STREAM MONITORING PROGRAM

Northeast Ohio Regional Sewer District

Industrial Waste Section

James Weber, Manager

Timothy Whipple, Program Developer

Northeast Ohio Regional Sewer District

Industrial Waste Section - Stream Monitoring Program

James Weber - Manager   Timothy Whipple - Program Developer

EXECUTIVE SUMMARY

Since its inception in 1972 the Northeast Ohio Regional Sewer District has spent (or plans to spend) close to $1.0 billion in order to initiate programs to:

1) expand repair, and improve the area's three major wastewater treatment facilities
2) construct a series of large sewer interceptors that transport wastewater directly from the source to one of the large treatment plants
3) devise control systems to reduce the amount of combined sewer overflow released to the area waterways
4) develop a pretreatment monitoring program in order control the amount of toxics that enter the sewers from local industries

The central goals of these programs are water pollution abatement and protection of human health. Water quality in the area streams has improved, and will continue to improve as these programs continue to be implemented. However, at present, no program exists to enable the District to find sources of environmental disruptions and to measure the improvements in area water quality. The implementation of a stream monitoring program would provide the District with several benefits. First, the

program would provide the District with substantial and significant data to illustrate that the goal of water pollution abatement is being reached. Secondly, water quality disruptions would be identified, and in many cases remedied. Third, having a complete data base would help to avoid generalizations about water quality that are occasionally made by environmental groups.

The program includes 52 monitoring locations on 17 streams and rivers within the District's jurisdiction. The monitoring locations are designed to acquired the optimum amount of information through a reasonable number of monitoring locations.

<u>East Side Parallel Direct Drainage Streams</u>

- Euclid Creek - 4 monitoring locations
- Green Creek - 3 monitoring locations
- Nine-Mile Creek - 3 monitoring locations
- Shaw Creek - 1 monitoring location
- Dugway Brook - 4 monitoring locations
- Doan Brook - 4 monitoring locations

<u>Cuyahoga River Basin</u>

- Cuyahoga River - 5 monitoring locations
- Big Creek - 6 monitoring locations
- Mill Creek - 5 monitoring locations
- West Creek - 3 monitoring locations
- Tinkers Creek - 4 monitoring locations
- Chippewa Creek - 2 monitoring locations

<u>Storm Sewer "Streams"</u>

- Walworth Run - 1 monitoring location
- Kingsbury Run - 1 monitoring location

- Morgana Run - 1 monitoring location

- Burke Brook - 1 monitoring location

<u>Rocky River Basin</u>

- East Branch Rocky River - 3 monitoring locations

- West Branch Rocky River - 1 monitoring location

The program includes chemical, physical, and biological analyses. The frequency of each type of sampling is as follows:

<u>Chemical Sampling</u> - monthly; 9 times per year at every monitoring location for 35 separate parameters (including bacteria)

<u>Physical Sampling</u> - monthly; 9 times per year at each monitoring location (includes discharge determinations to calculate parameter loadings)

<u>Biological Sampling</u> -

Macroinvertebrates (invertebrate aquatic animal life) - 3 times per year at most locations

Periphyton (algae and associated species) - once a year, at a few different locations annually

Macrophyton (fiberous aquatic plants) - same as periphyton

Fish - same as periphyton

As monitoring results become redundant, the frequency of chemical and physical sampling will be reduced to 3 times per year. Conversely, the biological sampling will begin slowly and increase as the IWS personnel become familiar with the analyses. If a problem area is located, a more intensive short-term study will undertaken in order to isolate and eliminate the problem.

Because the District discharges into a Priority Water Quality Area, the program is designed to collect all the data needed to determine the District's rank on the State's Construction Grants Priority List. The state also requires "Before and After" studies for eligibility for the Construction Grants Program. The IWS program will satisfy most if these requirements.

The program will avoid duplication of data by exchanging data with other concerned agencies (the most important agencies being OEPA, NOACA, etc.).

The program will assess the impact of the District's facilities on the environment.

The program will also assess whether or not the streams are meeting the OEPA's Water Quality Standards, and Stream Use Designations. If the streams are not meeting the standards, are the standards attainable ? If the standards are not attainable, should the standards be changed ? The data acquired throughout the program will answer these questions.

Statistical analyses will be performed in order to:
test the significance of changes of water quality over time, and
test the significance of quality differences between segments of one stream.

When good water qualities are found or significant improvements are made, the public should be made aware of these positive issues.

A computer map of each stream has been generated. The maps will be used to illustrate the stream quality of various stretches of the streams.

The appendices provide a full explanation of numerous concepts and techniques used to complete analyses, including:

1) Rationale for various chemical parameters
2) Macroinvertebrate sampling and analysis
3) Periphyton sampling and analysis
4) Macrophyton sampling and analysis
5) Fish sampling and analysis
6) Exact monitoring locations and rationale for choosing each
7) Editing and updating computer maps to illustrate various stream quality
8) Explanation of OEPA's Water Quality Standards, and Stream Use Designations
9) Portions of Ohio Water Quality Inventory - 305(b) Report
10) Contacts with other agencies including names, addresses, phone numbers, and materials that will be exchanged
11) Complete explanation of statistical tests and interpretation
12) Storing data on the Data Base File

TABLE OF CONTENTS

APPENDICIES

LIST OF FIGURES

LIST OF TABLES

BACKGROUND & PROBLEM IDENTIFICATION

The Northeast Ohio Regional Sewer District (the District) was created by a Cuyahoga County Court order in 1972. The District was established as an independent political subdivision of the State of Ohio. By its own definition, the District's purpose is to provide for the environmentally safe collection, treatment, and disposal of wastewater generated by homes, businesses, and industries in a way conducive to public health, convenience, and welfare.

To implement the court order the District has begun to:

1) expand, repair, and improve the area's three major wastewater treatment facilities
2) construct a series of large sewer interceptors that transport wastewater directly from the source to one of the large treatment plants
3) devise control systems to reduce the amount of combined sewage overflow released to area waterways
4) control toxic pollutant discharges through a pretreatment program

A tremendous expenditure has been necessary to implement all of the programs needed to reach the goals described above. The District reports that to date, over $600 million has been committed to planning, design, and construction of wastewater treatment plants; $117 million for design and construction of interceptor sewer planning,; and $19 million for improvements to the combined sewer overflow systems. As the District's jurisdiction expands, so will the capital expenditures needed to reach its goals.

The District's central goal of protecting water quality and human health is drawn from a number of Federal control programs. The success of these control programs depends greatly on both the United States Environmental Protection Agency (USEPA) and other agencies, such as the District. These programs were developed as the result of a number of legislative acts, the most important of which is the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) and 1977 (P.L. 95-217, or Clean Water Act "CWA" of 1977). The objective of the Act, as stated by Congress, is to "..restore and maintain the physical, chemical, and biologic integrity of the nation's waters." This objective is (or ideally was by 1983) to be met by eliminating discharges of pollution, and by a national policy that prohibits the discharge of lethal amounts of toxic pollutants into the nation's waters.

The District is obligated under section 301 of the Federal Water Pollution Control Act to meet wastewater plant effluent standards set by the USEPA under the National Pollution Discharge Elimination System (NPDES). The District has successfully met most of the NPDES effluent limits, and the programs implemented by the District since its inception (described above) show marked improvements in some of the area waterways. However, despite these improvements, many urban streams remain severely degraded due to cross-connections, broken sewers, combined sewer overflows

(CSO), urban runoff, and occasional malfunctioning pump stations.

As the District continues to implement its programs, these problems will be eliminated and improvements to the area stream quality will continue. However, at present, no program exists to enable the District to find sources of environmental disruptions and to measure the improvements in area water quality. The implementation of a stream monitoring program would provide the District with several benefits. First, the program would provide the District with substantial and significant data to illustrate that the goal of water pollution abatement is being reached. Second, water quality disruptions would be identified, and in many cases remedied. Third, having a complete data base would help to avoid generalizations about water quality that are occasionally made by environmental groups. As shapers of public opinion, it is important that these organizations have substantial data before making accusations as to the source of water quality problems. The acquisition of quantitative data and improvements in stream quality will result in an improved public perception of the District's investments.

The USEPA defines "water quality monitoring" to be the set of activities that provide chemical, physical, biological, and other environmental data required by environmental managers (USEPA, October, 1985). To complement this definition, a "program" can be defined as a collection of projects, each having a set of objectives that relate to the problems associated with that project. The aggregation of these two concepts provides the framework of the Industrial Waste Section's (IWS) stream monitoring program. In short, the goals of IWS's program will be to initiate the activities necessary to acquire the chemical, physical, and biological data needed to develop a broad data base; to statistically analyze the condition of and changes in water quality for various stream or stream segments in the area. It is important, however, that the program be limited to studies (selected on a priority basis) that can be accommodated by a limited amount of time and money.

The term "monitoring of streams" implies that a change in water quality is anticipated; monitoring is conducted to study the changes. Monitoring should be seen as one part of the quality management system. It does not exist for its own sake, but rather as a necessary support for planning and decision making. The data acquired throughout the program will aid in determinations of water quality needs. The data will be supplied to concerned parties, such as the Ohio Environmental Protection Agency (OEPA) to assess if any "Stream Use Designations" should be changed. (For instance, Kingsbury Run is presently defined as a warm-water habitat, and thus should be able to sustain a reproducing population of fish and related species. However, it is unlikely that Kingsbury Run could support any forms of higher life because it is basically a storm sewer.) Water Quality Criteria and "Stream Use Designations" are discussed later in this paper.

A major goal for the District is to develop a monitoring program that will be effective. Many water quality programs have failed because of little planning which results in insufficient data. IWS's program, however, was developed over numerous months, with a great deal of forethought. The following concepts were used to develop the program and will help make it effective:

1) The program should have a specific set of objectives which should be checked periodically to determine if they are being met. If not, they should be redefined.
2) The number of variables should be reduced as much as possible (sampling methodologies should be consistent with OEPA's).
3) The data base should be broad enough to meet present and future goals. The data should be able to answer questions that arise in the future.
4) The data should be summarized and stored correctly so they can be used to complete statistically meaningful work.
5) The data should determine if applicable "Stream Use Designation" and Water Quality Criteria are being met.
6) Priority should be assigned to problem areas.
7) Historical data should also be acquired for reasons of comparison.
8) Basin reconnaissance is needed to select strategic sampling sites.
9) Monitoring should investigate the need for remedial action and/or show that remedies are effective.
10) Inherent variabilities and difficulties associated with sampling and testing of parameters should be considered.
11) The program should blend into the IWS work schedule and budget limitations.

(Langford, 1978, & Polls et.al., 1978)

PHYSICAL CONSTRAINTS

The most important constraint for the monitoring program is the physical boundary of the District's jurisdiction, which includes the majority of Cuyahoga County and part of Western Summit County. Within the District's boundaries there are 17 streams and rivers that will be included in the program. All of the East-Side parallel direct drainage (into Lake Erie) stream will be included in the program:

- Euclid Creek
- Green Creek
- Nine-Mile Creek
- Shaw Creek
- Dugway Brook
- Doan Brook

The portions of the Cuyahoga River within the District and its major tributaries are also included in the program:

- Big Creek (East & West Branch)
- Mill Creek
- West Creek
- Tinkers Creek
- Chippewa Creek

Four low-level, enclosed culverted streams will also be part of the sampling procedures:

- Morgana Run
- Burke Brook
- Kingsbury Run
- Walworth Run

In addition, a few sites on Rocky River will be included in the program due to the addition of Berea and Strongsville to the District's jurisdiction.

Other constraints to be considered are time and money limitations. There will be a limit to the amount of time available for normal chemical grab sampling, physical measurements, biological sampling, and biological identification There is a limit to the funds available for field studies and analysis.

The time available is limited to approximately 30 crew hours per week. The stream monitoring will be worked into IWS normal monitoring activities. Over the next few years the IWS budget will include any equipment or literature needed for biological monitoring and analysis.

Laboratory funds are available for the additional testing. If necessary, additional laboratory personnel will be hired to complete the additional testing.

GOAL AND OBJECTIVES OF STREAM MONITORING PROGRAM

The goal of the IWS ongoing stream monitoring program is to acquire sufficient data to determine present and future water quality. The program is also designed to monitor water quality changes (as the District's projects progress), and isolate (and eliminate) pollution problems.

The objectives of the monitoring program include:

1) Physical, chemical, and biological analysis.
   a) Physical analysis, including discharge determinations to calculate loading factors.
   b) Chemical analysis will be broad to cover many areas of concern.
   c) Biological analysis will include benthic species because they are long-term indicators of water quality.
2) The program will be designed to be reasonable with respect to both economics and work load.
3) The monitoring locations are designed to acquire the optimum amount of information through a limited number of sampling sites.
4) The sampling frequencies will gain data representative of natural and anthropogenic variations in stream quality.
5) If a problem location is defined, a more intensive short-term study will be undertaken in order to isolate and eliminate the problem.

6) The data base will be broad enough so that various evaluations can be made now and in the future.

7) Avoid duplication of data by taking advantage of contacts with other agencies. (Information will be exchanged between agencies).

   a) OEPA

   b) Northeast Ohio Areawide Coordinating Agency (NOACA)

   c) Cleveland Metropark System

   d) Shaker Lakes Regional Nature Center

   e) United States Geologic Survey

   f) Ohio Department of Natural Resources (ODNR)

   g) Cities of Berea, Strongsville, and Solon

   h) Other potentially important contacts

8) Statistical analyses will be performed to;

   a) Test the significance of changes in water quality over time,

   b) Test the significance of quality differences between streams and or stream segments.

9) Because the District is a discharger to a Priority Water Quality Area, the program is designed to collect all the data needed to determine the District's rank on the State's Construction Grants Priority List. The program will also collect most of the data needed to complete necessary "Before and After Tests"

10) The program will assess whether or not the streams are meeting the OEPA Water Quality Standards, and Stream Use Designations.

   a) If not meeting standards, are they attainable ?

b) If not attainable, should these designations be changed ?

11) The program will assess the impacts of the District's facilities on the environment.

12) When good water qualities are found or significant improvements are made, the public should be made aware of these positive issues.

13) Three maps that will be used to coordinate sampling and represent stream quality.

a) A wall map composed of 7.5 minute series United States Geological Survey topographic maps will be used to show both permanent and variable sampling locations. (Variable sampling locations will be used during specific investigations of pollution problems.)

b) A computer map will diagramatically show each stream and will include:

1- Variable stream quality along stream segments

2- permanent and variable sampling locations

3- major roads

4- enclosed culverted areas

c) A street guide of Cuyahoga County will be used in the field by the investigators. It will show the exact location of permanent samples.

14) IWS personnel will be trained to perform the following tasks:

a) Determination of stream discharges and loading factors

b) Benthic sampling and analysis

c) Statistical analysis:

1- Simple Linear Regressions

2- Block Designs

CONSTRUCTION GRANTS

In order to receive construction grants from the OEPA, the District must be placed on the Construction Grants Priority List (CGPL). In a letter dated July 9, 1985, Gregory H. Smith (OEPA, Manager, Environmental Planning Section, Division of Construction Grants) informed Erwin J. Odeal (Director of the District) of some changes in the CGPL ranking system. Since the District is within a Priority Water Quality Area, additional information is needed to rank the District on the CGPL. Additional testing is needed to test the District's impact on water quality. The additional information includes data on the chemical, physical, and biological status of the area's water. The IWS Stream Monitoring Program covers all of the additional testing that needs to be completed. A copy of the letter, which includes all of the required tests, is included in Appendix 1.

The Construction Grants Manual explains a series of "Before and After" tests that assess water quality improvements that result from the construction and improvements of treatment facilities. Completing these tests would likely improve the Districts rank on the CGPL. The IWS Stream Monitoring Program covers most of the "Before and After" tests, with the exception of modeling for various wasteload allocations. The "Before and After" Study Guidance section of the Construction Grants Manual is also included in Appendix 1.

TIME CONSTRAINTS

Approximately 30 crew-hours (2-person crew) per week will be available for the stream monitoring program. Taking into account travel time, equipment moving time, and various other occasional sampling activities (benthic, vertebrate, sediment, and discharge) approximately 2 hours are needed at each sampling site.

30 crew hours per week / 2 hours per site = 15 samples per week

Obviously, some sampling sites are closer together or are more accessible than others. Also, not all types of sampling will be performed during each visit. The above is then a conservative estimate of the number of samples that can be taken during one week.

Approximately 3 weeks per month will be spent sampling at permanent sampling locations. The resulting approximate number of permanent sampling locations is:

3 weeks per month X 15 samples per week = 45 permanent locations (conservative estimate)

Because this is also a conservative estimate, 52 sampling sites will be used to cover the study area.

<u>Additional Sampling Time</u>

Since the sampling at permanent locations will take 3 weeks of every month, the fourth week will be available to conduct, if necessary, more intensive surveys of a problem area. One or more of the following techniques used to acquire information may solve the problem:

1) Research - finding the potential source of the problem using the resources that IWS has available (i.e., route maps, industrial information, etc.).
2) Reconnaissance - field studies to try to isolate the problem.
3) Sampling - conducting more intensive sampling to further attempt to define the nature and the source of the problem.

The fourth week of the month can also be used to sample areas where specific questions arise. Sampling can be performed where specific developments are expected to take place. For example, if a new interceptor is being planned, samples can be taken before, during, and after construction to measure the previous water quality, impacts of the construction, and improvements after construction. These data will not be useful in a long-term sense, but are important for short-term comparisons. Likewise, samples can be taken after a major storm event. These samples can be taken at either permanent locations or in areas of special interest. For example, if data are needed for an area of combined sewer overflows, the necessary measurements should be taken during a storm event.

The fourth week can also be used to complete other aspects of the program that will be discussed later including discharge and loading calculations, statistical analysis, and benthic identification.

STREAM SAMPLING

FREQUENCY FOR VARIOUS TYPES OF SAMPLING

Sampling must be frequent enough to distinguish developments that affect water quality. The frequency must also be enough to distinguish cyclical variations from trends. Most importantly, sampling frequencies are determined by the objectives of the program. The objectives of concern when determining sampling frequencies include:

1) making the program efficient relative to time and money
2) acquiring sufficient data to cover natural and anthropogenic variations in water quality
3) gaining adequate data to find significant changes in water quality

Sampling will be completed at each location on a monthly cycle. The IWS monitoring program will use a monthly sampling frequency. Many programs follow a monthly sampling cycle, which should aid in exchanging data with other programs. The USEPA (1975 and 1977) suggests monthly sampling of all chemical parameters when monitoring streams and rivers. Monthly sampling also blends well with IWS personnel's work schedule.

<u>Chemical Sampling - Monthly interval at all permanent locations</u>

Chemical samples will be taken monthly at all locations. There will also be sampling of sediments at a few locations every year. The locations should generally be at major confluences, because they are representative of the quality of sediments moving downstream.

Physical Sampling - Monthly intervals at most locations

Physical measurements will be taken monthly at most locations. Discharge determinations will be performed at all locations except for the Cuyahoga River. The size of the river leads to obvious problems with discharge determinations. The United States Geological Survey has two permanent gauging stations within the District's jurisdiction (Cuyahoga River and Tinkers Creek). The discharges can be combined with OEPA data to supplement IWS's program (calculation of loadings).

Biological Sampling - Three times per year for most species

Biological sampling will begin slowly to familiarize IWS personnel with sampling and identification. Eventually, benthic macroinvertebrates will be sampled three times per year (spring, summer, fall) most of the 52 sampling locations. This frequency will cover the three most important stages of the life cycle. Vertebrates (fishes) will be sampled annually in locations that investigators feel will yield the best results. As stream quality improves some species should return to various stretches of streams.

Periphyton (algae and associated species) and macrophytes (larger botanical species) are indicators of water quality and should be sampled at the same time as fish (once annually at a few locations).

VARIABLE FREQUENCY STREAM SAMPLING

After baseline data are established and samples begin yielding consistent results, sampling frequency will be reduced. A variable frequency sampling program will be used because it allows for more flexibility in the program (better for the IWS work schedule) and avoids redundancy of data. The following is a further discussion of the variable sampling frequency in the program.

This variable frequency program of sampling is designed to create a baseline of data and stream quality. Each chemical parameter should be sampled 8 to 9 months per year at the initiation of the program. If water quality of the stream is found to be extremely consistent at that location, the number of samples taken per year should be decreased to 3. Likewise, if one set of parameters is found to be consistent, it can be eliminated while the other parameters are still tested for. Sampling locations that represent the total flow of a stream (and confluences) remain at the highest priority. At these locations the sampling frequency should remain high.

Statistical Significance

In order to make the data statistically significant there are a few concepts that need to be taken into consideration. At any given location, samples should be taken at approximately the same date each month. There will obviously be some variation, however, the closer the dates, the more significant the data. Also, when sampling frequency is reduced to 3 times per year, it is imperative that samples be taken during the same months each year. The program developer suggests that samples are taken in April, July, and October. All seasons will be represented with these three months.

If planned projects are likely to have an effect on stream quality, then the testing at that location should be increased to the full cycle (8 or 9 samples per year). For example: to establish baseline data on its state of degradation, a lower section of Doan Brook is sampled at full frequency. After consistent data are found, the sampling frequency can be reduced to 3 times per year (April, July, and October). Later on, when the Heights/Hilltop Interceptor relieves the community sewers, the improvements in stream quality can be documented by the full frequency of sampling (8 or 9 times per year). The improvements can be compared to the historical data.

WINTER SAMPLING

Regular sampling activities will be delayed during the winter because of obvious problems with sampling from November through March. Besides the safety problems, the flow of streams is significantly reduced due to freezing.

Unique events such as spills should be sampled. Samples should also be taken during periods of major snow melts. Chlorides are the most important parameter to monitor during this period, because the concentrations are increased due to runoff containing road salt, they and can be high enough to be toxic to biological organisms.

In winter, the time that is normally reserved for sampling can be used to catch up on biological identification and analysis. Also, any other discharge, loading, or statistical analyses can be completed during the winter.

CHEMICAL MEASUREMENTS

Numerous monitoring programs were surveyed to decide which chemical parameters would give the best representation of water quality. It is important that the parameters selected be meaningful indicators of water quality at present, and in the future. (They were also selected with the laboratory's capability and capacity in mind.) The 35 parameters reflect a broad range of water quality conditions and problems. Many of these parameters are included in USEPA criteria, regulations, and standards. There are standardized sampling and analytical techniques available to measure the parameters.

Bacterial studies are included in this section because they are included in the laboratory's daily analysis. Monthly stream samples will be analyzed for:

-Temperature (field measurement)

-Dissolved Oxygen (field measurement)

-pH

-5-day biological oxygen demand

-Chemical oxygen demand

-Total coliform

-Fecal coliform

-Fecal streptococcus

-Suspended solids

-Total solids

-Turbidity

-Specific conductivity

-Total dissolved solids

-Acidity

-Alkalinity

-Hardness

-Chlorides

-Sulfates

-Nitrates

-Nitrites

-Ammonia

-Total Kjeldahl nitrogen

-Organic nitrogen

-Total phosphorus

-Soluble phosphorus

-Nickel

-Copper

-Total chromium

-Hexavalent chromium

-Zinc

-Iron

-Cadmium

-Lead

-Mercury

-Color

Appendix 2 explains the usefulness of each of these parameters as water quality indicators.

Sediment Sampling

The program includes an occasional sampling of sediments (a few annually). The samples should generally be taken at confluences or other important sampling locations. Samples will be obtained using a core sampler in deeper portions of rivers, and grab techniques in shallower streams.

At present, the OEPA has not developed a standard methodology for sampling sediments. Samples that will be analyzed for metals are placed in a plastic container. Metal containers are used for samples to be analyzed for toxic organics (Mr. Robert Wysenski, Northeast office OEPA, phone conversation).

The complete list of parameters will be analyzed for each sample. This includes sediment oxygen demand instead of biological oxygen demand or chemical oxygen demand. In light of the USEPA's concern of toxics, a few sediment samples should be analyzed for toxics annually by an independent laboratory.

PHYSICAL MEASURES

Physical analysis of streams will be completed in the field. The following basic measurements and observations are consistent throughout most monitoring programs:

1) Date

2) Time

3) Ambient air temperature

4) Weather conditions (sunny, cloudy, rain, snow)

5) Wet or dry flow (i.e.,. rain in last 24 or 48 hours)

6) Temperature in Celcius degrees

7) Dissovled oxygen (DO)

Temperature, DO, (and pH) are of the utmost importance because of their involvement in most chemical reactions in a body of water. They are also essential factors that govern whether an ecosystem will maintain aquatic life.

8) Cross-sectional area

9) Velocity (with a flow meter)

The measurements of cross-sectional area, and velocity will be used to determine the discharge of the stream. The cross-sectional area multiplied by the velocity yields the stream discharge (volume per unit time). The discharge can then be used to determine the loading of any parameter of concern. This method is outlined in Appendix 3 and is commonly used by the OEPA and other agencies. It is relatively accurate when preformed correctly and is far less expensive than other discharge determination methods.

BIOLOGICAL MEASUREMENTS

The Federal Water Pollution Control Act stresses the need to restore and maintain the biological integrity of the Nation's waters and to achieve a water quality that provides for the protection and propagation of aquatic life. The Stream Use Designations created by the OEPA define a "warm water habitat" as a stream that is capable of supporting balanced reproduction of populations of warmwater fish, associated vertebrate and invertebrate organisms, and plants on an annual basis. The biological status is an important indication of the overall quality of a stream. The presence of certain organisms can be more important than the concentration of some chemical parameters.

When establishing a biological monitoring program, a number of factors should be taken into consideration (Mason, 1981):

1) Presence or absence of an organism must be a function of water quality
2) The program must be a reliable assessment of water quality in a simple form, but must be quantifiable to allow for comparisons
3) Assessment should relate to water quality over an extended period, rather than to a short period at the time of sampling
4) Sampling, sorting, identification, and data processing should be as simple as possible to conserve crew hours and money

For this program, biological monitoring includes: macroinvertebrates (animals that can be seen with the unaided eye), fish, periphyton (algae and attached species), and macrophytes (multi-cellular plants). (Although bacteriological studies are truly biological in nature, they are grouped with chemical parameters because of their frequency of sampling, and since their analysis is routine for the District's laboratory.) Macroinvertebrates will be emphasized because of their value as water quality indicators.

In general, biological material is difficult to sample and inherently variable. There are, however, several advantages to biological monitoring. Biological sampling is viewed as a relatively low-cost tool for water quality and effluent impact assessment. Organisms are excellent indicators of stress in aquatic habitats because they act as natural pollution monitors.

Pollution Effects on Community Structure

Pollution affects the community structure of macroinvertebrates, fish, and aquatic plants. Changes in the macroinvertebrate community will be used to illustrate the effects of pollution.

Differences in macroinvertebrate community structure between polluted and nonpolluted areas are detectable. The macroinvertebrate community that inhabits a specific stream segment is directly a product of its environment. When an aquatic community undergoes stress (pollution) or a reduction in stress, the community structure is affected. The organisms must adjust to the stress, migrate, or die. Since most macroinvertebrate species are not mobile, the more sensitive species tend to die as a result of stress. This leaves many biologic niches open for the more pollution-tolerant species. In this sense, aquatic organisms and communities act as natural pollution indicators, and consistent biological sampling of an area will show improvements or degradations in water quality. One example is a spill that is carried downstream in a few days. A chemical sample taken later will show no difference in water quality. However, the spill may have killed all of the pollution-sensitive species and thus changed the whole benthic community structure in the area. Therefore, the organisms act as a better indication of water quality than chemical samples.

The OEPA groups the tolerance of benthic species into three types: tolerant species, intermediate (facultative) species, and sensitive (intolerant) species.

The OEPA defines these categories of benthic tolerance as (OEPA, 1982):

Sensitive - organisms not often associated with gross contamination and generally intolerant of even moderate reductions in dissolved oxygen (i.e., stoneflies and mayflies).

Intermediate - organisms having a wide range of tolerance and frequently associated with moderate levels of contamination (i.e., some gastropods).

Tolerant - organisms more often associated with gross contamination and potentially capable of thriving under very low dissolved oxygen concentrations (i.e., some chironomids).

As water quality is degraded in an area, sensitive species are replaced with tolerant species. Below are two examples of replacement of pollution-sensitive species with pollution-tolerant species (indicating a decrease in water quality) (Welch, 1980):

Baetus (Mayfly) -> *Simulium* (Blackfly) -> *Hydrospyche* (Caddisfly) -> *Limnaea* (Snail) -> *Herpobdella* (Leech),

Nais (Worm) -> *Asellus* (Sowbug) -> *Sialis* (Alderfly) -> *Chironomus* (Midge) -> Tubifex (Worm).

As water quality degrades, diversity decreases. As diversity decreases, a small number of individuals in many different species (a balanced community) is replaced by a few species all having a large number of individuals (unbalanced community).
A hypothetical example is:

Unpolluted Waters (Pollution-sensitive species)	Polluted Waters (Pollution-tolerant species)
Organism A - 30 individuals	Organism G - 207 individuals
Organism B - 23 individuals	Organism H - 174 individuals
Organism C - 46 individuals	
Organism D - 12 individuals	
Organism E - 28 individuals	
Organism F - 54 individuals	

As expected, when stream quality improves, species diversity increases while the number of individuals per species decreases. Diversity indices are used as a measure of diversity within streams. These indices place a numerical value on the diversity of a stream and thus can be used to compare the amount of degradation of a stream.

Macroinvertebrates

The USEPA defines macroinvertebrates as animals that can be seen with the unaided eye, retained by a U.S. Standard No. 30 sieve, and live at least part of their life cycles within or upon available substrates in a body of water or water transport system (USEPA, 1973).

Major groups of freshwater macroinvertebrates include insects, annelids, mollusks, flatworms, roundworms, and crustaceans. Since they occupy all levels of the trophic structure they are more commonly classified by their size and habitat. Macroinvertebrates aid in the stabilization and purification of organic matter; they help to break it down to carbon dioxide, water, and heat (Welch, 1980). Most species of macroinvertebrates follow one of two different benthic life cycles:

1) Egg -> Naiad -> Adult

2) Egg -> Larvae -> Pupa -> Adult

If sampling is performed three times per year, samples should represent all stages of the life cycle.

Macroinvertebrates are excellent indicators of intermittent pollution due to the sensitivity of many of the species to environmental stress. Since many of the species are detritus feeders they are a good example of bioaccumulation. Bioaccumulation is the retention and accumulation of contaminants in an organism. As a result, contaminants such as metals, pesticides, and radioactive materials may be at an increased level in the organism, while concentrations in the water are at generally acceptable levels.

IWS Macroinvertebrate Sampling Program. The program will consist of qualitative and quantitative sampling of benthic organisms. The objective of qualitative analysis is to determine the presence or absence of benthic life having varying degrees of tolerance. Qualitative sampling involves searching the stream bottom for organisms until no new organisms are located. Quantitative sampling involves collecting all organisms within a limited area (i.e., 5 square feet), and then estimating the number of individuals of a species per unit area.

Initially, almost all sampling will be qualitative to allow the IWS personnel to become familiar with sampling and identification of the organisms. Qualitative sampling may be preferred to quantitative sampling because rare species are usually good indicators of water quality. Because quantitative samples are collected over a few square feet, species that are important indicators of water quality are often missed.

As the program progresses, qualitative sampling should be completed in the spring and fall, while quantitative sampling is completed in the summer. It is possible in the long run for quantitative sampling to be completed in the spring and fall also.

Macroinvertebrate Sampling Techniques

Initial quantitative sampling should be completed using the Surber Square Foot Sampler, which will enable the investigators to become familiar with the techniques involved with quantifying samples of benthic organisms. As time progresses, a Hester-Dendy Sampler should be used for quantitative sampling in areas wherever possible. This type of sampler requires slightly deeper water because it is a multiple plate sampler that is anchored in a stream for 6 weeks to allow organisms to become attached to it. The OEPA is beginning to use this type of sampler; however, it may not be appropriate for many of the area streams.

Of the 52 sampling locations, approximately 35 can be sampled using the Surber Sampler. These locations all have shallow water and most have similar substrates. At a few of these locations, stream conditions will be appropriate for the Hester-Dendy Sampler. Other locations on the Cuyahoga and Rocky Rivers will be sampled with the Hester-Dendy because of deep water. Lastly, the remaining locations are enclosed culverted areas where biological sampling will be very limited due to the lack of benthic organisms.

As discussed earlier, sampling should begin qualitatively and progress toward quantitative analysis. Table 1 is an example of possible progression of the program. The exact progression of the benthic sampling program will be determined by the program coordinator.

TABLE 1

Possible Macroinvertebrate Sampling Progression

1 - One Sample Per Year (Summer)

2 - Two Samples Per Year (Spring and Fall)

3 - Three Samples Per Year (Spring, Summer, and Fall)

L - Qualitative Sampling

T-S - Quantitative Sampling Using Surber Square Foot Sampler

T-HD - Quantitative Sampling Using Hester-Dendy Plate Sampler

Year	35 Sampling Locations (Shallow)	35 Sampling Locations (Appropriate For HD Sampler)	Cuyahoga
1	1-L	1-L	N.A.
2	2-L 1-T-S	2-L 1-T-S	N.A.
3	2-L 1-T-S	2-L 1-T-S	1-T-HD
4	2-(L or T-S) 1-T-S	2-(L or T-S) 1-T-HD	1-T-HD

The program should progress with as many qualitative or quantitative samples as possible/needed. The Hester-Dendy should be used where ever possible, using the Surber in the remaining locations.

Ideally, the program should complete three benthic analyses (per sampling location) per year, because pollutants effect organisms differently during various seasons or stages of their life cycle. There are obvious time constraints on the amount of sampling and analysis that can be undertaken. As with the chemical data, when benthic analysis become repetitive, sampling frequency should be reduced, but only after a few quantitative analyses have been properly completed at a location. As with chemical sampling, the full frequency of sampling should be restored when a change in water quality is expected. This will allow for complete analysis and documentation of changes in community structure as water quality changes. The program coordinator will have the authority to reduce or increase the frequency of sampling, as data becomes repetitive, or developments that may effect water quality take place.

The program developer suggests that a minimum of one qualitative sampling be completed at each location annually.

Appendix 4 describes the macroinvertebrate sampling and analysis techniques.

Periphyton

Periphyton is a wide assemblage of plants and animals that inhabit the substrate of standing and running waters. The most common types of organisms include bacteria, yeasts, algae, molds, protozoans, and some corals and sponges. Periphyton are the primary producers of the streams, they efficiently change nutrients, carbon dioxide, and sunlight into organic living materials.

Periphyton are good indicators of water quality. Increases in nutrients can spawn numerous species of periphyton. Foe example, if a community composed predominately of diatoms is exposed to organic wastes, the diatoms are replaced by bacterial slimes.

Another indicator of water quality is Cladophora which is a filamentous green algae that forms dense blankets. This algae is common in the recovery zone of streams where it provides both food and cover for macroinvertebrates. The ratio of ash free weight to the weight of Chlorophyll a per unit area is a measure of the degradable organic pollution. The higher the ratio, the lower the amount of degradable organic pollution present.

Many water quality monitoring programs emphasize macroinvertebrates and use periphyton as a secondary measure of stream quality. Because the changes in periphyton communities are not as rapid as changes in macroinvertebrate communities, periphyton are often used as long-term indicators of stream quality.

In the IWS program, the sampling frequency for periphyton will be lower than the sampling frequency for macroinvertebrates. The program developer suggests that periphyton be sampled at a few locations annually (the same time as fish). As with macroinvertebrate sampling, if a something is expected to affect water quality, sampling should be completed before and after. For instance, if an interceptor is expected to relieve the streams in an area from waste loading, the periphyton should be sampled before and a few times after the stress is removed to document the replacement of species.

Appendix 5 explains qualitative and quantitative sampling methods for periphyton.

Macrophyton

Macrophytes are the higher plants of water habitats. They are multi-cellular structures that are usually rooted and have rigid cell walls. Their sizes range from microscopic to massive cyprus trees (USEPA, 1973).

Some pollutants have a significant effect on macrophyte growth. Turbidity restricts light penetration, which results in decreased growth of submerged plants. Organic and inorganic nutrients can stimulate overproduction of macrophytes and periphyton, which can cause a decrease in both light penetration and eventually macrophyte growth. Herbicidal compounds can stimulate growth when present in sub-lethal concentrations; however, if present in lethal concentrations, plant growth will be eliminated. Sludge deposits, especially those that undergo rapid decomposition, are usually too unstable or too toxic to permit the growth of macrophytes (USEPA, 1973).

The type of species of macrophytes present in an area is an indication of general water quality. The IWS monitoring program should sample macrophytes to supplement the other chemical and biologic information.

Macrophytes should be sampled at the same time periphyton are sampled. As time passes, or as developments occur that may affect water quality, the macrophytes should be resampled.

Appendix 6 explains macrophyte sampling and analysis.

Fish

Fish are useful indicators of water quality. Beyond general appearance of the water, fish are the public's most important measure of water quality. Due to their sensitivity, fish are directly affected by water quality. Fish are also affected by the condition of all of the lower organisms of the food web because they are the highest member of most aquatic food webs. Water quality conditions that significantly affect the lower levels of the food web will affect the abundance, species composition, and condition of the fish population. In some cases, however, the fish are more sensitive to the pollutants than are the lower animals and plants; they may be adversely affected even when the lower levels of the food web are relatively unharmed (USEPA, 1973).

Many fish have stringent dissolved oxygen and temperature requirements and are intolerant to chemical and physical contaminants. Abrupt fish kills are an indication of dramatic changes in stream conditions. Fish can repopulate an area relatively quickly if their habitat has not been destroyed. Long term pollution changes the community structure; are lost (or decrease) and of favorable species, which are replaced by less favorable ones. During long-term pollution a decrease in species diversity also occurs; a small number of species will tend to dominate. An increased level of pollution over an extended period of time will obliterate the fish population.

Unlike most aquatic organisms, if pollution problems are local, fish are mobile enough to avoid the problem. For the most part, however, fish are sedentary, especially during the summer months. Many species of fish move less than 0.5-1.0 km during their lifetime (Gerking, 1953, 1959).

IWS studies will be principally concerned with:

1) species present

2) relative and absolute abundance of each species

3) condition of the fish

4) size distribution

5) incidence of disease

Additional factors may be studied in the future if the specific concerns arise:

1) growth rate

2) success of reproduction

3) palatability

Reconnaissance studies completed in the summer of 1986 revealed only a few locations in area streams that supported fish populations. Although these studies were not designed to be conclusive, they do give a general representation of fish populations.

Due to the lack of fish in most of the area streams, the sampling schedule will not be as aggressive as the benthic sampling schedule. Fish will be sampled at a lower frequency than macroinvertebrates because some of the streams that have been severely degraded will need adequate recovery time before they are be able to support fish populations. Cost and time constraints are also a consideration in sampling frequency of fish.

IWS will concentrate on sampling at a few major confluences during the first few years of the program. Initially, three to five locations should be sampled annually. As investigators become familiar with sampling techniques, other locations can be sampled. Ideally, as pollution abatement programs continue to be initiated, more locations will be capable of supporting fish populations and sampling can be increased accordingly.

NOACA also plans on initiating a biological monitoring program that emphasizes fish. Their data will be made available to IWS as it is acquired.

Appendix 7 describes the fish sampling and analysis techniques.

MONITORING LOCATIONS

Field reconnaissance of the streams in the study area was completed during the summer of 1986. The purpose of these preliminary studies was to familiarize the program developer with the drainage basins and aid in the selection of sampling locations. Considerations during reconnaissance included: qualitative evaluation of water quality, sampling of representative benthic species, evaluation of the stream substrates, location of bridges or culverts to aid in discharge determinations, and inspection for problems that influence stream quality. The accessibility of the sampling location was also taken into consideration for safety reasons and to limit the sampling time.

Several factors influenced the selection of permanent sampling locations. These factors also influenced the distribution of the limited number of sampling locations. Below are several factors that were considered in choosing sampling locations:

1. The principle rivers, streams, and tributaries in the study area
2. Total number of sites is limited to a manageable number relative to available crew hours (As discussed earlier the number of sites is 52)
3. The present monitoring locations of other agencies, including the District (There is no need to repeat the sampling of any of these streams)

4. The locations of previous sampling and the availability of historic water quality data (including the District, OEPA, and studies completed by various consulting firms)
5. Upstream and downstream of major point sources
6. Upstream and/or downstream of major parameter sinks (i.e., lakes or ponds)
7. Above confluences of streams or stream branches
8. Areas well below water quality standards
9. Areas of concern to Agency officials (i.e., Big Creek, Dugway, Kingsbury, etc.)
10. The number of sampling locations per stream is roughly a function of length of stream channels and drainage area of the basin
11. Areas where benthic sampling can be performed
12. Areas where discharge is regularly monitored or can be determined
13. Safety and accessibility of the sampling location

For sake of organization and discussion, the study area is broken into four subdivisions according to hydrologic characteristics and drainage basins. The four subdivisions are:

1) East-Side Parallel Direct Drainage Streams
2) Cuyahoga River Basin
3) Storm Sewer "Streams", (actually part of Cuyahoga Basin)
4) Rocky River Basin

The permanent monitoring locations of each stream are listed below. Also included in this text is a diagramatic map (not to scale) of each stream, which illustrates permanent sampling locations (represented by an X). A more exact explanation of the permanent sampling locations is included in Appendix 8. General problems of each stream and rationale for selection of each sampling location are also discussed in the appendix. Each permanent sampling location is assigned a number; there are 52 permanent sampling locations. Also included in the appendix are suggestions for possible changes in sampling locations, if more, or different types of information are needed in the future. If for any reason a permanent sampling location is added, a decimal number should be assigned to it. (For example, number 22.1 would be assigned to a sampling location added between locations 22 and 23 on the Cuyahoga River.) Likewise, if a permanent sampling location is dropped, the number should not be reassigned to any new locations.

In general, the following discussions start at the mouth and work upstream.

EAST-SIDE PARALLEL DIRECT-DRAINAGE STREAMS

Euclid Creek - 4 locations (Figure 1)

1) St. Clair Ave.

2) Highland Picnic Area, Euclid Creek Reservation, South Branch

3) Same location, North Branch

4) Mayfield and Dorsch Roads

Green Creek - 3 Locations (Figure 2)

5) Confluence with Lake Erie

6) Saranac and E. 171

7) South of Euclid on Green Road

Nine-Mile Creek - 3 Locations (Figure 3)

8) Lake Shore Blvd.

9) Belvoir Blvd.

10) South Belvoir Blvd.

Shaw Creek - 1 Location (Figure 4)

11) Lake Shore Blvd.

