STATE OF OHIO
BIENNIAL WATER QUALITY REPORT

EXECUTIVE SUMMARY

SYNOPSIS

1980 305(b) Report
Volume I

Volumes I through VIII Submitted
Pursuant to the Requirements of Section 305(b)
Federal Water Pollution Control Act Amendments 1972

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INTRODUCTION

The Federal Clean Water Act (1977) was established to preserve and protect the waters of the United States. A major goal of the Act is commonly expressed as "fishable/swimmable waters" and was defined in the Act as "...water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water..." (Section 101(a)(2) of PL 95-217). The Act further stated that this goal be achieved, wherever attainable, by July 1, 1983.

The Act requires each state to prepare a biennial report which describes existing water quality and evaluates the status of surface waters with regard to the 1983 goal. This report has been prepared to fulfill that requirement.

Section 305(b) of the Clean Water Act requires that the states provide the following information in their reports:

> A thorough description of existing water quality, including an analysis of the extent to which such waters currently support balanced populations of aquatic life and allow for recreational activity.
>
> Projections of water quality conditions after implementation of the control programs specified in the Act.
>
> An estimate of the environmental, social and economic impacts of achieving or not achieving the goals of the Act. An estimate of the date of such achievement should be included.
>
> An assessment of nonpoint source problems, along with recommendations for their control (including cost estimates for implementation).
>
> An evaluation of the effectiveness of existing pollution control programs and recommendations for future modifications to those programs, if needed.

Further information about water quality is available upon request from:

The Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards
361 East Broad Street
Columbus, Ohio 43216

Monitoring Programs

Ohio has 163 fixed monitoring stations in its ambient monitoring network. Most of these stations are located in problem areas and on certain principal streams (i.e., subbasin mainstems plus streams with at least 100 square miles of drainage area). These stations were chosen after a review of intensive river basin studies between 1949 and 1965 and involved over 1000 sampling stations. Additional water monitoring programs include (1), 30 biological monitoring sites, 20 of which are used for major discharge impact assessments; (2), approximately 6 intensive surveys per year that comprehensively evaluate water quality (i.e., they include extensive chemical/physical and biological sampling in selected rivers and streams); and (3), selected public lakes and reservoirs. Effluent monitoring consisted of 25 and 30 municipal and 51 and 53 industrial compliance monitoring sites during 1978 and 1979, respectively. These data are used to determine compliance with National Pollution Discharge Elimination System (NPDES) permits, to validate self-monitoring reports, and to provide support for enforcement actions.

The overall findings of the subbasin reports (Volume IV of the 1980 305(b) report) suggest that modifications to the Monitoring Strategy are in order. The fixed station network practically overlooks small streams, which are primarily evaluated with intensive surveys. Only 32 percent of the principal stream miles in Ohio have been evaluated with the fixed station network since 1972. It is clearly beyond the resources of the State to monitor all streams, but modifications to the present Monitoring Strategy and the development of computer software for data analyses could yield more information per sample analysis. A well designed sampling and data analysis program can provide useable information concerning existing ambient water quality and long term trends on a subbasin or regional basis without sampling every stream. Additional sampling in Ohio is needed to address the impact of watershed characteristics (i.e., land-use, soils, population density) on ambient water quality.[1] Such information can and will be obtained utilizing the fixed station network in conjunction with intensive stream surveys and special nonpoint source monitoring. The reader is referred to Volume II of the 1980 305(b) report for details concerning the Monitoring Strategy.

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1 This need is demonstrated by numerous subbasin reports in Volume IV that suggest that elevated heavy metal concentrations (especially iron, also lead and cadmium) and high fecal coliform concentrations are attributable to widespread existing or natural background conditions. More specific data are clearly needed to fully understand these and similar problems.

Intensive Surveys and Special Studies

Ohio EPA conducts intensive surveys and special studies on a regular basis to gather comprehensive chemical/physical and biological data on important stream segments. The results of these investigations are used to determine cause and effect relationships concerning pollution problems and water quality, to evaluate existing instream, chemical/physical and biological conditions, to determine compliance with water quality standards and NPDES permit conditions, to develope water quality standards and stream Use Designations and to provide a partial data base for 305(b) reports. Major intensive surveys and special studies conducted between 1977 and 1979 are the following: the Ottawa River (Allen and Putnam Counties); Brush Creek (Montgomery and Miami Counties); Mill Creek (Union County); Southwest Branch Vermilion River (Huron County); Blanchard River (Hancock and Putnam Counties); Rocky Fork (Richland County); Paramour Creek (Crawford County); Sandusky River (Wyandot and Crawford Counties); Olentangy River (Crawford County); Big Darby Creek (Union, Madison, Franklin and Pickaway Counties); Scioto River (Delaware, Franklin, Pickaway, Ross, Pike and Scioto Counties); and Gilroy Ditch (Clark County). Final reports are forwarded to USEPA; two of these reports (Ottawa River and Brush Creek) are included in this 305(b) report.

A. "Water Quality Study of the Ottawa River" (Intensive Survey)

A water quality study (intensive survey) of the Ottawa River was conducted by the Ohio Environmental Protection Agency between 1974 and 1977. The existing biological and chemical quality of the Ottawa River was evaluated to assess the impact of improvements in wastewater treatment from the city of Lima and industrial discharges located in Lima. The study area included a 45 mile segment of the Ottawa River from above Lima to the mouth, as well as a segment of the Auglaize River upstream and downstream from the mouth of the Ottawa.

Physical, chemical and biological parameters were used to evaluate water quality as either good, fair, or poor. Chemical-physical data were collected from 1974 to 1977, benthic macroinvertebrates were collected during the summers of 1974, 1976 and 1977 and fish were collected during 1976 and 1977.

Chemical-physical parameters evaluated included; temperature, pH, dissolved oxygen, suspended and dissolved solids, total hardness, ammonia-nitrogen, nitrate-nitrogen, total kjeldahl nitrogen, total phosphorus, foaming agents (MBAS), chemical oxygen demand (COD), total chromium, hexavalent chromium and phenolics. Biological evaluations included; quantitative analyses of benthic macroinvertebrate communities established on artificial substrate samplers, qualitative collections of benthic macroinvertebrates from natural stream substrates, qualitative samples of the fish communities and determination of relative species abundances, fecal coliform bacterial counts and biochemical oxygen demand (BOD).

The data show the Ottawa River was biologically healthy and water quality was good upstream from Lima at river mile 46.0. From just above the Lima STP (RM 37.7) to river mile 7.9 the fish and macroinvertebrate communities were degraded due to a variety of causes and water quality was poor. Near the mouth of the Ottawa River (RM 1.0) water quality was fair and the river had recovered to a near healthy biological condition. The water quality of the Auglaize River upstream and downstream of the Ottawa River was good, as indicated by healthy and well-balanced benthic macroinvertebrate communities.

The most severe water quality problems found during the study were: (1), low dissolved oxygen concentrations above the Lima STP due to combined sewer overflows and a series of dams in Lima; (2), chlorine toxicity problems immediately downstream from the Lima STP; and (3), high ammonia and chromium concentrations coupled with low dissolved oxygen concentrations downstream from an oil refinery and a petro-chemical plant in Lima. The most severely polluted stretch of the Ottawa River was from river mile 36.8 to the Allentown Dam (RM 28.8). Fish populations were essentially devoid from this segment of the river; only two pollution tolerant species were collected.

Despite the severe water quality problems documented, a dramatic improvement in the chemical and biological quality of the Ottawa River below Lima has occurred since 1960. In 1960, fish were absent from the entire Ottawa River downstream from Lima, and in a portion of the Auglaize River downstream from its confluence with the Ottawa. Continued improvement was observed between 1974 and 1977 as a result of large scale improvements in the Lima STP and industrial dischargers in Lima. Further improvement will be largely dependent on a reduction of the ammonia load entering the Ottawa River from the Standard Oil refinery and Vistron Corporation.

B. "An Evaluation of the K & S Circuits Effluent and its Impact on Brush Creek" (Special Study)

Brush Creek is a tributary of Ludlow Creek in the Stillwater River Subbasin. It originates in Northwestern Montgomery County and flows northeast into Miami County. The creek is 8.0 miles in length, has a gradient of 15.1 ft./mi. and drains an area of 23.7 square miles (Ohio DNR, 1960). The area is mostly rural with the town of Phillipsburg being the only community in the drainage basin. Domestic waste is treated by individual systems such as septic tanks. The only source of industrial wastewater in the Brush Creek Subbasin is K & S Circuits, a manufacturer of printed circuit boards, located in Phillipsburg. This entity discharges its process wastewater into a storm sewer which flows approximately 0.6 miles to Brush Creek. Other potential sources of pollution in Brush Creek are nonpoint sources such as agricultural runoff and septic tank leachate.

This investigation was undertaken by the Ohio EPA to determine the impact of the K & S Circuits discharge upon Brush Creek. Data were collected on the chemical/physical quality of the K & S Circuits effluent and on the toxicity of this effluent to aquatic life. On May 1, 1979, the owner stated that K & S Circuits was no longer discharging to the storm sewer. Additional studies were conducted to determine the extent of the residual effects upon Brush Creek from the K & S Circuits effluent. These studies included data on the chemical/physical quality, the chemical quality of the bottom sediments and the biological quality of Brush Creek.

The results of these studies show that K & S Circuits violated their NPDES permit limits, and that the K & S Circuits process wastewater was acutely toxic to aquatic life. Furthermore, evidence of the adverse effects of the K & S Circuits discharge upon Brush Creek remained after the discharge had reportedly ceased. Bottom sediments in Brush Creek downstream from the storm sewer were heavily contaminated with copper for at least 5.0 miles. The stream showed obvious signs of biological damage for the same distance. The results indicate that copper is the primary contaminant responsible for the biological damage observed in Brush Creek.

Subbasin Reports

The subbasin reports describe existing water quality throughout Ohio and evaluate the status of Ohio's surface waters with regard to the 1983 clean water goals established by the Clean Water Act of 1977. Additional information in this volume includes, wherever available: (a), projections of water quality conditions after implementation of pollution control programs; (b), an assessment of nonpoint source pollution problems (excluding cost estimates for implementation of nonpoint pollution control); and (c), an evaluation of the effectiveness of existing pollution control programs.

The goal of the Act, commonly expressed as "fishable/swimmable waters", was defined in the Act as "... water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water..."(Section 101(a)(2) of PL 95-217). The Act further stated that this goal be achieved, wherever attainable, by July 1, 1983. Streams and stream segments were classified with respect to the attainment of 1983 clean water goals as follows:

1) streams and stream segments that currently meet 1983 goals,

2) streams and stream segments that are expected to meet 1983 goals after implementation of pollution controls prior to 1983, and

3) streams and stream segments that are not expected to meet 1983 goals.

The evaluations with respect to the attainment of the fishable/swimmable goals in Ohio surface waters are summarized in Table IV-1. Recent data were not available for many streams, thus limiting the stream miles evaluated to 3758, or only 9 percent of the 43,900 stream miles in Ohio. Over 2700 stream miles were found to currently meet the fishable/swimmable goals, or are expected to achieve that goal prior to 1983. The small percentage of the total stream mileage actually evaluated in this report and the non-representative method of selecting streams for evaluation (i.e., a bias towards selecting stream segments in problem areas) precludes any projection of the percentage of total stream miles in Ohio that will meet the 1983 clean water goals. Considerably more is known about the principal streams[2] (32 percent of the 7080 miles of principal streams), reflecting the emphasis these areas receive in the Ohio Water Quality and Pollutant Source Monitoring Strategy (Monitoring Strategy). Of the principal streams evaluated, 1602 miles, or approximately 70 percent, were found to currently meet the fishable/swimmable goals, or are expected to achieve that goal prior to 1983. The substantial percentage of principal stream miles actually evaluated and the fact that the Monitoring Strategy primarily addresses known point source water quality problem areas suggests that 70 percent is a good estimate of the principal stream miles in Ohio that will meet the 1983 fishable/swimmable goal. It is important to point out that the degree of knowledge about the streams evaluated is quite variable and may not be sufficient in some cases to accurately assess water quality for other purposes. For example, the amount and kinds of information needed by Ohio EPA to determine water quality standard use designations in the future will probably be more extensive than the data utilized in some of the subbasin reports.

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2 Principal streams are all subbasin mainstems plus streams draining more than 100 square miles.

Table IV-1. Summary of the evaluations made in the 1980 305(b) subbasin reports.

Fishable/Swimmable Status	All Streams[a] miles (percent)	Principal streams[b] miles (percent)
Currently meets goals	2217 (5.0%)	1287 (18.2%)
Expected to meet goals prior to 1983	519 (1.2%)	315 (4.4%)
Not expected to meet goals prior to 1983	1022 (2.3%)	654 (9.2%)
Total evaluated	3758 (8.5%)	2256 (31.8%)
Total not evaluated	40,161 (91.5%)	4830 (68.2%)
Total stream mileage	43,919 (100.0%)	7086 (100.0%)

a Number of stream miles (excluding intermittent streams) listed in Gazetteer of Ohio Streams (Division of Water, Ohio DNR).

b Principal streams are all subbasin mainstems plus streams draining more than 100 square miles.

Ohio's point source problems fall into either one of two general categories, municipal or industrial. Wastewater discharged from (a) municipal wastewater treatment plants having minimal levels of treatment, (b) inadequate facilities resulting in overloading and bypasses, or (c) areas where combined sewers discharge directly to streams, generally cause water quality standards violations for dissolved oxygen, ammonia and fecal coliforms. Heavy metals violations for total iron, lead, zinc and cadmium may also occur in urban areas. Major water quality problems related to industrial point sources are generally found in highly industrialized-urban areas. A number of municipalities have enacted new laws which require better industrial effluent pretreatment prior to discharge to publicly owned wastewater collection systems. In addition, the enforcement of pretreatment requirements is a prerequisite for improving water quality in certain areas.

The findings of several key subbasin reports with water quality problems are outlined below.

Ottawa River Subbasin. The Ottawa River below Lima is not expected to meet the fishable/swimmable goals prior to 1983, but recent studies revealed substantial improvements in water quality compared to 1960 conditions. Further improvement in the Ottawa River will be dependent on a reduction of the ammonia load entering the Ottawa River from the Standard Oil Refinery and the Vistron Corporation.

Cuyahoga River Subbasin. Analysis of water quality data from the Cuyahoga River revealed substantial improvements in dissolved oxygen concentrations over the past ten years. However, most of the Cuyahoga River and many of the major tributaries are not expected to achieve fishable/swimmable conditions prior to 1983. Water quality improvements are expected during the mid and late 1980's after completion of numerous pollution abatement projects that are under construction or in the design stages.

Great Miami Basin. A 95-mile stretch of the Great Miami River from Tipp City to the Ohio River is not expected to meet the 1983 clean water goals. The worst degradation exists between Dayton and Franklin where numerous municipal and industrial dischargers cause severe temperature and dissolved oxygen problems. Continued water quality problems are foreseen despite numerous wastewater treatment improvements under construction or planned.

Middle Scioto River Subbasin. Pollutant loading from the metropolitan Columbus area exceeds the assimilative capacity of the Scioto River, despite wastewater treatment improvements at several facilities. Warmwater Habitat (WWH) standards violations for dissolved oxygen, ammonia, fecal coliforms, and phenolics were observed. The diversion of upstream flows for public water supplies combined with the sheer volume of wastes generated in the metropolitan Columbus area will likely prevent the attainment of the 1983 clean water goals in the foreseeable future.

Upper and Middle Tuscarawas River Subbasin. The upper Tuscarawas River from the headwaters to below the Sandy Creek confluence is a very complex system. Over 290 point sources discharge to the river or its tributaries. The primary water quality problems in the Tuscarawas River mainstem are dissolved oxygen, ammonia, phenolics and total dissolved solids. Improvements are expected in the Tuscarawas River above Barberton after completion of several pollution control projects. However, the river below Barberton is not expected to meet 1983 goals in the foreseeable future.

Mahoning River Subbasin. Urban and industrial land-use has a substantial impact on the water quality of the Mahoning River below the city of Warren. The sheer volume of wastewater generated combined with generally outdated wastewater treatment at municipal and industrial facilities creates a grossly polluted aquatic environment. Water quality improvements are anticipated following the termination of steel making operations at several plants in the Mahoning Valley, but 1983 clean water goals are not expected to be attainable within the foreseeable future.

The water quality problems discussed above result primarily from point source discharges and also urban nonpoint source runoff (including combined sewer overflows). Water quality degradation arising from mine drainage nonpoint pollution are prevalent in Southeast Ohio. Areas impacted by mine drainage include portions of the Hocking River Basin, the Raccoon Creek Basin, the Moxahala Creek Subbasin, and several minor Ohio River tributaries. The reader is referred to a separate document (Volume V of the 1980 305(b) report) compiled by the Industrial Coal Operations Group of the Ohio EPA for a detailed treatment of the mine drainage problem.

Little detailed information is available concerning the impact of agricultural nonpoint pollution on fishable/swimmable conditions in Ohio streams, although siltation, channelization, and riparian habitat alterations have had documented impacts on the fisheries of Ohio[3]. Intensive agricultural land-use exists in many areas of Ohio and potential water quality impacts were cited in subbasin reports from the Wabash, Maumee, Sandusky, Scioto and Great Miami River Basins. Impairment of the 1983 clean water goals was not attributed to agricultural nonpoint pollution in most instances. However, more comprehensive evaluations (i.e., encompassing in-depth physical/chemical and biological sampling) are needed to determine how intensive agricultural land-use affects fishable/swimmable conditions in many streams of western and central Ohio.

Abandoned Coal Mine Drainage

Drainage from abandonded coal mines has adversely affected approximately 1500 stream miles in 27 counties in Ohio (primarily southeast) and has resulted in Ohio water quality standards violations for sulfates, pH and total iron, manganese, zinc, and dissolved solids.

The Abandoned Coal Mine Drainage section provides a water quality assessment of all streams and reservoirs within watersheds containing coal mines abandoned without adequate reclamation prior to 1972. The assessment is based upon a compilation of all available water quality data (1955 to 1979), and provides a comprehensive analysis of areas and the degree of degradation due to past mining activities.

Of the 1500 total stream miles affected by mine drainage, approximately 980 miles are rivers with at least 100 square miles of drainage area. The distribution of affected stream miles by major river basin are as follows:

Major River Basin	Miles
Southeast Ohio River Tributaries Basin	295
Central Ohio River Tributaries Basin	210
Muskingum River Basin[a]	210
Hocking River Basin	150
Scioto River Basin	81
Mahoning and Little Beaver River Basins[a]	40

a. A detailed report for this Basin is in preparation.

Contributing to mine drainage affects are approximately 370,000 acres of abandoned strip mines, 7,000 acres of coal refuse piles (over one acre in area) and 3,000 underground mines.

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3 Trautman, M.B. 1957. The fishes of Ohio. Ohio Univ. Press, Columbus, Ohio. 683 p.

The Land Reborn study (1974)[4] estimated that approximately 70% of the acid mine drainage in Ohio originates from improperly sealed underground mines. This assessment supports those findings. Concentrations of sulfates, total manganese and iron, and pH exceed Public Water Supply standards in the raw water at 13 of 15 surface public water supplies affected by abandoned mines; proposed, federal, secondary drinking water standards are exceeded in the treated water at 10 of these water supply plants. Thirty fish kills attributed to mining have been reported by the Ohio Department of Natural Resources (DNR), Division of Wildlife between 1966 and 1978. Many have gone unreported.

Ohio DNR estimates the cost to reclaim the abandoned coal mines and refuse piles in Ohio is over 4 billion dollars. The projected funding available to Ohio for reclamation will be about 10 million dollars annually. Without reclamation most coal mine drainage affected streams will fail to meet Ohio's water quality standards.

Biological Evaluation

Benthic macroinvertebrate communities were used as indicators of water quality at sites on major streams and rivers across the State of Ohio during the years 1974 to 1978. Benthic data collected from modified Hester-Dendy, artifical substrate samplers included the types and numbers of taxa retrieved, Shannon diversity indices and, where applicable, Li coefficients of variation for replicate samples. Water quality evaluations were based on the above parameters, and stations were assigned to one of four classes: Class I (Excellent), Class II (Good), Class III (Fair), and Class IV (Poor).

The biological evaluations are not representative of conditions for all streams in Ohio. Many of the sampling locations were located below point source dischargers and were part of an NPDES monitoring program. Overall, 180 evaluations were made at 122 stations on 45 stream and river segments in Ohio. Of the 180 biological evaluations, 2 percent were Class I, 19 percent were Class II, 38 percent were Class III, and 41 percent were Class IV.

Ohio Lakes and Reservoirs

Trophic status determinations and concentrations of chemicals exceeding Ohio's water quality standards are presented in an inventory listing 210 public lakes and reservoirs (Table VII-1). Eighty-three lakes (40%) have been classified according to trophic status. Of these, 78% are eutrophic, 13% mesotrophic and 9% hypereutrophic. Results suggest that lakes and reservoirs in the sandstone bedrock areas of the State have lower trophic levels than those in the limestone and glaciated regions. The water quality in most of the 71 lakes and reservoirs surveyed by the Ohio EPA from 1975 to 1979 is generally good. Seventeen lakes and reservoirs had metal concentrations that exceeded Ohio water quality standards; the most common, copper, was exceeded in 13 lakes.

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4 Board on Unreclaimed Strip Mined Lands. 1974. "Land Reborn". Prepared by Skelly and Loy Consulting Engineers, Columbus, Ohio. 91 pp.

lakes. High bacterial counts were always associated with storm runoff events. Two lakes in urban environments have been adversely affected by activities in their drainage basins. Resource extraction (coal and/or oil and gas) has degraded water quality in five Ohio lakes and reservoirs. Four reservoirs have been affected to the extent that either their use as public water supplies is prevented, or expensive, supplemental treatment is needed.

Ohio Wetlands

The following changes in wetland acreage have occurred in Ohio between 1954 and 1974; shallow fresh marsh -7%, deep fresh marsh -38%, open fresh marsh +39%, shrub swamp +3%, wooded swamps +4% and bogs -3%. Lake Erie coastal wetlands are the most extensive wetlands in Ohio. They have decreased in area by approximately 50% between 1954 and 1974. This decrease was due, in part, to current high water levels and wetland drainage for agricultural, industrial and residential development. Currently, approximately 10,000 acres of wetland in Ohio are protected by Federal and State government and private organizations.

Ground Water

Most ground water in Ohio is uncontaminated, therefore, the major emphasis of the Agency's program has been the prevention of ground water contamination through proper land used practices, adequate well construction and siting, and defining ambient water quality as well as existing and potential problem areas.

Approximately 200 individual requests for information on local ground-water quality were handled by the Division of Ground Water during the reporting period. Nearly 75 percent of the documented contamination cases were related to on-lot sources. The most prevalent water quality problems were turbidity and bacterial contamination, on-lot sewage disposal effects or spillage and/or leakage of petroleum products. The vast majority of these problems were directly attributed to improper well siting or deficiencies in well construction and maintenance. A few problems were related to on-lot application of pesticides.

Contamination of individual wells from oil and gas drilling activity was the second most prevalent problem and comprised 48 individual requests during the two-year reporting period. Well contamination from brine, crude oil, or natural gas were equally common and were largely concentrated in southeastern areas of the State. Faulty annular injection systems for brine, inadequate casing or cementing, and leakage from brine storage pits were the most common sources of local contamination.

A total of only six contamination complaints were related to road salt application or open salt storage and were all in the northeastern area of the State. Less than 5% of the documented contamination problems were attributed to land disposal facilities.

Water Quality at Lake Erie Bathing Beaches

The majority of Lake Erie beaches had good to excellent bathing water quality in 1978-1979. The only reported beach closing was at Port Clinton for a portion of the 1979 recreational season. Five of seven beaches sampled

between Vermilion and Cleveland-Edgewater had poor bathing water quality, reflecting the impact of nearby urban development. There was a significant increase in the frequency of moderate fecal contamination (sample values exceeding 1000/100ml) in 1979 compared to 1978, probably as a result of weather conditions.

Water Depletion

Water quality problems arising from the depletion of a water resource are not a widespread concern in Ohio. However, segments of at least three rivers, the Cuyahoga River in the Akron-Kent area, the East Branch of the Rocky River at Berea and the Scioto River at Columbus, experience aggravated water quality problems because of water withdrawals for public water supplies. This diversion of substantial volumes of water during the dry summer months can leave inadequate dilution water for the assimilation of municipal and/or industrial wastewater effluents.

Toxics

The approximate number of water pollution incidents that were investigated by the Ohio EPA Emergency Response during 7/77 to 7/78 and 7/78 to 7/79 were 1314 and 1896, respectively. The numbers of incidents by category, i.e., hydrocarbons, chemical, sewage and other, are found in Tables VIII-7A and VIII-7B. The highest numbers of toxic incidents for each reporting year occurred in the hydrocarbon category (gasoline, oil, fuel oil, etc.) followed by toxic chemical incidents.

The Adjutant General Disaster Service Agency (DSA) has primary responsibility for responding to radiation incidents in Ohio. Ohio EPA Emergency Response generally responds to 3 to 5 radiation incidents per year. New programs are being developed by Emergency Respnse and DSA to coordinate radiation response activities throughout the State.

An estimate of the river miles affected by toxic spills is given for each month beginning with August 1978. An estimated 1215 river miles were affected by toxic spills from August 1978 to July 1979.

Sewage Byasses and Public Drinking Water

There were no known incidents where public drinking water was affected by sewage bypasses during the reporting period. The Ohio EPA Emergency Response notifies public drinking water personnel downstream of a reported sewage bypass. There were 69 and 50 reported sewage bypass incidents during 7/77 to 7/78 and 7/78 to 7/79, respectively (Table VIII-8). In most cases (71% and 82%), the amount of sewage bypassed was unknown; the duration of the bypass was unknown for 17% and 18% of the bypass incidents.

Table VIII-8: Sewage bypasses and public drinking water personnel notifications[a]

Year	Reported Incidents (Number of Dischargers)	Unknown Amount ( )[b]	Unknown Time ( )[c]
7/77 to 7/78	69 (40)	49 (71)	12 (17)
7/78 to 7/79	50 (40)	41 (82)	9 (18)

a Bypasses occurring in Lake Erie and the Ohio River are not included.

b Percent of incidents when the total amount of sewage bypassed was unknown.

c Percent of incidents when the duration of the sewage bypass, independent of unknown amount incidents, was unknown.

Point Source Basin Loading Estimates

The Ohio EPA NPDES self-monitoring program data are processed by LEAPS, a comprehensive data storage and processing system designed and used by the Ohio EPA. The two categories of NPDES Permit data contained in LEAPS are described. The Ohio EPA has not developed a computer software program for manipulating LEAPS data. Basin loading data could not be easily retrieved and aggregated (i.e., summed for more than one station or more than one calendar year), therefore, point source basin loadings are not reported. Sources of basin loading data, reported by entity, are listed in two tables; Table VIII-8 for continuing planning agency documents for designated areas and Table VIII-10 for the Ohio EPA Water Quality Management Planning documents for non-designated areas. The kind of basin loading data found in each designated and non-designated agency document are described.

Nonpoint Source Assessment

The Ohio EPA uses PEMSO, a computer data system which integrates land based, hydrologic and water quality information to process environmental data. A brief description of PEMSO and the Ohio EPA's strategy for nonpoint source pollution assessment is presented. A nonpoint source screening model, used in conjunction with PEMSO, has been utilized to rank the sediment producing potential of the 133 hydrologic subbasins in the State. Specific information concerning the PEMSO system and nonpoint pollution assessment details are contained in two documents cited in this section.

Economics

Available facts concerning the economic impact of the Clean Water Act on the State of Ohio are presented. According to the 1978 NEEDS Survey, a minimum of 6.8 billion dollars will be required for Ohio's publicly owned wastewater treatment plants to comply with the 1983 goals. Additionally, it is estimated that Ohio industries may be required to expend several billion dollars in order to meet the 1983 goals. The benefits to be derived from the achievement or non-achievement of the goals of the Clean Water Act cannot be easily quantified in all cases. The Ohio EPA has developed a methodolgy for benefits estimation and is currently refining it for use.

Attainment of the 1985 goal of zero discharge is an unreasonable expectation and any estimate as to its achievement date would therefore be academic. An attainment date for the 1983 goals of "fishable-swimmable" waters is difficult to estimate. It is somewhat uncertain what limitations will be enforced as compliance with the 1983 goals due to 1, incomplete BAT guidelines for industry; 2, the institution of AWT reviews for municipalities; and 3, questions concerning the continued availability of construction grant monies for municipalities.

Nonpoint Source Costs

Nonpoint source control needs have not been addressed to any great extent throughout the State. The funding levels currently available to control nonpoint source pollution in Ohio are reviewed. The analysis outlines four state and federal programs that will provide a total of 18.8 million dollars to deal primarily with agricultural nonpoint source pollution in the State of Ohio.

Progress and Difficulties in the Administration of Programs

Progress

With the exception of 14 cities on the Ohio and Mahoning Rivers and one on Lake Erie, secondary treatment facilities have been provided for all communities of over 5000 population in Ohio.

With minor exceptions, Ohio industries which discharge directly to surface waters, meet or exceed the requirements for Best Practical Treatment.

Substantial reduction of phosphorus inputs from Ohio point sources into Lake Erie have been accomplished.

Pollution from new strip mines has been controlled since 1973 by enforcement of the mining and reclamation law of the State.

A greatly expanded stream surveillance effort, which has been in effect since the passage of P.L. 92-500, has provided information needed to determine problem areas and analyze causes and alternatives for correction.

Initial water quality management planning has been completed for the entire state and implementation of some aspects of the planning recommendation is underway.

As documented in this report, there has been significant improvement in water quality due to point source pollution controls at many locations in Ohio.

Difficulties

The most serious difficulty has been the lack of coordination of the interelated program elements of the Clean Water Act (i.e., water quality standards, and wasteload allocations, effluent guidelines, toxic substances, permit issuance and the justification requirements with regard to Advanced Secondary Treatment/Advanced Wastewater Treatment (AST/AWT) projects). This absence of coordination, as well as the lack of a long term strategy, results in crisis management and less than effective use of already inadequate resources. An overall strategy, which takes these issues into account, will result in the maximum use of limited agency resources.

Industrial Program

Further progress in providing industrial wastewater pollution control facilities is dependent upon the establishment by USEPA of Best Available Technology Economically Achieveable (BATEA) Guidelines for toxic pollutants. Until this is done, issuance of National Pollutant Discharge Elimination System (NPDES) permits outlining further pollution abatement requirements for industry is being held in abeyance.

Municipal Program

Because of the 75% federal funding for municipal pollution control projects, progress on the construction of needed facilities is totally dependent upon the funding and administration of the 201 construction grants program. The proliferation of laws, regulations and requirements which apply to the grants program have resulted in a great deal of confusion and delay. Implementation of PRM 79-7, which requires development of elaborate justification for treatment better than secondary, has resulted in further confusion and delay and has caused a loss of credibility for the program.

Proposed funding cuts at the federal level will adversely affect the municipal program in Ohio, since much of the administrative work required is the responsibility of Region V. Joint administration of the program at both the State and federal level is inefficient and efforts thus far to have the program delegated to Ohio have been unsuccessful.

Non-Point and Combined Sewer Problems

As indicated in Ohio's Water Quality Standards, there are numerous stream segments in Ohio which are limited due to combined sewer overflows and many which are limited due to acid drainage from abandoned mines. The cost and feasibility of correcting these problems will preclude the possibility of substantial, overall improvement for these conditions in the near future.

Water quality management planning efforts to date have helped to emphasize the problems associated with the flushing of sediment, nutrients, pesticides, oil and various toxic materials from both urban and rural areas classed as nonpoint sources. It is doubtful that sufficient funding and/or control programs will be provided in the immediate future to produce a measurable improvement. Bans on the use of certain products have proven to be effective, but there is a practical limit in terms of acceptable tradeoffs between productivity and environmental concerns.

Water Quality Standards and Related Issues

Ohio EPA proposed revisions to the water quality standards (Ohio Administrative Code 3745-1) for the State of Ohio and held public hearings in 1977. Following the public comment period, revised water quality standards were adopted on February 14, 1978. The standards were disapproved by USEPA, Region V on May 17, 1978, but were later (August 9, 1978) approved except for certain provisions. These exceptions generally fall into three categories; 1) downgraded stream segments, 2) instream concentrations for certain parameters - notably dissolved oxygen and cyanide, and 3) certain provisions of the state's anti-degradation policy (i.e., the low flow stream criterion, conditions for exceptions, and mixing zone standards). Between August 1978 and June 1979, Ohio EPA and USEPA, Region V were involved in a series of negotiations with a view toward resolving the outstanding differences between the agencies regarding the disapproved parts of the standards. An early product of these negotiations was the idea of formulating a Memorandum of Understanding (MOU) which would codify the approach agreed upon to resolve differences between the two agencies. No fewer than eleven draft versions of the MOU were exchanged. The provisions of these drafts have varied substantially, and have yet to achieve any general acceptance by the two agencies. A joint hearing on the Ohio water quality standards was proposed by USEPA, Region V in early 1979. This effort failed and on July 6, 1979, USEPA published proposed water quality standards for Ohio surface waters (44FR 39486). Ohio EPA put forth a substantial effort to comment on the USEPA proposal that included an extensive technical justification of Ohio's dissolved oxygen, cyanide, and mixing zone standards, and limited use segment designations. On September 7, 1979, Ohio EPA filed suit against the original USEPA disapproval (August 9, 1978) of Ohio's water quality standards. At this time, there has been no action by USEPA to publish a final rule for Ohio surface waters, nor has there been a final decision on the September 7, 1979 lawsuit. One of the most critical issues at stake in the Ohio EPA-USEPA dispute over water quality standards is the general USEPA policy with regard to Quality Criteria for Water (USEPA 1978) which is commonly referred to as the "Red Book". Current USEPA policy is that all Red Book criteria have presumptive applicability nationwide, unless a state can show evidence that a less stringent criteria is justified. Ohio EPA firmly believes that it has presented adequate justification for water quality standards that deviate from Red Book criteria.

Synopsis

Monitoring Programs (Volume II)

The 61 page monitoring program section lists objectives, priorities, and present and projected Ohio EPA monitoring activities for the following: (1) compliance monitoring, (2) intensive surveys, (3) fixed station monitoring (National Ambient Water Quality Monitoring Network - NAWQMN; State Water Quality Monitoring Program - Ohio EPA), (4) lakes and reservoirs program, (5) radiological monitoring, (6) biological monitoring, (7) Ohio River Sanitation Commission (ORSANCO) monitoring, (8) U.S. Geological Survey (USGS) cooperative programs and (9) Lake Erie and International Joint Commission (IJC) programs. Ambient Station type (monthly, quarterly and low-flow), parameters sampled, sampling frequency, station description, river mile location, STORET station number (and equivalent USGS station number, where applicable), Ohio EPA district, station purpose, State Beneficial Use Designation at the station site and chemical/physical parameters sampled in addition to regularly monitored parameters are found in Table II-1. Tables listing similar information for the following programs are also included: Tables II-2, II-3, II-4 and II-5 for lakes and reservoirs, Table II-6 for radiological monitoring, Table II-7 for biomonitoring, Tables II-8 and II-9 for ORSANCO, Table II-10 for NASQAN stations, Tables II-11 and II-12 for IJC stations and Tables II-13 and II-14 for ground water stations.

Intensive Surveys and Special Studies (Volume III):
A. "Water Quality Survey of the Ottawa River";
B. "An Evaluation of the K & S Circuits Effluent and its Impact on Brush Creek".

A. The Ottawa River

Physical/chemical data (1974 to 1977) and biological data (benthic macroinvertebrate 1974, 1976 and 1977; fish 1976 and 1977) were used to evaluate water quality in a 45 mile segment of the Ottawa River from above Lima to the mouth, and in a segment of the Auglaize River upstream and downstream from the mouth of the Ottawa River.

The 58 page report describes the results of fish and macroinvertebrate sampling in detail. Certain physical/chemical parameters, such as ammonia and dissolved oxygen, were also evaluated in detail. Effluent data from 1974 to 1977 for three major dischargers to the Ottawa River are contained in the report.

B. Brush Creek

Physical/chemical and biological data were used to evaluate the water quality in Brush Creek, a small tributary (drainage area 24 square miles, length 8 miles) of Ludlow Creek in the Stillwater River Subbasin. The report contains results from fish, macroinvertebrate, and physical/chemical sampling, chemical bioassay tests, and sediment analysis.

Another intensive survey titled "Water Quality Study of Mill Creek" is in Press. The following intensive surveys were also completed in 1979; Big Darby Creek, Paramour Creek, the Upper Sandusky River, the Scioto River and the headwaters of the Olentangy River. These reports are in preparation and should be available in September 1980.

Subbasin Reports (Volume IV)

The 179 page subbasin evaluation section is a "comprehensive" (1973 to 1979), narrative report of the physical/chemical surface water quality of Ohio's rivers, streams and/or stream segments with regard to the 1983 clean water goals established by the Clean Water Act of 1972. Evaluations of the attainment of the 1983 goals were made primarily with Ohio EPA data regarding compliance with physical/chemical water quality standards. For the purpose of this report, meeting Ohio's Warmwater Habitat (WWH) Use Designation water quality standards (OAC 3745-1) are equated with meeting the 1983 goals. Data were compared to WWH standards and violations were noted (Reference Document 2). Streams and stream segments were classified with respect to the attainment of the 1983 clean water goals as follows:

1. Streams and stream segments that currently meet 1983 goals.

2. Streams and stream segments that are expected to meet 1983 goals after implementation of pollution controls prior to 1983.

3. Streams and stream segments that are not expected to meet 1983 goals by 1983.

Each subbasin report contains a summary which assesses overall water quality and water quality problems. Delineated streams or stream segments in categories 2 and 3 above include the identification of the following information, where available; problem type, location, source (by point and nonpoint source category), severity, extent, corrective measures being taken and conditions after the implementation of pollution controls. An evaluation of water quality trends were presented, when possible, along with recommendations.

Annual Summary Statistics Tables - Reference Document 1 (RD 1)

The 336 page Annual Summary Statistics Table Document (Reference Document 1-RD 1) contains yearly summary statistics for chemical/physical parameters monitored in Ohio's ambient monitoring network, i.e., at monthly, quarterly and low-flow stations. Station information includes: STORET station number, latitude and longitude, a narrative description of the station's location, major drainage basin, State river basin and station river mile index (RMI) or river mile location.

Statistical data for each parameter includes: parameter units, number of samples for the reporting period, mean, standard deviation, minimum and maximum values and the year and month for the beginning and end of the reporting period.

Violation Tables - Reference Document 2 (RD 2)

The 401 page Violations Tables Document (Reference Document 2-RD 2) contains all water quality standards violations recorded at National and State Ambient Monitoring Stations, at stations regularly monitored but not a part of the ambient monitoring network and at non-station locations for each year of the reporting period, i.e., 7/1/77 to 6/30/78 and 7/1/78 to 6/30/79.

Each violation table contains the following location information; year, major basin, subbasin, station name, STORET station code, State Beneficial Use Designation, station description and river mile location (measured from the mouth). The parameters in violation of Ohio's water quality standards, are listed in alphabetical order by abbreviation (See Key RD 2-1). The kinds of violations include: 1) all persistent toxicant violations, 2) all heavy metal violations, 3) any of the 65 priority pollutants not included in (1) and (2), 4) any violations which impact subbasin mainstems and 5) all violations on subbasin mainstems. The following violation data are recorded in each table; the total number of violations and the total number of samples for each parameter violated, the date, the time oxygen samples were taken, the sample concentration, the OEPA water quality standard limit and the % flow duration (where available).

Abandoned Coal Mine Drainage (Volume V)

The 235 page Abandoned Coal Mine Drainage section provides a water quality assessment of all streams and reservoirs within watersheds containing abandoned coal mines. The abandoned mines referred to in this section are mines left without adequate reclamation prior to 1972. It represents a compilation of all available water quality data (1955 to 1979), and provides a comprehensive analysis of areas and the degree of degradation due to past mining activities for major streams.

Two types of tables were used to show segment delineations, descriptions and chemical/physical characterizations (degree of degradation). Both types of tables record the following; stream name, river mile, segment length, Use Designation and pollution source. Data reported in the tables for major streams include; the number of Warmwater Habitat (WWH) Use Designation standards violations for mine drainage parameters, the number of parameter samples, the sample months, the number of years sampled during the period of record, the period of record, mean, maximum, minimum, the degree of the problem (from 0 to 3 = severe) and a remarks column. Data reported in the second type of table (tables for tributaries) include; the numbers of WWH standards violations for mine drainage parameters, sample size and mean for chemical/physical mine drainage parameters (i.e., pH, alkalinity, acidity, sulfates, total dissolved solids, conductivity, total iron, manganese, zinc and aluminum) and the period of record.

Biological Evaluation (Volume VI)

The 58 page Biological Evaluation section includes water quality determinations based on analyses of benthic, macroinvertebrate community data from 1974 to 1978 at sites on streams and rivers across the State of Ohio. Site selection was limited to stations located near entities found on the Ohio Major Dischargers List, stations that were included in the National Stream Quality Accounting Network (NASQAN), or the National Ambient Water Quality Monitoring Network (NAWQMN).

A detailed description of the methods used in the collection, processing and analysis of the benthic samples is given. The procedure used to assign sampling sites to their respective water quality evaluations, including the types and numbers of taxa present, diversity indices and, where applicable, coefficients of variation for replicate samples, is explained.

A basin-by-basin report of the location of each sampling site, the date(s) it was sampled, the water quality classification decided upon, why that classification was assigned and, where applicable, an assessment of the impact of a specific major discharger is presented.

Benthic Sampling Tables - Reference Document 3 (RD3)

Reference Document 3 (RD3) contains 200 pages of tabulated data of benthic sampling conducted in the State of Ohio from 1974 to 1978. The information consists of numbers and types of organisms, numbers of organisms per square foot and Shannon diversity indices. In those cases where replicate analyses were conducted, coefficients of variation are indicated. The data were generated from National Ambient Monitoring Network Stations and from water quality investigations of major dischargers. The data were collected by the use of Hester-Dendy multiple- plate artificial substrate samplers, as well as qualitative samples collected from the natural substrate.

Ohio Lakes and Reservoirs (Volume VII)

The 51 page Lakes and Reservoirs section includes a general description of the Ohio EPA's lake sampling program, chemical/physical and biological summaries for 45 lakes sampled by Ohio EPA/U.S. Geological Survey (1975 to 1977), an evaluation of lake water quality problems and a trophic level (nutrient) evaluation for 83 lakes and reservoirs. Table VII-1 lists 210 public lakes with a surface area greater than 15 acres and the following information; location (County, Longitude, Latitude and map codes), morphometric data, trophic level determination and chemical parameters which exceed Ohio's water quality standards.

Ohio Wetlands (Volume VIII)

A general definition of wetlands, a description of the general wetland types found in Ohio and a general description of wetland functions are presented in this 5 page section. A wetland inventory, reported by wetland type, acreage and percent, and a comparison of the percentage of wetland types in a 1954 and a 1974 inventory is presented in Tables VIII-2 and VIII-3. The reasons for wetland losses in Ohio are listed along with wetland protective programs currently in effect.

Ground Water (Volume VIII)

A brief, general description of ground water activities in Ohio during the reporting period including; geologic site evaluations, water quality requests and complaints and special projects, i.e., 208 Planning, Surface Impoundment Assessment and Underground Injection Control, are provided in this 3 page section. Future program needs are also listed. The reader is referred to Volume II for a general description of the ground water monitoring program.

Water Quality at Lake Erie Bathing Beaches (Volume VIII)

The Ohio Department of Health bacteriological data for Lake Erie beaches was evaluated in this 6-page section. One pollution related beach closing and a bacteriological water quality evaluation of the remaining 24 Lake Erie beaches was reported. A map showing beach locations (Figure VIII-1) and the following three Tables are included: Table VIII-5, a comparison of bathing water

quality at selected Lake Erie beaches in 1950-1951 and 1978-1979; Table VIII-6, the number of State bathing water standard violations at Lake Erie beaches, 1978 and 1979, based upon fecal coliform geometric means exceeding 200/100 ml; Table VIII-7, the number of fecal coliform concentrations exceeding 400/100 ml (bathing water standard violation), and 200/100 ml (primary contact recreation standard violation) at Lake Erie beaches, 1978 and 1979.

Toxics (Volume VIII)

The 3 page toxics section contains a description of the kind of toxics spill information kept in a computer data file by Ohio EPA Emergency Response in addition to the text found in the Executive Summary.

Point Source Basin Loading Estimates (Volume VIII)

A description of LEAPS, an Ohio EPA NPDES Self Monitoring Program data storage and processing system, is presented in this 13-page section. Two Tables (Table VII-8 and Table VII-10) list sources of basin loading data by entity for the State, i.e., for both designated and non-designated areas. A brief description of the kind of basin loading data found in each designated area document (Table VIII-9) and in each non-designated document (Pages VIII-11-13) are also given.

Nonpoint Assessment (Volume VIII)

A brief description of PEMSO, a computer data system which processes land based, hydrologic and water quality information for the Ohio EPA, and a brief summary of the Agency's strategy for nonpoint source pollution assessment are presented in this 2-page section.

Economics (Volume VIII)

The Economics Section includes a 7-page discussion of the economic impacts of achieving or not achieving the goals of the Clean Water Act. A quantitative assessment of these costs is presented for municipal and industrial compliance where available. The remaining sections deal with benefit estimation techniques and a discussion of a time frame for compliance with the goals of the Clean Water Act.

Nonpoint Source Costs (Volume VIII)

The 3 page nonpoint source cost section outlines those programs currently in use in Ohio to control primarily agricultural nonpoint source pollution. A listing of current funding levels is presented to summarize the dollar amounts expended for nonpoint source control measures within the State.

Progress and Difficulties in the Administration of Programs (Volume VIII)

The 3 page Progress and Difficulties in the Administration of Programs section is included in its entirety in the Executive Summary.

Reference Maps for Subbasins

River segments, lakes, reservoirs and monitoring station locations were coded using a system that corresponds to the Underground Water Resource maps (available from the Ohio Department of Natural Resources, Division of Water, Foutnatin Square, Columbus, Ohio, 43224). Each subbasin has a letter and number designation (Table I- Page I-22 and 23). A second number, when present, designates a specific river segment within the subbasin (Example - A-1-2 is river segment 2 in subbasin A-1). Figure I-1 (Page I-24) shows the location for each major basin and subbasin.

Table I -1: Subbasin Names and Codes

Maumee River Basin

A-1	St. Mary's River Basin
A-2	Little Auglaize River Basin
A-3	Upper Augliaze River Basin
A-4	Ottawa River Basin
A-5	Blanchard River Basin (lower portion)
A-6	Blanchard River Basin (upper portion)
A-7	Upper Maumee Basin
	Lower Auglaize River Basin
A-8	Tiffin River Basin
A-9	St. Joseph River Basin
A-10	Maumee River Basin (middle portion)
A-11	Maumee River Basin (part lower portion)
A-12	Maumee River Basin (lower portion)
	Tenmile Creek Basin

Portage River Basin and adjacent streams

B-1	Upper Portage River Basin
B-2	Lower Portage River
	Muddy Creek Basin
B-3	Toussaint Creek Basin
	Adjacent Lake Erie tributaries

Sandusky River Basin

C-1	Tymochtee Creek Basin
C-2	Sandusky River Basin (upper portion)
C-3	Sandusky River Basin (middle portion)
C-4	Sandusky River Basin (lower portion)

Huron, Vermilion, Black and Rocky River Basins and adjacent streams

D-1	Pickerel Creek-Pipe Creek area
	Adjacent Lake Erie tributaries
D-2	Huron River Basin
D-3	Vermilion River Basin
	Adjacent Lake Erie tributaries
D-4	Black River Basin
D-5	Rocky River Basin

Cuyahoga and Chagrin River Basins

E-1	Upper Cuyahoga River Basin
E-2	Lower Cuyahoga River Basin
	Adjacent Lake Erie tributaries
E-3	Chagrin River Basin

Grand River Basin and adjacent areas

F-1	Grand River Basin (upper portion)
F-2	Grand River Basin (lower portion)
F-3	Ashtabula River Basin
	Conneaut Creek Basin
	Adjacent Lake Erie tributaries
G	Wabash River Basin

Miami River Basin

H-1	Upper Miami River Basin
H-2	A portion of the Miami River Basin (Loramie and Mosquito Creek area)
H-3	Upper Mad River Basin
H-4,5	Miami River Basin (part of middle portion)
	Lower Mad River Basin
H-6,7	Stillwater River Basin
H-8,11a	Twin Creek Basin
	Ohio portion of East Fork of Whitewater River Basin
H-9	Miami River Basin (lower part of middle portion)
H-10	Fourmile Creek Basin
H-11	Miami River Basin (lower portion)
J	Mill Creek Basin
	Adjacent Ohio River tributaries

Little Miami River Basin

K-1	Upper Little Miami River Basin
K-2	Caesar Creek Basin
K-3	Todd Fork Basin
K-4	East Fork of Little Miami River Basin
K-5	A portion of the lower Little Miami River Basin
K-6	Indian Creek Basin area

Eagle, Ohio Brush, Straight and Whiteoak Creek Basins

L-1	Whiteoak Creek Basin
L-2	Ohio Brush Creek Basin
L-3	Eagle Creek Basin
	Straight Creek Basin

Scioto River Basin

M-1	Scioto River Basin (part upper portion)
M-2	Scioto River Basin (part upper portion)
M-3	Olentangy River Basin
M-4	Big Walnut Creek Basin

Table I-1: ntinued

M-5	Mill Creek Basin
	A portion of the middle Scioto River Basin
M-6	Upper Darby Creek Basin
M-7	Deer Creek Basin
M-8	Scioto River Basin (middle portion)
M-9	Walnut Creek Basin
M-10	Salt Creek Basin
M-11	Scioto River Basin (part lower portion)
M-12	Lower Paint Creek Basin
M-13,14	Upper Paint Creek Basin
M-15	Scioto River Basin (lower portion)
M-16	Little Salt Creek Basin
M-17	Scioto Brush Creek Basin
	Adjacent Ohio River tributaries

Raccoon Creek, Symmes Creek, Little Scioto River and Pine Creek Basins

N-1	Upper Raccoon Creek Basin
N-2	Lower Raccoon Creek Basin
N-3,5	Symmes Creek Basin, Ice Creek Basin,
	Indian Guyan Creek Basin
	Adjacent Ohio River tributaries
N-4	Little Scioto River Basin
	Pine Creek Basin
	Adjacent Ohio River tributaries

Hocking River, Shade River, and Leading Creek Basins

O-1	Hocking River Basin (upper portion)
O-2	Hocking River Basin (middle portion)
O-3	Hocking River Basin (lower portion)
O-4	Shade River Basin
	Leading Creek Basin

Muskingum River Basin

P-1	Black Basin
	Clear Fork Basin
P-2	Lower Mohican River Basin
P-3	Upper Killbuck Creek Basin
P-4	A part of the Walhonding River Basin
P-5	Middle Tuscarawas River Basin
	Sugar Creek Basin
P-6	Tuscarawas River Basin (upper portion)
P-7	Sandy Creek Basin
P-8	Conotton Creek Basin
P-9	Stillwater Creek Basin
P-10	A part of the lower portion Tuscarawas River Basin
P-11	Part of upper portion of the Muskingum River Basin
P-12	Kokosing River Basin
P-13	A portion of Licking River Basin
P-14	South Fork of Licking River Basin
P-15	Moxahala Creek Basin
P-16	A portion of the middle of Muskingum River Basin
P-17	Lower Wills Creek Basin
P-18	Upper Wills Creek Basin
P-19	Lower portion of the Muskingum River Basin
	Adjacent Ohio River tributaries
R-1,2	Little Muskingum River Basin
	Duck Creek Basin

Little Beaver, Yellow, Cross, Short, Wheeling, McMahon, Captina and Sunfish Creek Basins

S-1	Little Beaver Creek Basin
S-2	Yellow Creek Basin
	Cross Creek Basin
	McIntyre Creek Basin
S-3	Short Creek Basin
	Wheeling Creek Basin
S-4	McMahon Creek Basin
	Captina Creek Basin
	Sunfish Creek Basin

Mahoning River, Pymatuning and Yankee Creek Basins

T-1	Mahoning River Basin (upper portion)
T-2	Mahoning River Basin (middle portion)
T-3	Mahoning River Basin (lower portion)
T-4	Pymatuning Creek Basin
	Yankee Creek Basin

Figure I-1: Index map for underground water maps of Ohio ("Publications, Division of Water". 1975 Ohio Department of Natural Resrouces, p. 6)

OhioEPA Weekly Review

OHIO ENVIRONMENTAL PROTECTION AGENCY
WEEKLY REVIEW

The following categories of information are contained within the Weekly Review covering the week previous to publication:

ir permits to operate, permits
waste disposal licenses, sewer
certifications, orders, plans
l waivers.

, air permits to operate, permits
waste disposal licenses, sewer
certifications, orders, plans
l waivers.

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n category.

Only those counties and action types for which information was received are listed. For example, if no data regarding Brown County were received, no reference to Brown County is made in the listing. Likewise, if no complaints were made for Jefferson County, no mention of complaints within Jefferson County is made.

The entity names that are found in the listing reflect the name of either the entity to whom a permit, license, or variance is to be issued/denied or the entity against whom a complaint has been filed or the entity which is a party or the subject of an adjudication hearing or public meeting. The actual or proposed location of the facility owned by the entity follows the name.

FIRST CLASS

Final actions to issue, deny, modify, revoke, or renew a permit, license, or variance; or to approve or disapprove plans and specifications, may be appealed directly to the Environmental Board of Review, by any officer of an agency of the state or of a political subdivision, acting in a representative capacity, or by any person who would be aggrieved or adversely affected thereby, unless the final action was preceded by a proposed action that was the same or substantially the same as the final action. If a final action is of this type, the notice thereof will so state. The appeal must be filed within 30 days of the effective date of the action (not 30 days from publication of this booklet). The effective date of each final action is indicated in each notice. Such appeals may be filed with the Environmental Board of Review, 395 E. Broad St., Suite 305, Columbus, Ohio 43215.

However, if the Director issues a proposed action rather than a final action, any such person may file a request for an adjudication hearing. Requests for adjudication hearings on a proposed action must be filed within 30 days of issuance of said proposed action (not 30 days from publication of this booklet). The date of issuance of each proposed action is indicated in each notice. Unless otherwise stated, adjudication hearings, which are open to the public, will be held at the Ohio Environmental Protection Agency, 361 East Broad St., Columbus, Ohio. Any hearing may be cancelled or postponed.

Also, any person may request a public meeting with regard to proposed actions to issue or renew permits within thirty (30) days of publication in a newspaper in the affected county. Upon determination by the Director of OEPA that there is significant public interest and if a public meeting has not already been held, a public meeting with regard to the subject matter will be held in the county where the source or facility affected is located. Procedures for public meetings are set forth in Rule OAC 3745-47-12.

Finally, within thirty (30) days of the date of publication in a newspaper in the affected county, any person may submit written comments to the Director relating to verified complaints, Enforcement Compliance Schedule Letters, proposed actions, and actions. Any person may request, in writing, notice of further actions or proceedings with respect to a particular entity.

The statutes and regulations do not allow requests for hearings on orders, Enforcement Compliance Schedule Letters, and final actions preceded by the same or substantially the same proposed actions. All requests for adjudication hearings or for public meetings; other communications concerning public hearings, public meetings, and adjudication hearings; complaints of any kind; and regulations should be addressed to the Legal Records Section, Ohio EPA, P.O. Box 1049, Columbus, Ohio 43216, (614) 466-6037.

Unless otherwise stated in particular notices, all other communications, including comments on proposed actions, should be addressed either to the New Source, Air, or Permit and Approval Section, whichever is appropriate, at the Ohio EPA, P.O. Box 1049, Columbus, Ohio 43216.

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State of Ohio Environmental Protection Agency
Box 1049, 361 E. Broad St., Columbus, Ohio 43216

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Ohio EPA Weekly Review

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MONITORING PROGRAMS

1980 305(b) Report
Volume II

Editors

J.F. Estenik
J.H. Albrecht

Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards
Columbus, Ohio 43216
April 1980

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Summary

This section describes Ohio's monitoring strategy and program, as required by 40 CFR 35.562(a)(3) and 40 CFR 35.599 (b)(1), pursuant to Section 106 (e)(1) of the Clean Water Act. This Act requires the State to establish and maintain a broad range of monitoring activities, both before and after implementation of pollution controls.

Volume II lists objectives, priorities and present and projected Ohio EPA monitoring activities for the following: (1) compliance monitoring, (2) intensive surveys, (3) fixed station monitoring (National Ambient Water Quality Monitoring Network - NAWQMN; State Water Quality Monitoring Program - Ohio EPA), (4) lakes and reservoirs program, (5) radiological monitoring, (6) biological monitoring, (7) Ohio River Sanitation Commission (ORSANCO) monitoring, (8) United States Geological Survey (USGS) cooperative programs and (9), Lake Erie and International Joint Commission (IJC) programs. Ambient station type (monthly, quarterly and low-flow), parameters sampled, sampling frequency, station description, river mile location, STORET station number (and equivalent USGS station number, where applicable), Ohio EPA district, station purpose, State Beneficial Use Designation at the station site and chemical/physical parameters sampled in addition to regularly monitored parameters are found in Table II-1. Tables listing similar information for the following programs are also included: Tables II-2, II-3, II-4 and II-5 for lakes and reservoirs, Table II-6 for radiological monitoring, Table II-7 for biomonitoring, Tables II-8 and II-9 for ORSANCO, Table II-10 for NASQAN stations, Tables II-11 and II-12 for IJC stations, and Tables II-13 and II-14 for ground water stations.

Introduction

Ohio has 163 fixed monitoring stations in its ambient monitoring network. Most of these stations are located in problem areas and on certain principal streams (i.e., subbasin mainstems plus streams with at least 100 square miles of drainage area). These stations were chosen after a review of intensive river basin studies between 1949 and 1965 and involved over 1000 sampling stations. Additional monitoring programs include (1), 30 biological monitoring sites, 20 of which are used for major discharge impact assessments; and (2), approximately 6 intensive surveys per year that comprehensively evaluate water quality (i.e., they include extensive chemical/physical and biological sampling in selected rivers and streams); and (3), selected public lakes and reservoirs. Effluent monitoring consists of 25 and 30 municipal and 51 and 53 industrial compliance monitoring sites during 1978 and 1979, respectively. These data are used to determine compliance with National Pollution Discharge Elimination System (NPDES) permits, to validate self-monitoring reports, and to provide support for enforcement actions.

The overall findings of the subbasin reports (Volume IV of the 305(b) report) suggest that modifications to the Monitoring Strategy are in order. The fixed station network practically overlooks small streams, which are primarily evaluated with intensive surveys. Only 32 percent of the principal stream miles in Ohio have been evaluated with the fixed station network since 1972. It is clearly beyond the resources of the State to monitor all streams, but modifications to the present Monitoring Strategy and the development of computer software for data analyses could yield more information per sample analysis. A well designed sampling and data analysis program can provide useable information concerning existing ambient water quality and long term trends on a subbasin or regional basis without sampling every stream. Additional sampling in Ohio is needed to address the impact of watershed characteristics (i.e., land-use, soils, population density) on ambient water quality.[1] Such information can and will be obtained utilizing the fixed station network in conjunction with the intensive stream surveys and special nonpoint source monitoring.

Fixed monitoring station locations need periodic reevaluation to determine whether they are in the best locations to maximize the collection of useful water quality data, reflect changing water quality characteristics and/or changing program needs.

There is a critical need to coordinate intensive surveys, wasteload allocations, water quality management plans, water quality standards revisions, NPDES permits, and construction grants with one another so that

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1 This need is demonstrated by numerous subbasin reports in Volume IV that suggest that elevated heavy metal concentrations (especially iron, also lead and cadmium) and high fecal coliform concentrations are attributable to widespread existing or natural background conditions. More specific data are clearly needed to fully understand these and similar problems.

each program works to the benefit of the other. Currently, there is no comprehensive statewide strategy, and the lack of such a strategy results in crisis management and less than optimum use of limited resources. Only the initial steps have been taken to develop a statewide strategy to date. More coordination and comprehensive planning between various State agencies is necessary in the future.

The Ohio EPA is just beginning to address the priority toxic pollutant problem in Ohio's surface waters and is in the initial stages of developing this part of the monitoring strategy. A comprehensive toxics monitoring strategy for Ohio should include the identification of suspected toxics sources, the collecting and evaluation of preliminary toxics data, and the use of bioassays for toxics screening. Ohio EPA needs the ability to analyze water samples for organic compounds; this would require laboratory expansion and the addition of mass spectrometer - gas chromatograph analytical capabilities.

Data analyses are currently limited to a retrieval of STORET data, or an analysis of water quality data using STORET programs. The STORET programs have limited analytical flexibility and can not be used to analyze STORET data from several stations in a given river segment simultaneously. The development of computer software programs, which would allow for a more comprehensive analysis of STORET data, is necessary to more effectively evaluate water quality data in Ohio.

Currently U.S. EPA recommends only a pilot biological monitoring program which tends to detract from its value as a meaningful part of the overall surface water monitoring program. There is a real need for federal guidance and financial support that encourages more in-depth examinations, such as intensive stream segment investigations which integrate chemical/physical and biological analyses.

Presently, decision making with reference to NPDES permits, water quality management, etc. appears to be based heavily on the results of chemical/physical analyses and wasteload allocation modeling. Wasteload allocations are a very important and necessary portion of the total water pollution control program, however, these measurements of achieving the goal of the Clean Water Act (Sec. 101(a)(2) of PL 95-217) are often indirect and often fail to take biological phenomena into account. Efforts to control both point and nonpoint sources of pollution need to be assessed from the standpoint of real, observed improvements in water quality pursuant to the "... interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and ... recreation in and on the water ..." (Sec. 101(a)(2) of PL 95-217), beyond the scope of chemical/physical measurements alone. Current U.S. EPA policy is to equate compliance with numerical water quality criteria with attaining the "fishable/swimmable" waters goal. If the stated goal is to be attained through the restoration of damaged aquatic communities, then something must be known of the rate and sequence of natural recovery processes. Integrated biological and chemical/physical studies, conducted prior to and during the initiation of pollution control and water quality management programs and following their full implementation, will provide a measurement of realized improvements in water quality and the recovery of presently degraded, aquatic communities.

Finally, there is inadequate coordination between various state and federal agencies. There are instances when federally funded monitoring programs are awarded to various state agencies, universities, or other consultants without coordination with Ohio EPA. As a consequence, Ohio EPA does not always know who is doing what monitoring where.

