
Fecal Streptococcus	46	58	37

Note: BOD, COD, solids, ammonia, dissolved salts, nutrients and metals measured on 1 of 3 sample sets.

Data expressed in mg/L unless otherwise noted. Bacteriological data presented are geometric means in counts/100 ml.

pH range at all locations: 8.25-8.50

Appendix XVII-C: White City Beach

Sample Dates: 8/30, 9/1, 9/25, 10/17/89 (wet weather)

Location	North	East	West
Temperature (°C)	19.4	19.2	19.8
Dissolved Oxygen	8.9	8.8	8.5
BOD	5	4	4
COD	9	10	10
Suspended Solids	28	21	26
Total Solids	179	177	172
Dissolved Solids	149	156	148
Sp. Con. (umhos/cm)	315	316	306
Ammonia	0.17	0.34	0.31
Phosphorus	0.09	0.08	0.10
Ortho P	0.04	0.05	0.06
Nitrates	0.66	0.62	0.59
Nitrites	0.07	0.05	0.05
TKN	0.75	1.12	1.49
Chlorides	27	30	35
Sulfates	30	31	35
Alkalinity	90	92	93
Hardness	118	97	114
Nickel	0.01	0.01	<0.01
Copper	0.03	0.02	0.01
Chromium (Total)	0.02	<0.01	<0.01
Zinc	0.04	0.03	0.03
Iron	0.8	0.4	0.7
Cadmium	<0.01	<0.01	<0.01
Lead	0.03	0.03	0.01
Mercury (ug/L)	0.2	0.4	0.2
Total Coliform	7,200	8,400	13,000
Fecal Coliform	1,600	2,600	750
Fecal Streptococcus	360	1,100	140

Note: BOD, COD, solids, ammonia, dissolved salts, nutrients and metals measured on 3 of 4 sample sets.

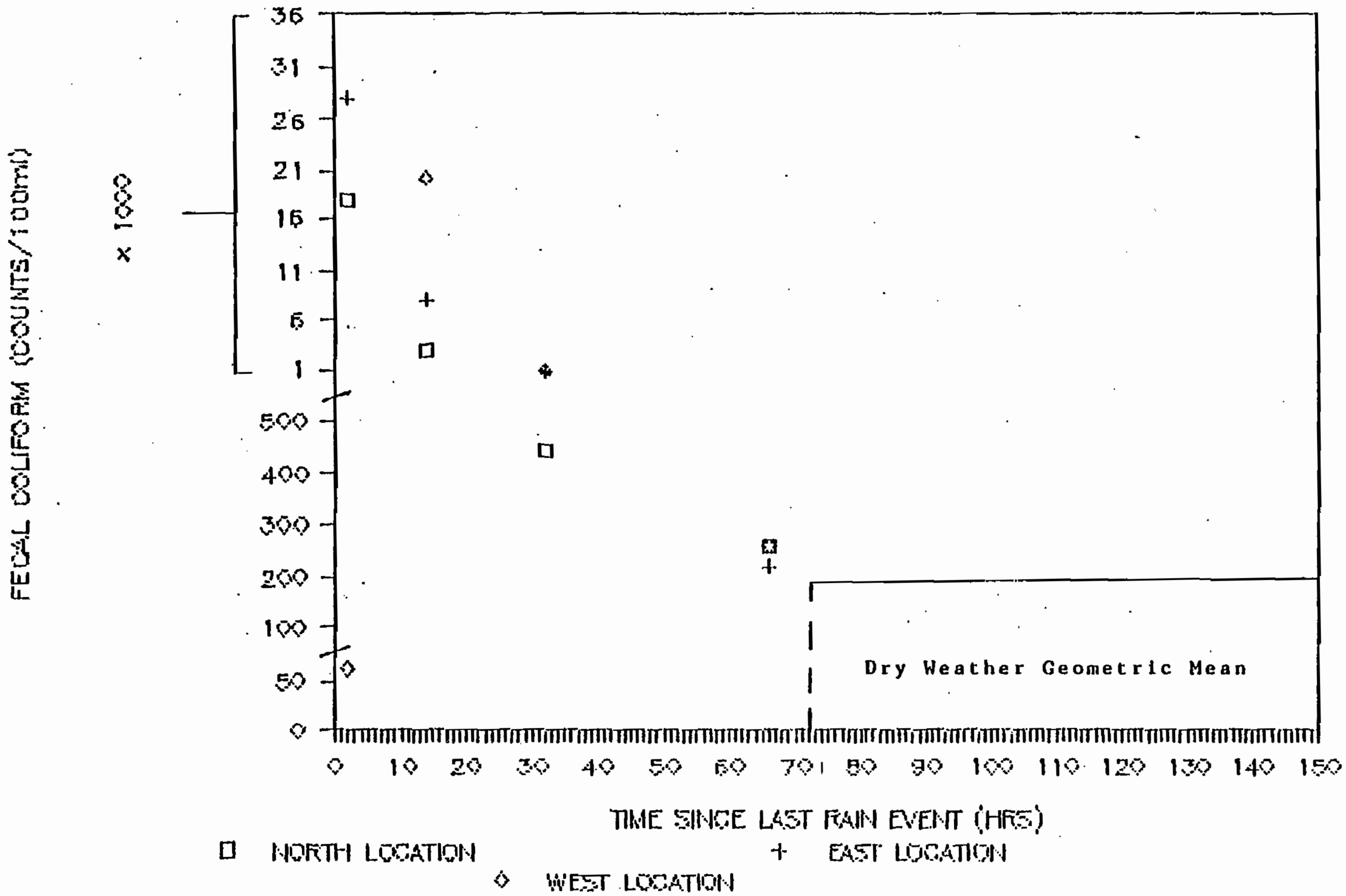
Data expressed in mg/L unless otherwise noted. Bacteriological data presented are geometric means in counts/100 ml.