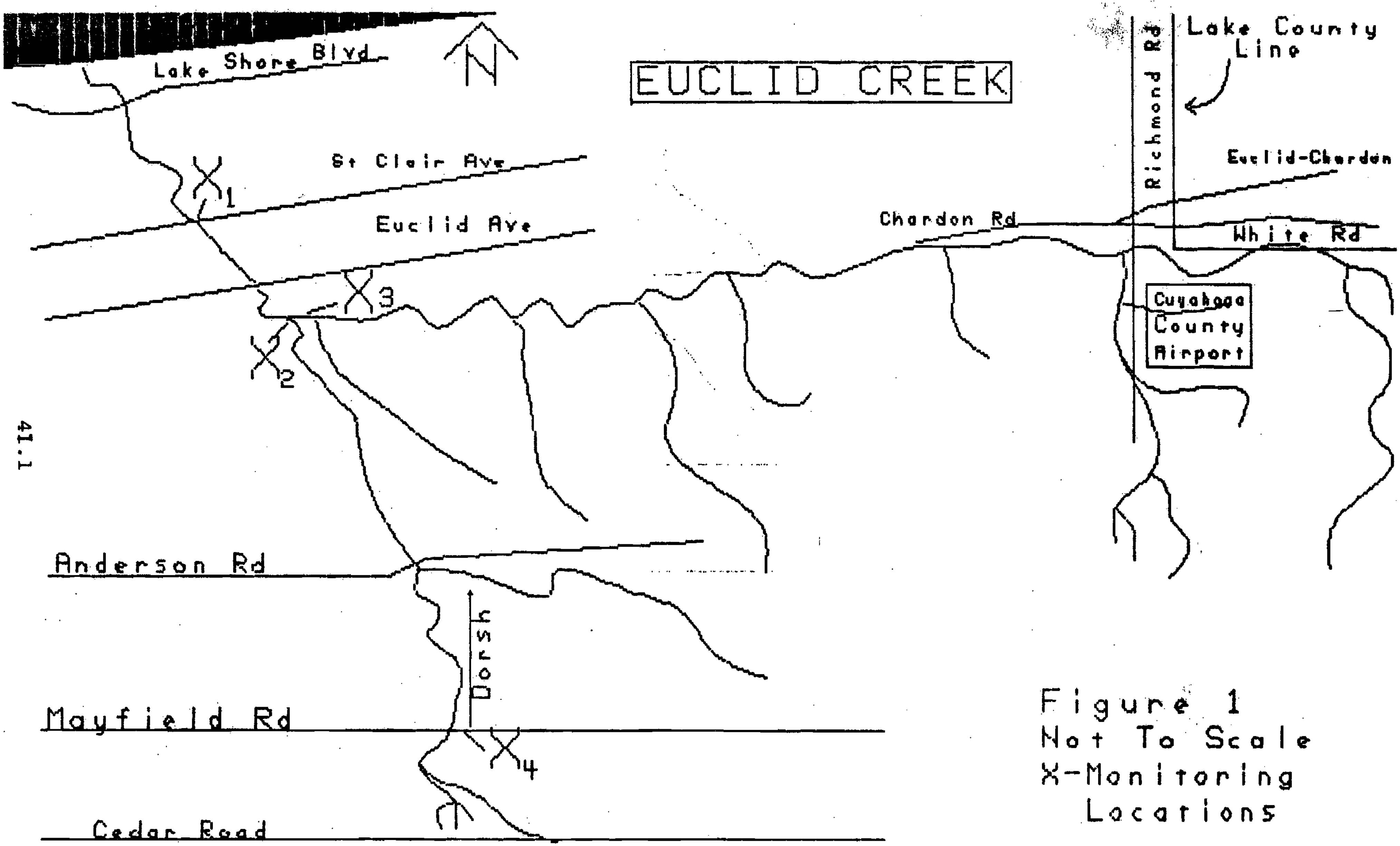


Figure 1
Not To Scale
X-Monitoring
Locations

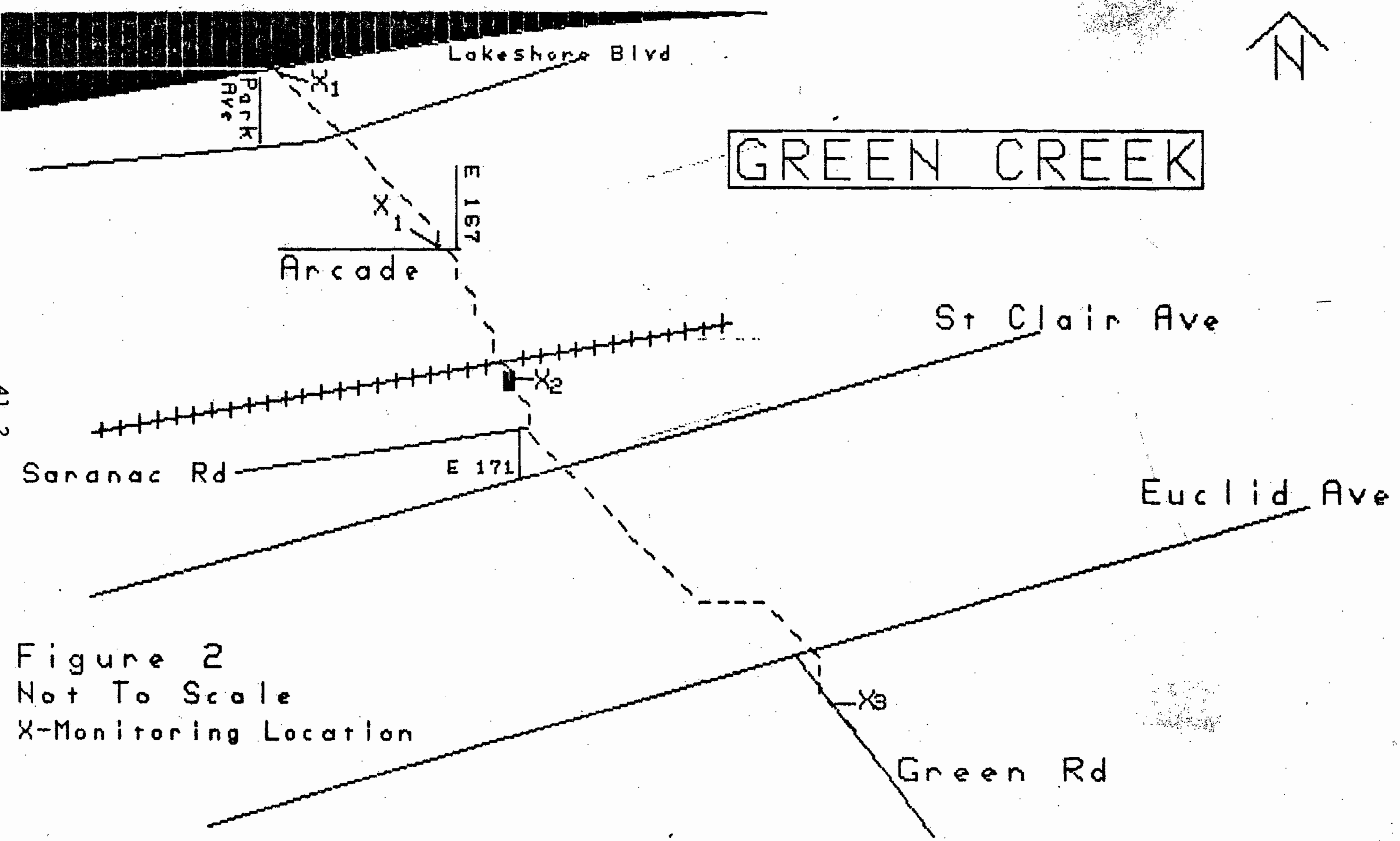


Figure 2
Not To Scale
X-Monitoring Location

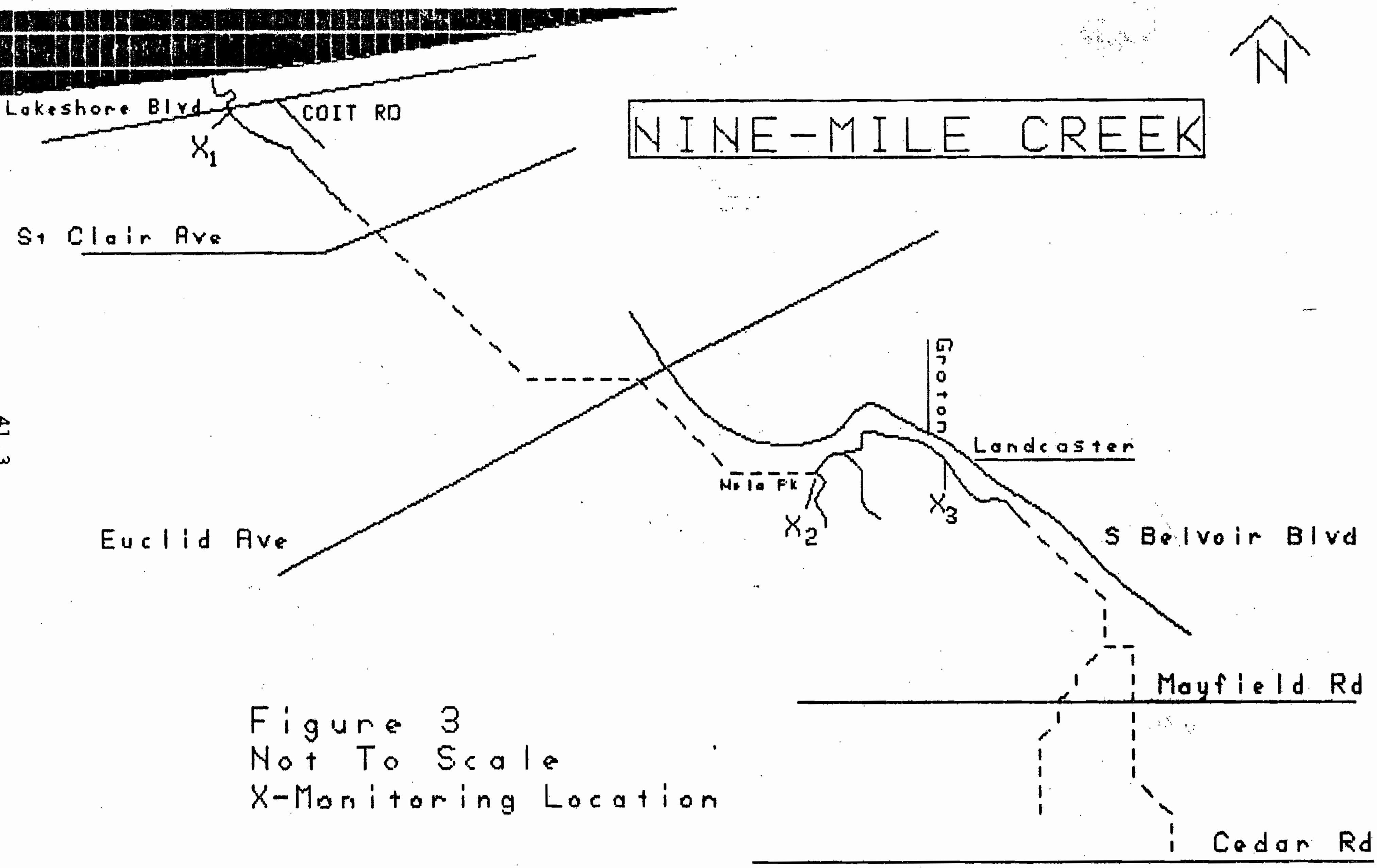


Figure 3
Not To Scale
X-Monitoring Location

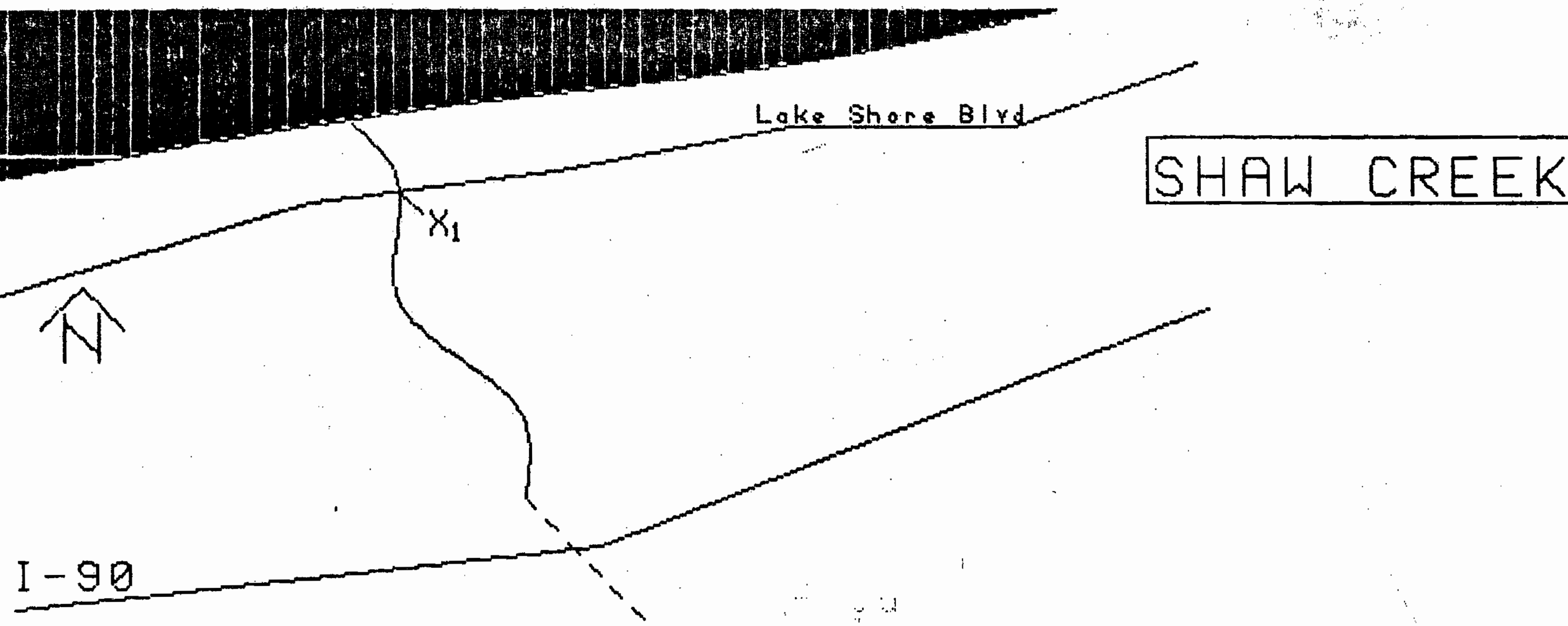


Figure 4 Not To Scale

X-Monitoring Location

Dugway Brook - 4 Locations (Figure 5)

12) Lake Shore Blvd.

13) Prime Rose Ave.

14) Lakeview Cemetery, Hillside Drive

15) Cumberland Park, Cumberland Road

Doan Brook - 4 Locations (Figure 6)

16) Martin Luther King Blvd. - North of St. Clair Ave.

17) Martin Luther King Blvd. below Cleveland Museum of Art.

18) South Park Road at Shaker Lakes Regional Nature Center, North Branch

19) Same location, South Branch

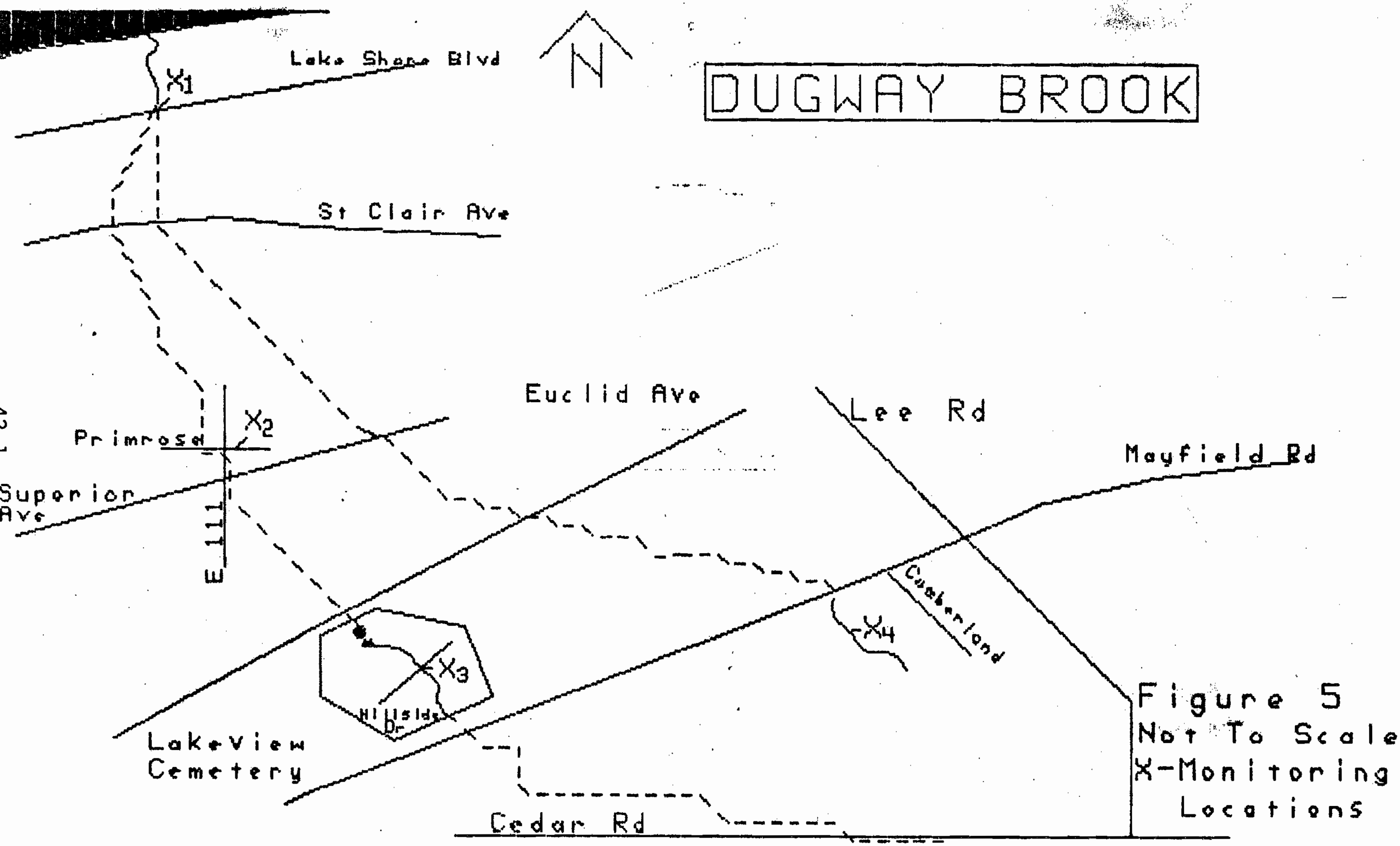


Figure 5
Not To Scale
X-Monitoring
Locations

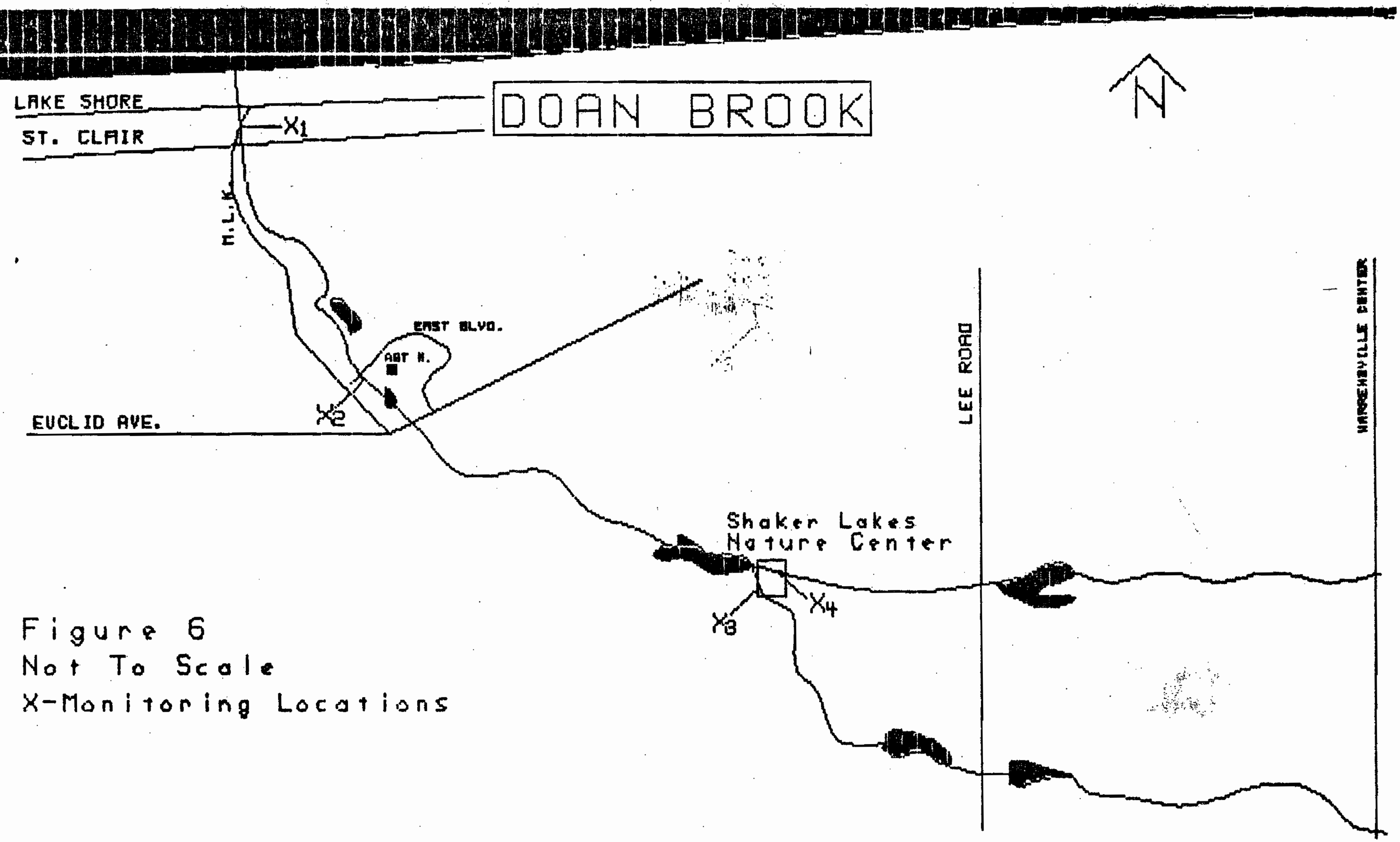


Figure 6
Not To Scale
X-Monitoring Locations

CUYAHOGA RIVER BASIN

<u>Cuyahoga River</u> - 5 Locations (Figure 7)

20) Mouth of River, Old River Road

21) Center Street Bridge

22) W. 3rd Street Bridge

23) Riverview Road Bridge

24) Station Road Bridge

<u>Big Creek</u> - 6 Locations (Figure 8)

25) Jennings Road

26) Memphis Park, East Branch

27) Memphis Park, West Branch

28) Puritas and W. 140th

29) Big Creek Parkway - Between Snow and Brookpark Roads

30) Stickney Creek

<u>Mill Creek</u> - 5 Locations (Figure 9)

31) Canal Road

32) Warner Road - Tributary to Mill Creek

33) Garfield Park - Wolf Creek Tributary

34) Rex Road

35) Northfield Road

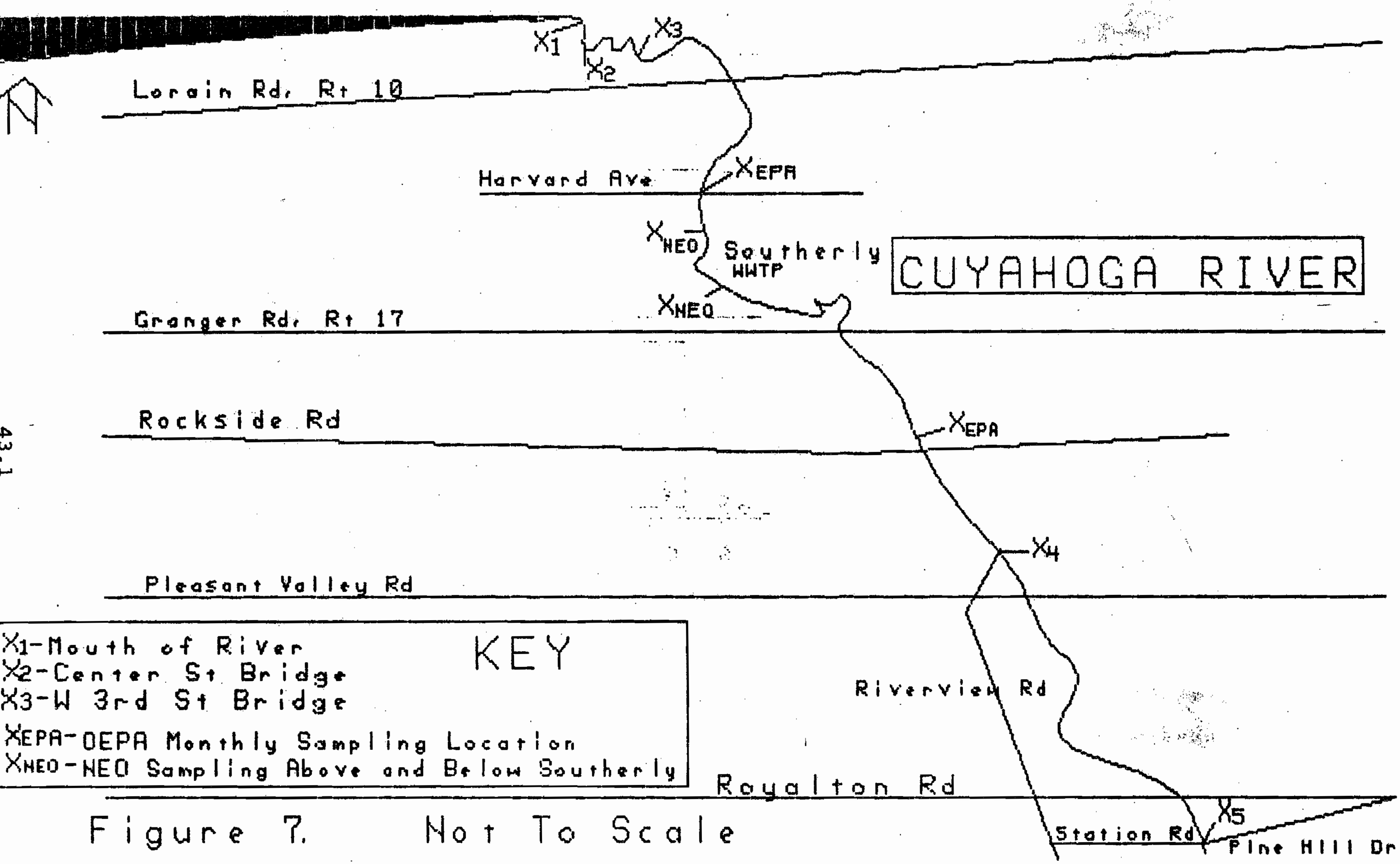


Figure 7. Not To Scale

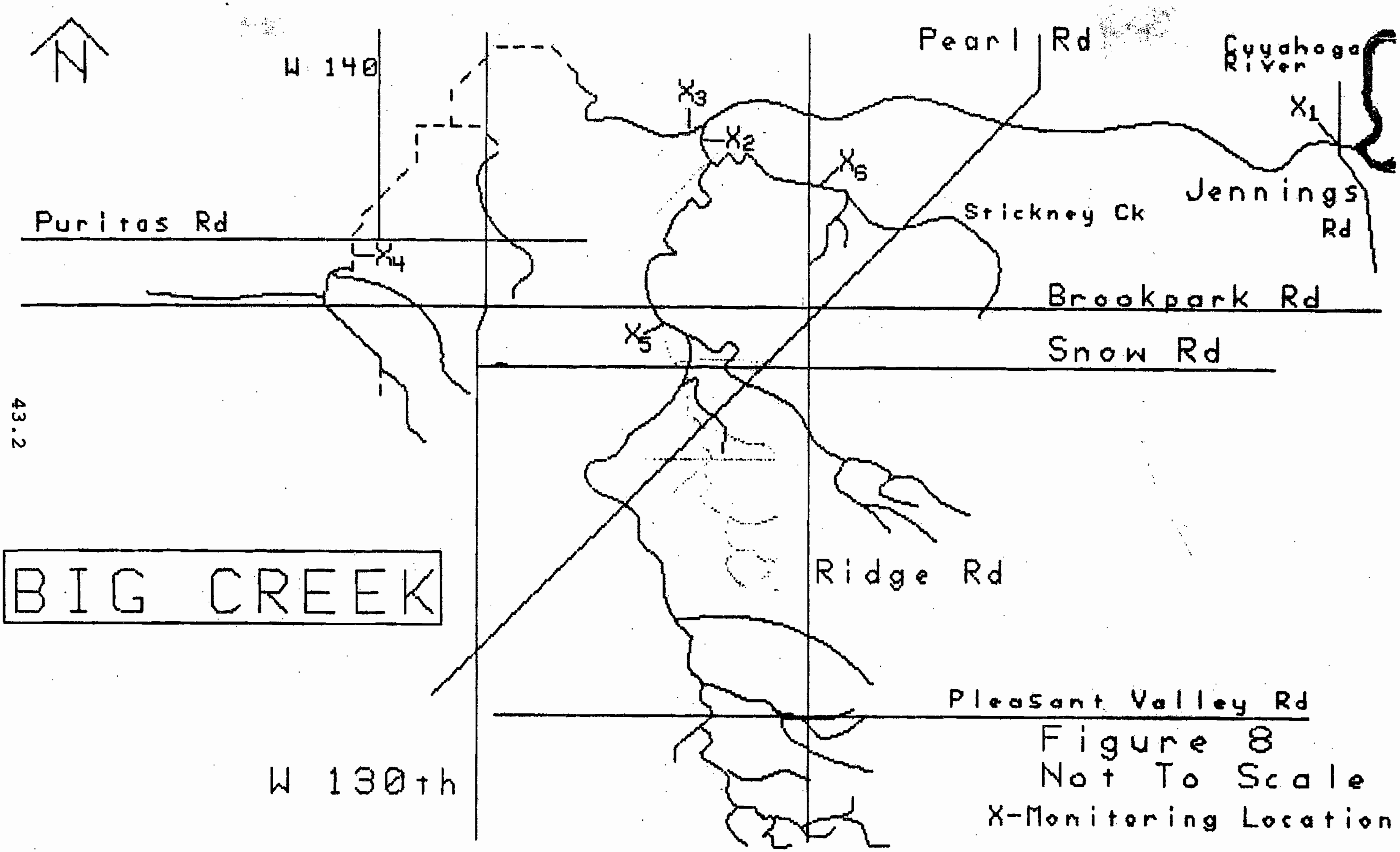


Figure 8
Not To Scale
X-Monitoring Location

43.2

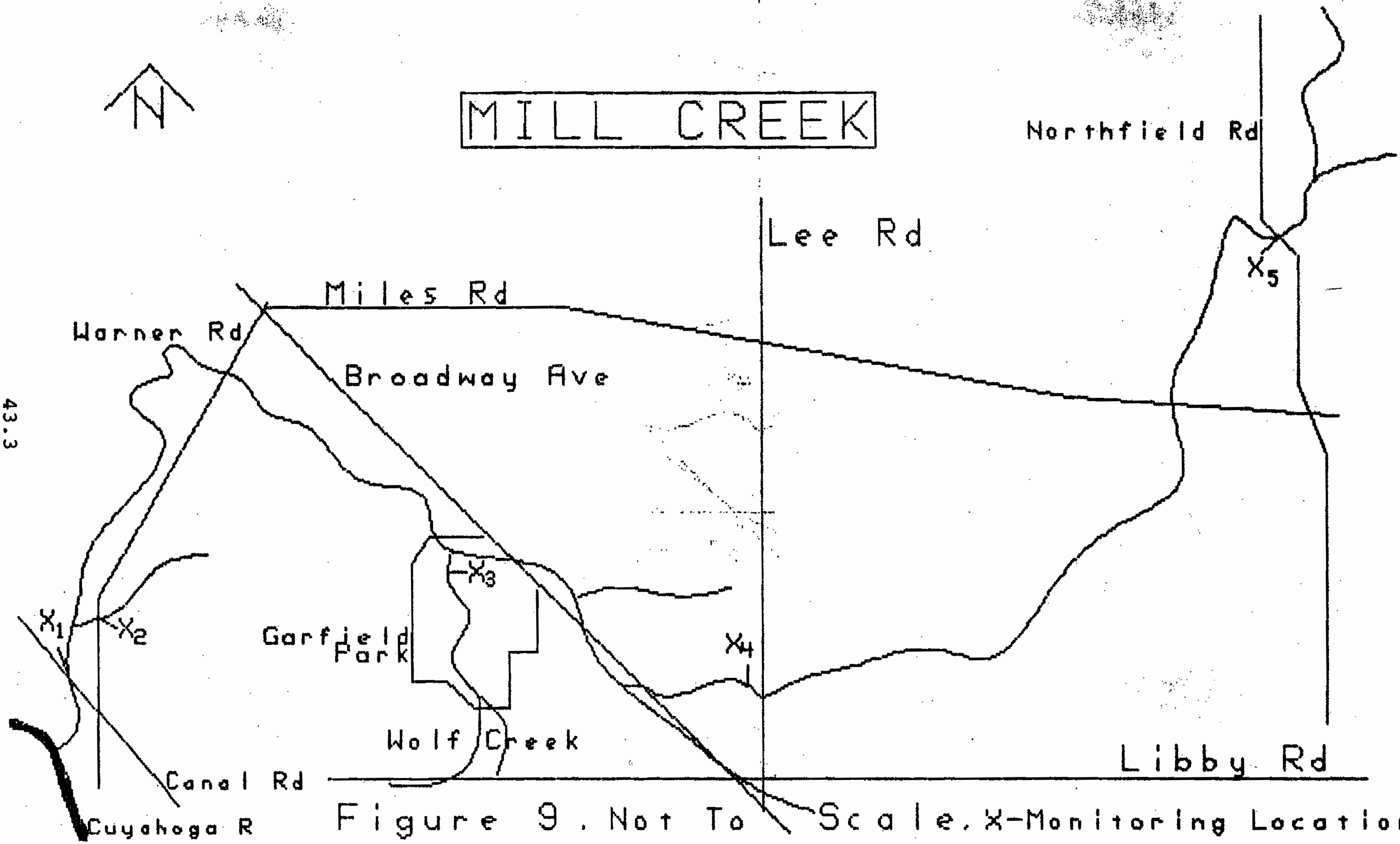


Figure 9. Not To Scale. X-Monitoring Location

West Creek - 3 Locations (Figure 10)

36) Granger Road

37) Broadview Road

38) Ridgewood Drive

Tinkers Creek - 4 Locations (Figure 11)

39) Gorge Parkway off of Dunham Road

40) Bedford Reservation Road off of Broadway Ave.

41) Richmond Road

42) Upstream of Solon WWTP effluent

Chippewa Creek - 2 Locations (Figure 12)

43) Chippewa Creek Drive off of Riverview Road

44) Avery Road

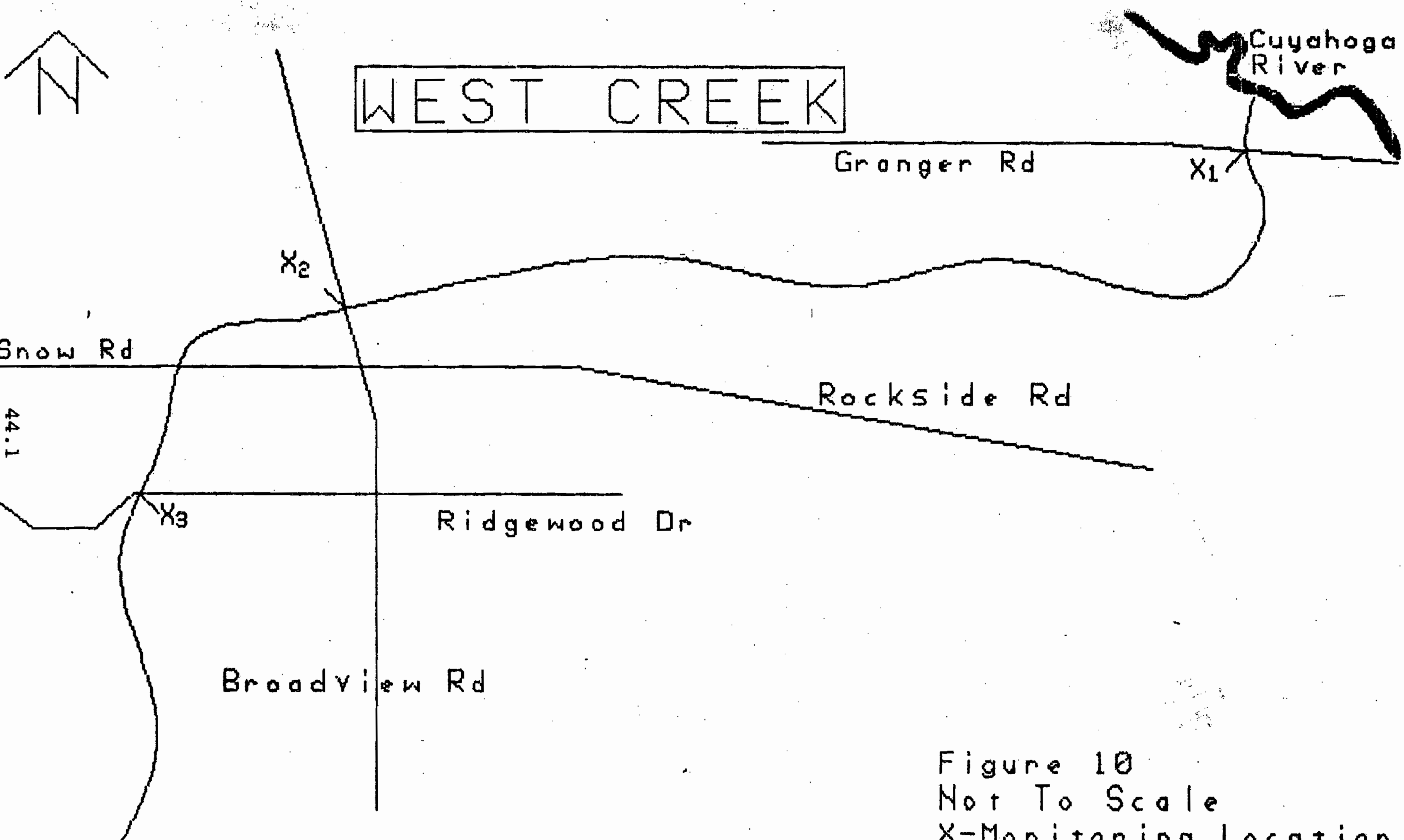


Figure 10
Not To Scale
X-Monitoring Location

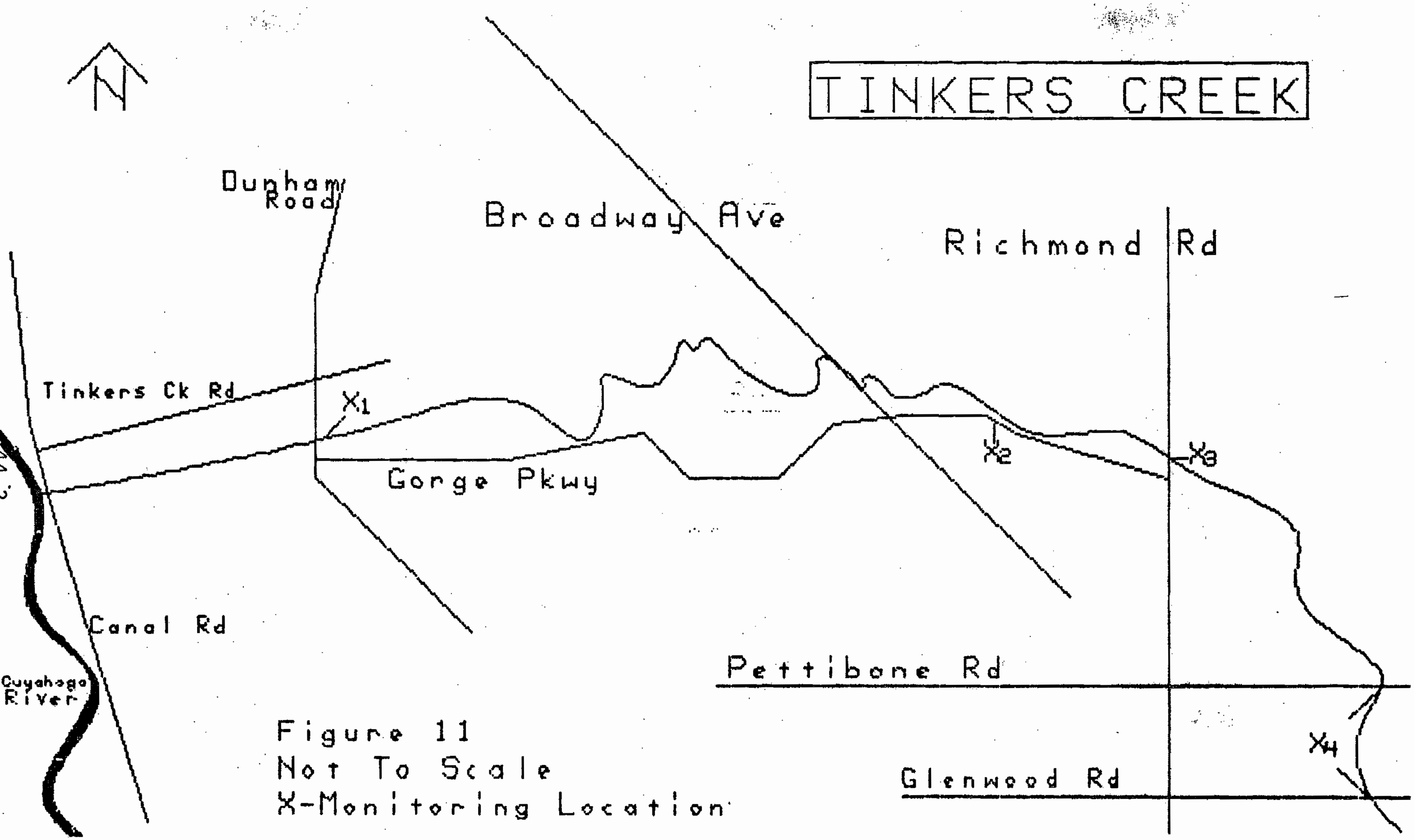


Figure 11
Not To Scale
X-Monitoring Location

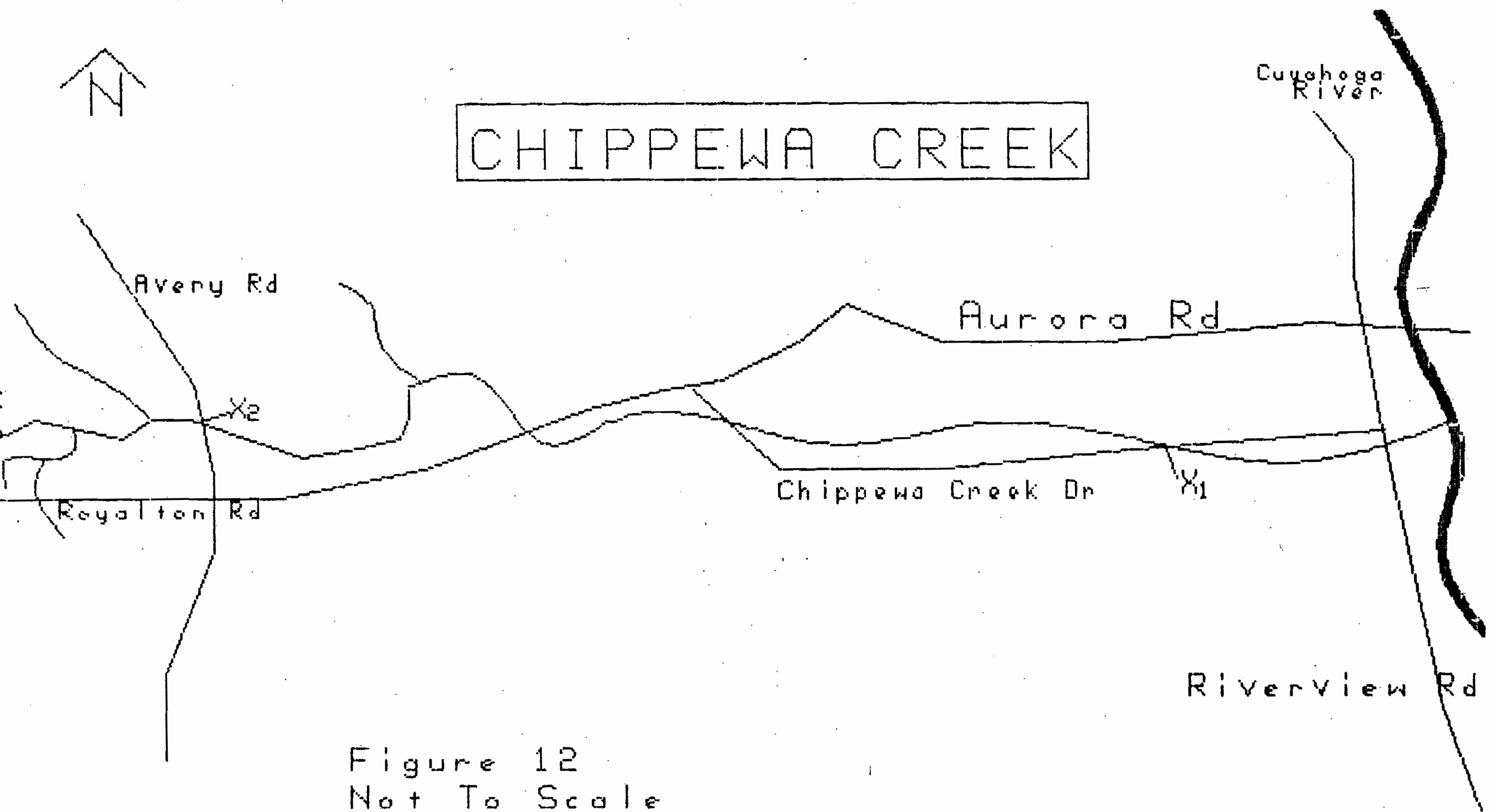


Figure 12
Not To Scale
X-Monitoring Location

STORM SEWER "STREAMS" – 4 locations (Figure 13)

45) Walworth Run at confluence with Cuyahoga River

46) Kingsbury Run at confluence with Cuyahoga River

47) Morgana Run at confluence with Cuyahoga River

48) Burke Branch at confluence with Cuyahoga River

ROCKY RIVER BASIN

<u>East Branch Rocky River</u> – 3 Locations (Figure 14)

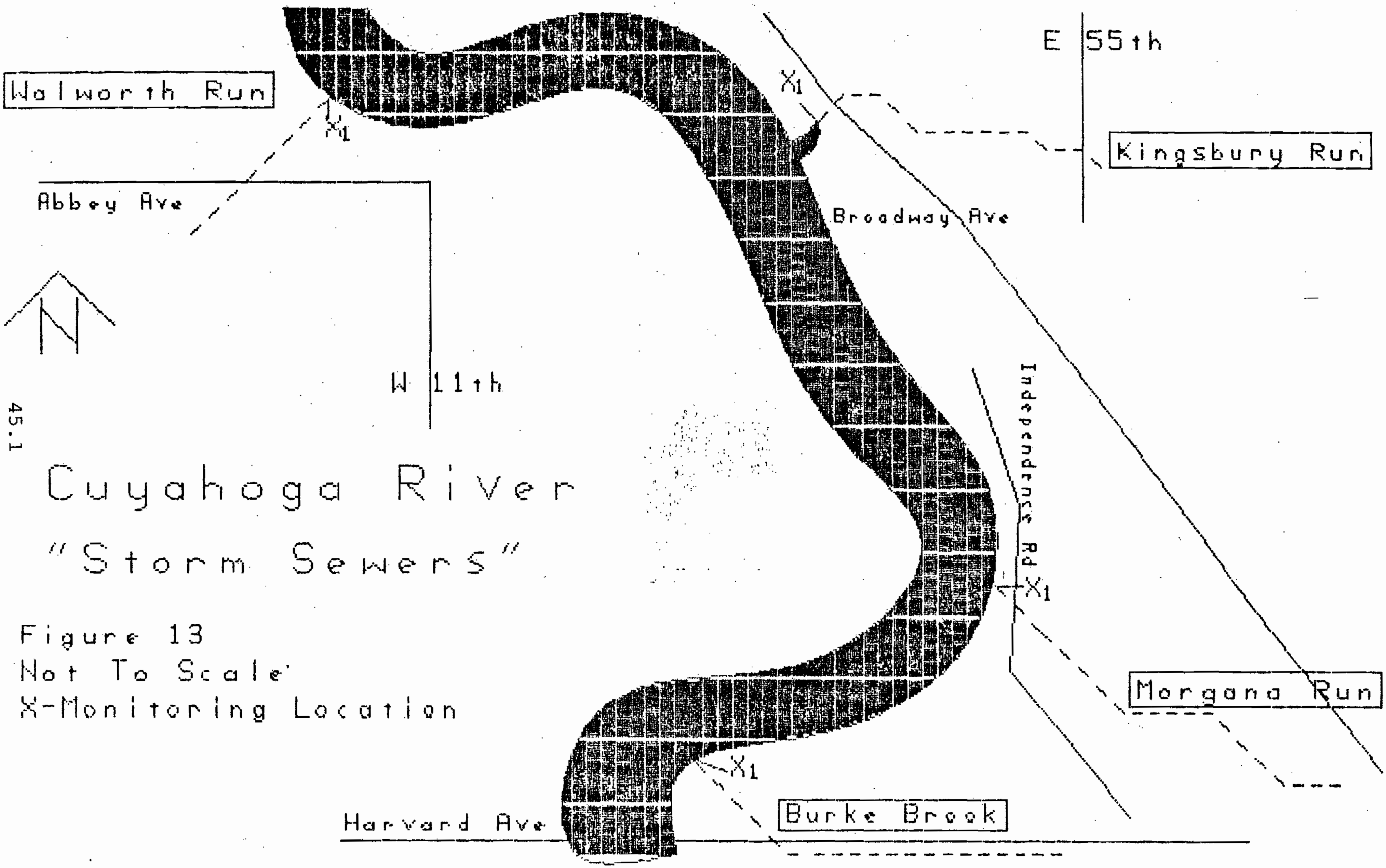
49) Rocky River Valley Parkway, North of Bagley Road
Below Berea WWTP discharge

50) North Quarry Road

51) East Access Road, Mill Creek Reservation

<u>West Branch Rocky River</u> – 1 Location (Figure 14)

52) West Branch below Blodgett Creek.



Cuyahoga River
"Storm Sewers"

Figure 13
Not To Scale
X-Monitoring Location

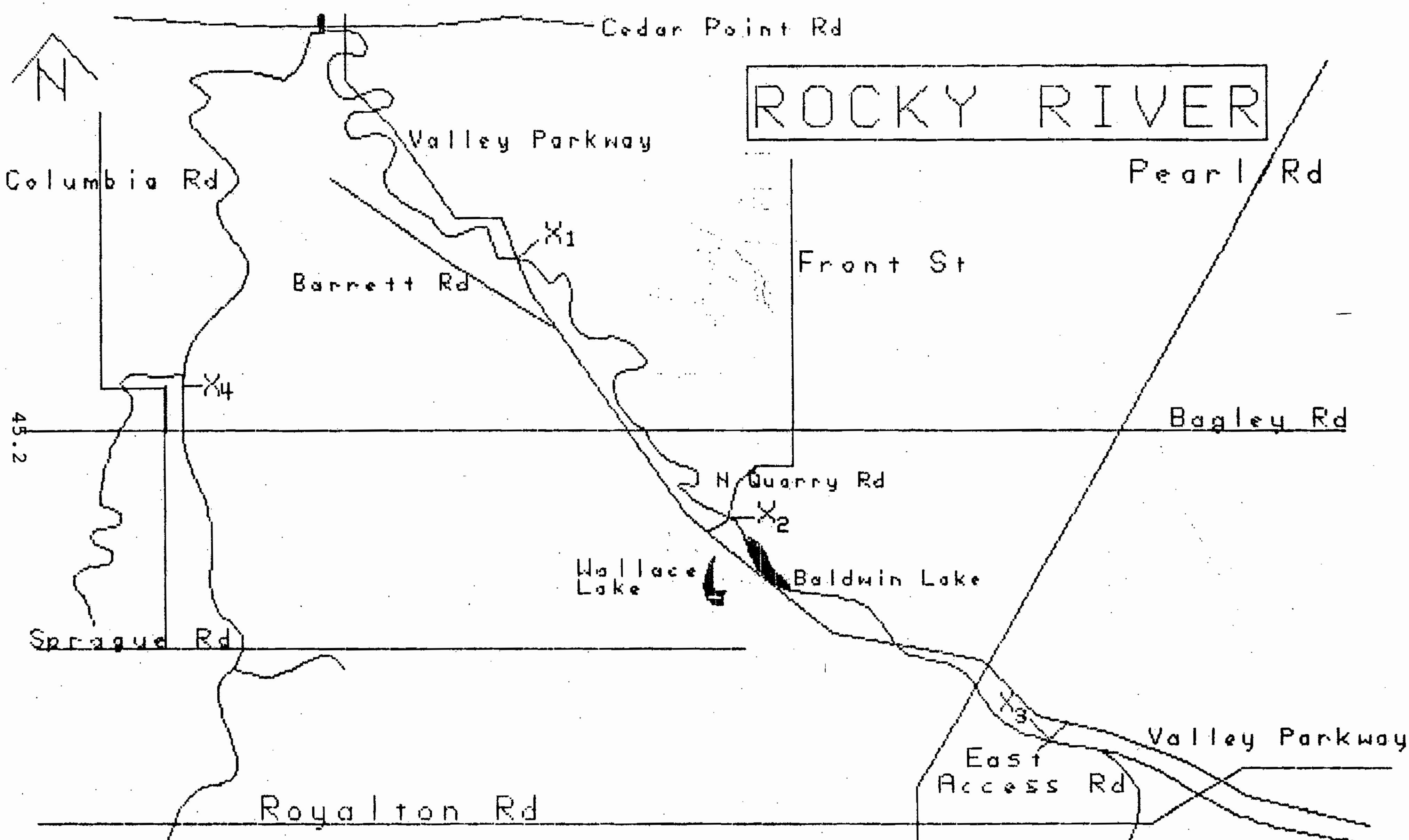


Figure 14. Not To Scale. X-Monitoring Locations

MAPS

Three types of maps are included in the IWS program. The first is a wall map composed of USGS 7.5 minute topographic maps. A total of seven maps are needed for complete coverage of the study area. The map uses numbered map pins to represent the 52 permanent sampling locations. An index of the streams and their numbered sampling locations is included on the map. The drainage patterns can be followed and the street representations are precise enough to aid in locations of problem areas. The map also gives a good impression of the size of the District's jurisdiction.