I. OBJECTIVES AND GENERAL REQUIREMENTS

The objective of the State Monitoring program, required by the Act, is the provision of the following information:

- Data and/or reports to determine compliance with permits and conditions,

- An understanding of water quality (causes and effects) in the State for the purpose of supporting State water pollution control activities in relation to the achievement of National goals according to the Act, and

- An assessment of the effectiveness of the State's water pollution control program.

To this end, the State is required to establish and maintain a broad range of monitoring activities, both before and after implementing pollution controls, including: measurement of pollutant sources, determination of water quality, and the evaluation of their effects upon the State's beneficial use designations.

Monitoring programs and activities shall be carried out according to normally accepted practices, promulgated or otherwise issued by the Administrator of USEPA, in the form of regulations, guidelines, technical manuals, and handbooks.

II. MONITORING STRATEGY

A. Compliance Monitoring

1. Objectives and Priorities

The primary objectives of the compliance monitoring component are:

- To determine compliance with permits.
- To validate self-monitoring reports.
- To provide support for enforcement actions.

Secondarily, the data generated are used to support the State's Continuing Planning Process, by the preparation and modification of NPDES Permits and facility design policies.

Entities on Ohio EPA's Major Industrial and Municipal Discharger list, as indicated in the Section 106 program submission, have the highest priority in the compliance monitoring sampling inspection program. Ohio EPA intends to conduct inspections, including effluent sampling, at least once each year at the facilities of all major dischargers, if resources are available.

2. Present and Projected Activities

The present monitoring activities for wastewater treatment facility effluent quality consists of:

Self-Monitoring Reports - Submission of monthly, self-monitoring reports to Ohio EPA are required of all NPDES Permit holders. These reports include chemical and/or physical data for parameters which are limited by the NPDES Permit, and may also include parameters required to be monitored, but not limited.

Compliance Monitoring Sampling Inspections - These are inspections of wastewater treatment facilities that include effluent sampling and analysis. Detailed procedures of the sampling and analytical techniques are found in "Compliance Monitoring Guidelines," Ohio EPA, Office of Wastewater Pollution Control, September, 1975. During these inspections, samples are split and analyzed by both the permittee and Ohio EPA to insure accuracy in quality control.

Inspections and Sampling by USEPA - USEPA, Region V, Eastern District Office (EDO), also undertakes sampling and performs inspections using methods similar to those used by Ohio EPA. EDO results are transmitted to Ohio EPA for use in water quality management programs.

B. Intensive Surveys

Ohio EPA has initiated an intensive survey program to investigate water quality in selected rivers and streams. Selections, made on a priority basis within the Office of Wastewater Pollution Control, are made during the March-April preceding the June-October field season. These investigations are conducted for the purpose of addressing specific water quality issues and to serve as a mechanism for integrating surface water monitoring programs.

Pre-survey planning and field work, coordinated by the Water Quality Section under the direction of the Division of Surveillance and Standards, are developed with the assistance of the appropriate District Surveillance staff. Simulation modeling, when included, is performed by the Division of Water Quality Planning and Assessment.

All intensive surveys include comprehensive chemical/physical and biological sampling. Flow, cross-sectional measurements and time-of-travel studies are performed when data for calibration and/or verification of the Water Quality Planning Model II (WQPM II) is required. All field and laboratory procedures conform to those outlined in the Ohio EPA Quality Assurance Manual, Ohio EPA, 1980. The following, while not an exhaustive list, are some specific examples of the purpose, use and application of intensive water quality survey results:

- To provide a partial data base for 305(b) reports.
- To provide some basis for understanding and describing receiving water quality and the processes that affect that water quality.
- To determine if the Clean Water Act goal of fishable/swimmable waters is being achieved.
- To evaluate water use designations and water quality standards.
- To biologically evaluate existing water quality.
- To identify toxic substances entering state waters and to assess their impact on existing and planned stream uses.
- To identify, quantify and differentiate water quality problems and contributions from both point and non-point pollution sources, and to assess their impact on existing or planned stream uses.
- To provide minimum data required for calibration and verification of WQPM-II.
- To validate stream segment classifications as water quality, or effluent limited.
- To evaluate the location and distribution of fixed station monitoring stations.

- To bridge gaps between data from effluent and fixed monitoring stations.

- To provide additional documentation to explain trends at fixed monitoring stations.

- To assess the effectiveness of surface water pollution control programs and to set priorities for their establishment or improvement.

- To provide support for the Agency's NPDES permit enforcement program.

Technical reports are prepared for each intensive survey and are completed by May 1, whenever possible. Chemical/physical data are entered into STORET and are included as a part of the next 305(b) report. Abstracts of each report will be sent to USEPA by June 30.

C. Fixed Station Monitoring

Monitoring at fixed stations represents one of several types of monitoring programs conducted by the State of Ohio. Fixed station monitoring in Ohio is designed to meet the following objectives:

- To establish quality baseline data for water and aquatic communities which contributes to the development and/or revision of water quality standards.

- To determine violations of current water quality standards.

- To aid in the confirmation of stream segment classification as either effluent limited, or water quality limited.

- To provide a continuing assessment of water pollution control programs.

- To characterize and define trends in the physical, chemical and biological condition of the State's surface water.

- To determine inputs and impacts from nonpoint sources.

- To determine inputs and impacts from urban areas.

- To determine loadings to Lake Erie.

- To provide a partial data base for the biennial Section 305(b) water quality assessment.

- To act as a triggering mechanism for intensive surveys, enforcement proceedings, or other actions.

1. National Ambient Water Quality Monitoring Network (NAWQMN)

   The primary objective of the NAWQMN network is to measure progress toward achieving national water quality goals. This network is the core of the Ohio EPA ambient monitoring program. These monthly stations (Table II-1) were selected using guidance developed by USEPA. Most of the stations have a great deal of historical monitoring data. The sampling frequency and parameters that are monitored at each NAWQMN station are listed in Table II-1.

2. State Water Quality Monitoring Program (Ohio EPA)

   In addition to the NAWQMN network, Ohio EPA has established stations to supplement National needs, and to address specific State and local needs. These stations will be sampled monthly, quarterly, or on a low-flow basis (Table II-1). Monitored and additional parameters are listed by each site in Table II-1.

   Sampling frequencies are as follows:

   Monthly - once every calendar month.
   Quarterly - every 90 days.
   *Low-Flow - at least once a year during a flow period that is less than the 80% duration flow for each stream.

D. Lakes and Reservoirs Program

A cooperative program between Ohio EPA and USGS, initiated in 1975, has surveyed 71 lakes and reservoirs to date. These surveys are designed to provide baseline data on a wide spectrum of parameters (Tables II-2 and II-3), while providing sufficient information for eutrophic status determination.

Sampling occurs in early spring, prior to the development of thermal stratification, and again in late summer during peak stratification. Physical and chemical profile measurements are made at primary stations established in the deepest part of a lake. Secondary stations are established in larger lakes to detect variations in sampled profiles. Sampling stations are also established on principal lake tributaries. Fourteen lakes will be sampled in FY '80 (Table II-4).

Certain lakes will be monitored seasonally on a four to five year rotational basis. Lakes will be selected for sampling based upon existing problems, expected problems, to determine trophic status, or to determine eutrophication rates. Three lakes which will be monitored in 1980 are Pine Lake (Ross Co.), Springfield Lake (Summit Co.) and Westerville Reservoir (Delaware Co.). Sampling frequency and parameters to be monitored are found in Table II-5. Additional parameters will be determined on a case-by-case basis.

*Due to the water quality justifications required by USEPA for AST/AAWT treatment plant construction, Ohio EPA will not sample low-flow stations during 1980.

Key for Table II-1[a]

PARAMETER	ABBREVIATION	M	Q	LF	ST
Acidity, Total, $CaCO_3$	Acid $CaCO_3$-T				X
Alkalinity, Total, $CaCO_3$	Alkaline $CaCO_3$-T				
Aluminum, Total, Al	Al-T				X
Arsenic, Total As	As-T				X
BOD 5 day	BOD-5				X
Cadmium, Total, Cd	Cd-T	4	4		X
Carbon, Total Org., C	C-T-Org				X
Chloride, Cl	Cl				X
Chlorine, Total Residual	Cl_2-T-R				X
Chromium, Hex, Cr	Cr-Hex				X
Chromium, Total Cr	Cr-T	4	4	1	X
COD	COD	12	4	1	
Conductivity (field)	Micromho (field)	12	4	1	
Copper, Total, Cu	Cu-T	4	4	1	X
Cyanide, Total, CN	CN-T				X
Dissolved Oxygen (field)	D.O. (field)	12	4	1	
Fecal Coli, Total, MF	Fecal Coli-T-MF	12	4	1	
Flow (USGS)	Flow (USGS)	12	4	1	
Fluoride, Diss., F	F-Diss				X
Hardness, Total $CaCO_3$	Hard $CaCO_3$-T	4	4	1	X
Iron, Total, Fe	Fe-T	4	4	1	X
Lead, Total, Pb	Pb-T	4	4	1	X
Manganese, Total, Mn	Mn-T				X
MBAS	MBAS				X

Key for Table II-1[a] (Continued)

PARAMETER	ABBREVIATION	M	Q	LF	ST
Mercury, Total, Hg	Hg-T	4	4	1	X
Nickel, Total, Ni	Ni-T	4	4	1	
Nitrate, NO_3 as N	NO_3-N-T	12	4	1	
Nitrite, NO_2 as N	NO_2-N-T	12	4	1	
Nitrogen, Ammonia, N	NH_3-N-T	12	4	1	
Oil-Grease, Total	O+G-T	12	4	1	
Organic Scan	OS				X
pH (field)	pH (field)	12	4	1	
Phenolics	Phenolics	4	4	1	X
Phosphorus, Dissolved, P	P-Diss				X
Phosphorus, Total, P	P-T	12	4	1	
Polychlorinated Biphenyls	PCB				X
Residue, Total Flt. (Diss)	TDS				X
Residue, Total Nflt. (Susp)	TSS	12	4	1	X
Silica, Total (Diss)	Si-T-Diss				X
Sulfate, SO_4	SO_4-T				X
Total Kjeldahl Nitrogen	Kjel-T-N	12	4	1	
Water Temperature (field)	Temp (field)	12	4	1	
Zinc, Total, Zn	Zn-T	4	4	1	X

a. Station Type and Sampling Frequency: Monthly (M); Quarterly (Q); Low Flow (LF); Special Tests (ST)

Key for Table II-1 (Continued)

COLUMN CODES

RM

River mile, miles from mouth

Station #

Top number - STORET (OEPA)

Lower number ( ) - USGS

District

CDO - Central District Office, Columbus

NEDO - Northeast District Office, Twinsburg

NWDO - Northwest District Office, Bowling Green

SEDO - Southeast District Office, Logan

SWDO - Southwest District Office, Dayton

Purpose

IJC - International Joint Commission

NASQAN - National Stream Quality Accounting Network (USGS)

NAWQMN - National Ambient Water Quality Monitoring Network

OEPA - Ohio EPA

Use Designation

CWH - Coldwater Habitat

EWH - Exceptional Warmwater Habitat

LE - Lake Erie Standards

MRS - Mahoning River Standards

PWS - Public Drinking Water Source

WWH - Warmwater Habitat

Table II-1: Fixed Station Monitoring Program

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
ASHTABULA RIVER						
Ashtabula River near Ashtabula (State Rd)	5.5	502760 (04212500)	NEDO	NAWQMN, IJC	WWH	
Fields Brook near Ashtabula (15th St)	0.3	502780	NEDO	OEPA	WWH	Cl_2-T-R, Hg-T, Phenolics, Cu-T, OS, Hard $CaCO_3$-T
BLACK RIVER						
Black River at Elyria (Cascade Pk)	15.6	501520 (04200500)	NEDO	NAWQMN	WWH	
Black River below Elyria (Ford Rd)	10.4	501510 (04200550)	NEDO	IJC	WWH	
CHAGRIN RIVER						
Chagrin River at Willoughby (Rt 84)	5.0	502400 (04209000)	NEDO	NAWQMN, IJC	EWH	
CONNEAUT CREEK						
Conneaut Creek at Conneaut (Keefus Rd)	6.4	502870 (04213000)	NEDO	NAQMN, IJC	CWH	
CUYAHOGA RIVER						
Cuyahoga River at Independence (Old Rockside Rd.)	13.5	502020 (04208000)	NEDO	NAWQMN, NASQAN	WWH	
Cuyahoga River at Cleveland (Lower Harvard Ave.)	7.3	502130 (04208503)	NEDO	IJC	WWH	

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
EUCLID CREEK						
Euclid Creek at Euclid (St. Clair Ave.)	1.7	504250 (04208690)	NEDO	OEPA	WWH	Cl, Zn-T, Fe-T, Pb-T, Cu-T, Phenolics, Hard $CaCO_3$-T
GRAND RIVER						
Grand River near Painesville (Rt 84)	8.7	502530 (04212100)	NEDO	NAWQMN, NASQAN	WWH	
Grand River at Painesville (Rt 535)	2.3	502520 (04212200)	NEDO	IJC	WWH	
GREAT MIAMI RIVER						
Great Miami River Below Lakeview (Rt 33)	156.2	600000	SWDO	OEPA	WWH	CN-T(Q)
Great Miami River near Taylorsville (SR 440)	90.7	610050 (03263000)	SWDO	OEPA	WWH	CN-T(Q)
Great Miami River at Dayton (Main St. Bridge)	80.0	610060 (03270500)	SWDO	NAWQMN	WWH	CN-T(Q)
Great Miami River at Miamisburg (SR 725)	66.4	600150 (03271500)	SWDO	OEPA	WWH	CN-T(Q)
Great Miami River at Hamilton (Columbia Bridge)	34.9	600270 (03274000)	SWDO	OEPA	WWH	CN-T(Q)

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
GREAT MIAMI RIVER (CONTINUED)						
Great Miami River at New Baltimore (Blue Rock Road)	20.8	600030 (03274600)	SWDO	NAWQMN, NASQAN	WWH	CN-T(Q)
Great Miami River near Lawrenceburg (Lost Bridge)	5.2	600300	SWDO	OEPA	WWH	CN-T(Q)
Dicks Creek near Excello (Yankee Rd)	2.5	600250	SWDO	OEPA	WWH	CN-T(Q)
Mad River at Eagle City (St. Paris Pike)	28.7	610040	SWDO	NAWQMN	CWH	CN-T(Q)
Mad River above Dayton (Rt 444)	5.9	600190	SWDO	OEPA	WWH	CN-T(Q)
Stillwater River near Englewood (U.S. 40)	8.9	600110 (03266000)	SWDO	OEPA	WWH	CN-T(Q)
HOCKING						
Hocking River below Lancaster (U.S. 33)	86.7	601550	CDO	OEPA	WWH	Phenolics
Hocking River at Enterprise (CR 31 Bridge)	72.5	601530 (03157500)	SEDO	OEPA	WWH	
Hocking River at Athens (U.S. 33)	39.6	601650 (03159510)	SEDO	NAMWQN, NASQAN	WWH	

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
HURON RIVER						
Huron River below Milan (Mud Brook Rd)	1.6	501050	NWDO	NAWQMN, IJC	EWH	
LAKE ERIE						
Oregon Water Intake	-	504240	NWDO	NAWQMN, IJC	EWH (LE), PWS	
Sandusky Water Intake	-	504030	NWDO	IJC	EWH (LE), PWS	
Mentor Water Intake	-	504130	NEDO	NAWQMN, IJC	EWH (LE), PWS	
Cleveland Crown Water Intake	-	504090	NEDO	IJC	EWH (LE), PWS	
Ashtabula Water Intake	-	504160	NEDO	IJC	EWH (LE), PWS	OS(Q)
Conneaut Water Intake	-	504170	NEDO	OEPA	EWH (LE), PWS	P-Diss, Si-T-Diss, C-T-Org, Fe-T, Cd-T, Phenolics, CN-T
LITTLE BEAVER CREEK						
Little Beaver Creek near East Liverpool (Grimms Bridge Road)	4.6	602000 (03109500)	NEDO	NAWQMN	WWH	
Chemline Tributary near Lisbon (SR 518)	0.1	602090	NEDO	OEPA	WWH	Cl, TDS, Fe-T, Mn-T, Hard $CaCO_3$-T, F-Diss, CN-T(Q)

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
LITTLE BEAVER CREEK (CONTINUED)						
Stateline Creek West Branch near Negley (Twp. Rd 1024)	0.1	602050 (03109320)	NEDO	OEPA	WWH	Cl, TDS, Fe-T, Mn-T, Hard $CaCO_3$-T, F-Diss, CN-T(Q), PCB(A)
Stateline Creek East Branch near Negley (Twp. Rd 1024)	0.1	602060	NEDO	OEPA	WWH	Cl, TDS, Fe-T, Mn-T, Hard $CaCO_3$-T, CN-T(Q)
LITTLE MIAMI RIVER						
Little Miami River at Oldtown (U.S. 68)	79.5	600570	SWDO	NAWQMN	EWH	CN-T(Q)
Little Miami River at Spring Valley (Roxanna-New Burlington Rd)	59.3	600600	SWDO	OEPA	WWH	CN-T(Q)
Little Miami River near Morrow (Stubbs Mill Rd)	35.7	610520	SWDO	OEPA	WWH	CN-T(Q)
Little Miami River at Milford (U.S. 50)	12.7	600520 (03245500)	SWDO	NAWQMN, NASQAN	WWH	CN-T(Q)
Caesar's Creek near Oregonia (Corwin Rd)	0.2	600550	SWDO	OEPA	EWH	CN-T(Q)
East Fork Little Miami River at South Milford (near Terrace Park Country Club)	0.8	610530	SWDO	OEPA	WWH	CN-T(Q)

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MAHONING RIVER						
Mahoning River at Leavittsburg (Leavitt Rd)	45.0	602280 (03094000)	NEDO	NAWQMN	MRS	
Mahoning River at Lowellville (First St)	11.6	602300 (03099500)	NEDO	NAWQMN	MRS	CN-T, Phenolics, F-Diss, Fe-T
MAUMEE RIVER						
Maumee River at Antwerp (SR 49)	100.3	500140 (04183500)	NWDO	NAWQMN	WWH	Hard $CaCO_3$-T, TDS SO_4-T, Cl, As-T, Cd-T, Cr-T, Cu-T, Pb-T, Hg-T, Zn-T, PCB
Maumee River at Waterville (Rt 64)	20.8	500080 (04193500)	NWDO	NAWQMN, IJC NASQAN	WWH	
Auglaize River above Defiance (Power Dam, Harding Road)	4.1	500290 (04191500)	NWDO	NAWQMN	WWH	Hard $CaCO_3$-T, P-Diss, SO_4-T, Cl, As-T, Cd-T, Cr-T, Cu-T, Pb-T, Hg-T, Zn-T, PCB, MBAS(Q)
Blanchard River below Findlay (County Rd)	53.0	500040 (04189000)	NWDO	OEPA	WWH	Hard $CaCO_3$-T, TDS, P-Diss, Cl, As-T, Cd-T, Cr-T, Cu-T, Ph-T, Hg-T, Ni-T, Zn-T, MBAS, BOD-5, PCB
Ottawa River at Allentown (SR 81)	28.4	500050 (04187500)	NWDO	OEPA	WWH	Hard $CaCO_3$-T, TDS P-Diss, Cl, BOD-5, As-T, Cd-T, Cr-T, Cr-Hex, Cu-T, Pb-T, Hg-T, Zn-T, MBAS, Phenolics, PCB

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MILL CREEK						
Mill Creek at Carthage (Anthony Wayne Avenue)	11.0	600410 (03259000)	SWDO	OEPA	WWH	CN-T(Q)
Mill Creek near Hamilton (Tylersville Rd)	24.5	600440	SWDO	OEPA	WWH	CN-T(Q)
Mill Creek at Cincinnati (Gest Rd)	0.5	600430	SWDO	OEPA	WWH	CN-T(Q)
MUSKINGUM RIVER						
Muskingum River below Coshocton (SR 83)	107.3	611740 (03140500)	SEDO	NAWQMN	WWH	Cl, Phenolics
Muskingum River at Dresden (SR 208)	91.3	611750 (03144500)	SEDO	OEPA	WWH	
Muskingum River at McConnelsville (SR 37)	48.2	601860 (03150000)	SEDO	NAWQMN, NASQAN	WWH	
Licking River below Newark (Stadden Bridge)	25.6	601770 (031416500)	CDO	NAWQMN	WWH	BOD-5, Phenolics, Cl, SO_4-T
Mohican River at Greer (Rt 514)	16.6	601870 (03136000)	SEDO	NAWQMN	WWH	
Nimishillen Creek at North Industry (Cheyenne St)	8.2	601940 (03118500)	NEDO	NAWQMN	WWH	CN-T, Phenolics, F-Diss, Fe-T

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MUSKINGUM RIVER (CONTINUED)						
Tuscarawas River near Massillon (Warmington St.)	85.3	601930 (03117000)	NEDO	NAWQMN	WWH	CN-T, Phenolics, F-Diss, Fe-T, PCB (Q)
Tuscarawas River at Newcomerstown (SR 83)	21.3	611790 (031129000)	SEDO	NAWQMN	WWH	Cl, Phenolics
Walhounding River at Nellie (U.S. 36)	14.7	601901 (03138500)	SEDO	NAWQMN	WWH	
OHIO BRUSH CREEK						
Ohio Brush Creek near West Union (SR 348)	13.1	600660 (03237500)	SEDO	NAWQMN	EWH	
PORTAGE RIVER						
Portage River at Woodville (U.S. 20)	28.2	500510 (04195500)	NWDO	NAWQMN, IJC	WWH	
RACCOON CREEK						
Raccoon Creek at Adamsville (U.S. Rt 35)	29.6	601400 (03202000)	SEDO	NAWQMN	WWH	Acid $CaCO_3$-T, Fe-T, Mn-T
ROCKY RIVER						
Rocky River near Berea (Cedar Pt Rd)	12.0	501800 (04201500)	NEDO	NAWQMN, IJC	WWH	
SANDUSKY RIVER						
Sandusky River above Fremont (Rice Rd)	20.3	500820 (04198000)	NWDO	NAWQMN, IJC, NASQAN	WWH	

MONTHLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
SCIOTO RIVER						
Scioto River near Circleville (Florence Chapel Rd)	101.8	601340	CDO	NAWQMN	WWH	BOD-5, Phenolics
Scioto River near Richmondale (Higby Rd)	56.0	600770 (03234500)	SEDO	NAWQMN, NASQAN	WWH	
Big Darby Creek at Darbyville (SR 316)	13.2	601300 (03230500)	CDO	NAWQMN	EWH	
Mill Creek below Marysville (Radnor Rd)	17.2	601350	CDO	OEPA	WWH	CN-T, Phenolics
Olentangy River near Worthington (I-270)	11.5	601290 (03226800)	CDO	NAWQMN	WWH	
Paint Creek near Bournesville (Jones-Levee Rd)	22.1	601320 (03234000)	SEDO	OEPA	EWH	
VERMILION RIVER						
Vermilion River at Vermilion (N. Ridge Rd)	4.5	501260 (04199500)	NWDO	NAWQMN, IJC	EWH	

QUARTERLY MONITORING REPORT

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
CUYAHOGA RIVER						
Little Cuyahoga River near Akron (Otto St. gage)	2.0	502080 (04205700)	NEDO	OEPA	WWH	MBAS, TDS, F-Diss, Cl
Big Creek at Cleveland (Jennings Ave)	0.3	502120	NEDO	OEPA	WWH	MBAS, TDS, F-Diss, Cl
Mill Creek at Garfield Heights (Canal Road)	0.1	502110	NEDO	OEPA	WWH	MBAS, TDS, F-Diss, Cl
GREAT MIAMI RIVER						
Buck Creek near Springfield (U.S. 40 and SR 4)	0.2	600350	SWDO	OEPA	WWH	CN-T
Four Mile Creek at New Miami (Jacksonburg Rd)	0.3	600260	SWDO	OEPA	WWH	CN-T
Greenville Creek near Covington (Rangeline Rd)	3.4	600060	SWDO	OEPA	WWH	CN-T
Indian Creek near Ross (SR 128)	0.5	600280	SWDO	OEPA	EWH	CN-T
Loramie Creek near Lockington (Harding-Wapak Rd)	0.4	600320	SWDO	OEPA	WWH	CN-T
Seven Mile Creek near Seven Mile (Taylor School Rd)	1.3	600340	SWDO	OEPA	WWH	CN-T

QUARTERLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
GREAT MIAMI RIVER (CONTINUED)						
Twin Creek near Franklin (Dayton-Oxford Rd)	0.6	600180	SWDO	OEPA	EWH	CN-T
Whitewater River near Hoover (Suspension Bridge Rd)	0.5	600290	SWDO	OEPA	WWH	CN-T
HURON RIVER						
Rattlesnake Creek at Norwalk (Lais Rd)	1.7	501080	NWDO	OEPA	WWH	BOD-5
LAKE ERIE						
Turkey Creek near Conneaut (Lake Rd)	0.1	504260	NEDO	OEPA	CWH	MBAS, TDS, CN-T, F-Diss
LITTLE BEAVER CREEK						
North Fork at Fredericktown (Fredericktown Rd)	0.2	612010	NEDO	OEPA	CWH	MBAS, TDS, Cl
West Fork near Guilford (SR 30)	6.6	612000	NEDO	OEPA	WWH	MBAS, TDS, Cl
LITTLE MIAMI RIVER						
Little Miami River near Xenia (Bellbrook Rd)	68.2	610550	SWDO	OEPA	WWH	CN-T
Beaver Creek near Xenia (Factory Rd)	0.1	600510	SWDO	OEPA	WWH	CN-T

QUARTERLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MAHONING RIVER						
Mahoning River at Warren (South St. gage)	37.4	602400	NEDO	OEPA	MRS	MBAS, TDS, CN-T, F-Diss
Mahoning River at Niles (W. Park Ave)	33.1	602290	NEDO	OEPA	MRS	MBAS, TDS, CN-T, F-Diss
MAUMEE RIVER						
Auglaize River at Wapakoneta (Water St)	74.5	510240	NWDO	OEPA	WWH	BOD-5
Auglaize River at Wapakoneta (Fox Ranch Rd)	70.8	510250	NWDO	OEPA	WWH	
St. Marys River at St. Marys (Aqueduct Rd)	47.2	510010	NWDO	OEPA	WWH	BOD-5
St. Marys River at St. Marys (Glynwood Rd)	43.0	510020	NWDO	OEPA	WWH	
MUSKINGUM RIVER						
Hurford Run at Canton (Church St)	0.2	611850	NEDO	OEPA	WWH	MBAS, TDS, Cl, F-Diss
Jerome Fork near Ashland (Rt 42)	13.0	611860	NWDO	OEPA	WWH	BOD-5
Jerome Fork near Ashland (CR 1032)	10.5	611870	NWDO	OEPA	WWH	BOD-5

QUARTERLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MUSKINGUM RIVER (CONTINUED)						
Kokosing River near Mt. Vernon (SR 661)	23.6	611880	NWDO	OEPA	WWH	BOD-5
Kokosing River near Mt. Vernon (Twp Rd 257)	21.6	611890	NWDO	OEPA	WWH	BOD-5
Rocky Fork near Mansfield (SR 39)	12.5	611900	NWDO	OEPA	WWH	BOD-5
Rocky Fork near Mansfield (Illinois Ave)	10.1	611910	NWDO	OEPA	WWH	BOD-5
Tuscarawas River at Massillon (Walnut St)	88.4	611840	NEDO	OEPA	WWH	MBAS, TDS, Cl, F-Diss
Wolf Creek at Barberton (Snyder Ave)	0.2	611820	NEDO	OEPA	WWH	MBAS, TDS, Cl, F-Diss
ROCKY RIVER						
West Branch Rocky River near Medina (Fenn Rd)	28.0	501820	NEDO	OEPA	WWH	MBAS, TDS, CN-T, Cl
SANDUSKY RIVER						
Sandusky River at Fremont (Twp Rd 549)	13.0	500890	NWDO	OEPA	WWH	BOD-5
SCIOTO RIVER						
Scioto River near Kenton (CR 175)	206.8	610760	NWDO	OEPA	WWH	BOD-5
Scioto River near Kenton (CR 106)	201.0	610770	NWDO	OEPA	WWH	BOD-5

QUARTERLY MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
SCIOTO RIVER (CONTINUED)						
Little Scioto River near Marion (SR 309)	8.9	610750	NWDO	OEPA	WWH	BOD-5
Little Scioto River near Marion (SR 739)	2.6	610740	NWDO	OEPA	WWH	BOD-5
Rocky Fork of Paint Creek near Barrett's Mills (Browning Rd)	2.8	610800 (03232500)	SEDO	OEPA	EWH	(a), TDS
Whetstone Creek near Mt. Gilead (SR 61)	21.5	610780	NWDO	OEPA	WWH	BOD-5
Whetstone Creek near Mt. Gilead (Cardington Rd)	19.9	610790	NWDO	OEPA	WWH	BOD-5
WABASH RIVER						
Beaver Creek at Celina (above and below STP discharge, Myer Rd and SR 703)	9.6	605020	NWDO	OEPA	WWH	BOD-5
Beaver Creek at Celina (SR 703)	10.7	605010	NWDO	OEPA	WWH	BOD-5

(a) Nitrate and Nitrite deleted from minimum parameter list.

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
BLACK RIVER						
French Creek near Lorain (Rt 301)	0.7	501530	NEDO	OEPA	WWH	
CUYAHOGA RIVER						
Cuyahoga River near Akron (USGS gage, Old Portage Trail)	40.3	502160 (04206000)	NEDO	OEPA	WWH	
Cuyahoga River at Cleveland (W. Third St)	3.0	502140 (04208506)	NEDO	OEPA	WWH	F-Diss, CN-T, No Flow
Tinkers Creek at Bedford (USGS gage at SR 14)	5.5	502220 (04207200)	NEDO	OEPA	WWH	Hard $CaCO_3$-T, Zn-T, Pb-T, Cr-T
GREAT MIAMI RIVER						
Great Miami River below Piqua (Peterson Rd)	108.8	600090	SWDO	OEPA	WWH	
Mad River near Urbana (SR 36)	39.0	600130	SWDO	OEPA	CWH	
Mad River below Springfield (lower Valley Pike)	23.5	610010	SWDO	OEPA	WWH	
HURON RIVER						
East Branch Huron River below Norwalk (Schaeffer Rd)	2.0	501070	NWDO	OEPA	WWH	

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
LITTLE BEAVER CREEK						
Middle Fork near Salem (Beachwood Rd)	52.8	602120	NEDO	OEPA	WWH	TSS, CN-T, F-Diss
MAUMEE RIVER						
Maumee River at Defiance (WTP)	65.6	500180 (04184100)	NWDO	OEPA	WWH	
Maumee River near Florida (CR 18)	54.6	510210	NWDO	OEPA	WWH	
Auglaize River near Fort Jennings (SR 224)	39.5	500070	NWDO	OEPA	WWH	
Auglaize River near Cloverdale (SR 114)	28.5	500110	NWDO	OEPA	WWH	
Auglaize River near Oakwood (SR 613)	19.3	500130	NWDO	OEPA	WWH	
Blanchard River near Dupont (CR 21)	2.5	500090	NWDO	OEPA	WWH	
Little Auglaize River below Melrose (SR 613)	2.0	510200	NWDO	OEPA	WWH	
Ottawa River above Lima (Thayer Rd)	45.4	500270	NWDO	OEPA	WWH	
Ottawa River near Kalida (CR 19)	0.7	500150	NWDO	OEPA	WWH	

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MAUMEE RIVER (CONTINUED)						
St. Joseph River below Edgerton (SR 49)	8.9	510180	NWDO	OEPA	WWH	
St. Marys River near Willshire (SR 81)	1.3	510170	NWDO	OEPA	WWH	
Tiffin River at Defiance (W. High St)	0.8	500160	NWDO	OEPA	WWH	
MUSKINGUM RIVER						
Chippewa Creek at Easton (USGS gage at SR 585)	6.8	611810 (03116200)	NEDO	OEPA	WWH	Fe-T
Killbuck Creek near Wooster (Willow Rd)	44.8	601880	NEDO	OEPA	WWH	Fe-T
Sandy Creek at Waynesburg (USGS gage)	17.4	611800 (03117500)	NEDO	OEPA	WWH	
Tuscarawas River at Canal Fulton (Market St)	95.9	611830	NEDO	OEPA	WWH	TSS, Fe-T
Wills Creek at Cambridge (Twp Rd 452)	54.9	611760	SEDO	OEPA	WWH	TSS
Wills Creek below Dam (Twp Rd 274)	6.2	611770 (03143500)	SEDO	OEPA	WWH	TSS

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
PORTAGE RIVER						
North Branch Portage River at Pemberville (N. River Rd)	0.1	500520	NWDO	OEPA	WWH	
ROCKY RIVER						
Abrams Creek near Berea (Cedar Point Rd)	0.9	501830	NEDO	OEPA	WWH	Hard $CaCO_3$-T, F-Diss, Zn-T
SANDUSKY RIVER						
Sandusky River below Mexico (Scott Bridge Rd)	48.0	500830	NWDO	OEPA	WWH	
Sandusky River below Upper Sandusky (CR 121)	78.7	500860	NWDO	OEPA	WWH	
SCIOTO RIVER						
Big Darby Creek below Plain City (Cemetary Pike Rd)	50.3	600790	CDO	OEPA	EWH	
Paint Creek below Washington C.H. (SR 35)	64.3	600740	CDO	OEPA	WWH	
Walnut Creek below Baltimore (Leonard Rd)	36.6	600750	CDO	OEPA	WWH	
WABASH RIVER						
Wabash River near New Corydon, Ind (State Line)	465.6	610000	NWDO	OEPA	WWH	

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
MINOR OHIO TRIBUTARIES						
Bullskin Creek near Cedron (Cedron Rd)	3.1	609100	SWDO	OEPA	WWH	(a)
Captina Creek near Powhatan Point (SR 148)	3.2	609210	SEDO	OEPA	WWH	(a), TDS, Al-T, Mn-T
Cross Creek near Mingo Junction (Twp Rd 167)	1.7	609250	SEDO	OEPA	WWH	(a), TDS
Duck Creek near Marietta (SR 26)	1.8	609180	SEDO	OEPA	WWH	(a), TDS
Eagle Creek near Ripley (CR 49)	3.7	609120	SEDO	OEPA	EWH	(a), TDS
Indian Guyan Creek near Bradrick (SR 243)	2.5	609150	SEDO	OEPA	WWH	(a), TDS
Leading Creek near Middleport (SR 7)	1.4	609160	SEDO	OEPA	WWH	(a), TDS
Little Muskingum River near Reno (CR 9)	2.3	609190	SEDO	OEPA	WWH	(a), TDS
Little Scioto River near Sciotoville (Twp Rd 248)	2.1	609130	SEDO	OEPA	EWH	(a), TDS

(a) Nutrients (Nitrate-Nitrite, Total Phosphorus, TKN, NH_3-N) are deleted from the minimum parameters list.

LOW FLOW MONITORING PROGRAM

STATION DESCRIPTION	RM	STATION #	DISTRICT	PURPOSE	USE DESIGNATION	ADDITIONAL PARAMETERS
McMahon Creek near Bellaire (SR 147)	1.3	609220	SEDO	OEPA	WWH	(a), TDS, Al-T, Mn-T
Pine Creek near Garden City (SR 52)	4.1	609140	SEDO	OEPA	WWH	(a), TDS
Shade River near Keno (Twp Rd 114)	5.9	609170	SEDO	OEPA	EWH	(a), TDS
Short Creek near Rayland (SR 150)	3.9	609240	SEDO	OEPA	WWH	(a), TDS, Al-T, Mn-T
Sunfish Creek near Cameron (SR 78)	6.8	609200	SEDO	OEPA	WWH	(a), TDS
Symmes Creek near Chesapeake (SR 7)	0.4	609270	SEDO	OEPA		
Ten Mile Creek near New Palestine (SR 749)	1.1	609050	SWDO	OEPA	WWH	(a)
Yellow Creek near Hammondsville (SR 213)	2.5	609260	SEDO	OEPA	WWH	(a), TDS, Al-T, Mn-T
Wheeling Creek near Bridgeport (CR 24)	1.5	609230	SEDO	OEPA	WWH	(a), TDS, Al-T, Mn-T
White Oak Creek below Georgetown (Rt. 221)	5.7	609110	SEDO	OEPA	WWH	(a), TDS

(a) Nutrients (Nitrate-Nitrite, Total Phosphorus, TKN, NH_3-N) are deleted from the minimum parameters list.

Table II-2: Lake Sampling Locations and Parameter Sampling Schedules - Lake Stations

	Station Location[a]		Sampling Period[b]			Sampling Depth[c]		
PARAMETER (Chemical/Physical)	1	2	Sp	Su	P	Sur	Bot	I
Acidity, Total, $CaCO_3$	X		X	X		X	X	
Alkalinity, Total, $CaCO_3$	X		X	X		X	X	
Arsenic, Total, As	X		X					X
Barium, Total, Ba	X		X					X
BOD, 5 day	X		X	X		X	X	
Boron, Total, B	X		X					X
Cadmium, Total, Cd	X		X					X
Calcium, Total, Ca	X		X					X
Carbon, Total Org., C	X		X	X			X	
Chloride, Cl	X		X					X
Chromium, Total, Cr	X		X					X
Cobalt, Total, Co	X		X					X
COD	X		X	X		X	X	
Color	X		X	X		X	X	
Conductivity (field)	X	X	X	X	X			
Copper, Total, Cu	X		X					X
Dissolved Oxygen (field)	X	X	X	X	X			
Fecal Coli, Total, MF	X		X	X		X	X	
Fecal Strep, Total, MF	X		X	X		X	X	
Fluoride, Diss., F	X		X					X
Hydrogen Sulfide, H_2S	X		X	X			X	
Iron, Total, Fe	X		X					X
Lead, Total, Pb	X		X					X
Magnesium, Total, Mg	X		X					X
Manganese, Total, Mn	X		X					X
MBAS	X		X					X
Mercury, Total, Hg	X		X					X
Molybdenum, Total, Mo	X		X					X
Nickel, Total, Ni	X		X					X
Nitrate, NO_3 as N	X		X	X		X	X	
Nitrite, NO_2 as N	X		X	X		X	X	

Table II-2: (Continued)

PARAMETER (Chemical/Physical)	Station Location[a] 1	2	Sampling Period[b] Sp	Su	Sampling Depth[c] P	Sur	Bot	I
Nitrogen, Ammonia, N	X		X	X		X	X	
pH (field)	X	X	X	X	X			
Phosphorus, Dissolved, P	X		X	X		X	X	
Phosphorus, Total, P	X		X	X		X	X	
Potassium, Total, K	X		X					X
Residue, Total Flt., TDS	X		X					X
Residue, Total Nflt., TSS	X		X					X
Secchi Disc	X	X	X	X				
Selenium, Total, Se	X		X					X
Silica, Total (Diss), SiO_2	X		X	X		X	X	
Silver, Total, Ag	X		X					X
Sodium, Total, Na	X		X					X
Sulfate, SO_4	X		X					X
Total Kjeldahl Nitrogen	X		X	X		X	X	
Turbidity	X		X	X		X	X	
Water Temperature (field)	X	X	X	X	X			
Zinc, Total, Zn	X		X					X
PARAMETER (Biological)								
Phytoplankton								
Total Count	X		X	X				X
Identification (Principal Genera)	X		X	X				X
Chlorophyll a	X		X	X				
Macrophyte Observations			X	X				

a. Primary lake stations (1); secondary lake stations (2)

b. Spring (Sp); Summer (Su)

c. Profile (P); Surface (Sur) samples are taken at a depth of 2 feet; Bottom (Bot); Integrated (I)

Table II-3: Lake Survey Station Locations and Parameter Sampling Schedules - Inflow Stream Stations[a]

PARAMETER	PARAMETER
Carbon, Total Org., C	Nitrite, NO_2 as N
Color	pH (field)
Conductivity (field)	Phosphorus, Total, P
Dissolved Oxygen (field)	Total Kjeldahl Nitrogen
Flow (USGS)	Turbidity
Nitrate, NO_3 as N	Water Temperature (field)

a. All parameters are sampled in spring and summer, and are taken at a depth of 6 inches (surface) except total organic carbon, which is a bottom sample.

Table II-4: Tentative List of Lakes to be Surveyed in 1980*.

Amick Reservoir (Morrow Co.)	Delaware Reservoir (Delaware Co.)
Barnesville City Reservoir (Belmont Co.)	Findlay Lake (Lorain Co.)
Barkcamp Lake (Belmont Co.)	O'Shaughnessy Reservoir (Franklin Co.)
Beach City Reservoir (Tuscarawas Co.)	Pleasant Hill Lake (Ashland Co.)
Beaver Creek Reservoir (Seneca Co.)	Pymatuning Lake (Ashtabula Co.)
Clouse Lake (Perry Co.)	Sharon Lake (Hamilton Co.)
Van Buren Lake (Hancock Co.)	Summit Lake (Summit Co.)
Newport Lake (Mahoning Co.)	

*This list will be finalized by April 15.

Table II-5: Minimum Parameters and Sampling Frequency for the Seasonal Lakes Monitoring Program[a]

Parameters	Units
pH	SU
Temperature	^{o}C
Dissolved Oxygen	mg/l
Conductivity	UNHOS/cm @25°C
Fecal Coliform	#/100ml
Total phosphorus	mg/l
Total kjeldahl nitrogen	mg/l
Total Nitrate + Total Nitrite	mg/l
Total suspended solids	mg/l
Transparency (Secchi desk)	ft.

a. All parameters are monitored quarterly.

E. Toxic Substances Monitoring

Ohio EPA currently does not have the laboratory resources to conduct a comprehensive toxics monitoring program. Until such resources are developed, toxics monitoring by Ohio EPA will be limited to that of previous years. A fish tissue analysis program for PCB's and pesticides was conducted in 1977, in cooperation with the Ohio Department of Natural Resources and Department of Agriculture. Fish were collected during 1978 by Ohio EPA, in cooperation with USEPA, Region V. Sample analysis was performed by the USEPA Environmental Research Laboratory-Duluth. A similar program is being conducted in 1979.

Arrangements will be made with the Ohio Department of Health in 1980, to conduct up to 100 analyses for heavy metals and organics on sediment samples. Most of these samples will be taken during the 1980 intensive surveys. Although Ohio EPA possesses the resources to carry out the collection of samples, the extent of the fish tissue monitoring program for 1980 will be entirely dependent upon available analytical capabilities.

F. Radiological Monitoring

Total alpha and gross beta activity, in both dissolved and suspended parameters, are monitored at the stations listed (Table II-6) upon notification of a radiation emergency.

Table II-6: Ohio EPA Emergency Radiological Monitoring Stations[a]

STATION DESCRIPTION	RM	STATION #	DISTRICT	USE DESIGNATION
LAKE ERIE				
Cleveland Nottingham Intake (Cuyahoga Co.)	-	504120	NEDO	EWH(LE),PWS
Toledo Intake (Lucas Co.)	-	504010	NWDO	EWH(LE),PWS
SCIOTO RIVER				
Scioto River at Shadesville (SR 665) (Franklin Co.)		600810	CDO	WWH
GREAT MIAMI RIVER				
Great Miami River near New Baltimore (Hamilton Co.)	20.8	60030	SWDO	WWH

a. Abbreviations are described in the key for Table II-1.

G. Biological Monitoring

The Ohio EPA Biomonitoring Program uses field and laboratory analyses to assess pollution effects on aquatic community structure and pollutant toxic effects on selected test organisms. Data from acute, static bioassays, utilizing both daphnids (*Daphnia pulex*) and fathead minnows (*Pimephales promeles*), are used in Agency enforcement, litigation proceedings, water quality standards compliance assessments, and evaluations of toxic effects of unknown chemical mixtures in effluent discharges.

Field investigations are conducted at 20 locations, as part of the NAWQM Network (Table II-7), and at additional locations where major dischargers impact. Data from these stations are used for long-term trend analyses, and as a measure of effectiveness of Ohio WQS to establish conditions satisfactory to support balanced, aquatic communities. Ten, additional State biomonitoring sites are selected yearly based upon special needs (i.e. intensive surveys, or special surveillance monitoring problems). All biomonitoring investigations emphasize benthos (counts, identifications and diversity indices) and periphyton (counts, identifications, chlorophyll *a* content, biomass and autotrophic indices). In addition, intensive surveys include fish data (relative abundance, species composition, similarity coefficients and diversity indices).

Table II-7: NAWQMN Biomonitoring Sampling Sites[a]

STATION DESCRIPTION	RM	STATION #	DISTRICT	USE DESIGNATION
Great Miami River Basin				
Great Miami River at Dayton	87.1	600310	SWDO	WWH
Mad River at Eagle City	28.7	610040	SWDO	CWH
Little Miami River Basin				
Little Miami River at Old Town	80.0	600570	SWDO	EWH
Scioto River Basin				
Scioto River near Circleville	100.8	601340	CDO	WWH
Scioto River near Richmondale	56.2	600770	SEDO	WWH
Olentangy River near Worthington	12.3	601290	CDO	WWH
Raccoon Creek Basin				
Raccoon Creek near Adamsville	29.6	601400	SEDO	WWH
Ohio Brush Creek Basin				
Ohio Brush Creek near West Union	16.5	600660	SEDO	EWH
Muskingum River Basin				
Muskingum River at McConnellsville	47.7	601860	SEDO	WWH
Licking River below Newark	25.6	601770	CDO	WWH
Mohican River at Greer	16.7	601870	SEDO	WWH
Hocking River Basin				
Hocking River at Athens	33.1	601650	SEDO	WWH

Table II-7: (Continued)

STATION DESCRIPTION	RM	STATION #	DISTRICT	USE DESIGNATION
Conneaut Creek Basin				
Conneaut Creek at Conneaut	6.8	502870	NEDO	CWH
Grand River Basin				
Grand River near Painesville	8.4	502530	NEDO	WWH
Cuyahoga River Basin				
Cuyahoga River at Independence	14.2	502020	NEDO	WWH
Huron River Basin				
Huron River below Milan	12.3	501050	NWDO	WWH
Portage River Basin				
Portage River at Woodville	27.8	500510	NWDO	WWH
Maumee River Basin				
Maumee River at Waterville	21.0	500080	NWDO	WWH
Mahoning River Basin				
Mahoning River at Lowellville	10.3	602300	NEDO	MRS
Black River Basin				
Black River at Elyria	14.9	501520	NEDO	WWH

a. Abbreviations are described in the key for Table II-1.

H. ORSANCO Programs

Ohio is a signatory state of the Ohio River Valley Sanitation Commission (ORSANCO). In May, 1973, the ORSANCO Commission directed a study team composed of the signatory states, the ORSANCO staff, the USEPA, the U.S. Corps of Engineers, and the U.S. Geological Survey (USGS) to prepare a monitoring strategy for the Ohio River and mouths of major tributaries that would satisfy the needs of state, interstate and federal agencies for the appraisal of water quality. ORSANCO published a monitoring strategy in December, 1973, titled, "Water Quality Monitoring Strategy for the Ohio River and Lower Reaches of Major Tributaries."

Ohio EPA endorses the ORSANCO monitoring strategy and relies on ORSANCO monitoring programs for water quality data on the Ohio River. The ORSANCO monitoring strategy addresses (1) Intensive Basin/Segment Surveys, (2) A Primary-In-Stream Monitoring Network, and (3) Compliance Monitoring. The reader is referred to the ORSANCO monitoring strategy document for specific information regarding these three program areas.

The primary in-stream monitoring network consists of 37 stations, 22 located on the Ohio River and 15 in lower reaches of major tributaries. Thirteen primary monitoring stations are located in the 450 mile portion of the Ohio River which borders the State of Ohio. Four, additional stations are located in the lower reaches of major, Ohio tributaries (Table II-8).

ORSANCO also conducts biological monitoring at 13 stations, either located in the Ohio River bordering Ohio, or in lower reaches of major tributaries (Table II-9). Macroinvertebrate count, identification and diversity index are determined from three replicate samples at each station using methods recommended in the USEPA Biological Methods Manual. The macroinvertebrate data are used as an indication of water quality and suitability of the food chain to support balanced fish populations.

Fish are collected at selected locks and dams with rotenone, and are identified, counted and weighed to provide fish species composition and relative abundance data. Edible portions of selected specimens of carp, channel catfish and shiners from each location are preserved and analyzed for concentrations of organic contaminants specified in the USEPA publication "Basic Water Monitoring," 1976.

I. U.S. Geological Survey (USGS) Cooperative Programs

The USGS in Ohio conducts programs for, or cooperatively with, municipal, state and federal agencies. The Ohio EPA engages in a cost sharing contract with the USGS for the collection of water quality data which are generally made available to public and government users. Data collection activities by the USGS in Ohio are described in "Index of Current Water Resources Activities in Ohio" and Geological Survey Circular 719, "The National Stream Quality Accounting Network (NASQAN) - Some Questions and Answers" Ficke, J.F. and Hawkinson, R.O., 1975) and are available from District Chief, USGS, 975 West Third Avenue, Columbus, Ohio 43212 (614-469-5553).

Table II-8: ORSANCO Primary Stream Monitoring Network, Ohio Portion - The Ohio River and Major Ohio Tributaries

Station	Approximate Mile Point	Type(a)
Ohio River, Pennsylvania-Ohio Border	40	A
Ohio River, above Wheeling	87	A
Ohio River, below Wheeling	126	A
Ohio River, Willow Island Dam	162	B
Muskingum River	6	B
Ohio River, below Little Kanawha River	192	B
Ohio River, Kyger Creek	260	A
Ohio River Gallipolis Dam	279	A
Ohio River, above Huntington	304	A
Ohio River, below Huntington	316	B
Ohio River, Greenup Dam	341	A
Scioto River	15	B
Ohio River, Meldahl Dam	436	B
Ohio River, above Cincinnati	463	A
Little Miami River	4	B
Great Miami River	6	A
Ohio River, Indiana-Ohio Border	490	A

a - Automatic Water Quality Monitor and Manual Sampling(A); Manual Sampling Only(B)

Table II-9: ORSANCO Biological Monitoring Network, Ohio Portion - The Ohio River and Major Ohio Tributaries

Station	Approximate Mile Point	Monitoring Parameter
Ohio River at Pike Island Dam	84.2	Macroinvertebrates, Fish
Ohio River at Hannibal Dam	126.4	Macroinvertebrates, Fish
Ohio River at Willow Island Dam	161.8	Macroinvertebrates
Muskingum River near lock and Dam #2	5.8	Macroinvertebrates
Ohio River at Belleville Dam	203.9	Macroinvertebrates, Fish
Ohio River at Addison	260.0	Macroinvertebrates
Ohio River at Gallipolis Dam	279.2	Macroinvertebrates, Fish
Ohio River at Huntington	304.2	Macroinvertebrates
Ohio River at Greenup Dam	341.0	Macroinvertebrates
Scioto River near Lucasville	15.0	Macroinvertebrates
Ohio River at Meldahl Dam	436.2	Macroinvertebrates, Fish
Little Miami at Cincinnati	7.5	Macroinvertebrates
Great Miami near Elizabethtown	5.5	Macroinvertebrates

The Ohio EPA/USGS cooperative program consists of stream gaging, automatic water quality monitoring, manual water quality sampling, time of travel analysis and lake water quality assessment. The program operates 32 fixed stream gaging stations and 27 fixed, automatic water quality monitors. Ohio EPA ambient monitoring stations are coordinated, when possible, with these fixed gaging and continuous monitoring sites.

The USGS operates 9 National Stream Quality Accounting Network (NASQAN) stations in Ohio, as part of the National Ambient Water Quality Monitoring Network. Systematic, continuous measurements are made at NASQAN stations (Table II-10) which emphasize long-term trend analyses of the quality of the Nation's streams.

J. Lake Erie and IJC Programs

Ohio EPA, in cooperation with USEPA and the International Joint Commission on the Great Lakes (IJC), conducts a monitoring program utilizing parameters requested by IJC. There are 17 IJC sampling sites; 12 Lake Erie tributaries (Table II-11) and 5 water intakes (Table 12). Samples are collected and analyzed for 43 parameters at the specified tributary sites, and for 47 parameters at the water intakes. Sampling frequency ranges from 1 to 26 times annually, depending upon the parameter (Tables 11 and 12).

Table II-10: Ohio NASQAN Stations[a]

Station Description	RM	Station #	District	Use Designation
Cuyahoga River				
Cuyahoga River at Independence (Old Rockside Rd.)	13.5	502020 (04208000)	NEDO	WWH
Grand River				
Grand River near Painesville (Rt. 84)	8.7	502530 (04212200)	NEDO	WWH
Great Miami River				
Great Miami River at New Baltimore (Blue Rock Rd.)	20.8	600030 (03274600)	SWDO	WWH
Hocking River				
Hocking River at Athens (U.S. 33)	39.6	601650 (03159510)	SEDO	WWH
Little Miami River				
Little Miami River at Milford (U.S. 50)	12.7	600520 (03245500)	SWDO	WWH
Maumee River				
Maumee River at Waterville (Rt. 64)	20.8	500080 (04193500)	NWDO	WWH
Muskingum River				
Muskingum River at McConnelsville (Rt. 37)	48.2	601860 (03150000)	SEDO	WWH
Sandusky River				
Sandusky River at above Fremont (Rice Rd.)	20.3	500820 (04198000)	NWDO	WWH
Scioto River				
Scioto River near Richmondale (Higby Rd.)	56.0	600770 (03234500)	SEDO	WWH

a. Abbreviations are described in the key for Table II-1.

TABLE II-11: Lake Erie (IJC) Tributary Sampling Locations and Parameter Sampling Frequency

	Ashtabula River	Black River	Chagrin River	Conneaut Creek	Cuyahoga River	Grand River	Huron River	Maumee River	Portage River	Rocky River	Sandusky River	Vermilion River
Alkalinity	12	12	12	12	12	12	12	12	12	12	12	12
Aluminum, Total	2	2	2	2	2	2	2	2	2	2	2	2
Ammonia-N, Total	12	12	12	12	12	12	12	12	12	12	12	12
Arsenic, Total	2	2	2	2	2	2	2	2	2	2	2	2
Cadmium, Total	6	12	6	6	6	6	6	6	6	6	6	6
COD	12	12			12	12	12					
Chloride	12	12	12	12	12	12	12	12	12	12	12	12
Chromium, Total	6	12	6	6	6	6	6	6	6	6	6	6
Copper, Total	12	12	6	6	12	12	6	6	6	6	6	6
Dissolved Organic Carbon	12	12	12	12	26	12	12	26	12	12	12	12
Dissolved Oxygen	12	12	12	12	12	12	12	12	12	12	12	12
Dissolved Silicate, Total	12	12	12	12	12	12	12	12	12	12	12	12
Dissolved Solids, Total	12	12			12	12		12				
Fecal Coliform	12	12	12	12	12	12		12		12	12	
Flow	12	12	12	12	12	12	12	12	12	12	12	12
Fluoride					12							
Hardness	12	12	6	6	12	12	6	6	6	6	6	6
Iron, Total	6	6	6	6	12	6	6	6	6	6	6	6
Lead, Total	12	6	6	6	12	6	6	6	6	6	6	6
Manganese	2	2	2	2	2	2	2	2	2	2	2	2
MBAS					12	12						
Mercury, Total	6	6	6	6	6	6	6	6	6	6	6	6

TABLE II-11: (Continued)

	Ashtabula River	Black River	Chagrin River	Conneaut Creek	Cuyahoga River	Grand River	Huron River	Maumee River	Portage River	Rocky River	Sandusky River	Vermilion River
Nickel, Total	6	6	6	6	6	6	6	6	6	6	6	6
Nitrate-Nitrite	12	12	12	12	12	12	12	12	12	12	12	12
Oil & Grease	*	*	*	*	*	*	*	*	*	*	*	*
Organic Scan	1	1	1	1	1	1	1	1	1	1	1	1
Phenolics	12	12	12	12	12	12				12		
Phosphorus, Soluable Reactive	12	12	12	12	12	12	12	12	12	12	12	12
Phosphorus, Total	12	12	12	12	12	12	12	12	12	12	12	12
pH	12	12	12	12	12	12	12	12	12	12	12	12
Phthalic Acid Esters		12			12							
Polychlorinated Biphenyls		12			12							
Selenium, Total	2	2	2	2	2	2	2	2	2	2	2	2
Specific Conductance	12	12	12	12	12	12	12	12	12	12	12	12
Sulphate	12	12	12	12	12	12	12	12	12	12	12	12
Suspended Solids	12	12	12	12	12	12	12	12	12	12	12	12
Total kjeldahl Nitrogen	12	12	12	12	12	12	12	12	12	12	12	12
Total Organic Carbon	12	12	12	12	26	12	12	26	12	12	12	12
Turbidity	12	12	12	12	12	12	12	12	12	12	12	12
Vanadium, Total	2	2	2	2	2	2	2	2	2	2	2	2
Water Temperature	12	12	12	12	12	12	12	12	12	12	12	12
Zinc, Total	12	12	6	6	12	12	6	6	6	6	6	6

Table II-12: Lake Erie (IJC) Intake Sampling Locations and Parameter Sampling Frequency

	Ashtabula	Cleveland Crown	Oregon	OWS Mentor	Sandusky
Aldrin/Dieldrin		4	4		
Alkalinity	12	12	12	12	12
Aluminum, Total		4	4		
Ammonia-N, Total	12	12	12	12	12
Arsenic, Total		4	4		
Cadmium, Total		4	4		
Chlordane		4	4		
Chloride	12	12	12	12	12
Chromium, Total		4	4		
Copper, Total		4	4		
Cyanide		4	4		
DDT & Metabolites		4	4		
Diazinon		4	4		
Dissolved Oxygen		12	12		
Dissolved Silicate, Total	12	12	12	12	12
Endrine		4	4		
Fecal Coliform	12	12	12	12	12
Fecal Streptococci		12	12		
Fluoride		4	4		
Hardness		4	4		
Heptachlor		4	4		
Iron, Total		4	4		
Lead, Total		4	4		

TABLE II-12: (Continued)

	Ashtabula	Cleveland Crown	Oregon	OWS Mentor	Sandusky
Lindane		4	4		
Mercury, Total		4	4		
Methoxychlor		4	4		
Mirex		4	4		
Nickel, Total		4	4		
Nitrate-Nitrite	12	12	12	12	12
Parathion		4	4		
Phenolics		4	4		
Phosphorus, Soluble Reactive		12	12		
Phosphorus, Total	12	12	12	12	12
pH	12	12	12	12	12
Phthalic Acid Esters		4	4		
Polychlorinated Biphenyls		4	4		
Selenium, Total		4	4		
Specific Conductance	12	12	12	12	12
Sulfate	12	12	12	12	12
Taste & Odor		12	12		
Total Kjeldahl Nitrogen	12	12	12	12	12
Toxaphene		4	4		
Turbidity	12	12	12	12	12
Vanadium, Total		4	4		
Water Temperature	12	12	12	12	12
Zinc, Total		4	4		

K. Ground Water

Monitoring Programs

The collection of ground-water quality data in Ohio has been conducted by the State for a number of years. A sampling and analyses program of all municipal ground-water supplies was initiated by the Ohio Department of Health more than 40 years ago. Sampling continued on an annual or bi-annual schedule through the early 1970's with many of the originally sampled wells still in service. Since mid-1972, this surveillance function has been under the direction of the Ohio EPA, Office of Public Water Supply. Between 500 and 600 municipal ground water supplies are regularly sampled and more than 10,000 analyses are on file in the Agency. From 15 to 20 chemical parameters are recorded for each sample. The basis for the program has been to provide a continuing record of water quality so that any departures from the required standards for public water supplies can be immediately recognized and corrected.

A systematic data collection program on ground-water quality was initiated by the Ohio Department of Natural Resources in the early 1960's and included one-time sampling and analyses of several hundred selected wells throughout the State. This continuing program primarily emphasizes sampling private wells in areas of high development potential and is now administered by the Ohio EPA, Division of Ground Water. The purpose of the program is to provide broad areal coverage on ground-water quality for the purpose of adequately defining ambient water-quality ranges for each of Ohio's major aquifer systems. At present, a total of approximately 1500 detailed analyses from private sources are contained in the files of the Agency.

An ambient monitoring program for recognizing seasonal and annual changes in ground-water quality was initiated in 1967, and included semi-annual sampling and analyses of 12 producing wells on a continuing, long-term basis. Most of the sampling sites were high-capacity industrial or municipal wells developed in the principal valley aquifers along the Ohio River and the major tributaries and in the principal bedrock aquifers. One of the provisions of the Federal Water Pollution Control Act Amendments of 1972 called for the development of a statewide mopnitoring program in areas of high ground-water utilization. To conform with the recommendations of this Act and to provide a more comprehensive picture of water-quality changes, the original monitoring network was expanded in 1974 to include a total of 60 stations. Most of the stations in the current network are situated in urban or industrial areas where potential pollution sources are likely to be concentrated. The site locations (Figures 1 and 2) and descriptions of each well (Tables 1 and 2), are arranged according to major aquifer systems. The sampling schedule for the current program has continued on a semi-annual basis at times of the year which roughly coincide with seasonal extremes in ground-water levels.

Another monitoring program of the Division of Ground Water includes the regular sampling of ground-water quality in the vicinity of potential, pollution sources to provide early detection of ground-water pollution problems. This monitoring activity consists of semi-annual sampling and analyses of cluster wells around selected landfills, waste lagoons, spray irrigation sites and other sources where ground-water quality may be susceptible to pollution. The purpose is to provide information for measuring and evaluating the adequacy of waste disposal activities as they relate to local geologic conditions. Included in this pollution source network are 20 landfill sites, 24 industrial lagoons, 5 coal stock piles, and 7 miscellaneous sites. The site locations and the number of monitor wells at each site are shown in Figure 3. An average of 300 water samples are collected annually as part of this program.