pH range at all locations: 7.75-8.25

Appendix XVII-D

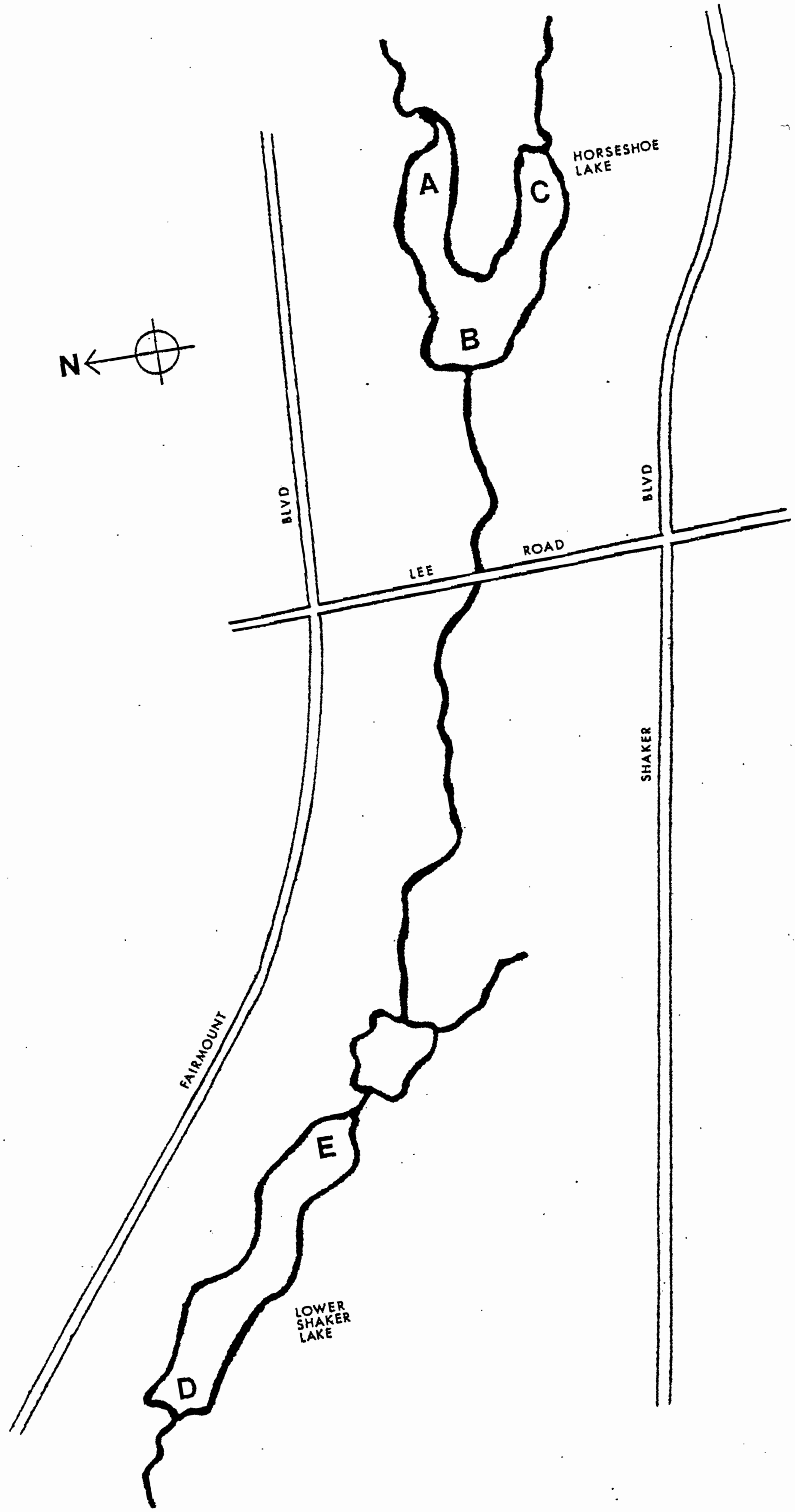
WHITE CITY BEACH

FECAL COLIFORM



APPENDIX XVIII

1990 NEORSD SAMPLING
AT SHAKER LAKES



Appendix XVIII-A:
Shaker Lakes
Sampling Stations
(Not to scale)

Appendix XVIII-B: Chemical and Bacteriological Analyses of Water at Surface

	Lower Shaker Lake (at outlet)		Horseshoe Lake (at outlet)	
Sample Date	8/29/90	8/30/90	8/29/90	8/30/90
BOD	6	---	6	---
Suspended Solids	8	---	10	---
Spec. Con. (umhos/cm)	472	---	433	---
Turbidity (NTU)	4	---	4	---
Ammonia	0.10	---	0.28	---
Phosphorus	0.11	---	0.14	---
Nitrates	0.03	---	0.12	---
Nitrites	<0.01	---	<0.01	---
TKN	1.12	---	0.56	---
Chlorides	45	---	42	---
Sulfates	38	---	34	---
Alkalinity	133	---	127	---
Hardness	112	---	112	---
Nickel	<0.01	---	<0.01	---
Copper	0.01	---	<0.01	---
Chromium (Total)	0.01	---	<0.01	---
Chromium (Hex.)	<0.01	---	<0.01	---
Zinc	0.02	---	<0.01	---
Iron	0.1	---	0.2	---
Cadmium	<0.01	---	<0.01	---
Lead	<0.01	---	<0.01	---
Mercury (ug/L)	<0.2	---	<0.2	---
Total Coliform	20	140	20	100
Fecal Coliform	10	<10	<10	30
Fecal Streptococcus	10	30	<10	10
pH (standard units)	7.6	---	8.6	---

(Chemical data are in mg/L unless otherwise specified.
Bacteriological data are in organisms/100 ml.)

Appendix XVIII-C: Horseshoe Lake Dissolved Oxygen Profiles (8/29/90)

Station A - North Arm

Depth (ft.)	Temperature (°C)	Dissolved Oxygen (ppm)
1	23.8	5.6
2	23.8	5.6
3	23.7	5.9
4	23.6	6.0
5	23.1	6.3

Station B - Mid-Lake

Depth (ft.)	Temperature (°C)	Dissolved Oxygen (ppm)
1	23.9	6.4
2	23.9	6.4
3	23.8	6.5
4	23.8	6.6
5	23.7	6.7

Station C - South Arm

Depth (ft.)	Temperature (°C)	Dissolved Oxygen (ppm)
1	23.6	6.5
2	23.4	6.5
3	23.2	6.6

Appendix XVIII-D: Lower Shaker Lake Dissolved Oxygen Profiles (8/29/90)

Station D - Northwest End

Depth (ft.)	Temperature (°C)	Dissolved Oxygen (ppm)
1	24.2	7.8
2	24.0	7.7
3	23.9	7.6
4	23.9	7.6
5	23.8	7.5

Station E - Southeast End

Depth (ft.)	Temperature (°C)	Dissolved Oxygen (ppm)
1	24.3	6.6
2	24.1	6.8
3	24.1	6.9

Appendix XVIII-E: Concentrations of Metals in Shaker Lakes' Sediments

	Lower Shaker Lake (Station D)	Horseshoe Lake (Station A/B/C Composite)
Sample Date	8/29/90	8/30/90
Nickel	10	40
Copper	30	10
Chromium (Total	30	40
Zinc	130	410
Iron	22,000	32,000
Cadmium	10	10
Lead	50	160
Mercury	0.2	—
% Volatile Solids	10.46	12.22
% Total Solids	4.27	25.34

(Metals sediment concentrations are in mg/kg.)

APPENDIX XIX

DISCUSSION OF CUYAHOGA RIVER REMEDIAL ACTION PLAN
1989 FISH TISSUE ANALYSES

APPENDIX XIX

Cuyahoga River Remedial Action Plan
1989 Fish Tissue Analysis

In 1989, the Cuyahoga River Remedial Action Plan (RAP) Technical Committee identified evaluating the potential risk posed to human health through consumption of fish caught in the Cuyahoga River Area of Concern (AOC) as a high priority. Since only limited scientific data on chemical contaminants in Cuyahoga River fish had been collected, the RAP Fish Tissue Group was formed, consisting of representatives from the Ohio EPA, the Ohio Department of Health, the Ohio Department of Natural Resources, the U.S. Fish & Wildlife Service, the National Park Service, the Cuyahoga County Board of Health, the Northeast Ohio Regional Sewer District, and the City of Akron.

In the fall of 1989, using personnel and equipment provided by the Ohio EPA, the Northeast Ohio Regional Sewer District, and the National Park Service, the RAP Fish Tissue Group collected 20 single-species composite samples of 103 fish. 14 of the samples were from five AOC sites on the Cuyahoga River between the Ohio Edison dam pool in Akron and Harvard Avenue in Cleveland, and 6 of the samples were from two non-industrial "reference" sites located on the upper Cuyahoga River near Shalersville and on the Chagrin River at Daniels Park. The fish included bottom-dwellers (i.e., common carp, white sucker, golden redhorse, brown bullhead, yellow bullhead), which are most often found to have high levels of some contaminants when the sediment is contaminated. Also sampled were "sport" fish (i.e., largemouth bass, smallmouth bass, bluegill, pumpkinseed, rock bass, black crappie), which represent the most likely human consumption and, because of their higher trophic status, have a higher potential for contaminant biomagnification through the food chain. The samples were prepared as skin-on fillets of the largest size classes by weight to reflect the worst-case likely method of preparation for human consumption.

With $39,430 in funds from the Ohio EPA and the Northeast Ohio Regional Sewer District, the samples were analyzed for 130 priority pollutants, including volatile organic compounds, base/neutral/acid-extractable compounds, pesticides, polychlorinated biphenyls (PCBs), and heavy metals. Other chemicals were tentatively identified in the samples through a scan using the National Bureau of Standards spectral library of organic compounds.

The analytical results were evaluated by the Ohio Department of Health's Bureau of Epidemiology and Toxicology. Concentrations of contaminants detected in the fish tissue did not exceed U.S. Food & Drug Administration (USFDA) Action Levels. The Ohio Department of Health uses this and other information to decide whether to issue a fish consumption advisory. No advice was issued on the basis of these data.