The second type of map is the computer generated maps included in the previous section describing monitoring locations. These maps are diagramatic, and not to scale. These maps delineate:

1) open stretches of streams
2) enclosed culverted stretches of streams
3) lakes
4) major roads
5) variable water quality along stretches of streams

Another version of these maps uses a series of numbers to represent variable stream quality at every sampling location. Each number represents a series of contaminants. This numbering scheme is consistent with the USEPA's reporting procedure for showing variable stream quality as specified in section 305 (b) of the 1977 Clean Water Act (P.L. 95-217). Appendix 9 contains an explanation of the numbering system used to designate variable stream quality. The appendix also explains the procedure used to update the computer maps.

The final map used is a Cuyahoga County Street Guide that illustrates the exact location of every permanent sampling location. This map will be used in the field by the investigators.

WATER QUALITY CRITERIA, STANDARDS, AND "USE DESIGNATIONS"

There is often confusion between the terms "criteria" (scientific yardsticks to measure environmental conditions) and "standards" (legal measures of environmental conditions). The misuse of the two measures can lead to misrepresentation of the seriousness or existence of a problem. The difference seems to be one of language and applicability. Similarly, problems can be created by simple legal adjustments of a standard; for example, raising a dissolved oxygen standard by 0.5 mg/l. Some questions need to be carefully considered before such an adjustment is made: Is the change meaningful? Is the new standard attainable? What are the monitoring variables that will affect enforcement? (Rice, et. al., 1978).

Water quality standards are composed of three parts:

1) an antidegradation statement

2) designated uses of individual waterbodies

3) narrative and/or numerical criteria

Section 305 (b) of the Clean Water Act requires the state EPAs to submit a biennial report to the USEPA describing the qualities of the navigable waters within the state. When possible this report also includes: analysis of the extent to which the water provides a healthy aquatic community for wildlife and recreation, the extent to which pollution controls have achieved water use designations, economic and social costs and benefits, and description of nonpoint sources of pollution (OEPA, 1986). Appendix 11 contains the portion of Ohio's 305(b) report that deals with streams in the study area.

The goal of the Act is commonly expressed as "fishable/swimmable waters" was defined as "..water quality which provides for the protection and propogation of fish, shellfish, and wildlife and provide for recreation in and on the water.." (section 101(a)(2) of PL 95-217). States set water quality standards based on the criteria needed to protect aquatic life and human health. Water quality standards are one method of assessing the progress toward attaining "fishable/swimmable waters." However, data on the physical, chemical, and biological condition of the water give a better determination of whether the goals of the CWA are being attained (OEPA, 1985).

Included in Appendix 10 are the water quality criteria for warmwater streams in northeastern Ohio as defined by OEPA as of May, 1986. A "warmwater habitat" is defined as waters that are capable of supporting balanced reproduction of populations of warmwater fish and associated vertebrate and invertebrate organisms on an annual basis. Included in the appendix is a list of all major chemical parameters and their "warmwater habitat" concentration limits. The concentration limit of many metals is dependent on the hardness of the water.

From these criteria the OEPA establishes "Stream Use Designations," which describe the allowable limits of human contact with the water. The OEPA's "Stream Use Designations" of most of the streams in the study area are included in Appendix 10. Some streams have no "Use Designations" because of the lack of data. Human contact for recreational purposes is listed as secondary contact (partial body contact), primary contact (full-body contact), and bathing waters (full contact for extended periods). The bacterial criteria used to help set these "Use Designations" and complete human contact definitions are also included in Appendix 10.

Both chemical/physical data and biological integrity are evaluated to attain "Use Designations." The criteria in Table 2 are also used to evaluate the "Use Designations."

TABLE 2

Criteria for Evaluating the Support of a Designated Use

SUPPORT OF DESIGNATED USE

A) Waters support designated use.

Minor to no impairment of uses.

B) Waters partially support designated use.

Moderate - some interference with designated uses.

C) Waters do not support designated uses.

Severe - designated uses are precluded.

BIOLOGICAL/PHYSICAL INFORMATION

A) Information shows there is no impairment of the designated aquatic life community.

B) After evaluating information, there is some uncertainty that a balanced aquatic life community is fully supported. For instance, some species may not propagate in the stream, although a put-and-take fishery exists.

C) Data show the water body does not support the designated aquatic community. For example, the community is definitely imbalanced or severely stressed; few or none of the expected species exist in the water body.

CHEMICAL INFORMATION

A) Standard is exceeded in 0 - 10% of the analyses and the mean measured value is less than the standard.

B) Standard is exceeded in 11 - 25 % if the analyses and the mean measured value is less than the standard; or the standard is exceeded in 0 - 10 % of the analyses and the mean measured value exceeds the standard.

C) The standard is exceeded in more than 25% of the analyses and the mean measured value is less than the standard; or the standard is exceeded in 11 - 24 % of the analyses and the mean measured value exceeds the standard.

DIRECT OBSERVATION/PROFESSIONAL JUDGEMENT

A) Direct observation shows the designated use is supported or the professional judgement indicates that there is no reason for the use not to be supported.

B) Direct observation shows that the use exists in the water body but the professional judgement supports that the use is not at maximum level (i.e., citizen complaint on record, fisherman success-rates declining).

C) Direct observation show overt signs of obvious use impairment (i.e., severe or frequent fish kills), or provide no evidence that the use exists. Professional judgement suggests that the use cannot be supported due to known or suspected water quality impacts.

(USEPA, October, 1985)

STREAM CLASSIFICATION

Some subjectivity is almost always involved in the classification of stream habitats and their "Stream Use Designations." However, Burke Brook, Morgana Run, and Kingsbury Run are all defined as warm water habitats, with allowable primary human contact. The enclosed culverted nature of these streams lead to obvious problems with the defining them as warm water habitats, with allowable primary human contact.

As data are acquired through the IWS monitoring program, it will be supplied to the OEPA. Where applicable, suggestions will also be included relative to changing the habitat classification and "Use Designations" of some of the area streams. Almost every stream is presently classified as a Warm Water Habitat, with a "Use Designation" of primary contact for humans (Appendix 10). It is possible that with additional data, different classifications will be applied to some streams. In addition, those streams not yet classified due to lack of data may later receive a habitat classification and "Use Designation." In both of these cases, if marked improvements in water quality are documented, the improvements in their classification will reflect favorably upon the District.

RATING STREAM CONDITION

Table 3 illustrates the rating system used to classify a stream's condition. The system is an accurate assessment of water quality because it integrates chemical and physical data with biological data. This table is a synthesis of the system used by the OEPA Division of Water Quality Monitoring and Assessment (OEPA, 1986), which uses chemical, physical, and biological characteristics; and the system used by the OEPA Biological Field Evaluations Group (OEPA, 1984), which uses biological characteristics only.

TABLE 3

Rating System for Various Stream Qualities

Exceptional (Class I, meets CWA aquatic life goals.)

Biological characteristics (previous table)

- Pollution sensitive species abundant
- Intermediate pollution tolerant species present in low numbers
- Pollution tolerant species present in low numbers
- Number of taxa greater than 29
- High species diversity, Shannon Index greater than 3.5

Chemical/Physical characteristics

- Violations of water quality standards are rare or confined to parameters of minor consequence to aquatic biota (i.e., iron, fecal coliform)

Good (Class II, meets CWA aquatic life goals)

Biological characteristics (previous table)

- Pollution sensitive species present in moderate numbers
- Intermediate pollution tolerant present in moderate numbers
- Pollution tolerant species present in low numbers
- Number of taxa, 19 - 28
- Moderately high to average species diversity, Shannon Index between 2.9 and 3.9

Chemical/Physical characteristics

- Violations of water quality standards are infrequent and generally not severe in magnitude

Fair (Class III, when based upon biological data - partially meets CWA aquatic life goals. When based upon chemical data - may, or may not meet CWA aquatic life goals)

Biological characteristics (previous table)

- Pollution sensitive species present in low numbers
- Intermediate pollution tolerant species abundant
- Number of taxa, 19 - 28
- Average to low species diversity, Shannon Index between 2.3 and 3.3

Chemical/Physical characteristics

- Violations of water quality standards common with some episodes of severe magnitude

Poor (Class IV, does not meet CWA aquatic life goals)

Biological characteristics (previous table)

- Pollution sensitive species absent
- Intermediate pollution tolerant species are in low numbers or absent
- Pollution tolerant forms abundant (unless water is too toxic for any life)
- Number of taxa less than 23
- Low species diversity, Shannon Index less than 2.7

Chemical/Physical characteristics

- Violations of water quality standards very common, with frequent episodes of severe magnitude

OHIO WATER QUALITY INVENTORY

The 1986 OEPA 305(b) report to the USEPA includes an assessment of the condition of various streams in Ohio. The condition of some of the streams in the District's study area are included in the 305(b) subbasin summaries in Appendix 11. Classified streams in Appendix 11 include:

- East Branch Rocky River
- West Branch Rocky River
- Cuyahoga River
- Tinkers Creek
- Mill Creek
- Big Creek
- Euclid Creek

According to the previously listed criteria, the conditions of these streams are listed as <u>poor</u>. Also listed in Appendix 11 are the mile segments of the stream which are used to generate the "Stream Use Designations." Most of these streams do not meet their "Use Designations."

Also included in Appendix 11 are two streams in Northeastern Ohio that meet their "Use Designations" and are classified as being in <u>good</u> condition. The streams in this classification are the Ashtabula River upstream of the City of Ashtabula, and upstream of the Mill Creek (in Ashtabula County) confluence with the Grand River. A long-term goal for the streams in the Districts study area is to reach the proper "Stream Use Designations" and match the conditions of the upper Ashtabula River and Mill Creek (in Ashtabula County).

STATISTICAL ANALYSIS

After data are acquired, two types of statistical tests will be used to show trends in water quality.

Simple Linear Regressions illustrate changes in the concentration of a parameter over time at a certain sampling location. The test shows the significance of the change in concentration over time. If necessary, the test can be used to predict the the future concentration at at location. Appendix 13 gives a further explanation of Simple Linear Regressions, and computations for this test.

A "Block-style" Experimental Design Model compares the significance between the mean concentrations of a parameter at different locations along a stream. For example, the test could be used to determine if there is a significant difference between the mean Dissolved Oxygen concentrations at West Branch, East Branch, and at the Mouth of Big Creek. Appendix 12 gives a further explanation, and computations for this test.

CONTACTS WITH OTHER AGENCIES

Appendix 13 explains the various agencies that will be exchanging data with IWS. The agencies include:

- Ohio Environmental Protection Agency (OEPA)
- Northeast Ohio Areawide Coordinating Agency (NOACA)
- Cleveland Metroparks
- Shaker Lakes Regional Nature Center
- United States Geologic Survey
- Ohio Department of Natural Resources (ODNR)
- Cities of Berea, Strongsville, and Solon
- Other potentially important contacts

STORING DATA

All data acquired will be stored on a data base file. The file includes all of the chemical parameters that will be measured at each location. There are also spaces provided for weather observations and other relevant observations. Appendix 14 contains an explanation of the observations, as well as an directions accessing the file and entering data.

APPENDIX 1

Testing Needed for OEPA Construction Grants Priority List

Ohio EPA

Re: PWQA Nomination for FY 1986
Construction Grants Priority List

July 9, 1985

Erwin J. Odeal, Acting Director
Northeast Ohio Regional Sewer District
1127 Euclid Avenue, 5th Floor
Cleveland, Ohio 44115

Dear Mr. Odeal:

Thank you for your interest in being considered for inclusion on the FY 1986 Priority List as a discharger to a Priority Water Quality Area.

To be able to determine if your community is discharging to a PWQA, and if so to be able to rank it properly on the FY 1986 Priority List, we will need additional information to be collected by your community on your plant's water quality impacts. The following items represent the types of additional data which will be needed. Before any data is collected, please contact this office so that it can be determined specifically what tasks you should perform in this effort.

1. Water Quality Sampling and Analysis:

   a. Take grab samples on 4-6 dates, from July through October, from a representative number of sampling points.
   b. Sampling points will be determined through consultation with Ohio EPA.
   c. Parameters analyzed will be: dissolved oxygen, calcium, magnesium, temperature, pH, total dissolved solids, total suspended solids, chemical oxygen demand, biological oxygen demand, ammonia nitrogen, nitrate nitrogen, total Kjeldahl nitrogen, total phosphorus, and fecal coliform.
   d. Dissolved oxygen measurements will need to be taken at both 5:00 A.M. - 8:00 A.M. and 2:00 P.M. - 6:00 P.M.
   e. If a toxics problem is suspected, additional sampling for the parameters of concern may be necessary.
   f. Data will be reviewed by Ohio EPA personnel.

NEORSD INDUSTRIAL WASTE SECTION
JUL 17 1985
RECEIVED

2. Biological Sampling:

   a. Benthic macroinvertebrate work:

      i. Community should provide qualitative data, and for larger streams also quantitative data, from a representative number of locations, taken on 4-6 occasions between July and October. Sample sites should be determined through consultation with Ohio EPA.

RECEIVED
DIRECTOR'S OFFICE
JUL 15 1985
NORTHEAST OHIO REGIONAL SEWER DISTRICT

State of Ohio Environmental Protection Agency
361 E. Broad St., Columbus, Ohio 43216-1049, (614) 466-8565

ii. Qualitative data should be obtained by dip net sampling, quantitative data by the use of artifical substrate samplers.

iii. Data should be used to develop species diversity indices. This information will be interpreted by Ohio EPA personnel.

b. Fish sampling:

i. Basic structure of sampling program should be the same as described under 2-a-i above for benthic macroinvertebrates.

ii. Fish samples should be collected by electrofishing and seining.

iii. Data should be used to develop species diversity indices. This information will be reviewed by Ohio EPA personnel.

3. Stream morphometry and bottom types should be determined and described.

a. Should look at potential capability of stream to support biota and recreational activities.

The above information will be taken by Ohio EPA and correlated to determine both degree of degradation and restoration potential. This, along with Agency information about your treatment plant, will be used by the Agency to determine whether or not your community is discharging to a PWQA, and if you are having a significant impact on the PWQA.

To be considered for inclusion on the final FY 1986 Priority List, the necessary information will need to be submitted by the close of the public comment period on the Draft FY 1986 Priority List, which will be in September.

To pursue doing the data collection work or to have any questions answered, please contact Bob Monsarrat or Jan DeLorenzo of my staff at 614/466-8866.

Sincerely,

Robert W. Monsarrat, Jr.
for

Gregory H. Smith
Manager, Environmental Planning Section
Division of Construction Grants

GHS:sw
0005D/1-2

cc: Reading
File

APPENDIX 2

Chemical Parameters

CHEMICAL PARAMETERS

Listed below is a brief explanation of the significance each of the various water quality parameters. Test methods used to determine the concentration of each parameter are consistent with Standard Methods for the Examination of Water and Wastewater, 16th edition, 1985 (American Public Health Association).

Temperature, pH, and dissolved oxygen are included because they are involved in most chemical reactions within a body of water. They are essential in determining whether or not a body of water is capable of supporting aquatic life.

Biological oxygen demand, and chemical oxygen demand are measures of the oxygen demand placed on the system (for complete oxidation of natural organic material and chemical material, respectively). If demands are too high, oxygen can be depleted until septic conditions result.

Total coliform, fecal coliform, and fecal streptococcus are counts of bacteria present in water. They are an indication of possible existence of pathogenic organisms in a system. Bacterial indicators are used to establish human contact criteria for bodies of water.

Suspended solids, total solids, and turbidity are indicators of the concentration of solids in a system, and are an indication of water clarity and probability of chemical adsorption.

Specific conductivity and total dissolved solids determine the degree to which dissolved solids affect water quality.

Acidity, alkalinity, and hardness are neutralizing capacities. Acicity is the base neutralizing capacity of water. Alkalinity is the acid neutralizing capacity of water. Hardness is the net effect of the calcium, magnesium, and other ions on water.

Sulfates and chlorides are dissolved inorganic solids. Chlorides are extremely persistent in water; they are a indication of man's activities.

Nitrates, nitrites, ammonia, organic nitrogen, and total Kjeldahl nitrogen represent all stages of nitrification within the nitrogen cycle. They are also part of the total nutrient load that enters a system. These are important in setting Water Quality Criteria and Stream Use Designations.

Total phosphorus, and soluble phosphorus are part of the total nutrient load that enters a system. These are also used for Water Quality Criteria and Stream Use Designations.

Trace metals are important because they are toxic at certain levels. They can also be used to determine the loading of a particular metal over time. OEPA uses these to set Water Quality Criteria and Stream Use Designations.

- Nickel
- Copper
- Total Chromium
- Hexavalent Chromium
- Zinc
- Iron
- Cadmium
- Lead
- Mercury

Color is a test that gives an indication of the overall appearance of the body of water.

APPENDIX 3

Determining Discharge

DETERMINING DISCHARGE

PRINCIPLES

Discharge is defined to be volume of flow over time. Discharge measurements will be made by using the cross section method. This method is used by many researchers due to its relative accuracy, low cost, and simplicity. The basic concept is to partition the width of a stream into a logical number of sections. The USEPA suggests a minimum of 10 sections (and ideally 20). The size and nature of most of the streams in the IWS study area suggest that 10 sections should be sufficient. The discharge of some of the small streams in the study can be determined using less than 10 sections. In general, however, the more sections that a stream is divided into, the more accurate the final discharge determination will be. This is due to the reduction in variability of the stream bottom.

The section of stream that is measured should be very close to the location where the chemical and physical samples and measurements were taken. This is important when determining loadings of various parameters.

Ideally, the following conditions should exist:

1) the stream should be straight and free of eddy currents,
2) the stream bed should be stable and free of large rocks and protruding obstructions.
3) the stream bed profile should be flat to eliminate vertical components of velocity.

Usually all of these conditions will not be satisfied, especially with the rocky nature of many stream substrates in the area. If possible, rocks should be moved to produce a better stream bed profile. The stream should have a minimum velocity greater than 0.5 feet/second and should be deep enough to use the current meter correctly. The velocity should be measured perpendicular to the flow direction.

It is also possible to determine the discharge of the stream using the base of a bridge or the culverts through which the stream flows. If the bridge is narrow enough to contain the flow, the cross section can be easily determined. If the stream flows through a culvert, the diameter of the pipe and depth of the water can be used to determine the area through which the water is flowing. The discharge of many of the enclosed culverted streams can be determined by this method.

After selecting the stretch of stream to be used, determine the width of the stream by stretching a tape measure across it at right angles to the direction of flow. Two poles with a tag line containing flags can be used for reference points. The stream should then be divided into the number of segments needed to characterize the flow. It is possible that the sections will be of equal width if the stream is dominated by laminar (smooth) flow. If the flow is variable the flags can be used to partition the stream into characteristic segments.

CROSS-SECTION MEASUREMENTS

1) Facing downstream, number the sections starting from the left bank and moving toward the right bank.
2) Measure the width of each section.
3) Measure the depth of each section.
4) Measure the velocity of each section.

The investigator must decide whether all three measurements are taken at each station before moving to the next station, or if another method is used; for instance, all widths are taken, and then all depths are taken, and so on. The important thing is that the investigation is consistent and all measurements are recorded <u>immediately</u> by the person assisting the equipment operator

<u>Measuring Depth</u>

The depth of the section should be measured from the center of the width of the section. The depth of the column at the center is a good indication of the average depth. If the investigator does not find this to be the case, adjustments should be made using the investigator's judgement.

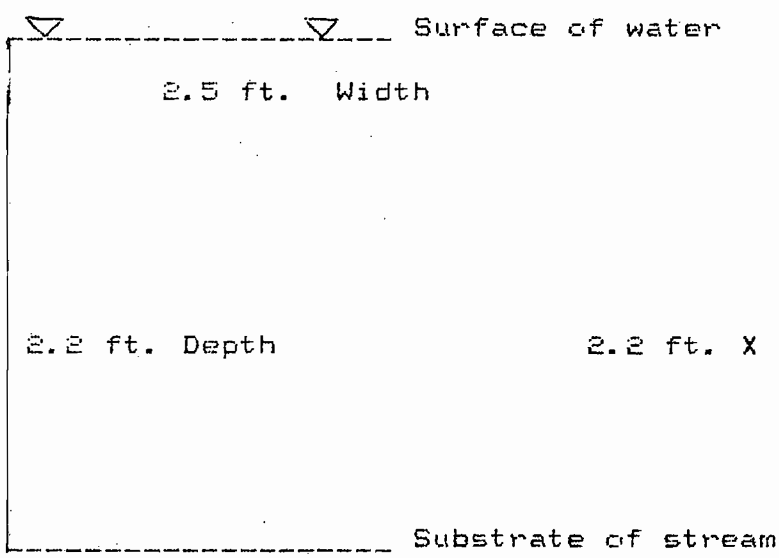
<u>Measuring Velocity</u>

The velocity reading should generally be taken in the middle of the water column. Usually, the velocity is slowest near the substrate (due to drag), and fastest near the surface (lack of drag). The velocity in the center of the column is usually representative of the average. If the investigator notices quite a bit of variability between heights of the water column, two or three readings should be taken along the column (top, middle, bottom). The average of these readings will represent the velocity of the column. This will increase to the accuracy of the test. Revolutions should be counted for 40 to 70 seconds. It is imperative that the flow meter be perpendicular to the direction of flow.

Determining Area

The area of each section is calculated by multiplying the width by the depth. For example:

Cross-sectional diagram



Area

2.2 ft. X 2.5 ft. = 5.5 sq. ft.

Average Velocity and Discharge

The average velocity is needed for this calculation. In the example below there is three velocity readings representing the top, middle, and bottom of the water column.

Cross-sectional diagram

```
__▽___________▽___Surface of water
|
|
| Velocity = 3.0 ft./ sec.                    Total Velocity
|
|________________
|
|                                                  3.0
| Velocity = 2.8 ft./ sec.                         2.8
|________________                                + 2.6
|                                                  7.4 ft./ sec.
|
| Velocity = 2.6 ft./ sec.
|________________ Substrate  of stream
```

Average Velocity   7.4 ft./ sec. / 3 readings = 2.8 ft./ sec.

The area multiplied by the determined velocity yields the discharge for that section.

Area	X	Velocity	=	Discharge
5.5 sq. ft.	X	2.8 ft./ sec.	=	15.4 cubic ft./ sec.

Sum of Discharges for Stream Sections

The sum of the discharges of all of the sections yields the discharge of the stream at that point. For example:

Section	Discharge
1	15.4 cubic ft./ sec.
2	12.4 "
3	16.0 "
4	16.0 "
5	17.3 "
6	16.7 "
7	16.9 "
8	17.0 "
9	16.6 "
10	15.5 "

= 15.98 or 16.0 cubic ft./ sec.

(Using Significant Figures)

Conversion to Million Gallons Per Day (MGD)

To convert this measurement to (MGD) multiply the discharge of the stream by .646317 .

Derivation of conversion factor:

cubic ft./sec. X 86400 sec./day X 7.48 gal./cubic ft. ÷ 1 MGD =

.646317 MGD/ cubic ft./ sec. (conversion factor)

An example is:

16.0 cubic ft./ sec. X .646317 MGD/ cubic ft./ sec. = 10.3 MGD

Discharge = 10.3 MGD

Conversion to Metric

To determine the loading of a certain parameter, it needs to be converted to metric. Example:

16.0 cubic ft/sec. X 28.32 liter/sq.ft. X 3600 sec./hr. X 24 hr./day

Which simplifies to:

16.0 cubic ft./ sec. X 2,446,848 liters/ sq.ft./ day =
(Conversion Factor)

39,149,568 liters/ day

Daily Loading

Loading is defined to be the total mass of material (in a mixture) that enters a body of water. If the concentration of iron is 2.0 mg/liter, the daily loading of iron is:

2.0 mg/liter X 39,149,568 liters/ day = 78,299,136 mg/ day

Which is equivalent to:

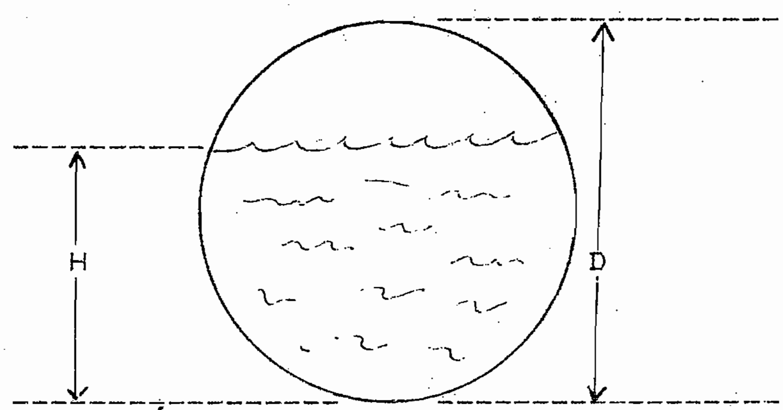
78.3 kg/ day

If the parameter is expressed in mg/liter , the loading is converted to kg/ day by dividing by 1 million. If the parameter is in ug/liter, the loading is converted to kg/ day by dividing by 1 billion.

DETERMINATION OF DISCHARGE FROM AN ENCLOSED CULVERT

The only difference in this calculation is determining the area through which the water flows. If the flow is through a box culvert, the area is simply the width of the culvert times the depth of the water. If the culvert is round the calculation is as follows:

Round Culvert:



H and D are in feet

H/D = column B, read column C (From TABLE 4)

C X D = area, A in square feet

A X Velocity = Discharge in cubic feet/second (CFS)

CFS X 448.83 = Gallons/minute (GPM)

GPM X 1440 = Gallons/day (GPD)

TABLE 4 Determining Discharge From An Enclosed Culvert

B	C	B	C
0.01	0.0013	0.51	0.4027
0.02	0.0037	0.52	0.4127
0.03	0.0069	0.53	0.4227
0.04	0.0105	0.54	0.4327
0.05	0.0147	0.55	0.4426
0.06	0.0192	0.56	0.4526
0.07	0.0242	0.57	0.4625
0.08	0.0294	0.58	0.4723
0.09	0.0350	0.59	0.4822
0.10	0.0409	0.60	0.4920
0.11	0.0470	0.61	0.5018
0.12	0.0534	0.62	0.5115
0.13	0.0600	0.63	0.5212
0.14	0.0668	0.64	0.5308
0.15	0.0739	0.65	0.5404
0.16	0.0811	0.66	0.5499
0.17	0.0885	0.67	0.5594
0.18	0.0961	0.68	0.5687
0.19	0.1039	0.69	0.5780
0.20	0.1118	0.70	0.5872
0.21	0.1199	0.71	0.5964
0.22	0.1281	0.72	0.6054
0.23	0.1365	0.73	0.6143
0.24	0.1449	0.74	0.6231
0.25	0.1535	0.75	0.6318
0.26	0.1623	0.76	0.6404
0.27	0.1711	0.77	0.6489
0.28	0.1800	0.78	0.6573
0.29	0.1890	0.79	0.6655
0.30	0.1982	0.80	0.6736
0.31	0.2074	0.81	0.6815
0.32	0.2167	0.82	0.6893
0.33	0.2260	0.83	0.6969
0.34	0.2355	0.84	0.7043
0.35	0.9450	0.85	0.7115
0.36	0.2546	0.86	0.7186
0.37	0.2642	0.87	0.7254
0.38	0.2739	0.88	0.7320
0.39	0.2836	0.89	0.7384
0.40	0.2934	0.90	0.7445
0.41	0.3032	0.91	0.7504
0.42	0.3130	0.92	0.7560
0.43	0.3229	0.93	0.7612
0.44	0.3328	0.94	0.7662
0.45	0.3428	0.95	0.7707
0.46	0.3527	0.96	0.7749
0.47	0.3627	0.97	0.7785
0.48	0.3727	0.98	0.7816
0.49	0.3827	0.99	0.7841
0.50	0.3927	1.00	0.7854

APPENDIX 4

Macroinvertebrate Sampling and Analysis

QUALITATIVE ANALYSIS TECHNIQUES FOR SAMPLING MACROINVERTEBRATES

The objective of qualitative studies is to determine the presence or absence of benthic organisms that have varying degrees of tolerance to pollution. Many techniques can be used to determine what species are present in a segment of a stream. An advantage of qualitative analysis is that it shows more of a complete sample of which species are present. Quantitative samples can miss some species since they are limited to a few square feet of sampling area.

The rocky nature of most of the stream substrates in the area disallows the use of most grab samplers (i.e., Ekman Grab). After entering the stream, the investigators should collect all types of benthos. The hand picking technique should be used in most cases. Specimens are collected by turning over rocks, leaves, and by picking directly off of the substrate. Samples should be collected from all types of habitats. The habitat specimens collected should be recorded (runs, riffles, or pools).

Species that live in the sediments can be sampled using a core sampler. The sediments are then washed through a bucket with a 30 mesh screen bottom. The sediments wash through the screen and the benthos are retained in the bucket.

It is also possible to used a Surber Square Foot Sampler in a qualitative method as a "kick sampler." (The Quantitative Analysis Section includes a description of the use of the Surber

Sampler). Scrubbing the rocks and stirring up the sediments will result in a representative sample of the area.

For qualitative sampling each species should be returned to the lab for analysis. It is best if a few of each type of organism are collected. Often samples can be damaged during transport, sorting, and identification. Also, organisms that appear to be the same to the naked eye can sometimes be different species under closer inspection.

Hand picked samples of each species should be retained in small bottles and preserved with AGW (alcohol 70%, glycerol 20%, water 10%). Larger masses of organisms collected from the core sampler (or by using the Surber Sampler for "kick samples") should be well washed through the 30 mesh bottomed bucket. These samples can be retained in larger bottles. Water and formalin should be added to approximate a 10% solution. After the final washings in the laboratory the samples are preserved in AGW.

LABELING SAMPLES

All vials containing specimens should be labeled with:

1) Log Number - Sampling Station Number / Year / Month / Date

   Example: 43/87/5/25 (This sample was taken May 25, 1987 in Chippewa Creek above the confluence with the Cuyahoga).

2) Type of sample (hand pick, core, Surber)
3) Environment (run, riffle, pool)
4) The number of any chemical sample taken concurrently

QUANTITATIVE ANALYSIS TECHNIQUES

Quantitative sampling involves the estimation of numbers of organisms (or biomass) per unit area. The program will be using a Surber Square Foot Sampler which presumably collects all of the organisms enclosed in a one square foot area (.09 square meters). All organisms in a one square foot area are dislodged and collected in a net. This type of sampler is best used in waters less than 18 inches deep. In deeper waters the program will eventually use a Hester-Dendy Multiple Plate Sampler. This is an artificial substrate sampler that is placed in a stream for six weeks. Organisms that inhabit the sampler are collected at the end of that period.

The Surber Sampler consists of a net (number 30 mesh) that has a hinged connection to a frame one square foot in area. The sampler is positioned so that the opening of the net faces upstream, and the closed end of the net downstream. The sampler frame is pushed into the stream substrate so that it is stationary. Within the area of the frame, all of the stones, detritus, and sediments are scrubbed and stirred to dislodge all of the organisms. The materials are carried downstream. The sediments pass through the net, and the detritus and benthos are retained in the net. The sample are then washed in a 30 mesh bottomed bucket and placed in a container. Water and formalin are added to the sample to approximate a 10% solution. The sample should be labeled with the same information as specified for qualitative samples.

OEPA suggests this procedure be completed 5 times per sampling visit. In total, the organisms sampled represent 5 square feet of the substrate.

The Hester-Dendy is a multiple plate artificial substrate sampler that is place in the stream for a period of time, which allows a benthic community to form on the plates. (The following discussion of sampling techniques is adapted from OEPA Quality Assurance Manual 1980.) The sampler is constructed of three-inch square plates and one-inch spacers made of 1/8 inch tempered hardboard. The spacers are at variable widths to create different habitats. A total of eight plates and twelve spacers are used for each sampler. A 1/4-inch eyebolt runs through the center of the apparatus. The total surface area of the sampler (excluding the eyebolt) is 145.6 square inches; approximately 1 square foot.

Concrete blocks are used to anchor the sampler in the stream. They also prevent the sampler from coming in contact with the natural substrate. In water deeper than four feet the samplers are attached to a float (1 liter cubitainer) to keep them within the four foot depth. A set of samplers consists of three units. The three units should be evenly spaced across the stream while maintaining similar habitats. Samplers are placed in runs (laminar flow) rather than in pools or riffles. An attempt should be made to place all samplers in similar habitats.

All samplers should be exposed for six weeks. IWS should use six week periods between approximately June 15 and September

15 (the sampling period for National Ambient Monitoring Stations).

When the samplers are retrieved, each is placed in a one quart plastic container while still submerged. This is done so organisms are not lost during removal. The anchor line is cut and the sampler is removed from the water. Enough formalin is added to each container to approximate a 10 % solution. The container should be labeled as specified earlier.

Because quantitative sampling can miss some of the important species (limited area of sampling and preference of substrate by many organisms), qualitative samples should also be taken at the time of quantitative samples. Core samplers or grab samplers can be used to collect qualitative samples. These methods are more precise than qualitative samples and can be used for comparisons of number of individuals per unit area. It is also possible to determine productivity of a stream because the biomass (weight of benthos) per unit area can be determined. (The following discussions are based on sections of Biological Field and Laboratory Methods, USEPA, 1973.)

SIEVING

There are always materials left in the samples when they are returned to the laboratory. The sediments, organic materials (detritus), and other materials can be removed by again washing the samples through a 30 mesh screen. The original sample is placed on a 30 mesh screen and agitated as it is washed in water. Any large pieces of debris or rocks should be removed manually.

It is important that no organisms are removed with the debris. A good sieve has no cracks or crevices in which organisms can become lodged. Preserved organisms should be sieved as soon as possible, because they often become fragile and identification of a broken sample is difficult.

Organisms are retrieved from the Hester-Dendy Multiple Plate Sampler by placing it in a bucket of water, dismantling it, and scrubbing the plates with a soft toothbrush. The bucket of water with the sample is run through a 30 mesh screen, which retains the organisms.

PRESERVING SAMPLES

If it is not possible to identify the organisms immediately, they will have to be preserved in AGW. The container should be filled no more than half way with full organisms before the AGW is poured into the container.

Various sized containers are needed for field and laboratory preservation of samples. The small vials containing hand picked samples are placed into liter containers to keep them organized. Liter-sized and smaller containers can be used to store the core, Surber, and Hester-Dendy samples.

LABELING SAMPLES

The containers should be labeled with the same information as the field container (log number, sampling technique, and habitat).

A ledger must be started. As soon as the sample is preserved or ready for analysis the following information should be recorded in the ledger:

1) log number

2) sampling technique

3) habitat

4) investigators

5) the regular IWS chemical sample number (if chemical sample is taken concurrently)

6) other environmental information (depth of water, recent rain, discharge of stream)

The front of the ledger should contain a listing of all 52 permanent sampling locations. If special samples are taken, the log number should be in the same format as the permanent locations. The station should be assigned a number, in order, using the notation S1, S2, S3, etc. If the first special sample is taken on June, 5, 1987, it will be assigned a log number of S1 / 87 / 6 / 5. The numbers assigned to special sample stations should be recorded in the front of the ledger.

SAMPLE STORAGE

Ideally, samples should be analyzed as soon as possible after they are collected. However, if this is not possible, it is good is samples should at least be sorted into gross taxonomic groups before being stored. However, the many time constraints that are placed on IWS will necessitate the storage of many samples until they can be analyzed. The fourth week of every month (not considered in normal sampling time), and winter (November - March) will be the best times for benthic analysis.

A system will have to be established to store the samples in an organized fashion. The system should be established immediately to avoid lost or mixed up samples. Until IWS's new building is completed, space is limited in the existing facility.

A group of consistent sized boxes with dividers, a book shelf, or a cabinet are possible storage locations. The best method is storage in cabinets, one of which contains samples that have to be analyzed, and one that contains analyzed samples that have to be retained for certain reasons. Samples should be placed in the cabinets in chronological order. After they are analyzed they can be disposed of, unless they need to be retained for a specific reason.

SORTING SAMPLES

Samples are sorted into gross taxonomic groups by eye and by low-power scanning lens. A small amount of organisms (approximately a tablespoon) are placed in a white enamel pan filled approximately 1/3-filled with water. Most of the preserved organisms will float free of any remaining debris.

IDENTIFICATION OF SAMPLES

The taxonomic level to which organisms are identified depends on the skills of the identifier. The taxonomic level should be consistent throughout a given study. The long-term nature of the IWS study and the period of familiarization of the investigators will initially cause different levels of identification. As investigators become more familiar with the the organisms a consistent level of identification should be established. Most organisms should be identified to at least the family level. Identification to the genera level should be completed if possible.

An index of all organisms sampled throughout the program should be started to aid in identification. Organisms found that are not in the index should be identified and retained in the index. Likewise, when organisms already in the index are identified to a more specific taxonomic level, the index should be modified.

Identification to the family level is usually possible with a 50X stereoscopic microscope. Identification to the genus and species level often takes a compound microscope with power up to 100X.

All identifications are recorded on a Macroinvertebrate Bench Sheet similar to the one at the end of this section. A classification of the tolerance (to pollution stress) of many macroinvertebrate species by various authors is located with the reference materials.

DETERMINING BIOMASS

Biomass (weight of organisms per unit area) is a measure of the productivity of a stream. If IWS determines that this measurement would be useful for comparison the procedure should be performed as described below.

Dry weight of organisms is determined by drying them to a constant weight in an oven for four hours at 105 degrees C. The Dry weight can also be obtained by vacuum drying at 105 degrees C, for 15 to 30 minutes at a pressure of 1/2 atmosphere. Cool to room temperature in a desiccator and weigh.

Ash-free dry weight can be calculated by completely incinerating the organic material at 550 degrees C for 1 hour. Cool the ash to room temperature in a desiccator and weigh. The biomass is expressed as ash-free dry weight.

DIVERSITY INDEX

After quantitative samples are identified and counted, the diversity indices are used to show relative stream quality. IWS will make use of the Shannon Index. The index becomes larger with an increase in diversity of organisms in a stream. Since stream quality improves as diversity increases, a larger diversity index indicates a cleaner stream. The Shannon Index - (Shannon, 1948):

$$\bar{d} = -\sum_{i=1}^{S} \frac{ni}{n} \log 2 \frac{ni}{n}$$

where: ni is the total number of individuals in the ith taxa,

n is the total number of individuals, and

s is the total number of taxa.

BENTHOS AS WATER QUALITY CRITERIA INDICATORS

The Shannon Index and concept of indicator species (species usually found in polluted or pristine waters) are used to establish water quality criteria. Streams quality is categorized by qualitative and quantitative evaluations of the macroinvertebrate community. Evaluations based on presence of a single organism or single sample should be avoided. The CEPA (Biological Field Evaluations Group, 1984) has developed four stream classes; Class I (excellent), Class II (good), Class III (fair), Class IV (poor). Table 5 summarizes the se criteria.

TABLE 5 Criteria Used To Classify Streams Based On Quantitative And Qualitative Biological Evaluations

(A complete stream classification using biological, chemical, and physical characteristics is located in Table 3, in the text.)

Class I (exceptional)

- Pollution sensitive species abundant.
- Intermediate species present in low numbers.
- Tolerant species present in low numbers.
- Number of taxa greater than 29.
- Exceptional diversity, Shannon Index greater than 3.5.

Class II (good)

- Pollution sensitive species present in moderate numbers.
- Intermediate species present in moderate numbers.
- Tolerant species present in low numbers.
- Number of taxa 24 - 33.
- High diversity, Shannon Index between 2.9 and 3.9.

Class III (fair)

- Pollution sensitive species present in low number.
- Intermediate species abundant.
- Tolerant species in moderate numbers.
- Number of taxa 19 - 28.
- Moderate diversity, Shannon Index between 2.3 and 3.3.

Class IV (poor)

- Pollution sensitive species absent.
- Intermediate species present in low numbers or absent.
- Tolerant species are abundant (unless waters are too toxic to support any life).
- Number of taxa less than 23.
- Low diversity, Shannon Index less than 2.7.

TABLE 6

MACROINVERTEBRATE LAB BENCH SHEET

Name of water body ______________________ Lot No. __________

Collected by ______________________ Station No. __________

Sorted by ______________________ Date collected __________

*	DIPTERA	L(N)[1]	P[1]	TOTAL #	DRY WGT (mg)
	TRICHOPTERA				
	PLECOPTERA				
	EPHEMEROPTERA				
	ODONATA				
	NEUROPTERA				
	HEMIPTERA				
	COLEOPTERA				

*	CRUSTACEA	TOTAL #	DRY WGT
	HIRUDINEA		
	NEMATODA		
	BIVALVIA		
	GASTROPODA		
	OTHER		

Total # of organisms ______________ Total dry weight ______________

Total # of taxa ______________ Ash-free weight ______________

* Initials of taxonomists in this column

[1] L=larvae, N = nymph, P = pupae

Source: USEPA, 1973

APPENDIX 5

Periphyton Sampling and Analysis

SAMPLING METHODS FOR PERIPHYTON

The following discussions of sampling methods and analysis are based on Biological Field and Laboratory Methods, (USEPA, 1973).

QUALITATIVE SAMPLING

If time limits call for qualitative studies (those without the use of artificial substrates), then samples are taken directly from the natural substrates. Periphyton usually appears as brown, greenish brown, or green growth on the substrate. In standing or flowing water, periphyton may be qualitatively collected by scraping the surface of several rocks or the stream bottom with a pocket knife. As many different habitats as possible should be sampled during this procedure. This method may also be used as a quantitative sampling if the exact surface area being sampled is known. A composite sample of 5 to 10 ml is sufficient.

After scraping has been completed, store the materials in bottles containing 5% formalin if the sample is needed for identification or counts. If the sample is needed for chlorophyll analysis do not preserve. Store at 4 degrees C in the dark in 100 ml of 90% aqueous acetone. Use bottle caps with a cone shaped polyethylene seal to prevent evaporation.

QUANTITATIVE SAMPLING

One possible technique of quantitative sampling is to scrape the periphyton from a known surface area, as described above.

Another method is to use a standard (plain, 25 X 75 mm) glass microscope slide. (Plexiglass is a more sturdy option). Numerous methods of stabilizing the slides on the substrate. Plastic Tak can be used to anchor the slides to rocks or bricks on the stream bottom. A small slide holder can be constructed a keep a number of slides stationary during growth periods. It is important that all slides be placed in similar conditions in the stream. There should be a minimum of four substrate samplers for this analysis.

The length of exposure depends on: season, growth patterns, and hydrologic conditions. The optimum exposure period is between 2 and 4 weeks.

SAMPLE PREPARATION AND ANALYSIS

The sample preparation varies according to the method of analysis; see the 16th edition of Standard Methods, Section 602-3 (APHA, 1985).

Identification and Autotrophic index are the most useful analyses for the IWS program.

The end of this section includes a list of references that aid in periphyton identification.

The Autotrophic Index is a ratio:

A.I. = Ash-free weight (mg/m2) / Chlorophyll a (mg/m2).

The ash-free weight (amount of organic material) is determined by heating a dried sample of periphyton to 500 degrees C. for one hour. The ash weight subtracted from the dry weight yields the ash-free weight. The chlorophyll a content is used as an estimation of the algal content of the sample. Periphyton growing in clean water contains 1 - 2 % chlorophyll a by dry weight. To extract the chlorophyll a grind and steep the sample in 90% aqueous acetone. (A more exact description of these two methods is located in USEPA Biological Field and Laboratory Methods, 1973.) The A. I. can be used to determine the extent of degradable organic pollution. Periphyton communities in clean water are dominated by algae, and have an A. I. of 50-100. However, if the water is grossly polluted by degradable organic wastes, non-chlorophyll consumer organisms (i.e., bacteria, slimes) will overgrow the algae. The index in this situation will be greater than 100 (USEPA, 1977).

This test is appropriate for many of the severely degraded streams in the District's study area. A few of these streams could be tested annually using the quantitative scraping technique. Sampling and analysis a few years later (especially after the installation of an interceptor) will show changes in water quality. This information could be a useful supplement to the normal chemical analyses. The exact frequency and locations will be determined by the program coordinator.

APPENDIX 6

Macrophyton Sampling and Analysis

SAMPLING METHODS FOR MACROPHYTES

The size and sturdy nature of most macrophytes makes sampling and analysis relatively easy.

Qualitative sampling involves visual inspection and sampling of all representative species. If identification of the plants is completed within a day, there is no need for preservation. If the identification will be completed later, or the sample seems to be delicate, the plants can be preserved in a buffered 4% formalin solution. The investigation should note if the plant coverage is dense, moderate, or sparse. Samples can be taken by pulling the plants from the substrate, or by cutting them free.

Quantitative sampling involves sampling plants from a known area and calculating the standing crop (amount of organic material), or productivity of the plants. These measures can be related to pollution only on a broad level and thus have limited applicability to the IWS monitoring program.

Samples can be taken when periphyton is sampled. As with periphyton sampling, frequency is dependent on the importance of the data, and the amount of time available.

APPENDIX 7

Fish Sampling and Analysis

FISH SAMPLING AND ANALYSIS

Numerous techniques are available for sampling fish. They can be samples with seines, electrofishing, chemicals, and hook and line. The most efficient method of sampling fish in area streams (with respect to time and money) is the seine.

The seine is essentially a strip of strong netting hung between a float line at the top, and a lead line on the bottom. The ends of the seine are tapered because they are in more shallow water. The mesh size of seines vary to enable researchers to catch varying sizes of fish.

Each end of the seine is controlled by an investigator. The investigators walk upstream and collect fish in the seines. Results are expressed in number of fish caught per unit area of seine. This is truly a qualitative measure; however, quantitative measurements with seines are difficult to perform (USEPA, 1973). This method is more useful in determining the variety rather than the number of fish inhabiting the stream.

The length of seines vary considerably; there should be a determination of the appropriate size needed for most of the area streams. The mesh size of the seine varies depending on size of fish to be sampled (i.e., carp or minnows).

Both the total size and mesh size of seines are restricted by ODNR. A license is needed to seine any stream within Ohio. A permit application is included at the end of this appendix. The permit must be completed and sent to Columbus prior to any sampling. The exact location and type of sampling must be included on the application. Locations must be decided upon before in the sampling season to allow time for the permits to be authorized. A $2.00 fee accompanies the licensing permit. The address of ODNR is included in Appendix 12. Upon request, ODNR will send IWS a few applications to have on reserve.