Chemical Parameters

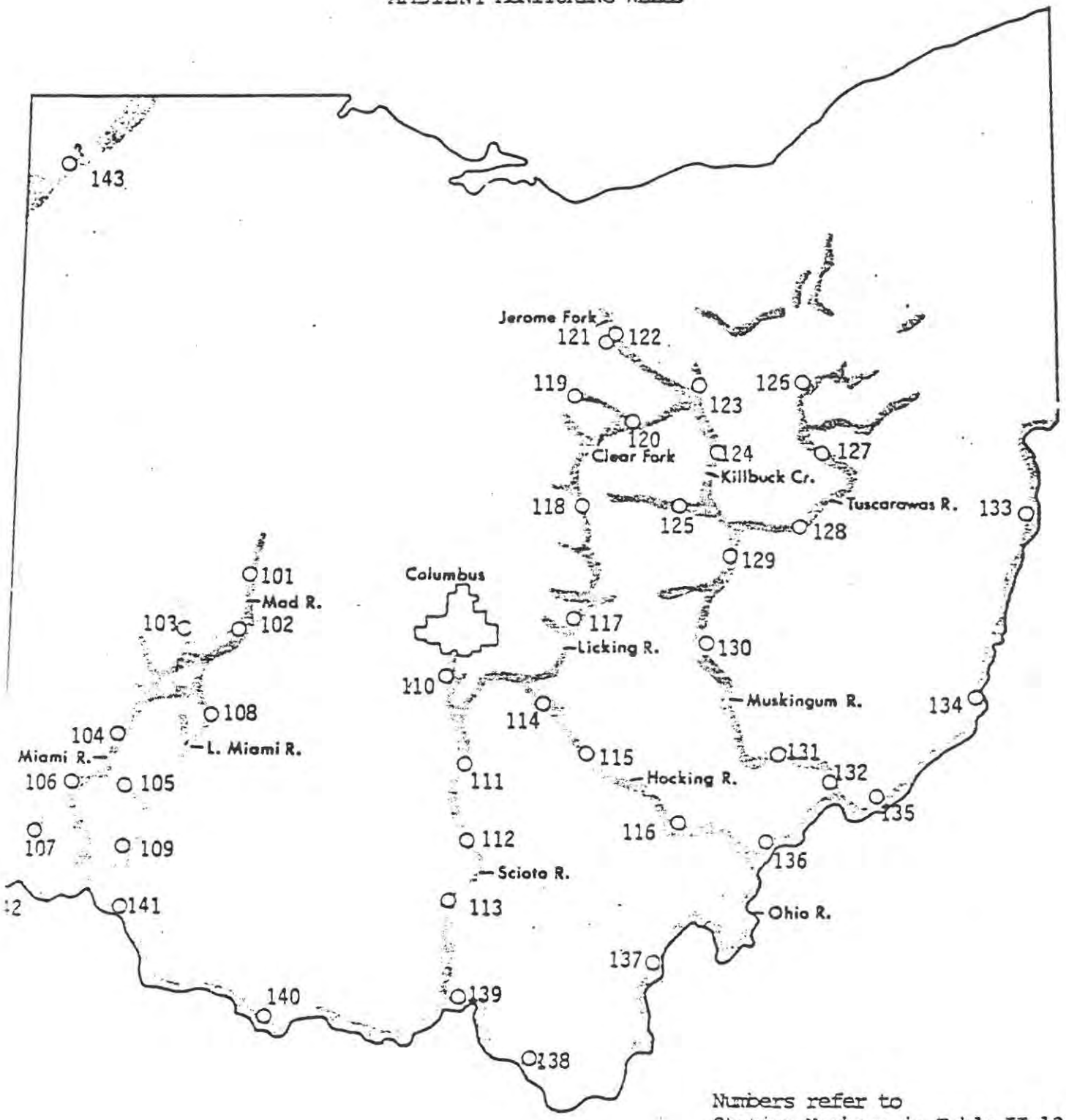
The early surveillance program for public ground water supplies included routine determinations in raw water for total dissolved solids, total alkalinity, hardness, pH, calcium, magnesium, sodium, iron, manganese, sulfate, chloride, fluoride and nitrate. Since the early 1970's, other heavy metal determinations are regularly conducted and include arsenic, barium, cadmium, chromium, copper, lead, mercury, silver and zinc. Analyses for ammonia, phosphate, selenium and MBAS are also conducted on a regular basis. Radiological analyses and pesticide scans are done on an occasional basis. With the enactment of the Federal Safe Drinking Water Act in 1975, the current sampling program is directed largely toward analyses of finished water quality and primary drinking water parameters.

The ambient ground-water monitoring for major aquifer systems includes regular determinations for dissolved solids, total alkalinity, sulfate, chloride, nitrate, ammonia, calcium, magnesium, sodium, iron, chromium, lead, chemical oxygen demand, total organic carbon and MBAS. Occasional or periodic analyses are conducted for phenol, barium, cadmium, and phosphate.

The pollution source monitoring program includes varying chemical parameters selected on the basis of the type of land disposal facility and the character of the wastes. Conventional sanitary landfills may involve as many as 20 specific chemical parameters, while the routine monitoring of wells around coal piles generally include around six or eight parameters.

FIGURE II-1

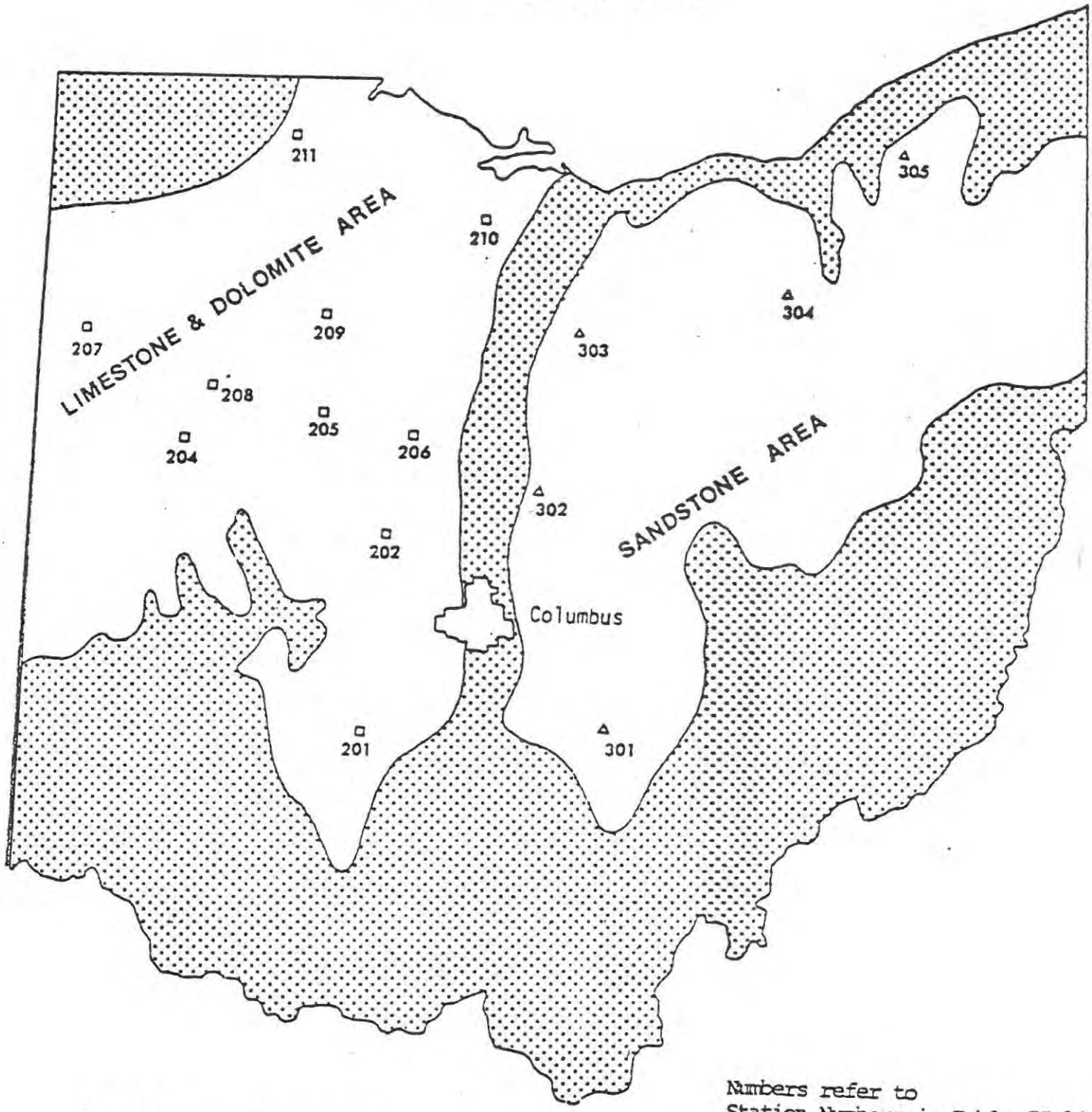
VALLEY AQUIFER SYSTEMS
AND
AMBIENT MONITORING WELLS



Numbers refer to
Station Numbers in Table II-13

FIGURE II-2

BEDROCK AQUIFER SYSTEMS
AND
AMBIENT MONITORING WELLS



Numbers refer to
Station Numbers in Table II-14

Shaded areas underlain by
shale and other rocks of
low ground-water potential

FIGURE II-3

OHIO GROUND WATER QUALITY
POLLUTION SOURCE MONITORING
(SEMI-ANNUAL SAMPLING)

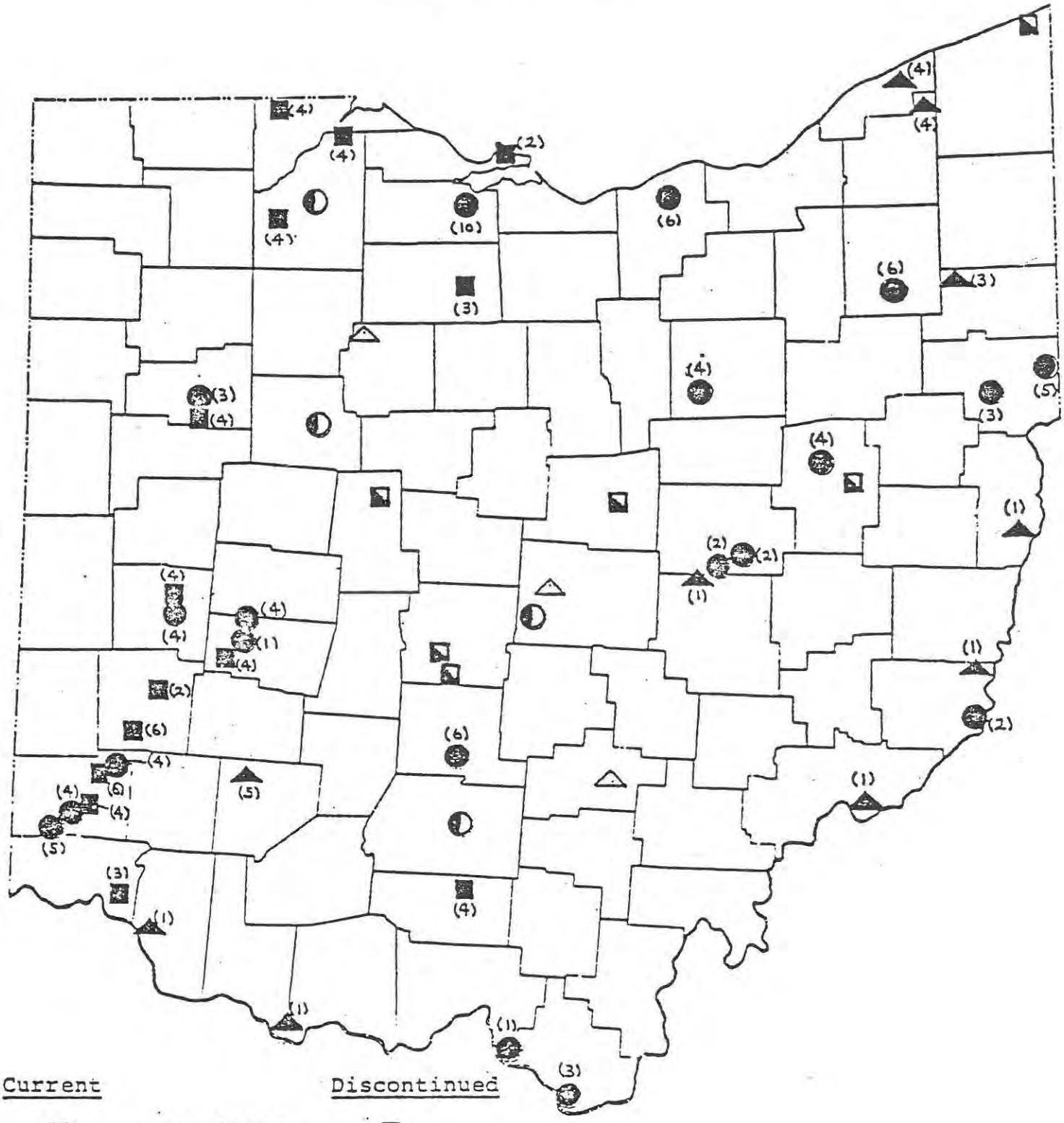


TABLE II-13

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				MIAMI AND MAD RIVER AREA						
101	40°05'08"	83°48'01"	Champaign	Urbana	Southwest	1	63	1500	ODH	Jun.'73
102	39°58'35"	83°49'17"	Clark	Springfield	Southwest	1	80	2800	USGS	Jun.'67
103	40°02'58"	84°12'28"	Miami	Troy	Southwest	1	125	2100	USGS	Aug.'69
104	39°38'53"	84°17'07"	Montgomery	Miamisburg	Southwest	2	65	1600	USGS	Sep.'72
105	39°26'20"	84°19'07"	Warren	Lebanon	Southwest	5	129	750	ODH	Jan.'74
106	39°24'45"	84°33'30"	Butler	Hamilton	Southwest	2	181	1100	USGS	Dec.'65
107	39°17'48"	84°39'38"	Hamilton	Venice	Southwest	2	140	9000	USGS	Oct.'64
				LITTLE MIAMI RIVER AREA						
108	39°42'59"	83°58'04"	Greene	Xenia	Southwest	6	67	520	ODH	Dec.'73
109	39°16'34"	84°15'26"	Hamilton	Loveland	Southwest	1	70	1800	USGS	Jun.'67

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-13 (Continued)

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				SCIOTO RIVER AREA						
110	39°47'38"	83°00'33"	Pickaway	Shadeville	Central	3	100	600	ODH	Jun.'73
111	39°33'25"	82°57'11"	Pickaway	Circleville	Central	2	135	1500	USGS	Jun.'67
112	39°19'22"	82°57'44"	Ross	Chillicothe	Southeast	2	90	2800	ODH	Jan.'72
113	39°06'33"	82°58'45"	Pike	Waverly	Southeast	1	70	1000	ODH	Nov.'73
				HOCKING RIVER AREA						
114	39°42'00"	82°35'04"	Fairfield	Lancaster	Central	2	25	55	ODH	Jun.'73
115	39°31'10"	82°22'12"	Hocking	Logan	Southeast	2	25	-	ODH	Jun.'73
116	39°19'34"	82°06'50"	Athens	Athens	Southeast	1	52	800	USGS	Jun.'67

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-13 (Continued)

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				MUSKINGUM BASIN TRIBUTARIES AREA						
117	40°01'12"	82°26'23"	Licking	Heath	Central	1	200	500	ODH	Jun.'73
118	40°24'06"	82°29'45"	Knox	Mt. Vernon	Northwest	2	96	950	ODH	Jul.'73
119	40°44'46"	82°28'55"	Richland	Mansfield	Northwest	6	114	600	ODH	Jan.'74
120	40°39'26"	82°18'24"	Ashland	Perrysville	Northwest	2	84	300	ODH	Jan.'74
121	40°53'03"	82°17'08"	Ashland	Ashland	Northwest	1	91	800	ODH	Jun.'73
122	40°52'58"	82°17'01"	Ashland	Ashland	Northwest	1	326	750	ODH	Jun.'73
123	40°46'21"	81°56'44"	Wayne	Wooster	Northeast	2	101	100	ODH	Jan.'74
124	40°37'36"	81°55'10"	Holmes	Holmesville	Southeast	2	90	500	ODH	Nov.'73
125	40°19'57"	81°59'43"	Coshocton	Warsaw	Southeast	2	76	120	ODH	Nov.'73

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-13 (Continued)

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				TUSCARAWAS AND MUSKINGUM RIVER AREA						
126	40°46'49"	81°31'39"	Stark	Massillon	Northeast	2	137	500	ODH	Jun.'73
127	40°32'10"	81°29'31"	Tuscarawas	Dover	Southeast	1	103	2100	USGS	Jun.'67
128	40°15'53"	81°36'30"	Tuscarawas	Newcomerstown	Southeast	2	90	50	ODH	Jun.'73
129	40°11'02"	81°52'53"	Coshocton	Conesville	Southeast	3	92	2000	ODH	Jul.'73
130	39°57'53"	81°59'35"	Muskingum	Zanesville	Southeast	1	65	900	USGS	Jun.'67
131	39°35'23"	81°40'47"	Washington	Beverly	Southeast	3	63	180	ODH	Jun.'73
132	39°25'56"	81°28'15"	Washington	Marietta	Southeast	1	30	1027	USGS	Jun.'73

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-13 (Continued)

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				OHIO RIVER AREA						
133	40°18'53"	80°36'11"	Jefferson	Mingo Junction	Southeast	1	74	1000	USGS	Jun.'67
134	39°46'50"	80°51'32"	Monroe	Clarington	Southeast	1	70	165	ODH	Jun.'73
135	39°21'41"	81°19'18"	Washington	Marietta	Southeast	5	-	-	ODH	Jun.'73
136	39°16'39"	81°40'02"	Washington	Porterfield	Southeast	1	60	400	ODH	Jun.'73
137	38°50'00"	82°09'46"	Gallia	Gallipolis	Southeast	4	60	30	ODH	Dec.'73
138	38°30'36"	82°40'02"	Lawrence	Ironton	Southeast	2	84	400	ODH	Jun.'73
139	38°45'00"	82°56'02"	Scioto	New Boston	Southeast	2	81	-	ODH	Jun.'73
140	38°38'14"	83°41'18"	Adams	Aberdeen	Southeast	3	107	585	ODH	Apr.'73
141	38°59'33"	84°17'46"	Clermont	New Richmond	Southwest	3	113	620	ODH	May '73
142	39°06'45"	84°48'05"	Hamilton	North Bend	Southwest	2	133	650	USGS	Nov.'64

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-13 (Continued)

VALLEY AQUIFER MONITORS

(Wells Developed in Sand and Gravel)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
				NORTHWEST OHIO OUTWASH AREA						
143	41°28'53"	84°32'20"	Williams	Bryan	Northeast	1	137	1800	USGS	Jun.'67

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-14

BEDROCK AQUIFER MONITORS

(Wells Developed in Limestone and Dolomite)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
201	39°31'15"	82°25'27"	Fayette	Washington C.H.	Central	2	185	100	ODH	Jan.'74
202	40°14'16"	83°21'17"	Union	Marysville	Central	2	210	-	ODH	Mar.'73
204	40°34'03"	84°12'57"	Auglaize	Wapakoneta	Northwest	1	268	600	USGS	Jun.'67
205	40°37'38"	83°37'25"	Hardin	Kenton	Northwest	2	400	400	ODH	Jun.'73
206	40°34'23"	83°17'05"	Marion	New Bloomington	Northwest	5	290	500	ODH	Jun.'73
207	40°51'33"	84°35'22"	Van Wert	Van Wert	Northwest	2	400	130	ODH	Jan.'74
208	40°42'56"	84°08'00"	Allen	Lima	Northwest	2	415	700	ODH	May '74
209	41°01'46"	83°39'38"	Hancock	Findlay	Northwest	2	310	250	ODH	Jun.'73
210	41°15'30"	83°04'46"	Sandusky	Green Springs	Northwest	5	108	500	ODH	May '74
211	41°31'46"	83°51'15"	Lucas	Whitehouse	Northwest	5	250	500	ODH	May '74

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

TABLE II-14 (Continued)

BEDROCK AQUIFER MONITORS

(Wells Developed in Sandstone)

Station Number	Latitude	Longitude	County	Nearest Town	Ohio EPA District	(a) Use Code	Well Depth (Feet)	(b) Well Yield	(c) Analysis by	Start of Record
301	39°39'33"	82°27'11"	Hocking	Rockbride	Southeast	4	215	12	ODH	Jan.'74
302	40°38'28"	82°50'00"	Morrow	Mt. Gilead	Northwest	2	75	80	ODH	Jan.'74
303	40°45'02"	82°29'10"	Richland	Mansfield	Northwest	2	200	500	ODH	Jan.'74
304	41°00'40"	81°42'49"	Medina	Wadsworth	Northeast	1	227	450	USGS	May '67
305	41°27'38"	81°17'57"	Geauga	South Russell	Northeast	4	136	40	ODH	Jan.'74

(a) Use Code:
1. Public Water Supply
2. Industrial Use
3. Electric Power Plant
4. Private or Commercial Supply
5. State Owned Facility
6. Municipal Sewage Treat. Plant

(b) Well Yield: As reported in Gallons/Minute

(c) Analyses by:
ODH - Ohio Department of Health
USGS - U.S. Geological Survey

III. DATA HANDLING, STORAGE AND REPORTING

Data and information from the State's water monitoring programs are made available to USEPA in the form, volume and manner agreed upon by the State and the Regional Administrator. The details of this agreement may be found in the Annual Program Plan.

A. Compliance Monitoring

Ohio EPA Compliance Monitoring Program data is processed by LEAPS, a comprehensive data storage and processing system designed and used by Ohio EPA. NPDES permit holders submit data which is stored, processed and screened by LEAPS to determine exceptions to entities' permit requirements. Data stored and processed by LEAPS are reported to USEPA per "Memorandum of Agreement" under Ohio's 402b Application.

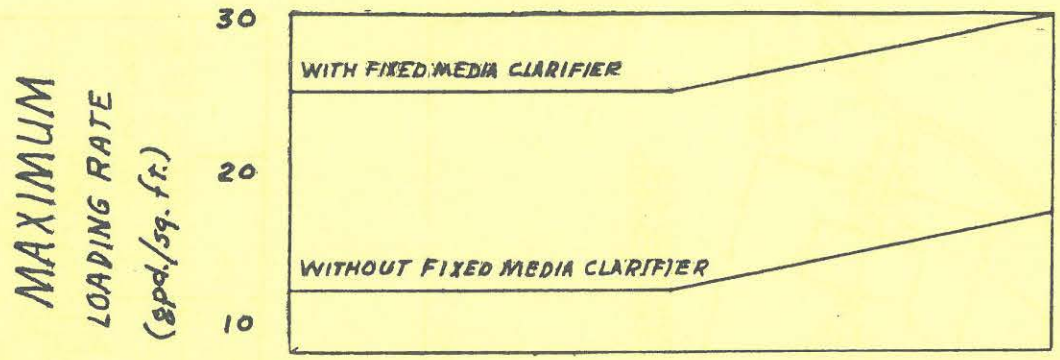
B. Fixed Station Monitoring

Fixed Station Monitoring data is entered into the STORET System, edited and checked for accuracy. USGS data is stored in the USGS computerized data storage system and then transferred to STORET. ORSANCO data is stored in the ORSANCO electric data processing system. The time frame for entering data into these systems from the time of sampling to final editing depends upon several variables including laboratory turn around, key-punching loads and "uptime" on STORET. Generally, 3 months are required for data processing, reporting and storage.

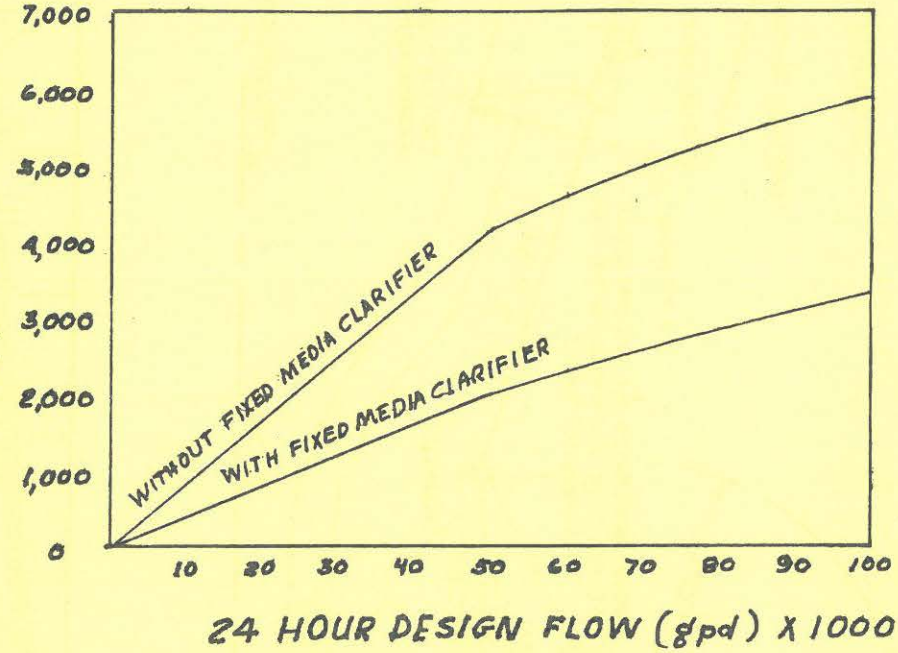
C. Fish Information System (FINS)

The State Data Center, DEC system, is being used to develop the Fish Information System (FINS) for the purpose of storing and analyzing fish relative abundance data.

APPENDIX



Ottawa and Kind & Circuit are volume 3



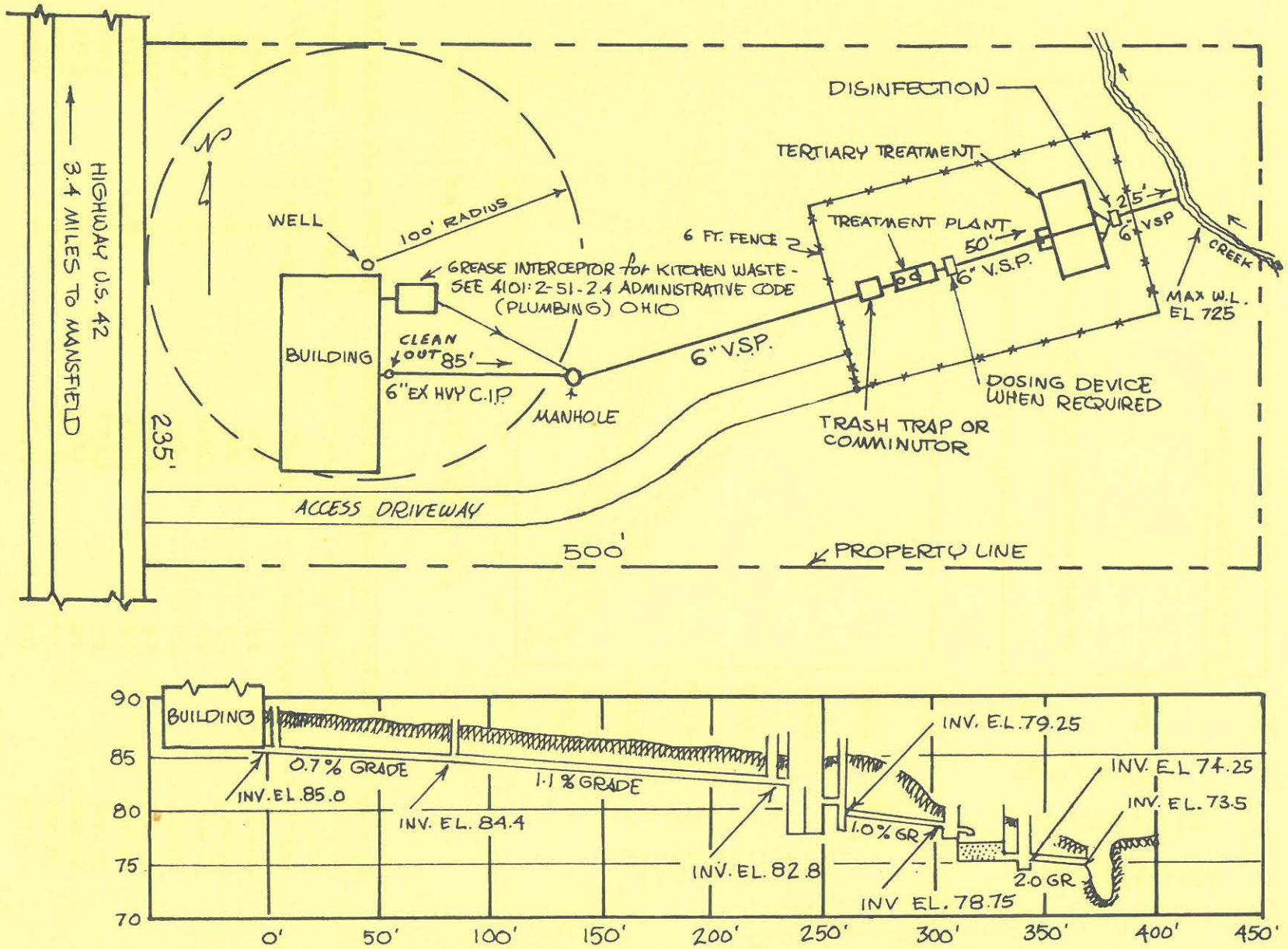
24 HOUR DESIGN FLOW (gpd)	WITH FIXED MEDIA CLARIFIER		WITHOUT FIXED MEDIA CLARIFIER	
	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)
10,000	25	400	12	833
20,000	25	800	12	1,667
30,000	25	1,200	12	2,500
40,000	25	1,600	12	3,333
50,000	25	2,000	12	4,167
60,000	26	2,308	13	4,615
70,000	27	2,593	14	5,000
80,000	28	2,857	15	5,333
90,000	29	3,103	16	5,625
100,000	30	3,333	17	5,882

SLOW SAND FILTERS - LOADING RATE AND AREA

(SEE PAGE 16)

TYPICAL SITE PLAN AND PROFILE

(SEE PAGES 3 & 9)
DRAWING No. 1



THE SUBBASIN REPORTS VOLUME

PART 3

THE PREPARATION OF THE SUBBASIN REPORTS VOLUME
(Volumes IV, V and VI of the 1980b 305(b) report)

OBJECTIVE(S):

1. To provide a comprehensive evaluation of existing stream water quality. Physical/chemical, biological (fish and benthos), sediment and fish tissue analysis data should be integrated whenever possible.

2. To compare existing stream water quality to State Water Quality Standards.

3. To compare existing stream water quality to National Water Quality Goals.

4. To identify parameter type(s), or parameter areas (i.e., metals, nutrients, etc.), locate (point source and/or nonpoint source category), and assess the severity of existing water quality problems. Point source categories include; 1. Municipal and 2. Industrial Nonpoint source categories include; 1. Combined Sewer Overflow 2. Urban, 3. Agriculture, 4. Silviculture, 5. Mining, 6. Hydrologic Modification, 7. Individual Disposal, 8. Solid Waste Disposal, 9. Construction 10. Natural and 11. Other (specify).

5. To project water quality conditions after the implementation of pollution controls.

6. To report water quality trends (both physical/chemical and biological) and assess water quality improvements or degradation, when possible. Trends should be evaluated as follows: 1. Improvement, 2. Degradation, 3. No Change and 4. Trend Unknown.

RESPONSIBILITIES:

1. Reorganize the 1980 305(b) Volume IV text - 305(b) COORDINATOR.

2. Enter reorganized text into Wang - SECRETARY.

3. Combine and integrate texts of the 1980 305(b) Volumes IV and VI - 305(b) COORDINATOR.

4. Enter reorganized text (Volumes IV and VI) into Wang - SECRETARY.

5. Combine and integrate text of reorganized Volumes IV and VI with the 1980 305(b) Volume V text, if possible - 305(b) COORDINATOR.

6. Enter reorganized text of Volumes IV, V and VI - SECRETARY.

7. Provide a supercopy of the reorganized text (Volumes IV, V and VI) to the 305(b) Coordinator - SECRETARY.

8. Send a supercopy of the reorganized text (Volumes IV, V and VI) to District Surveillance and Biological Laboratory Personnel and the Intensive Survey Coordinator - 305(b) COORDINATOR.

9. Evaluate current and past data and write updated subbasin reports - DISTRICT SURVEILLANCE AND BIOLOGICAL LABORATORY PERSONNEL AND INTENSIVE SURVEY COORDINATOR.

10. Enter updated subbasin reports into the Wang - SECRETARY.

11. Edit, organize and proof draft of subbasin reports - 305(b) COORDINATOR AND DISTRICT SURVEILLANCE AND BIOLOGICAL LABORATORY PERSONNEL AND INTENSIVE SURVEY COORDINATOR.

GENERAL OVERVIEW AND PROCEDURE:

1. The 1980 305(b) Volume IV text has been reorganized in the following manner. Delineated segments (both mainstem and tributary) were arranged in decreasing river mile order. Evaluated tributary segments also appear in a geographical sequence (at the proper mainstem river mile).

   REASON:

   This reorganization allows the reader to follow segment/stream water quality impact(s) from source to mouth. The effects on downstream segments from the impact(s) occurring in preceeding degraded segments can be more easily evaluated.

2. The 1982 305(b) Subbasin Volume will be a "comprehensive" report (i.e., there will not be a separate Biological Volume similar to the 1980 305(b) Volume VI). The subbasin reports will be organized in the following manner:

   A. A Major Basin Map. This will be provided by Central Office.

      Number the following locations on the maps provided (be as accurate as possible).

      1. Physical/chemical evaluations for each year (78-79; 79-80) coded red for major problemss, green for minor problems, and blue for no problem.

      2. Geographic locations referred to in the text.

      3. Discharger locations referred to in the text.

      4. Monitoring station locations.

   B. Major Basin Summary (includes all subbasins in the major basin).

   C. Subbasin Summary (one for each subbasin).

   D. A water quality evaluation using adequate (i.e., biological) data. This is a <u>MAJOR CHANGE</u> from the 1980 305(b). Biological data will be used to evaluate segments as 1. DOES, 2. WILL, or 3. WILL NOT meet the 1983 Water Quality Goals "fishable /swimmable".

   E. Physical/chemical water quality evaluations where biological data is inadequate or nonexistent will be preliminary evaluations and will be coded MAJOR, MINOR, or NONE under the segment/subbasin code.

F. A discussion section identical to the 1980 305(b) Volume IV will be written for all segments in Class III and Class IV. Physical/chemical water quality evaluations will be determined with the Ohio EPA physical/chemical criteria table (page 4).

G. A Literature Cited section for each subbasin.

H. A special section presenting the analysis of information from USGS continuously monitored stations. This will be done by Central Office staff and will be integrated into the appropriate subbasin report.

I. A new part will be added to the 1982 305(b) segment discussions. This will be an evaluation of standards violations through time for Class III and Class IV segments.

EVALUATIONS AND DELINEATIONS OF SEGMENT(S)/STREAM(S) WHERE BIOLOGICAL DATA EXISTS

3. Evaluate and delineate segment(s)/stream(s) and place it in one of the following categories based on Ohio EPA biological criteria tables (pages 5 and 6):

   A. Segments and/or streams that currently meet 1983 goals (coded DOES under the subbasin segment number),

   B. Segments and/or streams that are expected to meet 1983 goals prior to 1983 after the implementation of pollution controls (coded WILL under the subbasin segment number),

   C. Segments and/or streams that are not expected to meet 1983 goals by 1983 (coded WILL NOT under the subbasin segment number).

4. The segment/stream evaluations are made with Ohio EPA fish criteria (page 5) and Ohio EPA macroinvertebrate criteria (page 6). A MINIMUM of THREE biological stations are required: one in the affected area, one upstream, and one downstream from the affected area in the recovery zone.

5. Each delineated segment/stream (organized in decreasing river mile measured from the mouth ; river mouth = 0) should be reported in the subbasin report in the following way:

Segment 1983 Goals	Name Description	Mile Points Use Designation
M-3-2 DOES	Olentangy River Below Galion to Near Delaware	76.2 - 32.1 WWH

The location of a delineated river mile segment should be as precise as possible.

6. Integrate Intensive Survey summary information into your subbasin reports. Central Office will discuss specifics with districts that have completed intensive surveys during the reporting period. In addition, intensive survey abstracts are included in the Summary Volume (Volume I)

7. Macroinvertebrate and/or fish data (i.e., something less than an intensive survey) should be integrated into the subbasin reports as a separate section.

EVALUATIONS AND DELINEATIONS OF SEGMENT(S)/STREAM(S) WHERE BIOLOGICAL DATA ARE INADEQUATE OR ABSENT

NOTE - This entire section is similar (BUT NOT IDENTICAL) to what was done for the 1980 305(b) Subbasin Volume IV

8. Review current violations table data to help highlight physical/chemical problems in each segment being evaluated.

9. Determine the frequency and note the magnitude of standards violations. The Ohio EPA physical/chemical criteria table (page 4) lists the standards violations frequency limit that is to be used in the physical/chemical evaluating process. Standards violations concentrations that are very high compared to Ohio Water Quality Standards should be discussed.

10. Evaluate ALL stream segments with the Ohio EPA criteria to see if they currently meet a Warmwater Habitat (WWH) Use Designation You must have at least four (4) physical/chemical samples per year to evaluate a specific segment for the 1982 305(b) report. Record the information on a criteria format summary sheet (page 8) to help organize the information being used in the evaluation.

11. If the segment is evaluated as meeting Warmwater Habitat Standards (i.e., Class II), report the delineated segment exactly as reported in the EXAMPLE, number 13.

12. If a stream/segment is evaluated as Class III or Class IV based upon the Ohio EPA physical/chemical criteria table (page 4), the stream/segment is evaluated as having minor problems (Class III) or having major problems (Class IV).

EXCEPTIONS

A segment/stream evaluated as Class III that has very few physical/chemical violations can be described as having no problems (i.e., NONE) if the violations are very close to the Ohio Water Quality Standard. Any exceptions must be fully explained in the text.

13. Each delineated segment/stream should be reported in the subbasin report in the following way;

EXAMPLE

Segment Problem	Name Description	Mile Points Use Designation
M-3-2	Olentangy River	76.2 - 32.1
NONE	Below Galion to Near Delaware	WWH

The location of a delineated river mile segment should be as precise as possible.

14. A problem evaluation (NONE, MINOR, or MAJOR) for a segment/stream for which you have only physical/chemical data can be extended upstream and downstream from the sampling point only to the mile point of the next tributary (confluence), or to the next discharger or nonpoint source which impacts the stream (i.e., changes the physical/chemical characteristics of the segment being evaluated). Exercise your best judgement concerning the influence of point source discharges or nonpoint source effects. Remember, you are concerned with these impacts not only during low flow periods, but also on an annual basis.

15. Each delineated segment/stream that is evaluated as Class III (MINOR PROBLEM) or Class IV (MAJOR PROBLEM) should have a summary paragraph(s) which includes the following information:

    A. An assessment of water quality problems which includes the identification of the following;
        1. Parameter Type,
        2. Location, (river mile)
        3. Source (by point source or nonpoint category)

            a. Point Source Category
                1. Municipal
                2. Industrial

            b. Nonpoint Source Category
                1. Combined Sewer Overflow
                2. Urban
                3. Agriculture
                4. Silviculture
                5. Mining
                6. Hydrologic Modification
                7. Solid Waste Disposal
                8. Construction
                9. Individual Disposal
                10. Natural
                11. Other (specify)

        4. Severity or magnitude of the problem.

B. An evaluation of present water quality information for;

1. Current conditions
2. Conditions after implementation of pollution controls.

C. Corrective measures being taken.

WRITING THE SUBBASIN SEGMENT PARAGRAPH(S)

16. You have been provided with a reorganized 1980 Subbasin Volume IV draft copy.

A. Draw a line through any information in the draft where data are incorrect or where statements are no longer valid.

B. Write minor correction(s) and/or new text (i.e., words or short phrases) on the draft copy where and when necessary. (ATTACH NEW PARAGRAPHS TO THE END OF THE SUBBASIN WRITE-UP.)

C. Use the same general style when writing and correcting your new text.

D. Update the violations discussion in the text (if necessary).

E. Make changes in the text ONLY WHEN OR WHERE NECESSARY.

Use the criteria format summary sheet (page 8) to organize your information for each year of data separately before writing the paragraph(s) for each segment/stream evaluated as Class III or Class IV. Include a Xerox copy of your criteria format summary sheets with your subbasin reports. Each paragraph(s) should be a summary which includes a discussion of information from both reporting years.

17. District Surveillance personnel will have to compute the standards violations for NH_3, Ni, Zn and Cu (you will already have standards violations computed and organized for 6 months from the 1980 305(b) Violations Tables Volume RD-2 - 10/1/78 through 6/30/79). These data will be formatted as in the table on page 10. Where possible, include a paragraph(s) discussing violations through the current reporting period for Class III and Class IV segments.

18. Segments/streams that have a Coldwater Habitat or Exceptional Warmwater Habitat (CWH or EWH) Use Designation should be evaluated against CWH or EWH physical/chemical water quality standards first, followed by an evaluation against the WWH standards. Segments/streams that have special standards (Example - Cuyahoga and Mahoning Rivers) are also evaluated twice; first against meeting minimum (WWH) standards and second against meeting special (Cuyahoga or Mahoning) standards. Information about segments/streams that meet or do not meet WWH standards and that do not meet their special standards should be discussed.

19. If a nutrient evaluation is necessary, the Ohio EPA Nutrient Criteria (page 13) should be used . Total Nitrogen referred to in the Nutrient Criteria Table is defined as Kjel-T-N + NO_3-N-T + NO_2-N-T.

    A. Use annual mean values from national and state monitoring sites. These values will be (have been) generated by STORET for ambient monitoring network stations. Annual mean values are used to facilitate direct comparisons with previous studies.

    B. Mean values from other sampling locations (i.e. intensive surveys, special samples, etc.) may be used to supplement the National and State Monitoring Network data provided the samples represent normal stream conditions (i.e. no unusual pollution or extreme low flow, etc.)

    C. Extend the nutrient status classification as far as possible in both directions from the point of sampling, while exercising your best judgement concerning the influence of major point source discharges or nonpoint source effects. Remember, you are concerned with point source and nonpoint source impacts on the annual mean concentation and not just during low flow periods.

    D. ALWAYS report the nutrient status (classification) for a segment being evaluated as high as possible. Exceedence by two nutrient parameters is required for classifying a stream segment in the "next" higher nutrient level category.

EXAMPLE

PARAMETERS	EVALUATION
6 Low	Low
5 Low and 1 Moderate or High	Low
4 Low and 2 Moderate	Moderate
4 Low, 1 Moderate and 1 High	Moderate
3 Low, 2 Moderate and 1 High	Moderate
3 Low, 1 Moderate 2 High	High
4 Low and 2 High	High

    E. A Fecal Coliform evaluation with respect to an environmental problem in a specific segment is a special problem.

        1. All Fecal Coliform standards violations are to be recorded in the Violations Tables (RD-2).

        2. The evaluation of "swimmable" involves only the summer months. (May thru September)

20. Check USGS data (or special studies) to see if they can be used in your subbasin segment evaluations.

21. CITE ALL SOURCES of information (reports and data) used in text of the subbasin reports. Use the same method for citing sources that was used in the 1980 305(b) Volume IV.

Cite author and year in the text.

EXAMPLE

(OEPA, 1975)
(OEPA, SWDO data, 1977-1979)
(Martin, *et al.*, 1979)
(Havens and Emerson, 1976)

Create a literature cited section at the end of each subbasin report. Use the following style of bibliographic entry.

General format. (Literature cited section)

Authors name(s). Date. Title. Publication.
Pages (if known).
Punctuate and capitalize as in the examples below.

EXAMPLE

Literature cited

Havens and Emerson, Ltd. Environmental Consulting Engineers. 1976. Muskingum watershed water quality assessment and low flow analysis. Report prepared for Ohio EPA. n.p. (pages not numbered).

Martin, G.L., T.J. Balduf, D.O. McIntyre, and J.P. Abrams. 1979. Water quality study of the Ottawa River, Allen and Putnam counties, Ohio. Ohio Environmental Protection Agency, Office of Wastewater Pollution Control, Division of Surveillance. 35 pp.

Ohio Environmental Protection Agency. 1975. State of Ohio annual water quality report. Ohio EPA, Columbus, Ohio. 135 pp.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

22. DO NOT make recommendations about upgradings, downgradings, or use designation changes in your subbasin reports, or as part of 305(b). The 305(b) report is a summary of existing conditions, an analysis and presentation of summarized data and a conclusion stating what this data means in relation to water quality and Ohio water quality standards. If the 305(b) information suggests that a change should be made (upgrading, downgrading, or Beneficial Use Designation), make a note for yourself. Your recommendations, with details will be developed as a special justification document independent of 305(b).

23. The preparation of the continuous monitoring parameter analyses (USGS continuous D.O., pH, temperature and conductivity data) will be prepared by Central Office staff.

24. All of the above information will be used to update the 305 (b) report for the reporting period 10/1/78-9/30/80. Details regarding the historical update are forthcoming.

25. Best of luck in this endeavor. If you have any problems or questions the chances are very good that everyone else is having the same problem. Contact the 305 (b) coordinator as early as possible so that we can maintain the highest degree of consistency between districts.

OHIO EPA CHEMICAL/PHYSICAL CRITERIA

Evaluation Class / Parameter	NONE Class I (EWH)	NONE Class II (WWH)	MINOR Class III	MAJOR Class IV
Dissolved Oxygen	avg. = 6.0 mg/l min. = 5.0 mg/l	avg. = 5.0 mg/l min. = 4.0 mg/l	min. occasionally[1] < 4.0 mg/l	min. frequently[2] < 4.0 mg/l
pH	6.5 to 9.0	6.5 to 9.0	occasionally < 6.5, > 9.0	frequently < 6.5, > 9.0
Non-persistent Toxics	< 10% exceedence of EWH (CWH) standards	< 10% exceedence of WWH standards	occasional exceedence of WWH standards	frequent exceedence of WWH standards
Persistant Toxics	< 5% exceedence of EWH (CHW) standards	< 5% exceedence of WWH standards	occasional exceedence of WWH standards	frequent exceedence of WWH standards
Aesthetics	Citizen compliants, odors, fish kills extremely rare	Rare citizen compliants, odors, fish kills	occasional compliants, odors, fish kills	frequent compliants, odors, fish kills

1. Occasionally - WWH standard(s) exceeded twice/year based upon a monthly sampling frequency; once/year based upon a quarterly sampling frequency; or > 10% and < 25% exceedence based upon some other sampling frequency (example - intensive survey sampling).

2. Frequently - WWH standard(s) exceeded three or more times/year based upon a monthly sampling frequency; twice or more/year based upon a quarterly sampling frequency; or > 25% exceedence based upon some other sampling frequency (example - intensive survey sampling).

OHIO EPA NUTRIENT CRITERIA

Evaluation Parameter	Low	Moderate	High
Total Phosphorus	<0.11 mg/l	0.11 to 0.50 mg/l	>0.50 mg/l
Total Nitrogen	<0.21 mg/l	0.21 to 5.0 mg/l	>5.0 mg/l
Biological Oxygen Demand (BOD)	<4.1 mg/l	4.1 to 10.0 mg/l	>10.0 mg/l
Total Dissolved Solids (TDS)	<251 mg/l	251 to 750 mg/l	>750 mg/l
Fecal Coliforms	<1001/100 ml	1001 to 2000/100 ml	>2000/100 ml
Aesthetics	Rare citizen compliants, odors, algal blooms	Occasional[1] citizen compliants, odors, algal blooms	Frequent citizen compliants, odors, algal blooms

1. See Ohio EPA Chemical/Physical Criteria for definitions of occasional and frequent.

Basin _____ YEAR _____

Sub basin _____

Segment _____ RM _____

Parameter	RANGE/ MEDIAN	REMARKS	Physical / Chemical				NUTRIENTS		
			Except	Good	Fair	Poor	LOW	MOD	HIGH
Aesthetics									
D.O.									
pH									
Toxics, Per.									
Toxics, Non Per.									
Phosphorus, T									
Nitrogen, T									
BOD									
TDS									
fecal, Colif.									

Table 2. Biological criteria (fish) for determining aquatic life use designations and attainment of Clean Water Act goals (November 1980).

	CWA GOALS MET		CWA GOALS NOT MET	
Evaluation Class Category	"Exceptional" Class I (EWH)	"Good" Class II (WWH)	"Fair" Class III	"Poor" Class IV
1.	Exceptional, or unusual assemblage of species	Usual association of expected species	Some expected species absent, or in very low abundance	Most expected species absent
2.	Sensitive species abundant	Sensitive species present	Sensitive species absent, or in very low abundance	Sensitive species absent
3.	Exceptionally high diversity	High diversity	Declining diversity	Low diversity
4.	Composite index $>9.0 - 9.5$	Composite index $>7.0 - 7.5, <9.0 - 9.5$	Composite index $>4.5 - 5.0, <7.0 - 7.5$	Composite index $<4.5 - 5.0$
5.	Outstanding recreational fishery		Tolerant species increasing, beginning to dominate	Tolerant species dominate
6.	Rare, endangered, or threatened species present			

Conditions: Categories 1, 2, 3 and 4 (if data is available) must be met and 5 or 6 must also be met in order to be designated in a particular class.

Table 1. Biological criteria (macroinvertebrate) for determining aquatic life use designations and attainment of Clean Water Act goals (March 1981).

	CWA GOALS MET		CWA GOALS NOT MET	
Evaluation Class Category	"Exceptional" Class I (EWH)	"Good" Class II (WWH)	"Fair" Class III	"Poor" Class IV
1.	Pollution sensitive species abundant	Pollution sensitive species present in moderate numbers	Pollution sensitive species present in low numbers	Pollution sensitive species absent
2.	Intermediate species present in low numbers	Intermediate species present in moderate numbers	Intermediate species abundant	Intermediate species present in low numbers or absent
3.	Tolerant species present in low numbers	Tolerant species present in low numbers	Tolerant species present in moderate numbers	Tolerant species abundant (all types may be absent if extreme toxic conditions exist)
4.	Number of taxa >30	Number of taxa 25-30	Number of taxa 20-25	Number of taxa <20
5.	Exceptional diversity Shannon index >3.5	High diversity Shannon index 2.9-3.5	Moderate diversity Shannon index 2.3-2.9	Low diversity Shannon index <2.3

Table RD 2-180: Ohio WQS Violations Located at National and State Monitoring Sites (7/1/78 - 6/30/79)

Maumee River Basin
Ottawa River - 500050 - WWH[a]
S.R. 81, RM 28.4[b]

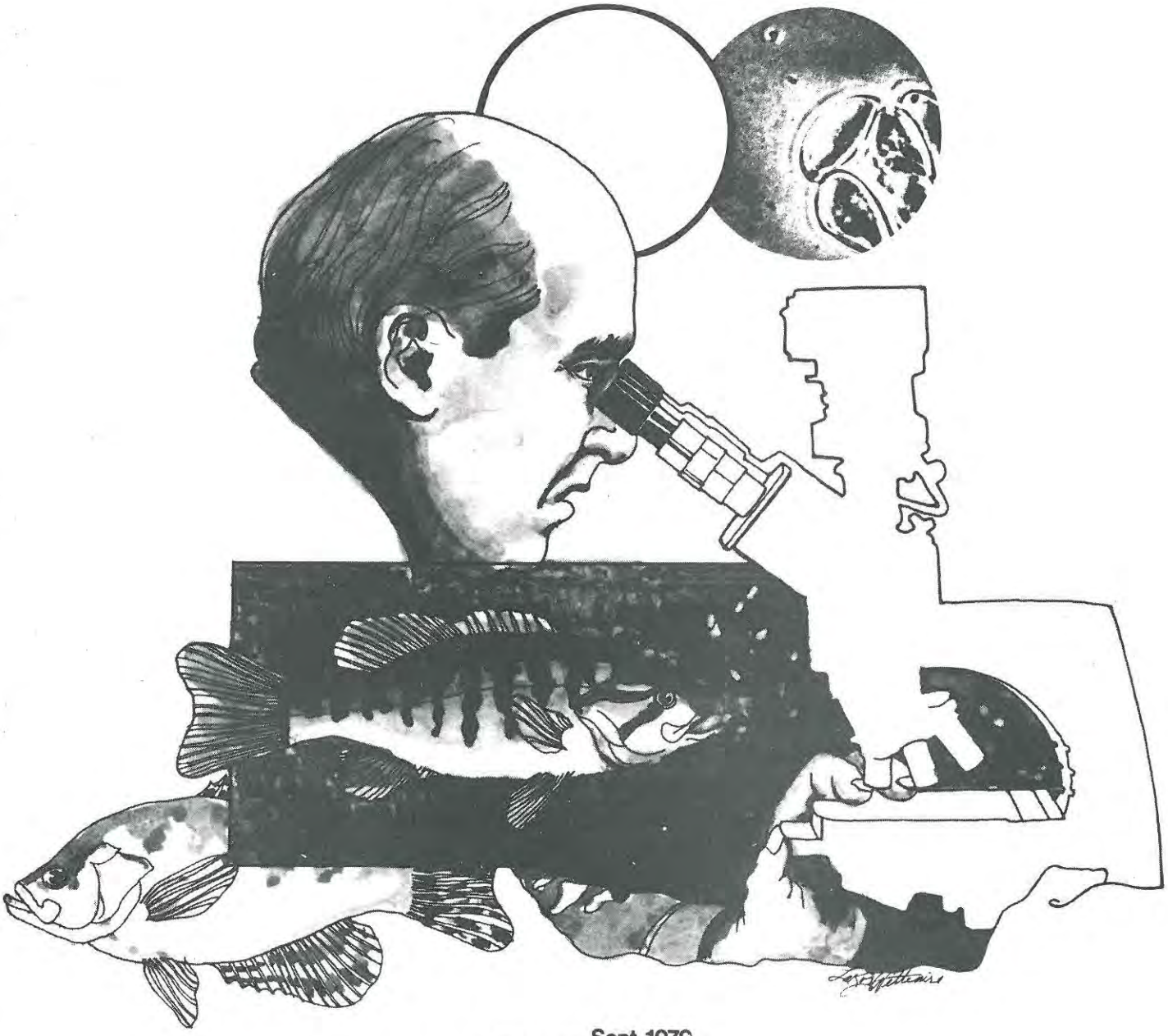
Parameter	(V/N)[c]	Date (T)[d]	Sample Conc.	OEPA WQS Limit	% Flow Duration[e]
CN	(06/10)	01/31	90	25	
		02/21	30	25	
		05/17	50	25	
		06/06	30	25	
D.O.	(1/8)	11/07(1315)	3.8	5/4	
Fecal Coli-T-MF	(5/12)	09/20	3500	2000	50
		12/06	13000		
		01/31	3290		
		04/12	TNTC		
		06/06	4400		
MBAS	(3/11)	09/20	0.54	0.50	50
		10/25	0.56		
		06/06	0.54		
NH_3-N-T	(1/12)	02/21	13.40	7.0	
Phenolics	(1/9)	10/25	14	10	

(a) Station name - STORET code - Beneficial use designation.
(b) Station Location and river mile (RM).
(c) Total number of Ohio WQS violations/Total number of samples.
(d) Time oxygen sample was taken.
(e) Based upon daily average USGS data.

OhioEPA
water quality survey

water quality study of the ottawa river

allen and putnam counties, ohio



Sept. 1979
Office of Wastewater
Division of Surv. & W.Q. stds.
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INTENSIVE SURVEY

WATER QUALITY STUDY OF THE OTTAWA RIVER, ALLEN AND PUTNAM COUNTIES, OHIO

1980 305(b) Report
Volume III-B

Prepared by

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Division of Surveillance and Water Quality Standards

September, 1979

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Summary

A water quality study of the Ottawa River was conducted by the Ohio Environmental Protection Agency between 1974 and 1977. The existing biological and chemical quality of the Ottawa River was evaluated in order to assess the impact of improvements in wastewater treatment from the City of Lima and industrial discharges located in Lima. The study area included a 45 mile segment of the Ottawa River from above Lima to the mouth, as well as, a segment of the Auglaize River upstream and downstream from the mouth of the Ottawa.

Physical, chemical, and biological parameters were used to evaluate water quality as either good, fair or poor. Chemical-physical data were collected from 1974 to 1977, benthic macroinvertebrates were collected during the summers of 1974, 1976 and 1977 and fish were collected during 1976 and 1977.

Chemical-physical measures of water quality included in this report are temperature, pH, dissolved oxygen, suspended and dissolved solids, total hardness, ammonia-nitrogen, nitrate-nitrogen, total Kjeldahl nitrogen, total phosphorus, foaming agents (MBAS), chemical oxygen demand (COD), total chromium, hexavalent chromium, and phenols. Biological measures of water quality included quantitative analyses of benthic macroinvertebrate communities established on artificial substrate samplers, qualitative collections of benthic macroinvertebrates from natural stream substrates, qualitative samples of the fish communities and determination of relative species abundances, fecal coliform bacteria counts, and biochemical oxygen demand (BOD).

The data show that the Ottawa River was biologically healthy and water quality was good upstream from Lima at river mile 46.0. From just above the Lima STP (RM 37.7) to river mile 7.9 the fish and macroinvertebrate communities were degraded due to a variety of causes and water quality was poor. Near the mouth of the Ottawa River (1.0) water quality was fair and the river had recovered to a near healthy biological condition. The water quality of the Auglaize River upstream and downstream of the Ottawa River was good, as indicated by healthy and well-balanced benthic macroinvertebrate communities.

The most severe water quality problems found during the study were: low dissolved oxygen concentrations above the Lima STP due to combined sewer overflows and a series of dams in Lima; chlorine toxicity problems immediately downstream from the Lima STP; and high ammonia and chromium concentrations coupled with low dissolved oxygen concentrations downstream from an oil refinery and a petro-chemical plant in Lima. The most severely polluted stretch of the Ottawa River was from river mile 36.8 to the Allentown Dam (RM 28.8). Fish populations were essentially devoid from this segment of the river; only two pollution tolerant species were collected.

Despite the severe water quality problems documented, a dramatic improvement in the chemical and biological quality of the Ottawa River below Lima has occurred since 1960. In 1960 fish were absent from the entire Ottawa River downstream from Lima, as well as, a portion of the Auglaize River downstream from its confluence with the Ottawa. Continued improvement was observed between 1974 and 1977 as a result of large scale improvements in the Lima STP and industrial dischargers in Lima. Further improvement will be largely dependent on a reduction of the ammonia load entering the Ottawa River from the Standard Oil refinery and Vistron Corporation.

Conclusions

1. The water quality of the Ottawa River at the control station (RM 46.0) was good. Biologically the stream was healthy at this location with diverse and well-balanced fish and macroinvertebrate communities being present. Chemically the stream was within limits established by Ohio's Water Quality Standards. At no other station sampled in the Ottawa River was the water quality equal to that found here.

2. The water quality of the Ottawa River immediately upstream from the Lima STP (RM 37.7) was poor. Biologically, the stream was stressed at this point, being dominated by pollution tolerant fishes and macroinvertebrates. The major water quality problem at this station appeared to be low dissolved oxygen levels during early morning hours. These low dissolved oxygen levels were due to combined sewer overflows and a series of dams located within the City of Lima.

3. The water quality of the Ottawa River immediately downstream from the Lima STP (RM 37.4) improved dramatically after the completion of improvements to the Lima STP in 1977. Biologically the river remained degraded at this location, primarily because of excessive chlorine levels in the sewage treatment plant effluent.

4. The water quality of the Ottawa River from river mile 36.8 to the Allentown Dam (RM 28.8) was extremely poor. Biologically the river was very degraded with only pollution tolerant macroinvertebrates being present. Fish were extremely rare in this segment of the river. Water quality standards for ammonia, dissolved oxygen, MBAS, chromium, and phenols were frequently violated. Biologically, no improvement was observed in this segment of the river during the study.

5. The water quality of the Ottawa River from the Allentown Dam to river mile 7.9 was poor. Although the river showed continued improvement downstream, the fish and macroinvertebrate communities remained stressed. Water quality standards violations for ammonia, dissolved oxygen, MBAS, phenols, and chromium occurred, although with less severity than upstream from the Allentown Dam.

6. Improvement in water quality was found in the Ottawa River at river mile 1.0 near the mouth. The water quality at this station was fair. Though complete recovery has not taken place, water quality at this site had improved considerably since 1960. Continued improvement was observed between 1974 and 1977. Biologically, the river had recovered to a near healthy state and water quality standards violations were less severe and less frequent than in upstream reaches.

7. The pollutant most detrimental to fish populations downstream from Lima is believed to be ammonia. Low dissolved oxygen levels and high chromium concentrations were also detrimental to the aquatic ecosystem. (The chromium problem was eliminated in 1977.)

8. The Auglaize River below the confluence with the Ottawa River exhibited good water quality with marked improvement over what was found in 1960, as evidenced by the macroinvertebrate community.

9. The Auglaize River above the confluence with the Ottawa exhibited good water quality equal to what was found in 1960, as evidenced by a healthy and well-balanced macroinvertebrate community.

10. Efforts to abate pollution from combined sewer overflows in the City of Lima were not completed during this study period. Therefore the success of Lima's combined sewer overflow control program could not be evaluated.

11. Improvements at the Lima sewage treatment plant markedly improved water quality downstream from the plant; however, biological recovery in the river did not occur, apparently because of chlorine toxicity.

12. Although improvements in the effluent quality of the Standard Oil Refinery and Vistron Corporation have occured, excessive ammonia still limits aquatic life downstream. With continued ammonia reduction from these two sources, the Ottawa River should return to a healthy biological condition.

Recommendations

1. A biological and water quality study should be conducted in the Ottawa River from river mile 40.5 to river mile 37.7 to determine the biological condition of this segment of the river and evaluate the success of Lima's combined sewer overflow control program.

2. A cooperative study should be initiated between the Ohio Environmental Protection Agency and the City of Lima to determine the extent of chlorine reduction necessary in order to establish a healthy biological community in the Ottawa River immediately downstream from the Lima STP.

3. The Standard Oil Refinery and Vistron Corporation must reduce ammonia loadings to the Ottawa River if the biological integrity of the river is to be restored.

4. The Ottawa River should be monitored closely to measure improvements in attaining water quality standards and goals.

INTRODUCTION

The Ottawa River drains 373 square miles of predominately agricultural land in northwest Ohio. This river is a sub-basin of the Maumee River Basin and is located mainly in Allen and Putnam counties, joining the Auglaize River near Kalida. The Ottawa is 53 miles long and has an average fall of four feet per mile.

The headwaters of the Ottawa River rise in Hardin County, the stream flowing in a generally westerly direction, with a major northern bend west of the City of Lima. The topography of the Ottawa River Basin is defined within the Till Plains and Lake Plains sections of the Central Lowlands physiographic province. The underlying bedrock consists of Devonian and Silurian Age limestone.