The highest concentrations of detected contaminants having USFDA Action Levels are presented in Appendix XIX-A. These concentrations are only the highest levels detected in any of the fish tissue samples. In all other samples collected during 1989, the levels were either lower or not detectable. For each contaminant, the median level (e.g., 0.17 parts per million total PCBs in the AOC samples) was much lower than the highest concentration. Differences between the data from the AOC sites and the data from the reference sites may be due in part to the higher fat content of the AOC samples. Higher fat content can lead to greater bioaccumulation of some organic compounds.

To further evaluate the data, the RAP Fish Tissue Group also used quantitative risk assessment. Because of this methodology's conservative assumptions regarding toxicological uncertainties, it is not endorsed by the Ohio Department of Health. However, the RAP Fish Tissue Group believed that risk assessment could have some value in ranking pollutants according to relative concern. In its application of the methodology, the Group assumed two levels of 70-year lifetime exposure: a moderate consumption rate of 20 grams per day (approximately 5 quarter-pound meals per month) and a subsistence-level consumption rate of 140 grams per day (approximately 38 quarter-pound meals per month).

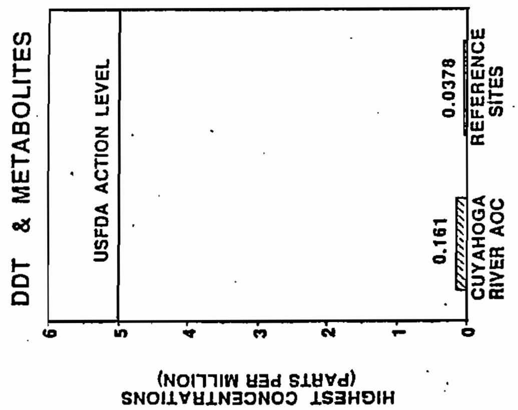
The risk assessment indicated that the contaminants of highest relative concern in Cuyahoga River fish tissue, due to their carcinogenic potential, would be PCBs and the pesticides heptachlor epoxide, dieldrin, and DDE (a metabolite of DDT). The manufacture and usage of these substances are banned, but their presence, which is probably residue from historical environmental contamination, is attributable to their high persistence and bioaccumulative properties. The levels detected are consistent with levels detected in similar bodies of water around the State. Human exposure may be minimized through proper meal preparation; anglers are advised to remove the skin and as much fat as possible when cleaning all fish and to bake, broil, or grill the fish on an open rack, allowing liquid to drain away.

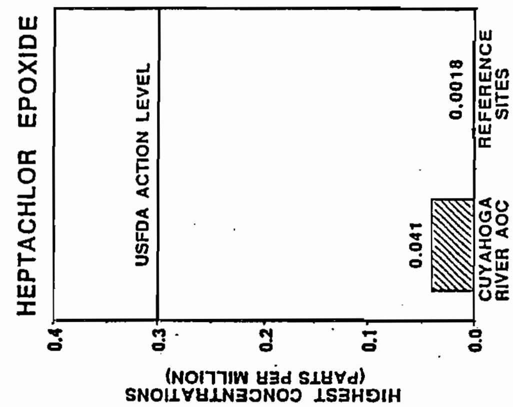
The RAP Fish Tissue Study was continued in 1990, when the sampling area was expanded to include six additional sites on nearshore Lake Erie between Rocky River and Eastlake. In the summer of 1990, 32 single-species composite samples of 133 fish, including walleye, were collected. Utilizing $87,560 in funds from the Ohio EPA, the City of Akron, the Northeast Ohio Regional Sewer District, the National Park Service, and the Cuyahoga River Community Planning Organization, the 1990 samples are presently under analysis. The analytical results are expected to be complete by 1992.

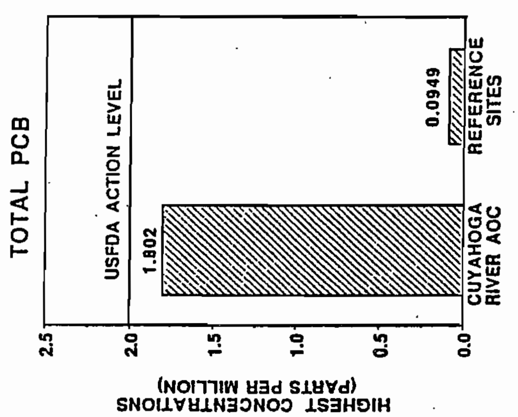
The RAP fish tissue analysis is to be presented in detail in the Cuyahoga River Remedial Action Plan Stage One Report.

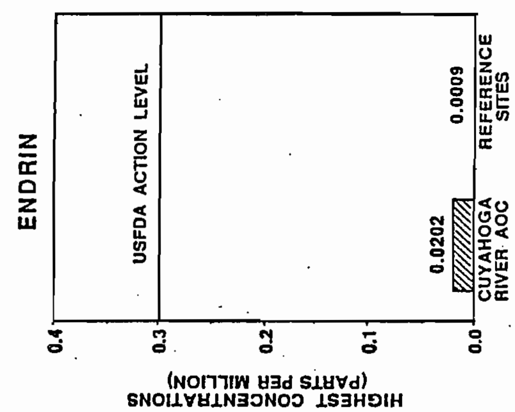
Appendix XIX-A

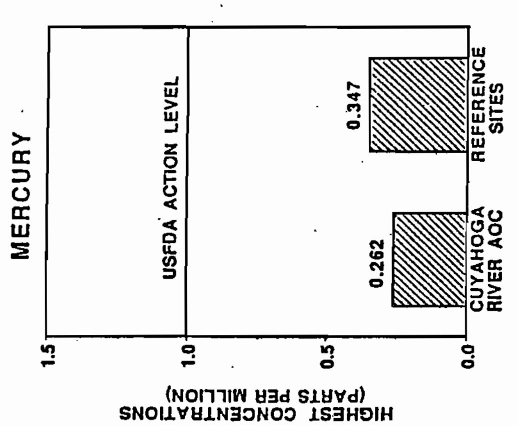
Contaminants Detected in 1989 Remedial Action Plan
Fish Tissue Sampling:
Highest Observed Levels of Contaminants
which have USFDA Action Levels

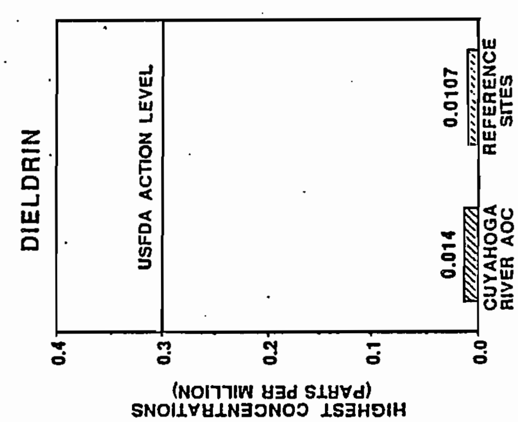












APPENDIX XX

1990 NEORSD STUDY OF
THE EFFECTS OF COMBINED AND SEPARATE STORM SEWERS
IN THE MILL CREEK AREA

THE EFFECTS OF COMBINED AND SEPARATE STORM SEWERS IN THE MILL CREEK AREA

Northeast Ohio Regional Sewer District

by
Tina Giammarco, Co-op Student
Betsy Yingling, Planning Engineer

October, 1991

INTRODUCTION

A study of the Mill Creek area was performed in 1990 by the District's Water Quality and Surveillance section, to compare the contamination of the creek by the flow from the separate storm sewers and overflow from the combined sewers. Presented here is an analysis of the data gathered from the study.

The Mill Creek area is serviced by the Mill Creek Interceptor and Southerly Wastewater Treatment Plant with overflows into Mill Creek. The Mill Creek Interceptor area accounts for more than 30% of the Southerly District. The Mill Creek Interceptor area encompasses approximately 17,000 acres, 4,500 of which use the combined sewer system. Seven communities lie either wholly or partially within the study area: Cleveland, Garfield Heights, Maple Heights, Warrensville Heights, Warrensville Township, Beachwood and North Randall.

The land is primarily zoned for single and multiple family dwellings. A small portion, located mostly along the main streets, is zoned for business and office space or industry. There is no agricultural application and open space is limited to small parks, cemeteries, golf courses and a race track.