SAMPLE PRESERVATION AND IDENTIFICATION

(This section is based on Biological Field and Laboratory Methods, USEPA, 1973.)

Preserve fish in the field in a 10% formalin solution. Add three grams of borax and 50 ml gylcerin to every liter of formalin solution. Specimens larger than 7.5 cm should be slit on the side at least 1/3 of the length of the body to permit the solution to bathe the internal organs.

If the fish cannot be identified immediately they need further preparation. Fixation can take from a few hours for small specimens to a week for larger fish. After fixation, the fish may be washed in running water, or by several changes of standing water (24 hours of soaking). After washing they are placed in 40% isopropyl alcohol. One change of alcohol is needed to remove the last traces of formalin. Then after they can be permanently preserved in 40% isopropyl alcohol.

The same record keeping scheme as described for macroinvertebrates should be used for fish.

Because different species have differing tolerance to pollution, identification of the species of fish is the important aspect of water quality analysis.

Weight and size of the individuals should be recorded (use metric system). For each sample, a length frequency graph should be constructed. Plot the number of fish per length interval on graph paper. Since fish grow as they age, peak on the graph represents an age group.

Community diversity can be determined using the Shannon Index (same as macroinvertebrates). The overall well-being of a fish community can be determined using a composite index (Gammon, 1976). The larger the index, the better the condition of the community.

Composite Index:

$$I = 0.5 \log_e N + 0.5 \log_e B + \bar{H}\ (\text{no.}) + \bar{H}\ (\text{wt.})$$

H = relative number of all species

B = relative weight of all species

H (no.) = Shannon Index based on relative numbers

H (wt.) = Shannon Index based on relative weight

OFFICE USE ONLY
☐ Annual Report Received
Permit No. ______

Ohio Department of Natural Resources
Division of Wildlife

Form 167
(R784)

SCIENTIFIC COLLECTING PERMIT APPLICATION

Check Appropriate Block: ☐ New ☐ Renewal

Full Name of Applicant		Telephone	Date of Birth	Social Security No.
Street Address			County	
City	State		Zip Code	
Name and Address of Corporation, College, University, Organization or Agency which you are representing:				

Recommendation of two well-known scientific persons or teachers of science:

The applicant is of good character, and may properly be entrusted with such a permit.

(Signature)	(Address)	(Occupation)
(Signature)	(Address)	(Occupation)

Check or money order No. ______ for $2.00 payable to the **Ohio Division of Wildlife** is attached.

The applicant agrees to keep daily records, submit an annual report and abide by provisions of the law:

______ (Applicant's Signature) ______ (Date)

Outline the project for which wild animals are to be collected. Indicate purpose, objectives and what the data will be used for. Use additional sheets if necessary.

______

______

______

______

______

Permit is needed from ______ (Month-Day-Year) to ______ (Month-Day-Year)

COLLECTION LOCATIONS	SPECIES AND AMOUNTS TO BE COLLECTED	*COLLECTION METHOD	LOCATION WHERE SPECIMENS WILL BE DEPOSITED

**Unattended collection equipment will be marked with the name, address of user and permit number.*

Send this application to the Division of Wildlife, Survey and Inventory Section, 1500 Dublin Road, Columbus, Ohio 43215.

DISTRIBUTION OF COPIES: 1. Survey and Inventory 2. District Office 3. Game Protector 4. Office of Business and Adm. Services

Completion of this form is required-Section 2921.13 O.R.C., Penalty: Imprisonment up to 6 months or $1000 fine or both. Section 1533.99 O.R.C., Penalty: Imprisonment up to 30 days or $250 fine or both.

APPENDIX 8

Monitoring Locations

EAST-SIDE PARALLEL DIRECT DRAINAGE STREAMS

As the name suggests, these streams are located on the East-Side and are predominately parallel in nature. They drain directly into Lake Erie. Many of these streams are severely degraded for a number of reasons. One major cause is the overburdening of many of the municipal sewer systems designed and constructed when populations were much lower and combined sewers were an accepted form of storm and wastewater transportation and treatment. This situation has resulted in many sewer overflows which allow raw sewage to enter the environment and place enormous stress on the streams.

To remedy this condition the District has designed the Height/Hilltop Interceptor. The project is designed to collect wastewater from the communities of Mayfield, Highland Heights, Richmond Heights, South Euclid, East Cleveland, Cleveland, Cleveland Heights, and Shaker Heights.

The project is divided into 9 separate contracts, costing $187 million over the 15 years of construction. The 28-mile interceptor is projected to serve 252,000 residents from 13 eastern suburbs. In addition to reducing the number of combined sewer overflows, it will also reduce the number of incidents of potentially harmful sewage backing up into private basements. Wastewater will be taken directly from the existing municipal systems to the District's Easterly Wastewater Treatment Plant (The District, 1985 Annual Report).

As progress is made on the interceptor, improvements in water quality will be monitored. These improvements should be made public to demonstrate the District's effectiveness.

Euclid Creek - 4 Locations (Figure 1)

1) St. Clair Ave - this location represents most of the flow that enters Lake Erie. Discharge (at bridge) and benthic studies can be completed at this spot. Improvements in water quality can be monitored as the Nottingham Potable Water Treatment Plant stops discharging its filter backwash sometime in the future. Presently, the discharge turns the water black.

2) South Branch, Highland Picnic Area, Euclid Creek Reservation - this location is directly above the confluence of the two branches and represents the total flow of the southern branch that drains the Richmond Heights, South Euclid, and Lyndhurst area. The shale bed of the stream will limit the number of benthos found, but fish and macrophytes are present at this location.

3) North Branch - Highland Picnic Area, Euclid Creek Reservation - this location is directly above the confluence of the two branches and represents the total flow of this branch that drains Highland Heights, the

Cuyahoga County Airport, and the western section of Lake County. The physical nature of the stream bed and benthos habitat are similar to the South Branch location.

4) Mayfield and Dorsch - next to the Euclid-Lyndhurst Library - this location represents drainage of a few tributaries south of Mayfield and Cedar Roads. Discharge (at bridge) and benthic samples are possible at this location.

Possible modification (can be used if specific questions arise)

a) Richmond and White Roads - represents the water quality that enters Cuyahoga County.

Green Creek - 3 Locations (Figure 2)

The creek drains part of Cleveland and South Euclid. The stream is an enclosed culvert for most of its length, which necessitates some variation in sampling techniques and locations.

5) At Confluence with Lake Erie - end of Park Ave. There is a 7-foot concrete inlet to the lake. If the high level of the lake interferes with the sampling, samples can be taken in two manholes on Arcade Ave. Samples and discharge can easily be acquired from these very shallow manholes.

6) Saranac and E.171 - there is a 10-foot open section of stream adjacent to the rail road tracks. Both discharge and benthic samples can be acquired at this location. The field guide contains a more exact description of the location.

7) South of Euclid on Green Road - this location is an enclosed culvert that runs along the east side of the road. There are three manholes from which the stream can be sampled.

Nine-Mile Creek - 3 Locations (Figure 3)

The creek drains portions of Cleveland, Bratenahl, East Cleveland, South Euclid, and Cleveland Heights. It is an enclosed culvert for approximately one-half of its length.

8) Lake Shore Blvd. - 200 feet east of Coit Road (adjacent to pump station for Easterly Interceptor.) This area represents the total flow of the stream. The area is very silted and low-lying but is appropriate for taking benthic samples.

9) Belvoir Blvd. - 6/10-mile south of Euclid Ave. The stream enters a culvert under Belvoir. One hundred feet upstream there is a confluence with the storm sewer that

drains the G.E. Nela Park Landfill. A 16-inch sanitary line also crosses the stream numerous times and is apparently leaking sanitary sewage. This location is appropriate for determining discharge and completing benthic studies.

10) South Belvoir Blvd. - open lot across from North Groton. This location is approximately 1 mile upstream from the Belvoir Blvd. site. Comparison studies can be completed between the two. This site is appropriate for all necessary measurements.

Other sections of this stream are not readily accessible, due to the deep ravine the creek has formed.

Shaw Creek - 1 Location (Figure 4)

Shaw Creek drains portions of East Cleveland, Cleveland, and Bratenahl. Earlier studies found the upper portion of the creek in poor enough condition that it now runs directly into the Easterly Interceptor. The remaining stream is drains the area from approximately I-90 up to the lake.

11) Lake Shore Blvd. - east of Bratenahl Place. This location is appropriate to measure discharge (6-foot enclosed culvert under Lakeshore Blvd.) and to complete benthic studies. The quality seems fairly good at this location due to it's limited drainage area.

Dugway Brook - 4 Locations (Figure 5)

Dugway Brook drains portions of East Cleveland, Cleveland, and Bratenahl. The brook is culverted for almost its entire length, it is also very degraded due to the extreme overloading of municipal sewers in the area. In 1983, IWS Investigator Frank Schuschu completed a study of Dugway; he located approximately 25 areas that contributed to the pollution problem of the stream. Some of these problems have been alleviated, and the Heights/Hilltop Interceptor will solve more, however, the stream presently remains severely degraded.

12) Lake Shore Blvd. - west of Bratenahl Place. This location represents the total flow of the East and West Branches. Discharge can be determined using the culvert under Lakeshore Blvd. Benthic samples can be gained by placing an artificial substrate sampler at the site. IWS has been taking monthly samples at this location for a number of years.

13) Prime Rose - 30 feet West of East 111th. This location is approximately midstream on the West Branch. It is a shallow manhole from which samples can be taken and discharge determined.

14) Lake View Cemetery - Hillside Drive. This stream is open for the length of the cemetery. This is the most

accessible spot in the cemetery, and represents the upper stretches of the west branch. All necessary samples and determinations can be made at this location.

15) Cumberland Park - off of Cumberland and Mayfield. This open section of the East Branch is a good representation of the stream quality of the upper waters of Dugway. All necessary determinations and samples can be made at this location.

Doan Brook - 4 Locations (Figure 6)

Doan Brook drains portions of Shaker Heights, Cleveland Heights, and Cleveland. The segments of both branches located in the Upper Shaker Lakes region appear to be in fairly good condition. The only problem upon visual inspection is large masses of algae which are likely caused by nutrients carried by runoff over the rolling landscape in an area that has several golf courses, numerous institutions, and several residences that make use of lawn treatment systems. Fish were located where the South Branch crosses at the intersection of South Park Blvd. and South Woodland Road. Degradation in this area takes place below the Upper Lake and above the Lower Lakes. The program developer suggests that both branches be sampled above the Lower Lakes and at several places further down stream.

16) Martin Luther King Blvd. - north of St. Clair Ave.

All measurements and samples should be able to be completed at this location. Should there be any problems, the sampling location can be moved a half-mile south between St. Clair and Superior. Both of these locations represent the total flow of both branches before they enter the culvert to be discharged into the Lake.

17) Martin Luther King Blvd. - below the Cleveland Museum of Art. This location represents flow from both branches, and a point where all measurements can be completed. There is significant evidence of sanitary sewage at this location.

18) South Park Road at Shaker Lakes Regional Nature Center. North Branch - 100 feet above confluence. The area is low lying and swampy, but is appropriate for all necessary studies.

19) South Park Road at Shaker Lakes Regional Nature Center. South Branch - 100 feet above confluence. The segment appears much more degraded than upstream. All necessary studies can be completed at this location.

If an additional sampling location is desired the area below the Lower Shaker Lake should be considered. The effects the of Lakes on the concentration of various parameters could be evaluated.

CUYAHOGA RIVER BASIN

The portion of the basin within the District's jurisdiction will be included in the program. Programs that have been implemented by the District have resulted in some improvements in stream quality (for instance, Cuyahoga Valley Interceptor and resulting decommissioning of several wastewater treatment plants). However, most of these streams do not meet their quality criteria and thus are not in accordance with the use designation applied to them by OEPA. In a qualitative sense, reconnaissance studies showed an increase in stream quality and benthos diversity as distance from the center of the city increased (as population and industry decreased).

Cuyahoga River - 5 Locations (Figure 7)

The problems associated with the river are well known, and well publicized. Consistent advances have been made in water quality since the beginning of the 1970's. The increase in water quality has improved the aesthetic value of the water, which has lead to the rebirth of recreational activities around the lower stretches of the river (including boating in the river and near shore Lake Erie), and to the economic revival of the Flats.

The District's programs designed to regulate industrial discharges, reduce the combined sewage overflows, and improve the quality of treatment plant effluents have played an instrumental role in the improvement of water quality within the river basin. Nevertheless, more improvements need to be made before the water quality criteria applied to the river are reached.

In addition to the monitoring locations discussed on the following page, the District samples the river above and below Southerly Treatment Plant. Monthly sampling is completed at downstream at River Smelting off of Bradley Road, and upstream at the Conrail Railroad crossing (approximately at State Route 21).

As part of The National Ambient Water Quality System, OEPA completes monthly samples of the river at the Lower Harvard Bridge, and Old Rockside Road in Independence. The United States Geologic Survey also has daily monitoring of basic chemical and physical parameters, and continuously monitors the discharge at the Old Rockside Road location (USGS "Indepedence" location, number is 04208000). This information will be acquired from these agencies upon implementation of the IWS program.

To complement this information, IWS monitoring locations are as follows:

20) The mouth of the river - Old River Road (behind Fagans). This has been an IWS sampling location for a number of years and represents the quality of the total flow of the river before it enters Lake Erie.

21) The Center Street Bridge - River Mile 0.55.
This has been an IWS sampling location for annual studies completed over a few years. It was also a sampling location for a study OEPA recently completed. The comparison of new data to historical data will be valuable.

22) The West Third Street Bridge - River Mile 3.3.
This has also been a sampling location for IWS and OEPA for previous studies. Comparison to historic data is also valuable here.

23) Riverview Road - dead-end bridge off of Pleasant Valley Road. This location is approximately four miles upstream from Southerly, and is within the Cuyahoga Valley National Recreation Area. The bridge is low to make sampling easy.

24) Station Road - dead-end bridge off of Riverview Road. This location is approximately 4 miles upstream of the Riverview Road station. It also represents the river quality that enters the District's jurisdiction. A low bridge makes monitoring easy at this location.

Big Creek - 6 Locations (Figure 8)

Big Creek has been a concern of many agencies for a number of years. IWS Investigator Keith Linn completed a study of the area in 1983. The study pointed out numerous problems that have caused degradation of Big Creek. The high contaminant level of the West Branch has been a particular concern. Some of the problems have been remedied; for instance, the previously broken Cooley Road Regulator. (The regulator was allowing one thousand cubic feet of raw sewage to enter the creek daily.) Samples taken in the West Branch are likely to show improvements in quality.

25) Jennings Road - Off of W. 14th and Harvard.
This location represents the total flow of Big Creek. There is quite a bit of construction debris near the bridge, which may cause some difficulty in discharge determination.

26) Memphis Park - East Branch just above confluence.
This location represents the total flow of the East Branch of Big Creek. This has been a sampling location for IWS for a number of years. All measurements can be taken at this location.

27) Memphis Park - West Branch just above confluence.
This location represents the total flow of the West Branch of Big Creek. This has also been a sampling

location for IWS for a number of years. All measurements can be taken at this location.

28) Puritas and W. 140th - Behind Puritas Shopping Center before West Branch enters an enclosed culvert. This location represents the drainage of all of the upper stretches of the West Branch. A fence has to be scaled to access the creek. All measurements can be taken at this location.

29) Big Creek Parkway - Between Snow and Brookpark Roads. East Branch, across from Knollwood Apartments. This location represents the drainage of all upper stretches of the West Branch (primarily Parma). This location is easily accessible and is appropriate for all measurements.

30) Stickney Creek - Leads to East Branch of Big Creek. This creek drains portions of Brooklyn and Cleveland. An exact sampling location needs to be chosen for this creek. The location should be chosen near the confluence with Big Creek East Branch.

Mill Creek - 5 Locations (Figure 9)

Mill Creek drains portions of Cleveland, Warrensville Heights, and most of Garfield Heights. The urban nature of the drainage area has lead to the degradation of many of its stretches.

31) Canal Road - Just above confluence with Cuyahoga River. This location represents the total flow of the creek before it enters the Cuyahoga. The location is fairly accessible and is appropriate for all measurements.

32) Tributary to Mill Creek - Warner Road in front of Allied Chemical Company. This is a tributary that runs along Warner Road directly in front of Allied Chemical Company. The confluence with Mill Creek is approximately 30 yards down Warner Road. This tributary is commonly discolored and contains white flocc. All measurements can be made at this location.

33) Wolf Creek Tributary - Garfield Park. The location is directly below the old stream beds directly above the confluence with Mill Creek. This location is best accessed directly off of Broadway Ave. This location is appropriate for all measurements.

34) Rex Road - Off of Old McCracken, southwest side of I-480. This location represents the mid-range drainage

of Mill Creek. The location is appropriate for all measurements.

35) Northfield Road. This location represents the upper drainage of Mill Creek. Investigators will be able to make all measurements at this location.

West Creek - 3 locations (Figure 10)

Quarry Creek drains portions of Parma and most of Seven Hills. There are no major documented problems in Quarry Creek. However, the normal urban degradation should be monitored.

36) Route 17 - Granger Road.

This location represents the total flow that enters the Cuyahoga a few hundred yards downstream. It is the most accessible location near the Cuyahoga River (SW side of Granger Road). All measurements can be made at this location.

37) Route 176 - Broadview Road.

This location is approximately mid-length of the stream. It is accessible, and appropriate for all measurements.

38) Ridgewood Drive

This location represents the upper reaches of Quarry Creek. A sampling location further upstream is not possible due to the relief of the creek valley. If the data from this location becomes too repetitive with location 37, one of the two locations should be eliminated.

Tinkers Creek - 4 locations (Figure 11)

Tinkers Creek drains portions of Bedford, Bedford Heights, Walton Hills, Oakwood, Glen Willow, Solon, Twinsburg, and Aurora. The discharge of the creek is a significant contribution to the Cuyahoga River. Qualitative improvements in the creek have resulted from elimination of discharges (Walton Hills WWTP and direct industrial discharges) into an unnamed tributary of the creek. Further improvements can be quantified by monitoring the stream quality. The effect of the Solon Central WWTP will also be monitored.

39) Gorge Parkway just off of Dunham Road, Bedford Reservation. This location is approximately 1.5 miles upstream from the confluence with the Cuyahoga. There are no major contributions to stream flow downstream of this location; thus, it is representative of the total flow.

40) Bedford Reservation Road - 0.1 miles east of Broadway Ave. This location represents the mid-length drainage of the portion of the stream within the District's

jurisdiction. The location is easily accessible, and all measurements can be made here. The USGS will be sending IWS discharge information from this location (USGS "Bedford" location, number 04207200).

41) Route 175 - Richmond Road.

This location is downstream of the Beaver Meadow Creek tributary in which Solon discharges its treated wastewater. All measurements can be completed at this location.

42) Upstream of Beaver Meadow Creek Tributary.

This sampling location can either be established at Pettibone Road or Glenwood Road. The Pettibone location is directly upstream of the tributary; however, during the reconnaissance studies it was extremely stagnant due to log jams. The Glenwood location is slightly further upstream, but would be a more appropriate location for sampling. When this area is sampled the first time, investigators should check the status of the two locations, and decide which is better for sampling.

Chippewa Creek - 2 location (Figure 12)

Chippewa Creek is the southern most stream within the District's jurisdiction. It drains Broadview Heights and Brecksville. The relatively sparse human population result in a qualitatively clean stream. There is still a need to monitor any changes in the stream quality, especially in light of the District's activities in Broadview Heights.

43) Ford on Chippewa Creek Drive, off of Riverview Road, Brecksville Reservation. This location represents the total flow of the creek; the confluence with the Cuyahoga River is 1/4 mile downstream. All measurements can be easily made at this location. The ford can be used to determine discharge.

44) Avery Road.
This location is representative of the headwaters of the creek. The stream is accessible under the bridge; however, the creek is down a fairly steep gradient. If this location becomes a problem, it can be changed to where the stream crosses Old Royalton Road. All measurements can be completed at each location.

STORM SEWER "STREAMS"

These "streams" are all are part of the Cuyahoga River drainage network; however, they are quite different than the streams previously discussed. They are all enclosed culverts for most, if not all of their lengths. They all discharge into the Cuyahoga River within a 2-mile distance in the industrialized "Flats" area.

The quality of these "streams" has been suspect for a number of years. According to the District's planning department, the USEPA is considering making storm sewers point source discharges and mandating the monitoring of their effluents. This monitoring and data could eventually lead to discharge permits for all storm sewers.

The monitoring of these storm sewer discharges will aid the District if USEPA decides to implement any of these programs. The monitoring locations for all of these "streams" will be at their confluence with the Cuyahoga River.

Storm Sewers "Streams" - 4 Locations (Figure 13)

45) Walworth Run

46) Kingsbury Run

47) Morgana Run

48) Burke Brook

ROCKY RIVER BASIN

With the addition of Strongsville and Berea to the District, it is necessary to monitor Rocky River. The discharge of Strongsville B and C plants eventually reaches the East Branch of Rocky River. The discharge of Berea's WWTP directly discharges into the East Branch. The effect of both of Strongsville's plants will be monitored. When the Berea plant is decommissioned in a few years, the improvements in water quality can be documented.

The discharge of the Strongsville A plant enters Blodgett Creek, which joins the West Branch of Rocky River. There is one sampling location downstream of Blodgett Creek. Later, if other communities (i.e., Olmsted Falls) fall into the District's jurisdiction, other locations on the river can be added to the monitoring program.

<u>East Branch Rocky River</u> - 3 Locations (Figure 14)

49) Rocky River Valley Parkway (North) - First ford (0.6 miles North of Barrett Road). This location is 30 yards downstream of the discharge of Berea's WWTP. It is also the northernmost point of the District's jurisdiction of the Rocky River. All measurements will be easily made at this location. The ford can be used to determine discharge.

50) North Quarry Road - Metroparks, across from Wallace Lake. This location is roughly mid-length on the East Branch, and is approximately 0.5 miles downstream of where the Strongsville C plant effluent stream enters the river. The location is also directly downstream of Baldwin Lake, which acts as a sink. The samples representative of water quality that flows out of the sink.

51) Mill Creek Reservation, East Access Road (Wildlife Area turnoff, 0.5 miles south of Pearl Road, directly south of Toboggin Run area). This location represents the uppermost portions of the river within the District's jurisdiction. It is also just below the tributary into which Strongsville B discharges.

<u>West Branch Rocky River</u> - 1 Location (Figure 14)

52) West Branch below Blodgett Creek.
The exact location of this sampling point needs to be determined. Bagley Road is an option, although the river may not be too accessible there. River Road off of Columbia (route 252) is also an option.

APPENDIX 9

Editing Computer Maps

COMPUTER MAPS

A computer map of each stream has been produced. Each map includes:

1) sampling locations (represented by X's)
2) major roads
3) lakes
4) open stream segments (represented by solid lines)
5) enclosed culverted areas (represented by dashed lines)

Water quality upstream of each sampling location is represented on the maps by a numbering scheme that is consistent with the representation in the USEPA's reporting of water quality. The reporting of water quality is part of the section 305(b) of the "Clean Water Act" (P.L. 95 - 217). In this format, a number represents a group of contaminants. Water quality problems are represented by:

1 - Harmful substances (i.e., metals)

2 - Physical modification (suspended solids, temperature, etc.)

3 - Eutrophic potential (nutrients, untreated wastewater)

4 - Salinity, alkalinity, acidity,

5 - Oxygen depletion,

6 - Elevated coliform levels.

Numbers can be added (or modified) if there is a need for more exact representations.

To enter or modify numbers for water quality problems on the computer maps:

1) At the C> on the opening menu, (The Screen Says "PC/AT Function Menu") press "p" (this calls up the Prodesign program)

2) Once program is up, press "F9" (single key on far left side of keyboard). Do not press enter.

3) The top of the screen will ask you to input file name; type in, and enter the stream of your choice. The file names are: -

Euclid1	Cuya1
Green1	Big1
9mile1	Mill1
Shaw1	Quarry1
Dugway1	Tinkers1
Doan1	Chipp1

Storm1 (includes Walworth, Burke, Kingsbury, and Morgana)

[Note: There is also a version of each map that does not contain the numbers that represent stream quality. The file names for the streams are the same as above, but without the number "1" on the end (i.e., Cuya, Doan, or Storm).]

4) It takes some time for the computer to read the file. A cursor that looks like the letter "X" will appear on

the screen when the complete file has been loaded.

5) The screen is only capable of displaying 1/4 of the total picture. The cursor is moved by using the the arrows on the right side of the keyboard. The "home", "Pg Up", "Pg Dn", and "End" keys move the cursor diagonally. The number keys on the top of the keyboard make small movements with the cursor. DO NOT USE THE ZERO ("0") FOR CURSOR MOVEMENT, IT IS USED FOR SETTING POINTS. It is best to experiment to learn the motion of these keys. (Even numbers make straight movements and odd numbers move diagonally).

6) To remove numbers from the box

   a) Move the cursor inside the box that contains the numbers representing water quality. Move the cursor into any corner of the box.

   b) Set a point in the corner by pushing the zero ("0", on the top row of the key board), a point will appear in the center of the cursor. Figure 15 is an example of setting one point.

   c) Move the cursor into the opposing corner (the corner that is diagonal from the original point). Again, set a point using the zero ("0"). These two opposing points are the corners of an imaginary box. Figure 16 is an example of two opposing points.

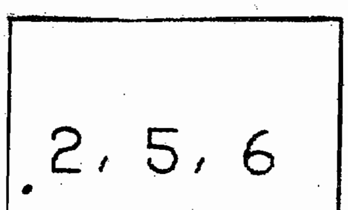


Figure 15

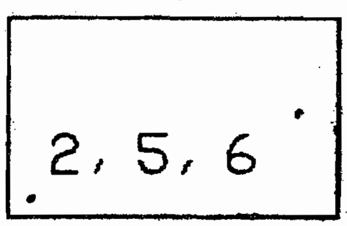


Figure 16

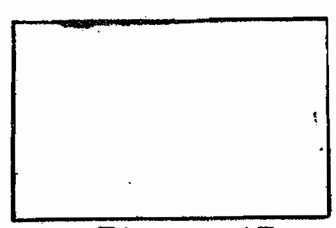


Figure 17

d) If you set a point that is not in the correct location (i.e., in the wrong corner or outside of the box), hit the escape key "ESC." This key deletes the last command. [Be cautious that you have set a point that has to be deleted, because this key will delete the last command, no matter what it was.] In other words, if you have not set a point, and you use the "ESC" key, portions of the drawing will be deleted.

e) After the two points have been set in diagonally opposing corners of the box, push the "D" key. This is the "delete" command, it deletes any command that completely lies within the imaginary box set up by the two points. Figure 17 is an example of a deleted set of numbers.

f) The numbers within the box will be deleted from the screen. If they do not delete, chances are that the imaginary box that you created was not large enough to contain the numbers. If this is the case, set the corners of the imaginary box again; making them a little farther apart to enlarge the imaginary box, and delete again.

7) To add new numbers to the box:

a) There are six numbers that represent variations in water quality. A maximum of 4 numbers can be placed on one row in the boxes. In other words, if 4 or more numbers are used, there will be two rows of numbers.

b) Set a point close to the bottom left corner of the box using the zero ("0") key (Figure 18). This is the left point in the bottom row.

c) To set the right point in the bottom row, move the cursor 3 keystrokes to the right for every number that will be placed in that row (this ensures that the numbers will fit in the box). It is best if you stay on the same line. Set a point using the zero ("0") key. Figure 19 is an example of setting the right-hand point on the bottom row.

d) These two points set up an imaginary line on which you will type in some text (which in this case will be numbers).

e) Push the "T" key, which is a command for text.

f) The word "TEXT:" will appear at the top of the screen. The keyboard will now act as a typewriter. Type in the numbers that represent the pollution problems (i.e., 4,5,6).

g) Push the enter (return) key and the text will appear between the two points that were set (Figure 20).

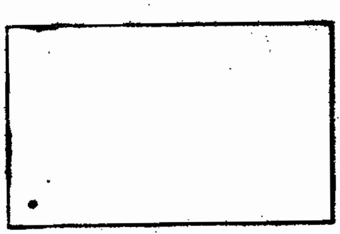


Figure 18

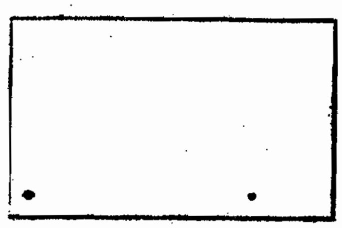


Figure 19

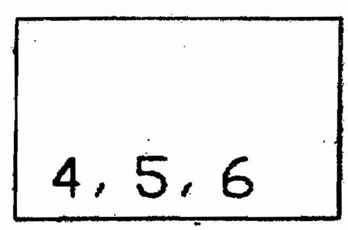


Figure 20

h) If the placement of the numbers is wrong, or the wrong numbers were placed in the box, push the escape key ("ESC"). The text command, including the two points (which is the last command) will be deleted.

i) Return to step 7 (above) and set the points, and try again.

j) If a second row of numbers need to be added, the procedure is the same for setting the points, except place the points close to the center row of the box (Figure 21). Return to step 7. The end result is shown in Figure 22.

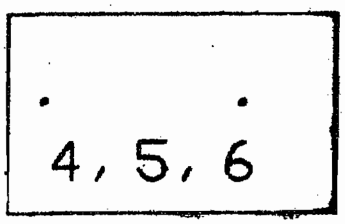


Figure 21

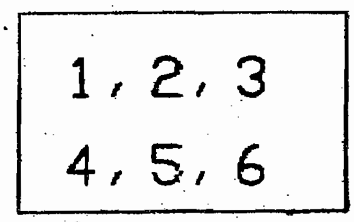


Figure 22

8) Make all necessary changes in other boxes.

9) Save the current drawing to disk, press the "F10" key. The drawing must always be saved to the disk, or the changes will not be saved. When the prompt at the top of the screen asks for a file name, type the same name that was used to call up the file, and enter (i.e., Cuya1, Doan1).

10) The prompt will say that the "file already exists, reuse ?", type "YES" (or simply a "Y").

11) AFTER saving the program, if you don't want to print a map, it can be terminated by pressing the "F8" key. The prompt will ask "DO you really want to stop the program ?" Type "Yes" (or "Y") if you want to stop the program.

12) If you want to print a map:

a) Press "F5" Key

b) The prompt will ask if you have saved the drawing yet. IF YOU HAVE NOT ALREADY SAVED THE DRAWING, DO IT NOW (see step 9). If you have already saved it answer "Yes" (or "Y").

c) A menu will appear called "Prodesign Print Command;" type a "1" and press "Enter." This is command to print a single drawing.

d) The prompt asks "Imput File Name". Enter the name of the file that you want to be printed. The prompt will tell you to wait because the drawing is being read.

e) A large menu containing drawing specifications will appear on the screen. The only specifications that you should be concerned with are "width of drawing" and "length of drawing." Use the arrow keys on the right side of the keyboard to move the cursor up or down.

- Move the cursor to the "width of drawing" line, and type "8.5" (using numbers at top of keyboard). This will make a drawing 8.5 inches wide.

- Move the the cursor to the "length of drawing" line, type in "10.5". This will make a drawing approximately 10.5 inches wide.

f) Press the "F1" key to start printing. There is a delay while the computer sends the information to the printer.

g) If it is necessary to stop the print command, press the escape ("ESC") key.

13) After the map is printed, push the "6" key and "enter" to stop the program. This will return you the opening DOS menu.

APPENDIX 10

Water Quality Standards and Stream Use Designations

WATER QUALITY CRITERIA FOR WARMWATER STREAMS IN NORTHEASTERN OHIO AS DEFINED BY OHIO EPA AS OF MAY 1985

" WARMWATER " - Warmwater Habitat - Waters that are capable of supporting balanced reproduction of populations of warmwater fish and and associated vertebrate and invertebrate organisms and plants on an annual basis.

PARAMETER		UNITS	WARMWATER
Ammonia		mg/l	
	maximum		
	30 day ave.		Table 7 & 8
Arsenic (Total Recoverable)			
	maximum	ug/l	
	30 day ave		36
Barium (Total Recoverable)			
	maximum	ug/l	N.A.
	30 day ave		
Beryllium (Total Recoverable)			
	maximum	ug/l	
	30 day ave		Table 9 & 10
Cadmium (Total Recoverable)			
	maximum	ug/l	
	30 day ave		Table 9 & 10
Chlorides			
	maximum	mg/l	N.A.
	30 day ave		
Chlorine (Total Residual)			
	maximum		
	30 day ave	ug/l	2.0
Total Chromium (Total Recoverable)			
	maximum	ug/l	N.A.
	30 day ave		
Hexavalent Chromium (Total Recoverable)			
	maximum	ug/l	
	30 day ave		10
Trivalent Chromium (Total Recoverable)			
	maximum	ug/l	
	30 day ave		N.A.

PARAMETER	UNITS	WARMWATER
Copper (Total Recoverable)		
maximum	ug/l	N.A.
30 day ave		
Cyanide (Free)		
maximum	ug/l	
30 day ave		8.1
Dissolved Oxygen		
min. at any time	mg/l	4.0
min. 24 hr. ave		5.0
Dissolved Solids		
maximum		
30 day ave	mg/l	1500
Fluoride		
maximum	mg/l	N.A.
30 day ave		
Iron (Total Recoverable)		
maximum	mg/l	
30 day ave		1.0
Iron (Soluble)		
maximum	mg/l	
30 day ave		N.A.
Lead (Total Recoverable)		
maximum	ug/l	
30 day ave		30
Manganese (Total Recoverable)		
maximum	ug/l	N.A.
30 day ave		
MBAS (Foaming Agent)		
maximum	mg/l	0.50
30 day ave		
Mercury (Total Recoverable)		
maximum	ug/l	
30 day ave		0.2
Nickel (Total Recoverable)		
maximum	ug/l	
30 day ave		Table 9 & 10
Nitrate-N		
maximum	mg/l	N.A.
30 day ave		

PARAMETER	UNITS	WARMWATER
Nitrates & Nitrites		
maximum	mg/l	N.A.
30 day ave		
Oil & Grease		N.A.
Pesticides		
maximum	ug/l	
30 day ave		Table 11
pH		6.5-9.0
Phenolic Compounds		
maximum	ug/l	
30 day ave		Table 11
Phosphorus		N.A.
Phthalate Esters		
maximum		
30 day ave	ug/l	3
PCB's		
maximum	ug/l	.001 m
30 day ave		
Selenium (Total Recoverable)		
maximum	ug/l	
30 day ave		34
Silver (Total Recoverable)		
maximum	ug/l	
30 day ave		1.3
Sulfates		
maximum	mg/l	N.A.
30 day ave		
Temperature		
maximum	Degrees F	Table 12
30 day ave	(Degrees C)	
Toxic Substances		p
Zinc (Total Recoverable)		
maximum	ug/l	
30 day ave		Table 9

STREAM USE DESIGNATION AS DEFINED BY OEPA

Primary Contact - these are waters that during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as result of water quality.

Secondary Contact - these are waters that during the recreation season, are suitable for partial body contact recreation such as, but not limited to, wading with minimal threat to public health as a result of water quality.

- State Resource Water

Note: Limited Warmwater Habitats have different criteria than Warmwater streams

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
CUYAHOGA RIVER BASIN			
CUYAHOGA RIVER			
Southerly to Mouth	No Designation		
(Standards will be set when field assessment is performed)			
# Bath Rd to Rockside Rd.	*	*	
All Other Segments	*	*	
KINGSBURY RUN	*	*	
MORGANA RUN	*	*	
BURKE BROOK	*	*	
BIG CREEK			
Ford Motor Co. to Cuyahoga	* Limited	*	
Varied criteria for year around: ammonia - 4.0 mg/l total lead - 100 ug/l total zinc - 500 ug/l MBAS - 1.5mg/l			
# Boundaries Of Metroparks	*	*	
All Other Segments		*	

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
MILL CREEK			
Granger Rd. To Cuyahoga	* Limited	*	
Varied criteria for year around: ammonia - 8.0 mg/l total copper - 150 ug/l total zinc - 500 ug/l MBAS - 0.8 mg/l phenols - 20 mg/l			
All Other Segments	*	*	
TINKERS CREEK			
Herrick Nature Preserve	*	*	
All Other Segments	*	*	
CHIPPEWA CREEK			
# Rt. 82 To Cuyahoga River	*	*	
All Other Segments	*	*	
WEST CREEK	*	*	

EAST SIDE PARALLEL DIRECT DRAINAGE STREAMS

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
DOAN BROOK			
# Shaker Lakes Nature Center	*	*	
NINEMILE CREEK	*	*	
EUCLID CREEK			
Rt. 20 to Anderson Rd.	*		
All Other Segments	*	*	
DUGWAY BROOK	No Designation		
SHAW CREEK	No Designation		
GREEN CREEK	No Designation		

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
	ROCKY RIVER BASIN		
EAST BRANCH			
# Upstream Boundaries of Metroparks to Confluence with West Branch	*	*	
All Other Segments	*	*	
Abram Creek (Middleburg Hts. & Brookpark WWTPs Tributary)	*	*	
# Baldwin Creek (Strongsville C & N.Royalton B WWTPs Tributary)	*	*	
WEST BRANCH			
Blodgett Creek (Strongsville A WWTP Tributary)	*	*	

BACTERIOLOGICAL CRITERIA FOR RECREATIONAL USE DESIGNATIONS

BATHING WATERS - Fecal Coliform - geometric mean fecal coliform content [either most probable number (mpn) or membrain filter (mf)], based on not less than five samples within a 30 day period shall not exceed 200 per 100 ml and shall not exceed 400 per 100 ml in more than 10% of the samples taken during any 30 day period.

PRIMARY CONTACT - Fecal Coliform - geometric mean fecal coliform content (either mpn or mf), based on not less than 5 samples within a 30 day period shall not exceed 1000 per 100 ml, and shall not exceed 2000 per 100 ml in more than 10% of the samples taken during any 30 day period.

SECONDARY CONTACT - Fecal Coliform - shall not exceed 5000 per 100 ml (either mpn or mf) in more than 10% of the samples taken during any 30 day period.

TABLE 7

Warmwater and Exceptional Warmwater Habitat 30-Day Average Total Ammonia-Nitrogen Criteria (mg/l).
Temperatures from 0 to 15°C apply only during the months of December through February.
Temperatures from 16 to 30°C apply during the months of March through November.

Temp. (°C) \ pH	6.5	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.8	9.0
0-10	13.0	13.0	13.0	12.6	11.7	10.7	9.6	8.6	7.6	6.6	5.6	4.8	4.0	3.4	2.8	2.3	1.9	1.5	1.2	1.0	0.7	0.5
11	13.0	13.0	12.4	11.6	10.5	9.8	9.1	7.8	7.0	6.1	5.3	4.4	3.7	3.1	2.6	2.1	1.7	1.4	1.2	0.9	0.7	0.4
12	13.0	12.6	11.4	10.6	9.6	9.1	8.4	7.2	6.5	5.7	4.9	4.1	3.5	2.9	2.4	2.0	1.6	1.3	1.1	0.9	0.6	0.4
13	12.4	11.6	10.6	9.8	8.9	8.4	7.7	6.8	6.0	5.3	4.5	3.8	3.2	2.7	2.2	1.8	1.5	1.2	1.0	0.8	0.6	0.4
14	11.4	10.8	9.8	9.1	8.3	7.8	7.2	6.3	5.6	4.9	4.2	3.5	3.0	2.5	2.0	1.7	1.4	1.2	0.9	0.7	0.5	0.3
15	10.7	10.2	9.1	8.5	7.7	7.2	6.7	5.8	5.2	4.5	3.9	3.3	2.7	2.3	1.9	1.6	1.3	1.1	0.8	0.7	0.5	0.3
16	7.0	6.6	6.0	5.6	5.2	4.8	4.4	3.9	3.4	3.0	2.6	2.1	1.8	1.5	1.2	1.1	0.8	0.7	0.6	0.5	0.3	0.2
17	6.5	6.1	5.5	5.2	4.9	4.4	4.0	3.6	3.1	2.7	2.4	2.0	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.4	0.3	0.2
18	6.0	5.7	5.2	4.9	4.5	4.1	3.7	3.3	3.0	2.6	2.2	1.9	1.6	1.3	1.1	0.9	0.7	0.6	0.5	0.4	0.2	0.2
19	5.6	5.3	4.8	4.5	4.2	3.9	3.5	3.1	2.7	2.4	2.1	1.7	1.5	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.2	0.2
20	5.2	4.9	4.4	4.2	3.9	3.5	3.2	2.9	2.6	2.2	1.9	1.6	1.4	1.2	0.9	0.8	0.7	0.6	0.4	0.3	0.2	0.2
21	4.9	4.5	4.1	3.9	3.6	3.3	3.0	2.7	2.4	2.1	1.7	1.5	1.2	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.2
22	4.4	4.2	3.9	3.6	3.4	3.0	2.8	2.5	2.2	1.9	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2
23	4.2	4.0	3.6	3.4	3.1	2.9	2.6	2.3	2.1	1.8	1.6	1.3	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2
24	3.9	3.7	3.4	3.1	2.9	2.7	2.4	2.1	1.9	1.6	1.4	1.2	1.1	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2
25	3.6	3.4	3.1	3.0	2.7	2.5	2.2	2.0	1.8	1.6	1.3	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2
26	3.4	3.2	2.9	2.7	2.6	2.3	2.1	1.9	1.7	1.5	1.2	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
27	3.2	3.0	2.7	2.6	2.4	2.2	2.0	1.7	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2
28	3.0	2.8	2.6	2.4	2.2	2.1	1.8	1.6	1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2
29	2.8	2.6	2.4	2.2	2.1	1.9	1.7	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
30	2.6	2.4	2.2	2.1	1.9	1.8	1.6	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.1

TABLE 8

Nuisance Prevention Maximum Total Ammonia-Nitrogen Criteria (mg/l).
Temperatures from 0 to 15°C apply only during the months of December through February.
Temperatures from 16 to 30°C apply during the months of March through November.

Temp. (°C) \ pH	6.5	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.8	9.0
0-10	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.4	10.2	8.4	6.9	5.7	4.6	3.8	2.5	1.7
11	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.4	9.5	7.8	6.4	5.3	4.3	3.5	2.3	1.6
12	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.8	10.6	8.8	7.2	5.9	4.9	4.0	3.3	2.2	1.5
13	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.9	9.9	8.2	6.8	5.5	4.5	3.7	3.0	2.1	1.4
14	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.0	9.1	7.6	6.3	5.1	4.2	3.5	2.8	1.9	1.3
15	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.1	10.2	8.5	7.1	5.8	4.8	4.0	3.2	2.6	1.8	1.2
16	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.4	10.5	8.9	7.4	6.2	5.1	4.2	3.5	2.8	2.3	1.6	1.1
17	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.5	9.8	8.2	6.9	5.8	4.8	3.9	3.2	2.6	2.1	1.5	1.1
18	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.5	10.7	9.1	7.7	6.4	5.4	4.4	3.6	3.0	2.5	2.1	1.4	1.0
19	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.7	10.0	8.5	7.2	6.0	4.9	4.1	3.4	2.8	2.3	1.9	1.3	0.9
20	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.5	10.9	9.3	7.9	6.7	5.6	4.6	3.9	3.2	2.6	2.1	1.8	1.2	0.9
21	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.6	10.0	8.6	7.4	6.2	5.2	4.4	3.6	3.0	2.5	2.1	1.6	1.2	0.8
22	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.3	10.8	9.4	8.1	6.8	5.8	4.9	4.0	3.4	2.8	2.3	1.9	1.6	1.1	0.8
23	13.0	13.0	13.0	13.0	13.0	13.0	12.8	11.4	10.0	8.7	7.5	6.4	5.4	4.5	3.8	3.1	2.6	2.2	1.8	1.5	1.1	0.7
24	13.0	13.0	13.0	13.0	13.0	13.0	11.9	10.6	9.4	8.2	7.0	6.0	5.0	4.2	3.5	3.0	2.5	2.1	1.7	1.4	1.0	0.7
25	13.0	13.0	13.0	13.0	13.0	12.3	11.1	10.0	8.7	7.6	6.8	5.6	4.7	4.0	3.3	2.7	2.3	1.9	1.6	1.3	0.9	0.7
26	13.0	13.0	13.0	13.0	12.4	11.4	10.4	9.2	8.2	7.1	6.1	5.2	4.4	3.7	3.1	2.6	2.1	1.8	1.5	1.2	0.9	0.7
27	13.0	13.0	13.0	12.5	11.6	10.7	9.6	8.6	7.7	6.7	5.7	4.9	4.1	3.5	2.9	2.4	2.0	1.7	1.4	1.2	0.8	0.7
28	13.0	13.0	12.5	11.7	10.8	10.0	9.1	8.1	7.1	6.2	5.4	4.5	3.9	3.2	2.7	2.3	1.9	1.6	1.3	1.2	0.8	0.6
29	13.0	12.8	11.7	11.0	10.1	9.3	8.4	7.6	6.7	5.8	5.0	4.3	3.6	3.0	2.6	2.1	1.8	1.5	1.2	1.1	0.7	0.6
30	12.7	11.9	10.9	10.2	9.5	8.7	7.9	7.1	6.3	5.4	4.7	4.0	3.4	2.9	2.4	2.0	1.6	1.4	1.2	1.0	0.7	0.6

TABLE 9

Warmwater (WWH), Exceptional Warmwater (EWH) and Coldwater (CWH) Habitat 30-Day Average Criteria for Water Hardness Dependent Parameters. Criteria for values of water hardness not listed in this table shall be interpolated from the criteria corresponding to the two nearest values of water hardness. Criteria for values of water hardness less than 150 mg/l $CaCO_3$ and greater than 500 mg/l $CaCO_3$ shall be calculated from the appropriate equations on a case-by-case basis. All criteria are expressed as total recoverable concentration and ug/l.

Parameter	Hardness (mg/l $CaCO_3$)														
	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500
Beryllium															
WWH, EWH, CWH	5.4	6.8	8.4	10	12	14	16	18	20	22	24	26	29	31	34
Cadmium															
WWH, EWH	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.4	2.5	2.7	2.9	3.1
CWH	0.12	0.14	0.16	0.19	0.21	0.24	0.26	0.29	0.31	0.34	0.36	0.39	0.42	0.44	0.47
Tri. Chromium															
WWH, EWH, CWH	44	50	55	61	67	72	77	83	88	93	98	103	108	113	118
Copper															
WWH, EWH, CWH	7.0	8.0	9.1	10	11	12	13	14	15	16	17	18	19	20	21
Nickel															
WWH, EWH	167	193	218	243	268	292	317	341	365	389	412	436	460	483	506
CWH	147	169	191	213	235	257	278	299	320	341	362	383	404	424	445
Zinc															
WWH, EWH, CWH	99	113	126	139	152	164	177	189	201	213	224	236	247	259	270

TABLE 10

Nuisance Prevention Maximum Criteria for Water Hardness Dependent Parameters. Criteria for values of water hardness not listed in this table shall be interpolated from the criteria corresponding to the two nearest values of water hardness. Criteria for values of water hardness less than 150 mg/l $CaCO_3$ and greater than 500 mg/l $CaCO_3$ shall be calculated from the appropriate equations on a case-by-case basis. All criteria are expressed as total recoverable concentration and ug/l.

Parameter	Hardness (mg/l $CaCO_3$)														
	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500
Beryllium	1280	1610	1980	2360	2770	3210	3660	4130	4620	5140	5660	6210	6780	7360	7950
Cadmium	46	55	64	74	83	93	103	113	123	133	144	154	165	175	186
Tri. Chromium	2170	2460	2740	3020	3290	3560	3820	4080	4340	4590	4840	5080	5330	5570	5800
Copper	23	26	29	33	36	39	42	46	49	52	55	58	61	64	67
Nickel	1580	1820	2060	2300	2530	2760	2990	3220	3450	3680	3900	4120	4350	4570	4790
Silver	3.2	4.2	5.3	6.4	7.7	9.1	11	12	14	16	17	19	21	23	25
Zinc	390	443	495	546	596	645	693	741	788	834	880	925	970	1010	1060

TABLE 11

Pesticides Criteria. Concentrations for Public Water Supply are maximum criteria. Concentrations for Aquatic Life Habitat are 30-day average criteria. All concentrations are expressed in ug/l.