Although non-point source pollution is a significant water quality problem within the Ottawa River Basin, the present study was intended to evaluate the effects of point sources during periods of relatively low stream flows. Major municipal and industrial dischargers in the Ottawa River Basin are shown in Figure 1. The most significant point sources affecting the water quality on the Ottawa River are the Lima Sewage Treatment Plant (STP), the Standard Oil Refinery, and the Vistron Corporation. These three dischargers are all located in the city of Lima within one mile of each other. Their effluent qualities between 1974 and 1977 are summarized in Table 1.

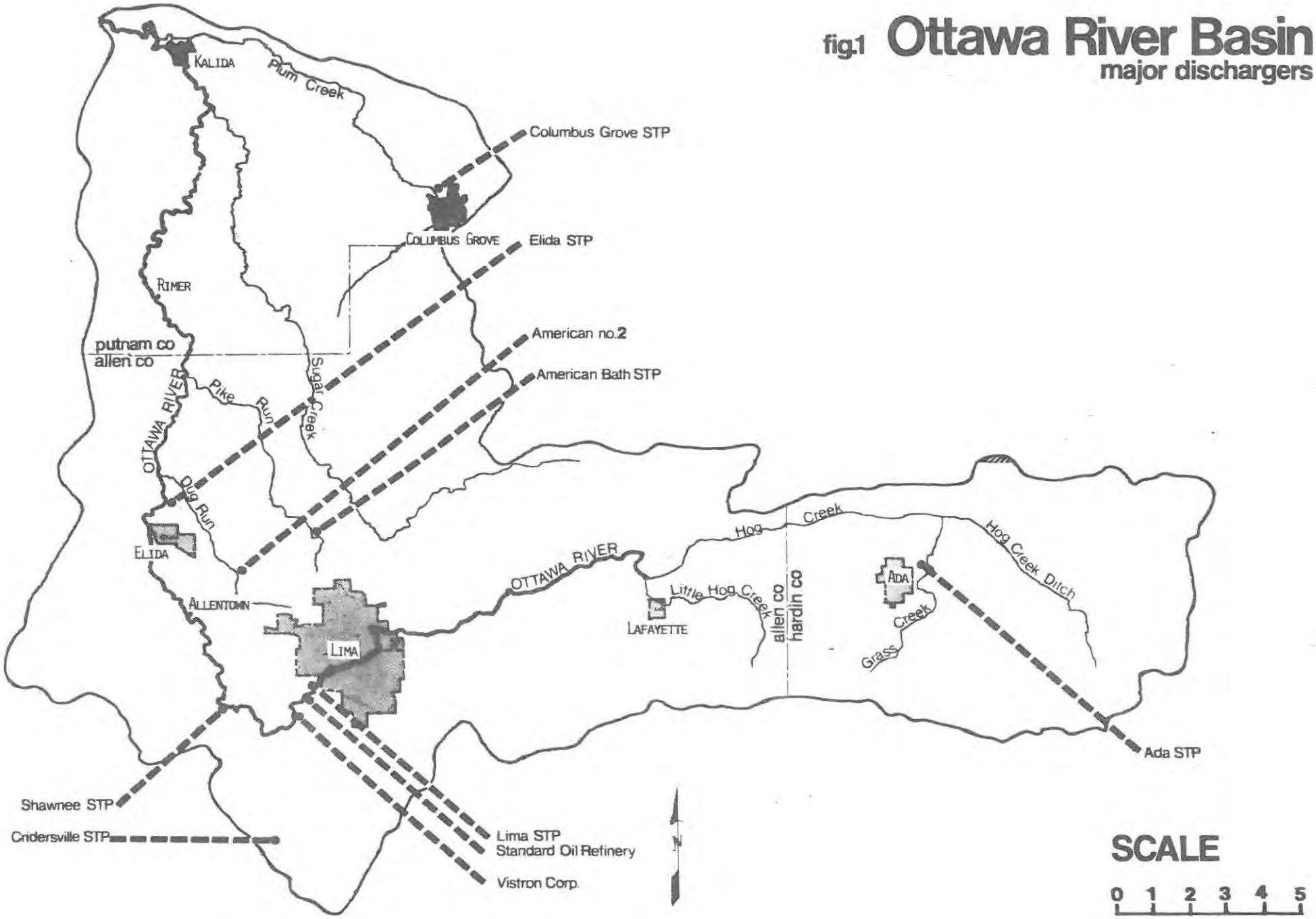
Table 1. Effluent Data of Three Major Dischargers to the Ottawa River for July through September 1974-1977.[a]

		Lima STP			Vistron Corporation				Standard Oil Refinery			
		75	76	77	74	75	76	77	74	75	76	77
BOD[b]	mg/l	8.6	9.4	1.8	12.0	13.5	11.6	7.0	NA[c]	10.7	8.2	18.5
	lbs/day	1114	1191	243	261	300	245	159	NA	366	296	188
Ammonia	mg/l	10.0	1.7	0.9	31.2	43.5	78.3	44.1	33.1	20.8	23.1	23.7
NH_3-N	lbs/day	1239	212	231	654	960	1667	973	1287	784	848	960
Total	ug/l	NA	NA	NA	3500	2292	2530	104	30	30	100	NA
Chromium	lbs/day	NA	NA	NA	85	50	54	2.2	1.4	1.2	4.4	NA
Flow	MGD	15.2	15.3	16.5	1.9	2.6	2.6	2.7	4.7	4.5	4.4	5.2

(a) Values shown are mean concentrations and loadings.
(b) Biochemical oxygen demand.
(c) Not available.

Although historical information specifically referring to the Ottawa River prior to the twentieth century is not readily available, inferences can be made from literature concerning other Ohio streams. This information has been reviewed by Stuckey and Wentz (1969), who concluded that the Ottawa River was

fig.1 Ottawa River Basin
major dischargers



badly polluted as early as 1885. Data from the early 1950's were summarized in a report by the Ohio Department of Health (1953). That report emphasized the high phenol and oil content of the industrial wastewater from a refinery and creosoting plant. Evidence of the industrial discharge was at all times present on the Ottawa River "in the form of oil slicks, color, and sludge deposits".

Biological and chemical studies by Patrick, et al (1956) in the Ottawa River resulted in very useful chemical data, including pre-dawn dissolved oxygen levels, as well as ammonia measurements at several stations. The means for a series of four ammonia-nitrogen samples ranged from 47.80 mg/l, 300 feet downstream from Adgate Road, to 2.60 mg/l near Kalida. A station located about 400 feet above the Adgate Road bridge had a four-series mean of 2.65 mg/l of ammonia-nitrogen. Pre-dawn dissolved oxygen measurements for eight stations, extending from 400 feet above Adgate Road to the last station near Kalida, were all below 4.0 mg/l on both July 3 and 4, 1956.

Stuckey and Wentz cited chemical data from a Public Health Service report, which included very low dissolved oxygen levels downstream from Lima (below 1.0 mg/l near Lima, below 2.0 mg/l near the mouth of the Ottawa River), as well as high levels of ammonia, biochemical oxygen demand (BOD), fecal coliform, and fecal streptococcus bacteria. Observations made by Stuckey and Wentz may serve to describe the appearance of the Ottawa River below Lima, at least through the late 1960's: "The color of the river water ranges through various shades of green, red-orange, or black, depending upon when and where observations are made along the river. Oil is much in evidence in the water, on the water surface, and along the bank throughout its reach from Lima to its mouth. During the times of low flow in summer, strong petrochemical and phenolic odors are present over the stream". Stucky and Wentz also remarked that the portion of the Ottawa River upstream from Lima did not appear to be grossly polluted, having a more typical brown color, higher dissolved oxygen levels (approximately 5.0 mg/l), and low fecal bacteria counts.

The U.S. Department of the Interior (1966) stated that "the Ottawa River is grossly polluted -- the worst in the entire Maumee River Basin" and went on to point out that the flow of the Ottawa River (during low flow conditions) below Lima is composed entirely of effluents from the Lima STP and downstream industries. That report indicated that pollution from the Lima area adversely affected water quality on the Ottawa, Auglaize, and lower Maumee Rivers. Concentrations of ammonia below Lima ranged from 22 mg/l to 127 mg/l with a median value of 63 mg/l. One mile above the mouth of the Ottawa River ammonia concentrations ranging from 12 mg/l to 136 mg/l were detected with a median value of 60 mg/l. This report pointed out that the average concentrations for phenols in the Ottawa River downstream from Lima were greater than 20 ug/l, with values greater than 100 ug/l occurring. The data for the report were collected during 1963-1966.

An Ohio Department of Health report (1966) stated that "high concentrations (of ammonia) are found in the Ottawa River in the Lima area and -- the effect of this load extends not only the entire length of the Ottawa River but also the lower Auglaize River and at times in the lower Maumee River as far down stream as Waterville". This paper pointed out that during June through October of 1964, minimum dissolved oxygen concentrations for the Ottawa River from below Lima to the mouth, were in the 0 - 1.0 mg/l range. During the period from June, 1964, through April, 1965, 40 to 100 percent of the dissolved oxygen tests were less than 4.0 mg/l for the same section of the river.

Trautman (1957) recorded 36 species of fish from the Ottawa River. Patrick, et al (1956) recorded 33 species during the Philadelphia Academy of Natural Sciences survey. Patrick indicated that well-balanced fish communities existed on the Ottawa River upstream from Lima, near the mouth of the Ottawa, and upstream and downstream from the Ottawa River in the Auglaize River. No fish were found at three stations within the City of Lima. Patrick concluded that the absence of fish in Lima was an indication that the Ottawa River was grossly polluted in that segment. The stations on the Ottawa and Auglaize Rivers with diverse and well-balanced fish populations were considered to be biologically healthy.

A 1960 study of the effects of the Ottawa River on the Auglaize River (Patrick, et al, 1960) showed that although the Auglaize River upstream from the Ottawa River contained a well-balanced fish fauna with game and forage fishes, the Auglaize River downstream from the Ottawa River and the Ottawa River near its mouth did not contain fish. The diversity and excellent condition of fishes collected in the Auglaize upstream from the Ottawa River indicated a healthy biological condition; however, the absence of fish at the other two stations showed that water quality in the Ottawa River had severely deteriorated since 1956.

The Auglaize River has been sampled upstream from the confluence with the Ottawa River near Fort Jennings and downstream near Cloverdale by the Ohio Department of Natural Resources. Fish population estimates were obtained by seining at both stations. Clark and Allison (1966) reported the upstream location had good populations of desirable fish that consistently improved from 1960 through 1964. The fish populations were considered to be characteristic of the streams in Northwest Ohio where water quality is satisfactory for fish life. Clark and Allison found the location downstream from the Ottawa River had continuously deteriorated in fish populations since 1949. No fish were found there in 1960, 1962, 1963, and 1964.

Previous benthic macroinvertebrate investigations on the Ottawa River are restricted to those conducted by the Philadelphia Academy of Natural Sciences in 1955, 1956, and 1960 (Patrick, et al, 1956, 1960). In 1955 and 1956 Patrick found the Ottawa River above Lima and the Auglaize River above its confluence with the Ottawa, contained a large and diversified macroinvertebrate fauna and, therefore, considered these segments to be "healthy". Below Lima, Patrick regarded the Ottawa to be very polluted due to the presence of only tolerant macroinvertebrate forms with some stations devoid of aquatic insect populations. While the Academy station at the mouth of the Ottawa deteriorated in "health" from 1955 to 1956 with a 29% decrease in number of species, the station in the Auglaize below the confluence with the Ottawa increased in "health" with an increase in pollution sensitive invertebrates.

In 1960, Patrick, noted a substantial reduction in water quality at their stations near the mouth of the Ottawa and at the Auglaize below the Ottawa as determined by significant decreases in the number of species collected at each site. The only other station sampled in 1960 was the Auglaize above the confluence with the Ottawa and it remained "healthy".

The purpose of our study was to evaluate the existing biological and chemical quality of the Ottawa River and to assess the impact of improvements in the Lima STP and industrial dischargers located in Lima. Physical/chemical data

were collected in 1974 through 1977; benthic macroinvertebrates were collected during the summers of 1974, 1976 and 1977; fish were collected during 1976 and 1977. Physical/chemical measures of water quality included in this report are temperature, pH, dissolved oxygen, suspended and dissolved solids, total hardness, ammonia- nitrogen, nitrate-nitrogen, total Kjeldahl nitrogen, total phosphorus, foaming agents (MBAS), chemical oxygen demand (COD), total chromium, hexavalent chromium, and phenols. Biological measures of water quality included quantitative analyses of benthic macroinvertebrate communities collected on artificial substrate samplers, qualitative collections of benthic macroinvertebrates from natural stream substrates, qualitative samples of fish communities and determination of relative species abundance, BOD, and fecal coliform bacteria. Appendix A gives the station characteristics for the major sampling sites.

PHYSICAL/CHEMICAL WATER QUALITY

Methods

Chemical and physical samples were collected from 1974 through 1977. Generally, samples consisted of discrete, monthly grab samples. Samples included in this report were collected during moderate to low flow conditions (i.e.,June through November). Dissolved oxygen and temperature measurements were made in the field using a YSI dissolved oxygen meter (Model 54). Subsurface grab samples were collected, preserved, and transported according to recommendations of the United States Environmental Protection Agency (USEPA, 1974) and the Ohio Department of Health. Water sample analyses were conducted by the Ohio Department of Health Laboratories in accordance with test procedures specified by the U.S. EPA under 40 CFS 136[1].

Results and Discussion

The evaluation of water quality by means of chemical and physical sampling and analysis can be a very useful tool in a pollution study of lotic waters, but only if the drawbacks as well as the advantages of such an evaluation are considered. Most chemical and physical samples are taken as grab samples and can be used effectively to determine the water quality at a given point in time. Typical grab sample results cannot, however, be used to make complex statements regarding such phenomena as vertical changes in water quality or the daily fluctuations of certain parameters (particularly dissolved oxygen). They seldom can be used to accurately assess downstream chemical reactions, or many significant short term stresses, whose effects may leave no detectable evidence, other than that reflected in the biota.

A chemical sampling program can be very useful in several ways, provided that we appreciate the drawbacks and do not attempt to derive very diverse statements from relatively small bits of information. The chemical and physical interactions of the atmosphere, sediment, water layers, sunlight, organisms, flow patterns, and discharges are so complex that only by relating a very diverse sampling program to time of travel determinations and multiple samples can we begin to approach the maximum utility of physical/chemical sampling.

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1 The list of approved test procedures was published in the Federal Register, Volume 38, Number 199 - Tuesday, October 16, 1974, pp. 28757-28760.

Analysis of grab samples can, however, be used adequately to determine sources of pollution, when compared to effluent samples from known discharges. Grab samples may also be useful in confirming the investigator's conjectures regarding the presence or absence of organisms at specific stations provided adequate numbers and types of samples are taken.

If physical/chemical grab samples have been collected over a relatively long period of time, they may be useful in estimating historical changes in the water quality of the stream, as well as, reflecting changes in the level of wastewater treatment of discharging entities. We can use grab samples to interpret stream water quality, if over-interpretation of the data can be avoided and if the data are taken and used in conjuction with sampling of other segments of the lotic ecosystem; e.g., fish, macroinvertebrates, or aquatic plants.

The following sections will be concerned with data collected by the Ohio Environmental Protection Agency in 1974, 1975, 1976, and 1977. Station locations are shown in Figure 2. As mentioned previously,only limited interpretation of the data with regard to actual downstream chemical reactions (e.g., nitrification) will be made due to the complexity of this ecosystem and inherent sampling problems. We will, however, discuss water quality on a station by station basis, compare annual trends, particularly of dissolved oxygen and ammonia-nitrogen, and show changes in the chemical composition of the river water during the sampling period.

Water Quality Data 1974

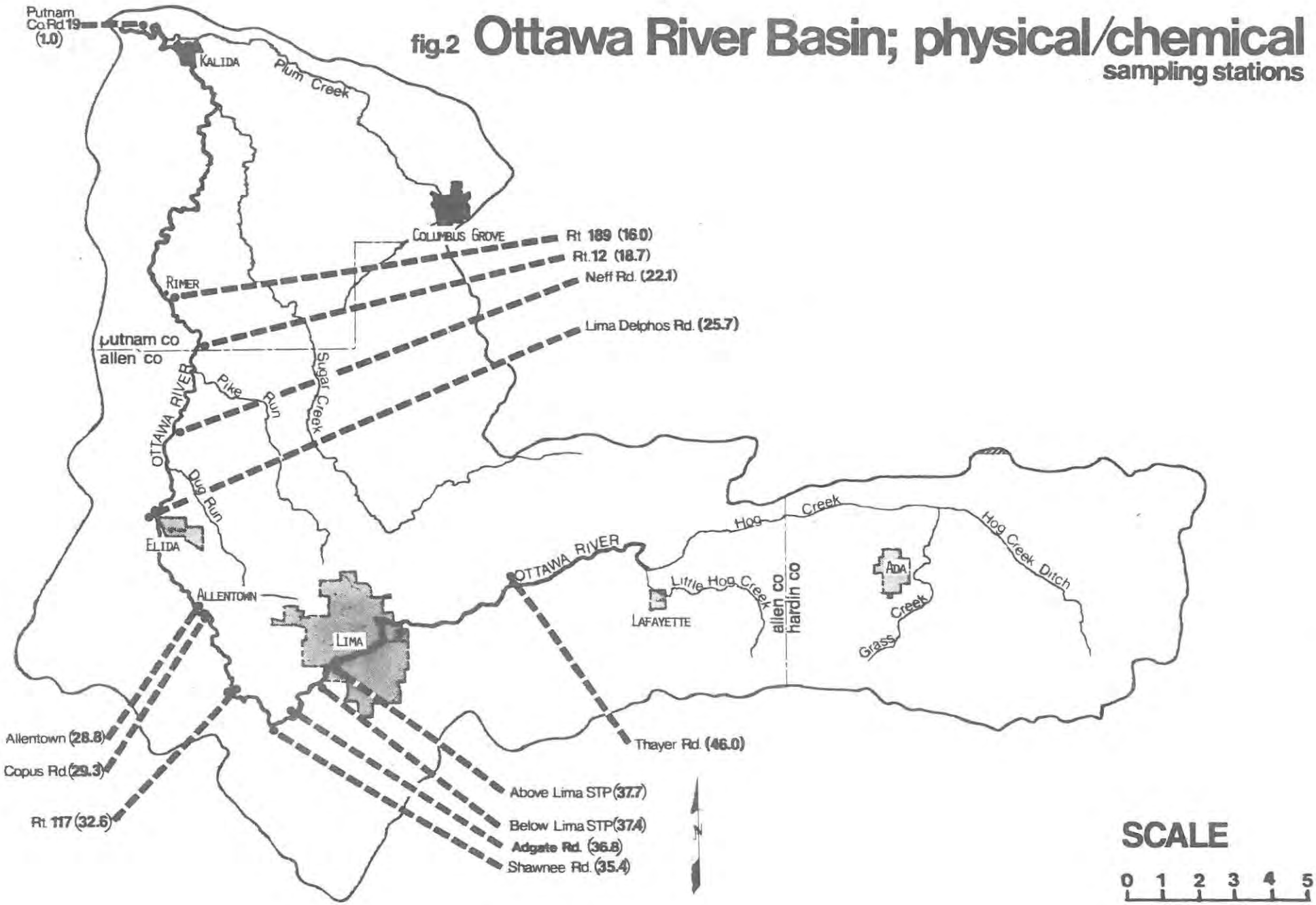
Results of water samples taken at three stations (RM 46.0, 28.8, 1.0) on the Ottawa River, as part of the OEPA ambient monitoring program for 1974 are shown in Appendix B, Table B-1. The water quality at the control station (RM 46.0) above Lima was relatively good, and no problems were found for dissolved oxygen, ammonia-nitrogen, phenols, and chromium. This station does not receive industrial discharges; the main pollution load consisting of non-point source contributions.

The station at Allentown (RM 28.8) was located below the industrial and municipal discharges in Lima (8.5 miles below the STP). Relatively high levels were found here for chromium, phenols, and fecal coliform bacteria. All dissolved oxygen samples had concentrations of less than 4.0 mg/l. All ammonia-nitrogen levels were potentially toxic to fish and other aquatic organisms, containing un-ionized ammonia concentrations higher than 0.05 mg/l. The amount of un-ionized ammonia contained in the samples is dependent on water temperature and pH. This station was near or at the dissolved oxygen sag point downstream from Lima. The low dissolved oxygen levels at this station, in conjunction with toxic materials originating from upstream, would be expected to exert a negative influence on the diversity of the aquatic community.

It became evident, during the 1974 stream observations, that much of the nutrient load from upstream was being converted into algal biomass. This was very apparent farther downstream in the vicinity of the Rimer Bridge (RM 16.0) where there was abundant growth of filamentous green algae on the bedrock.

The last station sampled was downstream from Kalida (RM 1.0), near the mouth of the Ottawa River. The data indicated potential problems with dissolved oxygen and chromium. The ammonia-nitrogen concentrations in the water samples

fig.2 Ottawa River Basin; physical/chemical sampling stations



contained levels of un-ionized ammonia, which should have been nontoxic to fish. Some of the water quality problems at this station, including fecal coliform bacteria, may be related to discharges from Kalida, which has no central sewage treatment plant. The maximum concentrations of chromium (100 ug/1) and phenols (10 ug/1) had decreased from levels detected at Allentown. The water quality this far downstream from Lima (36.5 miles below the STP) was still poor.

The data for July-August of 1974 (Appendix B, Table B-2) were collected during a special study to determine time of travel. Samples were collected at river miles 37.7, 36.8, 35.4, 32.6, 29.3, 25.7, 18.7, 16.0, and 1.0. While the attempt was not particularly successful, useful chemical data were generated. There were two dissolved oxygen measurements less than 4.0 mg/l in the July 29 - August 1 data; since these measurements were taken at different times of the day, they did not show a marked dissolved oxygen sag, as would be evident in a series taken at frequent intervals over a 24 hour period. Six of nine ammonia-nitrogen samples contained potentially toxic levels of un-ionized ammonia. The relatively high dissolved oxygen (9.0 mg/1) and the absence of detectable levels of ammonia-nitrogen at the station below Kalida on August 1 were the best water quality conditions detected at that station in 1974.

Among the samples collected during August 12 and 13, three dissolved oxygen concentrations of less than 4.0 mg/l were found. Also, eight of nine ammonia-nitrogen samples had potentially toxic concentrations of un-ionized ammonia.

In samples collected on August 26 and 27, no dissolved oxygen measurements were less than 4.0 mg/l, but seven of nine ammonia-nitrogen measurements indicated potentially toxic concentrations of un-ionized ammonia. The instream ammonia concentrations indicated that almost all of the Ottawa River below Lima was relatively unsuitable for the support of any but the most tolerant fish and macroinvertebrates. Sludge beds were common below Lima in 1974; specifically, black, oily sludge was present at river mile 36.8 during the July-August sampling period.

It was obvious that, though water quality was improved in 1974 over that discussed in historical documents, it was still far from desirable. This poor water quality would certainly exert a deleterious influence on desirable biota.

Water Quality Data - 1975

Physical/chemical data were collected at river miles 46.0, 28.8, and 1.0 during 1975. Data collected in 1975 at station 46.0 (Appendix B, Table B-3) indicated good water quality. The minimum dissolved oxygen level was 4.6 mg/1, while the maximum concentration was 9.1 mg/l. The data from this station continued to represent a relatively undamaged stream reach, when compared with the stations below Lima.

Data from the Allentown station (RM 28.8) revealed important problems, most of which probably resulted from the STP and industries in Lima. The maximum dissolved oxygen concentration found at this station was 4.8 mg/l (minimum was 2.3 mg/l). This station was near the estimated sag point below Lima where the dissolved oxygen levels reach their minima. All three ammonia-nitrogen samples contained potentially toxic concentrations of un-ionized ammonia. Fecal coliform bacteria numbers were high at this station, and the chromium levels were much higher than at the other two stations (RM 46.0 and RM 1.0).

Water quality near Kalida (RM 1.0) in 1975 was similar to that found in 1974. One of four dissolved oxygen samples was below 4.0 mg/1. Occasional low dissolved oxygen levels at RM 1.0 indicated that recovery was not complete at this station. However, flow characteristics of this reach, as well as benthic oxygen demand and discharges from Kalida, may also have been important factors in the dissolved oxygen levels of this station.

None of the four ammonia-nitrogen samples taken below Kalida in 1975 contained levels of un-ionized ammonia high enough to threaten fish survival. High fecal coliform bacteria numbers were probably a result of discharges from Kalida and from non-point sources.

Water Quality Data - 1976

Dissolved oxygen profiles were taken on the Ottawa River at 20 data points between river miles 46.0 and 1.0 during September, 1976 (Appendix B, Table B-4). The dissolved oxygen profile taken on September 11, 1976 showed that levels above the Lima STP were, for the most part, acceptable. A relatively low level (3.5 mg/1) was found at river mile 42.6. The fact that this station was located in a pool formed by a downstream dam undoubtedly contributed to the low dissolved oxygen concentration recorded.

The effect of the discharges from the Lima STP, the Standard Oil Refinery, and the Vistron plant at Adgate Road (RM 36.8) was apparent in the steady decrease in dissolved oxygen from Adgate Road downstream to Long Road (RM 30.1). The recovery of the stream dissolved oxygen levels began approximately 1.3 miles further downsteam. The dam below Allentown Road undoubtedly contributes considerable aeration to the stream.

The low dissolved oxygen concentrations, in combination with high levels of un-ionized ammonia would have made survival of intolerant aquatic species very difficult between Adgate Road and the Allentown Dam. A slight decrease in dissolved oxygen concentrations between RM 3.7 and RM 1.0 may have been related to flow conditions of the lower river (i.e., deep with less turbulence for reaeration), as well as sewage discharges from Kalida.

The series of dissolved oxygen samples taken on the morning of September 29, showed approximately the same pattern of fluctuation as that of September 11. The samples below the sag point were not as high as corresponding samples of September 11, probably due to the effects of algal respiration. The afternoon samples were similar to those of the morning, but with higher individual measurements due to algal photosynthesis. It was apparent from this data and from that collected during July-August of 1974, that the dissolved oxygen flux in the Ottawa River was heavily influenced by the metabolism of the stream algae, with the availability of dissolved oxygen depending on the extent of respiration and photosynthesis.

Additional physical/chemical samples were collected at river miles 46.0, 37.4, 32.6, 28.8, 22.1, 16.0 and 1.0 during October and November. Data collected in 1976 indicated that the water quality at the control station (RM 46.0) remained quite good, though one ammonia-nitrogen concentration was unusually high (2.07 mg/1). This sample however, contained a concentration of un-ionized ammonia less than 0.05 mg/1 and presented no threat to fish survival.

At station 37.4 the Lima STP did not appear to be adding a particularly large pollutional load to the river; none of the ammonia-nitrogen samples contained significant levels of un-ionized ammonia. Monthly operating reports for the STP showed a definite decrease in the monthly average concentrations of ammonia-nitrogen discharged in 1976, compared to reports for 1975.

All ammonia-nitrogen concentrations in samples from station 32.6 contained potentially toxic levels of un-ionized ammonia. Relatively high levels of chromium and phenols were also found. Concentrations of chromium and phenols remained relatively high at all remaining stations (RM 28.8, 22.1, 16.0 and 1.0).

Water quality at Allentown (RM 28.8) remained poor; all ammonia-nitrogen samples contained potentially toxic concentrations of un-ionized ammonia. There appears to have been little improvement in water quality between river miles 28.8 and 1.0, with all ammonia-nitrogen samples having potentially toxic levels of un-ionized ammonia. The source of much of the ammonia-nitrogen can be traced to the Vistron Corporation, whose monthly operating reports for June through November of 1976 revealed much higher monthly averages than for 1974, 1975, or 1977.

Water Quality Data - 1977

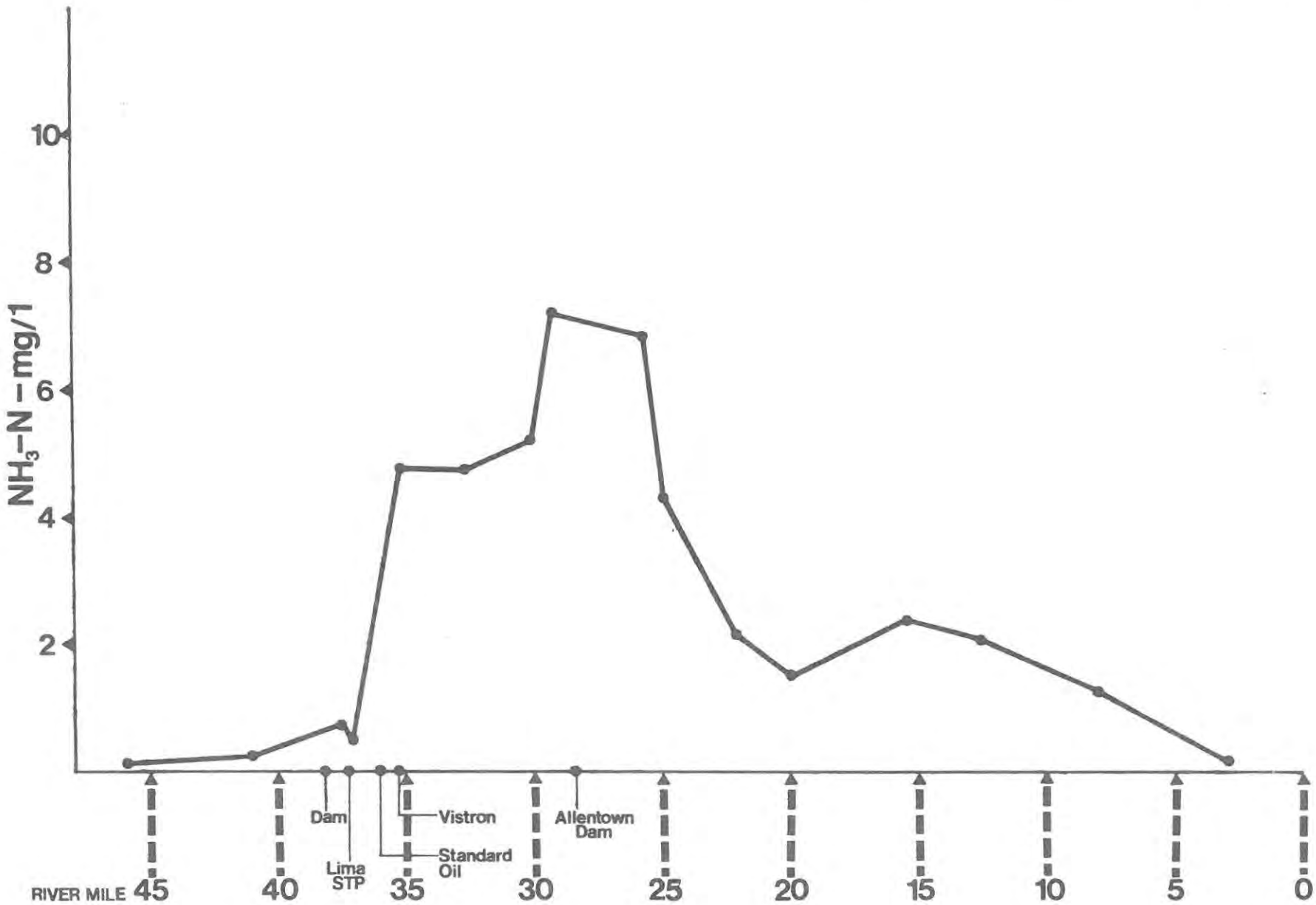
Ammonia-nitrogen data collected on August 31, 1977 is shown in Appendix B (Table B-6). The data indicated a relatively low concentration of ammonia-nitrogen above the Lima STP, particularly at the control station at Thayer Road (see Figure 3). The ammonia-nitrogen concentrations at two different sample times were both lower below the STP than the respective samples immediately above the plant. The increase in ammonia-nitrogen at the Shawnee Street (RM 35.4) station can be attributed to the discharges of the Vistron Corporation and the Standard Oil Refinery. The ammonia-nitrogen concentrations at the stations of this series were well below the average concentrations of earlier samples taken during the 1974, 1975, and 1976 sampling series. Potentially toxic concentrations of un-ionized ammonia did not appear as far downstream in 1977 as in 1976, or the previous year's samples. Therefore, the extent of the lower Ottawa River with water quality suitable for repopulation by fish had increased.

Several of the Ottawa River tributaries were also sampled for ammonia-nitrogen. Most of the tributaries were low in ammonia-nitrogen with the levels found probably originating from non-point sources. The only concentration which was relatively high was that from Kessler Run (3.37 mg/1).

Data were collected in August, 1977 (Appendix B, Table B-7) in order to compare the water quality of the Ottawa River above the Lima STP (RM 37.7) with that at Adgate Road, (RM 36.8). This comparison reflected the increase of several parameters due to the Lima STP, Vistron Corporation, and the Standard Oil Refinery. The most significant changes in the stream constituents at Adgate Road (in comparison to the upstream station) were seen in decreased dissolved oxygen and increases in dissolved solids, nitrogen forms, total phosphorus, chlorides, chromium and zinc.

In addition to data collected at river miles 37.7 and 36.8, physical/chemical samples were collected at river miles 46.0, 37.4, 32.6, 28.8, 22.1, 16.0, and 1.0. No water quality problems were found in chemical samples taken from the control station (RM 46.0) in 1977 (Appendix B, Table B-8).

fig. 3 Ammonia Concentrations (NH_3–N) in the Ottawa River Measured on August 31, 1977



Three ammonia-nitrogen samples from the Ottawa River below the Lima STP (RM 37.4) all contained relatively low concentrations of un-ionized ammonia. The stream water was very clear and the stream bottom was free of sludge deposits. In general, this station looked much better than at any previous collection period during this study.

Only two multi-parameter samples were taken at river mile 32.6 in 1977, but they suggest improved water quality. One dissolved oxygen sample had a concentration of less than 4.0 mg/l, and both ammonia-nitrogen samples had potentially toxic concentrations of un-ionized ammonia. The average for the two ammonia-nitrogen samples was 10.6 mg/l. The average of the ammonia-nitrogen samples taken in 1976 was 20.3 mg/l, and in 1974 (July-August) it was 14.9 mg/l.

Two of the dissolved oxygen samples taken at Allentown (RM 28.8) in 1977 had concentrations of less than 4.0 mg/l. Five of six ammonia-nitrogen samples contained potentially toxic concentrations of un-ionized ammonia, but the average concentration was only 6.9 mg/l as compared to average concentrations in 1976 of 25.2 mg/l, 14.0 mg/l in 1975 and 23.9 mg/l in 1974.

Improvement in water quality was also noted at Neff Road (RM 22.1) in 1977. The average ammonia-nitrogen concentration was 4.8 mg/l; the average concentration was 25.3 mg/l in 1976. There were no dissolved oxygen levels detected at this station which were below 4.0 mg/l.

The sample series taken at Rimer (RM 16.0) presented good evidence of improved water quality below Lima. None of the ammonia-nitrogen samples had high un-ionized ammonia concentrations and the average concentration of ammonia-nitrogen was 0.97 mg/l, compared to average values of 18.8 mg/l in 1976 and 10.3 mg/l for three samples taken in 1974. No dissolved oxygen problems were found at this station in 1977.

Only one sample out of five for ammonia-nitrogen at Kalida exceeded 0.05 mg/l un-ionized ammonia. The average concentration of ammonia nitrogen (0.57 mg/l) was lower than those for 1976 (21.2 mg/l), 1975 (1.9 mg/l), and 1974 (5.8 mg/l - June-October, 1.1 mg/l - July-August).

Concentrations of chromium in the 1977 sample series decreased considerably relative to the 1976 series at most stations due to decreased loadings from Vistron Corporation.

The data discussed above clearly indicate that the water quality of the Ottawa River below Lima is improving. The decrease in problems with ammonia-nitrogen, dissolved oxygen, and chromium are especially significant in relation to potential repopulation of damaged reaches of the river. While there are and will continue to be water quality problems in the Ottawa, the trend appears to be in a positive direction. The improvement in water quality should not only allow for the growth of more diverse aquatic communities, but also increased use of the river for recreational purposes.

FISHERIES INVESTIGATIONS

Methods

Fish collections were made at river miles 46.0, 37.4, 22.1, and 1.0 during 1976. All stations were sampled during late August and early September. Station 22.1 was also sampled once in early November. During 1977, collections were made at ten stations. Six of these (RM 32.6, 30.1, 28.8, 22.1, 7.9, and 1.0) were sampled in April and eight (RM 46.0, 37.7, 37.4, 28.8, 22.1, 16.0, 7.9, and 1.0) were sampled in late August and early September. Collections were made during periods of relatively low stream flows. Sampling locations are shown in Figure 4 and station descriptions are given in Appendix A.

Fish sampling equipment consisted of three nets. The first, a bag seine, measured 30 feet by four feet deep, with 1/4 inch mesh. The other two were straight seines measuring six feet by four feet deep and ten feet by four feet deep with mesh sizes of 1/8 and 1/4 inch, respectively.

All available habitats were sampled at each station in order to insure the capture of species with different habitat preferences. Stations were sampled until no new species were being captured and the relative abundance of the different species could be estimated. Generally, between two and three hours of seining at each station were found to be sufficient to determine the relative abundance of the species of fish present. At stations where species diversity was low, a shorter period of time was adequate to sample the fish community, whereas, more diverse fish populations required a longer period of sampling. Representative specimens were preserved as a reference collection; however, most of the fish collected were field identified and released.

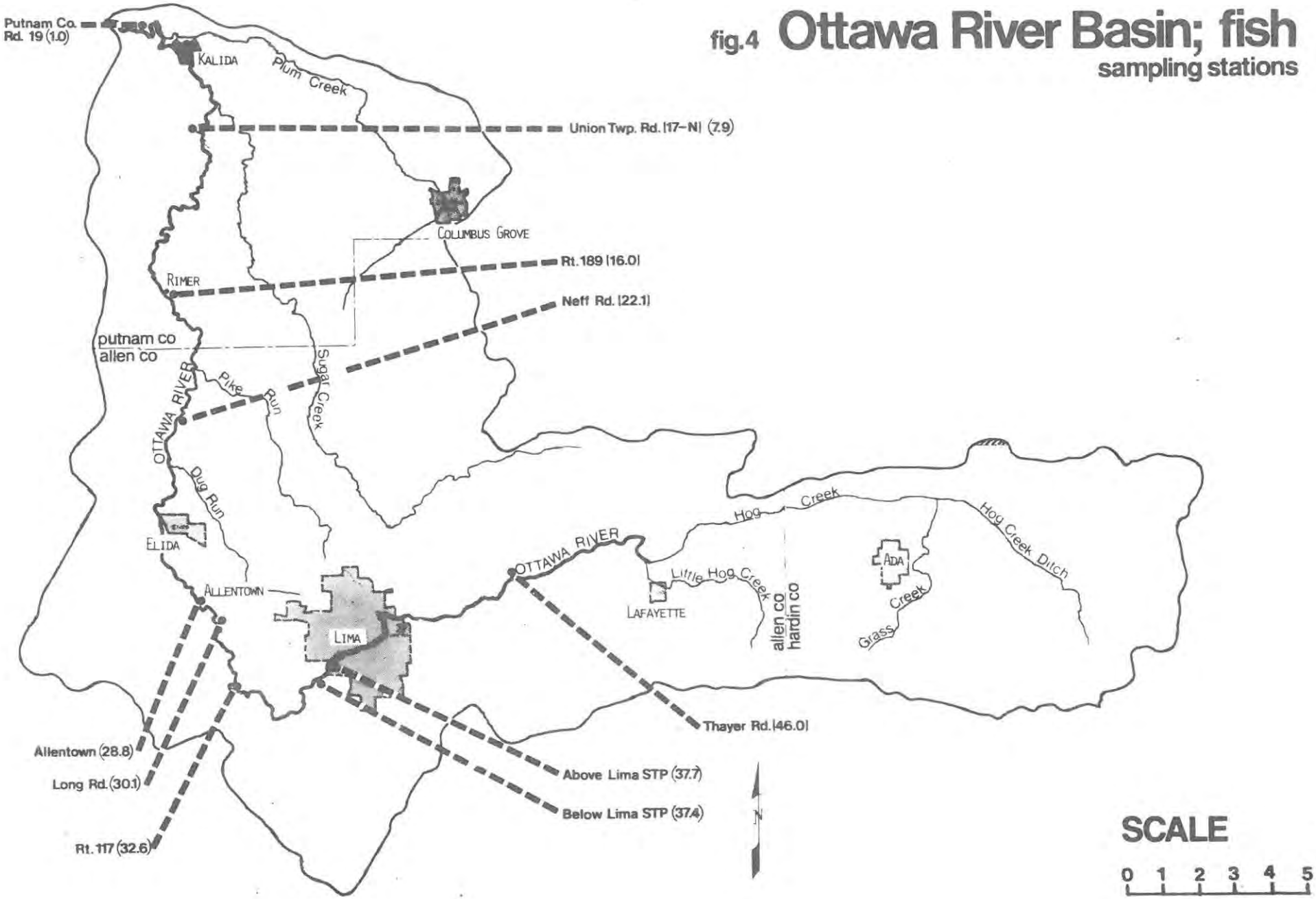
Although the collection methods were only roughly quantitative, the relative species abundances were determined as follows: 50 or more fish collected were referred to as abundant; 10 to 49, common; 3 to 9, uncommon; and 1 or 2, rare. No rigorous statistical treatment of the data was possible; however, the observed differences in the fish communities were so evident that sampling errors were deemed to be relatively unimportant.

Results and Discussion

Fish are useful indicators of water quality and, as the highest aquatic life forms found in streams, they are the biological indicators of stream health most noticeable to the general public. Generally, the most stringent water quality standards are set in order to protect aquatic life and most of these standards are based upon data derived from studies using fish. For these reasons, and for the economic, recreational, and aesthetic value of many fish species, fish were included as a part of this study.

Fish, as the end product of an aquatic food web, are important indicators of water quality. However, the presence of a species does not necessarily mean that the species can survive and successfully complete its life cycle under the existing environmental conditions (Doudoroff and Warren, 1957; White, et al, 1975). Some fishes are highly mobile and they may temporarily enter a grossly polluted zone (Trautman, 1957). White, et al (1975) observed this in the Lower Cuyahoga River.

fig.4 Ottawa River Basin; fish sampling stations



There are a number of factors that determine whether or not a species of fish can successfully complete its life cycle in a stream. Adequate water quality, suitable spawning areas, proper habitat, adequate food supply, as well as other factors, must be satisfied for a species to successfully survive and reproduce in a stream. However, when other ecological factors are similar, the absence of the normal fish community from a segment of a stream indicates inadequate water quality. Doudoroff and Warren (1957) concluded that fish themselves are the best indicators of the environmental conditions generally suitable or unsuitable for their existence. The presence of healthy fish populations of non-migratory species, particularly when intolerant species are present, is a useful indicator of good water quality. Katz and Gaufin (1953), in their study of Lytle Creek, stated that the number of species present and their relative abundance are the most important considerations, when pollution in a stream is being evaluated.

Thirty-nine species representing nine families were collected during the present study. Previous studies recorded 36 species (Trautman, 1957) and 33 species (Patrick, et al, 1956). This information is summarized in Table 2.

The only species collected during this study that was not collected in the previous studies was the emerald shiner (Notropis atherinoides). Fishes recorded in earlier studies but not collected in this study were the northern pike (Esox lucius), the smallmouth bass (Micropterus dolomieui), the tadpole madtom (Noturus gyrinus), the mimic shiner (Notropis volucellus), and the bullhead minnow (Pimphales vigilax).

Collections were made at four different locations in the Ottawa River during 1976. The species collected at each station are shown in Appendix C (Table C-1). Station 46.0 located at Thayer Road upstream from Lima was the control station. Twenty-five species of fish from seven families were collected. This station was well represented by various species of suckers, minnows, darters, and centrarchids. Species of interest to fishermen included the black bullhead (Ictalurus melas), the rock bass (Ambloplites rupestris), the bluegill (Lepomis macrochirus), the largemouth bass (Micropterus salmoides) and the white crappie (Pomoxis annularis). The diversity of species collected, their relative abundances, and the condition of the individuals collected indicated a healthy community of fishes.

Station 37.4 was located approximately 0.2 mile downstream from the Lima STP outfall. The creek chub (Semotilus atromaculatus), the carp (Cyprinus carpio), the fathead minnow (Pimephales promelas), and the green sunfish (Lepomis cyanellus) were the only species collected at this station. These species are all tolerant to organic pollution (Katz and Gaufin, 1953; Balduf and Martin, 1978). The green sunfish was found to be successfully reproducing in the very polluted lower Cuyahoga River (White, et al, 1975). The very low diversity of fishes coupled with the presence of only pollution tolerant species indicated a highly stressful environment for fish at this station.

Ten species of fish were collected at station 22.1. The community was dominated by pollution tolerant species; the low diversity of fishes and the lack of pollution sensitive species show that this station represented a stressful environment for fish.

Table 2 A Summary of Species of Fish Collected in the Ottawa River

Species	Common Name	Ohio EPA 1976-77	Trautman 1953	Patrick etal. 1956
Dorosoma cepedianum	Gizzard shad	X		X
Esox americanus vermiculatus	Grass pickerel	X	X	X
Esox lucius	Northern pike		X	
Semotilus atromaculatus	Creek chub	X	X	X
Cyprinus carpio	Carp	X	X	X
Notemigonus crysoleucas	Golden shiner	X	X	X
Notropis volucellus	Mimic shiner		X	
Notropis umbratilis	Redfin shiner	X	X	X
Notropis spilopterus	Spotfin shiner	X	X	X
Notropis stramineus	Sand shiner	X	X	X
Notropis atherinoides	Emerald shiner	X		
Notropis cornutus	Common shiner	X	X	
Campostoma anomalum	Stoneroller	X	X	X
Ericymba buccata	Silverjaw minnow	X	X	X
Phenacobius mirabilis	Suckermouth minnow	X	X	
Pimephales vigilax	Bullhead minnow			X
Pimephales notatus	Bluntnose minnow	X	X	X
Pimephales promelas	Fathead minnow	X	X	
Moxostoma erythrurum	Golden redhorse	X	X	X
Carpiodes cyprinus	Quillback	X		X
Hypentelium nigricans	Northern hog sucker	X	X	
Catostomus commersoni	White sucker	X	X	X
Minytrema melanops	Spotted sucker	X	X	X
Ictalurus punctatus	Channel catfish	X	X	
Ictalurus melas	Black bullhead	X	X	X
Ictalurus natalis	Yellow bullhead	X	X	X
Noturus gyrinus	Tadpole madtom			X
Labidesthes sicculus	Brook silverside	X		X
Fundulus notatus	Blackstripe topminnow	X	X	X
Ambloplites rupestris	Rock bass	X	X	X
Lepomis cyanellus	Green sunfish	X	X	X
Lepomis macrochirus	Bluegill	X	X	
Lepomis megalotis	Longear sunfish	X	X	X
Lepomis humilis	Orangespotted sunfish	X		X
Micropterus dolomieui	Smallmouth bass		X	X
Micropterus salmoides	Largemouth bass	X	X	X
Pomoxis annularis	White crappie	X		X
Etheostoma nigrum	Johnny darter	X	X	X
Etheostoma blennioides	Greenside darter	X	X	X
Etheostoma caeruleum	Rainbow darter	X	X	X
Etheostoma spectabile	Orangethroat darter	X	X	
Etheostoma flabellare	Fantail darter	X	X	X
Percina caprodes	Logperch	X	X	
Percina maculata	Blackside darter	X	X	X
	Total Number Species	39	36	33

The last station sampled (RM 1.0) during 1976 was near the mouth of the Ottawa River. Twenty-five species from seven families were collected. The fish community was well-represented by suckers, minnows, and centrarchids; however, the Johnny darter (Etheostoma nigrum) was the only darter species collected. The Johnny darter is primarily a pool species and, presumably, is the most pollution tolerant darter species found in the Ottawa River. Station 1.0 included a riffle area and therefore several species of darters should have been collected (assuming the presence of adequate water quality). In spite of intensive collecting, only two Johnny darters were found. The lack of darters at this station indicates that the Ottawa River was still undergoing recovery as it entered the Auglaize River.

During the summer of 1977, eight stations were sampled in the Ottawa River. Species collected and their relative abundances for each station are shown in Appendix C (Table C-2). Station 46.0 had a diverse and well-balanced community of fishes represented by 23 species. There were no apparent changes since the 1976 collection. Patrick, et al (1956) recorded 28 species at Cool Road which is immediately upstream from this station. Smallmouth bass were collected by Patrick, but were not collected during our survey. A local resident indicated that some smallmouth bass were still taken by fishermen; however, he believed that they were less abundant in recent years.

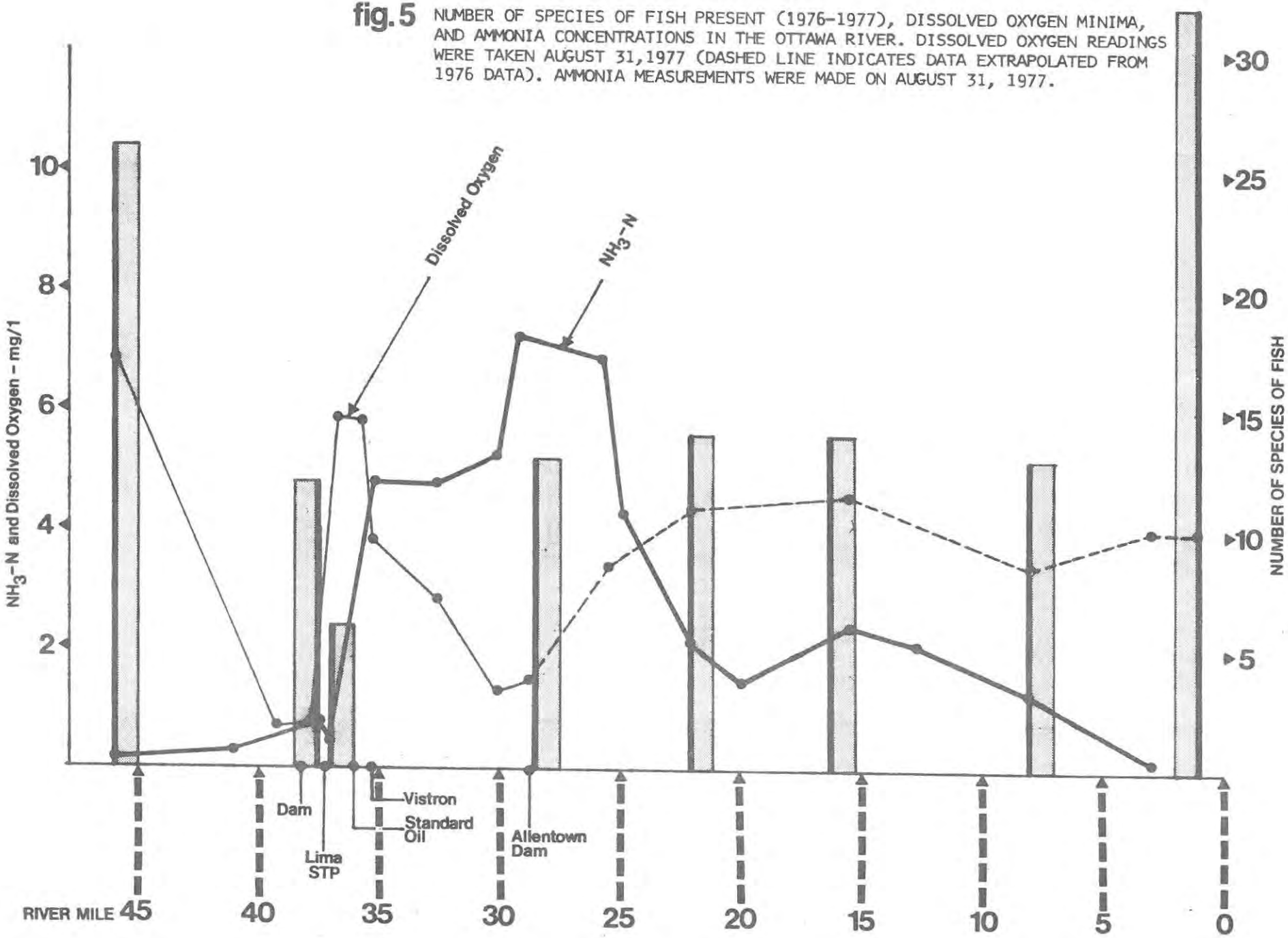
Station 37.7 is located immediately upstream from the Lima STP. This station was not sampled in 1976. During 1977, 11 species were collected. Green sunfish, fathead minnows, and carp were the most abundant species. The fish community was characterized by pollution tolerant species and a low species diversity indicative of a stressed ecosystem. As in 1976, the station downstream from the Lima STP (37.4) had a very low species diversity. Only six pollution tolerant species were collected.

Only a limited amount of collecting was done between river mile 36.8 and river mile 28.8 (Allentown Dam). The section of the Ottawa River from the Vistron Corporation outfall (RM 36.8) to the Allentown Dam appeared to be essentially devoid of fish populations. Two fathead minnows were collected at station 30.1 in the spring of 1977 and young green sunfish were observed in the summer of 1977 immediately above the Allentown Dam. Other than these two species, no other living fish were observed in this segment of the Ottawa River during this study.

At station 28.8, immediately downstream from Allentown Dam, nine species of fish were collected during the summer of 1977. An additional four species were taken during the spring of 1977. Carp, the white sucker (Catostomus commersoni), and the bluegill were the most abundant species collected. The increase in species found below the dam, we believe, was partially the result of increased dissolved oxygen in the stream after it passed over the dam.

A total of 20 species of fish were collected between river mile 22.1 and 7.9. Collections made at river miles 22.1, 16.0, and 7.9 yielded 14 species at the first two stations and 13 species of fish at the last. The species collected and species diversity at these three stations were similar. Ammonia and dissolved oxygen concentrations were also similar (Figure 5). Although species diversity showed improvement in this segment of the river, pollution tolerant species still dominated the fish populations. Despite ideal habitat, no pollution sensitive darters were found. Six centrarchid species, including largemouth bass and bluegill were collected; however, all were uncommon or rare in abundance.

fig. 5 NUMBER OF SPECIES OF FISH PRESENT (1976-1977), DISSOLVED OXYGEN MINIMA, AND AMMONIA CONCENTRATIONS IN THE OTTAWA RIVER. DISSOLVED OXYGEN READINGS WERE TAKEN AUGUST 31,1977 (DASHED LINE INDICATES DATA EXTRAPOLATED FROM 1976 DATA). AMMONIA MEASUREMENTS WERE MADE ON AUGUST 31, 1977.



The final station of the Ottawa River (RM 1.0) showed signs of continued improvement during 1977. Twenty-three species of fish were collected, including three pollution sensitive species found in 1977 that, to our knowledge, have not been recorded for at least 20 years. The presence of the greenside darter (Etheostoma blenniodes), the logperch (Percina caprodes), and the blackside darter (Percina maculata) demonstrated that marked improvement in water quality had occurred at this station.

Figure 5 plots dissolved oxygen and ammonia concentrations and the number of species of fish collected by river mile. It is believed that ammonia and dissolved oxygen concentrations are two of the more important water quality parameters affecting fish populations in the Ottawa River downstream from Lima. Dissolved oxygen and ammonia measurements were made on August 31, 1977. As dissolved oxygen measurements were not taken downstream from the Allentown Dam on August 31, data downstream from river mile 28.8 was extrapolated from 1976 data based upon percent saturation values. The number of species of fish represent the combined number of species collected at each station during 1976 and 1977.

During the survey, 26 species of fish were collected at station 46.0, while 32 species were collected at station 1.0. Dissolved oxygen minimum generally remained above 4 mg/1 at these two stations. On August 31, 1977, ammonia-nitrogen levels were 0.09 mg/1 at the upstream station and 0.20 mg/1 at station 1.0. Both of these stations maintained well-balanced populations of fishes and a good diversity of species. Both stations also had fish communities in 1977 that one would expect to find in Northwest Ohio streams with similar habitat, and relatively good water quality.

Twelve species were collected at station 37.7 during the spring and summer of 1977. The low dissolved oxygen levels that occurred during early morning hours (2.0 mg/1) contributed to the low diversity of fish species found at this station. These low dissolved oxygen levels were the result of combined sewer overflows in the City of Lima upstream from the STP. A series of dams above the Lima STP allow for the deposition of sludge deposits in the pool areas formed by the dams. These sludge deposits, in conjunction with phytoplankton populations that undoubtedly develop, cause excessive diurnal oxygen fluctuations that are detrimental to well-balanced and diverse fish communities.

At station 37.4, immediately downstream from the Lima STP, only six species of fish were collected. Ammonia levels were relatively low and dissolved oxygen concentrations were high. The primary factor limiting the diversity of fishes at this station is probably chlorine. Fish diversity should increase considerably at this station if residual chlorine levels in the final effluent of the Lima STP are decreased. Martin and Balduf (1977) found 21 species of fish in the Scioto River immediately downstream from the Kenton STP. Seven species of pollution sensitive darters and the smallmouth bass were among the species collected. No residual chlorine was detected in the STP effluent. Tsai (1973), in his study of fish species diversity in streams below secondary sewage treatment plants, found chlorine and turbidity increases to be the major causative factors for fish species diversity reduction below the outfalls. Since the Lima STP has a very clear effluent, chlorine toxicity is considered to be the primary cause for the reduction of fish species diversity immediately downstream from the plant outfall. During periods of low stream flow, over 90% of the flow of the Ottawa River at station 37.4 is from the Lima STP.

Only two species of fish were collected between river mile 36.8 and 28.8 during this study. High ammonia concentrations and low dissolved oxygen concentrations were considered to be the primary factors causing the near absence of fish in this segment of the river. Elevated concentrations of chromium were undoubtedly an additional factor. During 1977, the Standard Oil Refinery and Vistron Corporation were the causes of the high ammonia concentrations and contributed to the low dissolved oxygen levels found. Prior to 1976, the Lima STP was also a major source of ammonia.

A total of 13 species were collected at station 28.8, immediately below the Allentown dam, during the spring and summer of 1977. The increase in fish diversity below the dam was probably the result of increased oxygen concentrations in the Ottawa River as it flowed over the dam. In addition, the dam undoubtedly acts as a barrier to upstream fish migrations except during periods of high stream flow. Fish are able to repopulate the Ottawa River throughout the year below the dam. However, upstream from the dam only high flow periods allow for repopulation. Recovery from fish mortality upstream from the dam would be primarily dependent upon recruitment of new individuals from tributary streams or downstream populations migrating upstream during high stream flows. The green sunfish is apparently the only species that was able to successfully reproduce in the Ottawa River upstream from Allentown Dam and downstream from river mile 36.8.

A total of 20 species was recorded from river mile 22.1 to 7.9. This increase in species diversity corresponded with a decline in ammonia concentrations and increased dissolved oxygen concentrations. The complete absence of darters was conspicuous, as the habitat in this stream segment is ideal for several different species. Several species of darters are known to be present in Sugar Creek, a tributary that enters the Ottawa River at river mile 6.3. Other tributaries to the Ottawa River undoubtedly contain darters that could repopulate the Ottawa River when water quality is adequate. Katz and Gaufin (1953) found that various species of darters and black bass were highly sensitive to pollutants and their presence was usually indicative of favorable water quality. We have observed similar circumstances in our studies of streams in Northwest Ohio; although the smallmouth bass appears to be relatively sensitive to organic pollution while the largemouth bass appears to be more tolerant. Balduf and Martin (1978) found largemouth bass to be fairly numerous in a segment of the Blanchard River downstream from the Findlay STP. In the Ottawa River, largemouth bass were found in areas with elevated ammonia concentrations and low dissolved oxygen levels. Since the largemouth bass is essentially a species of non-flowing waters (Trautman, 1957) it is not surprising that this species is more tolerant to organic pollution than the smallmouth bass which is mainly an inhabitant of waters with current. A repopulation of the Ottawa River by darters and smallmouth bass should indicate that the stream has returned to a healthy condition. Since darters are more easily sampled than smallmouth bass, the movement of darters upstream towards Lima appears to offer a very good measure of stream recovery.

BENTHOS STUDIES

Methods

The primary sampling equipment used for collection of benthos was the modified Hester-Dendy multiple-plate artificial substrate sampler. The sampler was constructed of 1/8 inch tempered hardboard cut into three inch square plates and one inch square spacers. A total of eight plates and twelve spacers were used for each sampler. The plates and spacers were placed on a 1/4 inch eyebolt so that there were three single spaces, three double spaces, and one triple space between the plates. The total surface area of the sampler, excluding the eyebolt, was 145.6 square inches.