The weather in Northeast Ohio follows highly localized patterns. The sites sampled, however, lie in a close enough proximity to each other to assume that they experience the same atmospheric conditions.

The data was collected over a three month period from July to October. The CSOs were monitored as part of the normal monitoring required by Ohio EPA, with samplers and flow monitors usually in place for about 2 months. The storm sewers were monitored in addition to this, all with equipment in place for the entire three months. The data collected from 8 CSOs and 5 separate storms sewers on 8 rain days was used for the water quality comparison. These days were chosen because they had a good amount of data from the separate and combined sewer sites.

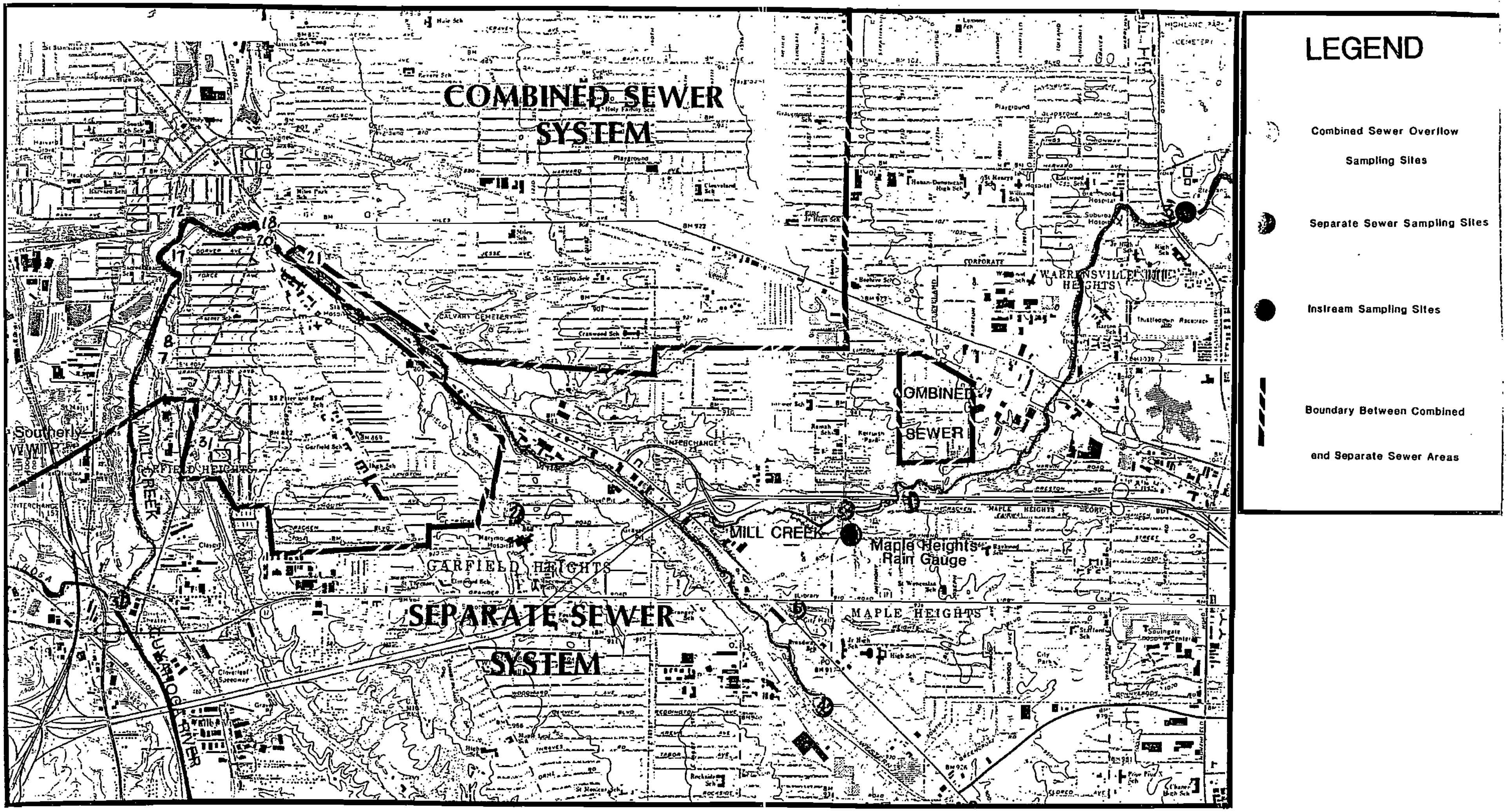
The flow was monitored with ADS flow monitors in the separate storm sewers and Marsh-McBirney flow monitors in the combined sewers and one of the storm sewers. ISCO automatic samplers were used to collect the pollutant samples during flow situations in the separate sewers and overflow situations in the combined sewers. During a rain event, samples were drawn every five minutes with a maximum number of 28 samples possible. The individual sample bottles were composited into two samples: the first half-hour of the storm (6 bottles) and all remaining bottles for the storm duration. These samples were analyzed in the NEORSD laboratories. Below is a listing of the sewers sampled, their locations and the rain events during which they were sampled.

Mill Creek itself was periodically grab sampled, and samples analyzed by the NEORSD laboratories. These samples were taken in both wet and dry weather at three points along the creek. The site locations and sampling dates are also listed below.

Table 1 Sampling Locations and Dates

ID	Location	Sampling Dates used for Analysis
Combined Sewers		
CSO007	7611 Bancroft	7/30,8/6,8/19
CSO008	Rosewood Avenue	7/30,9/6
CSO017	Dorver Avenue	7/30,8/6,8/13,8/19,9/6
CSO018	Miles Park at Broadway	9/6,10/4,10/9,10/12
CSO020	Warner exit ramp from Broadway	9/6,10/4,10/9,10/12
CSO021	Broadway at East 94th St.	10/4,10/12
CSO031	West Vista and Birchwood	7/30,8/6,8/19
CSO072	West of East77th & Finney	10/4,10/9
Separate Storm Sewers		
STM001	I-480	7/30,8/6,8/13,8/19 9/6,10/4,10/9,10/12
STM002	Henry at Southern	7/30,8/13,8/19,9/6 10/4,10/12
STM003	Northfield and Selfridge	7/30,8/6,8/13,8/19 9/6,10/4,10/9,10/12
STM004	Home and Garden	7/30,8/13,8/19 9/6,10/4
STM005	Maple Heights Blvd	8/13,9/6,10/4 10/9,10/12
Instream Sampling		
NEORSD35	Northfield Rd. (upstream)	6/19,7/27,8/7,8/13,9/6 9/7,9/19,9/20,10/4,12/7
NEORSD34	Rex & Glenburn Aves. (midstream)	6/9,9/6,12/7
NEORSD31	Canal Rd. (downstream)	7/27,8/7,8/13,9/6 9/7,9/20,12/7

MILL CREEK STUDY AREA



DATA

SOURCE POLLUTANTS

The pollutants deposited by the CSOs and the separate sewers largely determine the instream water quality. The degree to which the water quality of Mill Creek was affected by the pollutant loading by the CSOs and the storm sewers was determined by examining five parameters. Phosphorus, ammonia, suspended solids and BOD are contaminants which were used as indicators of the water quality. Zinc, the only metal parameter, was selected because a large number of samples were above detection limits, and varied by site and rain event. The figures presented are based upon the samples gathered by ISCO automatic samplers and analyzed by the NEORSD laboratory. As explained earlier, the samples were analyzed in two groups. The first, which was a composite of 6 samples, was drawn during the first 30 minutes of the storm. The second, which contained anywhere from 1 to 22 samples, was drawn during the duration of the storm. The following concentration tables indicate whether the results are from the first or second group by using the words "first" or "rest", respectively.