Pesticide	Public Water Supply[a]	Aquatic Life Habitat
Aldrin[b]	0.000074[c]	0.01
Benzene Hexachloride	--	0.1
Chlordane	0.00046[c]	0.01
Chlorophenoxy herbicides		
2,4-D	100.0	--
2,4,5-TP (Silvex)[b]	10.0	--
Ciodrin	--	0.1
Coumaphos	--	0.001
Dalapon	--	110.0
DDT[b]	0.000024[c]	0.001
Demeton	--	0.1
Diazinon	--	0.009
Dicamba	--	200.0
Dichlorvos	--	0.001
Dieldrin[b]	0.000071[c]	0.005
Diquat	--	0.5
Dursban	--	0.001
Endosulfan	74	0.003
Endrin	1.0	0.002
Guthion	--	0.005
Heptachlor[b]	0.00028[c]	0.001
Heptachlor Epoxide	0.1	--
Lindane	0.019[c]	0.01
Malathion	--	0.1
Methoxychlor	100.0	0.005
Mirex	--	0.001
Naled	--	0.004
Parathion	--	0.008
Phosphamidon	--	0.03
Simazine	--	10.0
TEPP	--	0.4
Toxaphene	0.00071[c]	0.005

a Pesticides are not to exceed the concentrations in this table, or the Safe Drinking Water Act, whichever is more stringent.

b Use has been banned.

c For protection of human health from the potential carcinogenic effects, at a 10^{-6} incremental increase of cancer risk over the lifetime, due to exposure through ingestion of contaminated water and contaminated aquatic organisms.

TABLE 12

Table 10e: Muskingum River - entire mainstem. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	45 (7.2)	45 (7.2)	53 (11.7)	53 (11.7)	58 (14.4)	65 (18.3)	68 (20.0)	72 (22.2)	76 (24.4)
Daily Maximum:	50 (10.0)	50 (10.0)	58 (14.4)	58 (14.4)	63 (17.2)	70 (21.1)	74 (23.3)	77 (25.0)	84 (28.9)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	85 (29.4)	85 (29.4)	85 (29.4)	85 (29.4)	80 (26.7)	73 (22.8)	67 (19.4)	62 (16.7)	47 (8.3)
Daily Maximum:	89 (31.7)	89 (31.7)	89 (31.7)	89 (31.7)	85 (29.4)	77 (25.0)	72 (22.2)	67 (19.4)	52 (11.1)

General Lake Erie Basin - includes all surface waters of the state within the boundaries of the Lake Erie drainage basin, excluding those water bodies as designated in Table 10g through 10i. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	44 (6.7)	44 (6.7)	48 (8.9)	51 (10.6)	54 (12.2)	60 (15.6)	64 (17.8)	66 (18.9)	72 (22.2)
Daily Maximum:	49 (9.4)	49 (9.4)	53 (11.7)	56 (13.3)	61 (16.1)	65 (18.3)	69 (20.6)	72 (22.2)	76 (24.4)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	82 (27.8)	82 (27.8)	82 (27.8)	82 (27.8)	75 (23.9)	67 (19.4)	61 (16.1)	54 (12.2)	44 (6.7)
Daily Maximum:	85 (29.4)	85 (29.4)	85 (29.4)	85 (29.4)	80 (26.7)	72 (22.2)	66 (18.9)	59 (15.0)	49 (9.4)

TABLE 13

Partial List of Representative Species of Ohio Fishes

SPECIES	AQUATIC LIFE USE DESIGNATION[1]				
	WWH	EWH	CWH	NP	SSH
Banded killifish (*Fundulus diaphanus*)	U[2]	-	-	X	-
Black crappie (*Pomoxis nigromaculatus*)	X	X	-	-	-
Blacknose dace (*Rhinichthys atratulus*)	X	U	X	-	-
Bluegill (*Lepomis macrochirus*)	X	U	-	-	-
Bluntnose minnow (*Pimephales notatus*)	X	X	-	-	-
Brook trout (*Salvelinus fontinalis*)	-	-	U	-	-
Brown bullhead (*Ictalurus nebulosus*)	X	-	-	X	-
Brown trout (*Salmo trutta*)	-	-	X	-	X
Channel catfish (*Ictalurus punctatus*)	X	X	-	-	-
Coho salmon (*Oncorhynchus kisutch*)	-	-	-	-	X
Common carp (*Cyprinus carpio*)	X	X	X	X	-
Common shiner (*Notropis cornutus*)	X	X	X	-	-
Creek chub (*Semotilus atromaculatus*)	X	X	X	-	-
Fathead minnow (*Pimephales promelas*)	X	-	-	-	-
Golden shiner (*Notemigonus crysoleucas*)	X	-	-	-	-
Goldfish (*Carassius auratus*)	U	-	-	X	-
Green sunfish (*Lepomis cyanellus*)	X	U	-	X	-
Largemouth bass (*Micropterus salmoides*)	X	X	-	-	-
Mosquitofish (*Gambusia affinis*)	U	-	-	-	-
Mottled sculpin (*Cottus bairdi*)	X	X	X	-	-
Northern pike (*Esox lucius*)	U	X	-	-	-
Orangethroat darter (*Etheostoma spectabile*)	X	-	-	-	-
Pumpkinseed (*Lepomis gibbosus*)	X	-	-	-	-
Rainbow darter (*Etheostoma caeruleum*)	X	X	X	-	-
Rainbow trout (*Salmo gairdneri*)	-	-	X	-	X
Red shiner (*Notropis lutrensis*)	U	-	-	-	-
Redear sunfish (*Lepomis microlophus*)	U	-	-	-	-
Rock bass (*Ambloplites rupestris*)	X	X	X	-	-
Smallmouth bass (*Micropterus dolomieui*)	X	X	-	-	-
Speckled dace (*Rhinichthys osculus*)	R	-	R	-	-
Spotfin shiner (*Notropis spilopterus*)	X	X	-	-	-
Stoneroller (*Campostoma anomalum*)	X	X	X	-	-
Striped bass (*Morone saxatilis*)	U	-	-	-	-
Striped shiner (*Notropis chrysocephalus*)	X	X	X	-	-
Walleye (*Stizostedion vitreum*)	R	R	-	-	-
White perch (*Morone americana*)	R	-	-	-	-
White sucker (*Catostomus commersoni*)	X	R	X	-	-
Yellow perch (*Perca flavescens*)	U	-	-	-	-

1 WWH = warmwater Habitat; EWH = exceptional warmwater habitat; CWH = coldwater habitat; NP = nuisance prevention; SSH = seasonal salmonid habitat.

2 X = species common; R = representative of another species that is common; U = species occurs, but is uncommon.

APPENDIX 11

Portions of Ohio's Water Quality Inventory

OEPA 305 (b) Report

ROCKY RIVER BASIN

SUBBASIN SUMMARY

An intensive biological and water quality survey was conducted in the Rocky River Basin in 1981. Elevated stream flow during the survey period (1981) was undoubtedly a predominant influence on the relative magnitude of point and nonpoint source impacts. The relatively high rainfall and stream flows were expected to minimize impacts from point source effluents and potentially reveal nonpoint influences on chemical and biological parameters. In general, chemical parameters (particularly total iron and fecal coliform bacteria) were indicative of nonpoint source runoff at many sites; however, with the exception of the segment downstream from the Montville landfill, nonpoint source runoff did not have a significant impact on biological communities in the East Branch, the West Branch, or the mainstem of Rocky River.

Considering the six major dischargers to the Rocky River (on the basis of loading rates), only three had a significant impact on water quality and biological communities in the East Branch, West Branch or mainstem. The Medina Co. 500 WWTP had a significant impact on the West Branch, the Berea WWTP impacted the East Branch, and the Strongsville A WWTP had a significant impact on the immediate receiving stream and the West Branch downstream from the confluence. The remaining major dischargers, the North Olmsted WWTP, the Middleburg Heights WWTP and the Brookpark WWTP did not have a significant impact on the mainstem water quality or biological condition; however, the latter two treatment plants did significantly impact water quality and biological communities in Abram Creek. Several relatively smaller dischargers had significant impacts on the immediate receiving stream water quality (i.e. North Royalton A WWTP on unnamed tributary and Brentwood WWTP on Plum Creek) but no detectable impact on the East or West Branchs. The North Royalton B and Strongsville C WWTPs had a severe impact on water quality and biological communities in Baldwin Creek. This, in combination with combined sewer overflows upstream from Berea, had an impact particularly on the fish community in the East Branch.

The Montville landfill had a relatively severe impact (in magnitude and extent) on water quality and biological communities in the West Branch downstream from the tributary receiving the runoff from the landfill. Rainfall during the study period may have served to exacerbate the impact of the landfill on the West Branch; however the magnitude of the impact on chemical water quality indicated the potential to influence water quality even during relatively drier periods. Clean up of the landfill is pending litigation.

Urban nonpoint source runoff was identified as a potential influence on biological communities in two tributaries (Abram Creek and the tributary receiving the Strongsville A WWTP effluent) upstream from point source effluents. Both streams were relatively small, and the potential impact of nonpoint source runoff in downstream areas was difficult to assess because of the predominant influence of WWTP effluents.

Biological sampling in 1981 demonstrated potential or realized warmwater communities in North Branch (and Plum Creek), Baldwin Creek, Plum Creek (West Branch RM 3.1), Healey Creek, the tributary receiving the North Royalton A effluent (East Branch RM 12.9), as well as the East Branch, West Branch, and Mainstem of the Rocky River. Full recovery and attainment of the Warmwater Habitat (WWH) use in all areas is directly contingent on controlling point source loading from these WWTP's and controlling runoff into the West Branch from the Montville Landfill. Abram Creek and the tributary receiving the Strongsville A WWTP effluent were the only segments where potential WWH was not verified. Abram Creek, however, was near its WWH potential near the mouth. The failure to document potential WWH was a result of urban runoff in headwater areas and point source influences through the remainder of the stream lengths (Ohio EPA 1985).

Since the intensive survey in 1981, many dischargers in this basin have upgraded or are planning to upgrade water treatment facilities. These facilities include the Strongsville A, B and C WWTP's, North Olmsted WWTP, North Royalton A and B WWTP's, Berea WWTP and Brook Park WWTP (Ohio EPA, NEDO 1985). Lakewood and Rocky River WWTP's have moved their discharges to Lake Erie. As a result, Ohio EPA expects to see improvement in the quality of water and aquatic life downstream from these plants.

Detailed information on the biological condition of the Rocky River harbor and nearshore areas is not available. Existing data does indicate polluted sediment in the harbor area, and eutrophic to mestrophic conditions around the nearshore.

Spills and fish kills in the area are very uncommon with only seven spills being recorded over the past twenty years and only four of those causing kills. All were related to sewage discharge except one from NASA in which high ammonia concentrations were responsible for the loss of 2600 animals (Ohio EPA 1986). Recently, in 1984, the Ohio Department of Natural Resources reported 800 wild animals killed in Champion Creek, a tributary of the West Branch (confluence at RM 31.5), by an unknown pollutant from a public sewerage system. No fish kills were reported by Ohio Department of Natural Resources in 1983.

SEGMENT REPORTS

WEST BRANCH ROCKY RIVER
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 12.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	West Branch of Rocky River upstream from Montville Tributary	WWH 33.6-33.4
04110001-008 POOR* NO	West Branch downstream from Montville Tributary	WWH 33.4-32.4
04110001-008 FAIR* PARTIAL	West Branch recovery zone	WWH 32.4-29.8

Data from the 1981 intensive survey showed chemical parameters and biological communities upstream from the unnamed tributary (Montville Tributary) were indicative of good water quality. The Montville landfill runoff (entering the tributary at RM 33.4 of the West Branch) had a severe impact on chemical water quality and biological communities. Distinct elevations in many chemical parameters (particularly heavy metals) were indicative of the impact on chemical water quality. The macroinvertebrate community evidenced severe degradation at the station 0.1 miles downstream from the confluence, with an exclusively tolerant assemblage of species. There was a modest recovery 2.0 miles downstream but a low density of organisms suggested a continued toxic impact potentially aggravated by low dissolved oxygen concentrations. In contrast, the fish community was indicative of a relatively minor impact at the site 0.1 miles downstream from the confluence and there was a moderate decline in diversity 2.4 miles further downstream (Ohio EPA 1985). Limited monthly sampling continues to show violations of water quality standards for ammonia (Ohio EPA 1977-1985).

MONTVILLE TRIBUTARY[u]
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 33.4

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	Montville Tributary from the Montville Landfill to the mouth	NP 1.0-0.0

This tributary to the West Branch drains the Montville Landfill (RM 1.0) in Medina County. Leachate from this landfill has created water quality violations for dissolved solids, total iron, total zinc, total copper, total nickel, total chromium, total manganese, phenolics and ammonia. Limited monthly chemical sampling still shows violations of water quality standards for ammonia (Ohio EPA 1977-1985). A comprehensive clean up study is being conducted on the landfill and should be completed in May or June of 1986. Responsibility for clean up of the landfill is pending the results of the study and ongoing litigation (Paul Hancock, Attorney General's Office, pers. comm.).

WEST BRANCH MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	West Branch upstream from Medina County 500 WWTP	WWH 29.8-14.8
04110001-008 FAIR-GOOD* PARTIAL	West Branch downstream from Medina County 500 WWTP	WWH 14.7-4.4

Some impacts were noted on chemical water quality in this segment of the West Branch from nonpoint source runoff, the Montville landfill, and particularly the Medina County 500 WWTP. Chemical water quality was fair in the segment upstream from the Medina County 500 WWTP. The macroinvertebrate community was indicative of continued influence from the Montville landfill at RM 29.4 (four miles downstream) and was largely recovered at RM 27.3 (6.1 miles downstream). There was a marked difference in impact from the Montville tributary on fish as compared to macroinvertebrates at the two stations in the vicinity of the Montville Tributary confluence and the North Branch confluence. The less severe impact on fish communities was undoubtedly a function of available refuge areas (upstream from the Montville Tributary and in the North Branch) for fishes, and the ability of fishes to reinvade degraded areas during periods of improved water quality.

Water quality and biological condition were good immediately upstream from the Medina County 500 WWTP (RM 14.7, 0.3). Water quality parameters (particularly TKN, phosphorus and dissolved oxygen) and fish species diversity indicated a marked impact downstream from the WWTP. Continued influence from the WWTP along with physical characteristics (i.e. pooling as a result of impoundment at RM 5.5) impacted the fish community 2.9 miles downstream from the WWTP.

Ohio EPA's Northeast District Office (NEDO) reports that the Medina 500 WWTP has improved its treatment performance in the past year and a half resulting in less degradation.

Chemical parameters and biological communities at the two stations downstream from the dam (RM 5.5) but upstream from the Strongsville A tributary (RM 4.5) were indicative of relatively good water quality with slight organic enrichment (but low concentrations of heavy metals) (Ohio EPA 1985).

NORTH BRANCH
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 29.7

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD-EXCEPTIONAL* YES	North Branch downstream from Remsen Road bridge	WWH 5.5-0.0

PLUM CREEK
NORTH BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 5.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	Plum Creek downstream from Sleepy Hollow Road	WWH 2.1-0.0

Chemical water quality parameters and biological communities in these tributaries were indicative of good to exceptional water quality. Several elevated concentrations of chemical parameters indicated some influence from nonpoint source runoff but no impact was noted on biological communities. Macroinvertebrate communities were characterized by a diverse and apparently healthy community at both stations in the North Branch, and fish community diversity values were among the highest values in the Rocky River study area (Ohio EPA 1985).

WEST BRANCH ROCKY RIVER

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD-POOR* PARTIAL	West Branch mouth region	WWH 4.4-0.0

Water quality immediately upstream from the mouth of the West Branch showed some recovery; however, slightly higher concentrations of ammonia-N and total phosphorus, and considerably higher concentrations of heavy metals (compared to concentrations in the East Branch) were noted. In contrast to the apparent complete recovery of the fish community (potentially a function of improved water quality downstream), the macroinvertebrate community evidenced some recovery, but not to diversity levels comparable to those observed upstream from the Strongsville A Tributary (Ohio EPA 1985).

STRONGSVILLE A TRIBUTARY (BLODGETT CREEK)[u]
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 4.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	Strongsville A Tributary downstream portion	WWH 1.9-0.0

PLUM CREEK
WEST BRANCH ROCKY RILER TRIBUTARY
CONFLUENCE AT RM 3.1

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA GOOD* YES	Plum Creek upstream of Brentwood WWTP	WWH 8.5-1.9
04110001-NA POOR-FAIR* NO	Plum Creek downstream of Brentwood WWTP	WWH 1.9-0.0

In 1981, macroinvertebrate and fish communities in the Strongsville A Tributary upstream from the WWTP were indicative of poor water quality, apparently in response to urban nonpoint source runoff. Macroinvertebrates were further degraded at the station 1.1 miles downstream from the

Strongsville A WWTP, and indicated little improvement at the mouth of the tributary (1.7 miles downstream from the WWTP). No fish were collected on either sampling date at the station 1.3 miles downstream from the WWTP. The West Branch was influenced by water quality in the Strongsville A Tributary in 1981 as indicated by distinct increases in heavy metals concentrations and a marked decline in fish diversity (to the lowest value measured in the study area) downstream from the confluence. The Strongsville A WWTP was upgraded in 1982. Additional clarifiers and sludge handling facilities were added. There have been no permit compliance problems in the past 2 1/2 years (since 1984).

A diverse fish community at RM 8.5 in Plum Creek was indicative of good water quality upstream from the Brentwood WWTP (RM 3.1, 1.8). A pronounced decline in fish community diversity, along with macroinvertebrate and chemical parameters were indicative of fair to poor water quality near the mouth of Plum Creek. This decline in water quality was attributed to influence from the Brentwood WWTP as well as septic leachate in the vicinity of the WWTP and downstream. Chemical parameters were indicative of only a minor influence from water quality in Plum Creek on the West Branch, and continued degradation from the Strongsville A Tributary masked any potential influence on macroinvertebrate communities. In contrast, the fish community exhibited a relatively rapid recovery downstream from the confluence (RM 2.0) with apparently complete recovery near the mouth of the West Branch (RM 0.3) (Ohio EPA 1985).

EAST BRANCH ROCKY RIVER
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 12.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-009 GOOD* YES	East Branch from headwaters to the Baldwin Lake Dam	WWH 26.7-5.0

NORTH ROYALTON A TRIBUTARY[u]
EAST BRANCH TRIBUTARY
CONFLUENCE AT RM 12.9

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	North Royalton A Tributary mouth region	WWH 0.6-0.0

Although chemical parameters were indicative of nonpoint source runoff from RM 26.7-13.0, healthy and diverse fish and macroinvertebrate communities were indicative of good to exceptional water quality in this segment of the East Branch in 1981. A large number of bigmouth shiner, an Ohio Endangered Fish Species, were collected in this segment of the East Branch. Further, there was not apparent impact from the Medina County 300 WWTP on water quality or biological communities.

Water quality was generally good from RM 12.9-5.0 in 1981. There was some evidence of organic enrichment but rapid recovery from any impact on biological communities. The North Royalton A WWTP had a relatively minor but detectable impact on chemical water quality and biological condition in the East Branch, and a severe impact within the receiving tributary as evidenced by the decline in fish biomass, density and diversity. The Strongsville B WWTP also had a minor but detectable impact on chemical water quality (particularly ammonia-N) in the East Branch. The fish and macroinvertebrate communities showed little adverse impact from the Strongsville B plant, with some indications of organic enrichment immediately downstream and complete recovery 2.7 miles downstream (Ohio EPA 1985).

The North Royalton A WWTP is currently planning for additional final settling, sludge storage and sludge dewatering facilities. The Northeast District Office of Ohio EPA reports that this WWTP was generally in compliance with permit limits during 1985.

The Strongsville B WWTP is in the process of improving secondary treatment processes and solids handling capabilities in addition to adding tertiary treatment completion for construction is scheduled for the summer of 1986 (Ohio EPA, NEDO 1985). These plant modifications should result in improved water quality and biological conditions in this segment.

EAST BRANCH ROCKY RIVER

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-009 FAIR-POOR* NO	East Branch from the Baldwin Lake Dam to the confluence with Rocky River	WWH 5.0-0.0

Water quality in this segment of the East Branch was generally fair to poor as indicated by chemical and biological parameters. Although only a minor impact was indicated by macroinvertebrate communities, downstream from the confluence of Baldwin Creek there was a marked decline in fish community diversity and some impact on chemical water quality (particularly an increase in heavy metal concentrations). This impact was attributed to a combination of poor water quality from Baldwin Creek and influences from the Berea combined sewer overflows.

In 1981, the Berea WWTP had a marked impact on chemical water quality as evidenced by an increase in ammonia-N and phosphorus concentrations and a decline in dissolved oxygen concentration. There was a pronounced decline in fish biomass and diversity, and macroinvertebrates were characterized by low density, a moderate number of taxa and a relatively high diversity index, suggestive of some toxic influence (Ohio EPA 1985).

Ohio EPA, NEDO reports no major permit violations for Berea WWTP in 1985. The plant has approved plans for phosphorus removal. There is also the possibility that the Berea WWTP will tie into the Southwest Intercepter Sewer.

BALDWIN CREEK
EAST BRANCH TRIBUTARY
CONFLUENCE AT RM 4.9

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA FAIR-POOR* NO	Baldwin Creek from just upstream of two WWTP's to the confluence with East Branch	WWH 7.1-0.0

Water quality and biological communities in Baldwin Creek were severely impacted by effluent from the two WWTPs. Macroinvertebrate communities upstream from the two plants were indicative of fair water quality and some organic enrichment. There was a marked decline in macroinvertebrate and fish community diversity downstream from the North Royalton B WWTP, with some recovery apparent approximately 1.5 miles further downstream. Severe degradation of macroinvertebrates and some impact on fish (as evidenced by reductions in relative density, biomass and mean number of species) were also apparent downstream from the Strongsville C WWTP. There was minimal recovery of biological communities within Baldwin Creek. The fish community was composed of predominantly moderate to highly pollution tolerant species with the lowest relative biomass and density in the East Branch study area. A large number of bigmouth shiner, an Ohio Endangered fish species, were collected in Baldwin Creek (Ohio EPA 1985).

Recent information on the WWTP's in this segment indicate that the North Royalton B plant is in the initial planning stages for an upgrade and the Strongsville C plant is currently upgrading and due on line in the summer of 1986. The Strongsville C plant is improving secondary treatment and solids handling and installing tertiary treatment (Ohio EPA, NEDO 1985).

ROCKY RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR-GOOD* PARTIAL	Rocky River from the confluence of East and West Branches to the harbor	WWH 12.4-0.9

The apparent impact of East and West Branch water quality in the mainstem differed as inferred from chemical and biological evidence. Chemical parameters indicated more degraded water quality in the West Branch, while the relative impact on biological communities appeared more severe on the East Branch. The most downstream biological samples in the East Branch were indicative of potential toxic impacts while in the West Branch the communities were indicative of organic enrichment (with few or no toxic impacts).

Chemical parameters as well as biological communities in the mainstem upstream from the North Olmsted WWTP were indicative of some organic enrichment but not acute impacts. In 1981, there was a detectable but minor impact from the

North Olmsted WWTP on both chemical parameters and biological communities downstream from the plant. There was no detectable impact from Abram Creek on the Mainstem, however loading from Abram Creek may have had an impact on the rate of recovery from upstream perturbations.

Ohio EPA, NEDO reports that North Olmsted WWTP is almost finished with a major plant upgrade. It is due on line in the summer of 1986.

Water quality parameters as well as biological communities demonstrated some recovery in the lower portion of the Mainstem, and appeared to be nearly completely recovered at the most downstream station (RM 2.9). The only exception in this recovery were some continued indications of nutrient loading from upstream (Ohio EPA 1985).

In the lower river, occasional violations for fecal coliform and iron were found. Violations for copper, cadmium, lead, zinc and phenol have been recorded, but a review of water quality over the last five years reveals both the number and extent of violations to be decreasing and presently almost non-existent. Concentrations of conventional eutrophication parameters have also been decreasing (Ohio EPA 1986). A segment of this section (RM 6.4-0.0) has been designated SSH in addition to WWH, requiring that no chlorine be discharged from October to May.

ABRAM CREEK
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 10.4

Segment Condition Use Attainment	Name Description	Use designation Mile Points
04110001-NA FAIR-POOR* NO	Abram Creek from upstream of WWTPs to the confluence with Rocky River	WWH 4.6-0.0

Water quality and biological communities in Abram Creek were severely impacted by both the Middleburg Heights WWTP (RM 4.0) and the Brookpark WWTP (RM 3.7). Although fish community diversity was relatively low upstream from the WWTPs, a distinct decline was evidenced downstream from each plant. Chemical and biological parameters downstream from the two WWTPs were indicative of a severe impact from sewage effluent as well as potential impacts from foundry sand runoff.

Some recovery was documented on macroinvertebrate communities at RM 1.0 and a marked improvement in the fish community was noted at RM 0.9. This recovery on biological communities was at least partially a function of settling and assimilation in an instream dam pool at approximately RM 1.0. Chemical parameters indicated some recovery of water quality (particularly a considerable increase in dissolved oxygen concentrations), however there were continued indications of severe nutrient loading to the Rocky River (Ohio EPA 1985).

Ohio EPA, NEDO reports no permit violations for Middleburg Heights WWTP since August 1984. Brookpark WWTP, on the other hand, has had dissolved oxygen problems with its effluent. Brookpark, however, is planning an upgrade with phosphorus removal, sludge handling and additional clarifiers.

ROCKY RIVER HARBOR AREA

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR* PARTIAL	Rocky River Harbor	ELEH (WWH) 0.9-0.0

Harbor water quality is difficult to assess. Little data is available. Plant records below the former Lakewood effluent (RM 1.8) indicate an increase in dissolved oxygen levels and a decrease in ammonia concentrations over a ten year period, reflecting a decreased organic load. Lakewood WWTP effluent is now being discharged to Lake Erie. All conventional eutrophication related parameters indicate a decreasing trend based on the data that is available. Even though water quality appears to be good, sediments are polluted throughout much of the harbor area and the macrobenthic community indicates a highly degraded environment. Fish collected from the river mouth have been found to contain quite a number of contaminants with no obvious source (Rathke 1984). None of these contaminants exceed FDA action limits or U.S. EPA criteria. Although future improvements in the basin are expected to lead to further improvements in water quality and certainly no further degradation, the status of the harbor at present can only be ranked fair (Ohio EPA 1986).

ROCKY RIVER NEARSHORE AREA

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR-GOOD* PARTIAL	Rocky River Nearshore	ELEH

A detailed survey, as done for the lower Rocky River, is not available for the nearshore zone. A summary of the sport fishery harvest indicates yellow perch, white bass, freshwater drum, walleye and channel catfish to be the most important species. Fish larvae studies conducted along the south shore in conjunction with power plant entrainment, indicate emerald shiners, gizzard shad and spottail shiners comprise the bulk of the fish larval biomass. Fish community structure in this nearshore area is similar to that of the central basin.

Based on results of the 1978 and 1979 Lake Erie intensive report (Rathke, 1984), the nearshore zone is considered eutrophic to mesotrophic. Two WWTPs discharge to the nearshore zone, the Rocky River WWTP and the Lakewood WWTP. The Lakewood outfall was moved from the river (RM 1.8) to the lake in 1984 and the treatment works has undergone considerable improvement in recent years. The Rocky River WWTP is also undergoing major renovation and both plants are expected to be in-compliance with their final permits by 1988. Fecal coliform counts were elevated in the vicinity of the harbor mouth and CSO and WWTP outfalls, but violations of standards were not confirmed. Most of the beaches in the area have experienced high coliform concentrations, particularly in the pre-1975 time period, but this has not been a problem in recent years. No beach closings have been recently reported. The Lake Erie nearshore is considered to be Excepted Lake Erie Habitat, so WWH standards are applicable here rather than the more stringent Lake Erie standards. Copper and cadmium concentrations continue to exceed WWH standards, but all other parameters are within acceptable limits.

REFERENCES

Havens and Emerson Ltd. 1975. Water quality assessment and basin modeling; Rocky River and Tinkers Creek.

Ohio Department of Natural Resources. 1984. Water pollution, fish kill, and stream litter investigations. Publication 7. Ohio DNR, Columbus, Ohio. 14 pp.

Ohio Environmental Protection Agency. 1977-1986 (unpublished). Data available from the Northeast District Office, Ohio EPA, Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1985. Draft Comprehensive Water Quality Report for Rocky River, Rocky River basin, Summit, Medina, Lorain, and Cuyahoga Counties, Ohio. Ohio EPA, Division of Wastewater Pollution Control, Columbus, Ohio.

Ohio Environmental Protection Agency. 1986. Lower Rocky River and harbor assessment report; supplement to the State of Ohio 305(b) Water Quality Inventory, Division of Water Quality Monitoring and Assessment. Columbus, Ohio.

Rathke, D.E. (Ed), 1984. Lake Erie intensive study 1978 - 1979. U.S. EPA, Great Lakes National Program Office, Region V, Chicago, IL.

CUYAHOGA AND CHAGRIN RIVER BASINS

CUYAHOGA RIVER BASIN

BASIN SUMMARY

The Cuyahoga River Basin contains areas with exceptional physical/chemical water quality, and areas where there are significant water quality problems. An estimated 134.0 stream miles in this basin have major physical/chemical problems. The headwaters and upper reaches flow through farmland and sparsely populated areas. Limited data indicated that there were occasional dissolved oxygen violations, but the overall water quality in these reaches was very good. The upper Cuyahoga River above Lake Rockwell (RM 61.0) has the capacity to assimilate wastes from the small, widely dispersed sources of pollution.

The middle and lower portions of the Cuyahoga River Basin are considerably more populated and industrialized than the upper portion. Cleveland and Akron, the two major metropolitan areas in the basin, greatly influence water quality of the Cuyahoga River. Numerous other smaller cities including Ravenna, Kent, Stow, Cuyahoga Falls, Hudson, Macedonia, Twinsburg, Solon, Bedford, Bedford Heights, Maple Heights, Walton Hills, Garfield Heights, Brookpark and Parma also influence stream quality. Water quality conditions begin to deteriorate at the Lake Rockwell Dam (RM 58.0) where the city of Akron diverts a substantial portion of the river for the city's drinking water supply. During dry weather periods, diversion leaves very little water in the river for dilution of point and nonpoint sources of pollution. Five dams between Kent (RM 54.9) and Cuyahoga Falls (RM 44.6) create long pools of very slow moving water. Increased BOD_5 loadings from the Ravenna, Franklin Hills, Kent, and Fish Creek WWTP's, coupled with the slow moving water in the dam pools caused low dissolved oxygen levels during the early moring hours of the summer months (Ohio EPA data, 1975).

The city of Akron, located in the middle portion of the Cuyahoga River Subbasin, has a major impact upon the river (Figure II-7). Numerous industrial dischargers and the Akron WWTP (RM 37.4) effluent make up approximately 75% of the Cuyahoga River flow during critical low-flow conditions. Urban runoff and combined sewer overflows are also a major problem in Akron. Further downstream, Tinkers Creek (RM 16.4), delivers additional pollutants to the Cuyahoga River. This loading comes from urban runoff, combined sewer overflows and several suburban municipal WWTP's. Due to the good reaeration capabilities of lower Tinkers Creek, most of the organic wastes are assimilated prior to reaching the Cuyahoga River. However, considerable amounts of nutrients, heavy metals and fecal coliform bacteria are carried downstream. Two urban tributaries within the Cleveland metropolitan area, Mill Creek (RM 11.5) and Big Creek (RM 7.2), have severe water quality problems. Industrial dischargers, urban runoff, and combined sewer overflows are the major sources of pollutants carried to the Cuyahoga River by these tributaries.

The lower portion of the Cuyahoga River receives major discharges from the LTV Steel Mills, two chemical companies (DuPont and Harshaw) and the 100 MGD Cleveland Southerly WWTP.

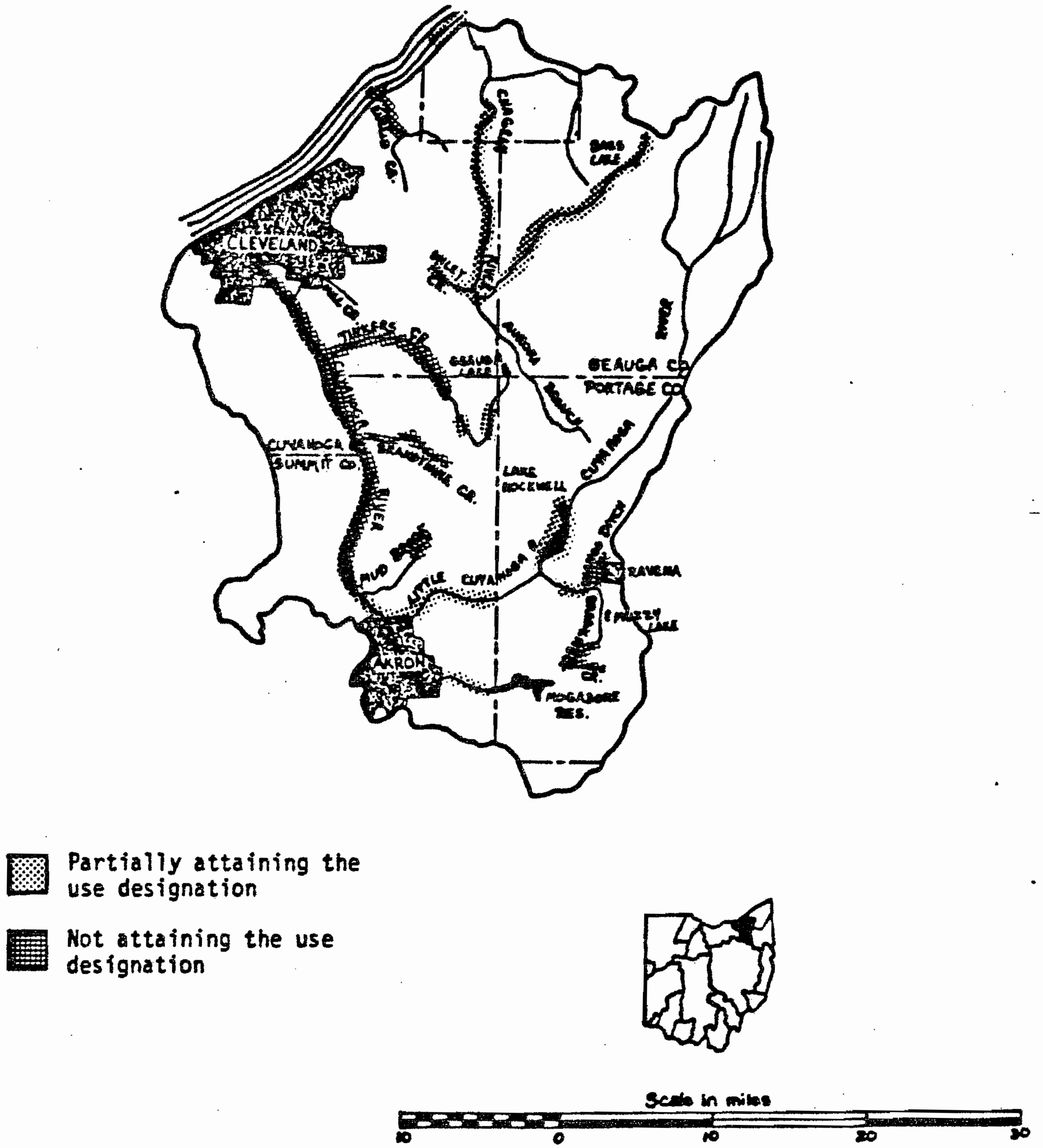


Figure II-6. Use attainment map of Cuyahoga and Chagrin River basins (Ohio). Stream segments that were judged not to support aquatic life in accordance with the goals of the Clean Water Act are highlighted with stippled shading.

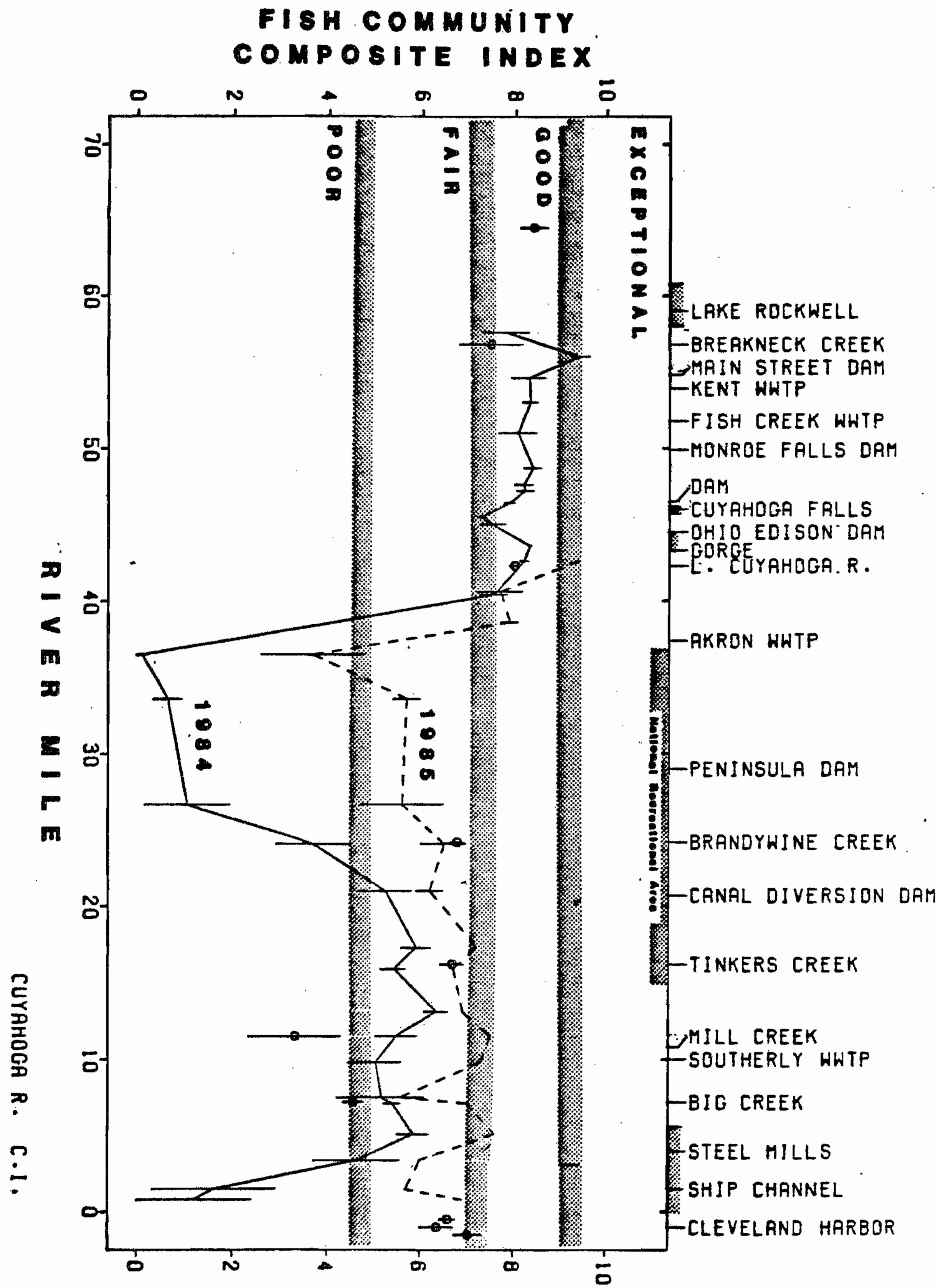


Figure II-7. Summary of biological conditions of the middle and lower Cuyahoga River, 1984-1985.

Significant improvements in the water quality of the Cuyahoga River have occurred. Data collected downstream from the urban Akron area has shown an overall improvement since 1969, with a reduction of pollutants and an increase in dissolved oxygen levels. However, this improving trend appears to be leveling off. Further downstream, at Independence (RM 13.1), increasing dissolved oxygen concentrations were also evident during the 1970's. Aesthetic (i.e. visual, appearance, odors, etc.) improvements near the mouth of the Cuyahoga River have been noted. The oil and debris problems, the cause of the infamous fire in 1969, have been greatly minimized, if not eliminated.

SEGMENT REPORTS

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-011 GOOD YES	Cuyahoga River from the East Branch Reservoir Dam to Hiram Rapids	WWH 88.0-75.0

Occasional WQS violations for dissolved oxygen have been reported in this portion of the Cuyahoga River (Ohio EPA, NEDO data, 1973, 1974, 1976). These violations occurred during low-flow, warm weather periods (Ohio EPA, NEDO data, 1973, 1976, 1977). Low dissolved oxygen concentrations may be a natural phenomenon in the upper Cuyahoga River due to the low stream gradient and the high organic matter loading from the extensive marsh areas within the drainage basin. The possibility requires further investigation.

Point source dischargers within this segment include the Middlefield WWTP (RM 87.1), Sperry Pond WWTP (RM 1.8), the Burton WWTP (RM 85.3), and the Middlefield Swiss Cheese Company (RM 87.6, Tar Creek RM 1.4). Wastewater treatment improvements at the Burton WWTP and Middlefield Swiss Cheese Company during the late 1970's greatly reduced the organic loadings to this segment. Facility plans for upgrading the Middlefield WWTP should be certified by mid 1982. Even with these improvements, the clean water goals may not be totally achieved. Occasional dissolved oxygen violations during the low flow summer months may continue to occur due to natural conditions, but the frequency and severity of these violations should be greatly reduced (Ohio EPA 1984).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-010 GOOD-EXCEPTIONAL YES	Cuyahoga River from Hiram Rapids to Lake Rockwell	WWH 75.0-64.0

Historical chemical/physical water quality data and recent chemical and biological sampling at a site just upstream from Lake Rockwell indicate no use impairment in this river segment. A very diverse aquatic macroinvertebrate community was recorded at RM 64.5 in 1984. The fish community was also rated in good condition with numerous sensitive species present in moderate numbers.

LAKE ROCKWELL

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-007 -- PARTIAL	Lake Rockwell	Public Water Supply 64.0-58.0

Lake Rockwell is formed by a man-made impoundment on the Cuyahoga River and is the primary public water supply for the city of Akron. The lake has been plagued by excessive growths of aquatic macrophytes and algae, hence, the quality of the drinking water supply is adversely affected by taste and odors. The city of Akron and Kent State University are studying the problem and investigating methods of reducing available plant nutrients, thereby decreasing plant growth and the taste and odor problems (Ohio EPA 1984).

BREAKNECK CREEK[U]
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 56.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-005 FAIR-POOR NO	Breakneck Creek from the headwaters to Interstate 805	WWH 17.0-11.0

The headwaters of Breakneck Creek and its system of feeder canals and tributaries drain predominately low lying, marsh areas. Sampling of one such tributary, Potter Creek, in 1983 and 1984 revealed very low dissolved oxygen concentrations (less than 1 ppm) attributable to the natural background conditions. A reasonably diverse macroinvertebrate community was recorded, but only 2 species of fish were collected in very low numbers. It is probable that much of the upper Breakneck Creek drainage cannot attain the WWH use designation because of the prevailing background conditions (Ohio EPA 1983-84).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-005 FAIR-GOOD* PARTIAL	Breakneck Creek from Interstate 805 to the Cuyahoga River	WWH 11.0-0.0

A survey conducted in 1984 revealed good chemical and biological quality of a site upstream from Wahoo Ditch and the discharge of the Ravenna WWTP. Dissolved oxygen concentrations were depressed downstream from Wahoo Ditch, although values were above the 4 mg/l standard. An impact on the fish community was noted downstream from Wahoo Ditch but full recovery was demonstrated within several miles. Other pollution sources in the segment include the Franklin Hills WWTP (no impact detected) and the A and B Landfill near RM 3.5. Sediment chemistry data on heavy metal contaminations suggested possible contributions from the landfill (Ohio EPA 1984).

WAHOO DITCH[u]
BREAKNECK CREEK TRIBUTARY
CONFLUENCE AT RM 4.6

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* NO	Wahoo Ditch from headwaters to Breakneck Creek	WWH 4.0-0.0

Wahoo Ditch receives the discharge from the Ravenna WWTP via the Hommon Avenue Ditch (RM 1.4). Two small industries and a package sewage treatment plant discharge to Wahoo Ditch near its origin in Ravenna. The Ravenna WWTP was upgraded in 1975; but the improvements did not include nitrification. Facilities plans currently being prepared for the city will address ammonia removal and improved sludge handling capabilities.

Biological and chemical/physical data collected in 1984 revealed grossly polluted conditions in Wahoo Ditch. Macroinvertebrate and fish communities were rated poor at sites upstream and downstream from the Ravenna WWTP discharge. Dissolved oxygen concentrations below 2 mg/l at both sites and elevated ammonia concentrations downstream from the Ravenna WWTP discharge were identified as the major problems (Ohio EPA, CO 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-006,-004 GENERALLY GOOD* PARTIAL	Cuyahoga River from Lake Rockwell to the Little Cuyahoga River confluence	WWH 58.0-42.3

The Cuyahoga River below Lake Rockwell has been greatly altered by man's activities. The City of Akron removes an average of 50 million gallons of water per day from Lake Rockwell for its drinking water supply. This rate of removal exceeded the total discharge of the Cuyahoga River during dry weather conditions. Thus, the flow of the Cuyahoga River below the impoundment often consists primarily of treated wastewater with minor dilution from small tributaries. Water quality problems are further complicated by the presence of five dams within this river segment. Low dissolved oxygen (D.O.) levels frequently occur in all of these dam pools. Field surveys during 1975 and 1984, revealed depressed D.O. in the Kent Main Street Dam (RM 54.9) and the Munroe Falls Dam (RM 50.0) (Ohio EPA, NEDO data, 1975 and 1984).

Biological data collected in 1984 revealed reasonably healthly fish and macroinvertebrate communities in this river segment. Benthic communities were rated good at most locations and the fish community composite index was between 7.5 and 9.0, except for 2 locations within the Ohio Edison Gorge Plant dam pool. Slightly lower values there (7.0-7.5) seem to reflect the habitat conditions, thermal load from the power plant and the unique settling of a dam pool within the natural riverine gorge. Full attainment of the WWH use within the gorge dam pool and the river segment as a whole is contingent upon maintaining the appropriate thermal standards, controlling other pollutants loads and allowing adequate time for aquatic populations to colonize isolated river segments between dam pools (Ohio EPA 1984).

LITTLE CUYAHOGA RIVER
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 42.3

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-002 FAIR-POOR PARTIAL	Little Cuyahoga River from Mogadore Reservoir to the Cuyahoga River	WWH 13.0-0.0

The Little Cuyahoga River flows through the densely populated urban and industrial area of Akron. Combined sewer overflows, urban nonpoint sources, and old sewers in need of repair create significant water quality problems. Historical data, collected at the Otto Street gage (RM 1.8), revealed WQS violations for phenolics, total iron, total lead, and fecal coliform bacteria. Chemical/physical and biological sampling at this single location in 1984 did not reveal any acute problems, although biological communities were not at their full potential.

A Combined Sewer Overflow Study (CSOS) and several interim Sewer System Evaluation Studies (SSES) which address Akron's sewer problems have been completed. As a result, overflow retention basins have been constructed at Memorial Parkway and Martha Avenue. These two systems have greatly reduced the combined sewer overflows from these areas. Plans to construct a third retention basin at Kelly Avenue have been postponed due to financial constraints (Ohio EPA 1984).