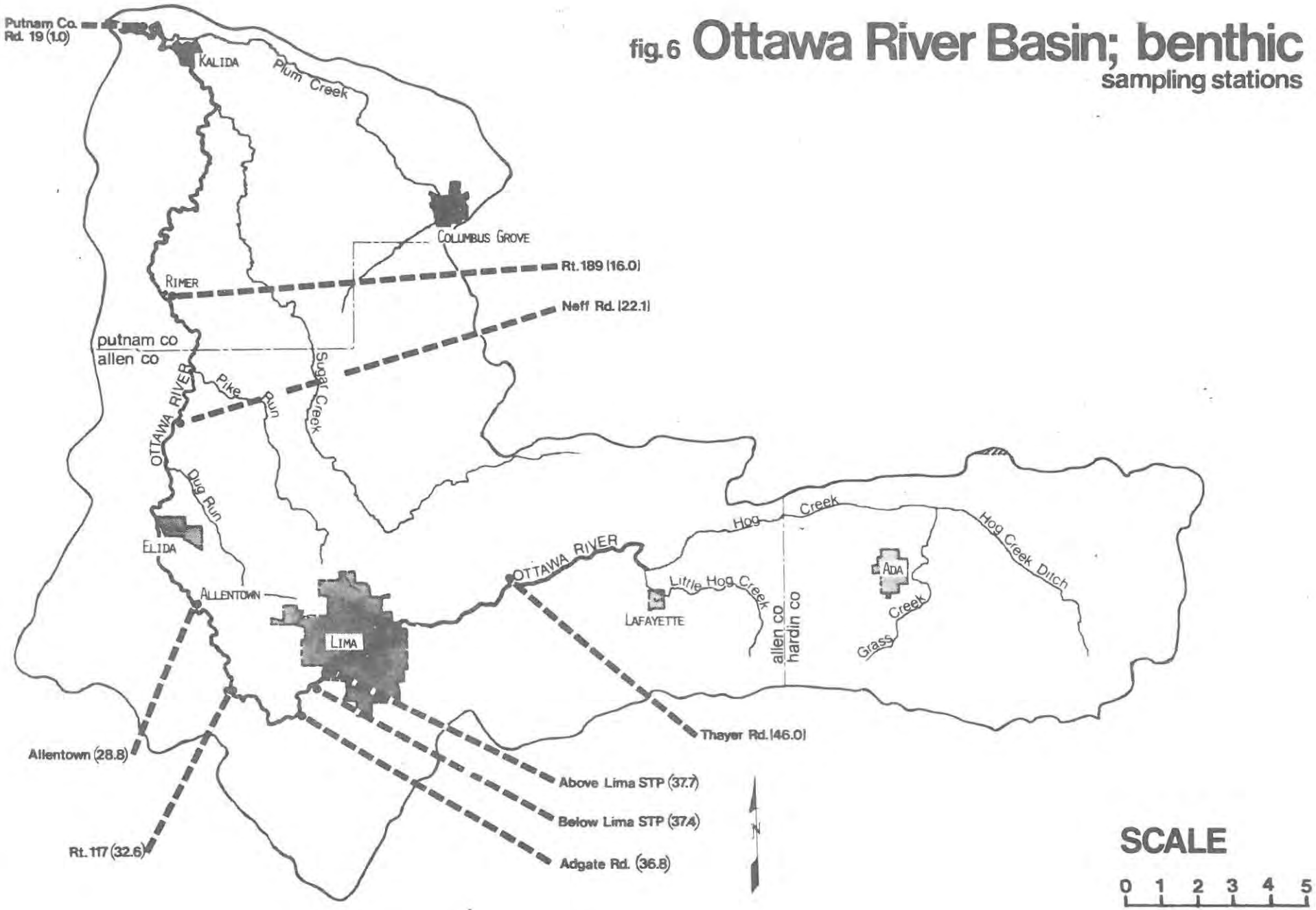
Artificial substrate samplers were installed in the Ottawa River in 1974, 1976, and 1977. Samplers were located at river mile points 46.0, 37.7, 37.4, 36.8, 32.6, and 28.8 in 1974. Two additional stations were established in 1976 at river mile points 16.0 and 1.0. During 1977, a new station was established at river mile 22.1, other stations remained the same as in 1976, except that station 16.0 was not sampled. Figure 6 shows the station locations for the Ottawa River. In addition, two stations were established in the Auglaize River in 1977 above and below its confluence with the Ottawa at river mile points 34.6 and 28.5. The samplers, five at each station, were exposed for a six week period. When the samplers were installed in these streams they were tied to a concrete building block which anchored them in place and also prevented the multiple-plates from coming into contact with the natural substrate. The samplers were placed in runs rather than pools or riffles, when possible, and an attempt was made to establish stations in as similar an ecological situation as possible. Station locations and descriptions are given in Appendix A.

When the samplers were retrieved, each was placed in a one quart plastic container while still submersed. The line was then cut and the container removed from the water. The volume of formalin needed to approximate a 10% solution was added to each container. Qualitative samples from the natural substrate were collected at the time of retrieval of the multiple-plates. Dip net samples were taken in a stream segment approximately 20 yards long, in the area where the samplers were exposed. The qualitative sampling continued until, by gross examination, no new taxa were being taken.

The multiple-plates were dismantled in the laboratory and the material washed through a U.S. Standard Testing Sieve number 40 (0.425 mm openings). Larger organisms were hand picked from the screens and the smaller material washed into a jar containing 70% alcohol. Where the number of organisms collected was so large that identification of each individual was impractical, a Folsom sample splitter was used to obtain a subsample. Identifications and counts were made using dissecting and compound microscopes. Dipterans of the family Chironomidae were prepared following the methods described by Mason (1973). Identifications were made using the following taxonomic keys: Beck and Beck (1966), Brown (1972), Burch (1972), Burks (1953), Frison (1935), Harman and Berg (1971), Hilsenhoff (1970), Hobbs (1972), Holsinger (1972), Klemm (1972), Lewis (1974), Pennak (1953), Roback (1957), Ross (1944), Usinger (1956), Walker (1958), Walker and Corbett (1975), Ward and Whipple (1959), and Williams (1972). After the benthic organisms had been identified and counted, species diversity indices ($\bar{d}$) were calculated using the formula:

$$\bar{d} = -\sum\left(\frac{ni}{n}\right)\log_2\left(\frac{ni}{n}\right).$$

fig. 6 Ottawa River Basin; benthic sampling stations



This formula is a function of the number of species (ni), total number of individuals (n), and the distribution of the individuals within the number of species.

Results and Discussion

Benthic macroinvertebrates have been widely used to evaluate the quality of flowing water. This group has a number of qualities that make their use in pollution oriented studies particularly advantageous. The species composition and community structure of benthic communities in a given stream are determined by environmental factors which have existed during the life span of the organisms. They are sensitive to most types of pollution and even a short term exposure to unfavorable conditions may alter the community structure.

The benthic community, therefore, is a reflection of past environmental conditions as well as what is occurring at the moment the sample is taken. In addition, these organisms form permanent or semi-permanent stream communities, are less transient than fish, are less sporadic in occurrence than micro-organisms, and usually occur in statistically significant numbers even in small streams.

Benthic macroinvertebrates can be defined by location; i.e., those organisms living on or interacting with the substrate, or by size; i.e., those organisms retained in a screen of a certain size, but they cannot be defined by position in the trophic structure since they occupy virtually all levels. They may be omnivores, carnivores, or herbivores; and in a well balanced system, all types will likely be present. They include detritus feeders, parasites, scavengers, grazers, and predators. In streams exhibiting high water quality, and otherwise suitable habitat, a stable and diverse benthic community will usually exist consisting of a great many species, but because of competition, no single species will occur in great numbers. When the water quality is adversely affected, the more pollution sensitive forms will decline in number or be eliminated. The more pollution tolerant species that remain may increase, resulting in a population imbalance where fewer types exist but some occurring in great numbers. The nature and magnitude of the community alteration depends upon the nature and severity of the environmental change.

The biological criteria used to evaluate water quality at stations established in the Ottawa and Auglaize Rivers were (1) the types of organisms present, (2) the number of taxa colonizing the artificial substrate samplers, and (3) the diversity index, $\bar{d}$.

Certain types of organisms have historically been associated with high water quality areas. Examples of more pollution sensitive groups would include stoneflies, mayflies, and caddisflies. Organisms usually dominating polluted stream segments include the oligochaetes, pulmonate snails, and many types of diptera. We have not attempted to use the "indicator species" concept in this report, but have noted the presence, or perhaps more importantly, the absence of some major taxonomic groups from particular stations.

From previous stream water quality biological investigations, we have found the number of different taxa colonizing multiple-plate samplers to range from three in grossly polluted areas, to over 40 in very high water quality stream segments. The number of taxa colonizing the plates is usually not less than 20 in high quality reaches and not more than 25 in degraded segments.

The diversity index $\bar{d}$ is a function of numbers of taxa, total number of individuals, and most importantly, the distribution of the individuals among the taxa. Unlike some diversity indices, $\bar{d}$ distinguishes among species of different abundance. This index strongly reflects a population imbalance that in some cases may not be readily apparent in tabulated data. A minimum of 100 organisms is needed to calculate this index which generally ranges from less than 1.0 to over 3.0. Previous investigations of Ohio streams have revealed a range of index values from a low of 0.01 in a grossly polluted area to 3.97 in a stream exhibiting very high water quality. Wilhm (1970) reported that clean streams often had $\bar{d}$ values between 3 and 4.

The benthic data collected during the three sampling periods may be found in Appendix D (Table D-1, D-2, D-3). A summary of the benthic data collected from the Ottawa may be found in Table 3.

The station located at river mile 46.0, upstream from the City of Lima consistently had the highest number of taxa (17, 28, 27) and diversity indices (3.35, 3.16, 3.45) during the three sampling periods. Pollution sensitive organisms such as mayflies, caddisflies, and stoneflies were collected here. These insects were greatly reduced or absent from most downstream stations. The water quality as reflected by the benthic biota, was considered good at this station. No other stations sampled in the Ottawa River had water quality equal to that found here.

The next downstream station was located at river mile 37.7, immediately upstream from the sewage treatment plant. This site appeared to undergo a notable stress even though the sampling was conducted above any major discharge. The near elimination of the pollution sensitive organisms coupled with low numbers of taxa (9, 8, 9) and low diversity indices (1.50, 2.03, 1.62) indicated a deterioration in water quality from that found at river mile 46.0. The apparent cause of this stress is dissolved oxygen depletion due to the effects of combined sewer overflows in the City of Lima. A series of five low head dams through the city, from Lovers Lane Dam to immediately upstream from station 37.7, act as settling basins through Lima. Benthic oxygen demands coupled with algal respiration contribute to widely fluctuating dissolved oxygen levels and result in early morning minima which are detrimental to healthy, well-balanced aquatic communities.

Station 37.4 was located just downstream from the sewage treatment plant. A decided improvement was noted here during the three sampling periods. In 1974 sludge deposits completely covered the multiple-plate samplers preventing any significant colonization. Only four taxa and three organisms per square foot were found on the plates, the latter precluding the determination of species diversity indices. The heavy sludge deposits were eliminated during the 1976 and 1977 sampling periods allowing colonization by benthic organisms to occur. The numbers of taxa (11, 14) diversity indices (2.31, 1.90) and lack of pollution sensitive organisms indicated poor water quality, but nevertheless, a slight improvement was shown over the last station and the previous sampling period. Increased oxygen concentrations improved the water quality markedly at this station, while chlorine was probably a major factor limiting diversity of the macroinvertebrates.

Table 3. Summary of Benthic Data Collected on Artifical Substrate Samplers in the Ottawa River, 1974, 1976, 1977.

River Mile	46.0	37.7	37.4	36.8	32.6	28.8	22.1	16.0	1.0
Diversity	3.44	1.62	1.90	1.96	2.04	0.29	1.87		2.20
1977								(b)	
Taxa	27	9	14	11	8	5	14		14
Diversity	3.16	2.03	2.31	1.73	0.01	0.32		2.27	3.10
1976							(b)		
Taxa	28	8	11	7	2	5		14	18
Diversity	3.35	1.50	(a)	1.17	1.78	0.11			
1974							(b)	(b)	(b)
Taxa	17	9	4	4	5	4			

(a) Insufficient number of organisms needed to calculate diversity ($\bar{d}$).
(b) Not sampled.

The station located at river mile 36.8 was immediately downstream from the Vistron Corporation outfall. The numbers of taxa (4, 7, 11) and diversity indices (1.17, 1.73, 1.96) from the three sampling periods illustrated degraded water quality conditions.

Data collected from the station located at river mile 32.6, indicated that water quality ranged from poor to very poor. The number of taxa (5, 8) and diversity values (1.78, 2.04) from 1974 and 1977 reflected similar water quality conditions, while the number of taxa (2) and diversity value (0.01) from 1976 were the lowest values recorded throughout the three year study. A major reason for the variance in these samples was the complete dominance of the chironomid Glyptotendipes sp in 1976. This midge, comprising 99.9% of the 1976 sample, greatly skewed the balance of the community which accounted for the low species diversity index. The organism was present in the 1974 and 1977 samples but only in moderate numbers. This organism contains hemoglobin which enables respiration to occur even in very low levels of dissolved oxygen. Therefore, when present in great numbers, it may indicate a drastic reduction in dissolved oxygen. At this site in September of 1976, dissolved oxygen was recorded at 2.9 mg/1 (1050 hours) which was the lowest level measured on the river for that day.

The station located at river mile 28.8 was immediately upstream from the Allentown dam and near the estimated oxygen sag point. The benthic data from all three sampling periods reflected a very depressed water quality situation. The low numbers of taxa (4, 5, 5) and diversity indices (0.22, 0.32, 0.29) found during the three years indicated that, of the stations sampled on the Ottawa River, this site had the most degraded water quality. Again, the dominance of the midge Glyptotendipes sp reflected the depleted dissolved oxygen situation in this segment. The similarity in data from all three sampling periods demonstrates no improvement in water quality from 1974 to 1977.

The next downstream station was located at river mile 22.1. This site, sampled only in 1977, showed a marked improvement over the preceeding stations with substantial increase in both numbers of taxa (14) and the diversity index (1.87). The benthic community found here, however, primarily consisted of pollution tolerant organisms such as chironmids, oligochaetes, leeches, and water scavenger bettles; chironomids comprised 87% of the sample.

The station located at river mile 16.0, sampled only in 1976, was similar to the preceeding station in regard to the number of taxa (14) and diversity index (2.27). Improvement was noted by the appearance of a mayfly (Callibaetis sp) in the quantitative sample. This was the first mayfly found on the multiple-plate samplers since river mile 46.0. However, the river at this point, approximately twenty miles below Lima, represented a substantially stressed environment.

The location of the farthest downstream station sampled on the Ottawa River was at river mile 1.0 (sampled in 1976 and 1977). The water quality from this station showed further improvement, as determined by increases in diversity (3.10, 2.20) and numbers of taxa (18, 14). Additional signs of improvement were the presence of two taxa of mayflies, which appeared in significant numbers, and the presence of one caddisfly taxon. Though improvement in water quality was demonstrated at this station, complete recovery had not occurred.

Two stations were sampled in the Auglaize River in 1977. The upstream station (RM 34.6) exhibited good water quality with good representation from the pollution sensitive groups of mayflies and caddisflies, 30 taxa (42 including the qualitative sample), and a diversity index of 3.27.

The downstream station (RM 28.5), located below its confluence with the Ottawa River, also exhibited good water quality. There were five taxa of mayflies, two taxa of caddisflies, 24 taxa total (34 including the qualitative sample), and a diversity index of 3.37. This suggested that the Ottawa River does not have a marked effect on the Auglaize at this point, though a reduction in number of taxa was noted.

Data generated from the two stations in the Auglaize River and one station in the Ottawa River (RM 1.0) in 1977 were compared to data collected by Patrick, et al (1960) of the Philadelphia Academy of Natural Sciences (Table 4). The Auglaize station at river mile 34.6 above the confluence with the Ottawa, was located approximately 1.5 miles downstream from the Philadelphia Academy site. It was of interest to note the large number of species collected by the Academy as opposed to the number collected in this study. This was due to the fact that the Academy used a variety of collecting methods and sampled a variety of habitats including riffles, pools, and "slackwater". These sampling techniques were all qualitative. The OEPA study emphasized quantitative collections using artificial substrate samplers and confined the qualitative sampling to the immediate area adjacent to the samplers. The additional taxa collected by the Academy were primarily the larger bivalves. Based on the types of organisms collected in 1960, the Academy considered this segment "healthy". Based on the types of organisms found at this station in this study in 1977, the number of taxa collected on the multiple-plates (30), and the diversity index (3.27), this was considered to be a high water quality segment. It appeared that the high quality of water found at this site in 1960 had not changed appreciably since that time.

The Auglaize station at river mile 28.5, below its confluence with the Ottawa, was located approximately 1.5 miles downstream from the Philadelphia Academy site. The Academy in 1960 referred to this as a polluted station which showed a marked deterioration since their previous sampling in 1956. The 1977 OEPA data indicated that this station was similar to the station above the confluence though there were fewer total taxa found below the confluence (42 as opposed to 34). The diversity index calculated for this station was 3.37. Organisms found in 1977, that were absent in 1960, included mayflies, caddisflies, and crayfish. There had been obvious improvement in this segment since the Academy investigation in 1960.

The Ottawa River station located at mile point 1.0 was approximately one mile below the Philadelphia Academy station. The Academy considered this a "very polluted" station which had undergone severe deterioration since 1956. Only twelve taxa were collected in 1960. Our 1977 study found fourteen taxa colonizing the multiple-plates with seven additional taxa taken in the qualitative samples. A diversity value of 2.20 was derived for this site. As compared to other stations in the Ottawa River, these data suggested meaningful improvement from perturbations originating upstream from this point. In any case, the presence of mayflies, caddisflies, and crayfish (not found in 1960), and a total of 21 taxa collected at this site, indicated improvement over the situation encountered by the Academy in 1960.

Table 4. Invertebrate Taxa Collected from Ohio EPA (1977) and Philadelphia Academy Stations (1960) in the Ottawa and Auglaize Rivers.

Taxa	Ottawa River River Mile 1.0		Auglaize River River Mile 34.6		Auglaize River River Mile 28.5	
	1960	1977	1960	1977	1960	1977
Insecta:						
Odonata	0	2	8	2	4	3
Ephemeroptera	0	4	11	6	0	8
Plecoptera	0	0	1	0	0	0
Hemiptera	2	1	4	1	5	0
Megaloptera	0	1	1	1	2	1
Coleoptera	4	1	6	5	12	4
Trichoptera	0	1	3	1	0	3
Diptera	6	9	4	13	5	11
Other Invertebrates:	0	2	33	13	4	4
Total Taxa	12	21	71	42	32	34

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APPENDIX A

SAMPLING STATION CHARACTERISTICS

1974, 1975, 1976, 1977

APPENDIX A

SAMPLING STATION CHARACTERISTICS

RM 46.0

General Location: Ottawa River upstream from Thayer Road
Width: 30 to 50 feet
Depth: 0.5 to 3 feet

Comments: Upstream from Thayer Road bridge the river consisted of well defined riffles, pools, and runs. The riffles and runs were predominantly comprised of rubble and gravel; the pools were silt and sand with detritus, fibrous peat, and muck.
Sample Type: Chemical - 1974, 1975, 1976, 1977; Fish - 1976, 1977; Benthos - 1974, 1976, 1977

RM 37.7

General Location: Ottawa River above Lima STP
Width: 50 to 60 feet
Depth: 0.5 to 2.5 feet

Comments: Above the Lima STP the river consisted of a large pool due to a low dam with a long riffle immediately downstream. The substrate of the pool was comprised mainly of silt, pulpy peat, and muck. The riffle contained bedrock, boulders, rubble, gravel, and sand.
Sample Type: Chemical - 1977; Fish - 1976, 1977; Benthos - 1974, 1976, 1977

RM 37.4

General Location: Ottawa River below Lima STP
Width: 40 to 60 feet
Depth: 1.0 to 2.5 feet

Comments: The river in this reach was predominantly a run consisting of gravel and sand with organic constiutents of fibrous peat and muck. The riffles contained bedrock, rubble, gravel, and sand.
Sample Type: Chemical - 1976, 1977; Fish - 1976, 1977; Benthos - 1974, 1976, 1977

RM 36.8

General Location: Ottawa River below Adgate Road
Width: 50 feet
Depth: 2 to 3 feet

Comments: Runs and pools predominated this segment of the river. The substrate consisted mainly of rubble with boulders, gravel, sand, detritus, and fibrous peat.
Sample Type: Chemical - 1974; Benthos - 1974, 1976, 1977

SAMPLING STATION CHARACTERISTICS (Continued)

RM 35.4
General Location: Ottawa River in immediate area of the Shawnee Road bridge
Width: 70 feet
Depth: 0.5 to 2 feet

Comments: Most of the upstream area visible from the bridge consisted of a series of riffles composed of rubble and gravel; the river downstream appeared to be an extensive pool area.
Sample Type: Chemical - 1974

RM 32.6
General Location: Ottawa River upstream from Route 117
Width: 40 to 50 feet
Depth: 1 to 3 feet

Comments: A large bend in the river formed a deep pool followed downstream by runs and a small riffle. The runs and riffle consisted of rubble, gravel, and sand; the pools were sand, pulpy peat, and muck.
Sample Type: Chemical - 1976, 1977; Fish - 1977;
Benthos - 1974, 1976, 1977

RM 30.1
General Location: Ottawa River below Long Road
Width: 60 to 80 feet
Depth: 0.5 to 2.5 feet

Comments: The downstream area generally consisted of a series of riffles and runs, with rubble and gravel predominating and occasional bedrock areas.
Sample Type: Fish - 1977

RM 29.3
General Location: Ottawa River at Copus Road
Width: 50 to 60 feet
Depth: 0.5 to 3 feet

Comments: The area upstream from the bridge was generally composed of a series of riffles, with a pool area just above the bridge. The downstream area consisted of a pool area followed by riffles; both had substrates consisting of boulders, rubble, and gravel.
Sample Type: Chemical - 1974

SAMPLING STATION CHARACTERISTICS (Continued)

RM 28.8

General Location: Ottawa River below Route 81 in Allentown
Width: 50 to 60 feet
Depth: 1 to 3 feet

Comments: Upstream from Route 81 a dam impounds the river forming a pool. Below the dam the river was mostly riffle and runs consisting of bedrock, boulders, and gravel. The substrate characteristics of the pool were sand, silt, clay, detritus, and pulpy peat.
Sample Type: Chemical - 1974, 1975, 1976, 1977; Fish - 1977; Benthos - 1974, 1976, 1977

RM 25.7

General Location: Ottawa River upstream from Lima - Delphos Road
Width: 50 to 60 feet
Depth: 0.5 to 2 feet

Comments: The river upstream from the bridge consisted of a well defined series of riffles and runs, with rubble and gravel predominating.
Sample Type: Chemical - 1974

RM 22.1

General Location: Ottawa River upstream from Neff Road
Width: 60 feet
Depth: 1 to 3 feet

Comments: Riffles, runs, and pools encompassed this segment of the river. The substrate was dominated by rubble in the riffle and runs. Gravel, sand, and muck comprised the pools.
Sample Type: Chemical - 1974; Fish - 1976, 1977; Benthos - 1977

RM 18.7

General Location: Ottawa River at Old Route 12
Width: 60 to 70 feet
Depth: 0.5 to 2 feet

Comments: The upstream area consisted of a series of riffles and runs, containing mainly of rubble and gravel, with some bedrock. The river just downstream from the bridge consisted of a pool area followed by riffles.
Sample Type: Chemical - 1974

SAMPLING STATION CHARACTERISTICS (Continued)

RM 16.0
General Location: Ottawa River upstream from Route 189 near Rime
Width: 60 to 70 feet
Depth: 2 to 3 feet

Comments: The upstream area consisted of a series of riffles and runs composed of rubble, gravel, and bedrock. The river downstream from the bridge was a pool area.
Sample Type: Chemical - 1976, 1977; Fish - 1977; Benthos - 1976

RM 7.9
General Location: Ottawa River immediately adjacent to Union Township Road 17-N
Width: 60 to 70 feet
Depth: 0.5 to 2.5 feet

Comments: This section of the river consisted of a series of riffles and runs, composed mainly of rubble and gravel.
Sample Type: Fish - 1977

RM 1.0
General Location: Ottawa River downstream from Putnam County Road 19
Width: 70 to 100 feet
Depth: 1.0 to 4 feet

Comments: Most of the river segment sampled consisted of an extensive pool with predominantly soft organic material and gravel. There was a well defined riffle about .25 mile below the bridge.
Sample Type: Chemical - 1974, 1976, 1976, 1977; Fish - 1976, 1977; Benthos - 1976, 1977

RM 34.6
General Location: Auglaize River above confluence with Ottawa adjacent to County Road 20
Lat-Long. 40° 59' 06" - 84° 14' 40"
Width: 35 to 45 feet
Depth: 1.0 to 2 feet

Comments: Well defined riffles, pools, and runs with large bordering patches of water willow predominated here. The substrate was mainly gravel with boulders, rubble, sand, and detritus.
Sample Type: Benthos - 1977

SAMPLING STATION CHARACTERISTICS (Continued)

RM 28.5

General Location: Auglaize River below confluence with Ottawa
Lat-Long. 41° 01' 09" - 84° 17' 20"

Width: 100 to 150 feet

Depth: 1 to 2 feet

Comments: A vast, wide, shallow riffle predominated in this section of the river. Shallow runs and slack waters were present but not as significant. Rubble, gravel, and sand comprised the substrate.

Sample Type: Benthos - 1977

APPENDIX B

PHYSICAL/CHEMICAL WATER QUALITY DATA 1974-1977

Table B-1. Ottawa River Water Quality, June-October, 1974

Station Location		pH S.U.	Temp. °C	D.O.[a] mg/1	TSS mg/1	TDS mg/1	NH_3 as N mg/1	NO_3 as N mg/1	TKN mg/1
Putnam Co. Rd. 19	MAX	7.3	23.0	4.5	56	1090	8.45	14.2	10
RM 1.0	MIN	6.7	13.2	3.9	38	950	1.93	6.5	3
June, Aug.-Oct.	MEAN	7.1	19.3	46%	48	1001	5.85	11.2	8.0
	N[b]	4	4	4	3	3	4	4	4
Allentown	MAX	7.8	24.0	3.2	46	1432	29.0	4.5	29
RM 28.8	MIN	7.3	17.0	2.4	NVS	454	20.6	3.9	21
August-September	MEAN	7.5	20.3	31%	19	1062	23.9	4.2	24
	N	3	3	3	3	3	3	3	3
Thayer Rd.	MAX	8.0	25.5	8.5	76	859	0.28	2.3	1
RM 46.0	MIN	7.4	13.5	7.6	NVS	404	0.03	0.1	1
August-September	MEAN	7.8	18.8	87%	28	608	0.16	1.1	1
	N	3	3	3	3	3	3	3	3

Station Location		Total P mg/1	MBAS mg/1	BOD ug/1	COD ug.1	Fecal Coli.[c] #/100 ML	Total Cr ug/1	Hex Cr ug/1	Phenols ug/1
Putnam Co. Rd. 19	MAX	2.0	0.71	12.9	40.0	1900	100	86	10
RM 1.0	MIN	0.9	0.43	5.7	36.2	600	<30	<30	5
June, Aug.-Oct.	MEAN	1.5	0.61	8.4	38.7	967	38	29	7
	N	4	4	4	4	4	4	4	3
Allentown	MAX	1.9	0.63	10.6	100.0	6400	320	290	12
RM 28.8	MIN	0.8	0.46	5.6	36.2	280	200	176	12
August-September	MEAN	1.5	0.55	7.5	60.3	1338	253	227	12
	N	3	3	3	3	2	3	3	2
Thayer Road	MAX	0.4	0.25	15.7	36.2	710	0	0	0
RM 46.0	MIN	0.3	0.17	3.5	16.1	60	0	0	0
August-September	MEAN	0.4	0.22	8.1	28.9	206	0	0	0
	N	3	3	3	3	2	3	3	2

(a) Means given as average percent saturation.
(b) N= Number of samples taken.
(c) Geometric mean.

Table B-2. Ottawa River Time of Travel Study, July-August, 1974

Station Location (River Mile)	Date & Time	pH S.U.	Temp. °C	D.O. mg/l	Total Hardness mg/l	Cond. mg/l
Above Lima STP (37.7)	7/29 0900	7.9	23.5	5.9	484	295
Adgate Road (36.8)	7/29 1230	7.9	25.5	5.9	384	1500
Shawnee Road (35.4)	7/29 1720	8.3	27.5	6.8	428	1820
Route 117 (32.6)	7/30 0130	8.0	23.0	2.0	448	1850
Copus Road (29.3)	7/30 1015	7.8	23.5	5.8	360	1750
Lima-Delphos Road (25.7)	7/30	7.8	24.5	4.2	456	1740
Route 12 (18.7)	8/1 1115	7.4	22.0	4.1	444	1680
Route 189 (16.0)	8/1 1930	7.3	24.8	3.0	396	1810
Putnam Co. Rd. 19 (1.0)	8/1 1615	8.3	25.0	9.0	440	1770

Station Location (River Mile)	Date & Time	NH_3-N mg/l	NO_3-N mg/l	TKN mg/l	Org.N mg/l
Above Lima STP (37.7)	7/29 0900	0.8	0.18	0.8	0.0
Adgate Road (36.8)	7/29 1230	16.6	2.03	19.5	2.9
Shawnee Road (35.4)	7/29 1720	17.3	3.91	19.1	1.8
Route 117 (32.6)	7/30 0130	13.6	4.43	16.7	3.1
Copus Road (29.3)	7/30 1015	12.0	4.70	16.7	4.7
Lima-Delphos Road (25.7)	7/30	9.5	5.85	13.9	4.4
Route 12 (18.7)	8/1 1115	6.1	6.35	8.4	2.3
Route 189 (16.0)	8/1 1930	2.1	7.66	3.9	1.8
Putnam Co. Rd. 19 (1.0)	8/1 1615	0.0	3.93	3.9	3.9

Ottawa River Time of Travel Study, July-August, 1974
(Cont'd)

Station Location (River Mile)	Date & Time	pH S.U.	Temp. °C	D.O. mg/l	Total Hardness mg/l	Cond. mg/l
Above Lima STP (37.7)	8/12 0945	7.5	23.0	2.6	188	690
Adgate Road (36.8)	8/12 1225	8.4	26.0	5.1	340	1400
Shawnee Road (35.4)	8/12 1345	8.6	27.0	4.8	320	1350
Route 117 (32.6)	8/12 1730	8.4	28.0	6.0	300	1320
Copus Road (29.3)	8/12 1850	8.0	27.5	3.4	260	1000
Lima-Delphos Road (25.7)	8/13 1000	7.5	24.5	2.7	308	1190
Route 12 (18.7)	8/13 1115	7.6	26.0	6.2	306	1480
Route 189 (16.0)	8/13	7.4	27.0	8.0	360	1630
Putnam Co. Rd. 19 (1.0)	8/13 1430	7.9	27.0	6.7	400	1650

Station Location (River Mile)	Date & Time	NH_3-N mg/l	NO_3-N mg/l	TKN mg/l	Org.N mg/l
Above Lima STP (37.7)	8/12 0945	0.7	1.11	3.9	3.2
Adgate Road (36.8)	8/12 1225	11.1	2.92	19.4	8.3
Shawnee Road (35.4)	8/12 1345	13.2	4.07	19.4	6.2
Route 117 (32.6)	8/12 1730	7.1	3.50	12.3	5.2
Copus Road (29.3)	8/12 1850	8.4	2.49	9.7	1.3
Lima-Delphos Road (25.7)	8/13 1000	10.3	2.71	14.6	4.3
Route 12 (18.7)	8/13 1115	14.0	3.34	20.6	6.6
Route 189 (16.0)	8/13	15.9	3.25	20.6	4.7
Putnam Co. Rd. 19 (1.0)	8/13 1430	3.4	4.72	5.6	2.2

Ottawa River Time of Travel Study, July-August, 1974
(Cont'd)

Station Location (River Mile)	Date & Time	pH S.U.	Temp. °C	D.O. mg/l	Total Hardness mg/l	Cond. mg/l
Above Lima STP (37.7)	8/26 1045	7.8	25.0	9.7	535	1100
Adgate Road (36.8)	8/26 1230	8.4	29.0	9.0	455	2050
Shawnee Road (35.4)	8/26	8.4	28.5	13.2	460	2290
Route 117 (32.6)	8/26 1530	8.2	28.0	10.9	435	2100
Copus Road (29.3)	8/26 1615	8.2	27.5	8.8	444	2140
Lima-Delphos Road (25.7)	8/27 0900	7.7	24.5	-	440	1920
Route 12 (18.7)	8/27 1045	7.5	24.5	4.4	423	1920
Route 189 (16.0)	8/27 1140	7.4	26.0	7.7	395	1780
Putnam Co. Rd. 19 (1.0)	8/27 1250	7.1	25.5	4.8	420	1700

Station Location (River Mile)	Date & Time	NH_3-N mg/l	NO_3-N mg/l	TKN mg/l	Org.N mg/l
Above Lima STP (37.7)	8/26 1045	1.3	0.14	6.5	5.2
Adgate Road (36.8)	8/26 1230	37.8	7.46	46.7	8.9
Shawnee Road (35.4)	8/26	32.9	6.06	36.6	3.7
Route 117 (32.6)	8/26 1530	24.1	5.60	26.2	2.1
Copus Road (29.3)	8/26 1615	32.1	3.80	40.3	7.2
Lima-Delphos Road (25.7)	8/27 0900	27.3	3.89	28.7	1.4
Route 12 (18.7)	8/27 1045	24.1	4.77	29.3	5.2
Route 189 (16.0)	8/27 1140	13.1	5.02	15.7	2.6
Putnam Co. Rd. 19 (1.0)	8/27 1250	2.7	4.75	5.0	2.3

Table B-3. Ottawa River Water Quality, June-October, 1975

Station Location		pH S.U.	Temp. °C	D.O.[a] mg/1	TSS mg/1	TDS mg/1	Total Hardness mg/1	NH_3 as N mg/1	NO_3 as N mg/1	TKN mg/1
Putnam Co. Rd. 19	MAX	-	25.8	8.7	170	617	324	3.65	9.4	6.4
RM 1.0	MIN	-	21.8	3.8	62	382	236	0.23	4.7	1.3
June-September	MEAN	-	24.0	62%	116	537	285	1.90	6.4	3.5
	N[b]	-	4	4	2	4	3	4	4	4
Allentown	MAX	-	25.1	4.8	0	976	428	17.2	6.9	22.3
RM 28.8	MIN	-	15.1	2.3	0	876	334	10.4	2.7	11.6
June-October	MEAN	-	21.5	36%	0	923	391	14.0	4.4	16.9
	N	-	3	3	2	3	3	3	3	3
Thayer Road	MAX	-	23.5	9.1	14	504	370	0.19	3.8	7.1
RM 46.0	MIN	-	23.0	4.6	-	468	348	0.13	0.2	1.3
June-August	MEAN	-	23.2	80%	-	486	359	0.16	2.0	4.2
	N	-	2	2	1	2	2	2	2	2

Station Location		Total P mg/1	MBAS mg/1	BOD mg/1	COD mg/1	Fecal Coli.[c] #/100 ML	Total Cr ug/1	Hex Cr ug/1	Phenols ug/1
Putnam Co. Rd. 19	MAX	1.4	0.47	6.1	-	2000	<30	<30	-
RM 1.0	MIN	0.5	0.26	-	-	1020	<30	<30	-
June-September	MEAN	1.0	0.35	-	-	1347	<30	<30	-
	N	4	3	1	-	3	3	2	-
Allentown	MAX	2.8	0.66	7.8	41.7	2700	160	128	3
RM 28.8	MIN	1.2	0.32	-	-	930	100	-	-
June-October	MEAN	1.8	0.46	-	-	1584	120	-	-
	N	3	3	1	1	2	3	1	1
Thayer Road	MAX	0.5	0.13	-	-	900	<30	<30	-
RM 46.0	MIN	0.3	-	-	-	-	<30	-	-
June-August	MEAN	0.4	-	-	-	-	<30	-	-
	N	2	1	-	-	1	2	1	-

(a) Means given as average percent saturation.
(b) N=Number of samples taken.
(c) Geometric Mean.

Table B-4. Ottawa River Dissolved Oxygen Profiles, September, 1976 [a]

September 11, 1976

River Mile	Miles Below STP	D.O. mg/l	Temp. °C	Time
46.0	-	4.5	19	1045
42.6	-	3.5	20	1130
40.0	-	6.0	20	1145
37.7	-	5.2	21	1215
37.5	STP	-	-	-
36.8	0.7	4.2	26	1300
35.4	2.1	3.6	25	1315
32.6	4.7	3.6	25	1330
31.0	6.3	3.5	24	1345
30.1	7.2	3.4	24	1400
29.3	8.1	-	-	-
28.8	8.5	4.5	24	1415
25.7	11.6	4.8	23	1425
24.1	12.8	5.1	23	1430
22.9	14.0	5.6	24	1445
22.1	14.8	6.2	23	1500
20.9	15.9	6.4	24	1515
19.9	16.9	6.4	24	1530
16.0	20.5	6.6	24	1540
8.1	28.3	6.5	24	1550
3.7	32.6	4.8	24	1600
1.0	35.2	4.6	24	1615

September 29, 1976

River Mile	Miles Below STP	D.O. mg/l	Temp. °C	Time	D.O. mg/l	Temp. °C	Time
46.0	-	5.8	16	1200	6.1	16	1300
42.6	-	6.0	16	1145	-	-	-
40.0	-	6.2	16	1130	6.0	16	1310
37.7	-	4.2	15	1125	5.0	15	1320
37.5	STP	-	-	-	-	-	-
36.8	0.7	-	-	-	-	-	-
35.4	2.1	3.2	14	1100	-	-	-
32.6	4.7	2.9	13	1050	3.8	19	1400
31.0	6.3	-	-	-	-	-	-
30.1	7.2	-	-	-	-	-	-
29.3	8.1	-	-	-	-	-	-
28.8	8.5	3.2	13	1030	5.4	19	1430
25.7	11.6	4.2	13	1020	-	-	-
24.1	12.8	4.5	14	1015	-	-	-
22.9	14.0	-	-	-	-	-	-
22.1	14.8	5.2	14	1005	6.5	19	1530
20.9	15.9	-	-	-	-	-	-
19.9	16.9	-	-	-	-	-	-
16.0	20.5	5.5	14	1000	8.2	19	1545
8.1	28.3	4.2	13	0940	5.6	19	1600
3.7	32.6	5.2	13	0930	-	-	-
1.0	35.2	5.0	14	0925	6.3	19	1630

[a] All measurements taken at a depth of 0.5 foot.

Table B-5. Ottawa River Water Quality Data, October-November, 1976

Station Location		pH S.U.	Temp. °C	D.O. mg/l	(a)TSS mg/l	TDS mg/l	Total Hardness mg/l	NH_3 as N mg/l	NO_3 as N mg/l	TKN mg/l
Thayer Road	MAX	8.0	13.8	12.8	<10	727	354	2.07	1.85	2.6
RM 46.0	MIN	6.8	0.0	6.2	<10	560	-	0.07	0.85	0.7
October-November	MEAN	7.6	9.4	73%	<10	656	-	0.80	1.46	1.4
	N(b)	5	5	5	5	5	1	3	3	3
Below Lima STP	MAX	7.6	10.0	10.1	33	650	263	4.10	6.45	5.7
RM 37.4	MIN	6.7	7.0	8.2	<10	624	-	0.99	3.61	2.4
November	MEAN	7.2	8.0	77%	18	627	-	2.5	4.87	3.9
	N	2	3	3	3	3	1	3	3	3
S.R. 117	MAX	7.4	7.0	10.9	12	1050	410	26.2	10.17	39.5
RM 32.6	MIN	6.8	4.0	5.5	<10	1032	-	12.3	6.64	16.8
November	MEAN	7.1	5.3	62%	11	1040	-	20.3	7.87	28.4
	N	2	3	3	3	3	1	3	3	3
Allentown	MAX	7.5	16.2	8.6	14	1187	438	35.2	13.10	45.5
RM 28.8	MIN	6.7	4.0	5.0	<10	1100	434	18.2	9.08	23.5
October-November	MEAN	7.1	8.7	53%	11	1134	436	25.2	11.24	31.1
	N	2	3	3	3	3	3	4	4	4
Neff Road	MAX	7.5	7.0	11.6	<10	1229	401	27.8	15.5	30.4
RM 22.1	MIN	6.7	3.0	8.5	<10	952	-	24.0	9.7	25.5
November	MEAN	7.1	5.3	75%	<10	1101	-	25.3	12.3	28.0
	N	2	3	3	3	3	1	3	3	3
Rt. 189	MAX	7.4	6.0	12.2	10	1213	396	47.0	14.60	57.2
RM 16.0	MIN	6.8	3.0	8.0	<10	874	-	17.8	9.98	21.1
November	MEAN	7.1	4.3	82%	10	1093	-	28.8	12.26	33.9
	N	2	3	3	3	3	1	3	3	3
Putnam Co. Rd. 19	MAX	7.7	15.9	11.8	14	1117	380	42.1	17.30	50.4
RM 1.0	MIN	7.4	2.0	5.2	<10	826	-	7.2	9.23	9.0
October-November	MEAN	7.6	6.7	72%	11	993	-	21.2	12.46	24.3
	N	4	4	4	4	4	1	4	4	4

Station Location		Total P mg/l	MBAS mg/l	BOD mg/l	COD mg/l	Fecal Coli.(c) #/100 ML	Total Cr ug/l	Hex Cr ug/l	Phenols ug/l
Thayer Road	MAX	1.73	0.26	4.4	28.0	<1	30	<30	4
RM 46.0	MIN	0.82	0.18	2.5	8.0	<1	<30	<30	3
October-November	MEAN	1.14	0.21	3.4	18.4	<1	30	<30	3
	N	3	3	2	5	2	3	3	3
Below Lima STP	MAX	5.90	0.95	-	52	-	180	<30	12
RM 37.4	MIN	0.40	0.35	-	8	-	<30	<30	8
November	MEAN	2.81	0.59	-	4	-	107	<30	10.3
	N	3	3	-	3	-	3	3	3
S.R. 117	MAX	2.1	0.81	-	40	-	210	140	19
RM 32.6	MIN	0.6	0.66	-	28	-	120	<30	17
November	MEAN	1.5	0.74	-	36	-	180	93	18
	N	3	3	-	3	-	3	3	3
Allentown	MAX	2.8	0.78	14.8	52	3100	240	182	20
RM 28.8	MIN	0.6	0.45	-	36	-	130	70	18
October-November	MEAN	2.0	0.62	-	46	-	173	108	19
	N	4	4	1	4	1	3	3	2
Neff Road	MAX	3.20	1.05	-	44	-	190	140	22
RM 22.1	MIN	1.05	0.53	-	20	-	120	<30	13
November	MEAN	2.25	0.77	-	31	-	163	75	17
	N	3	3	-	3	-	3	3	3
Rt. 189	MAX	3.70	0.92	-	32	-	160	117	23
RM 16.0	MIN	2.10	0.48	-	20	-	90	<30	10
November	MEAN	2.97	0.68	-	28	-	127	61	18
	N	3	3	-	3	-	3	3	3
Putnam Co. Rd. 19	MAX	3.80	0.75	9.0	40	600	100	71	17
RM 1.0	MIN	0.60	0.37	5.7	16	330	70	<30	12
October-November	MEAN	2.00	0.54	7.4	31	445	87	46	14
	N	4	4	2	4	2	3	3	2

(a) Mean given as average percent saturation.
(b) N= Number of samples taken.
(c) Geometric mean.

Table B-6. Ammonia Nitrogen and Chemical Oxygen Demand Data from the Ottawa River and Selected Tributaries, August 31, 1977[a]

Station Location	NH_3-N mg/1		COD mg/1		Station Location	NH_3-N mg/1	COD mg/1
Ottawa River:							
Thayer Road	0.09		40.6		Thompson Church Road	1.52	-
Sugar Street	0.20		22.4		At Kalida	0.20	-
Above Lima STP (b)	0.99 @ 0735	0.50 @ 1500	34.5 @ 0735	24.5 @ 1500	Two Miles below Kalida	0.20	-
Below Lima STP (b)	0.48 @ 0755	0.26 @ 1700	38.6 @ 0755	42.7 @ 1700	Selected Tributaries:		
Vistron Effluent (b)	83.00 @ 0800	67.80 @ 1715	50.8 @ 0800	114.8 @ 1715	Kessler at Elm St.	3.37	-
Shawnee Rd.	4.94		24.8		Dug Run at Dutch Hollow Rd.	0.28	-
Route 117	4.89		24.4				
Long Road	5.39		38.6		Honey Run at mouth	<0.02	-
Copus Road	7.35		26.4		Beaver Run at Bussert Road	0.28	-
Lima Delphos Rd.	7.02		32.4		Pike Run at Gomer Road	0.06	-
Crites Road	4.43		16.3		Leatherwood Crk. at Servis Road	0.04	-
Dutch Hollow Road	2.16		20.3		Sugar Creek	0.10	-
Route 30N	1.56		18.3		Little Ottawa R. at mouth	<0.02	-
Route 189	2.60		36.6				
Below Ottawa River Church	2.24		-				

(a) Data supplied by the OEPA Mobile Laboratory.
(b) Stations sampled twice on this date.

Table B-7. Ottawa River Water Quality Data at Two Stations, August, 1977

Parameter	Above Lima STP (River Mile 37.7)	Adgate Road (River Mile 36.8)
Temp. °C	26.5	25.3
D.O. mg/1	12.3	8.3
TSS mg/1	25	10
TDS mg/1	694	1252
Total Hardness mg/1	468	494
NH_3 - N mg/1	2.68	22.4
NO_3 - N mg/1	0.16	9.62
NO_2 - N mg/1	<0.01	0.58
TKN mg/1	2.77	29.4
Total P mg/1	0.21	1.20
MBAS mg/1	0.14	0.51
COD mg/1	28	58
Cl mg/1	40	175
As ug/1	<10	<10
Cd ug/1	<5	<5
Total Cr ug/1	<30	40
Hex Cr ug/1	<30	-
Cu ug/1	<30	<30
Pb ug/1	10	<5
Hg ug/1	<.5	<.5
Ni ug/1	<100	<100
Zn ug/1	<30	70

Table B-8. Ottawa River Water Quality Data, June-October, 1977

Station Location		pH S.U.	Temp. °C	D.O.[a] mg/l	TSS mg/l	TDS mg/l	Total Hardness mg/l	NH_3 as N mg/l	NO_3 as N mg/l	TKN mg/l
Thayer Road	MAX	8.1	21.3	7.3	28	604	406	0.47	1.82	0.86
RM 46.0	MIN	7.9	15.6	5.3	<10	416	265	0.05	0.06	0.47
June-September	MEAN	8.0	18.4	64%	17	526	358	0.23	0.74	0.69
	N[b]	4	4	4	4	4	3	3	3	3
Below Lima STP	MAX	-	24.0	9.4	<10	552	247	2.01	10.5	2.17
RM 37.4	MIN	-	22.5	6.0	-	-	-	0.26	-	-
August	MEAN	-	23.2	90%	-	-	-	0.92	-	-
	N	-	2	2	1	1	1	3	1	1
S.R. 117	MAX	-	25.7	10.3	<10	1205	471	16.4	8.96	18.9
RM 32.6	MIN	-	22.2	2.8	-	-	-	4.89	-	-
August	MEAN	-	23.9	79%	-	-	-	10.64	-	-
	N	-	2	2	1	1	1	2	1	1
Allentown	MAX	7.6	26.1	6.0	17	1360	480	16.40	27.05	35.30
RM 28.8	MIN	7.2	10.4	2.9	10	798	359	2.78	5.37	3.69
June-October	MEAN	7.5	20.4	53%	11.2	1032	421	6.91	13.13	14.97
	N	5	7	7	6	6	5	6	5	5
Neff Road	MAX	8.0	25.5	10.7	22	1296	556	16.80	20.74	19.10
RM 22.1	MIN	7.4	16.1	4.8	<10	770	355	2.00	7.14	3.37
June-September	MEAN	7.7	22.6	88%	13	1024	431	4.8	11.87	7.38
	N	3	5	5	4	4	4	6	4	4
Rt. 189	MAX	-	27.0	17.4	17	1208	460	2.60	10.44	2.83
RM 16.0	MIN	-	24.1	7.3	15	663	303	0.10	5.36	1.49
July-September	MEAN	-	25.4	141%	16	936	392	0.97	8.48	2.00
	N	-	5	5	2	2	3	5	3	3
Putnam Co. Rd. 19	MAX	8.4	25.0	10.8	44	1198	528	2.57	17.31	5.21
RM 1.0	MIN	7.9	16.9	5.3	29	712	377	0.05	5.75	1.05
June-September	MEAN	8.2	21.8	98%	36	978	433	0.57	11.00	2.55
	N	5	6	6	5	5	4	5	5	5

Station Location		Total P mg/l	MBAS mg/l	BOD mg/l	COD mg/l	Fecal Coli.[c] #/100 ML	Total Cr ug/l	Hex Cr ug/l	Phenols ug/l
Thayer Road	MAX	0.67	-	4.6	36	300	<30	-	-
RM 46.0	MIN	0.05	-	1.1	20	60	<30	-	-
June-September	MEAN	0.41	-	2.8	26	142	<30	-	-
	N	3	-	3	4	3	3	-	-
Below Lima STP	MAX	0.99	0.35	-	42.7	-	<30	<30	-
RM 37.4	MIN	-	-	-	24.0	-	-	-	-
August	MEAN	-	-	-	35.1	-	-	-	-
	N	1	1	-	3	-	1	1	-
S.R. 117	MAX	1.10	0.54	-	53.0	-	30	<30	-
RM 32.6	MIN	-	-	-	24.4	-	-	-	-
August	MEAN	-	-	-	38.7	-	-	-	-
	N	1	1	-	2	-	1	1	-
Allentown	MAX	1.25	0.91	20.6	54	TNTC	50	39	21
RM 28.8	MIN	0.50	0.37	5.9	30	90	<30	<30	6
June-October	MEAN	0.97	0.70	11.7	39	424	34	32	12
	N	4	5	4	5	5	5	5	5
Neff Road	MAX	1.30	0.63	14.8	40.0	2000	70	<30	8
RM 22.1	MIN	0.91	0.35	5.0	20.3	90	<30	<30	-
June-September	MEAN	1.05	0.52	9.9	26.9	330	40	<30	-
	N	4	4	2	5	3	4	4	1
Rt. 189	MAX	0.81	0.65	-	46.0	-	<30	<30	-
RM 16.0	MIN	0.58	0.57	-	36.6	-	<30	<30	-
July-September	MEAN	0.67	0.61	-	41.5	-	<30	<30	-
	N	3	2	-	3	-	3	2	-
Putnam Co. Rd. 19	MAX	0.66	0.73	12.0	58	3300	<30	<30	11
RM 1.0	MIN	0.24	0.26	6.5	26	350	<30	<30	6
June-September	MEAN	0.47	0.56	8.5	43	852	<30	<30	9
	N	5	5	3	5	4	5	5	3

(a) Means given as average percent saturation.
(b) N= Number of samples taken.
(c) Geometric mean.

APPENDIX C

FISH DATA 1976, 1977

Table C-1. Relative Abundance of Species of Fish Collected in the Ottawa River, August and September, 1976[a]

Species	Station (River Mile) 46.0	37.4	22.1	1.0
Gizzard shad			C	A
Grass pickerel	R			
Creek chub	A	U	U	C
Carp	C	R	R	U
Golden shiner	U			
Redfin shiner	A		C	C
Spotfin shiner				A
Sand shiner				U
Emerald shiner				U
Common shiner				R
Stoneroller	A		R	U
Silverjaw minnow				U
Bluntnose minnow	A		C	A
Fathead minnow		A	C	U
Golden redhorse	C			
Quillback				U
Northern hog sucker				R
White sucker	C			C
Spotted sucker	U			
Yellow bullhead				R
Black bullhead	R			
Blackstripe topminnow	C			R
Brook silverside			U	
Rock bass	A			U
Green sunfish	U	C	C	U
Bluegill	C		R	R
Longear sunfish	U			R
Orangespotted sunfish	C			R
Largemouth bass	U			U
White crappie	U			U
Johnny darter	C			U
Greenside darter	A			
Rainbow darter	C			
Fantail darter	A			
Logperch	R			
Blackside darter	R			
Total Number Species	25	4	10	25

[a] Fish were collected using a 10'x4'x1/4" seine and a 6'x30'x1/8" bag seine. Two different collections were made at 46.0, one collecting period lasted 3 1/2 hours and the other 3 hours. Approximately 1 1/2 hours of seining was done at 37.4, 2 1/4 hours at 22.1, and 3 1/2 hours at 1.0. All available habitats were sampled until no new species were being collected. Relative species abundances were determined as follows: 50 or more fish collected were referred to as abundant (A); 10 to 49 common (C); 3 to 9 uncommon (U); and 1 or 2 rare (R).

Table C-2. Relative Abundance of Species of Fish Collected in the Ottawa River, August and September, 1977(a)

Species	Station (River Mile) 46.0	37.7	37.4	28.8	22.1	16.0	7.9	1.0
Gizzard shad				U	A	C	C	A
Grass pickerel	C	U						
Golden shiner	U	U		R	R			U
Redfin shiner	A				R	C	C	A
Spotfin shiner								C
Emerald shiner						U	U	C
Stoneroller	A	R	R			R		U
Silverjaw minnow						U		R
Bluntnose minnow	A				R	C	C	A
Fathead minnow		A	A	R	A	C	C	C
Golden redhorse	U							R
Quillback					C	C	U	C
White sucker	U	U	R	C	C	C	C	C
Spotted sucker	R				R			
Creek chub	C	U	R		R	C	C	A
Carp	C	C	C	A	A	C	C	C
Black bullhead		U						
Channel catfish								R
Blackstripe topminnow	U							
Rock bass	A				R		R	U
Green sunfish	C	A	A	R	R	U	U	U
Bluegill	U	R		C	R			
Longear sunfish	U				R	R		R
Orangespotted sunfish	R			R				
Largemouth bass		U		U		R	R	U
White crappie	U						R	U
Johnny darter	U							
Greenside darter	A							R
Rainbow darter	U							
Orangethroat darter	U							
Fantail darter	U							
Logperch								U
Blackside darter	U							U
Total Number Species	23	11	6	9	14	14	13	23

(a) Fish were collected using a 10'x4'x1/4" seine and a 6'x30'x1/8" bag seine. The time spent seining at each station was as follows: 2 3/4 hours at 1.0; 2 1/4 hours at 46.0 and 16.0; 1 1/2 hours at 37.4; and 1 1/4 hours at 37.7, 28.8, 22.1, and 7.9. All available habitats were sampled until no new species were being collected. Relative species abundances were determined as follows: 50 or more fish collected were referred to as abundant (A); 10 to 49 common (C); 3 to 9 uncommon (U); and 1 or 2 rare (R).

APPENDIX D

BENTHOS DATA

1974, 1976 & 1977

Table D-1. Organisms Collected on Artificial Substrate Samplers from the Ottawa River, July 11 to August 20, 1974[a]

Taxa	Station (River Mile) 46.0	37.7	37.4	36.8	32.6	28.8
Turbellaria	*					
Oligochaeta	2	193		388*		
Placobdella papillifera	*					
Erpobdella punctata		7*				
Dina microstoma		1				
Asellus sp	*					
Hyalella azteca	*					
Crangonyx sp	*					
Orconectes sp	1*					
Acroneuria sp	*					
Hexagenia sp	*					
Stenonema interpunctatum group	18*					
Stenonema tripunctatum group	*					
Baetis sp	7*					
Caenis sp	1					
Callibaetis sp						*
Coenagrion sp			*			
Enallagma sp	*			*		
Hetaerina sp	*					
Libellulidae	*					
Boyeria vinosa	*					
Anax sp		*		*		
Plathemis lydia		*				*
Ischnura sp						*
Trichocorixa sp						*
Sigara sp		*			*	*
Notonecta sp						*
Sialis sp	*					
Cheumatopsyche sp	*					
Polycentropus sp	*					
Neophylax sp	*					
Tropisternus sp					*	*
Laccophilus sp		*				*
Peltodytes sp						*
Psephenus sp	*					
Dubiraphia sp	*					
Macronychus glabratus	*					
Stenelmis sp	*					
Dineutus sp		*				
Berosus sp		*			*	*

Organisms Collected on Artificial Substrate Samplers from the Ottawa River, July 11 to August 20, 1974[a] (Cont'd)

Taxa	Station (River Mile) 46.0	37.7	37.4	36.8	32.6	28.8
Polypedilum (P.) fallax	2					
Procladius sp	10	71			163*	
Glyptotendipes (G.) senilis	18	354				
Glyptotendipes sp	39*	3892*	6		342*	10416*
Tanytarsus (Stictochironomus) sp	*					
Tanytarsus (Tribelos) sp	2*					
Cryptochironomus sp						64
Polypedilum sp	5*					
Pentaneura sp	*					16
Tendipes (Kiefferulus) tendipediformis	10					
Tendipes sp	*	141*	3	87*	472*	*
Ablabesmyia sp	7					
Tanytarsus (Tanytarsus) obediens	2					
Tendipes (Einfeldia) insolita	10					
Calopsectra sp	2					
Anatopynia (Psectrotanypus) dyari		*		17*	*	*
Cricotopus sp		*	1	*	1836*	*
Harnischia abortiva		354		34*	2379*	
Culex sp		*	4	*		*
Stratiomys sp				*		
Ephydra sp					*	
Tipulidae	*					
Diptera						40
Physa sp		320*				
Ferrissia sp	2					
Helisoma trivolvis		*				
Goniobasis livescens	*					
Sphaerium sp	*					
Unionidae	*					
Number of organisms/ Sq. Ft. [b]	27	1321	3	105	1038	2107
Total number of taxa	17	9	4	4	5	4
$\bar{d}$[b]	3.35	1.50	(c)	1.17	1.78	0.11

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

Table D-2. Organisms Collected on Artificial Substrate Samplers from the Ottawa River, Jun 21 to August 2, 1976[a]

Taxa	Station (River Mile) 46.0	37.7	37.4	36.8	32.6	28.8	16.0	1.0
Hydra sp	56							
Turbellaria	2							
Nematoda		2	2					
Plumatella repens	1							
Oligochaeta	6	23	95	7	9	2	18	23
Helobdella stagnalis		2	10				16*	
Helobdella papillata		*						
Dina sp			8					
Asellus sp							11	
Hyalella azetca	*	4*					48*	2
Orconectes sp							*	3
Stenonema interpunctatum group	179*							88*
Caenis sp	12							1
Baetis sp	1							
Callibaetis sp		*				*	8*	
Libellula sp			*				*	
Anax sp			*			*		
Argia sp	5							38*
Enallagma sp		*	56*	20*	*	*	*	
Coenagrionidae	*	1				8	4	
Sigara sp							*	*
Sialis sp								10*
Hydropsyche bifida group	*							
Peltodytes sp				*				
Dubiraphia sp	1							
Stenelmis sp	1*							
Tropisternus sp			*					
Berosus sp			1		*	*	8	
Pentaneura sp	1			186			13	20
Pentaneura sp A	8							
Pentaneura sp B	8							
Labrundia	5							
Procladius sp	38*		24		*	*		13
Tendipes sp		77*	1563*	372*	*			3
Tendipes (Einfeldia) insolita								107*
Glyptotendipes (G) senilis	15							
Glyptotendipes sp	11	2	220		11625*	3858*	258	98
Tanytarsus (Endochironomus) sp	2*							

Organisms Collected on Artificial Substrate Samplers from the Ottawa River, June 21 to August 2, 1976[a] (Cont'd)

Taxa	Station (River Mile) 46.0	37.7	37.4	36.8	32.6	28.8	16.0	1.0
Paratendipes sp	5							
Harnischia (H) abortiva	5	1*				174	7	
Polypedilum (P) fallax	11							3
Polypedilum sp				41			7	3
Microtendipes sp	33							
Calopsectra sp	8							
Calopsectra Rheotanytarsus group								23
Calopsectra Group A	5							
Cricotopus sp	15	*	98	641				
Ceratopogonidae							8	
Empididae							9	2
Physa sp	6	*	8	2*		18	9	2
Ferrissia sp	1							14
Helisoma trivolvis		*		*				
Goniobasis sp	1*							
Number of organisms/ Sq. Ft.[b]	84	27	417	254	2327	812	85	91
Total number of taxa	28	8	11	7	2	5	14	18
$\bar{d}$[b]	3.16	2.03	2.31	1.73	0.01	0.32	2.27	3.10

(a) Qualitative samples were also collected from the natural substrate and their presence is indicated by an asterik *.

(b) Artificial substrate sample only.

Table D-3. Organisms Collected on Artificial Substrate Samplers from the Ottawa and Auglaize Rivers, July 18 to August 29, 1977[a]

	Station (River Mile)									
	Ottawa								Auglaize	
Taxa	46.0	37.7	37.4	36.8	32.6	28.8	22.1	1.0	34.6	28.5
Hydra sp	119							45	4	6
Turbellaria									3	
Plumatella repens	4	2*							4	26*
Oligochaeta	2	1572*	32	2		16*	4*	101*	42	16
Branchiobdellidae	2*								*	
Branchiura sowerbyii									*	
Hirudinidae		*								
Helobdella stagnalis		*	2							
Erpobdella sp		*								
Lirceus sp				*						
Hyalella azteca	1	*	*							
Astacidae	1*								2	
Orconectes sp		*							*	*
Potamanthus sp										*
Hexagenia sp								*		
Stenonema interpunctatum	36*						*	136*	207*	79*
Stenonema femoraturm										*
Stenonema pulchellum									4	
Heptagenia sp										3
Tricorythodes sp									3	7*
Caenis sp	10							34*	6*	14*
Baetis sp	*						*		7*	69*
Callibaetis sp						*	*			*
Pseudocloeon sp	5								*	
Neocloeon sp								*		
Baetidae						4				
Dromogomphus sp								*		
Anax sp			*		*	*				
Libellula lydia		*		*		*	*			
Argia sp	7		8	1*			*	7*	23	5*
Enallagma sp	*		82*		12*	*				
Ischnura sp	1	4*		*					9*	
Coenagrionidae							4*			*
Hetaerina sp										*
Acroneuria arida	*									
Trichocorixa sp							*			
Corixidae						*		*		
Buenoa sp				*		*				
Notonecta sp				*						
Pelocoris sp							*			
Ranatra sp									*	
Belastoma sp					*	*				
Sialis sp	*							1*		1

Organisms Collected on Artificial Substrate Samplers from the Ottawa and Auglaize Rivers, July 18 to August 29, 1977[a]

	Station (River Mile)									
	Ottawa								Auglaize	
Taxa	46.0	37.7	37.4	36.8	32.6	28.8	22.1	1.0	34.6	28.5
Cheumatopsyche sp	*							1	60*	173*
Hydropsyche bifida group										9
Hydropsyche sp										*
Polycentropus sp	2*								1	
Chimarra obscura	*									
Paragyractus sp									*	
Dubiraphia sp								*	6	*
Dubiraphia vittata	2	*								
Stenelmis sp		*							9*	3*
Macronychus glabratus										4
Psephenus herricki	*									
Laccophilus sp						*	*		*	
Dineutus sp							4		1	
Enochrus sp							*			
Berosus sp			10*	1	12*	*	76*			
Tropisternus sp					*		*		*	*
Peltodytes sp		*				*				
Simulium sp							*			*
Procladius sp			107	*	94*	*	29	*		
Pentaneura sp	17		534	175	235*	22	79	10	83	38
Ablabesmyia sp	17		*						10	3
Ablaesymia hauberi(?)							14			6*
Anatopynia (Psectrotanypus) dyari						*	*			
Cryptochironomus sp								*	10	
Tendipes sp		*	13*		988*		7			
Tendipes (Tendipes) riparius	17	63								
Tendipes (Limnochironomus) nervosus	17									
Tendipes (Einfeldia) insolita			213				7	10		
Glyptotendipes sp	123	626*	2562	*	141*	1668*	7	514*	388	46*
Glyptotendipes (Glyptotendipes) senilis	71	230						20		
Harnischia (Harnischia) abortiva					47	22				
Paratendipes sp	194								10	
Tanytarsus (Tribelos) quadripunctatus	17	63		12					10	
Tanytarsus (Endochironomus) sp			*							

Organisms Collected on Artificial Substrate Samplers from the Ottawa and Auglaize Rivers, July 18 to August 29, 1977[a]

	Station (River Mile)									
	Ottawa								Auglaize	
Taxa	46.0	37.7	37.4	36.8	32.6	28.8	22.1	1.0	34.6	28.5
Tanytarsus (Stictochironomus) sp									*	
Polypedilum sp			107*		*		*			
Polypedilum (Polypedilum) sp		*		245*						
Polypedilum (Polypedilum) fallax	17								10	6
Polypedilum (Polypedilum) convictum	*				659				*	191*
Polypedilum (Pentapedilum) tritum							468	20		9
Microtendipes sp	158								51	14
Calopsectra sp	140								51	
Calopsectra Group A								10		
Calopsectra Rheotonytarsus group										12
Cricotopus sp			107	23*					10	
Cricotopus bicinctus			*		*		7*			
Cricotopus sylvestris group			*		*					
Hydrobaenus sp				70						
Psectrocladius sp				12						9
Ceratopogonidae	1						4	7	5	
Empididae			2							
Physa sp	*	4*	2	3			4*		*	
Ferrissia sp	8	34							2	
Pleurocera sp	1*								4*	
Goniobasis sp				1*						
Helisoma sp		*								
Helisoma trivolvis							*			
Sphaerium sp	*								*	
Number of organisms/ Sq. Ft.[b]	198	520	796	109	438	346	143	183	213	150
Total number taxa	27	9	14	11	8	5	14	14	30	24
$\bar{d}$[b]	3.44	1.62	1.90	1.96	2.04	0.29	1.87	2.20	3.27	3.37

(a) Qualitative samples were also collected from the natural substate and their presence is indicated by an asterik *.
(b) Artificial substrate samples only.