Table 2a <u>BOD</u> **(values in mg/l)**

INDIVIDUAL LOCATIONS

	FIRST HALF HOUR			REST OF STORM		
	MEAN	RANGE	#STORMS	MEAN	RANGE	#STORMS
CSO007	28.3	12-45	3	18	-	1
CSO008	57.0	34-80	2	9	-	1
CSO017	45.0	11-96	5	14.3	7-28	3
CSO018	98.5	46-200	4	42.3	28-56	4
CSO020	63.0	14-100	4	43.0	12-85	4
CSO021	61.0	46-76	2	37.0	-	1
CSO031	87.3	24-210	3	28.5	12-45	2
CSO072	89.0	73-105	2	12.0	-	1
STM001	25.3	12-47	6	13.0	2-22	6
STM002	29.3	9-75	6	21.7	7-40	6
STM003	26.6	5-80	8	13.3	6-22	6
STM004	35.4	10-64	5	20.8	9-42	5
STM005	55.8	16-76	5	28.4	16-46	5

ALL DATA	MEAN	RANGE	PERCENTILE VALUE						
			5	10	25	50	75	90	95
cso-first	62.28	11-210	11	13	28	50	75	90	207
cso-rest	30.41	7-85	7	8	12	28	45	65	85
stm-first	33.23	5-80	7	9	12	24	56	75	78
stm-rest	19.07	2-46	4	7	9	17	23	40	44

Table 2b Suspended Solids (values in mg/l)

INDIVIDUAL LOCATION

	FIRST HALF HOUR			REST OF STORM		
	MEAN	RANGE	#STORMS	MEAN	RANGE	#STORMS
CSO007	291	110-574	3	-	-	0
CSO008	450	212-688	2	50	-	1
CSO017	306	118-534	5	146	67-230	3
CSO018	299	94-528	4	93.5	62-150	4
CSO020	209	98-452	4	276.8	70-756	4
CSO021	134	134	2	98	-	1
CSO031	257.7	98-552	3	79	28-130	2
CSO072	293	210-376	2	54	-	1
STM001	561.4	200-926	7	191.4	98-474	7
STM002	349.3	68-928	6	192.4	52-642	6
STM003	158.1	25-420	8	91.8	60-153	6
STM004	782.8	66-1470	5	332.2	39-566	5
STM005	271.2	72-680	5	107.2	36-176	5

ALL DATA	MEAN	RANGE	PERCENTILE VALUE 5	10	25	50	75	90	95
cso-first	278.5	94-688	95	98	120	190	450	560	653
cso-rest	142.4	28-756	28	43	63	95	148	388	756
stm-first	405.2	25-1470	50	66	126	228	610	928	1452
stm-rest	180.7	36-642	38	52	77	113	215	516	604

Table 2c **Total Phosphorus** (values in mg/l)

INDIVIDUAL LOCATIONS

	FIRST HALF HOUR			REST OF STORM		
	MEAN	RANGE	#STORMS	MEAN	RANGE	#STORMS
CSO007	1.51	-	1	-	-	0
CSO008	1.43	.64-2.21	2	.26	-	1
CSO017	1.40	.75-2.27	3	.47	.33-.58	3
CSO018	2.27	1.04-3.07	3	.71	.48-1.13	4
CSO020	0.99	.33-2.08	4	.76	.18-1.16	4
CSO021	NO DATA		0	1.04	-	1
CSO031	4.5	-	1	.75	.46-1.04	2
CSO072	11.3	-	1	1.16	-	1
STM001	.52	.31-.87	7	.34	.16-.65	7
STM002	1.20	0.2-3.1	6	.38	.17-.98	6
STM003	.35	.19-.58	8	.33	.18-.79	6
STM004	2.51	2.04-2.78	3	.88	.64-1.22	3
STM005	1.03	.38-2.08	5	.64	.36-.93	5

ALL DATA	MEAN	RANGE	PERCENTILE VALUE 5	10	25	50	75	90	95
cso-first	2.3	0.3-11.3	.3	.5	.7	1.5	2.7	7.2	11.3
cso-rest	0.7	0.2-1.2	.2	.25	.5	.6	1.0	1.2	1.2
stm-first	0.9	0.2-3.1	.2	.22	.34	.58	1.29	2.7	2.94
stm-rest	0.5	0.16-1.2	.16	.18	.22	.33	.7	.9	1.1

Table 2d <u>Ammonia</u> (values in mg/l)

INDIVIDUAL LOCATIONS

	FIRST HALF HOUR			REST OF STORM		
	MEAN	RANGE	#STORMS	MEAN	RANGE	#STORMS
CSO007	1.39	1.0-1.8	2	-	-	0
CSO008	1.2	0.3-2.1	2	0.58	-	1
CSO017	0.7	0.01-1.4	4	0.38	0.07-0.76	3
CSO018	1.1	0.64-1.5	4	0.79	0.43-1.43	4
CSO020	0.8	0.04-1.5	4	0.55	0.02-1.4	4
CSO021	NO DATA		0	1.90	-	1
CSO031	1.98	1.6-2.4	2	0.10	0.01-0.18	2
CSO072	1.58	-	1	0.96	-	1
STM001	0.58	0.13-1.06	7	0.31	0.01-1.25	7
STM002	0.61	0.15-0.84	6	1.94	0.10-10	6
STM003	0.46	0.04-1.67	8	0.33	0.01-0.76	6
STM004	0.77	0.04-1.7	3	0.32	0.01-0.54	3
STM005	0.66	0.05-1.43	5	0.70	0.16-1.4	5

ALL DATA	MEAN	RANGE	PERCENTILE VALUE 5	10	25	50	75	90	95
cso-first	1.11	0.01-2.41	.01	.04	.6	1.2	1.6	2.1	2.4
cso-rest	0.63	0.01-1.9	.01	.02	.2	0.5	0.9	1.6	1.9
stm-first	0.59	0.04-1.7	.04	.05	.2	0.6	0.8	1.4	1.7
stm-rest	0.75	0.01-10.0	.01	.01	.08	0.3	0.5	1.3	6.6

Table 2e <u>Zinc</u> (values in mg/l)

INDIVIDUAL LOCATIONS

	FIRST HALF HOUR			REST OF STORM		
	MEAN	RANGE	#STORMS	MEAN	RANGE	#STORMS
CSO007	.420	-	1	-	-	0
CSO008	.440	.18-.70	2	.060	-	1
CSO017	.282	.12-.39	4	.106	.08-.13	3
CSO018	.348	.12-.60	4	.110	.09-.16	4
CSO020	.200	.10-.40	4	.230	.07-.49	4
CSO021	.150	-	1	.100	-	1
CSO031	.465	.43-.50	2	.130	.07-.19	2
CSO072	.785	.47-1.10	2	.800	-	1
STM001	.269	.055-.48	7	.188	.08-.52	7
STM002	.246	.06-.60	6	.100	.04-.16	6
STM003	.176	.02-.39	8	.070	.05-.10	6
STM004	.448	.16-.70	5	.360	.24-.50	5
STM005	.258	.06-.60	5	.110	.08-.14	5

ALL DATA	MEAN	RANGE	PERCENTILE VALUE 5	10	25	50	75	90	95
cso-first	0.354	.10-1.1	.1	.12	.16	.37	.46	.69	1.08
cso-rest	0.181	.06-.80	.06	.07	.08	.10	.18	.58	.80
stm-first	0.268	.02-.70	.03	.06	.14	.24	.36	.60	.64
stm-rest	0.161	.04-.52	.04	.06	.08	.10	.18	.39	.51

INSTREAM POLLUTANTS

Instream sampling occurred at three points along Mill Creek. One point was upstream, near the source of the creek, one was downstream, close to the Cuyahoga River, and the last was in the middle, approximately where the systems change from separate sewers to combined sewers. Grab samples were taken on both rain and dry days and were analyzed by the NEORSD laboratories. The raw data is reported in the table below, followed by a comparison of wet and dry weather data.