POWERS BROOK
MUD BROOK TRIBUTARY
CONFLUENCE AT RM 9.1

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA FAIR-POOR NO	Mud Brook from Meadowbrook Lake to mouth	WWH 1.5-0.0

Powers Brook upstream from the Summit Co. #6 WWTP was in good biological condition based upon 1984 survey results. Downstream from the WWTP the overall biological rating was fair-poor and degradation extended into Mud Brook so that the minimum total stream length affected was approximately 2-3 miles. Ammonia-N concentrations were 2-7 times the WQS in the stream and dissolved oxygen minimums were 2.5-3.0 mg/l downstream from the WWTP in Mud Creek (Ohio EPA 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 FAIR-GOOD* PARTIAL	Cuyahoga River from the Little Cuyahoga River confluence to the Akron WWTP	WWH 42.3-37.4

This segment of the river is subject to pollutant loadings from upstream combined sewer overflows and point sources located on the Little Cuyahoga River. Sewer overflows contribute to bacterial contamination and the frequent exceedences of the Primary Contract Recreation Standard. An intensive survey in 1984 and 1985 revealed no other significant violation of chemical WQS. Biological communities in this river segment did suggest some degradation from upstream pollution sources (Ohio EPA 1983).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR* NO	Cuyahoga River from the Akron WWTP to the Canal Diversion Dam at SR 82	WWH 37.4-20.7

This segment of the Cuyahoga River is degraded by the combined sewer overflows in Akron and the Akron WWTP (RM 37.4). The Akron WWTP discharged an average of 75 million gallons of treated wastewater each day. This discharge accounted for more than sixty percent of the total flow of the Cuyahoga River during seven-day, once-in-ten-year low flows. Historical water quality violations include dissolved oxygen, fecal coliform bacteria, ammonia, and total lead (Akron Wastewater Quality Management Section, 1979-1980). Chemical/physical conditions have improved over the years and in 1984 and 1985 there were no significant dissolved oxygen, ammonia or heavy metal violations in this river segment. The bacteria contamination problem remains and the river water does not meet Primary Contact Recreation standards.

Despite the improvements in conventional pollutants measured in this segment of the Cuyahoga River the biological health of the river was found to be severely impaired by an unknown toxic component in the Akron effluent. The river segment was nearly devoid of fish and the macroinvertebrate community was clearly stressed. The immediate loss of nearly all fish strongly suggested a toxic impact and the failure of the community to recover to upstream levels indicated a persistent influence. Observations of fin erosion, lesions and external deformities on the fish collected in 1985 added more evidence of serious environmental stress in the Cuyahoga River downstream from Akron. There are ongoing studies being conducted by the City of Akron and the U.S. EPA Duluth Environmental Research Lab to identify and eliminate the toxicity.

Several of the interim improvements at the Akron WWTP which are now complete include chemical addition for improved solids settling and partial phosphorus removal, more efficient aeration, and stand-by power. Flow equalization to lessen primary by-passing is completed, but the plant is still experiencing operational problems. Bids for construction of Phase 1 final improvements are currently being received. Improvements now underway will include expansion of primary and secondary treatment facilities and improvements in the sludge treatment and handling facilities (Ohio EPA 1983).

BRANDYWINE CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 22.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR-FAIR NO	Brandywine Creek from Hudson to the Cuyahoga River	WWH 8.1-0.0

Two significant point sources, the Hudson Village WWTP (RM 8.1) and the Macedonia No. 15 WWTP (RM 3.9), degrade this relatively small stream. Tecumseh Corregated Box (RM 0.3) ceased operations in 1985. Wastewater treatment facilities at the Macedonia No. 15 WWTP were upgraded during the summer of 1979. The plant now provides adequate treatment for BOD_5, phosphorus, and suspended solids removal, but does not provide nitrification. The Hudson Village WWTP is currently under construction to upgrade to secondary treatment by 1983. The facility plan for this area recommended that all of these facilities be phased out and tied into the Cuyahoga Valley Interceptor when it becomes available, possibly in 1990.

A chemical/physical and biological survey was conducted in 1984. Biological degradation was apparent in Brandywine Creek and was attributed to the combined effects of the Hudson WWTP and Summit Co. #15. The overall condition of the stream was rated as fair and substantial improvement of 4 stream miles downstream from Summit Co. #15 could be realized with improved effluent quality. Effluent and in-stream samples indicated elevated ammonia-N (above WQS) was the major cause of the problem. Dissolved oxygen violations were not recorded at the routine grab sampling sites, although concentration were below 5 mg/l.

Brandywine Creek has been upgraded to WWH based upon the potential for aquatic life to repopulate the degraded segments if chemical water quality improved (Ohio EPA 1983).

TINKERS CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 16.4

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA FAIR-GOOD PARTIAL	Tinkers Creek from headwaters to Twinsburg	WWH 30.0-16.0

Numerous county and private sewage treatment plants discharge to the upper portions of Tinkers Creek. A survey in 1984 detected localized degradation of chemical and biological conditions downstream from these sources. Regional WWTPs are planned or are under construction in the Aurora and Steetsboro areas.

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR-FAIR* NO	Tinkers Creek from Twinsburg to the Cuyahoga River	WWH 16.0-0.0

With a drainage area of 96 square miles Tinkers Creek is the largest tributary to the Cuyahoga River. Water quality is heavily influenced by suburban and industrial land uses and numerous point source discharges. The larger WWTP's include Twinsburg, Solon, Bedford Heights and Bedford. The Walton Hills and numerous industrial sources were tied into the Cuyahoga Valley Interceptor in 1985.

The majority of the municipal point sources provide advanced secondary or teriary treatment and the degree of pollution from oxygen demanding wastes has declined markedly. However, data from a 1984 survey indicate that problems still remain in the form of frequent ammonia and heavy metal WQS violations. The fish community of the stream measured during the survey was rated poor to fair (composite index 4.5-7.5) and the benthic macroinvertebrate community was stressed at some locales (Ohio EPA 1983).

MILL CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 11.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* YES	Mill Creek from Granger Road to the Cuyahoga River	LWH 7.0-0.0

Mill Creek is a relatively small tributary, but it carries substantial quantities of pollutants to the Cuyahoga River. Combined sewer overflows, industrial discharges, and leachate from several landfills along the banks of Mill Creek contribute to the pollution problems. Historical WQS violations included ammonia, dissolved solids, phenolics, fecal coliforms, MBAS, total copper, total iron, and total lead (Ohio EPA, NEDO data, 1979-1980, 1984). A survey conducted in 1984 demonstrated high levels of domestic sewage throughout the stream. Macroinvertebrate and fish communities recorded in Mill Creek were indicative of severe pollution. Sewage bacteria completely dominated the stream substrate in the headwaters reach.

The Mill Creek Segmental Facilities Plan evaluated infiltration/inflow and combined sewer overflows for the Mill Creek Interceptor area. The plan recommended construction of the Southeast Interceptor, parallel relief sewers, off-line storage reservoirs, in-line combined sewer control regulators, and rehabilitation of existing sewers. The availability of funds for these much needed improvements is uncertain (Ohio EPA 1983).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR-FAIR* NO	Cuyahoga River from the Canal Diversion dam at S.R. 82 to the ship channel	WWH 20.7-5.6

This segment of river is also degraded as a result of the Akron WWTP and additional pollutant loading within the segment. Long term records collected at Independence (RM 13.1) clearly show vastly improved conditions for dissolved oxygen concentrations and ammonia. A survey in 1984 indicated no significant violations of the chemical/physical WQS. However, the poor to fair biological health of this river segment apparently reflects a persistent toxic impact attributable to the Akron WWTP. Other significant sources are confined to the lower 5 miles of the segment and include the Cleveland Southerly WWTP (RM 10.7) and the Mill Creek and Big Creek systems (Ohio EPA 1983).

BIG CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 7.0

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA GOOD* YES	Big Creek from headwaters to the Ford Branch	WWH 10.0-4.9

The headwaters of Big Creek flow through surban land use and the Big Creek Parkway Reservation of the Cleveland Metro Parks System. Chemical/physical and biological sampling (1984) near RM 8 revealed no apparent chemical water quality problem and biological communities were rated good considering the small stream size and prevailing land use (Ohio EPA 1984).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* YES	Big Creek from the Ford Branch to the Cuyahoga River	LWH 4.9-0.0

Urban nonpoint pollution, sewer overflows and several industrial discharges cause water severe quality problems in Big Creek downstream from the Ford Branch. WQS violations were reported for ammonia, phenolics, oil and grease, fecal coliforms, MBAS, total cadmium, total copper, total iron, total zinc and total lead (Ohio EPA, NEDO data, 1979-1980, 1984). Biological communities recorded in 1984 were extremely degraded in response to pollution from the sewage system. In some segments extreme channel and habitat modification also limits the biological condition.

Industrial dischargers during the reporting period included Ford Motor Company, General Motors Corporation, Harshaw Chemical, Ohio Drum and Cuyahoga Meat. By late 1980, Cuyahoga Meat and Ohio Drum ceased discharging and the Ford Motor Company tied its process water into sanitary sewers. Ford Motor Company and General Motors Corporation now discharge only treated storm water runoff. The continuous sanitary sewer overflow at Jennings Avenue has been repaired and a flow equalization tank has been installed to handle peak flows. Significant water quality improvements are anticipated as a result of these abatement activities (Ohio EPA 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR* NA	Cuyahoga River ship channel	Not Established 5.6-0.0

The lower Cuyahoga River exhibited very poor water quality, especially during the low flow summer months. WQS violations for dissolved oxygen, ammonia, fecal coliforms, phenolics, total cyanide, total lead, total iron, total cadmium, total copper and total zinc were reported at one or both monitoring sites (lower Harvard Ave., STORET station No. 502130, RM 7.3; West Third St. Bridge, STORET station No. 502140) (Ohio EPA, NEDO data 1979-1980, 1984). Typically segments of the ship channel are completely devoid of oxygen and fish life during periods of low river flow. However, a fish survey in 1985 showed a rapid repopulation of certain species in the fall of the year. Despite the existing level of water quality impairment, recreational use of the ship channel continues to expand in response to the economic revitalization of the area. The lower river is presently used for commercial navigation, industrial water supply, recreational boating and fishing on a seasonal basis. Major discharges that influence water quality in this segment (RM 10.7-0.0) include LTV Steel, Harshaw Chemical, DuPont Chemical and the Cleveland Southerly WWTP (Ohio EPA 1984-86).

REFERENCES

Akron Water Quality Management Section. 1969-1980 (unpublished). Analyses of the Cuyahoga River for the years 1969 through 1980. Akron Wastewater Treatment Plant, Akron, Ohio.

Ohio Environmental Protection Agency. 1974. Cuyahoga River 303(e) study, wasteload allocation report. Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1973-1986 (unpublished). Data available from Central Office and Northeast District Office, Ohio EPA, Columbus and Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1980 (unpublished). Biennial Water Quality Report. Reference Document 3. Benthic Sampling Tables.

United States Geological Survey. 1977. Water resources data for Ohio, Vol. II, St. Lawrence River Basin, USGS Water data report OH-77-2. USGS, Columbus, Ohio.

United States Geological Survey. 1978. Water resources data for Ohio, Vol. II St. Lawrence River Basin, USGS water data report, OH-78-2. USGS, Columbus, Ohio.

United States Geological Survey. 1979. (Provisional Data) USGS, Columbus, Ohio.

ADJACENT LAKE ERIE MINOR TRIBUTARIES

SEGMENT REPORTS

EUCLID CREEK

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-NA POOR NO	Euclid Creek from the West Tributary to the mouth	WWH 3.1-0.0

Major physical/chemical problems in Euclid Creek included fecal coliform bacteria, phenolics, total lead and total iron (OEPA, NEDO data, 1977-1980). The bacterial violations were probably the result of combined sewer overflows, individual septic systems and/or the Scottish Highlands WWTP (RM 1.4) in Richmond Heights. The remaining violations were probably the result of seepage from a covered waste disposal site at Cleveland Metal Cleaning (RM 2.0). The city of Cleveland's Nottingham Water Filtration Plant (RM 1.8) occasionally released chlorinated backwash water into Euclid Creek. The elevated chlorine levels have caused numerous fish kills. The discharge has been the subject of several complaints as well. The facility is now under orders from the Director of Environmental Protection to eliminate all discharge into Euclid Creek. The city is scheduled to tie into the Euclid Sanitary Sewer District in 1987.

A new swimming beach is being built just to the west of the mouth of Euclid creek as part of the Cleveland Lakefront State Park operated by the Ohio Department of Natural Resources.

EUCLID CREEK NEARSHORE

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-NA POOR NO	Lake Erie Nearshore immediately adjacent to Euclid Creek	LEH

Water quality at the mouth of Euclid Creek and the immediately adjacent nearshore was found to have elevated ammonia and total phosphorus values, and fecal coliform counts, copper, iron, manganese, nickel and zinc concentrations exceeding LEH Standards (Lake Erie Intensive, 1978 and 1979). No biological data is available to measure the effects of the water quality or aquatic life.

REFERENCES

Ohio Environmental Protection Agency. 1975, 1977-1980 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

STORET Data. 1978-1979. Lake Erie Intensive.

or more numbers are used, there will be two rows of numbers.

b) Set a point close to the bottom left corner of the box using the zero ("0") key (Figure 18). This is the left point in the bottom row.

c) To set the right point in the bottom row, move the cursor 3 keystrokes to the right for every number that will be placed in that row (this ensures that the numbers will fit in the box). It is best if you stay on the same line. Set a point using the zero ("0") key. Figure 19 is an example of setting the right-hand point on the bottom row.

d) These two points set up an imaginary line on which you will type in some text (which in this case will be numbers).

e) Push the "T" key, which is a command for text.

f) The word "TEXT:" will appear at the top of the screen. The keyboard will now act as a typewriter. Type in the numbers that represent the pollution problems (i.e., 4,5,6).

g) Push the enter (return) key and the text will appear between the two points that were set (Figure 20).

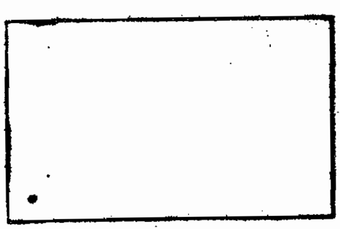


Figure 18

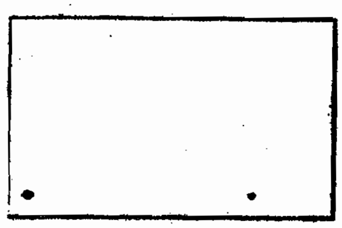


Figure 19

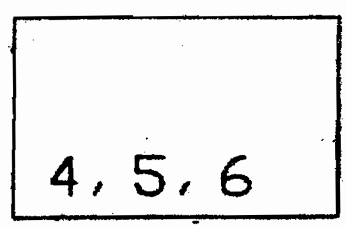


Figure 20

h) If the placement of the numbers is wrong, or the wrong numbers were placed in the box, push the escape key ("ESC"). The text command, including the two points (which is the last command) will be deleted.

i) Return to step 7 (above) and set the points, and try again.

j) If a second row of numbers need to be added, the procedure is the same for setting the points, except place the points close to the center row of the box (Figure 21). Return to step 7. The end result is shown in Figure 22.

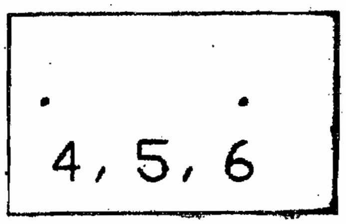


Figure 21

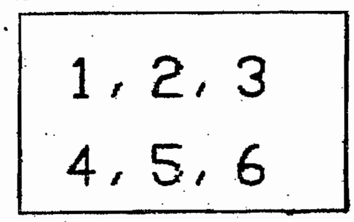


Figure 22

8) Make all necessary changes in other boxes.

9) Save the current drawing to disk, press the "F10" key. The drawing must always be saved to the disk, or the changes will not be saved. When the prompt at the top of the screen asks for a file name, type the same name that was used to call up the file, and enter (i.e., Cuya1, Doan1).

10) The prompt will say that the "file already exists, reuse ?", type "YES" (or simply a "Y").

11) AFTER saving the program, if you don't want to print a map, it can be terminated by pressing the "F8" key. The prompt will ask "DO you really want to stop the program ?" Type "Yes" (or "Y") if you want to stop the program.

12) If you want to print a map:

a) Press "F5" Key

b) The prompt will ask if you have saved the drawing yet. IF YOU HAVE NOT ALREADY SAVED THE DRAWING, DO IT NOW (see step 9). If you have already saved it answer "Yes" (or "Y").

c) A menu will appear called "Prodesign Print Command;" type a "1" and press "Enter." This is command to print a single drawing.

d) The prompt asks "Imput File Name". Enter the name of the file that you want to be printed. The prompt will tell you to wait because the drawing is being read.

e) A large menu containing drawing specifications will appear on the screen. The only specifications that you should be concerned with are "width of drawing" and "length of drawing." Use the arrow keys on the right side of the keyboard to move the cursor up or down.

- Move the cursor to the "width of drawing" line, and type "8.5" (using numbers at top of keyboard). This will make a drawing 8.5 inches wide.

- Move the the cursor to the "length of drawing" line, type in "10.5". This will make a drawing approximately 10.5 inches wide.

f) Press the "F1" key to start printing. There is a delay while the computer sends the information to the printer.

g) If it is necessary to stop the print command, press the escape ("ESC") key.

13) After the map is printed, push the "6" key and "enter" to stop the program. This will return you the opening DOS menu.

APPENDIX 10

Water Quality Standards and Stream Use Designations

WATER QUALITY CRITERIA FOR WARMWATER STREAMS IN NORTHEASTERN OHIO AS DEFINED BY OHIO EPA AS OF MAY 1985

" WARMWATER " - Warmwater Habitat - Waters that are capable of supporting balanced reproduction of populations of warmwater fish and and associated vertebrate and invertebrate organisms and plants on an annual basis.

PARAMETER	UNITS	WARMWATER
Ammonia	mg/1	
maximum		
30 day ave.		Table 7 & 8
Arsenic (Total Recoverable)		
maximum	ug/1	
30 day ave		36
Barium (Total Recoverable)		
maximum	ug/1	N.A.
30 day ave		
Beryllium (Total Recoverable)		
maximum	ug/1	
30 day ave		Table 9 & 10
Cadmium (Total Recoverable)		
maximum	ug/1	
30 day ave		Table 9 & 10
Chlorides		
maximum	mg/1	N.A.
30 day ave		
Chlorine (Total Residual)		
maximum		
30 day ave	ug/1	2.0
Total Chromium (Total Recoverable)		
maximum	ug/1	N.A.
30 day ave		
Hexavalent Chromium (Total Recoverable)		
maximum	ug/1	
30 day ave		10
Trivalent Chromium (Total Recoverable)		
maximum	ug/1	
30 day ave		N.A.

PARAMETER	UNITS	WARMWATER
Copper (Total Recoverable)		
maximum	ug/l	N.A.
30 day ave		
Cyanide (Free)		
maximum	ug/l	
30 day ave		8.1
Dissolved Oxygen		
min. at any time	mg/l	4.0
min. 24 hr. ave		5.0
Dissolved Solids		
maximum		
30 day ave	mg/l	1500
Fluoride		
maximum	mg/l	N.A.
30 day ave		
Iron (Total Recoverable)		
maximum	mg/l	
30 day ave		1.0
Iron (Soluble)		
maximum	mg/l	
30 day ave		N.A.
Lead (Total Recoverable)		
maximum	ug/l	
30 day ave		30
Manganese (Total Recoverable)		
maximum	ug/l	N.A.
30 day ave		
MBAS (Foaming Agent)		
maximum	mg/l	0.50
30 day ave		
Mercury (Total Recoverable)		
maximum	ug/l	
30 day ave		0.2
Nickel (Total Recoverable)		
maximum	ug/l	
30 day ave		Table 9 & 10
Nitrate-N		
maximum	mg/l	N.A.
30 day ave		

PARAMETER	UNITS	WARMWATER
Nitrates & Nitrites maximum 30 day ave	mg/l	N.A.
Oil & Grease		N.A.
Pesticides maximum 30 day ave	ug/l	Table 11
pH		6.5-9.0
Phenolic Compounds maximum 30 day ave	ug/l	Table 11
Phosphorus		N.A.
Phthalate Esters maximum 30 day ave	ug/l	3
PCB's maximum 30 day ave	ug/l	.001 m
Selenium (Total Recoverable) maximum 30 day ave	ug/l	34
Silver (Total Recoverable) maximum 30 day ave	ug/l	1.3
Sulfates maximum 30 day ave	mg/l	N.A.
Temperature maximum 30 day ave	Degrees F (Degrees C)	Table 12
Toxic Substances		p
Zinc (Total Recoverable) maximum 30 day ave	ug/l	Table 9

STREAM USE DESIGNATION AS DEFINED BY OEPA

Primary Contact - these are waters that during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as result of water quality.

Secondary Contact - these are waters that during the recreation season, are suitable for partial body contact recreation such as, but not limited to, wading with minimal threat to public health as a result of water quality.

- State Resource Water

Note: Limited Warmwater Habitats have different criteria than Warmwater streams

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
CUYAHOGA RIVER BASIN			
CUYAHOGA RIVER			
Southerly to Mouth	No Designation		
(Standards will be set when field assessment is performed)			
# Bath Rd to Rockside Rd.	*	*	
All Other Segments	*	*	
KINGSBURY RUN	*	*	
MORGANA RUN	*	*	
BURKE BROOK	*	*	
BIG CREEK			
Ford Motor Co. to Cuyahoga	* Limited	*	
Varied criteria for year around: ammonia - 4.0 mg/l total lead - 100 ug/l total zinc - 500 ug/l MBAS - 1.5mg/l			
# Boundaries Of Metroparks	*	*	
All Other Segments		*	

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
MILL CREEK			
Granger Rd. To Cuyahoga	* Limited	*	
Varied criteria for year around: ammonia - 8.0 mg/l total copper - 150 ug/l total zinc - 500 ug/l MBAS - 0.8 mg/l phenols - 20 mg/l			
All Other Segments	*	*	
TINKERS CREEK			
Herrick Nature Preserve	*	*	
All Other Segments	*	*	
CHIPPEWA CREEK			
# Rt. 82 To Cuyahoga River	*	*	
All Other Segments	*	*	
WEST CREEK	*	*	

EAST SIDE PARALLEL DIRECT DRAINAGE STREAMS

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY
DOAN BROOK			
# Shaker Lakes Nature Center	*	*	
NINEMILE CREEK	*	*	
EUCLID CREEK			
Rt. 20 to Anderson Rd.	*		
All Other Segments	*	*	
DUGWAY BROOK	No Designation		
SHAW CREEK	No Designation		
GREEN CREEK	No Designation		

STREAM SEGMENT	WARMWATER	PRIMARY	SECONDARY

ROCKY RIVER BASIN

EAST BRANCH			
# Upstream Boundaries of Metroparks to Confluence with West Branch	*	*	
All Other Segments	*	*	
Abram Creek (Middleburg Hts. & Brookpark WWTPs Tributary)	*	*	
# Baldwin Creek (Strongsville C & N. Royalton B WWTPs Tributary)	*	*	
WEST BRANCH			
Blodgett Creek (Strongsville A WWTP Tributary)	*	*	

BACTERIOLOGICAL CRITERIA FOR RECREATIONAL USE DESIGNATIONS

BATHING WATERS - Fecal Coliform - geometric mean fecal coliform content [either most probable number (mpn) or membrain filter (mf)], based on not less than five samples within a 30 day period shall not exceed 200 per 100 ml and shall not exceed 400 per 100 ml in more than 10% of the samples taken during any 30 day period.

PRIMARY CONTACT - Fecal Coliform - geometric mean fecal coliform content (either mpn or mf), based on not less than 5 samples within a 30 day period shall not exceed 1000 per 100 ml, and shall not exceed 2000 per 100 ml in more than 10% of the samples taken during any 30 day period.

SECONDARY CONTACT - Fecal Coliform - shall not exceed 5000 per 100 ml (either mpn or mf) in more than 10% of the samples taken during any 30 day period.

TABLE 7

Warmwater and Exceptional Warmwater Habitat 30-Day Average Total Ammonia-Nitrogen Criteria (mg/l).
Temperatures from 0 to 15°C apply only during the months of December through February.
Temperatures from 16 to 30°C apply during the months of March through November.

Temp. (°C) \ pH	6.5	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.8	9.0
0-10	13.0	13.0	13.0	12.6	11.7	10.7	9.6	8.6	7.6	6.6	5.6	4.8	4.0	3.4	2.8	2.3	1.9	1.5	1.2	1.0	0.7	0.5
11	13.0	13.0	12.4	11.6	10.5	9.8	9.1	7.8	7.0	6.1	5.3	4.4	3.7	3.1	2.6	2.1	1.7	1.4	1.2	0.9	0.7	0.4
12	13.0	12.6	11.4	10.6	9.6	9.1	8.4	7.2	6.5	5.7	4.9	4.1	3.5	2.9	2.4	2.0	1.6	1.3	1.1	0.9	0.6	0.4
13	12.4	11.6	10.6	9.8	8.9	8.4	7.7	6.8	6.0	5.3	4.5	3.8	3.2	2.7	2.2	1.8	1.5	1.2	1.0	0.8	0.6	0.4
14	11.4	10.8	9.8	9.1	8.3	7.8	7.2	6.3	5.6	4.9	4.2	3.5	3.0	2.5	2.0	1.7	1.4	1.2	0.9	0.7	0.5	0.3
15	10.7	10.2	9.1	8.5	7.7	7.2	6.7	5.8	5.2	4.5	3.9	3.3	2.7	2.3	1.9	1.6	1.3	1.1	0.8	0.7	0.5	0.3
16	7.0	6.6	6.0	5.6	5.2	4.8	4.4	3.9	3.4	3.0	2.6	2.1	1.8	1.5	1.2	1.1	0.8	0.7	0.6	0.5	0.3	0.2
17	6.5	6.1	5.5	5.2	4.9	4.4	4.0	3.6	3.1	2.7	2.4	2.0	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.4	0.3	0.2
18	6.0	5.7	5.2	4.9	4.5	4.1	3.7	3.3	3.0	2.6	2.2	1.9	1.6	1.3	1.1	0.9	0.7	0.6	0.5	0.4	0.2	0.2
19	5.6	5.3	4.8	4.5	4.2	3.9	3.5	3.1	2.7	2.4	2.1	1.7	1.5	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.2	0.2
20	5.2	4.9	4.4	4.2	3.9	3.5	3.2	2.9	2.6	2.2	1.9	1.6	1.4	1.2	0.9	0.8	0.7	0.6	0.4	0.3	0.2	0.2
21	4.9	4.5	4.1	3.9	3.6	3.3	3.0	2.7	2.4	2.1	1.7	1.5	1.2	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.2
22	4.4	4.2	3.9	3.6	3.4	3.0	2.8	2.5	2.2	1.9	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2
23	4.2	4.0	3.6	3.4	3.1	2.9	2.6	2.3	2.1	1.8	1.6	1.3	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2
24	3.9	3.7	3.4	3.1	2.9	2.7	2.4	2.1	1.9	1.6	1.4	1.2	1.1	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2
25	3.6	3.4	3.1	3.0	2.7	2.5	2.2	2.0	1.8	1.6	1.3	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2
26	3.4	3.2	2.9	2.7	2.6	2.3	2.1	1.9	1.7	1.5	1.2	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2
27	3.2	3.0	2.7	2.6	2.4	2.2	2.0	1.7	1.6	1.4	1.2	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2
28	3.0	2.8	2.6	2.4	2.2	2.1	1.8	1.6	1.5	1.3	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2
29	2.8	2.6	2.4	2.2	2.1	1.9	1.7	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2
30	2.6	2.4	2.2	2.1	1.9	1.8	1.6	1.4	1.2	1.1	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.1

TABLE 8

Nuisance Prevention Maximum Total Ammonia-Nitrogen Criteria (mg/l).
Temperatures from 0 to 15°C apply only during the months of December through February.
Temperatures from 16 to 30°C apply during the months of March through November.

Temp. (°C) \ pH	6.5	6.7	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.8	9.0
0-10	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.4	10.2	8.4	6.9	5.7	4.6	3.8	2.5	1.7
11	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.4	9.5	7.8	6.4	5.3	4.3	3.5	2.3	1.6
12	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.8	10.6	8.8	7.2	5.9	4.9	4.0	3.3	2.2	1.5
13	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.9	9.9	8.2	6.8	5.5	4.5	3.7	3.0	2.1	1.4
14	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.0	9.1	7.6	6.3	5.1	4.2	3.5	2.8	1.9	1.3
15	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.1	10.2	8.5	7.1	5.8	4.8	4.0	3.2	2.6	1.8	1.2
16	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.4	10.5	8.9	7.4	6.2	5.1	4.2	3.5	2.8	2.3	1.6	1.1
17	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.5	9.8	8.2	6.9	5.8	4.8	3.9	3.2	2.6	2.1	1.5	1.1
18	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.5	10.7	9.1	7.7	6.4	5.4	4.4	3.6	3.0	2.5	2.1	1.4	1.0
19	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.7	10.0	8.5	7.2	6.0	4.9	4.1	3.4	2.8	2.3	1.9	1.3	0.9
20	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.5	10.9	9.3	7.9	6.7	5.6	4.6	3.9	3.2	2.6	2.1	1.8	1.2	0.9
21	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	11.6	10.0	8.6	7.4	6.2	5.2	4.4	3.6	3.0	2.5	2.1	1.6	1.2	0.8
22	13.0	13.0	13.0	13.0	13.0	13.0	13.0	12.3	10.8	9.4	8.1	6.8	5.8	4.9	4.0	3.4	2.8	2.3	1.9	1.6	1.1	0.8
23	13.0	13.0	13.0	13.0	13.0	13.0	12.8	11.4	10.0	8.7	7.5	6.4	5.4	4.5	3.8	3.1	2.6	2.2	1.8	1.5	1.1	0.7
24	13.0	13.0	13.0	13.0	13.0	13.0	11.9	10.6	9.4	8.2	7.0	6.0	5.0	4.2	3.5	3.0	2.5	2.1	1.7	1.4	1.0	0.7
25	13.0	13.0	13.0	13.0	13.0	12.3	11.1	10.0	8.7	7.6	6.6	5.6	4.7	4.0	3.3	2.7	2.3	1.9	1.6	1.3	0.9	0.7
26	13.0	13.0	13.0	13.0	12.4	11.4	10.4	9.2	8.2	7.1	6.1	5.2	4.4	3.7	3.1	2.6	2.1	1.8	1.5	1.2	0.9	0.7
27	13.0	13.0	13.0	12.5	11.6	10.7	9.6	8.6	7.7	6.7	5.7	4.9	4.1	3.5	2.9	2.4	2.0	1.7	1.4	1.2	0.8	0.7
28	13.0	13.0	12.5	11.7	10.8	10.0	9.1	8.1	7.1	6.2	5.4	4.5	3.9	3.2	2.7	2.3	1.9	1.6	1.3	1.2	0.8	0.6
29	13.0	12.8	11.7	11.0	10.1	9.3	8.4	7.6	6.7	5.8	5.0	4.3	3.6	3.0	2.6	2.1	1.8	1.5	1.2	1.1	0.7	0.6
30	12.7	11.9	10.9	10.2	9.5	8.7	7.9	7.1	6.3	5.4	4.7	4.0	3.4	2.9	2.4	2.0	1.6	1.4	1.2	1.0	0.7	0.6

TABLE 9

Warmwater (WWH), Exceptional Warmwater (EWH) and Coldwater (CWH) Habitat 30-Day Average Criteria for Water Hardness Dependent Parameters. Criteria for values of water hardness not listed in this table shall be interpolated from the criteria corresponding to the two nearest values of water hardness. Criteria for values of water hardness less than 150 mg/l $CaCO_3$ and greater than 500 mg/l $CaCO_3$ shall be calculated from the appropriate equations on a case-by-case basis. All criteria are expressed as total recoverable concentration and ug/l.

Parameter	Hardness (mg/l $CaCO_3$)														
	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500
Beryllium															
WWH, EWH, CWH	5.4	6.8	8.4	10	12	14	16	18	20	22	24	26	29	31	34
Cadmium															
WWH, EWH	0.8	0.9	1.1	1.2	1.4	1.5	1.7	1.9	2.0	2.2	2.4	2.5	2.7	2.9	3.1
CWH	0.12	0.14	0.16	0.19	0.21	0.24	0.26	0.29	0.31	0.34	0.36	0.39	0.42	0.44	0.47
Tri. Chromium															
WWH, EWH, CWH	44	50	55	61	67	72	77	83	88	93	98	103	108	113	118
Copper															
WWH, EWH, CWH	7.0	8.0	9.1	10	11	12	13	14	15	16	17	18	19	20	21
Nickel															
WWH, EWH	167	193	218	243	268	292	317	341	365	389	412	436	460	483	506
CWH	147	169	191	213	235	257	278	299	320	341	362	383	404	424	445
Zinc															
WWH, EWH, CWH	99	113	126	139	152	164	177	189	201	213	224	236	247	259	270

TABLE 10

Nuisance Prevention Maximum Criteria for Water Hardness Dependent Parameters. Criteria for values of water hardness not listed in this table shall be interpolated from the criteria corresponding to the two nearest values of water hardness. Criteria for values of water hardness less than 150 mg/l $CaCO_3$ and greater than 500 mg/l $CaCO_3$ shall be calculated from the appropriate equations on a case-by-case basis. All criteria are expressed as total recoverable concentration and ug/l.

Parameter	Hardness (mg/l $CaCO_3$)														
	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500
Beryllium	1280	1610	1980	2360	2770	3210	3660	4130	4620	5140	5660	6210	6780	7360	7950
Cadmium	46	55	64	74	83	93	103	113	123	133	144	154	165	175	186
Tri. Chromium	2170	2460	2740	3020	3290	3560	3820	4080	4340	4590	4840	5080	5330	5570	5800
Copper	23	26	29	33	36	39	42	46	49	52	55	58	61	64	67
Nickel	1580	1820	2060	2300	2530	2760	2990	3220	3450	3680	3900	4120	4350	4570	4790
Silver	3.2	4.2	5.3	6.4	7.7	9.1	11	12	14	16	17	19	21	23	25
Zinc	390	443	495	546	596	645	693	741	788	834	880	925	970	1010	1060

TABLE 11

Pesticides Criteria. Concentrations for Public Water Supply are maximum criteria. Concentrations for Aquatic Life Habitat are 30-day average criteria. All concentrations are expressed in ug/l.

Pesticide	Public Water Supply[a]	Aquatic Life Habitat
Aldrin[b]	0.000074[c]	0.01
Benzene Hexachloride	--	0.1
Chlordane	0.00046[c]	0.01
Chlorophenoxy herbicides		
2,4-D	100.0	--
2,4,5-TP (Silvex)[b]	10.0	--
Ciodrin	--	0.1
Coumaphos	--	0.001
Dalapon	--	110.0
DDT[b]	0.000024[c]	0.001
Demeton	--	0.1
Diazinon	--	0.009
Dicamba	--	200.0
Dichlorvos	--	0.001
Dieldrin[b]	0.000071[c]	0.005
Diquat	--	0.5
Dursban	--	0.001
Endosulfan	74	0.003
Endrin	1.0	0.002
Guthion	--	0.005
Heptachlor[b]	0.00028[c]	0.001
Heptachlor Epoxide	0.1	--
Lindane	0.019[c]	0.01
Malathion	--	0.1
Methoxychlor	100.0	0.005
Mirex	--	0.001
Naled	--	0.004
Parathion	--	0.008
Phosphamidon	--	0.03
Simazine	--	10.0
TEPP	--	0.4
Toxaphene	0.00071[c]	0.005

a Pesticides are not to exceed the concentrations in this table, or the Safe Drinking Water Act, whichever is more stringent.

b Use has been banned.

c For protection of human health from the potential carcinogenic effects, at a 10^{-6} incremental increase of cancer risk over the lifetime, due to exposure through ingestion of contaminated water and contaminated aquatic organisms.

TABLE 12

Table 10e: Muskingum River - entire mainstem. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	45 (7.2)	45 (7.2)	53 (11.7)	53 (11.7)	58 (14.4)	65 (18.3)	68 (20.0)	72 (22.2)	76 (24.4)
Daily Maximum:	50 (10.0)	50 (10.0)	58 (14.4)	58 (14.4)	63 (17.2)	70 (21.1)	74 (23.3)	77 (25.0)	84 (28.9)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	85 (29.4)	85 (29.4)	85 (29.4)	85 (29.4)	80 (26.7)	73 (22.8)	67 (19.4)	62 (16.7)	47 (8.3)
Daily Maximum:	89 (31.7)	89 (31.7)	89 (31.7)	89 (31.7)	85 (29.4)	77 (25.0)	72 (22.2)	67 (19.4)	52 (11.1)

General Lake Erie Basin - includes all surface waters of the state within the boundaries of the Lake Erie drainage basin, excluding those water bodies as designated in Table 10g through 10i. Shown as degrees Fahrenheit and (Celsius).

	Jan. 1-31	Feb. 1-29	Mar. 1-15	Mar. 16-31	Apr. 1-15	Apr. 16-30	May 1-15	May 16-31	June 1-15
Average:	44 (6.7)	44 (6.7)	48 (8.9)	51 (10.6)	54 (12.2)	60 (15.6)	64 (17.8)	66 (18.9)	72 (22.2)
Daily Maximum:	49 (9.4)	49 (9.4)	53 (11.7)	56 (13.3)	61 (16.1)	65 (18.3)	69 (20.6)	72 (22.2)	76 (24.4)

	June 16-30	July 1-31	Aug. 1-31	Sept. 1-15	Sept. 16-30	Oct. 1-15	Oct. 16-31	Nov. 1-30	Dec. 1-31
Average:	82 (27.8)	82 (27.8)	82 (27.8)	82 (27.8)	75 (23.9)	67 (19.4)	61 (16.1)	54 (12.2)	44 (6.7)
Daily Maximum:	85 (29.4)	85 (29.4)	85 (29.4)	85 (29.4)	80 (26.7)	72 (22.2)	66 (18.9)	59 (15.0)	49 (9.4)

TABLE 13

Partial List of Representative Species of Ohio Fishes

SPECIES	AQUATIC LIFE USE DESIGNATION[1]				
	WWH	EWH	CWH	NP	SSH
Banded killifish (*Fundulus diaphanus*)	U[2]	-	-	X	-
Black crappie (*Pomoxis nigromaculatus*)	X	X	-	-	-
Blacknose dace (*Rhinichthys atratulus*)	X	U	X	-	-
Bluegill (*Lepomis macrochirus*)	X	U	-	-	-
Bluntnose minnow (*Pimephales notatus*)	X	X	-	-	-
Brook trout (*Salvelinus fontinalis*)	-	-	U	-	-
Brown bullhead (*Ictalurus nebulosus*)	X	-	-	X	-
Brown trout (*Salmo trutta*)	-	-	X	-	X
Channel catfish (*Ictalurus punctatus*)	X	X	-	-	-
Coho salmon (*Oncorhynchus kisutch*)	-	-	-	-	X
Common carp (*Cyprinus carpio*)	X	X	X	X	-
Common shiner (*Notropis cornutus*)	X	X	X	-	-
Creek chub (*Semotilus atromaculatus*)	X	X	X	-	-
Fathead minnow (*Pimephales promelas*)	X	-	-	-	-
Golden shiner (*Notemigonus crysoleucas*)	X	-	-	-	-
Goldfish (*Carassius auratus*)	U	-	-	X	-
Green sunfish (*Lepomis cyanellus*)	X	U	-	X	-
Largemouth bass (*Micropterus salmoides*)	X	X	-	-	-
Mosquitofish (*Gambusia affinis*)	U	-	-	-	-
Mottled sculpin (*Cottus bairdi*)	X	X	X	-	-
Northern pike (*Esox lucius*)	U	X	-	-	-
Orangethroat darter (*Etheostoma spectabile*)	X	-	-	-	-
Pumpkinseed (*Lepomis gibbosus*)	X	-	-	-	-
Rainbow darter (*Etheostoma caeruleum*)	X	X	X	-	-
Rainbow trout (*Salmo gairdneri*)	-	-	X	-	X
Red shiner (*Notropis lutrensis*)	U	-	-	-	-
Redear sunfish (*Lepomis microlophus*)	U	-	-	-	-
Rock bass (*Ambloplites rupestris*)	X	X	X	-	-
Smallmouth bass (*Micropterus dolomieui*)	X	X	-	-	-
Speckled dace (*Rhinichthys osculus*)	R	-	R	-	-
Spotfin shiner (*Notropis spilopterus*)	X	X	-	-	-
Stoneroller (*Campostoma anomalum*)	X	X	X	-	-
Striped bass (*Morone saxatilis*)	U	-	-	-	-
Striped shiner (*Notropis chrysocephalus*)	X	X	X	-	-
Walleye (*Stizostedion vitreum*)	R	R	-	-	-
White perch (*Morone americana*)	R	-	-	-	-
White sucker (*Catostomus commersoni*)	X	R	X	-	-
Yellow perch (*Perca flavescens*)	U	-	-	-	-

[1] WWH = warmwater Habitat; EWH = exceptional warmwater habitat; CWH = coldwater habitat; NP = nuisance prevention; SSH = seasonal salmonid habitat.

[2] X = species common; R = representative of another species that is common; U = species occurs, but is uncommon.

APPENDIX 11

Portions of Ohio's Water Quality Inventory

OEPA 305 (b) Report

ROCKY RIVER BASIN

SUBBASIN SUMMARY

An intensive biological and water quality survey was conducted in the Rocky River Basin in 1981. Elevated stream flow during the survey period (1981) was undoubtedly a predominant influence on the relative magnitude of point and nonpoint source impacts. The relatively high rainfall and stream flows were expected to minimize impacts from point source effluents and potentially reveal nonpoint influences on chemical and biological parameters. In general, chemical parameters (particularly total iron and fecal coliform bacteria) were indicative of nonpoint source runoff at many sites; however, with the exception of the segment downstream from the Montville landfill, nonpoint source runoff did not have a significant impact on biological communities in the East Branch, the West Branch, or the mainstem of Rocky River.

Considering the six major dischargers to the Rocky River (on the basis of loading rates), only three had a significant impact on water quality and biological communities in the East Branch, West Branch or mainstem. The Medina Co. 500 WWTP had a significant impact on the West Branch, the Berea WWTP impacted the East Branch, and the Strongsville A WWTP had a significant impact on the immediate receiving stream and the West Branch downstream from the confluence. The remaining major dischargers, the North Olmsted WWTP, the Middleburg Heights WWTP and the Brookpark WWTP did not have a significant impact on the mainstem water quality or biological condition; however, the latter two treatment plants did significantly impact water quality and biological communities in Abram Creek. Several relatively smaller dischargers had significant impacts on the immediate receiving stream water quality (i.e. North Royalton A WWTP on unnamed tributary and Brentwood WWTP on Plum Creek) but no detectable impact on the East or West Branchs. The North Royalton B and Strongsville C WWTPs had a severe impact on water quality and biological communities in Baldwin Creek. This, in combination with combined sewer overflows upstream from Berea, had an impact particularly on the fish community in the East Branch.

The Montville landfill had a relatively severe impact (in magnitude and extent) on water quality and biological communities in the West Branch downstream from the tributary receiving the runoff from the landfill. Rainfall during the study period may have served to exacerbate the impact of the landfill on the West Branch; however the magnitude of the impact on chemical water quality indicated the potential to influence water quality even during relatively drier periods. Clean up of the landfill is pending litigation.

Urban nonpoint source runoff was identified as a potential influence on biological communities in two tributaries (Abram Creek and the tributary receiving the Strongsville A WWTP effluent) upstream from point source effluents. Both streams were relatively small, and the potential impact of nonpoint source runoff in downstream areas was difficult to assess because of the predominant influence of WWTP effluents.

Biological sampling in 1981 demonstrated potential or realized warmwater communities in North Branch (and Plum Creek), Baldwin Creek, Plum Creek (West Branch RM 3.1), Healey Creek, the tributary receiving the North Royalton A effluent (East Branch RM 12.9), as well as the East Branch, West Branch, and Mainstem of the Rocky River. Full recovery and attainment of the Warmwater Habitat (WWH) use in all areas is directly contingent on controlling point source loading from these WWTP's and controlling runoff into the West Branch from the Montville Landfill. Abram Creek and the tributary receiving the Strongsville A WWTP effluent were the only segments where potential WWH was not verified. Abram Creek, however, was near its WWH potential near the mouth. The failure to document potential WWH was a result of urban runoff in headwater areas and point source influences through the remainder of the stream lengths (Ohio EPA 1985).

Since the intensive survey in 1981, many dischargers in this basin have upgraded or are planning to upgrade water treatment facilities. These facilities include the Strongsville A, B and C WWTP's, North Olmsted WWTP, North Royalton A and B WWTP's, Berea WWTP and Brook Park WWTP (Ohio EPA, NEDO 1985). Lakewood and Rocky River WWTP's have moved their discharges to Lake Erie. As a result, Ohio EPA expects to see improvement in the quality of water and aquatic life downstream from these plants.

Detailed information on the biological condition of the Rocky River harbor and nearshore areas is not available. Existing data does indicate polluted sediment in the harbor area, and eutrophic to mestrophic conditions around the nearshore.

Spills and fish kills in the area are very uncommon with only seven spills being recorded over the past twenty years and only four of those causing kills. All were related to sewage discharge except one from NASA in which high ammonia concentrations were responsible for the loss of 2600 animals (Ohio EPA 1986). Recently, in 1984, the Ohio Department of Natural Resources reported 800 wild animals killed in Champion Creek, a tributary of the West Branch (confluence at RM 31.5), by an unknown pollutant from a public sewerage system. No fish kills were reported by Ohio Department of Natural Resources in 1983.

SEGMENT REPORTS

WEST BRANCH ROCKY RIVER
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 12.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	West Branch of Rocky River upstream from Montville Tributary	WWH 33.6-33.4
04110001-008 POOR* NO	West Branch downstream from Montville Tributary	WWH 33.4-32.4
04110001-008 FAIR* PARTIAL	West Branch recovery zone	WWH 32.4-29.8

Data from the 1981 intensive survey showed chemical parameters and biological communities upstream from the unnamed tributary (Montville Tributary) were indicative of good water quality. The Montville landfill runoff (entering the tributary at RM 33.4 of the West Branch) had a severe impact on chemical water quality and biological communities. Distinct elevations in many chemical parameters (particularly heavy metals) were indicative of the impact on chemical water quality. The macroinvertebrate community evidenced severe degradation at the station 0.1 miles downstream from the confluence, with an exclusively tolerant assemblage of species. There was a modest recovery 2.0 miles downstream but a low density of organisms suggested a continued toxic impact potentially aggravated by low dissolved oxygen concentrations. In contrast, the fish community was indicative of a relatively minor impact at the site 0.1 miles downstream from the confluence and there was a moderate decline in diversity 2.4 miles further downstream (Ohio EPA 1985). Limited monthly sampling continues to show violations of water quality standards for ammonia (Ohio EPA 1977-1985).

MONTVILLE TRIBUTARY[U]
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 33.4

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	Montville Tributary from the Montville Landfill to the mouth	NP 1.0-0.0

This tributary to the West Branch drains the Montville Landfill (RM 1.0) in Medina County. Leachate from this landfill has created water quality violations for dissolved solids, total iron, total zinc, total copper, total nickel, total chromium, total manganese, phenolics and ammonia. Limited monthly chemical sampling still shows violations of water quality standards for ammonia (Ohio EPA 1977-1985). A comprehensive clean up study is being conducted on the landfill and should be completed in May or June of 1986. Responsibility for clean up of the landfill is pending the results of the study and ongoing litigation (Paul Hancock, Attorney General's Office, pers. comm.).

WEST BRANCH MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	West Branch upstream from Medina County 500 WWTP	WWH 29.8-14.8
04110001-008 FAIR-GOOD* PARTIAL	West Branch downstream from Medina County 500 WWTP	WWH 14.7-4.4

Some impacts were noted on chemical water quality in this segment of the West Branch from nonpoint source runoff, the Montville landfill, and particularly the Medina County 500 WWTP. Chemical water quality was fair in the segment upstream from the Medina County 500 WWTP. The macroinvertebrate community was indicative of continued influence from the Montville landfill at RM 29.4 (four miles downstream) and was largely recovered at RM 27.3 (6.1 miles downstream). There was a marked difference in impact from the Montville tributary on fish as compared to macroinvertebrates at the two stations in the vicinity of the Montville Tributary confluence and the North Branch confluence. The less severe impact on fish communities was undoubtedly a function of available refuge areas (upstream from the Montville Tributary and in the North Branch) for fishes, and the ability of fishes to reinvade degraded areas during periods of improved water quality.