OhioEPA

water quality survey

an evaluation of the K&S circuits effluent and its impact on brush creek

montgomery and miami counties, ohio

Dec. 1979
Office of Wastewater
Division of Surv. & W.Q. stds.
OEPA 79/2

SPECIAL STUDY

AN EVALUATION OF THE K & S CIRCUITS EFFLUENT AND ITS IMPACT ON BRUSH CREEK, MONTGOMERY AND MIAMI COUNTIES, OHIO

1980 305(b) Report
Volume III-A

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Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

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APPENDIX A

A REPORT ON THE ACUTE TOXICITY OF K & S CIRCUITS, INCORPORATED EFFLUENT TO *PIMEPHALES PROMELAS* AND *DAPHNIA PULEX*	A-1

APPENDIX B

STATION CHARACTERISTICS FOR BRUSH CREEK MACROINVERTEBRATE AND FISH COLLECTION SITES	B-1

CONCLUSIONS

1. Between January, 1977, and April, 1979, K & S Circuits violated their NPDES permit limitations for suspended solids, copper, lead, nickel and tin.

2. Based upon values reported in the K & S Circuits monthly operating reports, violations of Ohio Water Quality Standards would have occurred for copper, lead and nickel at a projected low flow condition of 0.1 CFS in Brush Creek. The copper concentrations projected in Brush Creek are acutely toxic to fish.

3. K & S Circuits effluent (KSE) was acutely toxic (lethal) to fathead minnows (Pimephales promelas) and an invertebrate (Daphnia pulex) in bioassay tests conducted at the Ohio EPA Biomonitoring Laboratory. The apparent cause of the toxicity was copper, because of its high concentration in KSE and its proven toxicity to aquatic organisms.

4. The results of Ohio EPA water quality surveys show that the storm sewer at S.R. 49 was a source of organic and inorganic pollution to Brush Creek. The organic pollutants most likely originated from septic tanks that discharge into the storm sewer. The inorganic pollutants, such as copper and nickel, were the result of K & S Circuits discharging inadequately treated process wastewater to the storm sewer.

5. Metal concentrations increased in the bottom sediments of Brush Creek downstream from K & S Circuits. This was especially true for copper which increased from 35.8 ppm upstream from the storm sewer at S.R. 49 to a peak of 23,561.8 ppm 200 feet below the storm sewer. The copper concentrations in the bottom sediments remained higher than background concentrations for at least 5.0 miles downstream from the storm sewer.

6. The biological community in Brush Creek was degraded for at least 5.0 miles downstream from the S.R. 49 storm sewer. The biological stress observed was, at least partially, the result of a toxic pollutant(s).

7. The discharge of K & S Circuits has caused environmental harm to Brush Creek. The damage to Brush Creek extends at least 5.0 miles downstream from the S.R. 49 storm sewer. Copper, because of its proven toxicity to aquatic life and its high concentration in the K & S Circuits effluent, was apparently the toxicant most harmful to the Brush Creek ecosystem.

8. The effects of the K & S Circuits discharge on Brush Creek are likely to remain for a period of time, due to the accumulation of copper in the stream sediments.

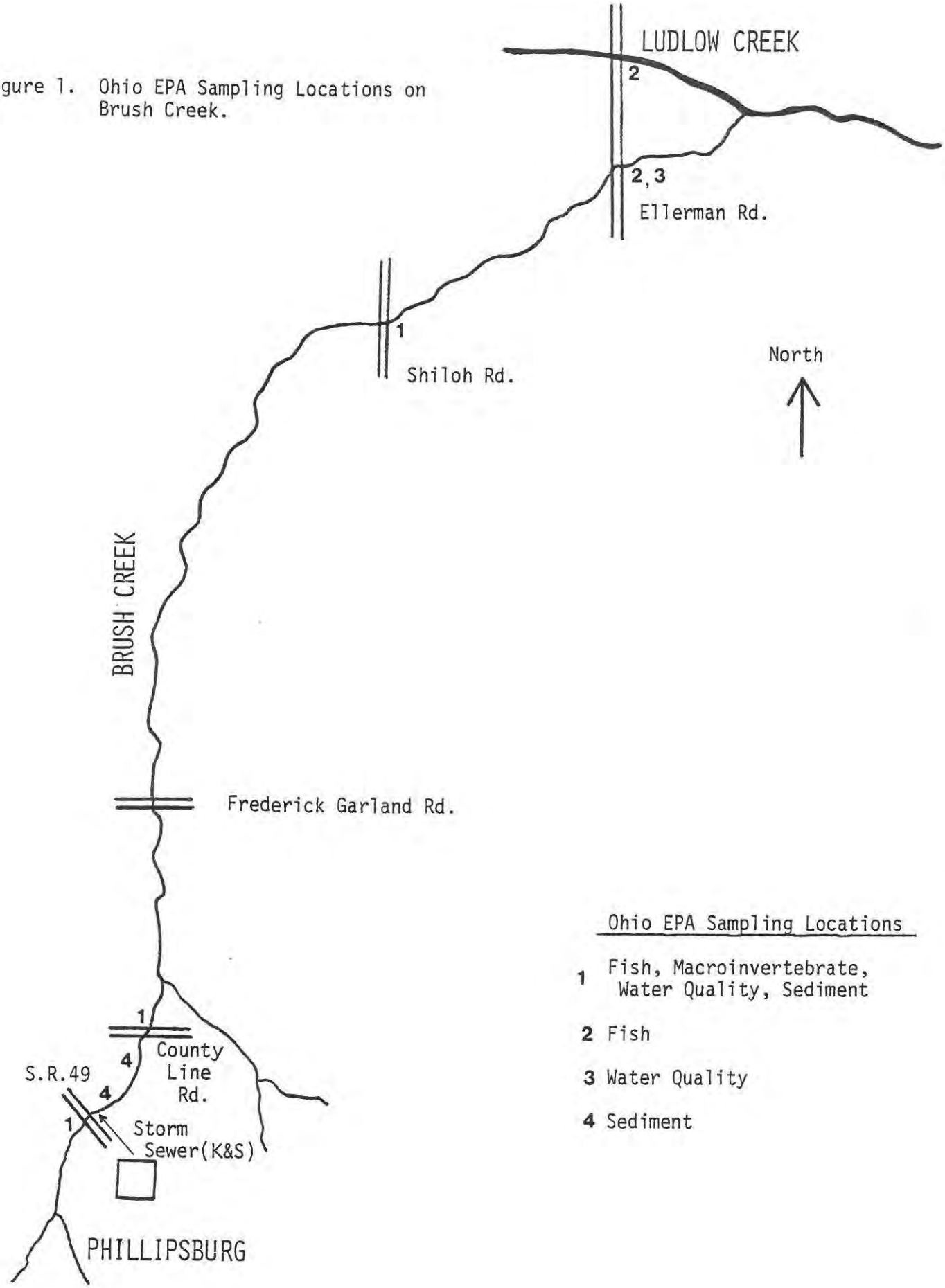
INTRODUCTION

Brush Creek is a tributary of Ludlow Creek in the Stillwater River sub-basin. It originates in Northwestern Montgomery County and flows northeast into Miami County. The creek is 8.0 miles in length, has a gradient of 15.1 ft./mi. and drains an area of 23.7 square miles (Ohio DNR, 1960). The area is mostly rural with the town of Phillipsburg being the only community in the drainage basin. Domestic waste is treated by individual systems such as septic tanks. The only source of industrial wastewater in the Brush Creek sub-basin is K & S Circuits, a manufacturer of printed circuit boards, located in Phillipsburg. This entity discharges its process wastewater into a storm sewer which flows approximately 0.6 miles to Brush Creek. Other potential sources of pollution in Brush Creek are non-point sources such as agricultural runoff and septic tank leachate.

This investigation was undertaken by Ohio EPA to determine the impact of the K & S Circuits discharge upon Brush Creek. Data were collected on the chemical/physical quality of the K & S Circuits effluent and on the toxicity of this effluent to aquatic life. On May 1, 1979, the owner stated that K & S Circuits was no longer discharging to the storm sewer. In order to determine the extent of residual effects upon Brush Creek from the K & S Circuits effluent, additional studies were conducted. These additional studies included data on the chemical/physical quality of the storm sewer discharge point at Brush Creek, the chemical/physical quality of Brush Creek, the chemical quality of the Brush Creek bottom sediments and the biological quality of Brush Creek. Figure 1 shows the stream locations sampled by the Ohio EPA in relation to the K & S Circuits storm sewer outfall.

The results of these studies show that K & S Circuits violated their NPDES permit limits and that the K & S Circuits process wastewater was acutely toxic to aquatic life. Furthermore, evidence of the adverse effects of the K & S Circuits discharge upon Brush Creek remained after the discharge had reportedly ceased. The bottom sediments in Brush Creek downstream from the storm sewer were heavily contaminated with copper for at least 5.0 miles. The stream showed obvious signs of biological damage for the same distance. The results indicate that copper is the primary contaminant responsible for the biological damage observed in Brush Creek.

Figure 1. Ohio EPA Sampling Locations on Brush Creek.



CHEMICAL AND BIOASSAY RESULTS

A Review of K & S Circuit's Monthly Operating Reports

The monthly operating reports submitted by K & S Circuits for their 001 discharge to Brush Creek are summarized in Table 1. This table includes data from January, 1977 through March, 1979 when the final NPDES permit limitations were in effect. The minimum and maximum values are recorded and average values were calculated for each parameter.

Table 1. A Comparison of K & S Circuits Monthly Operating Reports to Their NPDES Permit Limitations[a]

Parameter	Minimum Value	Maximum Value	Average Value	NPDES Permit Limitations Daily Avg.	Daily Max.
Residue-Total Non-filtrable (mg/l)	3.0	377	30	10	15
Total Copper (ug/l)	3,040	125,000	21,858	200	500
Total Lead (ug/l)	22	2,100	428	--	40
Total Nickel (ug/l)	15	30,900	781	1,000	2,000
Total Tin (ug/l)	35	24,600	2,013	500	1,000

(a) Average Discharge = 0.026 MGD

Significant violations of permit limitations are noted in Table 1. Of the minimum recorded values, copper is six times greater than daily maximum limitations. All of the maximum recorded values exceed daily maximum limitations: residue-total nonfiltrable (suspended solids) 25 times, copper 250 times, lead 52 times, nickel 15 times, tin 25 times. Of the average values, all parameters except nickel are in violation of daily maximum limitations: suspended solids 2 times, copper 44 times, lead 11 times, tin 2 times.

The projected effect of this discharge on water quality in Brush Creek during a low flow condition is summarized in Table 2. These values represent the concentrations in Brush Creek outside the mixing zone at the minimum, maximum and average effluent concentrations listed in Table 1. Minimum and maximum loadings were calculated using the daily total discharge on the day the sample was collected. Average loads were calculated using the average discharge for the period of record (0.026 MGD). The flow value used for Brush Creek was 0.1 CFS or 65,000 gallons per day measured in September, 1974, at Frederick-Garland Road, 1.9 miles downstream from the K & S Circuits discharge. This flow, 0.1 CFS, was used as an upstream dilution factor; at lower stream flows the calculated downstream concentrations would have been higher yet.

Table 2. Projected Stream Concentrations of Pollutants in Brush Creek Resulting From K & S Circuits Discharge at Minimum, Maximum, and Average Concentrations.

	Projected Stream Concentrations in Brush Creek		
Parameter	Minimum	Maximum	Average
Residue-Total Non-filtrable (mg/l)	0.86	66.8	8.6
Total Copper (ug/l)	870*	15,189*	6,234*
Total Lead (ug/l)	6	748*	122*
Total Nickel (ug/l)	6	5,794*	223
Total Tin (ug/l)	9	7,406	575

* Violations of Ohio Water Quality Standards.

Violations of Ohio Water Quality Standards are projected for copper at all three concentrations, lead at maximum and average concentrations and nickel at maximum concentrations. All copper concentrations projected in Brush Creek are acutely toxic to fish. Table 3 lists acute toxicity values for copper to fish species native to Brush Creek.

Table 3. Acute Toxicity of Copper to Selected Fish Species.[a]

Species	Copper (ug/l)	Hardness (mg/l)	Reference
Bluegill	2600	360	Pickering and Henderson 1966
Fathead Minnow	369	360	Pickering and Henderson 1966
Fathead Minnow	430	200	Mount 1968
Fathead Minnow	440	200	Anon. 1976
Bluntnose Minnow	290	200	Anon. 1976
Stoneroller	300	200	Anon. 1976
Creek Chub	310	200	Anon. 1976
Rainbow Darter	330	200	Anon. 1976

(a) Acute toxicity concentrations are the 96-hr. TL_{50} values.

Furthermore, in long-term exposure tests using fathead minnows, Pickering (1974) found that nickel concentrations of 730 ug/l caused a significant reduction ($P = 0.05$) on both the number of eggs per spawning and the hatchability of those eggs.

Ohio EPA Sampling of K & S Circuits and Brush Creek

On March 22, 1979, representatives of the Ohio EPA, Graham Mitchell and Tim Staiger, were admitted to the K & S Circuits Facility in Phillipsburg for the purpose of sampling industrial wastewater. At 1215 hours, a grab sample of effluent was collected at the 001 outfall to the storm sewer. These samples were preserved, refrigerated, and transported to the Ohio Department of Health Laboratory in Columbus. All methods of sample collection and preservation were in accordance with the "Manual of Sampling, Analytical and Reporting Procedures for Wastewater", (State of Ohio EPA, May, 1976). The results of the analysis of this sample along with NPDES permit limits are listed in Table 4.

Table 4. K & S Circuits Effluent Quality on March 22, 1979.

Parameter	Sample Result	NPDES Permit Limitations Daily Avg.	Daily Max.
pH (S.U.)	8.6	Between 6.0 - 9.0	
Residue-Total Nonfilterable (mg/l)	36.0	10	15
Total Copper (ug/l)	15900	200	500
Total Lead (ug/l)	17	--	40
Total Nickel (ug/l)	100	1000	2000
Total Tin (ug/l)	65	500	1000
Hardness (mg/l)	466	--	--

Daily maximum NPDES permit violations are noted for suspended solids and copper. The copper violation is the most significant, since the amount of copper is 32 times greater than the daily maximum allowed by the NPDES permit.

On March 27, 1979, Graham Mitchell and Tim Staiger, were again admitted to the K & S Circuits facility in Phillipsburg for the purpose of sampling industrial wastewater. Five, five-gallon carboys were collected for a bioassay study and 5 quart containers were collected for chemical analysis at the 001 outfall. As in the previous sampling, the 5 quart samples were preserved, refrigerated, and transported to the Ohio Department of Health Laboratory in Columbus. The results of the chemical analysis compared to NPDES limits are reported in Table 5. The bioassay results are discussed in the next section of this report.

Table 5. K & S Circuits Effluent Quality on March 27, 1979.

Parameter	Sample Result	NPDES Permit Limitations Daily Avg.	Daily Max.
pH (S.U.)	5.5	Between 6.0 - 9.0	
Residue-Total Nonfilterable (mg/l)	34	10	15
Total Copper (ug/l)	17300	200	500
Total Lead (ug/l)	70	--	40
Total Nickel (ug/l)	900	1000	2000
Total Tin (ug/l)	240	500	1000
Hardness (mg/l)	420	--	--

Daily maximum NPDES permit violations are noted for suspended solids, copper, and lead. Copper represents the most significant violation exceeding the daily maximum NPDES permit limit by 35 times.

On April 19, 1979, Tim Staiger sampled the mixing zone area of the storm sewer (transporting the K & S Circuits effluent) and Brush Creek. This area is considered the mixing zone because the storm sewer outfall is normally below the water level in Brush Creek. This allows creek water to backup in the storm sewer diluting the discharge. The results of the analysis are listed in Table 6.

Table 6. K & S Circuits Mixing Zone Water Quality on April 19, 1979.

Parameter	Sample Results
pH (S.U.)	7.4
Residue-Total Nonfilterable (mg/l)	22
Total Copper (ug/l)	8650
Total Lead (ug/l)	--
Total Nickel (ug/l)	100
Total Tin (ug/l)	100
Hardness (mg/l)	380

The copper concentration in this sample was high. Even considering the dilution provided by Brush Creek, the storm sewer discharge was 17 times the daily maximum NPDES permit limitation for copper.

On May 1, 1979, after being refused admittance to the K & S Circuits facility, three samples were collected in Brush Creek by Graham Mitchell and Tim Staiger. One sample was collected in Brush Creek approximately 100 feet upstream from the storm sewer outfall. A second sample was collected in the mixing zone of the storm sewer effluent and Brush Creek. A third sample was collected in Brush Creek approximately 200 feet downstream from the storm sewer outfall. Because of time constraints, the only parameters analyzed were pH, alkalinity, hardness, and copper. The results appear in Table 7.

Table 7. Brush Creek Water Quality Upstream, Downstream and in the Mixing Zone of K & S Circuits on May 1, 1979.

Parameter	Upstream of Discharge	Mixing Zone of Brush Creek and Storm Sewer	Downstream of Discharge
pH (S.U.)	8.4	7.6	8.3
Alkalinity (mg/l $CaCO_3$)	237	100	250
Hardness (mg/l $CaCO_3$)	337	382	343
Total Copper (ug/l)	<30	1990	200*

*Violation of Ohio Water Quality Standards.

Because copper concentrations were less than the detection limit at the upstream site, it is clear that the source of the copper in Brush Creek was the storm sewer which receives the K & S Circuits discharge. Although the copper in the discharge was considerably less than the sample taken at the same site on April 19, the Ohio Water Quality Standard for copper (145 ug/l based on water hardness) was violated at the downstream site. At times when the discharge contained greater levels of copper, more significant violations of Water Quality Standards would have occurred, resulting in conditions toxic to aquatic organisms in Brush Creek (see "A Review of K & S Circuits' Monthly Operating Reports").

Bioassay Results

The Ohio EPA Biomonitoring Group conducted static bioassays using a sample of K & S Circuits effluent (KSE) collected on 27 March, 1979. The test organisms, fathead minnows (*Pimephales promelas*) and an invertebrate (*Daphnia pulex*), were exposed to various concentrations of KSE mixed with dechlorinated Columbus, Ohio tapwater. The bioassays were performed in accordance with procedures outlined in "*Methods for Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians*", U.S. Environmental Protection Agency

(1975). Complete details of these tests may be found in Biomonitoring Group Report #79-156-SWDO (Appendix A).

Bioassay results showed KSE to be acutely toxic (lethal) to the test organisms, with toxicity being greater to D. pulex than to the fathead minnow. All D. pulex in the test concentrations were immotile within 12 hours. The lowest concentration tested was 1% KSE (percent by volume KSE). No immotility occurred in the D. pulex controls. Five fathead minnows were exposed in each of the following concentrations of KSE: 100%, 50%, 10%, and 1%. Five fish exposed to 100% KSE were dead after 46 hours. Two fish were dead in 50% KSE and one died in 10% KSE, after a 96 hour exposure. Two additional fathead deaths occurred in 10% KSE before 120 hours exposure. No fathead minnow mortality occurred in 1% KSE, or in the controls.

A second set of bioassays was conducted 144 hours after the KSE sample was collected to test for toxicant persistence. All D. pulex in the test concentrations were immotile after 46 hours. The lowest concentration tested was 1% KSE. Two fathead minnows in 100% KSE died during this 96 hour exposure.

Based upon the above results KSE was acutely toxic to the fathead minnow and D. pulex. The apparent cause of the toxicity was copper, because of its high concentration in KSE and its proven toxicity to aquatic organisms.

Chemical Sampling of Brush Creek

The owner of K & S Circuits stated that on May 1, 1979, his plant was no longer discharging wastewater to Brush Creek via the storm sewer. The purpose of this survey was to evaluate water quality in Brush Creek after the discharge was eliminated.

On May 23, 1979, and July 11, 1979, water samples were collected at five stations in Brush Creek. These samples were collected, preserved, and refrigerated, according to proper procedures and transported to the Ohio Department of Health Laboratories in Columbus. Field parameters collected were flow (July only), temperature, pH, and dissolved oxygen.

The locations of the five sampling stations are listed below:

1. Brush Creek at S.R. 49 - Samples were collected west of the bridge upstream from the storm sewer where K & S Circuits discharges industrial waste.

2. Storm Sewer at S.R. 49 - Samples collected just inside the pipe. This station is considered a mixing zone site because the storm sewer outfall is normally below the water level in Brush Creek. This allows creek water backup into the storm sewer diluting the discharge.

3. Brush Creek at County Line Road - 0.7 miles downstream from storm sewer discharge.

4. Brush Creek at Shiloh Road - 5.0 miles downstream from storm sewer discharge.

5. Brush Creek at Ellerman Road - 7.4 miles downstream from storm sewer discharge. This station is approximately 0.4 miles from the confluence with Ludlow Creek and is classified in Ohio Water Quality Standards as a State and National Resource Water.

The results of the analyses are recorded in Table 8. It is evident from the elevated levels of ammonia, phosphorus, COD, fecal coliforms, copper, and nickel that the storm sewer at S.R. 49 is a source of organic and inorganic pollution to Brush Creek. The organic pollutants most likely originated from septic tanks that discharge into the storm sewer. This source of organic pollution was probably the cause of the dissolved oxygen violation at County Line Road on May 23. The impact of organic pollution in Brush Creek was evident between the storm sewer and County Line Road (0.7 miles). Downstream from this point water quality in the creek appeared to recover. Fecal coliform violations occurred at County Line Road and at Shiloh Road on July 11. These fecal coliform violations may be related to non-point sources such as grazing and agriculture. The inorganic pollutants such as copper and nickel could be residual metals that were slowly being washed out of the storm sewer since the K & S Circuits discharge was eliminated. Although the concentration of copper increased at the County Line Road station (downstream), no Water Quality Standards violations were detected. The only metal violation noted was for lead at the Shiloh Road station on May 23. The cause of this violation is not known.

Sediment Sampling of Brush Creek

On September 4, 1979, six stream sediment samples and one soil sample were collected in Brush Creek. The purpose of this study was to determine the amount of pollutants in the sediments upstream and downstream from the K & S Circuits discharge point. Two samples were collected above the storm sewer outfall and four samples were collected below the discharge point (see Figure 1). Quart glass jars were used to collect the samples, which were refrigerated, and transported to the Ohio Department of Health Laboratory in Columbus. The analyses included copper, lead, nickel, tin, phenols and an organic solvent scan.

The analytical results for the sediment samples are recorded in Table 9. These results show an increase in the metals concentrations below the K & S Circuits discharge point. This was especially true for copper which increased from 35.8 ppm above the discharge point to a peak of 23,561.8 ppm (2.36 percent copper) 200 feet below the discharge point. The copper concentration, for the most part, decreased at the downstream stations to 290.9 ppm 5.0 miles from the discharge.

The metal concentrations in the soil sample collected near Brush Creek were low and do not represent a significant source of metals to Brush Creek. None of the soil or stream sediment samples contained any detectable amount of phenols or organic solvents.

Table 8. Analytical Results of Samples Collected in Brush Creek on May 23 and July 11, 1979.

	Brush Creek S.R. 49		Storm Sewer Brush Creek S.R. 49		Brush Creek County Line Rd.		Brush Creek Shiloh Road		Brush Creek Ellerman Road	
	5/23	7/11	5/23	7/11	5/23	7/11	5/23	7/11	5/23	7/11
Flow (CFS)	--	(a) 1.5	--	--	--	--	--	7.9	--	10.5
Temp. (°C)	14.0	17.0	--	17.0	14.0	18.0	15.0	20.2	14.5	21.0
pH (S.U.)	7.9	7.4	7.8	7.5	7.9	7.5	8.0	8.1	8.2	8.3
Dissolved Oxygen (mg/l)	6.0	7.3	--	7.4	3.8*	5.5	9.5	9.8	10.2	10.0
Conductivity (U-MHO)	779	813	1140	1350	781	785	691	761	691	628
Residue, Total NFLT(mg/l)	<10	<10	<10	--	<10	--	<10	<10	<10	<10
Ammonia-N mg/l	0.39	0.09	5.22 *	3.88	0.47	<0.05	0.42	<0.05	0.40	<0.05
Nitrate-N mg/l	6.45	7.78	2.84	3.43	6.33	8.81	6.27	8.32	6.30	8.28
TKN (mg/l)	0.43	0.88	6.52	4.40	0.48	0.69	0.42	0.55	0.51	0.47
Total Phosphorus (mg/l)	0.05	< 0.05	0.46	0.50	0.12	0.18	0.06	0.07	0.05	0.10
BOD (mg/l)	--	2.0	--	8.0	--	4.0	--	3.0	--	3.0
COD (mg/l)	8.0	6.0	32.0	12.0	6.0	6.0	12.0	14.0	9.0	8.0
Fecal Coliform (#/100ml)	650	1000	TNTC	50	730	2800*	1200	5700*	110	Lab Accident
Hardness (mg/l $CaCO_3$)	346	362	389	392	344	358	328	346	--	322
Copper (Total ug/l)	<30	<30	170 *	990 *	110	80	30	<30	< 30	< 30
Lead (Total ug/l)	10	8.0	11	8	<5	10	56*	13	< 5	< 5
Nickel (Total ug/l)	<100	<100	<100	1000 *	<100	<100	< 100	<100	< 100	< 100
Tin (Total ug/l)	< 10	<40	24	<100	29	<40	<10	< 40	< 10	< 40

* Exceeds allowable Water Quality Standard for Warmwater Habitat.

(a) Includes flow of storm sewer - Aquatic vegetation prevented measurement upstream from bridge.

Table 9. Sediment Analyses of Brush Creek.

PARAMETER STATION	COPPER (PPM)	LEAD (PPM)	NICKEL (PPM)	TIN (PPM)	PHENOL (PPM)	ORGANIC SCAN (PPM)
Brush Creek 400 ft. upstream from discharge near S.R. 49	35.8	0.0	5.1	0.0	N.D.	N.D.
Brush Creek 100 ft. upstream from discharge near S.R. 49	0.0	1245.0	276.7	620.0	N.D.	N.D.
Brush Creek 200 ft. downstream from discharge	23561.8	1505.3	294.5	4810.5	N.D.	N.D.
Brush Creek 1200 ft. downstream from discharge	5697.7	1500.9	1780.5	712.2	N.D.	N.D.
Brush Creek 3500 ft. downstream (County Line Rd.) from discharge	6418.5	256.7	1925.5	385.1	N.D.	N.D.
Brush Creek (Shiloh Rd.) 5.0 miles downstream from discharge	290.9	27.9	19.1	143.5	N.D.	N.D.
Soil Sample Soy Bean field along Brush Creek	10.7	17.9	69.8	38.9	N.D.	N.D.

MACROINVERTEBRATES

Benthic macroinvertebrates have been widely used to evaluate the quality of flowing water. This group has a number of qualities that make their use in pollution oriented studies particularly advantageous. The species composition and community structure of benthic communities in a given stream are determined by environmental factors which have existed during the life span of the organisms. They are sensitive to most types of pollution and even a short term exposure to unfavorable conditions may alter the community structure. The benthic community therefore is a reflection of past environmental conditions as well as what is occurring at the moment the sample is taken. In addition, these organisms form permanent or semi-permanent stream communities, are less transient than fish, are less sproadic than microorganisms, and usually occur in statistically significant numbers even in small streams.

Methods

Benthic macroinvertebrates were collected at three stations in Brush Creek on May 14, 1979. The first station was located west of State Route 49, approximately 40 yards upstream from the K & S Circuits discharge pipe. The second station was located at County Line Road which is about 0.7 mile downstream from the discharge, and the third was located approximately 5.0 miles below the discharge at Shiloh Road. Station characteristics are outlined in Appendix B. Four samples were collected at each site using a Surber square foot sampler with 1.024 mm mesh openings. The samples were collected by the following Ohio EPA Surveillance staff members: Graham Mitchell and Tim Staiger (Southwest District Office), Gary Martin and Dennis McIntyre (Central Office). The substrate material collected in the nets was preserved in 10% formalin and sealed in five gallon plastic buckets. The four Surber samples collected at each station were combined into one bucket resulting in a composite sample representing four square feet of substrate surface area. The labeled samples were returned to the Ohio EPA Biomonitoring Laboratory at 1025 Concord Ave., Columbus, Ohio, prior to processing and analysis.

On July 5, 1979, the preserved material was prepared for analysis by McIntyre and Jeff DeShon of the Central Office Surveillance staff. All material contained in the buckets was emptied into white enamel pans. The benthic organisms were hand picked from the gravel and debris, placed in jars of 70% alcohol, labeled, and stored in a locked chemical cabinet.

The benthic samples were analyzed by McIntyre on August 13 through August 15, 1979. Identification and counts were made using compound and dissecting microscopes. Identifications were based on standard taxonomic keys. After the benthic organisms had been identified and counted, species diversity indices ($\bar{d}$) were calculated for each station.

In general, field and laboratory methods followed those recommended in the USEPA Methods Manual (Weber, 1973) and those discussed in the Ohio EPA Quality Assurance Manual (1979).

Results and Discussion

The results of the benthic macroinvertebrate sampling is shown in Table 10. The water quality at station 1, located above the K & S discharge,

Table 10. Organisms Collected from Natural Substrates from Brush Creek, May 14, 1979 [a]

Taxa		Station 1	Station 2	Station 3
Turbellaria:	Unidentified		1	41
Annelida:	Oligochaeta	86		
	Helobdella stagnalis	1		
	Erpobdella punctata	5		
Isopoda:	*Lirceus* sp	182		
	Asellus forbesi	14		
Amphipoda:	*Crangonyx setodactylus*	7		
	Synurella dentata	261		
Decapoda:	Astacidae	3		
Plecoptera:	*Isoperla minuta*	378		1
	Perlidae	2		
Trichoptera:	*Rhyacophila lobifera*	43		
	Polycentropus sp	1		
	Cheumatopsyche sp			1
	Ochrotrichia sp	1		7
Coleoptera:	*Stenelmis* sp	1		2
	Dubiraphia sp			1
	Hydroporus sp:			2
Diptera:	*Pilaria* sp	1		
	Eriocera sp		1	
	Eriptera sp		1	
	Simulium sp			25
	Pentaneura sp			5
	Glyptotendipes (g) senilis			5
	Calopsectra Atanytarsus group	1		
	Cricotopus exilis (?)			827
	Cricotopus sp			31
	Cricotopus sp A		4	
	Cricotopus sp B		3	
	Eukiefferiella sp			16
	Ceratopogonidae			1
	Euparyphus sp	1		
	Number of organisms/sq.ft.	247	2.5	241
	Total number of taxa	17	5	14
	$\bar{d}$	2.27	(b)	0.98

(a) Four Surber samples were taken at each site.

(b) Insufficient number of organisms needed to calculate diversity index.

appeared good based on the presence of three taxa of caddisflies and two taxa of stoneflies. The most common organism at this station was the herbivorous stonefly Isoperla minuta which is considered sensitive to pollution (Gaufin, 1958). The average number of macroinvertebrate organisms per square foot was 247. According to Ross (1944) Rhyacophila lobifera, a caddisfly found at station 1, frequents small, rapid, clear streams that are of a temporary nature in drought years. This supports the assumption that station 1 has good water quality and suggests that Brush Creek, which is a second order stream in this segment, may be temporary during drought years. The temporary nature of this stream segment may account for the relatively low diversity index (2.27).

A noticeable change occurred at station 2. The number of taxa and average number of organisms per square foot were reduced to 5 and 2.5, respectively. The dramatic decline in both of these parameters suggested that the environmental stress was of a toxic nature. Generally, when an environmental stress is confined to organic pollution, the more sensitive forms are eliminated, while the survivors, free of competition and with a possible addition food source, increase in numbers. This combination of a reduction in taxa and increase in total number of organisms was not evident here. It is of interest to note that oligochaetes, which are tolerant of organic pollution but sensitive to heavy metals, were found at station 1, but were absent at station 2.

The benthic data from station 3 does not show complete recovery. The number of taxa (14) and average number of organisms per square foot (241) are similar to that found at station 1. Unlike station 1, however, few pollution sensitive forms were found here. Organic stress was suggested at station 3 by the dominance of the chironomid Cricotopus exilis (?). This organism, comprising 85% (827 individuals) of the total sample, greatly skewed the balance of the community which accounted for the low index value (0.98). As at station 2, oligochaetes were absent, suggesting that the bottom sediments still contain toxic concentrations of heavy metals at station 3.

The benthic data generated from Brush Creek clearly demonstrate that the discharge of K & S Circuits has a marked deleterious effect on the benthic biota.

FISH

Fish are useful indicators of surface water quality. As the end product of most aquatic food webs, fish are integrators of community response and their biomass is highly dependent on the primary and secondary productivity of the aquatic community. Fish also constitute a conspicuous part of the aquatic biota, generally reproduce only once per year, are sensitive to a wide range of substances and conditions, and there is an abundance of information dealing with their life history, environmental requirements, and geographical distribution.

Methods

Qualitative sampling for fish in Brush Creek was conducted at four locations on May 14, 1979, and five locations on May 23, 1979 (Table 11). Except for the Ellerman Rd. location on Ludlow Creek all stations are the same as those described in the chemical/physical sampling section. A 6' x 12' ¼" ace mesh seine was used to collect fish during the May 14, 1979, survey. Relative effort was based on time with 30 to 60 minutes spent sampling all available habitats at each location. The May 23, 1979, survey was conducted by using a battery powered back-pack electrofishing device (125-150 VDC). Relative effort was based on distance with 75 to 100 m long sections sampled at each location. During both surveys, captured fish were identified and released. Voucher specimens were preserved in a 10% formalin solution. Station characteristics are outlined in Appendix B. Sampling was performed by the following Ohio EPA Division of Surveillance staff: Graham Mitchell and Tim Staiger (Southwest District Office) and Gary Martin and Dennis McIntyre (Central Office) on May 14, 1979 and Gary Martin and Chris Yoder (Central Office) on May 23, 1979.

Results and Discussion

The results of the fish sampling in Brush Creek are shown in Table 11. Thirteen species were collected at all sampling locations combined. The fish community was observed to change longitudinally (upstream and downstream). Community diversity in terms of number of species showed a general overall increase from station 1 to station 4. However, a slight reduction in diversity was observed between stations 1 and 2. Relative numbers tended to show a similar pattern of reduction. Species composition changes were predominantly through species additions rather than species replacements.

The dominating presence of creek chubs (*Semotilus atromaculatus*) and fathead minnows (*Pimephales promelas*) and the absence of sedentary species at station 1 suggests that this section of Brush Creek may be dry or intermittent during low flow periods. The slight decrease in number of species and substantial decline in relative numbers at station 2 suggests that some type of environmental stress had occurred. Relative numbers increased markedly at station 3, however, 99% of May 23 collection consisted of two species, 76% being creek chubs. Although stream order (after Kuehne 1962) increased between stations 2 and 3 from order II to order III, the number of species increased only slightly. The number of species and composition exhibited more expected trends at station 4 and compared well with results at station 5 in Ludlow Creek.

Table 11. Relative numbers of fish collected at five locations in Brush Creek and one location in Ludlow Creek on May 14, 1979 and May 23, 1979.

	Station 1 Ust. St. Rt. 49		Storm Sewer	Station 2 County Line Rd.		Station 3 Shiloh Rd.		Station 4 Ellerman Rd. Brush Cr.	Station 5 Ellerman Rd. Ludlow Cr.
Species	5/14	5/23	5/23	5/14	5/23	5/14	5/23	5/23	5/14
Common white sucker						2		12	2
Creek chub	>10	35	3	>10	21	>10	210	97	>10
Striped shiner	5-10		1			>10	2	3	>10
Fathead minnow	>10	7	3		1				
Bluntnose minnow								6	1
Stoneroller			2			>10	64	48	5-10
Rock bass								17	
Green sunfish				1					
Bluegill sunfish	3	2				1			
Greenside darter								21	4
Rainbow darter								12	>10
Orangethroat darter						>10	16	36	>10
Fantail darter								22	2
Total Numbers	>28	44	9	>11	22	>43	292	274	>54
Number of Species	4	3	4	2	2	6	4	10	9
Cumulative Species	4		-	3		6		-	-

The expected pattern of community diversity in a stream such as Brush Creek is one of increasing number of species downstream in the form of species additions (Shelford 1911; Larimore and Smith 1963; Shedon 1968; Smith and Powell 1971; Jenkins and Freeman 1972; Tramer and Rogers 1973; Cashner and Brown 1977). This pattern did exist in Brush Creek at stations 1 and 4, but was interrupted between stations 1,2, and 3. Chemical analysis of water samples collected from Brush Creek on May 23 and July 11 revealed Water Quality Standards violations at the storm sewer outfall below station 1, and at stations 2 and 3 for dissolved oxygen, lead, fecal coliform, and copper. Bottom sediment sample analysis revealed substantial concentrations of copper at least 5.0 miles (station 3) below the storm sewer outfall four months after the apparent cessation of the K & S Circuits discharge. These observations coupled with the frequent violations of NPDES permit limits, especially for copper, point to the storm sewer outfall and the K & S Circuits effluent as the primary source of perturbations affecting the fish community in Brush Creek.

The results of this survey agree well with an earlier study of the effects of copper on fishes in Shayler Run in the nearby Little Miami River drainage basin (Geckler et al. 1976). Copper concentrations which adversely affected fishes in Shayler Run (90-120 ug/1) are similar to levels measured in Brush Creek on May 23 and July 11 at the storm sewer outfall and station 2. Although instream concentrations of copper at station 3 on these two dates did not approach the 90-120 ug/1 range, levels of copper in the bottom sediments at this location suggest that stream concentrations could well have been at those levels on previous occasions. This appears to be a logical explanation of the lower than expected diversity and dominance by pollution tolerant species observed at station 3. The overall effect of the observed water quality perturbations have been to cancel out the diversity enhancing characteristics (downstream distance and increasing stream order) of Brush Creek between stations 1, 2, and 3.

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APPENDIX A

A REPORT ON THE ACUTE TOXICITY OF K&S CIRCUITS, INCORPORATED EFFLUENT TO *PIMEPHALES PROMELAS* AND *DAPHNIA PULEX*

A Report on the Acute Toxicity of K&S Circuits, Incorporated Effluent to *Pimephales promelas* and *Daphnia pulex*

Report #79-156-SWDO

Biomonitoring Group
Ohio Environmental Protection Agency

Introduction

K&S Circuits, Incorporated located at 22 North State Street in Phillipsburg, Montgomery County, Ohio 45354 is a manufacturer of printed circuit boards. The discharge of process wastewater (effluent) from the K&S facility is subject to limitations imposed by NPDES Permit #C 131*AX. K&S effluent is discharged via storm sewer to Brush Creek in the Great Miami River Basin.

Fathead minnows (Pimephales promelas) and Daphnia pulex were used as test organisms in static bioassays to determine if the effluent of K&S Circuits exhibited measurable acute toxicity and persistant toxicity to aquatic organisms. At the point specified for sampling by the NPDES permit the effluent must be dipped from a small pit using a quart container. Because of the difficulty involved in obtaining a volume of effluent sufficient to perform definitive bioassays it was decided to collect a lesser volume for use in rangefinding bioassays. The rangefinders would determine if definitive bioassays were needed and concentrations to be used. However, Ohio Environmental Protection Agency (OEPA) personnel were subsequently refused admission to the K&S facility and effluent for use in the definitive bioassays could not be obtained.

Methods

These tests are termed rangefinding bioassays and not definitive bioassays because the dilution water did not come from the receiving stream and because of the wide range in concentrations and number of organisms exposed in the fathead minnow test. The methods used in conducting the bioassays were those recommended by the Committee (1975) except as evident in the detailed methods following.

Graham Mitchell and Tim Staiger of the Division of Surveillance, Southwest District Office, OEPA, collected the 25 gallons of K&S Circuits effluent (KSE) used in the bioassays as a grab sample. The sample was collected at the point specified for sampling in the NPDES permit between 1010 and 1050 hours on 27 March

1979. Collection containers were five-gallon carboys which were fitted with disposable polyethylene liners. Physicochemical measurements of KSE at time of sample collection were: temperature--15° Celsius, dissolved oxygen--9.8 parts per million, and pH--5.5 Standard Units. Ohio Department of Health Laboratory results of chemical analysis of appropriately preserved samples of KSE at the time of collection are listed on attached Water Quality Data sheets (WQDS).

The collectors transported the sample of KSE to be used in the bioassays to the OEPA Biomonitoring Laboratory in Columbus,Ohio. Upon arrival at the Biomonitoring Laboratory, the carboys of KSE were placed in a constant temperature waterbath maintained at the bioassay temperature of 22±1° Celsius. The following morning, 28 March 1979, these carboys of KSE were removed from the waterbath and the KSE used to mix the bioassay concentrations.

Dechlorinated Columbus, Ohio tapwater was used as bioassay dilution water. Dechlorination was accomplished by adding 1.6 milliliters of a 0.013 molar solution of sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) in distilled water per liter of tapwater. This water is routinely used in our rearing units.

Fathead minnows (*Pimephales promelas*) and *Daphnia pulex* from the Biomonitoring Laboratory rearing units were used as test organisms in the static bioassays. The fathead minnows were hatched during May of 1978. These fish were progeny of fathead minnows obtained from the United States Environmental Protection Agency Fish Toxicology Laboratory at Newtown, Ohio. The 15 survivors of the initial bioassay ranged in standard length between 26 and 38 millimeters, with a mean and standard deviation of 31.1 and 3.6 millimeters, respectively. Survivors had a mean weight of 0.7 (standard deviation 0.1) gram. *D. pulex* used in the bioassays were offspring of a pure culture originally obtained from Carolina Biological Supply. No ephippia were apparent in the stock culture of *D. pulex*.

Criteria for measuring the toxic effect of KSE were death of fathead minnows and immotility of *D. pulex*. Death and immotility are defined as the

cessation of all visible movement, with no response to gentle prodding (fathead minnows) or gentle agitation of the test container (D. pulex).

Single containers of 100,50,10, and 1 percent by volume effluent and control (dilution water only) were used in the fathead minnow bioassay. These containers were 44.5 centimeters (cm) in height and 29.2 cm in diameter; the 20 liters of test solution were 30.5 cm in depth. Duplicate containers of 100, 56, 32, 18, and 10 percent by volume effluent and control were initially set-up in the D. pulex bioassay. However, due to the rapid onset of immotility in these concentrations, additional duplicate containers of 5.6, 3.2, 1.8, and 1.0 percent by volume effluent were also set-up. Test containers in the D. pulex bioassay were 8.4 cm in height and 7.1 cm in diameter; the 200 milliliters of test solution were 6 cm in depth. Chemically-clean glass containers were used in all bioassays.

Five test organisms were randomly distributed to each container. Test organisms were not fed for 24 hours prior to, or during, the bioassays. Automatic timers maintained a photoperiod of 16 hour day and 8 hour night during the bioassays.

Physicochemical measurements of the effluent and dilution water were taken immediately prior to mixing the bioassay concentrations (Table 1) and in the fathead minnow test containers approximately one hour after fish were added and daily thereafter (Table 2). Dissolved oxygen, conductivity and pH were measured using, respectively , a Yellow Springs Instrument (YSI) model 54 oxygen meter, YSI model 33 S-C-T meter, and Corning model 10 pH meter. (Mention of commerical products does not constitute endorsement by OEPA). At the beginning of the bioassay samples of 100%, 10%, and control were submitted for chemical analysis (attached WQDS). Samples for chemical analysis were removed from the fathead minnow 100% container after 96 hours (attached WQDS). Test containers were restored to the original volume after samples were removed for chemical analysis.

The fathead minnow bioassay was not terminated after the standard 96 hour exposure to an effluent because of the difference in toxicity of KSE to the fathead minnow and D. pulex and because of the two fathead minnow deaths recorded at 0800 hours on 2 April 1979. Instead the bioassay was continued for an additional 96 hours and the containers inspected twice daily for fish mortality. Physicochemical measurements were taken daily (Table 2).

Peltier (1978) states: "The persistance of the toxicity of an effluent.... is determined by measuring its toxicity upon collection and again after holding 96 hours. If after holding the effluent 96 hours, its tox city has not decreased 50% or more, it is classified as persistant". This definition, with the exception that the holding time was 144 hours, was used to determine if the toxicity exhibited by KSE to the test organisms was persistent.

The KSE used in bioassays for persistant toxicity was stored in its collection carboys in the waterbath until 2 April 1979. Excess dilution water from the initial bioassays was reserved for use in these bioassays for persistant toxicity. Other conditions and methods were identifical to those described above.

Fathead minnows hatched in June of 1978 were exposed to the same concentrations and control as were used in the initial bioassay. Survivors of this bioassay ranged in standard length between 19 and 33 millimeters and had a mean of 25.1 (standard deviation 3.5) millimeters. Duplicate containers of 100, 56, 32, 18, 10, 5.6, and 1 percent by volume effluent and control were used in the D. pulex bioassay. Physicochemical parameters were measured in the fathead minnow containers approximately one hour post fish addition and daily thereafter (Table 3). Samples of 100% and dilution water at the time of bioassay set-up were submitted for chemical analysis. Samples for chemical analysis were removed from the fathead minnow 100% and control containers after 96 hours (attached WQDS). Samples submitted for chemical analysis during the bioassay for persistant toxicity are denoted by a

-2 on the attached WQDS.

Results and Discussion

All five fathead minnows in 100% KSE were dead with 46 hours exposure time (Table 4). Two of the fathead minnows in 50% KSE and one in 10% KSE were dead by the standard 96 hour exposure. Two additional deaths occurred in 10% KSE before 120 hours exposure. There was no additional mortality in 50% or 10% KSE when exposure time was extended to 196 hours. No mortality occurred in the 1% KSE or control during the 196 hour static bioassay. Based upon these results is is concluded that KSE is acutely toxic to the fathead minnow. Mortality usually is concentration dependent, occurring faster and in greater numbers in higher concentrations. The discrepancy in cumulative numbers of fathead minnows dead in 50% KSE and 10% KSE (Table 4) may be due to two modes of action of a single toxicant, one toxicant at a high concentration masking the effect of a second toxicant, or to either tolerant fish in 50% KSE or sensitive fish in 10% KSE. The chances of such seemingly anomalous results occurring in a definitive bioassay are decreased by using a greater number of fish per concentration and by using more concentrations which are more closely spaced.

Table 5 contains results of the fathead minnow bioassay to determine persistant toxicity. Two fathead minnows in 100% KSE were dead after 22 hours exposure time. No additional mortality occurred in the 96 hour bioassay. KSE is toxic to fathead minnows after a holding time of 144 hours. However, by the definition of persistant toxicity used, this toxicity may not be considered persistant.

Most D. pulex were immotile within five hours after being placed into a concentration of KSE and all were immotile after 12 hours exposure to KSE (Table 6). All control D. pulex were motile 96 hours after the bioassay began. Reproduction had occurred in both control containers 54 hours after the start of the bioassay.

The pattern of rapid toxicity and toxicity at low concentrations of KSE to

D. pulex was repeated in the bioassay for persistant toxicity (Table 7). Most D. pulex were immotile approximately five hours after being placed in the various KSE concentrations. All D. pulex in 1% KSE were immotile after 46 hours exposure.

Results of acute toxicity tests using D. pulex as the test organisms are usually expressed as the median effective concentration (EC50). The EC50 is the concentration at which 50% of the test organisms exhibit the effect measured after a stated exposure duration. An EC50 could not be determined in the initial D. pulex bioassay, therefore (by the definition of persistant toxicity used), the bioassay for persistant toxicity could only show KSE to be a non-persistant toxicant and could not show KSE to be a persistant toxicant. The bioassay for persistant toxicity did not show KSE to be a nonpersistant toxicant to D. pulex. After a 144 hour holding period, KSE was still acutely toxic to all D. pulex in the lowest concentration tested.

Small blue or bluish-green particles of what appeared to be plastic film were present in the KSE sample. The fathead minnow 100% and 50% KSE concentration had a milky color at the beginning of the bioassay. This milky color had essentially disappeared in 22 hours when a bluish colored flocculent precipitate appeared. Fathead minnows had a tendency to be near the air-test solution interface before a death occurred in the initial bioassay. This tendency was not noted in the bioassay for persistant toxicity.

The concentration of copper in KSE (10100 ug/1) was at least 23 times greater than the static bioassay median tolerance limit concentration reported by Mount (1968). The median tolerance limit (TLM) is that concentration which is lethal to 50% of the test organisms in the stated exposure duration. The 96 hour TLM for the fathead minnow in static and flow-through bioassays is 430 and 470 micrograms per liter for copper, respectively (Mount,1968). These values do not differ greatly. The National Water Quality Laboratory (NWQL) (U.S. Environmental Protection Agency, 1976), using flow through bioassays, reported a 96 hour TLM of 440 micrograms per liter for copper for the fathead

minnow. This is in close agreement with the values reported by Mount (1968). NWQL results for 96 hour flow-through bioassays (Table 8) show the bluntose minnow (Pimephales notatus), the stoneroller (Campostoma anomalum), the creek chub (Semotilus atromaculatus), the blacknose dace (Rhinichthys atratulus) and the rainbow darter (Etheostoma caeruleum) to be less tolerant of copper (lower median tolerance limits) than the fathead minnow. All of these species can be found in streams like Brush Creek. These species would be affected by KSE to a greater extent than the fathead minnow, based upon the above copper toxicity information.

In summary, KSE is acutely toxic to the fathead minnow and D. pulex. The apparent cause of the toxicity is copper, because of its high concentration in KSE and its proven toxicity to aquatic organisms.

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Table 1. Physicochemical measurements of K&S Circuits, Incorporated effluent and dechlorinated Columbus, Ohio tapwater used as dilution water in Bioassay # 79-156-SWDO

	Effluent Carboy Number 1	2	3	4	5	Mean (Standard Deviation)	Dilution Water
Temperature (°Celsius)	22.0	22.0	22.0	21.8	22.0	22.0(0.1)	21.5
Dissolved Oxygen (parts per million)	9.0	8.7	8.3	8.4	8.5	8.6(0.3)	8.5
pH (standard units)	7.0	7.1	7.1	7.2	7.2	7.1(0.1)	9.1
Conductivity (Micromhos/ Centimeter)	770	770	770	770	770	770(0)	295

Table 2. Physicochemical parameters measured in concentrations of K&S Circuits, Incorporated effluent used in Bioassay #79-156-SWDO

Concentration (% by volume effluent)	Temperature (°Celsius)	Dissolved Oxygen (Parts Per Million)	pH (Standard Units)	Conductivity (Micromhos/Centimeter)
28 March 1979				
100	21.5	8.5	7.2	780
50	21.3	8.4	7.6	550
10	21.3	8.4	8.5	360
1	21.0	8.4	9.1	320
Control	21.0	8.5	9.1	310
29 March 1979				
1115 hrs				
100	22.0	5.0	7.6	800
50	21.8	7.9	7.7	433
10	21.8	8.1	8.0	348
1	21.5	8.0	8.7	309
Control	21.5	7.7	8.8	300
30 March 1979				
1030 hrs				
100	22.2	8.9	7.7	800
50	22.0	8.3	7.8	550
10	22.0	5.3	7.5	330
1	22.0	5.5	7.5	310
Control	22.0	5.5	7.6	303
31 March 1979				
1050 hrs				
100	23.0	4.5	7.7	800
50	23.0	4.2	7.7	590
10	22.8	4.5	7.5	357
1	23.0	3.8	7.4	317
Control	22.5	3.9	7.4	310
1 April 1979				
1035 hrs				
100	22.0	2.2	7.8	790
50	22.0	4.0	7.7	550
10	22.0	5.2	7.4	340
1	22.0	4.3	7.3	309
Control	22.0	3.3	7.3	300

Table 2 (cont'd): Physicochemical parameters measured in concentrations of K&S Circuits, Incorporated effluent used in Bioassay #79-156-SWDO

Concentration (% by volume effluent)	Temperature (°Celsius)	Dissolved Oxygen (Parts Per Million)	pH (Standard Units)	Conductivity (Micromhos/Centimeter)
2 April 1979				
100	22.0	2.8	7.8	760
50	22.0	4.5	7.8	438
10	22.0	2.1	7.1	352
1	22.0	4.2	7.1	311
Control	22.0	2.9	7.1	309
3 April 1979				
1140 hrs				
100	22.0	3.0	7.9	790
50	22.0	3.0	7.6	550
10	22.0	3.1	7.2	350
1	22.0	3.4	7.0	309
Control	22.0	2.7	7.0	300
4 April 1979				
1050 hrs				
100	21.2	1.3	7.9	790
50	21.4	1.5	7.7	550
10	21.5	4.3	7.4	349
1	21.5	2.8	7.2	309
Control	21.2	2.7	7.1	305
5 April 1979				
1020 hrs				
100	21.2	2.2	7.8	750
50	21.5	3.8	7.5	530
10	21.5	5.6	7.2	345
1	21.5	4.0	6.9	309
Control	21.2	3.5	6.9	303
6 April 1979				
1000 hrs				
100	21.1	4.1	8.1	800
50	21.1	5.8	7.8	550
10	21.2	5.4	7.3	352
1	21.0	4.0	7.1	309
Control	21.0	3.7	7.1	300

Table 3. Physicochemical parameters measured in concentrations of K&S Circuits, Incorporated effluent used in bioassay for persistant toxicity. Bioassay # 79-156-SWDO

Concentration (% by volume effluent)	Temperature (°Celsius)	Dissolved Oxygen (Parts Per Million)	pH (Standard Units)	Conductivity (Micromhos/Centimeter)
2 April 1979				
100	22.0	7.8	7.5	780
50	22.0	8.3	7.7	439
10	22.0	8.6	-	345
1	22.0	8.8	8.7	309
Control	22.0	8.6	8.8	300
3 April 1979				
1140 hrs				
100	22.0	6.1	7.6	790
50	22.0	6.3	7.7	440
10	22.0	6.3	7.8	342
1	22.0	7.7	8.1	300
Control	22.0	7.2	8.3	300
4 April 1979				
1050 hrs				
100	21.8	4.8	7.7	790
50	21.7	5.7	7.8	432
10	21.5	-	7.5	342
1	21.5	5.3	7.5	310
Control	21.8	6.2	7.7	305
5 April 1979				
1020 hrs				
100	21.5	4.6	7.6	760
50	21.5	5.6	7.6	520
10	21.5	5.0	7.2	347
1	21.5	6.0	7.3	307
Control	21.5	6.4	7.3	299
6 April 1979				
1000 hrs				
100	21.2	4.1	7.9	790
50	21.0	4.8	7.7	440
10	21.3	5.0	7.3	345
1	21.0	6.1	7.3	305
Control	21.0	6.3	7.3	300

Table 4. Cumulative number of Pimephales promelas dead after exposure to the concentrations of K&S Circuits, Incorporated effluent used in Bioassay #79-156-SWDO.

	Concentrations Tested (a) (% by volume effluent)				
	100%	50%	10%	1.0%	Control
28 March 1979					
1029 hrs (b)	0	0	0	0	0
1640 hrs	0	0	0	0	0
29 March 1979					
0010 hrs	1	0	0	0	0
0800 hrs	1	1	0	0	0
1400 hrs	2	2	0	0	0
1630 hrs	3	2	0	0	0
30 March 1979					
0800 hrs	5	2	0	0	0
1630 hrs	5	2	0	0	0
31 March 1979					
1050 hrs	5	2	1	0	0
1 April 1979					
0900 hrs	5	2	1	0	0
2 April 1979					
0800 hrs	5	2	3 (c)	0	0

(a) = Five P. promelas/container; one 20 liter container of test solution/concentration.
(b) = Last fish added to test containers; start of bioassay.
(c) = Normally our bioassays using P. promelas are of 96 hour duration. However, if additional toxicity is indicated the bioassay duration is extended. Due to the two deaths recorded in 10% at 0800 hrs on 2 April 1979, this bioassay was extended an additional 96 hours. No additional deaths had occurred when the bioassay was terminated at 1000 hrs 6 April 1979.

Table 5. Cumulative number of *Pimephales promelas* dead after exposure to the concentrations of K&S Circuits, Incorporated effluent used in the bioassay for persistant toxicity. Bioassay #79-156-SWDO .

	Concentration Tested [a] (% by volume effluent)				
Date	100%	50%	10%	1%	Control
2 April 1979					
1000 hrs [b]	0	0	0	0	0
1615 hrs	0	0	0	0	0
3 April 1979					
0800 hrs	2	0	0	0	0[c]

(a) = Five *P. promelas*/container; one 20 liter container of test solution/concentration.

(b) = Last fish added to test containers; start of bioassay.

(c) = No additional deaths had occurred when the bioassay was terminated at 1000 hrs 6 April 1979.

Table 6. Percent of Daphnia pulex immotile after exposure to the concentrations of K&S Circuits, Incorporated effluent used in Bioassay #79-156-SWDO.

Concentrations Tested [a]
(% by volume effluent)

Date	100%	56%	32%	18%	10%	5.6%	3.2%	1.8%	1.0%	Control
28 March 1979										
1045 hrs [b]	0	0	0	0	0					0
1130 hrs	90	90	70	80	40					0
1215 hrs [c]						0	0	0	0	
1315 hrs	100	100	100	100	100	70	50	0	0	0
1525 hrs						100	90	90	40	0
29 March 1979										
0017 hrs							100	100	100	0 [d]

(a) = Five D. pulex/container; two containers of 200 milliliters test solution/concentration.

(b) = Start of bioassay; at this time the final group of five D. pulex was added to the last container of concentrations 100% through 10%, inclusive, and control.

(c) = Final group of five D. pulex added to last container of concentration 5.6% through 1.0%.

(d) = All control D. pulex were motile when discarded at 0915 hrs 2 April 1979. Reproduction had occurred in both control containers at 1630 hrs 30 March 1979.

Table 7. Percent of Daphnia pulex immotile after exposure to the concentrations of K&S Circuits, Incorporated effluent used in the bioassay for persistant toxicity. Bioassay #79-156-SWDO

Concentrations Tested [a]
(% by volume effluent)

Date	100%	56%	32%	18%	10%	5.6%	1%	Control
2 April 1979								
1015 hrs[b]	0	0	0	0	0	0	0	0
1325 hrs	100	100	100	100	100	90	0	0
1600 hrs						90	0	0
3 April 1979								
0810 hrs						100	70[c]	0
1030 hrs							80	0
1615 hrs							90	0 [d]
4 April 1979								
0810 hrs							100	10[e]

(a) = Five D. pulex/container; two containers of 200 milliliters test solution/concentration.

(b) = Start of bioassay.

(c) = Reproduction had occurred in one of the 1% containers. These young D. pulex, possibly four in number, were immotile at 1600 hrs 6 April 1979.

(d) = Reproduction had occurred in one of the control containers.

(e) = Reproduction had occurred in the other control container. Some young in each control container were motile when the bioassay was terminated at 1600 hrs 6 April 1979. There was no further immotility in D. pulex, which began the test, when the bioassay was terminated at 1600 hrs 6 April 1979.

Table 8. National Water Quality Laboratory 96 hour median tolerance limits for several fish species to copper in flow-through bioassays.

Fish Species	Micrograms copper per liter (a)
Fathead minnow (*Pimephales promelas*)	440
Bluntnose minnow (*Pimephales notatus*)	290
Stoneroller (*Campostoma anomalum*)	300
Creek chub (*Semotilus atromaculatus*)	310
Blacknose dace (*Rhinichths atratulus*)	330
Rainbow darter (*Etheostoma caeruleum*)	330

(a) = Values originally reported in milligrams copper per liter.