Table 3a Instream Sampling Data (all values in mg/l)

Date	Location	Zinc	BOD	NH3	SS	Phos
06/19/90	Upstream	0.02	1.0	0.01	19	0.04
	Midstream	0.02	18.0	6.62	2	0.86
	Downstream			NO DATA		
07/27/90	Upstream	0.02	2.0	0.65	1	0.06
	Midstream			NO DATA		
	Downstream	0.08	13.0	4.08	22	0.06
08/07/90	Upstream	0.02	3.0	0.16	20	0.12
	Midstream			NO DATA		
	Downstream	0.09	6.0	0.46	216	0.46
08/13/90	Upstream	0.03	7.0	0.01	97	0.23
	Midstream			NO DATA		
	Downstream	0.16	8.0	0.01	472	0.72
09/06/90	Upstream	0.02	2.0	0.03	3	0.02
	Midstream	0.01	3.0	0.19	5	0.19
	Downstream	1.20	60.0	1.42	2760	0.12
09/07/90	Upstream	0.02	6.0	0.10	24	0.16
	Midstream			NO DATA		
	Downstream	0.06	4.0	0.89	237	0.47
09/19/90	Upstream	0.01	1.0	0.10	2	0.06
	Midstream			NO DATA		
	Downstream			NO DATA		
09/20/90	Upstream	0.02	1.0	0.01	10	0.04
	Midstream			NO DATA		
	Downstream	0.10	2.0	2.91	23	0.04
10/04/90	Upstream	0.05	16.0	0.01	184	0.32
	Midstream			NO DATA		
	Downstream			NO DATA		
12/07/90	Upstream	0.01	2.0	0.04	53	0.10
	Midstream	0.02	5.0	0.55	53	0.20
	Downstream	0.12	13.0	3.52	18	0.07

Table 3b Comparison of Means of Wet and Dry Data

Location	Zinc	BOD	NH3	SS	Phos	# Samples
Dry Weather Samples						
Upstream	0.017	1.67	0.23	24.3	0.067	3
Midstream	0.02	3.0	3.59	27.5	0.53	2
Downstream	0.10	13.0	3.80	20.0	0.065	2
Wet Weather Samples						
Upstream	0.024	5.14	0.06	48.6	0.136	7
Midstream	0.01	3.0	0.19	5.0	0.19	1
Downstream	0.322	16.0	1.14	741.6	0.362	5

LOADINGS

For a comparison of the loading impact the two systems had on Mill Creek, three storms were analyzed. The rain events of September 6, October 4, and October 10 were selected because they had a significant number of samples in the "rest" of the storm.

The sampling sites reported were those which were being monitored on those dates, following Ohio EPA requirements. The flow data was reported in 15 minute increments by the flow monitoring devices. The flow was determined by identifying the storm, dividing it into first half-hour and duration flows, and averaging the values for each portion of the storm. The time was determined by multiplying the number of sample bottles used times five minutes. The volumes were then calculated by multiplying the flow by the time. Concentrations were obtained from sampling data and multiplied by the volumes to obtain a load in kilograms. Loads were calculated for the first half hour of the storm, the duration, and then added together to obtain a total load for the storm event. Loading calculations missing from the separate storm sewers indicate that the flow was not available, due to equipment malfunctions. There was not enough instream data for these storms to be able to compare to the source pollutants and loadings. The data is shown in tables 4a through 4c below.

Table 4a September 6, 1990

	FIRST HALF HOUR VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	REST OF STORM VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	TOT LOAD (kg)
BOD							
CSO008	0.03	34	3.9	0.02	9	0.7	4.6
CSO017	0.06	96	21.8	0.09	28	9.5	31.3
CSO018	0.01	84	3.2	0.07	44	11.7	14.9
CSO020	0.001	100	0.4	0.23	26	22.6	23.0
STM003	0.11	26	10.8	0.24	22	19.9	30.8
STM005	0.37	62	86.8	0.63	46	109.7	196.5
SUSPENDED SOLIDS							
CSO008	0.03	212	24.1	0.02	50	3.8	27.9
CSO017	0.06	534	121.3	0.09	230	78.4	199.7
CSO018	0.01	448	16.7	0.07	70	18.9	35.6
CSO020	0.001	452	1.7	0.23	756	658.1	659.8
STM003	0.11	176	73.3	0.24	98	89.0	162.3
STM005	0.37	304	425.7	0.63	680	1621.5	2047.2
TOTAL PHOSPHORUS							
CSO008	0.03	0.64	0.07	0.02	0.26	0.02	0.09
CSO017	0.06	2.27	0.52	0.09	0.50	0.50	1.02
CSO018	0.01	2.70	0.10	0.07	0.55	0.15	0.25
CSO020	0.001	2.08	0.008	0.23	0.84	0.73	0.74
STM003	0.11	0.48	0.2	0.24	0.79	0.72	0.92
STM005	0.37	0.64	0.9	0.63	2.08	4.96	5.86
AMMONIA							
CSO008	0.03	0.33	0.04	0.02	0.58	0.04	0.08
CSO017	0.06	1.36	0.31	0.09	0.76	0.26	0.57
CSO018	0.01	1.15	0.04	0.07	0.70	0.19	0.23
CSO020	0.001	1.50	0.006	0.23	0.36	0.31	0.37
STM003	0.11	0.47	0.2	0.24	0.48	0.44	0.64
STM005	0.37	1.43	2.0	0.63	1.40	3.44	5.34
ZINC							
CSO008	0.03	0.180	0.020	0.02	0.60	0.045	0.065
CSO017	0.06	0.390	0.088	0.09	0.13	0.044	0.132
CSO018	0.01	0.390	0.014	0.07	0.90	0.023	0.037
CSO020	0.001	0.400	0.001	0.23	0.49	0.426	0.428
STM003	0.11	0.220	0.091	0.24	0.05	0.046	0.137
STM005	0.37	0.600	0.840	0.63	0.10	0.240	1.079

Table 4b October 4, 1990

	FIRST HALF HOUR VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	REST OF STORM VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	TOT LOAD (kg)
<u>BOD</u>							
CSO018	0.18	200	136.3	0.60	56	127.2	263.5
CSO020	0.88	68	226.5	2.94	85	945.9	1172.4
CSO021	0.001	46	0.2	0.03	37	4.2	4.4
CSO072	0.001	105	0.4		NO FLOW		0.4
STM003	0.04	80	12.1	0.19	8	5.8	17.8
STM004	0.08	10	3.0		NO FLOW		3.0
STM005	0.16	76	46.0	1.63	22	135.7	181.7
<u>SUSPENDED SOLIDS</u>							
CSO018	0.18	528	359.7	0.60	150	340.7	700.4
CSO020	0.88	170	566.2	2.94	163	1813.9	2380.1
CSO021	0.001	134	0.5	0.03	98	11.1	11.6
CSO072	0.001	376	1.4		NO FLOW		1.4
STM003	0.04	420	63.6	0.19	153	110.0	173.6
STM004	0.08	66	19.9		NO FLOW		
STM005	0.16	326	197.4	1.63	104	641.6	839.0
<u>TOTAL PHOSPHORUS</u>							
CSO018	0.18	3.1	2.1	0.60	1.1	2.6	4.7
CSO020	0.88	1.0	3.4	2.9	1.2	12.9	15.8
CSO021	0.001	NO DATA		0.03	1.04	0.1	0.1
CSO072	0.001	11.3	0.04		NO FLOW		0.04
STM003	0.04	0.38	0.06	0.19	0.20	0.1	0.2
STM005	0.16	1.48	0.9	1.63	0.62	3.8	4.7
<u>AMMONIA</u>							
CSO018	0.18	1.5	1.0	0.6	1.4	3.3	4.3
CSO020	0.88	0.7	2.2	2.9	1.4	15.6	17.8
CSO021	0.001	NO DATA		0.03	1.9	0.2	0.2
CSO072	0.001	1.6	0.01		NO FLOW		0.01
STM003	0.04	0.5	0.07	0.19	0.01	0.007	0.08
STM004	0.08	0.36	0.11		NO FLOW		0.11
STM005	0.16	0.32	0.19	1.63	0.52	3.2	3.4
<u>ZINC</u>							
CSO018	0.18	0.60	0.40	0.6	0.160	0.363	0.76
CSO020	0.88	0.18	0.59	2.94	0.180	2.003	2.59
CSO021	0.001	0.15	0.0006	0.03	0.100	0.011	0.01
CSO072	0.001	0.11	0.0004		NO FLOW		0.0004
STM003	0.04	0.07	0.01	0.19	0.02	0.014	0.024
STM005	0.16	0.27	0.16	1.63	0.1	0.62	0.78