Water quality and biological condition were good immediately upstream from the Medina County 500 WWTP (RM 14.7, 0.3). Water quality parameters (particularly TKN, phosphorus and dissolved oxygen) and fish species diversity indicated a marked impact downstream from the WWTP. Continued influence from the WWTP along with physical characteristics (i.e. pooling as a result of impoundment at RM 5.5) impacted the fish community 2.9 miles downstream from the WWTP.

Ohio EPA's Northeast District Office (NEDO) reports that the Medina 500 WWTP has improved its treatment performance in the past year and a half resulting in less degradation.

Chemical parameters and biological communities at the two stations downstream from the dam (RM 5.5) but upstream from the Strongsville A tributary (RM 4.5) were indicative of relatively good water quality with slight organic enrichment (but low concentrations of heavy metals) (Ohio EPA 1985).

NORTH BRANCH
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 29.7

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD-EXCEPTIONAL* YES	North Branch downstream from Remsen Road bridge	WWH 5.5-0.0

PLUM CREEK
NORTH BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 5.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD* YES	Plum Creek downstream from Sleepy Hollow Road	WWH 2.1-0.0

Chemical water quality parameters and biological communities in these tributaries were indicative of good to exceptional water quality. Several elevated concentrations of chemical parameters indicated some influence from nonpoint source runoff but no impact was noted on biological communities. Macroinvertebrate communities were characterized by a diverse and apparently healthy community at both stations in the North Branch, and fish community diversity values were among the highest values in the Rocky River study area (Ohio EPA 1985).

WEST BRANCH ROCKY RIVER

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-008 GOOD-POOR* PARTIAL	West Branch mouth region	WWH 4.4-0.0

Water quality immediately upstream from the mouth of the West Branch showed some recovery; however, slightly higher concentrations of ammonia-N and total phosphorus, and considerably higher concentrations of heavy metals (compared to concentrations in the East Branch) were noted. In contrast to the apparent complete recovery of the fish community (potentially a function of improved water quality downstream), the macroinvertebrate community evidenced some recovery, but not to diversity levels comparable to those observed upstream from the Strongsville A Tributary (Ohio EPA 1985).

STRONGSVILLE A TRIBUTARY (BLODGETT CREEK)[u]
WEST BRANCH ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 4.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	Strongsville A Tributary downstream portion	WWH 1.9-0.0

PLUM CREEK
WEST BRANCH ROCKY RILER TRIBUTARY
CONFLUENCE AT RM 3.1

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA GOOD* YES	Plum Creek upstream of Brentwood WWTP	WWH 8.5-1.9
04110001-NA POOR-FAIR* NO	Plum Creek downstream of Brentwood WWTP	WWH 1.9-0.0

In 1981, macroinvertebrate and fish communities in the Strongsville A Tributary upstream from the WWTP were indicative of poor water quality, apparently in response to urban nonpoint source runoff. Macroinvertebrates were further degraded at the station 1.1 miles downstream from the

Strongsville A WWTP, and indicated little improvement at the mouth of the tributary (1.7 miles downstream from the WWTP). No fish were collected on either sampling date at the station 1.3 miles downstream from the WWTP. The West Branch was influenced by water quality in the Strongsville A Tributary in 1981 as indicated by distinct increases in heavy metals concentrations and a marked decline in fish diversity (to the lowest value measured in the study area) downstream from the confluence. The Strongsville A WWTP was upgraded in 1982. Additional clarifiers and sludge handling facilities were added. There have been no permit compliance problems in the past 2 1/2 years (since 1984).

A diverse fish community at RM 8.5 in Plum Creek was indicative of good water quality upstream from the Brentwood WWTP (RM 3.1, 1.8). A pronounced decline in fish community diversity, along with macroinvertebrate and chemical parameters were indicative of fair to poor water quality near the mouth of Plum Creek. This decline in water quality was attributed to influence from the Brentwood WWTP as well as septic leachate in the vicinity of the WWTP and downstream. Chemical parameters were indicative of only a minor influence from water quality in Plum Creek on the West Branch, and continued degradation from the Strongsville A Tributary masked any potential influence on macroinvertebrate communities. In contrast, the fish community exhibited a relatively rapid recovery downstream from the confluence (RM 2.0) with apparently complete recovery near the mouth of the West Branch (RM 0.3) (Ohio EPA 1985).

EAST BRANCH ROCKY RIVER
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 12.5

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-009 GOOD* YES	East Branch from headwaters to the Baldwin Lake Dam	WWH 26.7-5.0

NORTH ROYALTON A TRIBUTARY[u]
EAST BRANCH TRIBUTARY
CONFLUENCE AT RM 12.9

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA POOR* NO	North Royalton A Tributary mouth region	WWH 0.6-0.0

Although chemical parameters were indicative of nonpoint source runoff from RM 26.7-13.0, healthy and diverse fish and macroinvertebrate communities were indicative of good to exceptional water quality in this segment of the East Branch in 1981. A large number of bigmouth shiner, an Ohio Endangered Fish Species, were collected in this segment of the East Branch. Further, there was not apparent impact from the Medina County 300 WWTP on water quality or biological communities.

Water quality was generally good from RM 12.9-5.0 in 1981. There was some evidence of organic enrichment but rapid recovery from any impact on biological communities. The North Royalton A WWTP had a relatively minor but detectable impact on chemical water quality and biological condition in the East Branch, and a severe impact within the receiving tributary as evidenced by the decline in fish biomass, density and diversity. The Strongsville B WWTP also had a minor but detectable impact on chemical water quality (particularly ammonia-N) in the East Branch. The fish and macroinvertebrate communities showed little adverse impact from the Strongsville B plant, with some indications of organic enrichment immediately downstream and complete recovery 2.7 miles downstream (Ohio EPA 1985).

The North Royalton A WWTP is currently planning for additional final settling, sludge storage and sludge dewatering facilities. The Northeast District Office of Ohio EPA reports that this WWTP was generally in compliance with permit limits during 1985.

The Strongsville B WWTP is in the process of improving secondary treatment processes and solids handling capabilities in addition to adding tertiary treatment completion for construction is scheduled for the summer of 1986 (Ohio EPA, NEDO 1985). These plant modifications should result in improved water quality and biological conditions in this segment.

EAST BRANCH ROCKY RIVER

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-009 FAIR-POOR* NO	East Branch from the Baldwin Lake Dam to the confluence with Rocky River	WWH 5.0-0.0

Water quality in this segment of the East Branch was generally fair to poor as indicated by chemical and biological parameters. Although only a minor impact was indicated by macroinvertebrate communities, downstream from the confluence of Baldwin Creek there was a marked decline in fish community diversity and some impact on chemical water quality (particularly an increase in heavy metal concentrations). This impact was attributed to a combination of poor water quality from Baldwin Creek and influences from the Berea combined sewer overflows.

In 1981, the Berea WWTP had a marked impact on chemical water quality as evidenced by an increase in ammonia-N and phosphorus concentrations and a decline in dissolved oxygen concentration. There was a pronounced decline in fish biomass and diversity, and macroinvertebrates were characterized by low density, a moderate number of taxa and a relatively high diversity index, suggestive of some toxic influence (Ohio EPA 1985).

Ohio EPA, NEDO reports no major permit violations for Berea WWTP in 1985. The plant has approved plans for phosphorus removal. There is also the possibility that the Berea WWTP will tie into the Southwest Intercepter Sewer.

BALDWIN CREEK
EAST BRANCH TRIBUTARY
CONFLUENCE AT RM 4.9

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-NA FAIR-POOR* NO	Baldwin Creek from just upstream of two WWTP's to the confluence with East Branch	WWH 7.1-0.0

Water quality and biological communities in Baldwin Creek were severely impacted by effluent from the two WWTPs. Macroinvertebrate communities upstream from the two plants were indicative of fair water quality and some organic enrichment. There was a marked decline in macroinvertebrate and fish community diversity downstream from the North Royalton B WWTP, with some recovery apparent approximately 1.5 miles further downstream. Severe degradation of macroinvertebrates and some impact on fish (as evidenced by reductions in relative density, biomass and mean number of species) were also apparent downstream from the Strongsville C WWTP. There was minimal recovery of biological communities within Baldwin Creek. The fish community was composed of predominantly moderate to highly pollution tolerant species with the lowest relative biomass and density in the East Branch study area. A large number of bigmouth shiner, an Ohio Endangered fish species, were collected in Baldwin Creek (Ohio EPA 1985).

Recent information on the WWTP's in this segment indicate that the North Royalton B plant is in the initial planning stages for an upgrade and the Strongsville C plant is currently upgrading and due on line in the summer of 1986. The Strongsville C plant is improving secondary treatment and solids handling and installing tertiary treatment (Ohio EPA, NEDO 1985).

ROCKY RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR-GOOD* PARTIAL	Rocky River from the confluence of East and West Branches to the harbor	WWH 12.4-0.9

The apparent impact of East and West Branch water quality in the mainstem differed as inferred from chemical and biological evidence. Chemical parameters indicated more degraded water quality in the West Branch, while the relative impact on biological communities appeared more severe on the East Branch. The most downstream biological samples in the East Branch were indicative of potential toxic impacts while in the West Branch the communities were indicative of organic enrichment (with few or no toxic impacts).

Chemical parameters as well as biological communities in the mainstem upstream from the North Olmsted WWTP were indicative of some organic enrichment but not acute impacts. In 1981, there was a detectable but minor impact from the

North Olmsted WWTP on both chemical parameters and biological communities downstream from the plant. There was no detectable impact from Abram Creek on the Mainstem, however loading from Abram Creek may have had an impact on the rate of recovery from upstream perturbations.

Ohio EPA, NEDO reports that North Olmsted WWTP is almost finished with a major plant upgrade. It is due on line in the summer of 1986.

Water quality parameters as well as biological communities demonstrated some recovery in the lower portion of the Mainstem, and appeared to be nearly completely recovered at the most downstream station (RM 2.9). The only exception in this recovery were some continued indications of nutrient loading from upstream (Ohio EPA 1985).

In the lower river, occasional violations for fecal coliform and iron were found. Violations for copper, cadmium, lead, zinc and phenol have been recorded, but a review of water quality over the last five years reveals both the number and extent of violations to be decreasing and presently almost non-existent. Concentrations of conventional eutrophication parameters have also been decreasing (Ohio EPA 1986). A segment of this section (RM 6.4-0.0) has been designated SSH in addition to WWH, requiring that no chlorine be discharged from October to May.

ABRAM CREEK
ROCKY RIVER TRIBUTARY
CONFLUENCE AT RM 10.4

Segment Condition Use Attainment	Name Description	Use designation Mile Points
04110001-NA FAIR-POOR* NO	Abram Creek from upstream of WWTPs to the confluence with Rocky River	WWH 4.6-0.0

Water quality and biological communities in Abram Creek were severely impacted by both the Middleburg Heights WWTP (RM 4.0) and the Brookpark WWTP (RM 3.7). Although fish community diversity was relatively low upstream from the WWTPs, a distinct decline was evidenced downstream from each plant. Chemical and biological parameters downstream from the two WWTPs were indicative of a severe impact from sewage effluent as well as potential impacts from foundry sand runoff.

Some recovery was documented on macroinvertebrate communities at RM 1.0 and a marked improvement in the fish community was noted at RM 0.9. This recovery on biological communities was at least partially a function of settling and assimilation in an instream dam pool at approximately RM 1.0. Chemical parameters indicated some recovery of water quality (particularly a considerable increase in dissolved oxygen concentrations), however there were continued indications of severe nutrient loading to the Rocky River (Ohio EPA 1985).

Ohio EPA, NEDO reports no permit violations for Middleburg Heights WWTP since August 1984. Brookpark WWTP, on the other hand, has had dissolved oxygen problems with its effluent. Brookpark, however, is planning an upgrade with phosphorus removal, sludge handling and additional clarifiers.

ROCKY RIVER HARBOR AREA

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR* PARTIAL	Rocky River Harbor	ELEH (WWH) 0.9-0.0

Harbor water quality is difficult to assess. Little data is available. Plant records below the former Lakewood effluent (RM 1.8) indicate an increase in dissolved oxygen levels and a decrease in ammonia concentrations over a ten year period, reflecting a decreased organic load. Lakewood WWTP effluent is now being discharged to Lake Erie. All conventional eutrophication related parameters indicate a decreasing trend based on the data that is available. Even though water quality appears to be good, sediments are polluted throughout much of the harbor area and the macrobenthic community indicates a highly degraded environment. Fish collected from the river mouth have been found to contain quite a number of contaminants with no obvious source (Rathke 1984). None of these contaminants exceed FDA action limits or U.S. EPA criteria. Although future improvements in the basin are expected to lead to further improvements in water quality and certainly no further degradation, the status of the harbor at present can only be ranked fair (Ohio EPA 1986).

ROCKY RIVER NEARSHORE AREA

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110001-007 FAIR-GOOD* PARTIAL	Rocky River Nearshore	ELEH

A detailed survey, as done for the lower Rocky River, is not available for the nearshore zone. A summary of the sport fishery harvest indicates yellow perch, white bass, freshwater drum, walleye and channel catfish to be the most important species. Fish larvae studies conducted along the south shore in conjunction with power plant entrainment, indicate emerald shiners, gizzard shad and spottail shiners comprise the bulk of the fish larval biomass. Fish community structure in this nearshore area is similar to that of the central basin.

Based on results of the 1978 and 1979 Lake Erie intensive report (Rathke, 1984), the nearshore zone is considered eutrophic to mesotrophic. Two WWTPs discharge to the nearshore zone, the Rocky River WWTP and the Lakewood WWTP. The Lakewood outfall was moved from the river (RM 1.8) to the lake in 1984 and the treatment works has undergone considerable improvement in recent years. The Rocky River WWTP is also undergoing major renovation and both plants are expected to be in-compliance with their final permits by 1988. Fecal coliform counts were elevated in the vicinity of the harbor mouth and CSO and WWTP outfalls, but violations of standards were not confirmed. Most of the beaches in the area have experienced high coliform concentrations, particularly in the pre-1975 time period, but this has not been a problem in recent years. No beach closings have been recently reported. The Lake Erie nearshore is considered to be Excepted Lake Erie Habitat, so WWH standards are applicable here rather than the more stringent Lake Erie standards. Copper and cadmium concentrations continue to exceed WWH standards, but all other parameters are within acceptable limits.

REFERENCES

Havens and Emerson Ltd. 1975. Water quality assessment and basin modeling; Rocky River and Tinkers Creek.

Ohio Department of Natural Resources. 1984. Water pollution, fish kill, and stream litter investigations. Publication 7. Ohio DNR, Columbus, Ohio. 14 pp.

Ohio Environmental Protection Agency. 1977-1986 (unpublished). Data available from the Northeast District Office, Ohio EPA, Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1985. Draft Comprehensive Water Quality Report for Rocky River, Rocky River basin, Summit, Medina, Lorain, and Cuyahoga Counties, Ohio. Ohio EPA, Division of Wastewater Pollution Control, Columbus, Ohio.

Ohio Environmental Protection Agency. 1986. Lower Rocky River and harbor assessment report; supplement to the State of Ohio 305(b) Water Quality Inventory, Division of Water Quality Monitoring and Assessment. Columbus, Ohio.

Rathke, D.E. (Ed), 1984. Lake Erie intensive study 1978 - 1979. U.S. EPA, Great Lakes National Program Office, Region V, Chicago, IL.

CUYAHOGA AND CHAGRIN RIVER BASINS

CUYAHOGA RIVER BASIN

BASIN SUMMARY

The Cuyahoga River Basin contains areas with exceptional physical/chemical water quality, and areas where there are significant water quality problems. An estimated 134.0 stream miles in this basin have major physical/chemical problems. The headwaters and upper reaches flow through farmland and sparsely populated areas. Limited data indicated that there were occasional dissolved oxygen violations, but the overall water quality in these reaches was very good. The upper Cuyahoga River above Lake Rockwell (RM 61.0) has the capacity to assimilate wastes from the small, widely dispersed sources of pollution.

The middle and lower portions of the Cuyahoga River Basin are considerably more populated and industrialized than the upper portion. Cleveland and Akron, the two major metropolitan areas in the basin, greatly influence water quality of the Cuyahoga River. Numerous other smaller cities including Ravenna, Kent, Stow, Cuyahoga Falls, Hudson, Macedonia, Twinsburg, Solon, Bedford, Bedford Heights, Maple Heights, Walton Hills, Garfield Heights, Brookpark and Parma also influence stream quality. Water quality conditions begin to deteriorate at the Lake Rockwell Dam (RM 58.0) where the city of Akron diverts a substantial portion of the river for the city's drinking water supply. During dry weather periods, diversion leaves very little water in the river for dilution of point and nonpoint sources of pollution. Five dams between Kent (RM 54.9) and Cuyahoga Falls (RM 44.6) create long pools of very slow moving water. Increased BOD_5 loadings from the Ravenna, Franklin Hills, Kent, and Fish Creek WWTP's, coupled with the slow moving water in the dam pools caused low dissolved oxygen levels during the early moring hours of the summer months (Ohio EPA data, 1975).

The city of Akron, located in the middle portion of the Cuyahoga River Subbasin, has a major impact upon the river (Figure II-7). Numerous industrial dischargers and the Akron WWTP (RM 37.4) effluent make up approximately 75% of the Cuyahoga River flow during critical low-flow conditions. Urban runoff and combined sewer overflows are also a major problem in Akron. Further downstream, Tinkers Creek (RM 16.4), delivers additional pollutants to the Cuyahoga River. This loading comes from urban runoff, combined sewer overflows and several suburban municipal WWTP's. Due to the good reaeration capabilities of lower Tinkers Creek, most of the organic wastes are assimilated prior to reaching the Cuyahoga River. However, considerable amounts of nutrients, heavy metals and fecal coliform bacteria are carried downstream. Two urban tributaries within the Cleveland metropolitan area, Mill Creek (RM 11.5) and Big Creek (RM 7.2), have severe water quality problems. Industrial dischargers, urban runoff, and combined sewer overflows are the major sources of pollutants carried to the Cuyahoga River by these tributaries.

The lower portion of the Cuyahoga River receives major discharges from the LTV Steel Mills, two chemical companies (DuPont and Harshaw) and the 100 MGD Cleveland Southerly WWTP.

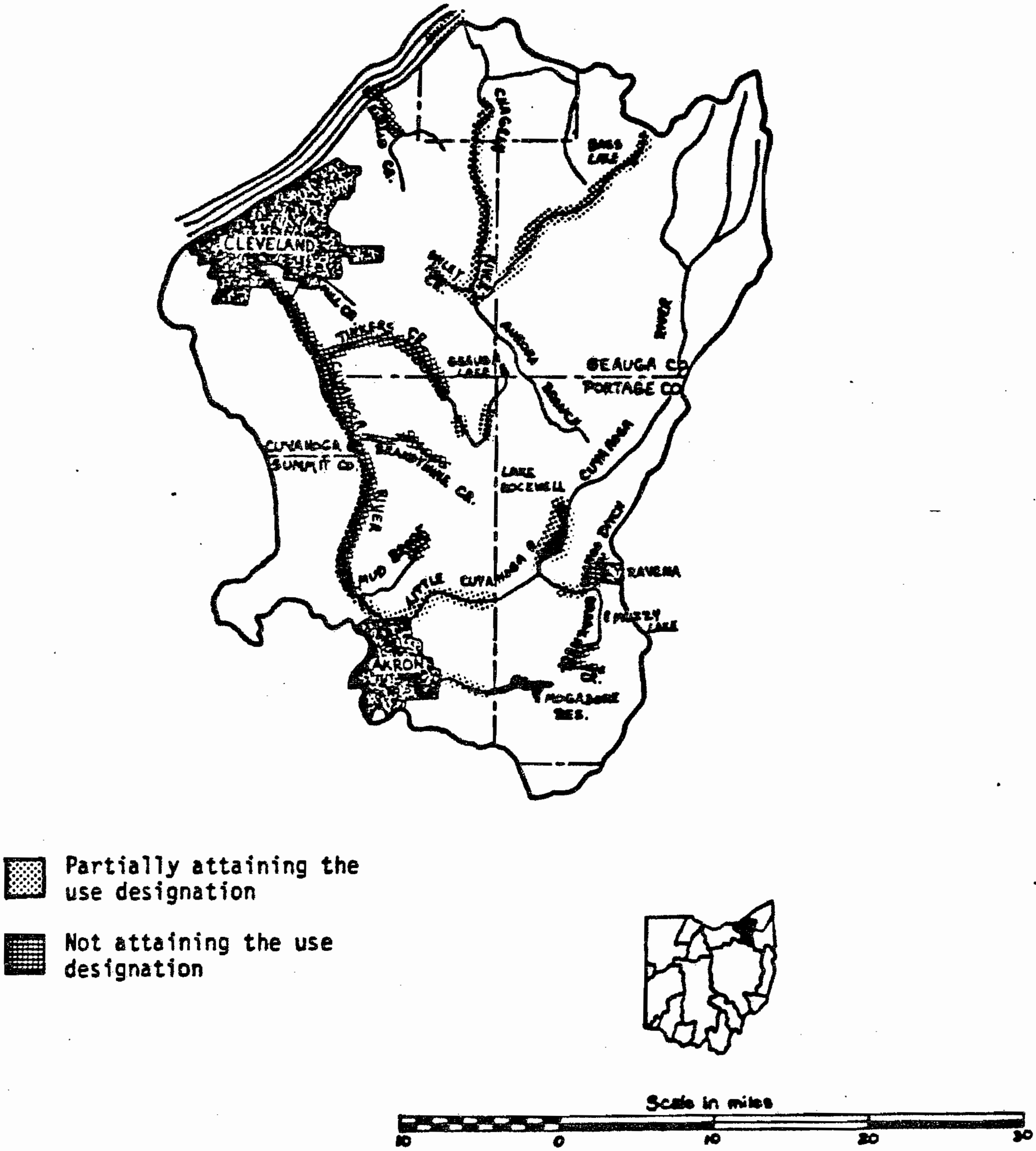


Figure II-6. Use attainment map of Cuyahoga and Chagrin River basins (Ohio). Stream segments that were judged not to support aquatic life in accordance with the goals of the Clean Water Act are highlighted with stippled shading.

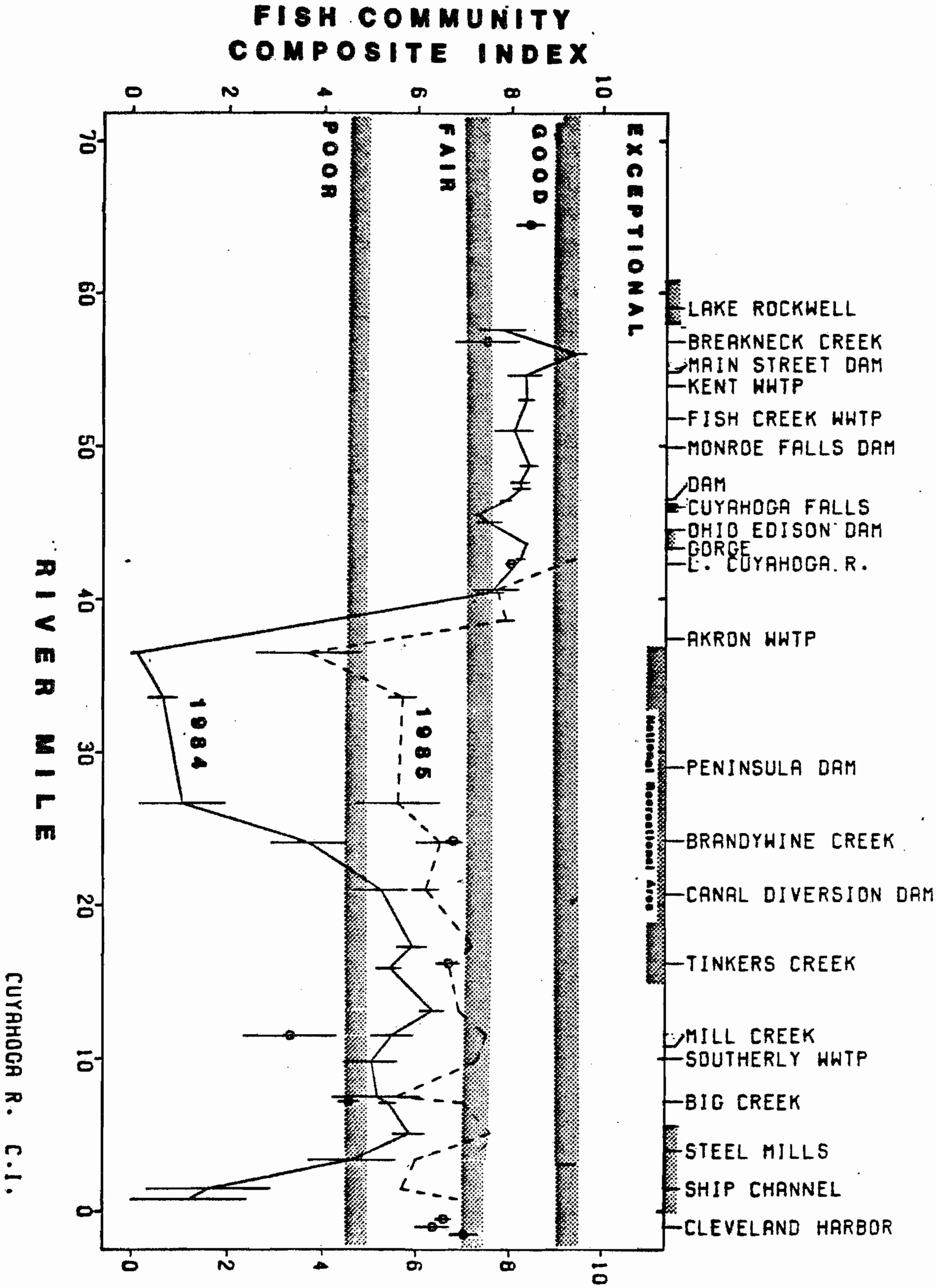


Figure II-7. Summary of biological conditions of the middle and lower Cuyahoga River, 1984-1985.

Significant improvements in the water quality of the Cuyahoga River have occurred. Data collected downstream from the urban Akron area has shown an overall improvement since 1969, with a reduction of pollutants and an increase in dissolved oxygen levels. However, this improving trend appears to be leveling off. Further downstream, at Independence (RM 13.1), increasing dissolved oxygen concentrations were also evident during the 1970's. Aesthetic (i.e. visual, appearance, odors, etc.) improvements near the mouth of the Cuyahoga River have been noted. The oil and debris problems, the cause of the infamous fire in 1969, have been greatly minimized, if not eliminated.

SEGMENT REPORTS

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-011 GOOD YES	Cuyahoga River from the East Branch Reservoir Dam to Hiram Rapids	WWH 88.0-75.0

Occasional WQS violations for dissolved oxygen have been reported in this portion of the Cuyahoga River (Ohio EPA, NEDO data, 1973, 1974, 1976). These violations occurred during low-flow, warm weather periods (Ohio EPA, NEDO data, 1973, 1976, 1977). Low dissolved oxygen concentrations may be a natural phenomenon in the upper Cuyahoga River due to the low stream gradient and the high organic matter loading from the extensive marsh areas within the drainage basin. The possibility requires further investigation.

Point source dischargers within this segment include the Middlefield WWTP (RM 87.1), Sperry Pond WWTP (RM 1.8), the Burton WWTP (RM 85.3), and the Middlefield Swiss Cheese Company (RM 87.6, Tar Creek RM 1.4). Wastewater treatment improvements at the Burton WWTP and Middlefield Swiss Cheese Company during the late 1970's greatly reduced the organic loadings to this segment. Facility plans for upgrading the Middlefield WWTP should be certified by mid 1982. Even with these improvements, the clean water goals may not be totally achieved. Occasional dissolved oxygen violations during the low flow summer months may continue to occur due to natural conditions, but the frequency and severity of these violations should be greatly reduced (Ohio EPA 1984).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-010 GOOD-EXCEPTIONAL YES	Cuyahoga River from Hiram Rapids to Lake Rockwell	WWH 75.0-64.0

Historical chemical/physical water quality data and recent chemical and biological sampling at a site just upstream from Lake Rockwell indicate no use impairment in this river segment. A very diverse aquatic macroinvertebrate community was recorded at RM 64.5 in 1984. The fish community was also rated in good condition with numerous sensitive species present in moderate numbers.

LAKE ROCKWELL

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-007 -- PARTIAL	Lake Rockwell	Public Water Supply 64.0-58.0

Lake Rockwell is formed by a man-made impoundment on the Cuyahoga River and is the primary public water supply for the city of Akron. The lake has been plagued by excessive growths of aquatic macrophytes and algae, hence, the quality of the drinking water supply is adversely affected by taste and odors. The city of Akron and Kent State University are studying the problem and investigating methods of reducing available plant nutrients, thereby decreasing plant growth and the taste and odor problems (Ohio EPA 1984).

BREAKNECK CREEK[u]
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 56.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-005 FAIR-POOR NO	Breakneck Creek from the headwaters to Interstate 805	WWH 17.0-11.0

The headwaters of Breakneck Creek and its system of feeder canals and tributaries drain predominately low lying, marsh areas. Sampling of one such tributary, Potter Creek, in 1983 and 1984 revealed very low dissolved oxygen concentrations (less than 1 ppm) attributable to the natural background conditions. A reasonably diverse macroinvertebrate community was recorded, but only 2 species of fish were collected in very low numbers. It is probable that much of the upper Breakneck Creek drainage cannot attain the WWH use designation because of the prevailing background conditions (Ohio EPA 1983-84).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-005 FAIR-GOOD* PARTIAL	Breakneck Creek from Interstate 805 to the Cuyahoga River	WWH 11.0-0.0

A survey conducted in 1984 revealed good chemical and biological quality of a site upstream from Wahoo Ditch and the discharge of the Ravenna WWTP. Dissolved oxygen concentrations were depressed downstream from Wahoo Ditch, although values were above the 4 mg/l standard. An impact on the fish community was noted downstream from Wahoo Ditch but full recovery was demonstrated within several miles. Other pollution sources in the segment include the Franklin Hills WWTP (no impact detected) and the A and B Landfill near RM 3.5. Sediment chemistry data on heavy metal contaminations suggested possible contributions from the landfill (Ohio EPA 1984).

WAHOO DITCH[u]
BREAKNECK CREEK TRIBUTARY
CONFLUENCE AT RM 4.6

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* NO	Wahoo Ditch from headwaters to Breakneck Creek	WWH 4.0-0.0

Wahoo Ditch receives the discharge from the Ravenna WWTP via the Hommon Avenue Ditch (RM 1.4). Two small industries and a package sewage treatment plant discharge to Wahoo Ditch near its origin in Ravenna. The Ravenna WWTP was upgraded in 1975; but the improvements did not include nitrification. Facilities plans currently being prepared for the city will address ammonia removal and improved sludge handling capabilities.

Biological and chemical/physical data collected in 1984 revealed grossly polluted conditions in Wahoo Ditch. Macroinvertebrate and fish communities were rated poor at sites upstream and downstream from the Ravenna WWTP discharge. Dissolved oxygen concentrations below 2 mg/l at both sites and elevated ammonia concentrations downstream from the Ravenna WWTP discharge were identified as the major problems (Ohio EPA, CO 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-006,-004 GENERALLY GOOD* PARTIAL	Cuyahoga River from Lake Rockwell to the Little Cuyahoga River confluence	WWH 58.0-42.3

The Cuyahoga River below Lake Rockwell has been greatly altered by man's activities. The City of Akron removes an average of 50 million gallons of water per day from Lake Rockwell for its drinking water supply. This rate of removal exceeded the total discharge of the Cuyahoga River during dry weather conditions. Thus, the flow of the Cuyahoga River below the impoundment often consists primarily of treated wastewater with minor dilution from small tributaries. Water quality problems are further complicated by the presence of five dams within this river segment. Low dissolved oxygen (D.O.) levels frequently occur in all of these dam pools. Field surveys during 1975 and 1984, revealed depressed D.O. in the Kent Main Street Dam (RM 54.9) and the Munroe Falls Dam (RM 50.0) (Ohio EPA, NEDO data, 1975 and 1984).

Biological data collected in 1984 revealed reasonably healthly fish and macroinvertebrate communities in this river segment. Benthic communities were rated good at most locations and the fish community composite index was between 7.5 and 9.0, except for 2 locations within the Ohio Edison Gorge Plant dam pool. Slightly lower values there (7.0-7.5) seem to reflect the habitat conditions, thermal load from the power plant and the unique settling of a dam pool within the natural riverine gorge. Full attainment of the WWH use within the gorge dam pool and the river segment as a whole is contingent upon maintaining the appropriate thermal standards, controlling other pollutants loads and allowing adequate time for aquatic populations to colonize isolated river segments between dam pools (Ohio EPA 1984).

LITTLE CUYAHOGA RIVER
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 42.3

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-002 FAIR-POOR PARTIAL	Little Cuyahoga River from Mogadore Reservoir to the Cuyahoga River	WWH 13.0-0.0

The Little Cuyahoga River flows through the densely populated urban and industrial area of Akron. Combined sewer overflows, urban nonpoint sources, and old sewers in need of repair create significant water quality problems. Historical data, collected at the Otto Street gage (RM 1.8), revealed WQS violations for phenolics, total iron, total lead, and fecal coliform bacteria. Chemical/physical and biological sampling at this single location in 1984 did not reveal any acute problems, although biological communities were not at their full potential.

A Combined Sewer Overflow Study (CSOS) and several interim Sewer System Evaluation Studies (SSES) which address Akron's sewer problems have been completed. As a result, overflow retention basins have been constructed at Memorial Parkway and Martha Avenue. These two systems have greatly reduced the combined sewer overflows from these areas. Plans to construct a third retention basin at Kelly Avenue have been postponded due to financial constraints (Ohio EPA 1984).

POWERS BROOK
MUD BROOK TRIBUTARY
CONFLUENCE AT RM 9.1

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA FAIR-POOR NO	Mud Brook from Meadowbrook Lake to mouth	WWH 1.5-0.0

Powers Brook upstream from the Summit Co. #6 WWTP was in good biological condition based upon 1984 survey results. Downstream from the WWTP the overall biological rating was fair-poor and degradation extended into Mud Brook so that the minimum total stream length affected was approximately 2-3 miles. Ammonia-N concentrations were 2-7 times the WQS in the stream and dissolved oxygen minimums were 2.5-3.0 mg/l downstream from the WWTP in Mud Creek (Ohio EPA 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 FAIR-GOOD* PARTIAL	Cuyahoga River from the Little Cuyahoga River confluence to the Akron WWTP	WWH 42.3-37.4

This segment of the river is subject to pollutant loadings from upstream combined sewer overflows and point sources located on the Little Cuyahoga River. Sewer overflows contribute to bacterial contamination and the frequent exceedences of the Primary Contract Recreation Standard. An intensive survey in 1984 and 1985 revealed no other significant violation of chemical WQS. Biological communities in this river segment did suggest some degradation from upstream pollution sources (Ohio EPA 1983).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR* NO	Cuyahoga River from the Akron WWTP to the Canal Diversion Dam at SR 82	WWH 37.4-20.7

This segment of the Cuyahoga River is degraded by the combined sewer overflows in Akron and the Akron WWTP (RM 37.4). The Akron WWTP discharged an average of 75 million gallons of treated wastewater each day. This discharge accounted for more than sixty percent of the total flow of the Cuyahoga River during seven-day, once-in-ten-year low flows. Historical water quality violations include dissolved oxygen, fecal coliform bacteria, ammonia, and total lead (Akron Wastewater Quality Management Section, 1979-1980). Chemical/physical conditions have improved over the years and in 1984 and 1985 there were no significant dissolved oxygen, ammonia or heavy metal violations in this river segment. The bacteria contamination problem remains and the river water does not meet Primary Contact Recreation standards.

Despite the improvements in conventinal pollutants measured in this segment of the Cuyahoga River the biological health of the river was found to be severely impaired by an unknown toxic component in the Akron effluent. The river segment was nearly devoid of fish and the macroinvertebrate community was clearly stressed. The immediate loss of nearly all fish strongly suggested a toxic impact and the failure of the community to recover to upstream levels indicated a persistent influence. Observations of fin erosion, lesions and external deformities on the fish collected in 1985 added more evidence of serious environmental stress in the Cuyahoga River downstream from Akron. There are ongoing studies being conducted by the City of Akron and the U.S. EPA Duluth Environmental Research Lab to identify and eliminate the toxicity.

Several of the interim improvements at the Akron WWTP which are now complete include chemical addition for improved solids settling and partial phosphorus removal, more efficient aeration, and stand-by power. Flow equalization to lessen primary by-passing is completed, but the plant is still experiencing operational problems. Bids for construction of Phase 1 final improvements are currently being received. Improvements now underway will include expansion of primary and secondary treatment facilities and improvements in the sludge treatment and handling facilities (Ohio EPA 1983).

BRANDYWINE CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 22.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR-FAIR NO	Brandywine Creek from Hudson to the Cuyahoga River	WWH 8.1-0.0

Two significant point sources, the Hudson Village WWTP (RM 8.1) and the Macedonia No. 15 WWTP (RM 3.9), degrade this relatively small stream. Tecumseh Corregated Box (RM 0.3) ceased operations in 1985. Wastewater treatment facilities at the Macedonia No. 15 WWTP were upgraded during the summer of 1979. The plant now provides adequate treatment for BOD_5, phosphorus, and suspended solids removal, but does not provide nitrification. The Hudson Village WWTP is currently under construction to upgrade to secondary treatment by 1983. The facility plan for this area recommended that all of these facilities be phased out and tied into the Cuyahoga Valley Interceptor when it becomes available, possibly in 1990.

A chemical/physical and biological survey was conducted in 1984. Biological degradation was apparent in Brandywine Creek and was attributed to the combined effects of the Hudson WWTP and Summit Co. #15. The overall condition of the stream was rated as fair and substantial improvement of 4 stream miles downstream from Summit Co. #15 could be realized with improved effluent quality. Effluent and in-stream samples indicated elevated ammonia-N (above WQS) was the major cause of the problem. Dissolved oxygen violations were not recorded at the routine grab sampling sites, although concentration were below 5 mg/l.

Brandywine Creek has been upgraded to WWH based upon the potential for aquatic life to repopulate the degraded segments if chemical water quality improved (Ohio EPA 1983).

TINKERS CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 16.4

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA FAIR-GOOD PARTIAL	Tinkers Creek from headwaters to Twinsburg	WWH 30.0-16.0

Numerous county and private sewage treatment plants discharge to the upper portions of Tinkers Creek. A survey in 1984 detected localized degradation of chemical and biological conditions downstream from these sources. Regional WWTPs are planned or are under construction in the Aurora and Steetsboro areas.

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR-FAIR* NO	Tinkers Creek from Twinsburg to the Cuyahoga River	WWH 16.0-0.0

With a drainage area of 96 square miles Tinkers Creek is the largest tributary to the Cuyahoga River. Water quality is heavily influenced by suburban and industrial land uses and numerous point source discharges. The larger WWTP's include Twinsburg, Solon, Bedford Heights and Bedford. The Walton Hills and numerous industrial sources were tied into the Cuyahoga Valley Interceptor in 1985.

The majority of the municipal point sources provide advanced secondary or teriary treatment and the degree of pollution from oxygen demanding wastes has declined markedly. However, data from a 1984 survey indicate that problems still remain in the form of frequent ammonia and heavy metal WQS violations. The fish community of the stream measured during the survey was rated poor to fair (composite index 4.5-7.5) and the benthic macroinvertebrate community was stressed at some locales (Ohio EPA 1983).

MILL CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 11.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* YES	Mill Creek from Granger Road to the Cuyahoga River	LWH 7.0-0.0

Mill Creek is a relatively small tributary, but it carries substantial quantities of pollutants to the Cuyahoga River. Combined sewer overflows, industrial discharges, and leachate from several landfills along the banks of Mill Creek contribute to the pollution problems. Historical WQS violations included ammonia, dissolved solids, phenolics, fecal coliforms, MBAS, total copper, total iron, and total lead (Ohio EPA, NEDO data, 1979-1980, 1984). A survey conducted in 1984 demonstrated high levels of domestic sewage throughout the stream. Macroinvertebrate and fish communities recorded in Mill Creek were indicative of severe pollution. Sewage bacteria completely dominated the stream substrate in the headwaters reach.

The Mill Creek Segmental Facilities Plan evaluated infiltration/inflow and combined sewer overflows for the Mill Creek Interceptor area. The plan recommended construction of the Southeast Interceptor, parallel relief sewers, off-line storage reservoirs, in-line combined sewer control regulators, and rehabilitation of existing sewers. The availability of funds for these much needed improvements is uncertain (Ohio EPA 1983).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR-FAIR* NO	Cuyahoga River from the Canal Diversion dam at S.R. 82 to the ship channel	WWH 20.7-5.6

This segment of river is also degraded as a result of the Akron WWTP and additional pollutant loading within the segment. Long term records collected at Independence (RM 13.1) clearly show vastly improved conditions for dissolved oxygen concentrations and ammonia. A survey in 1984 indicated no significant violations of the chemical/physical WQS. However, the poor to fair biological health of this river segment apparently reflects a persistent toxic impact attributable to the Akron WWTP. Other significant sources are confined to the lower 5 miles of the segment and include the Cleveland Southerly WWTP (RM 10.7) and the Mill Creek and Big Creek systems (Ohio EPA 1983).

BIG CREEK
CUYAHOGA RIVER TRIBUTARY
CONFLUENCE AT RM 7.0

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA GOOD* YES	Big Creek from headwaters to the Ford Branch	WWH 10.0-4.9

The headwaters of Big Creek flow through surban land use and the Big Creek Parkway Reservation of the Cleveland Metro Parks System. Chemical/physical and biological sampling (1984) near RM 8 revealed no apparent chemical water quality problem and biological communities were rated good considering the small stream size and prevailing land use (Ohio EPA 1984).

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-NA POOR* YES	Big Creek from the Ford Branch to the Cuyahoga River	LWH 4.9-0.0

Urban nonpoint pollution, sewer overflows and several industrial discharges cause water severe quality problems in Big Creek downstream from the Ford Branch. WQS violations were reported for ammonia, phenolics, oil and grease, fecal coliforms, MBAS, total cadmium, total copper, total iron, total zinc and total lead (Ohio EPA, NEDO data, 1979-1980, 1984). Biological communities recorded in 1984 were extremely degraded in response to pollution from the sewage system. In some segments extreme channel and habitat modification also limits the biological condition.

Industrial dischargers during the reporting period included Ford Motor Company, General Motors Corporation, Harshaw Chemical, Ohio Drum and Cuyahoga Meat. By late 1980, Cuyahoga Meat and Ohio Drum ceased discharging and the Ford Motor Company tied its process water into sanitary sewers. Ford Motor Company and General Motors Corporation now discharge only treated storm water runoff. The continuous sanitary sewer overflow at Jennings Avenue has been repaired and a flow equalization tank has been installed to handle peak flows. Significant water quality improvements are anticipated as a result of these abatement activities (Ohio EPA 1984).

CUYAHOGA RIVER MAINSTEM

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110002-001 POOR* NA	Cuyahoga River ship channel	Not Established 5.6-0.0

The lower Cuyahoga River exhibited very poor water quality, especially during the low flow summer months. WQS violations for dissolved oxygen, ammonia, fecal coliforms, phenolics, total cyanide, total lead, total iron, total cadmium, total copper and total zinc were reported at one or both monitoring sites (lower Harvard Ave., STORET station No. 502130, RM 7.3; West Third St. Bridge, STORET station No. 502140) (Ohio EPA, NEDO data 1979-1980, 1984). Typically segments of the ship channel are completely devoid of oxygen and fish life during periods of low river flow. However, a fish survey in 1985 showed a rapid repopulation of certain species in the fall of the year. Despite the existing level of water quality impairment, recreational use of the ship channel continues to expand in response to the economic revitalization of the area. The lower river is presently used for commercial navigation, industrial water supply, recreational boating and fishing on a seasonal basis. Major discharges that influence water quality in this segment (RM 10.7-0.0) include LTV Steel, Harshaw Chemical, DuPont Chemical and the Cleveland Southerly WWTP (Ohio EPA 1984-86).

REFERENCES

Akron Water Quality Management Section. 1969-1980 (unpublished). Analyses of the Cuyahoga River for the years 1969 through 1980. Akron Wastewater Treatment Plant, Akron, Ohio.

Ohio Environmental Protection Agency. 1974. Cuyahoga River 303(e) study, wasteload allocation report. Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1973-1986 (unpublished). Data available from Central Office and Northeast District Office, Ohio EPA, Columbus and Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1980 (unpublished). Biennial Water Quality Report. Reference Document 3. Benthic Sampling Tables.

United States Geological Survey. 1977. Water resources data for Ohio, Vol. II, St. Lawrence River Basin, USGS Water data report OH-77-2. USGS, Columbus, Ohio.

United States Geological Survey. 1978. Water resources data for Ohio, Vol. II St. Lawrence River Basin, USGS water data report, OH-78-2. USGS, Columbus, Ohio.

United States Geological Survey. 1979. (Provisional Data) USGS, Columbus, Ohio.

ADJACENT LAKE ERIE MINOR TRIBUTARIES

SEGMENT REPORTS

EUCLID CREEK

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-NA POOR NO	Euclid Creek from the West Tributary to the mouth	WWH 3.1-0.0

Major physical/chemical problems in Euclid Creek included fecal coliform bacteria, phenolics, total lead and total iron (OEPA, NEDO data, 1977-1980). The bacterial violations were probably the result of combined sewer overflows, individual septic systems and/or the Scottish Highlands WWTP (RM 1.4) in Richmond Heights. The remaining violations were probably the result of seepage from a covered waste disposal site at Cleveland Metal Cleaning (RM 2.0). The city of Cleveland's Nottingham Water Filtration Plant (RM 1.8) occasionally released chlorinated backwash water into Euclid Creek. The elevated chlorine levels have caused numerous fish kills. The discharge has been the subject of several complaints as well. The facility is now under orders from the Director of Environmental Protection to eliminate all discharge into Euclid Creek. The city is scheduled to tie into the Euclid Sanitary Sewer District in 1987.

A new swimming beach is being built just to the west of the mouth of Euclid creek as part of the Cleveland Lakefront State Park operated by the Ohio Department of Natural Resources.

EUCLID CREEK NEARSHORE

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-NA POOR NO	Lake Erie Nearshore immediately adjacent to Euclid Creek	LEH

Water quality at the mouth of Euclid Creek and the immediately adjacent nearshore was found to have elevated ammonia and total phosphorus values, and fecal coliform counts, copper, iron, manganese, nickel and zinc concentrations exceeding LEH Standards (Lake Erie Intensive, 1978 and 1979). No biological data is available to measure the effects of the water quality or aquatic life.

REFERENCES

Ohio Environmental Protection Agency. 1975, 1977-1980 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

STORET Data. 1978-1979. Lake Erie Intensive.

REFERENCES

Northeast Ohio Areawide Coordinating Agency. 1980. Current water quality in the NOACA 208 planning area. Technical Appendix A25. NOACA, Cleveland, Ohio.

Northeast Ohio Areawide Coordinating Agency. 1981. Analysis of stream habitats program update: the use of the community degradation value (CDV) as a planning tool. Technical Appendix A37. NOACA, Cleveland, OH.

Ohio Environmental Protection Agency. 1973-1985. Monthly sampling data for STORET Station No. 502400. Available at Ohio EPA, Columbus, OH.

Ohio Environmental Protection Agency. 1975-1986 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

Rathke, D.E. 1984. Lake Erie intensive study 1978-1979. Final Report. EPA-905/4-84-001. U.S. EPA, Great Lakes National Program Office, Region V, Chicago, Ill.

White, A.M. 1978. Analysis of Stream Habitats. Technical Appendix A-21, NOACA 208 Report. Cleveland, Ohio.