OHIO DEPARTMENT OF HEALTH LABORATORY

Sample Submission Report

Date Received

Date Reported

Laboratory

Laboratory Number

Analyst

Station

Station Code

County

Collected by

Identification of Samples

Sample Code

Date of grab sample (or last date of composite sample) 7 9 0 3 2 8 1 3 5

Composite Type

Sample Types: ☐ Industrial ☐ Sewage ☐ Water Supply ☐ Stream

Analysis to be Reported to: ☐ CO ☐ SEDO ☐ NEDO ☐ NWDO

Beginning Date of Composite Sample

Frequency

REASON FOR TAKING SAMPLE - ADDITIONAL INFORMATION - REMARKS BY ANALYST:

Added Silver to parameters by telephone, 28 March ≈ 1615 hrs. CDW

Number of Samples 3

☑ Alkalinity Total, $CaCO_3$	☐ Turbidity	☑ Acidity Total, $CaCO_3$	☑ Hardness Total, $CaCO_3$	☐ Residue, Vol Nflt	☐ Residue, Total Volatile
☐ Alkalinity Phth, $CaCO_3$	☑ Conductivity at 25C°	☐ Acidity M.O., $CaCO_3$	☑ Residue, Total	☑ Residue, Total Flt (Diss)	☑ Residue, Total Nflt (S
☐ Residue, Vol Flt	☐ Residue, Settlable	☐ Tannin	☑ Cyaninde	☑ ph	☑ MBAS

Ca	Mg	K	Na	Al	Sb	As	Ba	Be	Bi	Cd	Cr	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	Se	Ag	Sn	Tl	Sr	Ti	T	V	Zn	F													
☑	☑	☑	☑	☑	☐	☑	☐	☐	☐	☑	☑	☐	☑	☑	☑	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

☐ Oil-Grease	☐ Nitrogen TKN	☑ Nitrate, N	☐ Phosphorus Total, P	☐ Phosphate Total, PO_4	☑ Sulfate, SO_4	☐ Color
☑ Phenols	☐ Nitrogen Ammonia, N	☑ Nitrate, N	☐ Phosphorus Soluble, P	☐ Phosphate Ortho, PO_4	☑ Chloride, Cl	≈ 200

MILITARY TIME

	Year	Month	Day	Hour	Minute
Received from Denis McSutera EST (Name and Title)	7 9	0 3	2 8	1 3	3 5
Received by [illegible] (Name and Title)	7 9	0 3	2 8	1 3	3 5
Received from (Name and Title)					
Received by (Name and Title)					
Received from (Name and Title)					
Received by (Name and Title)					
Received from (Name and Title)					
Received by (Name and Title)					

Time and Date

OHIO DEPARTMENT OF HEALTH LABORATORY

Sample Submission Report

Date Received: [illegible]

Date Reported:

Laboratory:

Laboratory Number: [illegible]

Analyst:

Station: [illegible]

Station Code:

County: [illegible]

Collected by: [illegible]

Identification of Samples: [illegible] 1008-2, Cat-2

Sample Code:

Date of grab sample (or last date of composite sample): 2 1 0 4 0 2 1 1 2 0

Composite Type:

Sample Types: [X] Industrial [ ] Sewage [ ] Water Supply [ ] Stream

Beginning Date of Composite Sample:

Frequency:

Analysis to be Reported to: [X] CO [ ] SEDO [ ] NEDO [ ] NWDO

REASON FOR TAKING SAMPLE - ADDITIONAL INFORMATION - REMARKS BY ANALYST:

Possible Litigation

Number of Samples: 3. (2 qt + 1 gal each)

[X] Alkalinity Total, $CaCO_3$	[ ] Turbidity	[ ] Acidity Total, $CaCO_3$	[ ] Hardness Total, $CaCO_3$	[ ] Residue, Vol Nflt	[ ] Residue, Total Volatile
[ ] Alkalinity Phth, $CaCO_3$	[X] Conductivity at 25C°	[ ] Acidity M.O., $CaCO_3$	[ ] Residue, Total	[ ] Residue, Total Flt (Diss)	[ ] Residue, Total Nflt (Sus)
[ ] Residue, Vol Flt	[ ] Residue, Settlable	[ ] Tannin	[X] Cyaninde	[ ] ph	[ ] MBAS

Ca	Mg	K	Na	Al	Sb	As	Ba	Be	Bi	Cd	Cr	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	Se	Ag	Sn	Tl	Sr	Ti	T	V	Zn	F											
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

[ ] Oil-Grease	[ ] Nitrogen TKN	[ ] Nitrate, N	[ ] Phosphorus Total, P	[ ] Phosphate Total, PO_4	[ ] Sulfate, SO_4
[ ] Phenols	[ ] Nitrogen Ammonia, N	[ ] Nitrate, N	[ ] Phosphorus Soluble, P	[ ] Phosphate Ortho, PO_4	[ ] Chloride, Cl

[ ] Color

COD

MILITARY TIME

	Name and Title	Year	Month	Day	Hour	Minute
Received from	C.D. Webster Aquatic Biologist	7 9	0 4	0 2	1 4	0 7
Received by	S.J. Adams Chemist	7 9	0 4	0 2	1 4	0 7
Received from						
Received by						
Received from						
Received by						
Received from						
Received by						

Name and Title / Time and Date

OHIO DEPARTMENT OF HEALTH LABORATORY

Sample Submission Report

Date Received 4-6-79

Date Reported

Laboratory

Laboratory Number 27559-71

Analyst

Station I&S Circuit

Station Code

County Montgomery - Franklin

Collected by J.T. Fedor C.D. Webster

Bioassay # 79-156-SWDO

Identification of Samples 100%-2, Control Control-2

Sample Code

Date of grab sample (or last date of composite sample) 7 9 0 4 0 6 1 1 3 0

Composite Type

Sample Types: ☒ Industrial ☐ Sewage ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample

Frequency

Analysis to be Reported to: ☒ CO ☐ SEDO ☐ NEDO ☐ NWDO

REASON FOR TAKING SAMPLE - ADDITIONAL INFORMATION - REMARKS BY ANALYST:

Possible Litigation

Number of Samples 3 (of 4 qts + 1 gal. each)

☒ Alkalinity Total, $CaCO_3$	☐ Turbidity	☒ Acidity Total, $CaCO_3$	☒ Hardness Total, $CaCO_3$	☐ Residue, Vol Nflt	☐ Residue, Total Volatile
☐ Alkalinity Phth, $CaCO_3$	☒ Conductivity at 25C°	☐ Acidity M.O., $CaCO_3$	☒ Residue, Total	☒ Residue, Total Flt (Diss)	☒ Residue, Total Nflt (S
☐ Residue, Vol Flt	☐ Residue, Settlable	☐ Tannin	☒ Cyanide	☒ ph	☒ MBAS

Ca	Mg	K	Na	Al	Sb	As	Ba	Be	Bi	Cd	Cr	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	Se	Ag	Sn	Tl	Sr	Ti	T	V	Zn	F												
☒	☒	☒	☒	☒	☐	☒	☐	☐	☐	☒	☒	☐	☐	☒	☐	☐	☐	☐	☐	☒	☐	☒	☒	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

☐ Oil-Grease	☐ Nitrogen TKN	☒ Nitrate, N	☐ Phosphorus Total, P	☐ Phosphate Total, PO_4	☒ Sulfate, SO_4	☐ Color
☒ Phenols	☒ Nitrogen Ammonia, N	☒ Nitrate, N	☐ Phosphorus Soluble, P	☐ Phosphate Ortho, PO_4	☒ Chloride, Cl	CDD

MILITARY TIME

	Name and Title	Year	Month	Day	Hour	Minute
Received from	C.D. Webster Aquatic Biologist	79	04	06	13	30
Received by	Roger Hannah	79	04	06	13	30
Received from						
Received by						
Received from						
Received by						
Received from						
Received by						

Name and Title — Time and Date

NW20

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 3-27-79

Date Reported: 4/27/79

Laboratory:

Laboratory Number: 27377

Analyst: R. Hannah

Station Code:

Station: Biossay #
79-156-SCUDO

County: MONTGOMERY

Collected by: STAIGER/MITCHELL Phone: 461-4670

Identification of Sample: K+S Circuits Effluent

Sample Code:

Date of grab sample (or last date of composite sample): Year 79 Month 03 Day 27 Hour 10 Minute 56

Composite Type:

Sample Types: ☐ Ground Water ☒ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year 79 Month 03 Day 27 Hour 10 Minute 10

Frequency:

Analysis to be Reported to: ☐ CO ☐ CDO ☐ SE ☐ NE ☒ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:

PRESERVATIVE:
☑ NaOH
☑ $CuSO_4$
☐ H_2SO_4
☑ HNO_3
☑ OTHER NP

5 QUARTS

CONTINUOUS GRAB WHILE FILLING 25 GAL BIOASSAY CONTAINERS

☐ Regular (or indicate by checking boxes)										☐ Fluoride Diss, F	H1								mg/l	☑ Cyanide, CN	N1				< 0.01	mg/l
☐ Flow	Y2								CFS	☑ Calcium Total, Ca	H2						85.		mg/l	☑ MBAS	N2				0.37	mg/l
☑ Water Temperature, Field	Y3						15.0		C°	☑ Magnesium Total, Mg	H3						37.		mg/l	☐ Oil-Grease, Total	N3					mg/l
☑ pH, Field	Y4						5.5		S. U.	☑ Potassium Total, K	H4						29.		mg/l	☑ Phenols	N4				5.0	ug/l
☑ Dissolved Oxygen, Field	Y5						9.8		mg/l	☑ Sodium Total, Na	H5						39.		mg/l	☐ Tannin Lignin	N5					mg/l
☐ Hydrogen Sulfide, Field	Y6								mg/l	☑ Aluminum Total, Al	H6						300.		ug/l	☐ Aldrin, Whl Smpl	N6					ug/l
☐ Chlorine Free Avl, Field	Y7								mg/l	☐ Antimony Total, Sb	H7								ug/l	☐ DDD, Whl Smpl	N7					ug/l
☐ Chlorine Tot Resd, Field	Y8								mg/l	☑ Arsenic Total, As	H8					<	10.		ug/l	☐ DDE, Whl Smpl	N8					ug/l
☐ Color	Y9								Pt-Co	☐ Barium Total, Ba	H9								ug/l	☐ DDT, Whl Smpl	N9					ug/l
☐ Odor	Y0								T. N.	☐ Beryllium Total, Be	H0								ug/l	☐ Dieldrin, Whl Smpl	N0					ug/l
☐ Turbidity	U1								FTU	☐ Bismuth Total, Bi	J1								ug/l	☐ Chlordane, Whl Smpl	M1					ug/l
☑ Conductivity at 25 C°	U2					958.			U-MHO	☐ Boron Total, B	J2								ug/l	☐ Endrin, Whl Smpl	M2					ug/l
☑ pH, Lab	U3					7.8			S. U.	☑ Cadmium Total, Cd	J3						< 5.		ug/l	☐ Heptachlor, Whl Smpl	M3					ug/l
☐ pH, $CaCO_3$ Stability	U4								S. U.	☑ Chromium Total, Cr	J4					<	30.		ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4					ug/l
☑ Alkalinity Total, $CaCO_3$	U5					326.			mg/l	☐ Chromium Hex, Cr	J5								ug/l	☐ Lindane, Whl Smpl	M5					ug/l
☐ Alkalinity Phth, $CaCO_3$	U6								mg/l	☐ Cobalt Total, Co	J6								ug/l	☐ Methoxychlor, Whl Smpl	M6					ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7								mg/l	☑ Copper Total, Cu	J7				1	7.3	00.		ug/l	☐ Malathion, Whl Smpl	M7					ug/l
☐ Carbon Dioxide, CO_2	U8								mg/l	☑ Iron Total, Fe	J8					5	50.		ug/l	☐ Parathion, Whl Smpl	M8					ug/l
☑ Acidity Total, $CaCO_3$	U9						< 1.		mg/l	☐ Iron Diss, Fe	J9								ug/l	☐ Methyl Parathn, Whl Smpl	M9					ug/l
☐ Acidity M.O., $CaCO_3$	U0								mg/l	☐ Iron Ferrous, Fe	J0								ug/l	☐ Beta, Total	M0					pc/l
☑ Hardness Total, $CaCO_3$	I1					420.			mg/l	☑ Lead Total, Pb	K1						72.		ug/l	☐ Beta, Diss	,1					pc/l
☑ Residue, Total	I2					584.			mg/l	☐ Lithium Total, Li	K2								ug/l	☐ Beta, Suspd	,2					pc/l
☐ Residue, Total Volatile	I3								mg/l	☐ Manganese Total, Mn	K3								ug/l	☐ Alpha, Total	,3					pc/l
☑ Residue, Total Nflt (Sus)	I4						34.		mg/l	☐ Mercury Total, Hg	K4								ug/l	☐ Alpha, Diss	,4					pc/l
☐ Residue, Vol Nflt	I5								mg/l	☐ Molybdenum Total, Mo	K5								ug/l	☐ Alpha, Suspd	,5					pc/l
☑ Residue, Total Flt (Diss)	I6					516.			mg/l	☑ Nickel Total, Ni	K6					900.			ug/l	☐ Radium 226, Total	,6					pc/l
☐ Residue, Vol Flt	I7								mg/l	☐ Selenium Total, Se	K7								ug/l	☐ Strontium 90, Total	,7					pc/l
☐ Residue, Settlable	I8								mg/l	☒ Silver Total, Ag	K8						50.		ug/l	☐ Coliform Total, MF	,8					#/100ml
☐ Nitrogen Organic, N	I9								mg/l	☐ Strontium Total, Sr	K9								ug/l	☐ Coliform Total MPN, Conf	,9					#/100ml
☑ Nitrogen Ammonia, N	I0					273.			mg/l	☐ Thallium Total, Tl	K0								ug/l	☐ Fecal Coli Total, MF	,0					#/100ml
☑ Nitrite, N	O1					0.01			mg/l	☑ Tin Total, Sn	L1					240.			ug/l	☐ Fecal Strep Total, MF	.1					#/100ml
☑ Nitrate, N	O2					2.42			mg/l	☐ Titanium Total, Ti	L2								ug/l	☐ Plate Count, Total	.2					#/ml
☐ Phosphorus Total, P	O3								mg/l	☐ Tungsten Total, T	L3								ug/l	☐ Algae, Total	.3					#/ml
☐ Phosphorus Soluble, P	O4								mg/l	☐ Vanadium Total, V	L4								ug/l	☐ TOD	.4					mg/l
☐ Phosphate Total, PO_4	O5								mg/l	☑ Zinc Total, Zn	L5						50.		ug/l	☐ BHC	.5					ug/l
☐ Phosphate Ortho, PO_4	O6								mg/l	☐ Zirconium Total, Zr	L6								ug/l	☑ TKN	.6				3.5 L	mg/l
☐ Sulfate, SO_4	O7					58.			mg/l	☐ BOD, 5-Day	L7								mg/l	☑ Conductivity, Field	.7					U-MHO
☐ Sulfite, SO_3	O8								mg/l	☑ COD	L8					L 2.			mg/l	☐						
☐ Sulfide, S	O9								mg/l	☐ Chlorine Demand, 15 min	L9								mg/l	☐						
☑ Chloride, Cl	O0					46.			mg/l	☐ Carbon Total Org, C	L0								mg/l	☐						

COPY DISTRIBUTION: White – Data Processing White – Central Office Yellow – District Office Pink – Owner White – Laboratory

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 3-28-79

Date Reported: 4/27/79

Laboratory:

Laboratory Number: 27402

Analyst: R. Hannah

Station: 79-156-SW DO

Station Code:

County: Montgomery-Franklin

Collected by: McIntyre, Younger

Phone:

Identification of Sample: 100%

Sample Code:

Date of grab sample (or last date of composite sample): Year 79 Month 03 Day 28 Hour 11 Minute 15

Composite Type:

Sample Types: ☐ Ground Water ☐ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☑ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute

Frequency:

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:

WW 71

PRESERVATIVE:
- ☐ NaOH
- ☑ $CuSO_4 + H_2SO_4$ Qts. 1 Gal.
- ☑ H_2SO_4
- ☐ HNO_3
- ☑ OTHER NP

Bioassay

33 Parameters

☐ Regular (or indicate by checking boxes)			☐ Fluoride Diss, F	H1		☒ Cyanide, CN	N1	<0.01	mg/l
☐ Flow	Y2	CFS	☒ Calcium Total, Ca	H2	88.	mg/l	☒ MBAS	N2	0.5	mg/l
☐ Water Temperature, Field	Y3	C°	☒ Magnesium Total, Mg	H3	39.	mg/l	☐ Oil-Grease, Total	N3		mg/l
☐ pH, Field	Y4	S. U.	☒ Potassium Total, K	H4	3.1	mg/l	☒ Phenols	N4	15.	ug/l
☐ Dissolved Oxygen, Field	Y5	mg/l	☒ Sodium Total, Na	H5	27.	mg/l	☐ Tannin Lignin	N5		mg/l
☐ Hydrogen Sulfide, Field	Y6	mg/l	☒ Aluminum Total, Al	H6	300.	ug/l	☐ Aldrin, Whl Smpl	N6		ug/l
☐ Chlorine Free Avl, Field	Y7	mg/l	☐ Antimony Total, Sb	H7		ug/l	☐ DDD, Whl Smpl	N7		ug/l
☐ Chlorine Tot Resd, Field	Y8	mg/l	☒ Arsenic Total, As	H8	<10.	ug/l	☐ DDE, Whl Smpl	N8		ug/l
☐ Color	Y9	Pt-Co	☐ Barium Total, Ba	H9		ug/l	☐ DDT, Whl Smpl	N9		ug/l
☐ Odor	Y0	T. N.	☐ Beryllium Total, Be	H0		ug/l	☐ Dieldrin, Whl Smpl	N0		ug/l
☐ Turbidity	U1	FTU	☐ Bismuth Total, Bi	J1		ug/l	☐ Chlordane, Whl Smpl	M1		
☒ Conductivity at 25 C°	U2	918. U-MHO	☐ Boron Total, B	J2		ug/l	☐ Endrin, Whl Smpl	M2		ug/l
☒ pH, Lab	U3	7.5 S. U.	☒ Cadmium Total, Cd	J3	<5.	ug/l	☐ Heptachlor, Whl Smpl	M3		ug/l
☐ pH, $CaCO_3$ Stability	U4	S. U.	☒ Chromium Total, Cr	J4	<30.	ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☒ Alkalinity Total, $CaCO_3$	U5	304. mg/l	☐ Chromium Hex, Cr	J5		ug/l	☐ Lindane, Whl Smpl	M5		ug/l
☐ Alkalinity Phth, $CaCO_3$	U6	mg/l	☐ Cobalt Total, Co	J6		ug/l	☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7	mg/l	☒ Copper Total, Cu	J7	10100.	ug/l	☐ Malathion, Whl Smpl	M7		ug/l
☐ Carbon Dioxide, CO_2	U8	mg/l	☒ Iron Total, Fe	J8	410.	ug/l	☐ Parathion, Whl Smpl	M8		ug/l
☒ Acidity Total, $CaCO_3$	U9	<1. mg/l	☐ Iron Diss, Fe	J9		ug/l	☐ Methyl Parathn, Whl Smpl	M9		ug/l
☐ Acidity M.O., $CaCO_3$	U0	mg/l	☐ Iron Ferrous, Fe	J0		ug/l	☐ Beta, Total	M0		pc/l
☒ Hardness Total, $CaCO_3$	I1	433. mg/l	☒ Lead Total, Pb	K1	104.	ug/l	☐ Beta, Diss	,1		pc/l
☒ Residue, Total	I2	546. mg/l	☐ Lithium Total, Li	K2		ug/l	☐ Beta, Suspd	,2		pc/l
☐ Residue, Total Volatile	I3	mg/l	☐ Manganese Total, Mn	K3		ug/l	☐ Alpha, Total	,3		pc/l
☒ Residue, Total Nflt (Sus)	I4	23. mg/l	☐ Mercury Total, Hg	K4		ug/l	☐ Alpha, Diss	,4		pc/l
☐ Residue, Vol Nflt	I5	mg/l	☐ Molybdenum Total, Mo	K5		ug/l	☐ Alpha, Suspd	,5		pc/l
☒ Residue, Total Flt (Diss)	I6	482. mg/l	☒ Nickel Total, Ni	K6	1100.	ug/l	☐ Radium 226, Total	,6		pc/l
☐ Residue, Vol Flt	I7	mg/l	☐ Selenium Total, Se	K7		ug/l	☐ Strontium 90, Total	,7		pc/l
☐ Residue, Settlable	I8	mg/l	☒ Silver Total, Ag	K8	60.	ug/l	☐ Coliform Total, MF	,8		#/100ml
☐ Nitrogen Organic, N	I9	mg/l	☐ Strontium Total, Sr	K9		ug/l	☐ Coliform Total MPN, Conf	,9		#/100ml
☒ Nitrogen Ammonia, N	I0	3.17 mg/l	☐ Thallium Total, Tl	K0		ug/l	☐ Fecal Coli Total, MF	,0		#/100ml
☒ Nitrite, N	01	001 mg/l	☒ Tin Total, Sn	L1	320.	ug/l	☐ Fecal Strep Total, MF	.1		#/100ml
☒ Nitrate, N	02	2.56 mg/l	☐ Titanium Total, Ti	L2		ug/l	☐ Plate Count, Total	.2		#/ml
☒ ~~Phosphorus Total, P~~	03	mg/l	☐ Tungsten Total, T	L3		ug/l	☐ Algae, Total	.3		#/ml
☐ Phosphorus Soluble, P	04	mg/l	☐ Vanadium Total, V	L4		ug/l	☐ TOD	.4		mg/l
☐ Phosphate Total, PO_4	05	mg/l	☒ Zinc Total, Zn	L5	50.	ug/l	☐ BHC	.5		ug/l
☐ Phosphate Ortho, PO_4	06	mg/l	☐ Zirconium Total, Zr	L6		ug/l	☒ TKN	.6	9.40	
☒ Sulfate, SO_4	07	65. mg/l	☐ BOD, 5-Day	L7		mg/l	☒ Conductivity, Field	.7		U-MHO
☐ Sulfite, SO_3	08	mg/l	☒ COD	L8	16.	mg/l	☐			
☐ Sulfide, S	09	mg/l	☐ Chlorine Demand, 15 min	L9		mg/l	☐			
☒ Chloride, Cl	00	32. mg/l	☐ Carbon Total Org, C	L0		mg/l	☐			

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4956.32 – Ohio Department of Health

A-23

OEPA Biomonitoring Group X5 1025 Concord, Cols. H3212 (C. Webster)

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 3-28-79

Date Reported: 4/27/79

Laboratory:

Laboratory Number: 27401

Analyst: R. Hannah

[illegible]on: 79-156-SWDO

Station Code:

County: Montgomery - Franklin

Collected by: McIntyre, Youger

Phone:

Identification of Sample: 10%

Sample Code:

Date of grab sample (or last date of composite sample)	Year	Month	Day	Hour	Minute	Composite Type
	79	03	28	11	25	

Sample Types: ☐ Ground Water ☐ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☑ Stream

Beginning Date of Composite Sample	Year	Month	Day	Hour	Minute	Frequency
			C			

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:

WW30

PRESERVATIVE:
- ☑ NaOH
- ☑ $CuSO_4$+H_3PO_4 4 Qts. 1 Gal.
- ☑ H_2SO_4
- ☑ HNO_3
- ☑ OTHER NP

Bioassay

33 Parameters

Parameter (☐ Regular, or indicate by checking boxes)	Code	Value	Unit
☐ Flow	Y2		CFS
☐ Water Temperature, Field	Y3		C°
☐ pH, Field	Y4		S. U.
☐ Dissolved Oxygen, Field	Y5		mg/l
☐ Hydrogen Sulfide, Field	Y6		mg/l
☐ Chlorine Free Avl, Field	Y7		mg/l
☐ Chlorine Tot Resd, Field	Y8		mg/l
☐ Color	Y9		Pt-Co
☐ Odor	Y0		T. N.
☐ [Tur]bidity	U1		FTU
☐ [C]onductivity at 25 C°	U2	431	U-MHO
☑ pH, Lab	U3	7.7	S. U.
☐ pH, $CaCO_3$ Stability	U4		S. U.
☑ Alkalinity Total, $CaCO_3$	U5	66	mg/l
☐ Alkalinity Phth, $CaCO_3$	U6		mg/l
☐ Alkalinity, $CaCO_3$ Stabl	U7		mg/l
☐ Carbon Dioxide, CO_2	U8		mg/l
☑ Acidity Total, $CaCO_3$	U9	<1	mg/l
☐ Acidity M.O., $CaCO_3$	U0		mg/l
☑ Hardness Total, $CaCO_3$	I1	151	mg/l
☑ Residue, Total	I2	260	mg/l
☐ Residue, Total Volatile	I3		mg/l
☑ Residue, Total Nflt (Sus)	I4	<10	mg/l
☐ Residue, Vol Nflt	I5		mg/l
☑ Residue, Total Flt (Diss)	I6	230	mg/l
☐ Residue, Vol Flt	I7		mg/l
☐ Residue, Settlable	I8		mg/l
☐ Nitrogen Organic, N	I9		mg/l
☑ Nitrogen Ammonia, N	I0	0.38	mg/l
☑ Nitrite, N	01	<0.01	mg/l
☑ Nitrate, N	02	3.71	mg/l
☑ ~~Phosphorus Total, P~~	03		mg/l
☐ Phosphorus Soluble, P	04		mg/l
☐ Phosphate Total, PO_4	05		mg/l
☐ Phosphate Ortho, PO_4	06		mg/l
☐ [Su]lfate, SO_4	07	69	mg/l
☐ Sulfite, SO_3	08		mg/l
☐ Sulfide, S	09		mg/l
☑ Chloride, Cl	00	27	mg/l

Parameter	Code	Value	Unit
☐ Fluoride Diss, F	H1		mg/l
☑ Calcium Total, Ca	H2	40	mg/l
☑ Magnesium Total, Mg	H3	13	mg/l
☑ Potassium Total, K	H4	2.9	mg/l
☑ Sodium Total, Na	H5	14	mg/l
☑ Aluminum Total, Al	H6	200	ug/l
☐ Antimony Total, Sb	H7		ug/l
☑ Arsenic Total, As	H8	<10	ug/l
☐ Barium Total, Ba	H9		ug/l
☐ Berylium Total, Be	H0		ug/l
☐ Bismuth Total, Bi	J1		ug/l
☐ Boron Total, B	J2		ug/l
☑ Cadmium Total, Cd	J3	<5	ug/l
☑ Chromium Total, Cr	J4	<30	ug/l
☐ Chromium Hex, Cr	J5		ug/l
☐ Cobalt Total, Co	J6		ug/l
☑ Copper Total, Cu	J7	790	ug/l
☑ Iron Total, Fe	J8	60	ug/l
☐ Iron Diss, Fe	J9		ug/l
☐ Iron, Ferrous, Fe	J0		ug/l
☑ Lead Total, Pb	K1	9	ug/l
☐ Lithium Total, Li	K2		ug/l
☐ Manganese Total, Mn	K3		ug/l
☐ Mercury Total, Hg	K4		ug/l
☐ Molybdenum Total, Mo	K5		ug/l
☑ Nickel Total, Ni	K6	<100	ug/l
☐ Selenium Total, Se	K7		ug/l
☑ Silver Total, Ag	K8	<30	ug/l
☐ Strontium Total, Sr	K9		ug/l
☐ Thallium Total, Tl	K0		ug/l
☑ Tin Total, Sn	L1	<100	ug/l
☐ Titanium Total, Ti	L2		ug/l
☐ Tungsten Total, T	L3		ug/l
☐ Vanadium Total, V	L4		ug/l
☑ Zinc Total, Zn	L5	<30	ug/l
☐ Zirconium Total, Zr	L6		ug/l
☐ BOD, 5-Day	L7		mg/l
☑ COD	L8	6	mg/l
☐ Chlorine Demand, 15 min	L9		mg/l
☐ Carbon Total Org, C	L0		mg/l

Parameter	Code	Value	Unit
☑ Cyanide, CN	N1	<0.01	mg/l
☑ MBAS	N2	0.11	mg/l
☐ Oil-Grease, Total	N3		mg/l
☑ Phenols	N4	2	ug/l
☐ Tannin Lignin	N5		mg/l
☐ Aldrin, Whl Smpl	N6		ug/l
☐ DDD, Whl Smpl	N7		ug/l
☐ DDE, Whl Smpl	N8		ug/l
☐ DDT, Whl Smpl	N9		ug/l
☐ Dieldrin, Whl Smpl	N0		ug/l
☐ Chlordane, Whl Smpl	M1		ug/l
☐ Endrin, Whl Smpl	M2		ug/l
☐ Heptachlor, Whl Smpl	M3		ug/l
☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☐ Lindane, Whl Smpl	M5		ug/l
☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Malathion, Whl Smpl	M7		ug/l
☐ Parathion, Whl Smpl	M8		ug/l
☐ Methyl Parathn, Whl Smpl	M9		ug/l
☐ Beta, Total	M0		pc/l
☐ Beta, Diss	,1		pc/l
☐ Beta, Suspd	,2		pc/l
☐ Alpha, Total	,3		pc/l
☐ Alpha, Diss	,4		pc/l
☐ Alpha, Suspd	,5		pc/l
☐ Radium 226, Total	,6		pc/l
☐ Strontium 90, Total	,7		pc/l
☐ Coliform Total, MF	,8		#/100ml
☐ Coliform Total MPN, Conf	,9		#/100ml
☐ Fecal Coli Total, MF	,0		#/100ml
☐ Fecal Strep Total, MF	.1		#/100ml
☐ Plate Count, Total	.2		#/ml
☐ Algae, Total	.3		#/ml
☐ TOD	.4		mg/l
☐ BHC	.5		ug/l
☑ TKN	.6	0.59	mg/l
☑ Conductivity, Field	.7		U-MHO
☐			
☐			
☐			

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HEA 4956.32 — Ohio Department of Health

YS

OEPA Biomonitoring Group 1025 Concord Ave., Cols. 43212 (C. Webster)

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 3-28-79
Date Reported: 4/27/79
Laboratory:
Laboratory Number: 27400
Analyst: R. Hammond

Station: 79-156-SWDO
Station Code:
County: Montgomery - Franklin
Collected by: McEntyre, Younger
Phone:

Identification of Sample: Control Cols. tap water
Sample Code:

Date of grab sample (or last date of composite sample): Year 79 Month 03 Day 28 Hour 11 Minute 10
Composite Type:

Sample Types: ☐ Ground Water ☐ Industrial ☐ Sewage ☐ Comp Mon ☑ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute
Frequency:

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:
PRESERVATIVE:
☑ NaOH
☑ $CuSO_4 + H_3PO_4$ 4 Qts. 1 Gal.
☑ H_2SO_4
☑ HNO_3
☑ OTHER NP

Bioassay
33
~~34~~ Parameters

WW 20

☐ Regular (or indicate by checking boxes)			☐ Fluoride Diss, F	H1		☑ Cyanide, CN	N1	< 0.01	mg/l
☐ Flow	Y2	CFS	☑ Calcium Total, Ca	H2	34. mg/l	☑ MBAS	N2	0.1	mg/l
☐ Water Temperature, Field	Y3	C°	☑ Magnesium Total, Mg	H3	9. mg/l	☐ Oil-Grease, Total	N3		mg/l
☐ pH, Field	Y4	S. U.	☑ Potassium Total, K	H4	2.8 mg/l	☑ Phenols	N4	2.	ug/l
☐ Dissolved Oxygen, Field	Y5	mg/l	☑ Sodium Total, Na	H5	13. mg/l	☐ Tannin Lignin	N5		mg/l
☐ Hydrogen Sulfide, Field	Y6	mg/l	☑ Aluminum Total, Al	H6	< 200. ug/l	☐ Aldrin, Whl Smpl	N6		ug/l
☐ Chlorine Free Avl, Field	Y7	mg/l	☐ Antimony Total, Sb	H7	ug/l	☐ DDD, Whl Smpl	N7		ug/l
☐ Chlorine Tot Resd, Field	Y8	mg/l	☑ Arsenic Total, As	H8	< 10. ug/l	☐ DDE, Whl Smpl	N8		ug/l
☐ Color	Y9	Pt-Co	☐ Barium Total, Ba	H9	ug/l	☐ DDT, Whl Smpl	N9		ug/l
☐ Odor	Y0	T. N.	☐ Berylium Total, Be	H0	ug/l	☐ Dieldrin, Whl Smpl	N0		
☐ Turbidity	U1	FTU	☐ Bismuth Total, Bi	J1	ug/l	☐ Chlordane, Whl Smpl	M1		
☑ Conductivity at 25 C°	U2	367. U-MHO	☐ Boron Total, B	J2	ug/l	☐ Endrin, Whl Smpl	M2		ug/l
☑ pH, Lab	U3	7.8 S. U.	☑ Cadmium Total, Cd	J3	< 5. ug/l	☐ Heptachlor, Whl Smpl	M3		ug/l
☐ pH, $CaCO_3$ Stability	U4	S. U.	☑ Chromium Total, Cr	J4	< 30. ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☑ Alkalinity Total, $CaCO_3$	U5	38. mg/l	☐ Chromium Hex, Cr	J5	ug/l	☐ Lindane, Whl Smpl	M5		ug/l
☐ Alkalinity Phth, $CaCO_3$	U6	mg/l	☐ Cobalt Total, Co	J6	ug/l	☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7	mg/l	☑ Copper Total, Cu	J7	< 30. ug/l	☐ Malathion, Whl Smpl	M7		ug/l
☐ Carbon Dioxide, CO_2	U8	mg/l	☑ Iron Total, Fe	J8	30. ug/l	☐ Parathion, Whl Smpl	M8		ug/l
☑ Acidity Total, $CaCO_3$	U9	< 1. mg/l	☐ Iron Diss, Fe	J9	ug/l	☐ Methyl Parathn, Whl Smpl	M9		ug/l
☐ Acidity M.O., $CaCO_3$	U0	mg/l	☐ Iron Ferrous, Fe	J0	ug/l	☐ Beta, Total	M0		pc/l
☑ Hardness Total, $CaCO_3$	I1	124. mg/l	☑ Lead Total, Pb	K1	< 5. ug/l	☐ Beta, Diss	,1		pc/l
☑ Residue, Total	I2	228. mg/l	☐ Lithium Total, Li	K2	ug/l	☐ Beta, Suspd	,2		pc/l
☐ Residue, Total Volatile	I3	mg/l	☐ Manganese Total, Mn	K3	ug/l	☐ Alpha, Total	,3		pc/l
☑ Residue, Total Nflt (Sus)	I4	< 10. mg/l	☐ Mercury Total, Hg	K4	ug/l	☐ Alpha, Diss	,4		pc/l
☐ Residue, Vol Nflt	I5	mg/l	☐ Molybdenum Total, Mo	K5	ug/l	☐ Alpha, Suspd	,5		pc/l
☑ Residue, Total Flt (Diss)	I6	205. mg/l	☑ Nickel Total, Ni	K6	< 100. ug/l	☐ Radium 226, Total	,6		pc/l
☐ Residue, Vol Flt	I7	mg/l	☐ Selenium Total, Se	K7	ug/l	☐ Strontium 90, Total	,7		pc/l
☐ Residue, Settlable	I8	mg/l	☑ Silver Total, Ag	K8	< 30. ug/l	☐ Coliform Total, MF	,8		#/100ml
☐ Nitrogen Organic, N	I9	mg/l	☐ Strontium Total, Sr	K9	ug/l	☐ Coliform Total MPN, Conf	,9		#/100ml
☑ Nitrogen Ammonia, N	I0	0.16 mg/l	☐ Thallium Total, Tl	K0	ug/l	☐ Fecal Coli Total, MF	,0		#/100ml
☑ Nitrite, N	O1	< 0.01 mg/l	☑ Tin Total, Sn	L1	< 100. ug/l	☐ Fecal Strep Total, MF	.1		#/100ml
☑ Nitrate, N	O2	2.61 mg/l	☐ Titanium Total, Ti	L2	ug/l	☐ Plate Count, Total	.2		#/ml
10. ~~☑ Phosphorus Total, P~~	O3	mg/l	☐ Tungsten Total, T	L3	ug/l	☐ Algae, Total	.3		#/ml
☐ Phosphorus Soluble, P	O4	mg/l	☐ Vanadium Total, V	L4	ug/l	☐ TOD	.4		mg/l
☐ Phosphate Total, PO_4	O5	mg/l	☑ Zinc Total, Zn	L5	< 30. ug/l	☐ BHC	.5		ug/l
☐ Phosphate Ortho, PO_4	O6	mg/l	☐ Zirconium Total, Zr	L6	ug/l	☑ TKN	.6	0.22	
☑ Sulfate, SO_4	O7	68. mg/l	☐ BOD, 5-Day	L7	mg/l	☑ Conductivity, Field	.7		U-M
☐ Sulfite, SO_3	O8	mg/l	☑ COD	L8	8. mg/l	☐			
☐ Sulfide, S	O9	mg/l	☐ Chlorine Demand, 15 min	L9	mg/l	☐			
☑ Chloride, Cl	O0	27. mg/l	☐ Carbon Total Org, C	L0	mg/l	☐			

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4956.32 – Ohio Department of Health

OEPA Biomonitoring Group 1025 Concord Ave. Cols. 43212 (C. Webster)

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 4/2/79
Date Reported: 5/9/79
Laboratory:
Laboratory Number: 27480
Analyst: R. Kannah

Station Code:
County: Montgomery - Franklin
Collected by: McIntyre - Webster Phone: 466-4953

Identification of Sample: K+S Circuits BioAssay
79-156-SWDO
100%

Sample Code:

Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 02 Hour 11 Minute 15
Composite Type:

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute
Frequency:

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:
PRESERVATIVE:
☑ NaOH
☑ $CuSO_4$ - H_3PO_4
☑ H_2SO_4
☑ HNO_3
☐ OTHER
Unpres

Results to: C.D. Webster
OEPA Biomonitoring Lab
1025 Concord Ave.
Cols. Oh. 43212

Possible Litigation

WW20

4 qts. + 1 gal.

33 Parameters

☐ Regular	(or indicate by checking boxes)									☐ Fluoride Diss, F	H1								mg/l	☑ Cyanide, CN	N1				<0.01	mg/l
☐ Flow	Y2								CFS	☑ Calcium Total, Ca	H2						9	0	mg/l	☑ MBAS	N2				0.09	mg/l
☐ Water Temperature, Field	Y3								C°	☑ Magnesium Total, Mg	H3						4	2	mg/l	☐ Oil-Grease, Total	N3					mg/l
☐ pH, Field	Y4								S. U.	☑ Potassium Total, K	H4							3.3	mg/l	☑ Phenols	N4				11	ug/l
☐ Dissolved Oxygen, Field	Y5								mg/l	☑ Sodium Total, Na	H5						2	6	mg/l	☐ Tannin Lignin	N5					mg/l
☐ Hydrogen Sulfide, Field	Y6								mg/l	☑ Aluminum Total, Al	H6						2	0	ug/l	☐ Aldrin, Whl Smpl	N6					ug/l
☐ Chlorine Free Avl, Field	Y7								mg/l	☐ Antimony Total, Sb	H7								ug/l	☐ DDD, Whl Smpl	N7					ug/l
☐ Chlorine Tot Resd, Field	Y8								mg/l	☑ Arsenic Total, As	H8					<1	0		ug/l	☐ DDE, Whl Smpl	N8					ug/l
☐ Color	Y9								Pt-Co	☐ Barium Total, Ba	H9								ug/l	☐ DDT, Whl Smpl	N9					ug/l
☐ Odor	Y0								T. N.	☐ Beryllium Total, Be	H0								ug/l	☐ Dieldrin, Whl Smpl	N0					ug/l
☐ Turbidity	U1								FTU	☐ Bismuth Total, Bi	J1								ug/l	☐ Chlordane, Whl Smpl	M1					ug/l
☐ Conductivity at 25 C°	U2				9	3	5		U-MHO	☐ Boron Total, B	J2								ug/l	☐ Endrin, Whl Smpl	M2					ug/l
☑ pH, Lab	U3				7	9			S. U.	☑ Cadmium Total, Cd	J3						<5		ug/l	☐ Heptachlor, Whl Smpl	M3					ug/l
☐ pH, $CaCO_3$ Stability	U4								S. U.	☑ Chromium Total, Cr	J4					<3	0		ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4					ug/l
☑ Alkalinity Total, $CaCO_3$	U5				3	0	0		mg/l	☐ Chromium Hex, Cr	J5								ug/l	☐ Lindane, Whl Smpl	M5					ug/l
☐ Alkalinity Phth, $CaCO_3$	U6								mg/l	☐ Cobalt Total, Co	J6								ug/l	☐ Methoxychlor, Whl Smpl	M6					ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7								mg/l	☑ Copper Total, Cu	J7				1	8	5	0	ug/l	☐ Malathion, Whl Smpl	M7					ug/l
☐ Carbon Dioxide, CO_2	U8								mg/l	☑ Iron Total, Fe	J8						4	0	ug/l	☐ Parathion, Whl Smpl	M8					ug/l
☑ Acidity Total, $CaCO_3$	U9					<1			mg/l	☐ Iron Diss. Fe	J9								ug/l	☐ Methyl Parathn, Whl Smpl	M9					ug/l
☐ Acidity M.O., $CaCO_3$	U0								mg/l	☐ Iron Ferrous, Fe	J0								ug/l	☐ Beta, Total	M0					pc/l
☑ Hardness Total, $CaCO_3$	I1				4	0	6		mg/l	☑ Lead Total, Pb	K1						9		ug/l	☐ Beta, Diss	,1					pc/l
☑ Residue, Total	I2				5	2	7		mg/l	☐ Lithium Total, Li	K2								ug/l	☐ Beta, Suspd	,2					pc/l
☐ Residue, Total Volatile	I3								mg/l	☐ Manganese Total, Mn	K3								ug/l	☐ Alpha, Total	,3					pc/l
☑ Residue, Total Nflt (Sus)	I4					<1	0		mg/l	☐ Mercury Total, Hg	K4								ug/l	☐ Alpha, Diss	,4					pc/l
☐ Residue, Vol Nflt	I5								mg/l	☐ Molybdenum Total, Mo	K5								ug/l	☐ Alpha, Suspd	,5					pc/l
☑ Residue, Total Flt (Diss)	I6				4	9	2		mg/l	☑ Nickel Total, Ni	K6				1	0	0	0	ug/l	☐ Radium 226, Total	,6					pc/l
☐ Residue, Vol Flt	I7								mg/l	☐ Selenium Total, Se	K7								ug/l	☐ Strontium 90, Total	,7					pc/l
☐ Residue, Settlable	I8								mg/l	☑ Silver Total, Ag	K8					<3	0		ug/l	☐ Coliform Total, MF	,8					#/100ml
☐ Nitrogen Organic, N	I9								mg/l	☐ Strontium Total, Sr	K9								ug/l	☐ Coliform Total MPN, Conf	,9					#/100ml
☑ Nitrogen Ammonia, N	I0				1	9	1		mg/l	☐ Thallium Total, Tl	K0								ug/l	☐ Fecal Coli Total, MF	,0					#/100ml
☑ Nitrite, N	O1				0	0	1		mg/l	☐ Tin Total, Sn	L1				<1	0	0		ug/l	☐ Fecal Strep Total, MF	.1					#/100ml
☑ Nitrate, N	O2				2	6	2		mg/l	☐ Titanium Total, Ti	L2								ug/l	☐ Plate Count, Total	.2					#/ml
☐ Phosphorus Total, P	O3								mg/l	☐ Tungsten Total, T	L3								ug/l	☐ Algae, Total	.3					#/ml
☐ Phosphorus Soluble, P	O4								mg/l	☐ Vanadium Total, V	L4								ug/l	☐ TOD	.4					mg/l
☐ Phosphate Total, PO_4	O5								mg/l	☑ Zinc Total, Zn	L5					<3	0		ug/l	☐ BHC	.5					ug/l
☐ Phosphate Ortho, PO_4	O6								mg/l	☐ Zirconium Total, Zr	L6								ug/l	☑ TKN	.6				3.1	7 mg/l
☐ Sulfate, SO_4	O7				6	0			mg/l	☐ BOD, 5-Day	L7								mg/l	☐ Conductivity, Field	.7					U-MHO
☐ Sulfite, SO_3	O8								mg/l	☑ COD	L8					1	8		mg/l	☐						
☐ Sulfide, S	O9								mg/l	☐ Chlorine Demand, 15 min	L9								mg/l	☐						
☑ Chloride, Cl	O0				3	2			mg/l	☐ Carbon Total Org, C	L0								mg/l	☐						

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4956.32 – Ohio Department of Health

X5

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 4/2/79
Date Reported: 5/9/79
Laboratory:
Laboratory Number: 27481
Analyst: R.V. Hammuh

Station: K&S Circuits - BIOASSAY
Station Code:
County: Montgomery - Franklin
Collected by: McIntyre - Webster
Phone: 466-4853

Identification of Sample: # 79-156-SWDO #100% 2
Sample Code:
Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 02 Hour 11 Minute 10
Composite Type:

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute
Frequency:

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:
PRESERVATIVE:
☑ NaOH
☑ $CuSO_4$ + H_3PO_4
☑ H_2SO_4
☑ HNO_3
☐ OTHER
Results To: C.D. Webster
OEPA Biomonitoring Lab.
1025 Concord Ave
Cols. Ohio, 43212
Possible Litigation
WW20
4 qts + 1 gal. uniples
33 Parameters

☐ Regular (or indicate by checking boxes)				☐ Fluoride Diss, F	H1		mg/l
☐ Flow	Y2		CFS	☑ Calcium Total, Ca	H2	90.	mg/l
☐ Water Temperature, Field	Y3		C°	☑ Magnesium Total, Mg	H3	42.	mg/l
☐ pH, Field	Y4		S. U.	☑ Potassium Total, K	H4	3.1	mg/l
☐ Dissolved Oxygen, Field	Y5		mg/l	☑ Sodium Total, Na	H5	26.	mg/l
☐ Hydrogen Sulfide, Field	Y6		mg/l	☑ Aluminum Total, Al	H6	360.	ug/l
☐ Chlorine Free Avl, Field	Y7		mg/l	☐ Antimony Total, Sb	H7		ug/l
☐ Chlorine Tot Resd, Field	Y8		mg/l	☑ Arsenic Total, As	H8	<10.	ug/l
☐ Color	Y9		Pt-Co	☐ Barium Total, Ba	H9		ug/l
☐ Odor	Y0		T. N.	☐ Berylium Total, Be	H0		ug/l
☐ Turbidity	U1		FTU	☐ Bismuth Total, Bi	J1		ug/l
☑ Conductivity at 25 C°	U2	885.	U-MHO	☐ Boron Total, B	J2		ug/l
☑ pH, Lab	U3	7.7	S. U.	☑ Cadmium Total, Cd	J3	<5.	ug/l
☐ pH, $CaCO_3$ Stability	U4		S. U.	☑ Chromium Total, Cr	J4	<30.	ug/l
☑ Alkalinity Total, $CaCO_3$	U5	301.	mg/l	☐ Chromium Hex, Cr	J5		ug/l
☐ Alkalinity Phth, $CaCO_3$	U6		mg/l	☐ Cobalt Total, Co	J6		ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7		mg/l	☑ Copper Total, Cu	J7	11400.	ug/l
☐ Carbon Dioxide, CO_2	U8		mg/l	☑ Iron Total, Fe	J8	480.	ug/l
☑ Acidity Total, $CaCO_3$	U9	<1.	mg/l	☐ Iron Diss, Fe	J9		ug/l
☐ Acidity M.O., $CaCO_3$	U0		mg/l	☐ Iron Ferrous, Fe	J0		ug/l
☑ Hardness Total, $CaCO_3$	I1	434.	mg/l	☑ Lead Total, Pb	K1	60.	ug/l
☑ Residue, Total	I2	541.	mg/l	☐ Lithium Total, Li	K2		ug/l
☐ Residue, Total Volatile	I3		mg/l	☐ Manganese Total, Mn	K3		ug/l
☑ Residue, Total Nflt (Sus)	I4	32.	mg/l	☐ Mercury Total, Hg	K4		ug/l
☐ Residue, Vol Nflt	I5		mg/l	☐ Molybdenum Total, Mo	K5		ug/l
☑ Residue, Total Flt (Diss)	I6	483.	mg/l	☑ Nickel Total, Ni	K6	1100.	ug/l
☐ Residue, Vol Flt	I7		mg/l	☐ Selenium Total, Se	K7		ug/l
☐ Residue, Settlable	I8		mg/l	☑ Silver Total, Ag	K8	60.	ug/l
☐ Nitrogen Organic, N	I9		mg/l	☐ Strontium Total, Sr	K9		ug/l
☑ Nitrogen Ammonia, N	I0	259.	mg/l	☐ Thallium Total, Tl	K0		ug/l
☑ Nitrite, N	O1	0.01	mg/l	☑ Tin Total, Sn	L1	310.	ug/l
☑ Nitrate, N	O2	2.55	mg/l	☐ Titanium Total, Ti	L2		ug/l
☐ Phosphorus Total, P	O3		mg/l	☐ Tungsten Total, T	L3		ug/l
☐ Phosphorus Soluble, P	O4		mg/l	☐ Vanadium Total, V	L4		ug/l
☐ Phosphate Total, PO_4	O5		mg/l	☑ Zinc Total, Zn	L5	60.	ug/l
☐ Phosphate Ortho, PO_4	O6		mg/l	☐ Zirconium Total, Zr	L6		ug/l
☑ Sulfate, SO_4	O7	59.	mg/l	☐ BOD, 5-Day	L7		mg/l
☐ Sulfite, SO_3	O8		mg/l	☑ COD	L8	18.	mg/l
☐ Sulfide, S	O9		mg/l	☐ Chlorine Demand, 15 min	L9		mg/l
☑ Chloride, Cl	O0	30.	mg/l	☐ Carbon Total Org, C	L0		mg/l

☑ Cyanide, CN	N1	<0.01	mg/l
☑ MBAS	N2	0.56	mg/l
☐ Oil-Grease, Total	N3		mg/l
☑ Phenols	N4	10.	ug/l
☐ Tannin Lignin	N5		mg/l
☐ Aldrin, Whl Smpl	N6		ug/l
☐ DDD, Whl Smpl	N7		ug/l
☐ DDE, Whl Smpl	N8		ug/l
☐ DDT, Whl Smpl	N9		ug/l
☐ Dieldrin, Whl Smpl	N0		ug/l
☐ Chlordane, Whl Smpl	M1		
☐ Endrin, Whl Smpl	M2		ug/l
☐ Heptachlor, Whl Smpl	M3		ug/l
☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☐ Lindane, Whl Smpl	M5		ug/l
☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Malathion, Whl Smpl	M7		ug/l
☐ Parathion, Whl Smpl	M8		ug/l
☐ Methyl Parathn, Whl Smpl	M9		ug/l
☐ Beta, Total	M0		pc/l
☐ Beta, Diss	,1		pc/l
☐ Beta, Suspd	,2		pc/l
☐ Alpha, Total	,3		pc/l
☐ Alpha, Diss	,4		pc/l
☐ Alpha, Suspd	,5		pc/l
☐ Radium 226, Total	,6		pc/l
☐ Strontium 90, Total	,7		pc/l
☐ Coliform Total, MF	,8		#/100ml
☐ Coliform Total MPN, Conf	,9		#/100ml
☐ Fecal Coli Total, MF	,0		#/100ml
☐ Fecal Strep Total, MF	.1		#/100ml
☐ Plate Count, Total	.2		#/ml
☐ Algae, Total	.3		#/ml
☐ TOD	.4		mg/l
☐ BHC	.5		ug/l
☑ TKN	.6	280.	
☐ Conductivity, Field	.7		U-
☐			
☐			
☐			

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Date Received 4/2/79

Date Reported 5/9/79

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Laboratory

Laboratory Number 27482

Analyst RKennah

Station Code

County Montgomery - Franklin

Collected by: McIntyre - Franke

Phone:

Identification of Sample: K+S Circuits Bioassay #79-156-SWDO Cont-2

Sample Code

Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 02 Hour 11 Minute 20

Composite Type

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute

Frequency

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:

PRESERVATIVE:
☑ NaOH
☑ $CuSO_4 + H_3PO_4$
☑ H_2SO_4
☑ HNO_3 4qts + 1gal.
☐ OTHER
Unpres

Results to: C.D. Webster
OEPA Biomonitoring Lab.
1225 Concord Ave.
Cols. Oh. 43212

Possible Litigation

33 Parameters

WW20

☐ Regular	(or indicate by checking boxes)											☐ Fluoride Diss. F	H1											mg/l	☑ Cyanide, CN	N1											<.001	mg/l
☐ Flow	Y2											CFS	☑ Calcium Total, Ca	H2										36.	mg/l	☑ MBAS	N2											<.05	mg/l
☐ Water Temperature, Field	Y3											C°	☑ Magnesium Total, Mg	H3										9.	mg/l	☐ Oil-Grease, Total	N3												mg/l
☐ pH, Field	Y4											S. U.	☑ Potassium Total, K	H4										2.9	mg/l	☑ Phenols	N4											<2.	ug/l
☐ Dissolved Oxygen, Field	Y5											mg/l	☑ Sodium Total, Na	H5										13.	mg/l	☐ Tannin Lignin	N5												mg/l
☐ Hydrogen Sulfide, Field	Y6											mg/l	☑ Aluminum Total, Al	H6										200.	ug/l	☐ Aldrin, Whl Smpl	N6												ug/l
☐ Chlorine Free Avl, Field	Y7											mg/l	☐ Antimony Total, Sb	H7											ug/l	☐ DDD, Whl Smpl	N7												ug/l
☐ Chlorine Tot Resd, Field	Y8											mg/l	☑ Arsenic Total, As	H8										<10	ug/l	☐ DDE, Whl Smpl	N8												ug/l
☐ Color	Y9											Pt-Co	☐ Barium Total, Ba	H9											ug/l	☐ DDT, Whl Smpl	N9												ug/l
☐ Odor	Y0											T. N.	☐ Beryllium Total, Be	H0											ug/l	☐ Dieldrin, Whl Smpl	N0												ug/l
☐ Turbidity	U1											FTU	☐ Bismuth Total, Bi	J1											ug/l	☐ Chlordane, Whl Smpl	M1												ug/l
☐ Conductivity at 25 C°	U2						362.					U-MHO	☐ Boron Total, B	J2											ug/l	☐ Endrin, Whl Smpl	M2												ug/l
☑ pH, Lab	U3						8.4					S. U.	☑ Cadmium Total, Cd	J3										<5.	ug/l	☐ Heptachlor, Whl Smpl	M3												ug/l
☐ pH, $CaCO_3$ Stability	U4											S. U.	☑ Chromium Total, Cr	J4										<30.	ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4												ug/l
☑ Alkalinity Total, $CaCO_3$	U5						40.					mg/l	☐ Chromium Hex, Cr	J5											ug/l	☐ Lindane, Whl Smpl	M5												ug/l
☐ Alkalinity Phth, $CaCO_3$	U6											mg/l	☐ Cobalt Total, Co	J6											ug/l	☐ Methoxychlor, Whl Smpl	M6												ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7											mg/l	☑ Copper Total, Cu	J7										<30.	ug/l	☐ Malathion, Whl Smpl	M7												ug/l
☐ Carbon Dioxide, CO_2	U8											mg/l	☑ Iron Total, Fe	J8										40.	ug/l	☐ Parathion, Whl Smpl	M8												ug/l
☑ Acidity Total, $CaCO_3$	U9						<1.					mg/l	☐ Iron Diss. Fe	J9											ug/l	☐ Methyl Parathn, Whl Smpl	M9												ug/l
☐ Acidity M.O., $CaCO_3$	U0											mg/l	☐ Iron Ferrous, Fe	J0											ug/l	☐ Beta, Total	M0												pc/l
☑ Hardness Total, $CaCO_3$	I1						161.					mg/l	☑ Lead Total, Pb	K1										9.	ug/l	☐ Beta, Diss	,1												pc/l
☑ Residue, Total	I2						229.					mg/l	☐ Lithium Total, Li	K2											ug/l	☐ Beta, Suspd	,2												pc/l
☐ Residue, Total Volatile	I3											mg/l	☐ Manganese Total, Mn	K3											ug/l	☐ Alpha, Total	,3												pc/l
☑ Residue, Total Nflt (Sus)	I4						<10.					mg/l	☐ Mercury Total, Hg	K4											ug/l	☐ Alpha, Diss	,4												pc/l
☐ Residue, Vol Nflt	I5											mg/l	☐ Molybdenum Total, Mo	K5											ug/l	☐ Alpha, Suspd	,5												pc/l
☑ Residue, Total Flt (Diss)	I6						208.					mg/l	☑ Nickel Total, Ni	K6										<100.	ug/l	☐ Radium 226, Total	,6												pc/l
☐ Residue, Vol Flt	I7											mg/l	☐ Selenium Total, Se	K7											ug/l	☐ Strontium 90, Total	,7												pc/l
☐ Residue, Settlable	I8											mg/l	☑ Silver Total, Ag	K8										<30.	ug/l	☐ Coliform Total, MF	,8												#/100ml
☐ Nitrogen Organic, N	I9											mg/l	☐ Strontium Total, Sr	K9											ug/l	☐ Coliform Total MPN, Conf	,9												#/100ml
☑ Nitrogen Ammonia, N	I0						<0.05					mg/l	☐ Thallium Total, Tl	K0											ug/l	☐ Fecal Coli Total, MF	,0												#/100ml
☑ Nitrite, N	01						0.01					mg/l	☑ Tin Total, Sn	L1										<10.	ug/l	☐ Fecal Strep Total, MF	.1												#/100ml
☑ Nitrate, N	02						2.72					mg/l	☐ Titanium Total, Ti	L2											ug/l	☐ Plate Count, Total	.2												#/ml
☐ Phosphorus Total, P	03											mg/l	☐ Tungsten Total, T	L3											ug/l	☐ Algae, Total	.3												#/ml
☐ Phosphorus Soluble, P	04											mg/l	☐ Vanadium Total, V	L4											ug/l	☐ TOD	.4												mg/l
☐ Phosphate Total, PO_4	05											mg/l	☑ Zinc Total, Zn	L5										<30.	ug/l	☐ BHC	.5												ug/l
☐ Phosphate Ortho, PO_4	06											mg/l	☐ Zirconium Total, Zr	L6											ug/l	☑ TKN	.6											0.32	mg/l
☐ Sulfate, SO_4	07						70.					mg/l	☐ BOD, 5-Day	L7											mg/l	☐ Conductivity, Field	.7												U-MHO
☐ Sulfite, SO_3	08											mg/l	☑ COD	L8										8.	mg/l	☐													
☐ Sulfide, S	09											mg/l	☐ Chlorine Demand, 15 min	L9											mg/l	☐													
☑ Chloride, Cl	00						28.					mg/l	☐ Carbon Total Org. C	L0											mg/l	☐													

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YS

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 4-6-79

Laboratory Number: 27571

Date Reported: 5/21/79

Laboratory:

Analyst: R. Kammel

Station: KTS Circuits

Station Code:

County: Montgomery - Franklin

Blozsey # 79-156-SWDO

Collected by: C.D. Webster & T. Fredz

Phone: 466-4953

Identification of Sample: 100%-2

Sample Code:

Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 06 Hour 11 Minute 30

Composite Type:

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute

Frequency:

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST:

WW20

PRESERVATIVE:
- ☑ NaOH
- ☑ $CuSO_4$ + H_3PO_4
- ☑ H_2SO_4
- ☑ HNO_3
- ☐ OTHER

Results To: C.D. Webster
OEPA Bio-monitoring Lab.
1025 Concord Ave.
Cols. Oh. 43212

Possible Litigation
33 Parameters

☐ Regular (or indicate by checking boxes)									☐ Fluoride Diss. F	H1									☑ Cyanide, CN	N1									<.01	mg/l
☐ Flow	Y2							CFS	☑ Calcium Total, Ca	H2							58.	mg/l	☑ MBAS	N2									0.81	mg/l
☐ Water Temperature, Field	Y3							C°	☑ Magnesium Total, Mg	H3							41.	mg/l	☐ Oil-Grease, Total	N3										mg/l
☐ pH, Field	Y4							S. U.	☑ Potassium Total, K	H4							3.	mg/l	☑ Phenols	N4									<2.	ug/l
☐ Dissolved Oxygen, Field	Y5							mg/l	☑ Sodium Total, Na	H5							26.	mg/l	☐ Tannin Lignin	N5										mg/l
☐ Hydrogen Sulfide, Field	Y6							mg/l	☑ Aluminum Total, Al	H6							200.	ug/l	☐ Aldrin, Whl Smpl	N6										ug/l
☐ Chlorine Free Avl, Field	Y7							mg/l	☐ Antimony Total, Sb	H7								ug/l	☐ DDD, Whl Smpl	N7										ug/l
☐ Chlorine Tot Resd, Field	Y8							mg/l	☑ Arsenic Total, As	H8						<20.		ug/l	☐ DDE, Whl Smpl	N8										ug/l
☐ Color	Y9							Pt-Co	☐ Barium Total, Ba	H9								ug/l	☐ DDT, Whl Smpl	N9										ug/l
☐ Odor	Y0							T. N.	☐ Beryllium Total, Be	H0								ug/l	☐ Dieldrin, Whl Smpl	N0										ug/l
☐ Turbidity	U1							FTU	☐ Bismuth Total, Bi	J1								ug/l	☐ Chlordane, Whl Smpl	M1										
☑ Conductivity at 25 C°	U2					902.		U-MHO	☐ Boron Total, B	J2								ug/l	☐ Endrin, Whl Smpl	M2										ug/l
☑ pH, Lab	U3					7.9		S. U.	☑ Cadmium Total, Cd	J3							<5.	ug/l	☐ Heptachlor, Whl Smpl	M3										ug/l
☐ pH, $CaCO_3$ Stability	U4							S. U.	☑ Chromium Total, Cr	J4						<30.		ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4										ug/l
☑ Alkalinity Total, $CaCO_3$	U5					221.		mg/l	☐ Chromium Hex, Cr	J5								ug/l	☐ Lindane, Whl Smpl	M5										ug/l
☐ Alkalinity Phth, $CaCO_3$	U6							mg/l	☐ Cobalt Total, Co	J6								ug/l	☐ Methoxychlor, Whl Smpl	M6										ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7							mg/l	☑ Copper Total, Cu	J7						1900.		ug/l	☐ Malathion, Whl Smpl	M7										ug/l
☐ Carbon Dioxide, CO_2	U8							mg/l	☑ Iron Total, Fe	J8						<30.		ug/l	☐ Parathion, Whl Smpl	M8										ug/l
☑ Acidity Total, $CaCO_3$	U9					<1.		mg/l	☐ Iron Diss, Fe	J9								ug/l	☐ Methyl Parathn, Whl Smpl	M9										ug/l
☐ Acidity M.O., $CaCO_3$	U0							mg/l	☐ Iron Ferrous, Fe	J0								ug/l	☐ Beta, Total	M0										pc/l
☑ Hardness Total, $CaCO_3$	I1					388.		mg/l	☑ Lead Total, Pb	K1							<5.	ug/l	☐ Beta, Diss	,1										pc/l
☑ Residue, Total	I2					538.		mg/l	☐ Lithium Total, Li	K2								ug/l	☐ Beta, Suspd	,2										pc/l
☐ Residue, Total Volatile	I3							mg/l	☐ Manganese Total, Mn	K3								ug/l	☐ Alpha, Total	,3										pc/l
☑ Residue, Total Nflt (Sus)	I4					<10.		mg/l	☐ Mercury Total, Hg	K4								ug/l	☐ Alpha, Diss	,4										pc/l
☐ Residue, Vol Nflt	I5							mg/l	☐ Molybdenum Total, Mo	K5								ug/l	☐ Alpha, Suspd	,5										pc/l
☑ Residue, Total Flt (Diss)	I6					496.		mg/l	☑ Nickel Total, Ni	K6						1000.		ug/l	☐ Radium 226, Total	,6										pc/l
☐ Residue, Vol Flt	I7							mg/l	☐ Selenium Total, Se	K7								ug/l	☐ Strontium 90, Total	,7										pc/l
☐ Residue, Settlable	I8							mg/l	☑ Silver Total, Ag	K8						<30.		ug/l	☐ Coliform Total, MF	,8										#/100ml
☐ Nitrogen Organic, N	I9							mg/l	☐ Strontium Total, Sr	K9								ug/l	☐ Coliform Total MPN, Conf	,9										#/100ml
☑ Nitrogen Ammonia, N	I0					2.72		mg/l	☐ Thallium Total, Tl	K0								ug/l	☐ Fecal Coli Total, MF	,0										#/100ml
☑ Nitrite, N	O1					0.01		mg/l	☑ Tin Total, Sn	L1						<100.		ug/l	☐ Fecal Strep Total, MF	.1										#/100ml
☑ Nitrate, N	O2					1.05		mg/l	☐ Titanium Total, Ti	L2								ug/l	☐ Plate Count, Total	.2										#/ml
☐ Phosphorus Total, P	O3							mg/l	☐ Tungsten Total, T	L3								ug/l	☐ Algae, Total	.3										#/ml
☐ Phosphorus Soluble, P	O4							mg/l	☐ Vanadium Total, V	L4								ug/l	☐ TOD	.4										mg/l
☐ Phosphate Total, PO_4	O5							mg/l	☑ Zinc Total, Zn	L5						<30.		ug/l	☐ BHC	.5										ug/l
☐ Phosphate Ortho, PO_4	O6							mg/l	☐ Zirconium Total, Zr	L6								ug/l	☑ TKN	.6								3.47		mg/l
☑ Sulfate, SO_4	O7					59.		mg/l	☐ BOD, 5-Day	L7								mg/l	☐ Conductivity, Field	.7										U
☐ Sulfite, SO_3	O8							mg/l	☑ COD	L8						15.		mg/l	☐											
☐ Sulfide, S	O9							mg/l	☐ Chlorine Demand, 15 min	L9								mg/l	☐											
☑ Chloride, Cl	O0					11.		mg/l	☐ Carbon Total Org, C	L0								mg/l	☐											