Table 4c October 12, 1990

	FIRST HALF HOUR			REST OF STORM			
	VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	VOLUME (MG)	CONCENT. (mg/l)	LOAD (kg)	TOT LOAD (kg)
<u>BOD</u>							
CSO018	0.03	46.0	5.2	0.07	28.0	7.4	12.6
CSO020	0.005	14.0	0.3	0.01	12.0	0.5	0.8
CSO021	0.003	76.0	0.9		NO FLOW		0.9
STM003	0.034	9.0	1.16	0.81	16.0	49.1	50.2
STM005	0.07	16.0	4.3	1.93	16.0	116.9	121.2
<u>SUSPENDED SOLIDS</u>							
CSO018	0.03	126	14.3	0.07	92.0	24.4	38.7
CSO020	0.005	116	2.2	0.01	70.0	2.7	4.9
CSO021	0.003	134	1.5		NO FLOW		1.5
STM003	0.034	25	3.2	0.81	60.0	184.0	187.2
STM005	0.07	152	40.3	1.93	108.0	788.9	829.2
<u>TOTAL PHOSPHORUS</u>							
CSO018	0.03	1.04	3.94	0.07	0.68	0.18	4.12
CSO020	0.005	0.33	0.006	0.01	0.18	0.007	0.02
STM003	0.034	0.19	0.025	0.81	0.18	0.55	0.58
STM005	0.07	0.59	0.16	1.93	0.62	4.53	4.69
<u>AMMONIA</u>							
CSO018	0.03	1.22	1.36	0.07	0.61	0.16	1.52
CSO020	0.005	0.04	0.001	0.01	0.02	0.001	0.002
STM003	0.034	0.66	0.08	0.81	0.73	2.24	2.32
STM005	0.07	1.30	0.34	1.93	1.11	8.10	8.45
<u>ZINC</u>							
CSO018	0.03	0.12	0.014	0.07	0.09	0.024	0.038
CSO020	0.005	0.10	0.002	0.01	0.07	0.003	0.005
STM003	0.034	0.04	0.005	0.81	0.08	0.25	0.255
STM005	0.07	0.18	0.48	1.93	0.13	0.95	0.998

RAINFALL

Below is presented a summary of the rainfall during the three events of 9/06, 10/04, and 10/12. This information was obtained from the daily reports of the District's rain gauge network. The data shown is from the two closest gauges to the study area; Maple Heights and Southerly WWTP. The values for peak intensity and duration were not available for the Southerly gauge, but the accumulation at this station was compared to the average storm duration from other stations to obtain an overall intensity.

Table 5 Daily Rain Data

Date	Location	Duration (h:m)	Accum. Rainfall (in)	Peak Intensity (in/hr)	Overall Intensity (in/hr)
9/06	Maple Heights	9:49	0.96	0.49	0.10
	Southerly WWTP	-	0.83	-	0.08*
10/04	Maple Heights	6:30	0.82	0.26	0.13
	Southerly WWTP	-	0.70	-	0.11*
9/06	Maple Heights	10:10	0.55	0.12	0.05
	Southerly WWTP	-	0.39	-	0.04*

* using average duration from other stations

BACTERIA

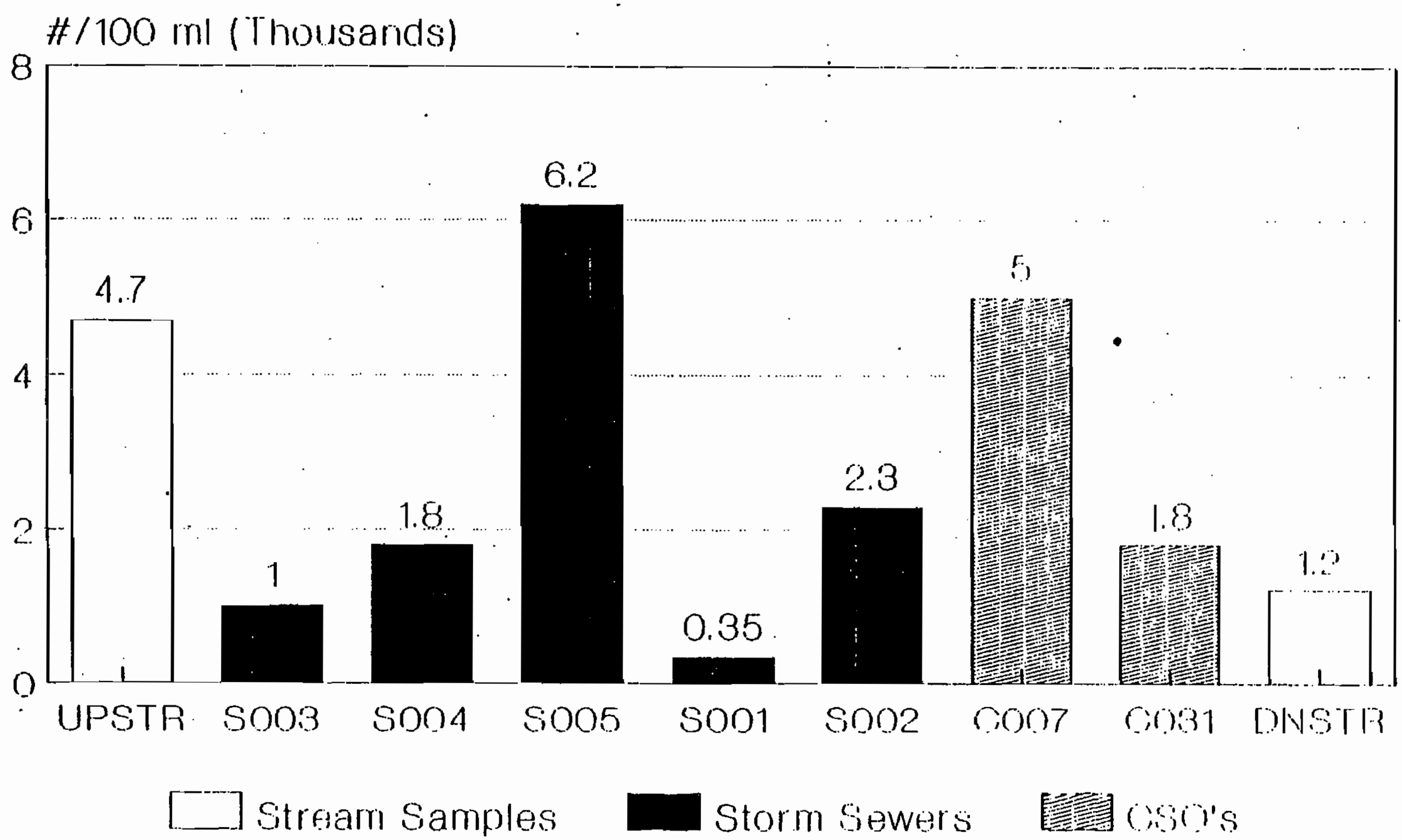
Fecal coliform was grab sampled during two of the storms selected. Samples were taken as soon as field crews could get to the sites, while the pipes were still flowing. Samples were also taken in Mill Creek upstream of all sites, and downstream near the junction with the Cuyahoga. Results are shown below.