SEGMENT REPORTS

GRAND RIVER
LAKE ERIE TRIBUTARY

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110004-003,-002,-001 GOOD YES	Grand River from headwaters to Big Creek confluence	WWH 98.5-8.9

The headwaters of the Grand River near Parkman were sampled by the Ohio EPA in 1978. The few grab samples analyzed showed exceptional physical/chemical water quality, despite poor wastewater treatment systems located in the village of Parkman. Ohio EPA grab samples collected in 1978 and 1979 from Swine Creek, Big Creek, Phelps Creek, Paine Creek, Coffee Creek and Red Creek showed very low nutrient levels in these creeks (OEPA, NEDO data, 1978-1979).

Nutrient levels in the Grand River near Harpersfield (RM 32.3 to 31.7) were also very low (Ohio EPA, NEDO data, 1979). The Ohio Water Service Company (RM 31.9) withdraws a substantial portion of the rivers flow for drinking water supplies at Harpersfield. This leaves very little water for the dilution of any nutrients that might enter the waterway. Therefore, any future development in this segment should be carefully planned. There have been no water samples collected from the Grand River from Parkman to Harpersfield. The nutrient level in this reach is probably very low due to the absence of significant dischargers.

MILL CREEK
GRAND RIVER TRIBUTARY
CONFLUENCE AT RM 23.6

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110004-005 GOOD YES	Mill Creek upstream portion	WWH 18.0-9.0

4810W/0305E

Biological data is available for sites at RM's 17.2 and 10.0 from Ohio EPA's Stream Regionalization Project in 1984. The fish composite indices from these locations were 8.8 and 7.9, respectively. One macroinvertebrate sample in this river segment revealed 27 total taxa and a diversity index of 3.5. This data is indicative of good biological condition.

REFERENCES

EG & G, Bionomics, 1982. The toxicity of dredged materials from Fairport Harbor, Ohio to aquatic organisms. Submitted to U.S. Army Corps of Engineers, Buffalo District, Buffalo, N.Y.

Fay, L.A. and C.E. Herdendorf, 1984. Environmental sensitivity index maps for the Lake Erie system. Prepared for the National Oceanic and Atmospheric Administration.

Northeast Ohio Areawide Coordination Agency (NOACA). Water Quality Management Plan (DRAFT) Technical Appendix A21.

Ohio Environmental Protection Agency. 1974. Grand River Basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Northeast District Office, Twinsburg, Ohio.

Ohio Department of Natural Resources. 1979. Grand Wild-Senic River Assistance Manual.

Ohio Environmental Protection Agency. 1975-1986 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1984 (unpublished). Stream Regionalization data available from Central Office, Ohio EPA, Columbus, Ohio.

Rathke, D.E. 1984. Lake Erie Intensive Study 1978-1979. Final Report. EPA-905/4-84-001. U.S. EPA, Great Lakes National Program Office, Region V, Chicago, ILL.

Richards, R.P. 1981. Chemical limnology in the nearshore zone of Lake Erie between Vermilion, Ohio and Ashtabula, Ohio, 1978-1979. Data summary and preliminary interpretations. A report to the Technical Assessment Team. Heidelberg College, Water Quality Lab, Tiffin, Ohio.

U.S. Army Corps of Engineers. 1981. Report on the sampling of harbors for the U.S. Army Corps of Engineers harbor dredging program. Wadsworth Testing Laboratories, Inc.

United States EPA. 1977. Fairport, Ohio. Report on the degree of pollution of bottom sediments. U.S. EPA, Region V, Great Lakes National Program Office.

United States Geological Survey. 1966-1980. Water resources data for Ohio, Volume 2. St. Lawrence River Basin. U.S. Geological Survey water-data reports OH-66-2 to OH-79-2. U.S. Geological Survey, Columbus, Ohio.

White, A.M., 1978. Analysis of stream habitats. Technical Appendix A-21. NOACA 208 Report. Cleveland, Ohio.

ASHTABULA RIVER

BASIN SUMMARY

Land use in the Ashtabula River Subbasin is primarily rural. The only significant population center is the city of Ashtabula located near the river's mouth. An estimated 10.8 stream miles in this subbasin had major physical/chemical problems. Major water quality problems were confined to the river mainstem (RM 6.0 to 0.0) and to Strong Brook and Fields Brook tributaries. Fields Brook, in particular, receives a large volume of industrial effluent and fish tissue analyses from the Ashtabula River have revealed the presence of toxic substances (CH_2M Hill et al. 1985). The Ohio Department of Health and the Ohio EPA issued a health advisory on March 1, 1983 entitled "Joint Statement of Health Advisory for Consumption of Ashtabula River Fish" recommending that people not eat fish caught in a two mile length of the river, from the mouth to the 24th Street Bridge. Particular chemicals of were PCB's, hexachlorobenzene, pentachlorobenzene and tetrachloroethane.

The physical/chemical water quality of Hubbard Run (tributary to the Ashtabula River at RM 5.1), Red Brook, and Indian Creek (tributaries to Lake Erie), which are near the city of Ashtabula, have been degraded by individual septic systems (OEPA, NEDO data, 1975, and Ashtabula Health Department sampling). Effluent from these septic systems will be diverted from these streams to a sewer extension called the Ashtabula County Sewer District #2. The construction was completed in March, 1986. The county is now in the process of getting people to tie in. This is expected to eliminate the bacteria, ammonia, and dissolved oxygen problems in these segments (Ohio EPA, NEDO 1986).

Samples collected by the Ohio EPA, U.S. EPA, and the USGS from 1977-1983 indicated degraded physical/chemical water quality in the Ashtabula River Estuary. Discharges which contributed to water quality problems in this river segment include combined sewer overflows and industrial discharges to Fields Brook and Strong Brook. Sediments analyzed by the U.S. EPA in 1979 and the U.S. Army Corps of Engineers in 1982 and 1983 confirm high concentrations of total zinc, total lead, total mercury, oil and grease, various organic contaminants and PCB's. Negotiations are currently underway with the Corps of Engineers, U.S. EPA and the city of Ashtabula to dredge and dispose of harbor sediments contaminated with runoff from Fields Brook dischargers. Bioassay results indicate the sediments from the harbor proper are suitable for open lake disposal, while those in the vicinity of the mouth of Fields Brook must be confined disposed. Particular concerns are how deep to dredge to remove all contaminated sediment, the degree to which river sediments will be recontaminated from Fields Brook, and a suitable disposal site for the spoils. Despite these water quality problems, the estuary of the Ashtabula River is an important spawning area for many important Lake Erie fishes. Local sport fishermen and the U.S. Coast Guard report salmonid migrations and large numbers of white bass in this segment. It should be noted, however, that Ohio Department of Natural Resources does not stock the Ashtabula River Harbor area.

SEGMENT REPORTS

ASHTABULA RIVER
LAKE ERIE TRIBUTARY

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-008 GOOD* YES	Ashtabula River headwaters to Ashtabula City Limits	WWH 27.5-6.0

The upper reaches of the Ashtabula River are relatively pollution free, except for infrequent total iron, fecal coliform and phenolics violations (OEPA, NEDO data, 1977-1985; USGS 1978, 1980). The source of this contamination is undocumented, but nonpoint sources are suspected.

In 1983, the Ohio EPA surveyed the upper Ashtabula River (approximately RM 27.5) as part of the Stream Regionalization Project (Ohio EPA 1983-84). The macroinvertebrate community was reflective of exceptional conditions with 43 taxa present and a diversity index of 4.39. The fish community was reflective of good conditions with 23 total fish species present and a composite index of 8.42.

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-008 FAIR PARTIAL	Ashtabula River between the Ashtabula City Limits	WWH 6.0-1.7

This segment of the Ashtabula River violated WQS for total lead, total iron, total mercury and phenolics (OEPA, NEDO data, 1977-1980). The only known point sources affecting this segment were small package plants which discharge treated sanitary wastes. These wastes are not thought to contain any of the compounds listed, therefore, the source of these violations was presumed to be nonpoint. No recent data (1980-1985) is available for this section of the Ashtabula River, however Ohio EPA, Northeast District Office has not received any reports of problems in the area.

STRONG BROOK[U]
ASHTABULA RIVER TRIBUTARY
CONFLUENCE AT RM 1.8

Segment Condition Use Attainment	Name Description	Use Designation Mile Points
04110003-NA POOR-FAIR NO	Strong Brook from the headwaters to the Ashtabula River	WWH 1.4-0.0

Samples collected from Strong Brook revealed water quality violations for phenolics, total iron, total zinc and fecal coliform bacteria (OEPA, NEDO data, 1977, 1979). There were occasional reports of oil and organic odors as

According to creel census surveys conducted by the Ohio Department of Natural Resources, the sport fishery in the area, specifically near Lakeshore Park, consists of walleye, yellow perch, white bass, freshwater drum, smallmouth bass and channel catfish. No fish tissue, sediment or water quality data has been taken in the nearshore area to assess any possible contamination from Fields Brook related sources.

REFERENCES

Aqua Tech Environmental Consultants. 1983. Analysis of sediment from Ashtabula River, Ashtabula, Ohio. Tech. Rept. No. 60072-02. Prepared for U.S. Army Corps of Engineers, Buffalo District, Buffalo, N.Y.

Aqua Tech Environmental Consultants. 1984. Analysis of sediment from Ashtabula Harbor. Ashtabula, Ohio. Prepared for U.S. Army Corps of Engineers, Buffalo District, Buffalo, N.Y.

CH_2M Hill, Ecology and Environmental Consultants. 1985. Final remedial investigation report-Fields Brook site, Ashtabula, Ohio. Prepared for U.S. EPA, Hazardous Site Control Division, Region V, Chicago, Illinois.

Environmental Resource Associates, Inc. 1983. Ashtabula Harbor reclassification study. Ashtabula, Ohio. Prepared for Army Corps of Engineers, Buffalo District.

Ohio Department of Health. 1980-1985. Beach monitoring data.

Ohio Department of Natural Resources. 1966. A preliminary report on currents and water masses in Lake Erie. ODNR, Div. Geological Survey.

Ohio Department of Natural Resources. 1980-1984. Results of creel census surveys.

Ohio Environmental Protection Agency. 1975-1986 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

Rathke, D.E. 1984. Lake Erie Intensive Study 1978-1979. Final Report. EPA-905/4-84-001. U.S. EPA, Great Lakes National Program Office, Region V, Chicago, Illinois.

STORET. 1978-1979. Data from Lake Erie Intensive Survey.

United States Environmental Protection Agency. 1981. Great Lakes Program Office data. Chicago, Illinois.

United States Environmental Protection Agency. 1979. Environmental Research Laboratory data. Duluth Minnesota.

United States Geological Survey. 1970-1980. Water resources data for Ohio Vol. 2. St. Lawrence River Basin. U.S. Geological Survey Water Data Reports OH-70-2 through OH-79-2. U.S. Geological Survey, Columbus, Ohio.

Woodruff Inc. Consulting Engineers. 1979. Ashtabula Facilities Plan. Cleveland, Ohio.

APPENDIX 12

Statistical Analysis

STATISTICAL ANALYSIS

SIMPLE LINEAR REGRESSIONS

For our needs, a Simple Linear Regression is a graph that shows the change in the concentration of a parameter over time. Time is the X-axis of the graph (the independent variable). The concentration of a parameter is the is the Y-axis (the dependent variable). The concentration of a parameter is the dependent variable because it is affected, at least in part, by time (which is independent because it always remains unaffected).

All points on the graph are best described by a single line ("line of best fit"). The slope of this line describes the significance of the linear relationship between the X's and Y's (in other words, the significance of the change in concentration over time). An equation that describes the line can be used to predict the future concentration of a parameter.

[Note 1: The types of data obtained in the stream monitoring program should be appropriate for Simple Linear Regression tests. However, some assumptions are made while using the test. The important is the fact that the Y's are completely independent of each other. A monthly sampling frequency should not interfere with this assumption. A higher frequency of sampling would destroy this assumption.]

[Note 2: Bad data from sampling error or analytical error will lead to bad results from Simple Linear Regression tests. Bad data can be excluded through screening the data using the with means and standard deviations. It is possible to replace a single bad data point with the mean value of all of the data points.

Purpose

1) To study the linear relationship between 2 variables; X and Y (i.e., what is the decrease in the concentration of copper over time).

2) To find an equation useful for predicting Y when X is known.

Data

Observations are paired $[(X_1, Y_1).....(X_n, Y_n)]$

X - independent variable

Y - dependent variable

Choosing Comparisons (Yearly Periodicity)

Two types of comparisons can be completed. The X-value can either be:

1) months in one year (i.e., March, April, May, June, 1990)

2) or the same month during different years (i.e., May of '89, '90, '91, '92, etc.)

The X-value (time, the independent variable) studied will vary as a result of the Y-value (parameter, the dependent variable). The X-value may change as a result of yearly periodicity. Periodicity explains Y values (parameters) that vary on a yearly cycle. An example is Dissolved Oxygen (DO), which is highest in the winter and lowest in the summer. Therefore, it is worthless to study linear relationship of the change in DO over a year because it will be a curved line (that resembles a cosine curve). It is worthwhile, however, to study the DO level during the same month in consecutive years. This is why it is important to sample the streams during the same months every year. The parameters that follow yearly periodicity are:

- Temperature
- DO
- Total Coliform
- Fecal Coliform
- Fecal Streptococcus

Some effect will also be noticed on:

- BOD
- COD
- Chlorides

If the investigator is unsure about the effect of periodicity on these and other parameters, the linear relationship can be studied between Y (the parameter of interest) and X:

1) months in one year
2) the same month in several years.

The relationship that yields more significant linear relationship should be used to complete the tests.

Linear Relationships

B_o - y intercept

B_i - slope of line, change in Y/ change in X

1) In a perfect linear relationship all (X,Y) pairs fall directly on a line.

2) The two variables are perfectly linearly related if B_o and B_i are such that $Y = B_o + B_iX$ (equation for a straight line).

<u>Notes</u>

It is unlikely that the X's and Y's will be perfectly linearly related. In other words, it is unlikely that all X and Y values will fall directly on the line that best describes them. There are random variables (that are basically "fudge factors") allowing the X and Y values to fall on the line.

<u>Goals</u>

Find the type of linear relationship between X and Y [(<u>positive</u>; concentration increases with time) or (<u>negative</u>; concentration decreases with time)]. Find the strength of the linear relationship (how fast is the concentration increasing or decreasing?).

1) If $B_i > 0$, then X and Y are <u>positively</u> related
   a) If X increases, Y will increase
   b) If X decreases, Y will decrease

2) If $B_i < 0$, then X and Y are <u>negatively</u> related
   a) If X increases, Y will decrease
   b) If X decreases, Y will increase

<u>Analysis</u>

The stats package will greatly reduce the amount of time and work needed to complete a Simple Linear Regression Analysis. At the end of this section there is an a outline that explains how to find each of the necessary tests in the program. The outline also gives the page numbers in the statistical package manual where specific instructions are given.

<u>Data Input</u>. Input the data and generate a data table according to the outline. The tabular form of the data is helpful for checking any data input errors.

<u>Obtaining a Graph</u>. If an X-Y graph of the data is desired the program will generate it complete with title and axis labels. The outline describes how to generate an X-Y graph. The graph is good for observing a general linear relationship (positive or negative) that can be used to check the other calculations.

<u>Generating an Anova Table, R-Squared Value, and an F-Stat</u>. The Anova Table is an "Analysis of Variance Table." It shows where error lies between the actual and predicted values. The R-Squared value is the "Coefficient of Determination." It is used to determine the strength of the linear relationship between X and Y. The F-Stat is a number that is used to determine if a significant linear relationship exists between X and Y. All three of these items are calculated and put on the screen at once. To print what is displayed on the screen, press the "shift" key and "PrtSc" key simultaneously. Follow the outline and manual directions to obtain these values.

<u>Hypothesis Generation</u>. Hypothesis generation and testing is simply the standardized way to test if there is a significant linear relationship between X and Y. There are two hypotheses that are used to test the significance of a linear relationship. The two are constant through every Simple Linear Regression test.

They must be stated as they are below (excluding the material in the parentheses).

1) Null Hypothesis $H_o: B_i = 0$

(There is no significant linear relationship between X and Y, because, the slope of the line is equal to 0; thus it is horizontal.)

2) Alternative Hypothesis $H_a: B_i = 0$

(There is a significant linear relationship between X and Y, because the slope is not equal to 0)

Hypothesis Testing. Hypothesis testing is completed using the Anova Table, the F-Stat, and the F-Table (a standard statistical table that is included in the stat manual).

1) On the Anova Table, read the Degrees Freedom (D.F. column) for the Regression Row (the intersection of the two). The number should be a 1 for Simple Linear Regressions because it represents the number of independent variables. (In our case "time" is the only independent variable.)

2) On the F-Table, read down the first column (Horizontal Axis). The D.F. for Regression is the numerator of the F-Table Value.

3) On the Anova Table, read the D.F. column for the Error Row (the intersection of the two). The number represents the total number of observations in the set minus 2.

4) On the F-Table, the D.F. for Error is the denominator of the F-Table Value (vertical axis). Read across the row

that most closely corresponds to the D.F. for Error.

5) The F-Table Value is the intersections of the column (D.F. for Regression) and the row (D.F. for Error).

<u>Example</u>:

a) On Anova Table, the D.F. for Regression = 1

b) Read down first column on F-Table

c) On Anova Table, the D.F. for Error = 10

d) Read across the tenth row on F-Table

e) F-Table Value = 4.96

6) Compare the F-Table Value (obtained in step 6) to the F-Stat (the "F" under the Anova Table).

7) If F-Stat is larger than the F-Table Value; <u>Reject</u> H_o.
If F-Stat is smaller than the F-Table Value; <u>Accept</u> H_o.
[<u>Note</u>: By statistical convention, it is only possible to accept or reject H_o (the Null Hypothesis). You may not accept or reject the H_a (the Alternative Hypothesis.)]

8) Recall that the Null Hypothesis is $H_o = 0$, or there is no significant linear relationship between X and Y.

9) <u>If</u> H_o <u>is rejected</u>; There is a significant linear relationship between X and Y. Or, there was a significant decrease is the concentration of a parameter over time.

10) <u>If</u> H_o <u>is accepted</u>; There is no significant linear relationship between X and Y. Or there was a no significant decrease in the concentration of a parameter over time.

Determining Strength of Linear Relationship. Two techniques can be employed to determine the strength of the linear relationship between X and Y. The tests are useful to determine which of two or more linear relationships are more significant. Example: the level of copper was significantly reduced in Big Creek during 1990 and 1991. In which year was the level of copper reduction most significant?

1) Coefficient of Determination (R-Squared) is the % of variation in Y that is explained by X. The R-Squared number is found directly under the Anova Table (the same table that was used earlier for Hypothesis Testing).

   a) Take the square root of R-Squared

   b) The following is a "Rule of Thumb" for the strength of the linear relationship. If R is:

      * $R > 0.7$ - Strong Linear Relationship
      * $0.4 < R < 0.7$ - Moderate Linear Relationship
      * $0.2 < R < 0.4$ - Poor Linear Relationship
      * $0 < R < 0.2$ - No Linear Relationship

2) Determining Slope of Line (From Equation of a Line). The steeper the slope of a line, the stronger the linear relationship.

   a) Choose any pair of X and Y values (it is possible to use the original table of values generated before the X-Y graph).

   b) Determine B_o (Y-intercept) off of the X-Y graph of the values. The Y-intercept is where the line crosses the Y-axis.

c) Plug these numbers into the equation for a straight line; $Y = B_o + B_i X$. Algebraically solve for the slope (B_i).

d) The slope with a larger absolute value shows a more significant decrease in Y (parameter concentration).

Example: If Big Creek had a copper decrease slope of -4 (absolute value = 4) in 1990, and had a copper decrease slope of -2.5 (absolute value = 2.5) in 1991, the decrease in copper during 1990 would be more significant than the decrease in 1991.

Obtaining a Predicted Y-Value and Confidence Interval. The outline describes how to obtain a predicted Y-Value and confidence interval. This test can be used if the investigator wishes to predict the future concentration of a parameter. The test should only be used if there is a strong linear relationship between X and Y.

1) The program will ask you to enter an X value. Enter the time in the future in which you are interested. You must make sure that your numbering of time is consistent with the data that you are using.

2) The program will give you a "Predicted Y-Value". The program will also give you a "95% Prediction Interval." (You need not worry about the "Variance of Prediction.")

3) Example:

   Enter a value for date? 20

Predicted Y-Value = 6.19.....

95% Prediction Interval 3.62..... to 8.76.....

4) The predicted Y-Value (concentration of the parameter) on the 20th time interval is 6.19.

5) The question is, how confident are we of this prediction? By looking at the prediction interval we can conclude: "We are 95% confident that the concentration of the parameter on the 20th time interval will be between 3.62 and 8.76."

<u>Increases in Parameter Concentration</u>. Of course all of these tests are valid for measuring increases in parameter concentration over time. All tests are all completed using the same tests. The only difference is the graph would show a positive linear relationship, rather than a negative linear relationship.

RANDOMIZED COMPLETE BLOCK DESIGN

The "Block Design" is an experimental design model.

Goal

The usual goal of an experimental design model is to obtain the comparisons of the means of a response (dependent) variable for the various levels of one or more factors (independent variables). In our case, this design will be used to study the differences in the mean concentrations of parameters at different locations.

Example: is there a significant difference between the mean concentration of chlorides at three different points on Rocky River? (Or if necessary, the difference between three different streams can be studied). If a significant increase in the mean concentration is found between point A and point B then a problem could potentially be located and remedied.

Terminology

1) A response variable is a dependent variable. The means of this variable will be compared (i.e., the concentration of a parameter).
2) Factors are independent variables that affect (at least potentially) the response variable. In this case, the two factors are location and time interval.
3) A Treatment is a combination of factor levels. Treatments are the factor of interest. In this case, locations are the Treatments.
4) A Block is factor that has some effect on the response

variable. In this case, time intervals are the Blocks.

5) A Cell is the combination of a Block and a Treatment.

Block Design

Example:

Time Intervals - Blocks

Treatments		Month or Year 1	Month or Year 2	Month or Year 3	Month or Year 4
Local 1		mean conc.	mean conc.	mean conc.	mean conc.
Local 2		mean conc.	mean conc.	mean conc.	mean conc.
local 3		mean conc.	mean conc.	mean conc.	mean conc.

Local = Location on a stream

mean conc. = mean concentration of a parameter over that time interval

Analysis

Once again, the stats program will reduce the time and work needed to complete analysis of a block design. Anova Table and mean calculations will be completed by the stats program. Comparisons of the means of the Treatments will be completed by hand because the program does not have that capability. Tukey's Multiple Comparison will be used for those calculations.

Data Input. Input the data and generate a table of the entered values according to the outline. The tabular form of data is helpful for checking any data input errors.

Generating a Two-Way Anova Table. A Two-Way "Analysis of Variance Table" is needed in this analysis because there are two independent variables. Obtain an Two-Way Anova Table by following the directions on the outline at the end of this section.

Hypothesis Generation. Hypothesis generation is similar to the Simple Linear Regression problem. However, instead of testing the linear relationship between two variables, we will test the hypothesis that the means of all of the Treatments are equal (the mean concentration at all of the locations are equal).

1) Null Hypothesis $H_o: \tau_1 = \tau_2 = \tau_3$

   τ_1 = mean concentration of a parameter at location 1

   (No difference in the mean concentration at any location)

2) Alternative Hypothesis H_a : At least two locations have a different mean concentration

   (If location 1 is different than location 2 there are two different mean concentrations)

Hypothesis Testing. Hypothesis testing is completed using the Two-Way Anova Table and the F-Table that are generated as described in the manual.

1) On the Two-Way Anova Table, read the D.F. column for the Treatments Row (the intersection of the two).

2) On the F-Table read down the column that most closely corresponds to the D.F. for Treatments. The D.F. for Treatments is the numerator on the F-Table.

3) On the Two-Way Anova Table, read the D.F. column for Error (the intersection of the row and column).

4) On the F-Table read across the row that most closely corresponds to the D.F. for Error. The D.F. for Error are the denominator on the F-Table.

5) The F-Table Value is the intersection of the column (D.F. for Treatments) and the column (D.F. for Error).

Example:

a) On Two-Way Anova Table, the D.F. for Treatment = 2

b) Read down second column on F-Table

c) On Two-Way Anova Table, the D.F. for Error = 3

d) Read across the third row on F-Table

e) F-Table Value = 9.55

6) Compare the F-Table Value (obtained in step 6) to the F-Stat (the F value for Treatments on the Two-Way Anova Table).

7) If F-Stat is larger than F-Table Value; Reject H_o
If F-Stat is smaller than F-Table Value; Accept H_o

8) Recall that the Null Hypothesis is that there is no difference in the mean concentration at any location.

9) If H_o is rejected; at least two locations have different mean concentrations.

10) If H_o is accepted; the mean concentrations at all locations are equal.

Note: If H_o is rejected it only signifies that the mean concentrations vary at two or more locations. The following tests are designed to calculate which treatment means are significantly different.

Calculating the Means of Each Treatment. The program will calculate the mean value of each Treatment group. These means will be used to complete Tukey's Multiple Comparison. The outline describes how to use the program to generate the Treatment means.

Tukey's Multiple Comparison. This test is designed to determine which of the Treatment means are significantly different. The test has a confidence level of 95% [from $(1 - \alpha)100\%$; with $\alpha = .05$]. In other words, we can be 95% confident that the outcome of the comparison is correct. The following explanation is not entirely in proper statistical notation.

If the absolute difference between two Treatment means is ≥ the Tukey Comparison Number, the means of those two Treatments are significantly different.

Table Values

$$Y_1 - Y_2 \quad \geq q\ [(\alpha,\ k,\ V)] \quad S^2 / b$$

Y_1 - Mean value for Treatment 1

Y_2 - Mean value for Treatment 2

q - Value from Studentized Range Table

α - Alpha value ($\alpha = .05$)

k - Number of Treatments

V - Degrees Freedom Error Value

On Two-Way Anova Table this is the value at the intersection on the D.F. Column and Error Row.

b - Number of Blocks

S^2 - Mean Square Error Value

On Two-Way Anova Table this is the value at the intersection of the MS Column (Mean Square) and the Error Row.

<u>Example</u>:

Iron levels have been measured for 5 years at 3 locations on Mill Creek. We have previously rejected the Null Hypothesis (Ho - mean of iron concentrations at all locations are equal) so we know that at least two mean iron concentrations are different. At which locations are the mean iron concentrations significantly different ?

Number of Blocks (years) - b = 5

Number of Treatments (locations) - k = 3

1) Mouth of Stream - Y_1 = 4.6245 mg/L (mean for 5 years)

2) Lee Road - Y_2 = 4.3410 mg/L (mean for 5 years)

3) Northfield Road - Y_3 = 3.9855 mg/L (mean for 5 years)

Mean Squared Error - S^2 = 0.0206511 (from Two-Way Anova Table)

Studentized Range Table Value - q

1) <u>Since α = .05 use the lower of the 2 tables</u>

2) k = 3 (number of treatments - locations)

3) V = 8 (D.F. Error from Two-Way Anova Table)

4) Read across the top of the Table to Column K = 3

5) Read down the side of the Table to Row V = 8

6) Intersection of column 3 and row 5 = q

$q = 4.04$

<u>Comparison Number</u> $= q \quad s^2 / b$

$= 4.04 \quad .0206511/ 5$

$= 0.3352$

There is a significant difference between the mean iron concentration at any two locations if the absolute difference ≥ 0.3353.

Difference in Means ≥ or ≤ Comparison Number

1) $Y_1 - Y_2 = 0.2835 \leq 0.3352$

There is no significant difference between the mean iron concentrations at the Mouth of Mill Creek and at Lee Road.

2) $Y_1 - Y_3 = 0.6390 \geq 0.3352$

There is a significant difference between the mean iron concentrations at the Mouth of Mill Creek and at Northfield Road.

3) $Y_2 - Y_3 = 0.3555 \geq 0.3352$

There is a significant difference between the mean iron concentrations at Lee Road and Northfield Road.

Missing Data

It is possible to fill one empty cell with a data estimate. This can be done if data are either missing, or complications resulted in bad data. This should be taken into consideration during analysis. In other words, if the results are borderline significant, they should be used with caution.

USING STATISTICAL PACKAGE

I. Put a formatted disk into drive (Drive A)

[When finished with stats package type "system" at "." (without quotation marks), this will return you to opening IWS menu.]

A. From opening menu C> press "6", this brings up the stats program.

II. To enter, edit, purge, or print out data:

A. Select Option 1 from the Main Program , "Central Program Directory"

B. To create new data files:

1. Select Option 1 from "Primary Program, Data Editor"

2. Enter data according to explanation in manual; p. 1-3 through 1-16

C. To printout data files:

1. Select Option 4 from "Primary Program, Data Editor"

2. Obtain printout of data files according to explanation in manual; p. 1-21 through p. 1-25

3. To print what is displayed on the screen press the "shift" key and "PrtSc" simultaneously

4. Return to Main Program, "Central Program Directory"

III. Simple Linear Regression

A. To obtain X-Y plot of data:

1. From Main Program, "Central Program Directory" Select Option 11, "X-Y Plot"

2. Generate X-Y graph according to explanation in manual; p. 11-1 through 11-4

3. Return to Main Program, "Central Program Directory"

B. To obtain Anova Table, F-Stat, and R^2:

1. From Main Program, "Central Program Directory", <u>Select Option 2</u>, "Regression Analysis"

a. From "Regression Analysis" menu <u>Select Option 1</u>, "Least Squares"

- From "Least Squares" menu, <u>Select Option 2</u>, "Anova, F-Stat, Durbin-Watson, R^2"
- Obtain an Anova Table, ect. according to explanation in manual; p. 2-11 through p. 2-12
- To print what is displayed on the screen, press the "Shift" key and "PrtSc" key simultaneously.

2. Return to Main Program, "Central Program Directory"

C. To obtain a Predicted Y-Value and Confidence Interval:

1. From Main Program, "Central Program Directory", <u>Select Option 2</u>, "Regression Analysis"

a. From "Regression Analysis" menu <u>Select Option 1</u>, "Least Squares"

- From "Least Squares" menu, <u>Select Option 10</u>, "Obtain A Predicted Value"
- Obtain a predicted value be entering a X value (independent) as explained on p. 2-15
- To print what is displayed on the screen, press the "Shift" key and "PrtSc" key simultaneously.

IV Experimental Design Model - Block Design

A. To obtain a Two-Way Anova:

1. From Main Program, "Central Program Directory",

Select Option 4, "Descriptive Statistics"

a. From "Descriptive Statistics" menu, Select Option 4, "Two-Way Anova"

- Obtain a Two-Way Anova as explained on p. 4-13 through p. 4-14

- To print what is displayed on the screen, press the "Shift" key and "PrtSc" key simultaneously.

B. To obtain the Mean of each Treatment to complete Tukey's Multiple Comparison.

1. From Main Program, "Central Program Directory", Select Option 4, "Descriptive Statistics"

a. From "Descriptive Statistics" menu, Select Option 1, "Mean, Median, Mode,...etc."

- From "Sub-Option" menu, Select Option 1, "Display Mean, Mode,....etc."

- Obtain the Mean of each Treatment as explained on p. 4-3

- To print what is displayed on the screen, press the "Shift" key and "PrtSc" key simultaneously.

V. To return to opening IWS PC/AT menu Select Option Ø.

A. When a "OK" appears at the bottom of the screen, type "System" (without the quotes).

APPENDIX 13

Contacts With Other Agencies

CONTACTS WITH OTHER AGENCIES

Agency: Ohio Environmental Protection Agency (OEPA), Northeast Office

Contact: Robert Wysenski

Address: 2110 East Aurora Rd

Twinsburg, Ohio, 44087-1969

Phone: 425-9171

Agency Will Send IWS:

1) Monthly sampling data on Cuyahoga River; lower Harvard Bridge and Old Rockside Rd.

IWS Will Send Agency:

2) Condensed versions of data.

3) Will contact IWS about specific data concerns.

Agency: OEPA, Office of Water Pollution Control

Division of Water Monitoring and Assessment

Contact: Vivian Davis, Information Distribution

Phone: 614-466-9092

Agency: OEPA, Office of Standards and Toxics

Division of Water Quality and Assessment

Contact: Dan Dudley

Phone: 614-466-8565

Agency: Notheast Ohio Areawide Coordinating Agency (NOACA)

Contact: Andy Vitrea, John Beeker

Address: 1501 Euclid Ave.

Cleveland, Ohio, 44015

Phone: 241-2414

Agency Will Send IWS:

1) Results from their fish monitoring program in Northeastern Ohio.

IWS Will Send Agency:

1) Any fish sampling data from IWS program.

Agency: Cleveland Metroparks System

Contact: Ken Halko

Address: 4101 Fulton Parkway

Cleveland, Ohio, 44144

Phone: 234-9597

Agency Will Send IWS:

1) Any data gathered on the Metropark streams within the District's jurisdiction.

IWS Will Send Agency Data On:

Euclid Creek

1) Sampling location #2, Highland Picnic Area, Euclid Creek Reservation.

2) Sampling location #3, same location.

Big Creek

3) Sampling Location #26, Memphis Road Park, East Branch.

4) Sampling location #27, same location, West Branch.

5) Sampling Location #29, Big Creek Parkway (between Snow Rd. and Pearl Rd.), East Branch.

Mill Creek

6) Sampling location #33, Garfield Park, Wolf Creek.

Tinkers Creek

7) Sampling Location #39, Bedford Reservation, Dunham Road.

8) Sampling location #40, Parkway off of Broadway Ave..

Chippewa Creek

9) Sampling location # 43, ford off of Riverview Road.

Rocky River

10) Sampling location #49, Valley Parkway, north of Bagley Road, Rocky River Reservation, East Branch.

11) Sampling location #50, North Quarry Road, Wallace Lake area, East Branch.

12) Sampling location #51, East Access Road, off of Valley Parkway, East Branch.

Agency: Shaker Lakes Regional Nature Center

Contact: Richard Horton, Director

Address: 2600 South Park Blvd.

Shaker Heights, Ohio, 44120

Phone: 321-5935

Agency Will Send IWS: N.A.

IWS Will Send Agency Data On:

Doan Brook

1) Sampling location #16, north of St. Clair, on MLK Bld..

2) Sampling location #17, below Art Museum, on MLK Bld..

3) Sampling location #18, North Branch at Nature Center.

4) Sampling location #19, South Branch at Nature Center.

Agency: United States Geologic Survey (USGS)

Contact: Ann Arnett, Information Officer

Phone: 614-469-5553

Agency Will Send IWS:

1) Discharge information for Cuyahoga River at "Independence", Old Rockside Road (USGS number 04208000).

2) Basic chemical parameters from Cuyahoga River at "Independence" (Temp., DO, Conductivity, pH).

3) Discharge information for Tinkers Creek at "Bedford", Broadway Ave. (USGS number 04207200).

IWS Will Send Agency Data On: N.A.

Agency: Ohio Department of Natural Resources - Seining License

Contact: Division of Wildlife - Survey and Inventory Section

Address: 1500 Dublin Road, Columbus, Ohio, 43215

Phone:

Agency Will Send IWS:

1) IWS must apply to Agency for a seining license prior to fish sampling.

IWS Will Send Agency: N.A.

Agency: City of Berea

Contact: Paul McCumbers, Director of Water Resources

Address: 11 Berea Commons

Berea, Ohio, 44017

Phone: 826-5815

City Will Send IWS: N.A.

IWS Will Send City Data On:

Rocky River

1) Sampling location #49, described above.

2) Sampling location #50, described above.

3) Sampling location #51, described above.

Agency: City of Strongsville

Contact: Jim Nickols, Service Director

Address: 16099 Fultz Industrial Parkway

Strongsville, Ohio, 44136

Phone: 238-5720

City Will Send IWS: N.A.

IWS Will Send City Data On:

Rocky River

1) Sampling location #50, described above.

2) Sampling location #51, described above.

3) Sampling location #52, River Road (off of Columbia Rd.), Olmsted Falls, West Branch.

Agency: City of Solon

Contact: Everett McDaries

Address: 6315 S.O.M. Center Road

Solon, Ohio, 44139

Phone: 248-4895

City Will Send IWS:

1) Weekly samples taken upstream and downstream of Wastewater plant. IWS Will Send City Data On:

Tinkers Creek

1) Sampling location #41, Richmond Road.

2) Sampling location #42, upstream of WWTP.

Agency: Ohio Division of Wildlife

Phone: 265-6305

Appendix 14

Storing Data

STORING DATA

A data base file has been started to allow data to be stored and retrieved in an organized fashion. The file contains all the chemical parameters that will be analyzed throughout the program.

This section explains the use and format of the data base.

DATA BASE FORMAT

The following fields are contained in the data base file:

1) SAMPLE_NO - The number of the chemical sample. The same number as the IWS log book except the year must go behind front of the number. The number contains 7 digits; zeros must precede any numbers less than 7 digits.

Example: 0145788, this is the 1457 sample taken in 1988.

2) DATE - The sample date in the form MM/DD/YY.

3) STREAMNAME - The name of the stream that was sampled.

4) LOC_NO - The permanent number of the sampling location.

5) SAMPLE_BY - The names of the investigators.

6) SAMPLETYPE - The sampling method used to collect the chemical sample.

7) EQUIPMENT - Any equipment used to collect the chemical sample.

8) PRIORITY - The priority of the sample, same as laboratory notation.

9) CERTIFIER - The laboratory certifier.

10) OBSERVE_1 - Any field observations that might have an

effect on the quality of the chemical samples.

11) OBSERVE_2 - Any additional observations that might have an effect on the quality of the chemical sample.

12) WEATHER3_D - The weather over the last 3 days.

13) BOD - Biological Oxygen Demand

14) COD - Chemical Oxygen Demand

15) SS - Suspended Solids

16) DO - Dissolved Oxygen

17) TOTAL_P - Total Phosphorus

18) SOLUBLE_P - Soluble Phosphorus

19) CHLORIDES

20) NITRATES

21) NITRITES

22) ORGANIC_N - Organic Nitrogen

23) AMMONIA

24) TKN - Total Kjeldhal Nitrogen

25) SULFATES

26) ACIDITY

27) ALKALINITY

28) SPEC_COND - Specific Conductivity

29) TOTALSOLID - Total Solids

30) TURBIDITY

31) TOT_DIS_SO - Total Dissolved Solids

32) HARDNESS

33) COLIFORM_T - Total Coliform

34) COLIFORM_F - Fecal Coliform

35) FECALSTREP - Fecal Streptococcus

36) PH - pH

37) NICKEL

38) COPPER

39) CHROME_T - Total Chromium

40) CHROME_HEX - Hexavalent Chromium

41) ZINC

42) IRON

43) CADMIUM

44) LEAD

45) MERCURY

46) TEMP_C - Temperature in Celcius

47) X_SECTION - Cross-Sectional Area in Cubic Feet

48) DISCHARGE - Discharge (flow rate) in Cubic Feet/ Second

49) COLOR - Numeric laboratory value for color

ACCESSING DATA BASE FILES

1) At the C> on the opening menu (top of the screen says "PC/AT Function Menu") press "2" (this calls up the DBase program - the IWS Master Menu).
2) From the IWS Master Menu select "!" (this option is not on the menu). This will allows you to break from the main IWS program.
3) At the bottom-left corner of the screen a "." will appear. Type "SET PATH TO" (without quotation marks) and press the "enter" key.
4) A second "." will appear in the same corner. Type "RUN

CD\DBASE" (Note: the \ is a backward slash mark) and press the "enter" key.

5) Place the floppy disk labeled "Stream.DBF" in the disk drive, and close the arm.

6) A third "." will appear, type "SET DEFA TO A" and press the "enter" key. This tells the computer to read the floppy disk drive.

7) A forth "." will appear, type "USE STREAM" and press the "enter" key. This tells the computer to find and use the stream data base file.

8) A fifth "." will appear, there are three ways to use the dbase file.

   a) "APPEND" allows the user to add new records to the file. This is used when an analysis is complete and the data has to be stored.

   b) "EDIT" allows the user to edit the existing files. This is used when a previously entered record needs to be modified.

   c) "MODI STRU" allows the user to modify the structure of the data base. For instance, if a chemical parameter is added to the investigations, a field containing that parameter can be added to the data base file.

[Note: To aid the user the Data Base System has commands and help commands at the top of every screen.

TO ADD DATA

1) At the fifth "." (step 8, above), type "APPEND" and press the enter key.

2) Type the appropriate datum into each field. The sample number is actually a character field, it should be preceded by zeros if it is early in the year.

Example: The 123rd sample of 1988 should be recorded as "0012388".

3) When every field is filled the user can:

a) press the "down arrow" key to enter another file.

b) press the "Ctrl" and "End" keys simultaneously to stop the append mode. This will enter and save all data.

4) To return to the opening menu type "QUIT" at the "." and press the "enter" key

TO EDIT PREVIOUSLY ENTERED DATA

1) Press the "Ctrl" and "W" keys simultaneously which takes the user into an interactive mode.

2) At the ".", type LOCA FOR SAMPLE_NO = '0000000' (the sample number that you are interested in editing.

3) At the "." (see step 8, above), type "EDIT" and press the "enter" key.

4) After the file is called up, make all necessary changes in the file.

a) press the "Ctrl" and "End" keys simultaneously to enter and save the changes.

5) To return to the opening menu type "QUIT" at the"." and press the "enter" key.

TO MODIFY THE DATA BASE STRUCTURE

1) At the fifth "." (see step 8, above), type "MODI STRU" and press the "enter" key. The data base format will appear on the screen.

2) Use the up and down arrows to move to the field of your choice.

3) The "Ctrl" and "U" keys pressed simultaneously will delete a field. The remaining fields will adjust themselves.

4) The "Ctrl" and "N" keys pressed simultaneously will add a blank field.

   a) Type in the "Field Name" (parameter name) and the "Type" (Numeric or Character). Any chemical parameters will be Numeric, type an "N", and the the word Numeric will appear.

   b) Type in the "Width" (the total number of numeral spaces), and the number of "Decimal" places.

   Example: Nickel has a width of 6 places, 2 of which are decimals (the field will show 0000.00).

5) To save changes press the "Ctrl" and "W" keys simultaneously.

6) Type "Clear All" at the ".", and enter.

7) At the ".", if you wish to:

   a) Edit existing data, type "EDIT" (See Above), and enter.

b) Add new records, type "APPEND" (See Above), and enter.

c) Return to opening menu, type "QUIT", and enter.

Appendix 15

Abbreviations

ABBREVIATIONS

AGW - alcohol, glycerol, and water

A.I. - Autotrohpic Index

APHA - American Public Health Association

ave. - average

BOD - 5-day biological oxygen demand

C degrees - temperature in Celcius degrees

CFS - cubic feet per second

CGPL - Construction Grants Priority List

COD - chemical oxygen demand

CSO - combined sewer overflows

CWA - Clean Water Act, Federal Water Pollution Control Act

District - Northeast Ohio Regional Sewer District

DO - dissolved oxygen

ft. - feet

g - grams

GPM - gallons per minute

GPD - gallons per day

hr. - hour

IWS - Industrial Waste Section of the District

kg. - kilogram

l - liter

m - meter

mf - membrain filter

mg - milligrams

MGD - million gallons per day

ml - milliliters

mm - millimeter

mpn - most probable number

N.A. - not applicable

no. - number

NOACA - Northeast Ohio Areawide Coordinating Agency

NPDES - National Pollution Discharge Elimination System

ODNR - Ohio Department of Natural Resources

OEPA - Ohio Environmental Protection Agency

P.L. - Public Law; United States Congress

sec. - second

sq. - square

USEPA - United States Environmental Protection Agency

ug - microgram

USGS - United States Geological Survey

wt. - weight

WWH - warmwater habitat

WWTP - waste water treatment plant

References

REFERENCES

American Public Health Association (APHA), American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater. 16th Edition. American Public Health Association, Washington D.C..

American Water Works Association (AWWA) Symposium Proceedings, 1978. Establishment of Water Quality Monitoring Programs, Lorne G. Everett, Kenneth D. Schmidt, Editors, AWWA, Minneapolis, Minnesota.

Erlebach, W.E., 1978. A Systematic Approach to Monitoring Trends in the Quality of Surface Waters. AWWA Symposium Paper.

Gammon, J.R., 1976. The Fish Population of the Middle 340 km of the Wabash River. Purdue University Water Resources Research Center, Technical Report number 86.

Gerking, S.D., 1953. Evidence for the Concepts of Home Range and Territory in Stream Fishes. Ecology, 34(2), 347-365.

Gerking, S.D., 1959. The Restricted Movements of Fish Populations. Biological Review, 34, 221-242.

Green, Roger H., 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, New York.

Langford, R.H., 1978. National Monitoring of Water Quality. AWWA Symposium Paper.

Mason, C.F., 1981. Biology of Freshwater Pollution. Longman, New York.

Metropolitan Sanitary District of Greater Chicago, 1984. Description of Routine Monitoring for Water Quality of Lake Michigan and Inland Waterways. Research and Development Department, Chicago, Illinois.

Northeast Ohio Areawide Coordinating Agency, 1984. Recommendations for a Permanent Biological Monitoring Program For NOACA Water Quality Management Planning Area. Cleveland, Ohio.

OEPA, 1980. Manual of Surveillance Methods and Quality Assurance Manual. Columbus, Ohio.

OEPA, 1982. Comprehensive Water Quality Report, Four Mile Creek, City of Oxford, Butler County. Division of Wastewater Pollution Control, Water Quality Management Section, Doc.2231J. Columbus, Ohio.

OEPA, 1984. *Division Water Quality Monitoring and Assessment Implementation Document*. DOC2866W, Columbus, Ohio.

OEPA, 1986. *Water Quality Inventory, 1986, 305(b) Report*, Volume II. Division of Water Quality Monitoring ans Assessment, 4807W/0305D. Theresa Heitzman, Editor, Columbus, Ohio.

Olive, John H., Kenneth R. Smith, 1975. *Benthic Macroinvertebtrates as Indexes of Water Quality in the Scioto River Basin, Ohio*. Ohio Biological Survey, Volume 5, Number 2, Ohio State University.

Pederson, G.I., M.A. Sylvester, H.H. Higgins, 1978. *Design of an Integrated Water Quality Monitoring Program for Santa Clara County, California*. AWWA Symposium Paper.

Polls, Irwin, Richard Laynon, Cecil Lue-Hing, Salvador Sedita, David Zenz, 1978. *A Water Quality Sampling Program for 208 Planning in Northeast Illinois*. AWWA Symposium Paper.

Rice, Jeffery M., Dale E. Anderson, 1978. *Useful Monitoring for Policy and Decision Makers*. AWWA Symposium Paper.

Shannon, C.E., 1948. *A Mathamatical Theory of Communications*. Bell System Technical Journal, 27:379-423.

USEPA, 1973. *Bilogical Field and Laboratory Methods, for Measuring the Quality of Surface Water Effluents*. Office of Research and Developing, EPA-905/9-74-012. C.I. Weber, Editor, Cincinnati, Ohio.

USEPA, June 1975. *Model State Water Monitoring Program*. Office of water and Hazardous Materials, EPA-440/9-74-002. R.L. Crim, Editor, Washington, D.C..

USEPA, December 1975. *Water Pollution Investigation: Cuyahoga River and Cleveland Area*. Region V Enforcement Division, EPA-905/9-74-012. Chicago, Illinois.

USEPA, 1977. *Basic Water Monitoring Program*. Standard Work Group on Water Monitoring, EPA 440/9-76-025. Washington, D.C..

USEPA, September, 1985. *Technical Support Document for Water Quality-based Toxic Control*. Office of Water. Washington D.C..

USEPA, October,1985. *Guidance for State Water Monitoring and Wasteload Allocation Programs*. Office of Water Regulations and Standards, EPA 440/4-85-031. Washington, D.C..

Weber, C.I., J.M. Bates, 1981. *Ecological Assessments of Effluent Impacts on Communities of Indigenous Aquatic*

Organisms. American Society For Testing And Materials, Philadelphia, Pennsylvannia.

Welch, E.B., 1980. Ecological Effects of Waste Water. Cambridge University Press, New York.

West Publishing, 1984. Selected Environmental Law Statutes. West Publishing Company, St. Paul, Minnasota.

Whipple, William Jr., 1977. Planning of Water Quality Systems. Lexington Books, Toronto.