Table 6
Fecal Coliform Counts

DATE	LOCATION	COUNT (#/100ml)	DATE	LOCATION	COUNT (#/100ml)
8/13/90	Upstream	4700	10/4/90	Upstream	150
	Downstream	1200		Downstream	5100
	CSO007	5000		CSO018	8000
	CSO031	1800		CSO020	7200
	STM001	350		CSO021	1900
	STM002	2300		CSO072	4800
	STM003	1000		STM001	30
	STM004	1800		STM002	2400
	STM005	6200		STM003	160
				STM004	10
				STM005	10

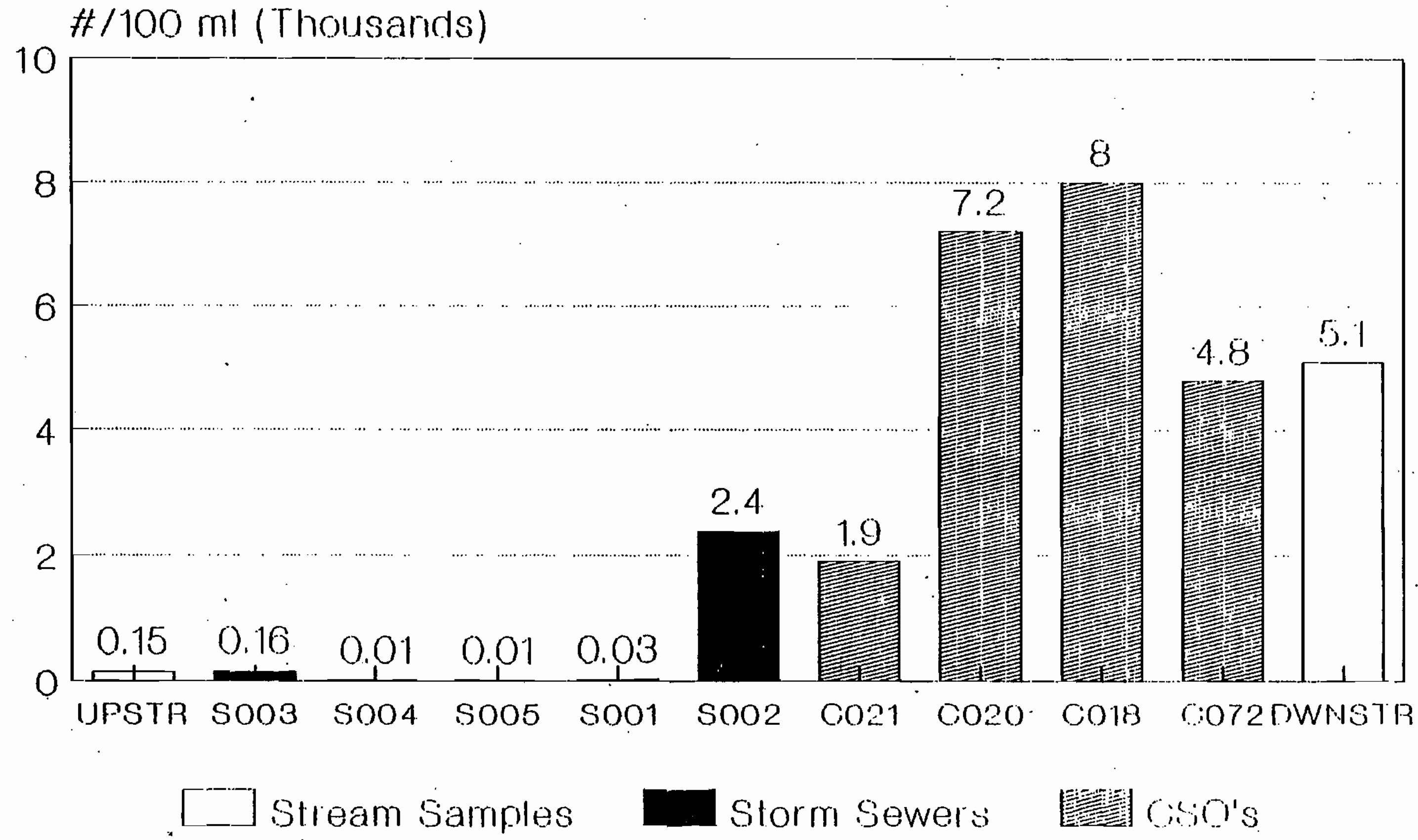
Fecal Coliform Data 08/13/90

Mill Creek CSOs and Storm Sewers



Northeast Ohio Regional Sewer District

Fecal Coliform Data 10/04/90
Mill Creek CSOs and Storm Sewers



Northeast Ohio Regional Sewer District

DISCUSSION OF RESULTS

STORM SEWERS

Storm sewer locations were divided into three categories: highway (I-480), residential (Henry at Southern and Northfield at Selfridge) and residential/industrial (Maple Heights Blvd and Home at Garden). The degree to which Mill Creek received a specific contaminant varied with the location category of the source. The I-480 site had high concentrations of suspended solids and low to average concentration of BOD, phosphorus, ammonia and zinc. The industrial/residential area of Home and Garden had the highest concentrations of suspended solid, phosphorus, ammonia and zinc. Northfield at Selfridge, a small residential area, continually displayed low pollutant concentrations. Generally, the residential areas produced lower concentrations than the areas that were residential and industrial. The highway concentrations varied, but tended to be near the mean value. The duration concentrations usually were 40 to 50% of the initial concentrations and had a smaller range of values.

COMBINED SEWERS VS. SEPARATE SEWERS

BOD
The combined sewers had a higher concentration of BOD than the separate sewers. However, the storm sewers flowed at a higher rate and for a longer amount of time than the combined sewers. This resulted in calculated loads which were higher for the separate sewers than for the combined sewers. Most of the BOD stemmed from sanitary refuse, however there is a large enough amount in the separate storm to indicate either a source above ground, or infiltration from the separate sanitary sewer.

Suspended Solids
The concentration and loadings of suspended solids were greater in the storm sewers than in the combined sewers on two of the three comparison days. It appeared that a significant amount of the suspended solids were coming from the streets, lawns, etc., as well as having sanitary origins.

Phosphorous
The concentration of phosphorous was significantly greater for the first half hour CSOs than the separate storm sewers. However, the loadings for two of the three days were greater for the storm sewers. A majority of the phosphorus seemed to come from a sanitary source. The low concentrations in the storm sewers indicated sanitary infiltration or possibly a minor amount present in street runoff. Either way, the higher volumes present in the storm line produced loadings which were capable of exceeding those of the CSOs.

Ammonia
Ammonia appeared to be present primarily in sanitary wastes. The concentration and loading of ammonia in the combined system was significantly greater than in the separate system. So much so that the greater volumes in the storms did not produce a loading similar to that of the CSOs.

Zinc
The highest concentrations of zinc were present in the combined sewers. But, as we have seen before, two of the three storms examined had higher loads of zinc produced by the separate sewers. Zinc's primary source appeared to be in sanitary waste.

Fecal Coliform
Although only two rain dates were sampled at a large number of stations, it did give us an indication of how varied the counts can be. The August 13 sample for storm site 2 was higher than the two CSO samples, but generally the storm sewer fecal count was less than the combined sewer count. Consistently high fecal counts in the separate sewer may indicate illegal connections and/or excessive infiltration. The number of samples presented did not give enough information to make any supposition as to the source of fecal bacteria in the storm sewers.

INSTREAM SAMPLING

In general, the pollutant concentrations showed an increase from the upstream to the downstream site, in both dry and wet weather. Some exceptions were the dry weather mean values for suspended solids and phosphorous, which decreased slightly downstream. Not enough data was obtained at the midstream site (#34) to define the impacts of the storm sewers up to that point. The storm of 9/06 showed extremely high values for zinc, BOD, and suspended solids at the downstream site (#31). The reason for this is not known, but it may have been due to some very localized source.

CONCLUSION

This report on Mill Creek was based on a limited amount of data, therefore the conclusions presented may not be typical of the entire system. Also, no attempt was made to correlate the rainfall intensity with pollutant concentrations.

The comparison of available data showed that the combined sewers had higher initial and duration concentrations in all categories except suspended solids. The comparison of the calculated loads however, indicated that the separate sewers were capable of contributing as much of the total pollutant load to Mill Creek as the combined sewers. The loads of the low concentration, high volume separate storm sewers were comparable to the loads of the high concentration, low volume combined sewers. However, the higher initial concentration from the CSOs, especially of toxics such as ammonia, could have a higher impact on aquatic life in the streams than the larger total load from the storm sewers.

The difference between the up- and downstream instream sampling data demonstrated the impact of both sewer types on the creek. These results should be compared to ongoing sampling of storm and combined sewers as part of the CSO Facilities Plan Phase I study.