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X5

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 4-6-79
Date Reported: 5/2/79
Laboratory
Laboratory Number: 27570
Analyst: R. Hannah

Station: K+S Circuits
Bioassay # 79-156-SWDO
Station Code
County: Montgomery - Franklin
Collected by: JT Freda CD Webster
Phone: 466-4953

Identification of Sample: Control-2
Sample Code

Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 06 Hour 11 Minute 00
Composite Type

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Beginning Date of Composite Sample: Year Month Day C Hour Minute — Frequency

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST: WW20

PRESERVATIVE:
☑ NaOH
☑ $CuSO_4$ + H_3PO_4
☑ H_2SO_4
☑ HNO_3
☐ OTHER
1 gal. Unpres

Results TO: C.D. Webster
OEPA Biomonitoring Lab
1025 Concord Ave
Cols. Oh. 43212
Possible Litigation
33 Parameters

Parameter	Code	Value	Unit	Parameter	Code	Value	Unit	Parameter	Code	Value	Unit
☐ Regular (or indicate by checking boxes)				☐ Fluoride Diss. F	H1		mg/l	☑ Cyanide, CN	N1	<.001	mg/l
☐ Flow	Y2		CFS	☑ Calcium Total, Ca	H2	35	mg/l	☑ MBAS	N2	.007	mg/l
☐ Water Temperature, Field	Y3		C°	☑ Magnesium Total, Mg	H3	10	mg/l	☐ Oil-Grease, Total	N3		mg/l
☐ pH, Field	Y4		S. U.	☑ Potassium Total, K	H4	3	mg/l	☑ Phenols	N4	<2	ug/l
☐ Dissolved Oxygen, Field	Y5		mg/l	☑ Sodium Total, Na	H5	13	mg/l	☐ Tannin Lignin	N5		mg/l
☐ Hydrogen Sulfide, Field	Y6		mg/l	☑ Aluminum Total, Al	H6	200	ug/l	☐ Aldrin, Whl Smpl	N6		ug/l
☐ Chlorine Free Avl, Field	Y7		mg/l	☐ Antimony Total, Sb	H7		ug/l	☐ DDD, Whl Smpl	N7		ug/l
☐ Chlorine Tot Resd, Field	Y8		mg/l	☑ Arsenic Total, As	H8	<10	ug/l	☐ DDE, Whl Smpl	N8		ug/l
☐ Color	Y9		Pt-Co	☐ Barium Total, Ba	H9		ug/l	☐ DDT, Whl Smpl	N9		ug/l
☐ Odor	Y0		T. N.	☐ Berylium Total, Be	H0		ug/l	☐ Dieldrin, Whl Smpl	N0		ug/l
☐ Turbidity	U1		FTU	☐ Bismuth Total, Bi	J1		ug/l	☐ Chlordane, Whl Smpl	M1		ug/l
☐ Conductivity at 25 C°	U2	364	U-MHO	☐ Boron Total, B	J2		ug/l	☐ Endrin, Whl Smpl	M2		ug/l
☑ pH, Lab	U3	7.4	S. U.	☑ Cadmium Total, Cd	J3	<5	ug/l	☐ Heptachlor, Whl Smpl	M3		ug/l
☐ pH, $CaCO_3$ Stability	U4		S. U.	☑ Chromium Total, Cr	J4	<30	ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☑ Alkalinity Total, $CaCO_3$	U5	41	mg/l	☐ Chromium Hex. Cr	J5		ug/l	☐ Lindane, Whl Smpl	M5		ug/l
☐ Alkalinity Phth, $CaCO_3$	U6		mg/l	☐ Cobalt Total, Co	J6		ug/l	☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7		mg/l	☑ Copper Total, Cu	J7	<30	ug/l	☐ Malathion, Whl Smpl	M7		ug/l
☐ Carbon Dioxide, CO_2	U8		mg/l	☑ Iron Total, Fe	J8	<30	ug/l	☐ Parathion, Whl Smpl	M8		ug/l
☑ Acidity Total, $CaCO_3$	U9	<1	mg/l	☐ Iron Diss. Fe	J9		ug/l	☐ Methyl Parathn, Whl Smpl	M9		ug/l
☐ Acidity M.O., $CaCO_3$	U0		mg/l	☐ Iron Ferrous, Fe	J0		ug/l	☐ Beta, Total	M0		pc/l
☑ Hardness Total, $CaCO_3$	I1	123	mg/l	☑ Lead Total, Pb	K1	<30	ug/l	☐ Beta, Diss	,1		pc/l
☑ Residue, Total	I2	232	mg/l	☐ Lithium Total, Li	K2		ug/l	☐ Beta, Suspd	,2		pc/l
☐ Residue, Total Volatile	I3		mg/l	☐ Manganese Total, Mn	K3		ug/l	☐ Alpha, Total	,3		pc/l
☑ Residue, Total Nflt (Sus)	I4	<1.0	mg/l	☐ Mercury Total, Hg	K4		ug/l	☐ Alpha, Diss	,4		pc/l
☐ Residue, Vol Nflt	I5		mg/l	☐ Molybdenum Total, Mo	K5		ug/l	☐ Alpha, Suspd	,5		pc/l
☑ Residue, Total Flt (Diss)	I6	200	mg/l	☑ Nickel Total, Ni	K6	<100	ug/l	☐ Radium 226, Total	,6		pc/l
☐ Residue, Vol Flt	I7		mg/l	☐ Selenium Total, Se	K7		ug/l	☐ Strontium 90, Total	,7		pc/l
☐ Residue, Settable	I8		mg/l	☑ Silver Total, Ag	K8	<30	ug/l	☐ Coliform Total, MF	,8		#/100ml
☐ Nitrogen Organic, N	I9		mg/l	☐ Strontium Total, Sr	K9		ug/l	☐ Coliform Total MPN, Conf	,9		#/100ml
☑ Nitrogen Ammonia, N	I0	0.08	mg/l	☐ Thallium Total, Tl	K0		ug/l	☐ Fecal Coli Total, MF	,0		#/100ml
☑ Nitrite, N	01	.001	mg/l	☑ Tin Total, Sn	L1	<10	ug/l	☐ Fecal Strep Total, MF	.1		#/100ml
☑ Nitrate, N	02	1.69	mg/l	☐ Titanium Total, Ti	L2		ug/l	☐ Plate Count, Total	.2		#/ml
☐ Phosphorus Total, P	03		mg/l	☐ Tungsten Total, T	L3		ug/l	☐ Algae, Total	.3		#/ml
☐ Phosphorus Soluble, P	04		mg/l	☐ Vanadium Total, V	L4		ug/l	☐ TOD	.4		mg/l
☐ Phosphate Total, PO_4	05		mg/l	☑ Zinc Total, Zn	L5	<30	ug/l	☐ BHC	.5		ug/l
☐ Phosphate Ortho, PO_4	06		mg/l	☐ Zirconium Total, Zr	L6		ug/l	☑ TKN	.6	.238	mg/l
☐ Sulfate, SO_4	07	56	mg/l	☐ BOD, 5-Day	L7		mg/l	☐ Conductivity, Field	.7		U-MHO
☐ Sulfite, SO_3	08		mg/l	☑ COD	L8	8	mg/l	☐			
☐ Sulfide, S	09		mg/l	☐ Chlorine Demand, 15 min	L9		mg/l	☐			
☑ Chloride, Cl	00	9	mg/l	☐ Carbon Total Org, C	L0		mg/l	☐			

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Y5A-30

OHIO DEPARTMENT OF HEALTH
WATER QUALITY DATA

Date Received: 4-6-79

Date Reported: 5/21/79

Laboratory:

Laboratory Number: 27569

Analyst: R. Kanneh

Station: K&S Circuits

Biossay # 79-156 - SWDO

Station Code: [ ] [ ] [ ] [ ] [ ]

County: Montgomery - Franklin

Collected by: Jil. Hode, CD Webster Phone: 466 4953

Identification of Sample: Control

Sample Code: [ ]

Date of grab sample (or last date of composite sample): Year 79 Month 04 Day 06 Hour 11 Minute 15; Composite Type [ ] [ ]

Beginning Date of Composite Sample: Year ___ Month ___ Day ___ C Hour ___ Minute ___; Frequency [ ] [ ]

Sample Types: ☐ Ground Water ☑ Industrial ☐ Sewage ☐ Comp Mon ☐ Water Supply ☐ Stream

Analysis to be Reported to: ☑ CO ☐ CDO ☐ SE ☐ NE ☐ SW ☐ NW

REASON FOR TAKING SAMPLE — ADDITIONAL INFORMATION — REMARKS BY ANALYST: WW20

PRESERVATIVE:
☑ NaOH
☑ $CuSO_4$ + H_3PO_4
☑ H_2SO_4
☑ HNO_3
☐ OTHER

1 gal Unpres

Results To: CD Webster
OEPA Biomonitoring Lab.
1025 Concord Ave
Cols. Oh. 43212

Possible Litigation

33 Parameters

☐ Regular	(or indicate by checking boxes)										
☐ Flow	Y2		CFS	☐ Fluoride Diss. F	H1		mg/l	☑ Cyanide, CN	N1	<001	mg/l
☐ Water Temperature, Field	Y3		C°	☑ Calcium Total, Ca	H2	35	mg/l	☑ MBAS	N2	007	mg/l
☐ pH, Field	Y4		S. U.	☑ Magnesium Total, Mg	H3	10	mg/l	☐ Oil-Grease, Total	N3		mg/l
☐ Dissolved Oxygen, Field	Y5		mg/l	☑ Potassium Total, K	H4	3	mg/l	☑ Phenols	N4	<2	ug/l
☐ Hydrogen Sulfide, Field	Y6		mg/l	☑ Sodium Total, Na	H5	13	mg/l	☐ Tannin Lignin	N5		mg/l
☐ Chlorine Free Avl, Field	Y7		mg/l	☑ Aluminum Total, Al	H6	260	ug/l	☐ Aldrin, Whl Smpl	N6		ug/l
☐ Chlorine Tot Resd, Field	Y8		mg/l	☐ Antimony Total, Sb	H7		ug/l	☐ DDD, Whl Smpl	N7		ug/l
☐ Color	Y9		Pt-Co	☑ Arsenic Total, As	H8	<10	ug/l	☐ DDE, Whl Smpl	N8		ug/l
☐ Odor	Y0		T. N.	☐ Barium Total, Ba	H9		ug/l	☐ DDT, Whl Smpl	N9		ug/l
☐ Turbidity	U1		FTU	☐ Berylium Total, Be	H0		ug/l	☐ Dieldrin, Whl Smpl	N0		ug/l
☑ Conductivity at 25 C°	U2	371	U-MHO	☐ Bismuth Total, Bi	J1		ug/l	☐ Chlordane, Whl Smpl	M1		ug/l
☑ pH, Lab	U3	7.2	S. U.	☐ Boron Total, B	J2		ug/l	☐ Endrin, Whl Smpl	M2		ug/l
☐ pH, $CaCO_3$ Stability	U4		S. U.	☑ Cadmium Total, Cd	J3	<5	ug/l	☐ Heptachlor, Whl Smpl	M3		ug/l
☑ Alkalinity Total, $CaCO_3$	U5	39	mg/l	☑ Chromium Total, Cr	J4	<30	ug/l	☐ Hchlr-Epoxide, Whl Smpl	M4		ug/l
☐ Alkalinity Phth, $CaCO_3$	U6		mg/l	☐ Chromium Hex, Cr	J5		ug/l	☐ Lindane, Whl Smpl	M5		ug/l
☐ Alkalinity, $CaCO_3$ Stabl	U7		mg/l	☐ Cobalt Total, Co	J6		ug/l	☐ Methoxychlor, Whl Smpl	M6		ug/l
☐ Carbon Dioxide, CO_2	U8		mg/l	☑ Copper Total, Cu	J7	<30	ug/l	☐ Malathion, Whl Smpl	M7		ug/l
☑ Acidity Total, $CaCO_3$	U9	<1	mg/l	☑ Iron Total, Fe	J8	<30	ug/l	☐ Parathion, Whl Smpl	M8		ug/l
☐ Acidity M.O., $CaCO_3$	U0		mg/l	☐ Iron Diss, Fe	J9		ug/l	☐ Methyl Parathn, Whl Smpl	M9		ug/l
☑ Hardness Total, $CaCO_3$	I1	124	mg/l	☐ Iron Ferrous, Fe	J0		ug/l	☐ Beta, Total	M0		pc/l
☑ Residue, Total	I2	244	mg/l	☑ Lead Total, Pb	K1	12	ug/l	☐ Beta, Diss	,1		pc/l
☐ Residue, Total Volatile	I3		mg/l	☐ Lithium Total, Li	K2		ug/l	☐ Beta, Suspd	,2		pc/l
☑ Residue, Total Nflt (Sus)	I4	<10	mg/l	☐ Manganese Total, Mn	K3		ug/l	☐ Alpha, Total	,3		pc/l
☐ Residue, Vol Nflt	I5		mg/l	☐ Mercury Total, Hg	K4		ug/l	☐ Alpha, Diss	,4		pc/l
☑ Residue, Total Flt (Diss)	I6	203	mg/l	☐ Molybdenum Total, Mo	K5		ug/l	☐ Alpha, Suspd	,5		pc/l
☐ Residue, Vol Flt	I7		mg/l	☑ Nickel Total, Ni	K6	<100	ug/l	☐ Radium 226, Total	,6		pc/l
☐ Residue, Settlable	I8		mg/l	☐ Selenium Total, Se	K7		ug/l	☐ Strontium 90, Total	,7		pc/l
☐ Nitrogen Organic, N	I9		mg/l	☑ Silver Total, Ag	K8	<30	ug/l	☐ Coliform Total, MF	,8		#/100ml
☑ Nitrogen Ammonia, N	I0	0.12	mg/l	☐ Strontium Total, Sr	K9		ug/l	☐ Coliform Total MPN, Conf	,9		#/100ml
☑ Nitrite, N	01	0.02	mg/l	☐ Thallium Total, Tl	K0		ug/l	☐ Fecal Coli Total, MF	,0		#/100ml
☑ Nitrate, N	02	1.62	mg/l	☑ Tin Total, Sn	L1	<10	ug/l	☐ Fecal Strep Total, MF	.1		#/100ml
☐ Phosphorus Total, P	03		mg/l	☐ Titanium Total, Ti	L2		ug/l	☐ Plate Count, Total	.2		#/ml
☐ Phosphorus Soluble, P	04		mg/l	☐ Tungsten Total, T	L3		ug/l	☐ Algae, Total	.3		#/ml
☐ Phosphate Total, PO_4	05		mg/l	☐ Vanadium Total, V	L4		ug/l	☐ TOD	.4		mg/l
☐ Phosphate Ortho, PO_4	06		mg/l	☑ Zinc Total, Zn	L5	<30	ug/l	☐ BHC	.5		ug/l
☑ Sulfate, SO_4	07	61	mg/l	☐ Zirconium Total, Zr	L6		ug/l	☑ TKN	.6	0.51	
☐ Sulfite, SO_3	08		mg/l	☐ BOD, 5-Day	L7		mg/l	☐ Conductivity, Field	.7		
☐ Sulfide, S	09		mg/l	☑ COD	L8	10	mg/l	☐			
☑ Chloride, Cl	00	9	mg/l	☐ Chlorine Demand, 15 min	L9		mg/l	☐			
				☐ Carbon Total Org, C	L0		mg/l	☐			

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YS

APPENDIX B

STATION CHARACTERISTICS FOR BRUSH CREEK MACROINVERTEBRATE AND FISH COLLECTION SITES

Appendix B

Station Characteristics for Brush Creek
Macroinvertebrate and Fish Collection Sites

Station 1 (Mile Point 7.8)

General Location	:	0.7 mi. NE of Phillipsburg, 30 yds. ust. St.Rt. 49 bridge, Montgomery Co., Clay Twp.
Latitude/Longitude	:	39°54'20"/84°24'20"
Width	:	1'-10'
Depth	:	1'-2'
Flow	:	Continuous
Stream Morphology	:	Channelized, beginning to recover; no well defined riffles, mostly run
Stream Order	:	II
Substrate	:	Coarse gravel - sand; silt depth 6"-12" under bridge, bottom relatively silt-free ust. bridge
Aquatic Vegetation	:	Filamentous green algae abundant, floating mats covering entire stream in several places
Canopy	:	10%
Prevailing Land Use	:	Cropland, pasture lands

Station 2 (Mile Point 7.1)

General Location	:	1.1 mi. N. of Phillipsburg, 50 yds. dst. and ust. County Line Rd., Miami and Montgomery Co., Clay and Union Twp.
Latitude/Longitude	:	39°55'15"/84°24'15"
Width	:	3'-15'
Depth	:	1'-2'
Flow	:	Continuous
Stream Morphology	:	Channelized, but recovering; small riffles, defined pools, runs
Stream Order	:	II
Substrate	:	Gravel-sand; some silting near bridge, bottom covered by dark sludge in some pools
Aquatic Vegetation	:	Filamentous green algae sparse dst. bridge, non ust.
Canopy	:	10% dst. bridge, 90-100% ust. bridge.

Prevailing Land Use : Cropland, pasture lands

Station 3 (Mile Point 2.8)

General Location : 1.5 mi. SE of Laura, 70 yds. dst. and 20 yds. ust. Shiloh Rd., Miami Co., Union Twp.

Latitude/Longitude : 39°58'5"/84°23'30"

Width : 10'-40'

Depth : 1'-3'

Flow : Continuous

Stream Morphology : Good pool-riffle development; submerged logs, stumps , boulders

Stream Order : III

Substrate : Boulder-rubble-coarse gravel-sand; some silting near drainage tiles

Aquatic Vegetation : None evident

Canopy : 50-90%

Prevailing Land Use : Cropland, pasture lands

Station 4 (Mile Point 0.4)

General Location : 2.3 mi. NW of West Milton, 90 yds dst. and 10 yds. ust. Ellerman Rd., Miami Co., Union Twp.

Latitude/Longitude : 39°59'0"/84°22"0"

Width : 30'-60'

Depth : 1'-4'

Flow : Continuous

Stream Morphology : Excellent pool-riffle development; submerged logs, stumps, boulders, undercut banks

Stream Order : III

Substrate : Boulder-rubble-coarse gravel-sand; silting not evident

Aquatic Vegetation : Non evident

Canopy : 75%-90%

Prevailing Land Use : Cropland, pasture lands

Station 5 (Ludlow Creek; Mile Point 2.9)

General Location	:	2.4 mi. NW of West Milton, Ellerman Rd., Miami Co., Union Twp.
Latitude/Longitude	:	39°59'20"/84°22'0"
Width	:	30'-60'
Depth	:	1'-2'
Flow	:	Continuous
Stream Morphology	:	Good pool - riffle development, area sampled predominately riffles and runs
Stream Order	:	III
Substrate	:	Boulder, rubble, coarse gravel, sand, silting not evident
Aquatic Vegetation	:	None evident
Canopy	:	50%
Prevailing Land Use	:	Cropland

SUBBASIN REPORTS

1980 305(b) Report
Volume IV

Compiled by

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Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards
Columbus, Ohio 43216
April 1980

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INTRODUCTION

This volume of the 305(b) report describes existing water quality and evaluates the status of Ohio's surface waters with regard to the 1983 clean water goals established by the Clean Water Act of 1977. Additional information in this volume includes, wherever available: (a), projections of water quality conditions after implementation of pollution control programs; (b), an assessment of non-point source pollution problems (excluding cost estimates for implementation); (c), an evaluation of the effectiveness of existing pollution control programs.

The goal of the Act is commonly expressed as "fishable/swimmable waters" and was defined in the Act as "... water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water..."(Section 101(a)(2) of PL 95-217). The Act further stated that this goal be achieved, wherever attainable, by July 1, 1983. Fishable/swimmable waters are difficult to define in precise and practical terms. Therefore, water quality standards commonly serve as surrogates for the fishable/swimmable goal and are the enforceable components of the Act upon which many pollution abatement programs rest. States set water quality standards based on the criteria necessary to protect aquatic life and human health. Thus, compliance with water quality standards is one method of assessing progress towards attaining fishable/swimmable waters. However, it should not be the only measure of the condition of a water resource; a comprehensive evaluation encompassing both physical/chemical and biological data is a better determination of whether or not the fishable/swimmable goal of the Act is being achieved.

Evaluations of the attainment of the 1983 goals in this report were made primarily with information regarding compliance with physical/chemical water quality standards. Biological evaluations generally were not included, however, they will be an integral part of the 1982 305(b) report. For the purpose of this report, data were compared to Warmwater Habitat(WWH) water quality standards (Chapter 3745-1 of the Ohio Administrative Code) and violations were noted. A supplemental document (Reference Document 2 to the 1980 305(b) report) contains tabular listings of standards violations[1] recorded from July 1, 1977 through June 30, 1979. Ohio EPA water quality information predating July 1977 was frequently considered in the evaluation of the attainment of 1983 goals for stream segments where recent data were inadequate. On occasion, published and unpublished data from outside the Agency were also considered. These subbasin reports primarily contain narrative descriptions of water quality; all unpublished data were referenced as accurately as possible and are available from the Ohio EPA upon request.

Streams and stream segments were classified with respect to the attainment of 1983 clean water goals as follows:

1) streams and stream segments that currently meet 1983 goals,

---

[1] Violations data include all persistant toxicants, all heavy metals and priority pollutants, and all standards violations which impacted subbasin mainstems or which occurred in subbasin mainstems.

2) streams and stream segments that are expected to meet 1983 goals after implementation of pollution controls prior to 1983, and

3) streams and stream segments that are not expected to meet 1983 goals.

A large number of streams could not be evaluated because of insufficent data. Approximately nine percent of the 43,900[2] stream miles in Ohio have been evaluated in this report; however, 32 percent of the principal rivers and streams in Ohio[3] were evaluated. The quanity of data needed to make an evaluation was not standardized, but it consisted of at least four or more samples per year at one or more stations, in most cases. Segment delineation was usually based upon the location of sampling stations in relation to major point source dischargers and major tributary streams. Data were not extrapolated beyond significant point sources or major tributaries.

The subbasin reports were assembled by District Surveillance personnel of the Ohio EPA. Guidelines were provided for evaluating water quality and classifying streams with respect to the 1983 goals. However, a degree of subjectivity is inherent in the evaluations contained in this report. For example, if data revealed no standards violations in a stream segment the evaluation indicated that the segment currently meets 1983 goals. But when occassional[4] standards violations for parameters like iron, lead, and fecal coliforms occurred, the segment may or may not have been classified as meeting 1983 goals. This decision depended upon the interpretation of the District Surveillance groups as to the severity of the problem and whether or not actual fishable/swimmable uses were being impaired. Wherever frequent[5] standard violations occurred for any parameter, the stream was classified in a category other than currently meeting 1983 goals.

Each subbasin report contains a summary which assesses overall water quality and water quality problems. Delineated streams or stream segments that are expected to meet 1983 goals after the implementation of pollution controls prior to 1983, or that are not expected to meet 1983 goals by 1983, include the following information, wherever available: problem type, location, source (by point or non-point source category), severity, extent, corrective measures being taken, and conditions expected after the implementation of pollution controls. An evaluation of water quality trends were presented, wherever possible, along with recommendations.

---

2 Number of stream miles (excluding intermitent streams) listed in Gazetteer of Ohio Streams, (Division of Water, Ohio Department of Natural Resources).

3 Principal streams are all subbasin mainstems plus streams draining more than 100 square miles.

4 Occasionally - WWH standard(s) exceeded twice/year based upon a monthly sampling frequency; one/year based upon a quarterly sampling frequency; or 10% and 25% exceedence based upon some other sampling frequency (example - intensive survey sampling).

5 Frequently - WWH standard(s) exceeded three or more times/year based upon a monthly sampling frequency; twice or more/year based upon a quarterly sampling frequency; or 25% exceedence based upon some other sampling frequency (example - intensive survey sampling).

Summary

The evaluations with respect to the attainment of the fishable/swimmable goals in Ohio surface waters are summarized in Table IV-1. Two important conclusions can be drawn from these findings. First, data were not available for many streams, thus limiting the stream miles evaluated to 3758, or only 9 percent of the 43,900 stream miles in Ohio. Over 2700 stream miles were found to currently meet the fishable/swimmable goals, or are expected to achieve that goal prior to 1983. The small percentage of the total stream mileage actually evaluated and the non-representative method of selecting streams for evaluation (i.e., a bias towards selecting stream segments in problem areas) precludes any projection of the percentage of total stream miles in Ohio that will meet the 1983 clean water goals. Considerably more is known about the principal streams (32 percent of the 7086 miles of principal streams), reflecting the emphasis these areas receive in the Ohio Water Quality and Pollutant Source Monitoring Strategy (Monitoring Strategy). Of the principal streams evaluated, 1602 miles, or approximately 70 percent, were found to currently meet the fishable/swimmable goals, or are expected to achieve that goal prior to 1983. The substantial percentage of principal stream miles actually evaluated and the fact that the Monitoring Strategy primarily addresses known point source water quality problem areas suggests that 70 percent is a good estimate of the principal stream miles in Ohio that will meet the 1983 fishable/swimmable goal. It is important to point out that the degree of knowledge about the streams evaluated is quite variable and may not be sufficient in some cases to accurately assess water quality for other purposes. For example, the amount and kinds of information needed by Ohio EPA to determine water quality standard use designations in the future will probably be more extensive than the data utilized in some of the subbasin reports.

Table IV-1. Summary of the evaluations made in the 1980 305(b) subbasin reports.

Fishable/Swimmable Status	All Streams[a] miles (percent)	Principal streams[b] miles (percent)
Currently meets goals	2217 (5.0%)	1287 (18.2%)
Expected to meet goals prior to 1983	519 (1.2%)	315 (4.4%)
Not expected to meet goals prior to 1983	1022 (2.3%)	654 (9.2%)
Total evaluated	3758 (8.5%)	2256 (31.8%)

a Number of stream miles (excluding intermittent streams) listed in Gazetteer of Ohio Streams (Division of Water, Ohio DNR).

b Principal streams are all subbasin mainstems plus streams draining more than 100 square miles.

Secondly, the overall findings of the subbasin reports suggest that modifications to the Monitoring Strategy are in order. As described above, the fixed station network practically overlooks small streams, which are primarily evaluated with intensive surveys. Only 32 percent of the principal stream miles in Ohio have been evaluated with the fixed station network since 1972. It is clearly beyond the resources of the State to monitor all streams, but modifications to the present Monitoring Strategy and the development of computer software for data analyses could yield more information per sample analysis. A well designed sampling and data analysis program can provide useable information concerning existing ambient water quality and long term trends on a subbasin or regional basis without sampling every stream. Additional sampling in Ohio is needed to address the impact of watershed characteristics (i.e., land-use, soils, population density) on ambient water quality.[6] Such information can and will be obtained utilizing the fixed station network in conjunction with the intensive stream surveys and special non-point source monitoring. The reader is referred to Volume II of the 1980 305(b) report for details concerning the Monitoring Strategy.

The findings of several key subbasin reports with water quality problems are outlined below.

Ottawa River Subbasin. The Ottawa River below Lima is not expected to meet the fishable/swimmable goals prior to 1983 but recent studies revealed substantial improvements in water quality compared to 1960 conditions. Further improvement in the Ottawa River will be dependent on a reduction of the ammonia load entering the Ottawa River from the Standard Oil Refinery and the Vistron Corporation.

Cuyahoga River Subbasin. Analysis of water quality data from the Cuyahoga River revealed substantial improvements in dissolved oxygen concentrations over the past ten years. However, most of the Cuyahoga River and many of the major tributaries are not expected to achieve fishable/swimmable conditions prior to 1983. Water quality improvements are expected during the mid and late 1980's after completion of numerous pollution abatement projects that are under construction or in the design stages.

Great Miami Basin. A 95-mile stretch of the Great Miami River from Tipp City to the Ohio River is not expected to meet the 1983 clean water goals. The worst degradation exists between Dayton and Franklin where numerous municipal and industrial dischargers cause severe temperature and dissolved oxygen problems. Continued water quality problems are foreseen despite numerous wastewater treatment improvements under construction or planned.

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6 This need is demonstrated by numerous subbasin reports in this volume that suggest that elevated heavy metal concentrations (especially iron, also lead and cadmium) and high fecal coliform concentrations are attributable to widespread existing or natural background conditions. More specific data are clearly needed to fully understand these and similar problems.

Middle Scioto River Subbasin. Pollutant loading from the metropolitan Columbus area exceeds the assimilative capacity of the Scioto River, despite wastewater treatment improvements at several facilities. Warmwater Habitat (WWH) standards violations for dissolved oxygen, ammonia, fecal coliforms, and phenolics were observed. The diversion of upstream flows for public water supplies combined with the sheer volume of wastes generated in the metropolitan Columbus area will likely prevent the attainment of the 1983 clean water goals in the foreseeable future.

Upper and Middle Tuscarawas River Subbasin. The upper Tuscarawas River from the headwaters to below the Sandy Creek confluence is a very complex system. Over 290 point sources discharge to the river or its tributaries. The primary water quality problems in the Tuscarawas River mainstem are dissolved oxygen, ammonia, phenolics, and total dissolved solids. Improvements are expected in the Tuscarawas River above Barberton after completion of several pollution control projects. However, the river below Barberton is not expected to meet 1983 goals in the foreseeable future.

Mahoning River Subbasin. Urban and industrial land-use has a substantial impact on the water quality of the Mahoning River below the city of Warren. The sheer volume of wastewater generated combined with generally outdated wastewater treatment at municipal and industrial facilities creates a grossly polluted aquatic environment. Water quality improvements are anticipated following the termination of steel making operations at several plants in the Mahoning Valley, but 1983 clean water goals are not expected to be attainable within the foreseeable future.

The water quality problems discussed above result primarily from point source discharges and also urban non-point source runoff (including combined sewer overflows). Water quality degradation arising from mine drainage non-point pollution are prevalent in Southeast Ohio. Areas impacted by mine drainage include portions of the Hocking River Basin, the Raccoon Creek Basin, the Moxahala Creek Subbasin, and several minor Ohio River tributaries. The reader is referred to a separate document (Volume V of the 1980 305(b) report) compiled by the Industrial Coal Operations Group of the Ohio EPA for a detailed treatment of the mine drainage problem.

Little detailed information is available concerning the impact of agricultural non-point pollution on fishable/swimmable conditions in Ohio streams, although siltation, channelization, and riparian habitat alterations have had documented impacts on the fisheries of Ohio[7]. Intensive agricultural land-use exists in many areas of Ohio and potential water quality impacts were cited in subbasin reports from the Wabash, Maumee, Sandusky, Scioto, and Great Miami river basins. Impairment of the 1983 clean water goals was not attributed to agricultural non-point pollution in most instances. However, more comprehensive evaluations (i.e., encompassing in-depth physical/chemical and biological sampling) are needed to determine how intensive agricultural land-use affects fishable/swimmable conditions in many streams of northwestern and central Ohio.

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7 Trautman, M.B. 1957. The fishes of Ohio. Ohio Univ. Press, Columbus, Ohio. 683 p.

MAUMEE RIVER BASIN

ST. MARYS RIVER SUBBASIN (A-1)

SUBBASIN SUMMARY

The condition of the St. Marys River Subbasin is generally good, with the exception of Wirth Ditch and Kopp Creek below the village of New Bremen, and the St. Marys River below the village of Rockford. Approximately 15.7 stream miles in this subbasin are not expected to meet 1983 goals. Occasional, serious health hazards may exist due to inadequate sewage treatment (i.e. sewage bypasses during storm runoff events) at the two villages. Otherwise, there are no serious problems in the subbasin. Hopefully, new facilities will be constructed at New Bremen by 1983 and possibly at Rockford by 1984-85.

STREAMS AND/OR SEGMENTS IN THE ST. MARYS RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-1-5	Center Branch From the headwaters to Clear Creek (East Branch)	6.4 - 0.0

Evaluation based upon Ohio EPA, NWDO data, 1978-1979.

STREAMS AND/OR SEGMENTS IN THE ST. MARYS RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
A-1-2	St. Marys River From St. Marys to Rockford	45.2 - 15.7

Fecal coliform and iron Warmwater Habitat violations occur in this segment (OEPA, NWDO data, 1978-1979). The coliform contamination can be attributed to both the St. Marys and New Bremen Wastewater Treatment Plants (WWTP), which should be significantly improved prior to 1983. The iron violations appear to be from non-point sources.

Segment	Name/Description	Mile Points
A-1-3	St. Marys River From the confluence of Kopp Creek to the village of St. Marys	47.7 - 45.2
A-1-4	Kopp Creek From the Wirth Ditch confluence to the St. Marys River	7.2 - 0.0

These segments are subject to fecal coliform and dissolved oxygen violations as a result of inadequately treated wastes from the New Bremen WWTP (OEPA, NWDO data, 1978-1979). This plant will be abandoned, and a new facility will be completed prior to 1983.

STREAMS AND/OR SEGMENTS IN THE ST. MARYS RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-1-1	St. Marys River From Rockford to the Indiana-Ohio State Line	15.7 - 0.0

An ineffective, primary sewage treatment facility, serving the village of Rockford (population 1100), causes frequent fecal coliform violations in this river segment (OEPA, NWDO data, 1978-1979). In September and October, 1979, a lift station breakdown caused raw sewage from the village to be discharged into the river. The 1983 goals will probably not be met for this segment because of the potential health hazard posed by inadequate and unreliable sewage treatment at the Rockford WWTP. The village of Rockford has not been certified for Step I planning, and it is unlikely than any improvements in the sewage treatment facility will be completed by 1983.

REFERENCES

Ohio Environmental Protection Agency. 1978-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

LITTLE AUGLAIZE RIVER SUBBASIN (A-2)

SUBBASIN SUMMARY

The Little Auglaize River water quality is good, and appears to meet the 1983 goals. Only one grab sample was collected in 1978; no samples were collected in 1979. However, a number of samples were collected in 1976 and in 1977 with no violations being noted (OEPA, NWDO data, 1976-1977). The Little Auglaize River has a slightly lower total nitrogen content than surrounding river basins.

The absence of recent information for Town Creek prohibits an accurate evaluation of the water quality, although observations indicate that the upper portions of Town Creek are adversely effected by a municipal discharge. Approximately 5.1 stream miles in the Town Creek drainage are not expected to meet 1983 goals. Additional sampling is necessary to adequately evaluate this segment.

STREAMS AND/OR SEGMENTS IN THE LITTLE AUGLAIZE RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-2-1	Little Auglaize River From Prairie Ditch to the Auglaize River	37.0 - 0.0
A-2-2	Middle Creek From Town Creek to the Little Auglaize River	6.9 - 0.0

Evaluation based upon Ohio EPA, NWDO data, 1976-1978.

STREAMS AND/OR SEGMENTS IN THE LITTLE AUGLAIZE RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

No segments fall into this category. However, there is insufficient data for portions of the subbasin.

STREAMS AND/OR SEGMENTS IN THE LITTLE AUGLAIZE RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-2-4	Town Creek From Van Wert to Middle Creek	5.1 - 0.0

The Van Wert Wastewater Treatment Plant (WWTP) has tertiary treatment and phosphorus removal; local industries are in compliance with NPDES permits. The municipal effluent is very large in proportion to stream flow and results in dissolved oxygen (D.O.) problems and a degraded aquatic community in this stream segment (OEPA, NWDO data, 1977-1978).

The Van Wert WWTP improvements have substantially improved water quality in the downstream reaches of Middle Creek and the Little Auglaize River. However, the segment of Town Creek downstream from Van Wert will continue to experience water quality problems, and is not expected to meet 1983 goals.

REFERENCES

Ohio Environmental Protection Agency. 1976-1978 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

UPPER AUGLAIZE RIVER SUBBASIN (A-3)
AND
LOWER AUGLAIZE RIVER SUBBASIN (A-7)

SUBBASIN SUMMARY

The main stem of the Auglaize River generally meets water quality standards based on 1978-79 data collected by the Ohio EPA. An exception is an eleven mile segment which extends from about 5 miles below Wapakoneta to just above the city. However, it is hoped that construction of wastewater treatment improvements will be completed prior to 1983. Segments not expected to meet the target date include Six Mile Creek below Spencerville and Jennings Creek below Delphos.

The primary non-point source problem in the Auglaize River Basin is sediment. This aspect is discussed in detail in the general statement for the Maumee Basin.

STREAMS AND/OR SEGMENTS IN THE AUGLAIZE RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-7-1	Auglaize River From the Blanchard River confluence to the Maumee River	26.0 - 0.0
A-3-2	Auglaize River From the Ottawa River confluence to the Blanchard River confluence	32.0 - 26.0
A-3-3	Auglaize River From Fisher Road to the Ottawa River confluence	73.8 - 32.0
A-3-5	Auglaize River From the headwaters to Hengstler Road	101.9 - 85.2
A-3-8	Pusheta Creek From the headwaters to the Augliaze River	13.7 - 0.0

The above segments meet 1983 goals based upon Ohio EPA sampling during 1978 and 1979 (OEPA, NWDO data, 1978-1979).

STREAMS AND/OR SEGMENTS IN THE AUGLAIZE RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
A-3-4	Auglaize River From Hengstler Rd. to Fisher Road	73.8 - 85.2

Violations in this segment included fecal coliforms, dissolved oxygen (D.O.), ammonia and occasional heavy metals (OEPA, NWDO data, 1977). The violations resulted from combined sewer overflows and inadequately treated wastewater from the city of Wapakoneta. Detail plans are under preparation for treatment plant and collection system improvements that should be completed by 1983. Also, the city is conducting an industrial waste and pretreatment program that should control the heavy metal violations.

STREAMS AND/OR SEGMENTS IN THE AUGLAIZE RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-3-6	Six Mile Creek From Spencerville to the Auglaize River	3.6 - 0.0

The violations noted have been for ammonia, and chromium (OEPA, NWDO data, 1976). Very high concentrations of phosphorus have also been observed. The source is presumed to be storm water runoff from a fertilizer supply plant which is still operating in much the same manner as 1976.

Segment	Name/Description	Mile Points
A-3-7	Jennings Creek From the Delphos WWTP to the Auglaize River	4.5 - 0.0

Violations occurred for fecal coliforms, ammonia and dissolved oxygen (OEPA, 1974). The source of the problem is inadequate sewage treatment at the city of Delphos Wastewater Treatment Plant. It does not appear that new facilities will be constructed before 1983.

REFERENCES

Ohio Environmental Protection Agency. 1974. Auglaize River (draft) waste load allocation report for the 303(e) continuing planning process for water quality management. Ohio EPA, Northwest District Office, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1976-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

OTTAWA RIVER SUBBASIN (A-4)

SUBBASIN SUMMARY

A water quality study of the Ottawa River was conducted by the Ohio Environmental Protection Agency between 1974 and 1977 (Martin et al., 1979). The existing biological and chemical quality of the Ottawa River was evaluated in order to assess the impact of improvements in wastewater treatment from the city of Lima and industrial discharges located in Lima. The study area included a 45 mile segment of the Ottawa River from above Lima to the mouth, as well as a segment of the Auglaize River upstream and downstream from the mouth of the Ottawa.

Approximately 39.5 stream miles in this subbasin are not expected to meet 1983 goals. The data show that the Ottawa River was biologically healthy and water quality was good upstream from Lima at river mile 46.0. Fish and macroinvertebrate communities were degraded from just above the Lima Sewage Treatment Plant (STP) (RM 37.7) to river mile 7.9. The water quality in this section was poor due to a variety of causes. Water quality was fair and the river had recovered to a near healthy biological condition near the mouth of the Ottawa River (RM 1.0). The water quality of the Auglaize River upstream and downstream of the Ottawa River was good, as indicated by healthy and well-balanced, benthic macroinvertebrate communities.

The most severe water quality problems found during the study were: low dissolved oxygen (D.O.) concentrations above the Lima STP due to combined sewer overflows and a series of dams in Lima; chlorine toxicity problems immediately downstream from the Lima STP; and high ammonia and chromium concentrations coupled with low dissolved oxygen concentrations downstream from an oil refinery and a petro-chemical plant in Lima. The most severely polluted stretch of the Ottawa River was from river mile 36.8 to the Allentown Dam (RM 28.8). Fish populations were essentially devoid from this segment of the river; only two pollution tolerant species were collected.

Despite the severe water quality problems documented, a dramatic improvement in the chemical and biological quality of the Ottawa River below Lima has occurred since 1960. In 1960, fish were absent from the entire Ottawa River downstream from Lima, as well as in a portion of the Auglaize River downstream from its confluence with the Ottawa. Continued improvement was observed between 1974 and 1977, as a result of large scale improvements in the Lima STP and industrial dischargers in Lima. Further improvement will be largely dependent on a reduction of the ammonia load entering the Ottawa River from the Standard Oil Refinery and Vistron Corporation.

STREAMS AND/OR SEGMENTS IN THE OTTAWA RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-4-1	Ottawa River From Putnam County Road 19 to the Auglaize River	1.0 - 0.0

A-4-2	Ottawa River From the Hog Creek confluence to just above Lima	47.5 - 40.5
A-4-5	Hog Creek From the headwaters to the Ottawa River	14.2 - 0
A-4-7	Sugar Creek From the Ford Motor Corp. to the Ottawa River	18.7 - 0

The above evaluations based upon Martin et al., 1979; OEPA, 1976; and OEPA, NWDO data, 1977-1979.

STREAMS AND/OR SEGMENTS IN THE OTTAWA RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
A-4-6	Little Ottawa River From the Cridersville WWTP to the Ottawa River	4.2 - 0.0

This segment is degraded by effluent from the inadequate wastewater treatment facilities at the village of Cridersville. Violations found in this segment include dissolved oxygen (D.O.) and fecal coliforms (OEPA, NWDO data, 1977-1979). Construction of new facilities should begin in 1980 and should be completed by 1983.

Segment	Name/Description	Mile Points
A-4-8	Plum Creek From the Columbus Grove WWTP to the Ottawa River	10.7 - 0

This segment is degraded by overflows from the Columbus Grove Collection System, even though the wastewater treatment plant produces and excellent effluent (OEPA, NWDO monthly operating reports, 1979). It is possible that improvements can be completed prior to 1983.

STREAMS AND/OR SEGMENTS IN THE OTTAWA RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-4-3	Ottawa River From the Vistron Corp. to Putnam County Road 19	36.8 - 1.0

This segment has significant violations for ammonia, D.O., MBAS, chromium and phenolics, which are primarily attributable to the Vistron Corporation and the Standard Oil Company (Martin, et al., 1979). The city of Lima STP also

discharges into this segment. Wastewater treatment improvements have recently been made (Table IV-1) but further upgrading of these facilities is not expected prior to 1983.

Table IV-2. Percentage reduction of pollutants discharged by major point sources on the Ottawa River from 1975 to 1977[a].

		Lima WWTP	Vistron Corporation	Standard Oil Refinery
BOD_5	lbs/day	+78	+47	+48
Ammonia NH_3-N	lbs/day	+81	0	-22
Total Chromium	lbs/day	NA[b]	+95	NA[b]

a Refer to Martin et al., 1979 for a more detailed analysis.
b Not applicable

Segment	Name/Description	Mile Points
A-4-4	Ottawa River From just above Lima to the Vistron Corp.	40.5 - 36.8

Dissolved oxygen (D.O.) violations occur in this segment of the Ottawa River (Martin, et al., 1979). Large diurnal fluctuations in D.O. probably result from high nutrient and organic matter loadings from combined sewer overflows (CSO) coupled with the activities of planktonic algal populations. A series of low head dams along this stream segment create favorable conditions for planktonic algal blooms, especially during low-flow periods. A program allowing for the controlled release of CSO discharge is underway in Lima; follow up is needed to assess the impact on water quality.

REFERENCES

Martin, G.L., T.J. Balduf, D.O. McIntyre, and J.P. Abrams. 1979. Water quality study of the Ottawa River, Allen and Putnam counties, Ohio. Ohio Environmental Protection Agency, Office of Wastewater Pollution Control, Division of Surveillance. 35 pp.

Ohio Environmental Protection Agency. 1976 (unpublished). Draft 305(b) report available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

BLANCHARD RIVER SUBBASIN (A-5 and A-6)

SUBBASIN SUMMARY

Land-use in the Blanchard River Subbasin is predominantly agricultural and water quality is generally good (OEPA, 1974). Approximately 23.4 stream miles in this subbasin are not expected to meet 1983 goals. A 14 mile segment of the Blanchard River fails to meet water quality standards for dissolved oxygen and ammonia due to sewage bypasses and insufficient treatment at the Findlay Wastewater Treatment Plant (WWTP). Oil Ditch, a small stream traversing an industrial area of Findlay, is seriously affected by various industrial discharges causing dissolved oxygen and metals violations. Shallow Run, a small stream draining the village of Dunkirk, is affected by septic tank effluent, causing dissolved oxygen problems. These three segments are not expected to meet 1983 goals in the foreseeable future.

STREAMS AND/OR SEGMENTS IN THE BLANCHARD RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-5-1	Blanchard River From the Ottawa Creek confluence to the Auglaize River	42.2 - 0.0
A-6-3	Blanchard River From the headwaters to the Eagle Creek confluence	91.0 - 56.5
A-5-4	Riley Creek From Felt Road to the Blanchard River	11.4 - 0.0
A-5-6	Riley Creek From the headwaters to Bluffton	22.2 - 14.0

Evaluation of segment 1 based upon current information (OEPA NWDO data, 1977-1979). Segments 3, 4 and 6 were evaluated in a previous report (OEPA, 1974).

STREAMS AND/OR SEGMENTS IN THE BLANCHARD RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
A-5-5	Riley Creek From Bluffton to Felt Road	14.0 - 11.4

This section is affected by the Bluffton WWTP and collection system. Dissolved oxygen violations below the Bluffton WWTP have been noted during field surveys (OEPA, NWDO data, 1978). Proposed improvements to the Bluffton system should allow this segment to meet the 1983 goals.

STREAMS AND/OR SEGMENTS IN THE BLANCHARD RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-6-2	Blanchard River From the Eagle Creek confluence to the Ottawa Creek confluence	56.5 - 42.2

This segment is subject to dissolved oxygen, fecal coliform and ammonia violations from combined sewer overflows and bypasses of the Findlay WWTP. It is unlikely that improvements will occur before 1983, although a facility plan is being written. A detailed study on the effects of the Findlay WWTP and collection system on the Blanchard River was conducted between 1975 and 1977 (Balduf and Martin, 1978).

Segment	Name/Description	Mile Points
A-6-7	Oil Ditch From the source to the Blanchard River	4.0 - 0

Oil Ditch originates at a catch basin which has six storm and sanitary sewer connections. Samples taken in 1976 from two of these connections indicated extremely high levels of copper, zinc, lead, iron, cadmium, aluminum, MBAS, phenolics, oil/grease, COD, and BOD_5 (OEPA, NWDO data, 1976). The ditch was extremely polluted by several industrial dischargers downstream of this catch basin. The only aquatic life observed was sewage fungus.

Samples taken during a 1975 water quality survey of the Blanchard River indicated dissolved oxygen and fecal coliform violations at the mouth of Oil Ditch (OEPA, NWDO data, 1975). This survey also indicated that Oil Ditch exerts a mildly toxic effect upon the macroinvertebrates in the Blanchard River.

Segment	Name/Description	Mile Points
A-6-8	Shallow Run From Dunkirk to the Blanchard River	5.2 - 0

A biological investigation of Shallow Run, a small tributary to the Blanchard River, was conducted in 1976 (Martin, 1976). The stream was found to be grossly polluted between U.S. Route 68 and S.R. 81; septic tank wastes from the village of Dunkirk caused the degradation. Bacteriological measurements averaged greater than 10,000/100ml, and were frequently much higher. The average BOD_5 was found to be greater than 42 mg/l, and the average dissolved

oxygen was 3.3 mg/l. The stream bottom at U.S. Route 68 was covered with blue-green algae and sewage fungus. A layer of black sludge several inches deep was found beneath this growth. The stream showed some recovery at S.R. 81, exhibiting pollution-tolerant macroinvertebrates and profuse growths of algae. The impact of this organic pollution on the Blanchard River appeared to be minimal.

REFERENCES

Balduf, T., and G. Martin. 1978 (unpublished). An assessment of the water quality in the Blanchard River with emphasis on the effects of the Findlay Sewage Treatment Plant, Hancock County, Ohio. Ohio Environmental Protection Agency, Northwest District Office, Bowling Green, Ohio. mimeo. 48 pp.

Martin, G.L. 1976 (unpublished). Biological investigation of Shallow Run, Dunkirk (Hardin County). Ohio Environmental Protection Agency, Northwest District Office, Bowling Green, Ohio. mimeo. 2 pp.

Ohio Environmental Protection Agency. 1974 (unpublished). Draft 305(b) report. Available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1975-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

UPPER MAUMEE RIVER SUBBASIN (A-7)

AND MIDDLE MAUMEE RIVER SUBBASIN (A-10)

SUBBASIN SUMMARY

The Maumee River from the Indiana State Line to just above Napoleon, Ohio, generally meets Warmwater Habitat (WWH) standards. This segment has relatively high BOD, nutrient, and dissolved solids concentrations. Fecal coliform levels have improved in recent years and are now generally below 1000/100 ml. The somewhat higher BOD and nutrient levels at the Antwerp sampling station (RM 100.3; STORET station No. 500140) reflect the impact of the Fort Wayne, Indiana, metropolitan area. All evaluations were based on current data (OEPA, NWDO data, 1977-1979).

Flat Rock Creek may meet WWH standards, since the only two municipalities located on this segment have waste stabilization ponds. These ponds are liberally sized and produce a good quality effluent. Additional sampling is necessary to adequately evaluate this segment.

See the Lower Auglaize River Subbasin report (A-7) for the evaluation of the Auglaize River.

STREAMS AND/OR SEGMENTS IN THE UPPER AND MIDDLE MAUMEE RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-7-2	Upper Maumee River Indiana State Line to Defiance	107.0 - 60.4
A-10-3	Upper Maumee River From Defiance to Napoleon	60.4 - 45.0
A-7-4	Flat Rock Creek From the Indiana Line to the Auglaize River	35.0 - 0.0

STREAMS AND/OR SEGMENTS IN THE UPPER AND MIDDLE MAUMEE RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE UPPER AND MIDDLE MAUMEE RIVER SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in these subbasins presently fall into these categories, however, the water quality in a portion of these subbasins has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

TIFFIN RIVER SUBBASIN (A-8)

SUBBASIN SUMMARY

The water quality in the Tiffin River Subbasin is generally good and should meet the 1983 goals. In previous years routine samples were collected at four (4) sampling stations (STORET station Nos. 500160, 500300, 500330, 500340) on the Tiffin River and in Bean Creek (OEPA, NWDO data, 1974-1978). These stations have not been sampled by the Ohio EPA since mid-1978, but present water quality conditions are probably similar to those reported previously. Those sample results were characterized by a high dissolved oxygen (D.O.) and a low biochemical oxygen demand (BOD) in 20 per cent of the samples, mainly during high water conditions. The nutrient level was slightly lower than in most of the other Maumee River Subbasins. Also, the water quality appeared to be somewhat degraded in the immediate area of Defiance, although not to an extent that would impair 1983 goals. No analytical data are available on water quality in the tributaries to the Tiffin River, other than for Bean Creek. However, indications are that the quality is satisfactory in most tributaries.

STREAMS AND/OR SEGMENTS IN THE TIFFIN RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-8-1	Tiffin River From the Bean Creek confluence to the Maumee River	49.9 - 0.0
A-8-2	Bean Creek From the Michigan State Line to the Tiffin River	9.4 - 0.0

STREAMS AND/OR SEGMENTS IN THE TIFFIN RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE TIFFIN RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in a portion of this subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1974-1978 (unpublished). Data available from Northwest District Office, OHiuo EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

ST. JOSEPH RIVER SUBBASIN (A-9)

SUBBASIN SUMMARY

The St. Joseph River currently meets the 1983 goals, although fecal coliform and total iron concentrations are near the upper limits of the Warmwater Habitat (WWH) standards (OEPA, 1975a). A field survey revealed a high diversity of macroinvertebrates and good water quality at three locations above and below the city of Edgerton (OEPA, 1975b).

STREAMS AND/OR SEGMENTS IN THE ST. JOSEPH RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-9-1	St. Joseph River From the confluence with the West Branch to below Egerton	70.3 - 41.6
A-9-2	St. Joseph River From below Edgerton to the Ohio-Indiana Line	41.6 - 33.6

STREAMS AND/OR SEGMENTS IN THE ST. JOSEPH RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE ST. JOSEPH RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in a portion of this subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1975a (unpublished). Draft 305(b) report available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1975b (unpublished). Stream survey - St. Joseph River. Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MAUMEE RIVER BASIN

LOWER MAUMEE RIVER SUBBASIN (A-11)

SUBBASIN SUMMARY

Approximately 14.1 stream miles in the Lower Maumee River Subbasin are not expected to meet 1983 goals. The segment between Napoleon, Ohio, and the Interstate 75 Bridge generally meets Warmwater Habitat (WWH) standards. This segment has slightly lower BOD and nutrient concentrations when compared to the upstream segments. Fecal coliform violations may occur as a result of combined sewer overflows caused by significant rainfall events. No WWH violations have been detected during periods of low water levels. The section of the Maumee River below the Interstate 75 Bridge is in the Maumee Estuary and frequent dissolved oxygen (D.O.) and fecal coliform violations have been noted in previous years.

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-11-1	Lower Maumee River From Napoleon to the Maumee-Perrysburg Bridge	45.0 - 14.1

Evaluation based upon monitoring at Waterville (RM 20.8; STORET station No. 500080)(OEPA, NWDO data, 1977-1979).

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFRER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-11-2	Lower Maumee River Estuary reach	14.1 - 0

Frequent WWH violations for D.O. and fecal coliforms occur in the Maumee River Estuary (Toledo-Lucas County Port Authority, 1974). Due to the nature of the estuary, extended periods with no outflow occur. Organic materials accumulate near and on the river bottom during these periods, because of the poor mixing

of the water column. Thus, water quality problems (i.e. D.O. violations) in the estuary are most severe in the lower 2 feet of the water column. A number of municipal waste water treatment plants (WWTP) discharge into this estuary including: the Lucas Co. WWTP (just upstream @ RM 18.3), the Perrysburg WWTP (via Grassy Creek @ RM 9.5), and the Toledo WWTP (@ RM 0.5). Combined sewer overflows from Toledo, via Swan Creek (RM 5.0), also empty into this segment.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Toledo-Lucas County Port Authority/W.W. Knight Foundation. 1974. The Maumee Bay environmental quality study - final report.

MAUMEE RIVER BASIN

LOWER MAUMEE RIVER SUBBASIN AND

TEN MILE CREEK SUBBASIN (A-12)

SUBBASIN SUMMARY

The upstream reach of the Ottawa River above Secor Road (RM 11.3) has greatly improved since the Sylvania Wastewater Treatment Plant (WWTP) was abandoned, and sewage flow was diverted to the Maumee River WWTP. Similar improvements have been observed in Ten Mile Creek. Although no sampling has been performed since 1975, the segment above Secor Road is now assumed to meet 1983 goals. The lower section of the Ottawa River is expected to meet 1983 goals upon completion of the various phases of the Ten Mile Creek Relief Sewer Project.

Approximately 14.0 stream miles in this subbasin are not expected to meet 1983 goals. The upper reaches of Swan Creek appear to meet 1983 goals, while the lower section, particularly the segment through Toledo, is not expected to attain 1983 goals.

Since recent sampling data is lacking, judgements are being made on the basis of earlier data and recent field observations, along with the knowledge of completed facility improvements, or facility improvements under construction.

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE RIVER-TEN MILE CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-12-1	Ten Mile Creek Secor Road to the Fulton Co. Line	34.6 - 11.9
A-12-4	Swan Creek From the Ohio Turnpike to U.S. Route 475	40.2 - 14.0

Evaluation of segment 1 based on Jones and Henry, 1977.
Evaluation of segment 2 based upon the Toledo Area River and Stream Reports, 1968-1974.

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE RIVER-TEN MILE CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
A-12-2	Ottawa River - Ten Mile Creek From Secor Rd. to North Maumee Bay	11.9 - 0.0

Current Warmwater Habitat (WWH) violations for this segment include dissolved oxygen (D.O.) and fecal coliforms. These problems should be eliminated upon completion of the Ten Mile Creek Relief Sewer Project, parts of which are under contract and/or construction (Jones and Henry, 1977).

STREAMS AND/OR SEGMENTS IN THE LOWER MAUMEE RIVER-TEN MILE CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
A-12-3	Swan Creek U.S. Route 475 to the Maumee River	14.0 - 0.0

Dissolved oxygen and fecal coliform WWH violations occur in the upper section of Swan Creek (above Reynolds Road - RM 10.5) due to septic tank discharges and small public or commercial treatment facilities (Jones and Henry, 1977). The section of Swan Creek below Reynolds Road is subject to periodic combined sewer overflows which contributes to the D.O. and fecal coliform violations in this segment. A timetable for the correction of these problems has not been determined at this time.

REFERENCES

Jones and Henry Engineers. 1977. Ten Mile Creek facilities plan. Prepared for the city of Toledo. Jones and Henry Engineers, Limited, Toledo, Ohio.

Toledo Area River and Stream Water Quality Data Reports. 1968-1974. Toledo Pollution Control Agency, Toledo, Ohio.

PORTAGE RIVER BASIN

UPPER PORTAGE RIVER SUBBASIN (B-1) AND LOWER PORTAGE RIVER SUBBASIN (B-2)

SUBBASIN SUMMARY

Water quality in the Portage River Subbasin is only fair, being affected in the upper reaches by point source discharges from the cities of Bowling Green (North Branch) and Fostoria (East Branch). Sediment loading from non-point sources is substantial during runoff events. Approximately 13.6 stream miles in this basin are not expected to meet 1983 goals. The two segments involved are low-flow streams and are degraded by sewage, which results in Warmwater Habitat (WWH) standards violations for dissolved oxygen (D.O.), ammonia, and fecal coliforms. In addition, WWH standards violations for copper and lead occur.

STREAMS AND/OR SEGMENTS IN THE UPPER AND LOWER PORTAGE RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
B-1-4	North Branch From the source to the Poe Ditch confluence	20.0 - 8.5
B-1-5	Middle Branch From the Rader Creek confluence to the South Branch	15.7 - 0.0
B-1-6	South Branch From the East Branch confluence to the Portage River	45.9 - 33.2
B-2-10	Sugar Creek From the source to the Portage River	17.8 - 0.0

Evaluations of the above stream segments based upon previous 303(e) reports (OEPA, 1975).

STREAMS AND/OR SEGMENTS IN THE UPPER AND LOWER PORTAGE RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
B-2-1	Portage River From Woodville to the beginning of the estuary	28.2 - 15.7

This segment of the Portage River currently violates Warmwater Habitat (WWH) standards for fecal coliforms, dissolved oxygen (D.O.) and total iron (RM 28.2; STORET station No. 500510) (OEPA, NWDO data, 1977-1979). The fecal coliform and D.O. violations are caused by the discharge from the city of Bowling Green's Wastewater Treatment Plant (WWTP). A construction grant has been awarded to Bowling Green, and it is probable that new facilities will be in operation prior to 1983. After the facility becomes operational, this section will meet WWH standards for all water quality parameters with the exception of total iron. Total iron will continue to exceed WWH standards due to background conditions and/or coal pile leachate from cement and lime plants in the Woodville area. A policy currently under development by Ohio EPA, Industrial Wastewater Division, should lead to the elimination of iron violations from coal pile leachate by 1983.

Segment	Name/Description	Mile Points
B-1-2	Portage River From the North Branch confluence to Woodville	33.2 - 28.2

This section is even more directly affected by the Bowling Green WWTP than segment B-2-1 (OEPA, 1975). In addition to D.O. and fecal coliform violations, there have been several ammonia violations. All of these violations should be eliminated by the construction of the Bowling Green (WWTP). Occassional iron violations slightly in excess of 1 mg/l occur, but these violations should be eliminated by 1983 through industrial control measures. A natural total iron concentration of approximately 0.5 mg/l appears to exist throughout the Portage River Basin.

Segment	Name/Description	Mile Points
B-1-3	North Branch From Poe Ditch to the Portage River	8.5 - 0.0

This section is a relatively low-flow stream with the predominance of flow originating from the Bowling Green WWTP during dry weather. Violations occur for D.O., fecal coliforms and ammonia, all of which are attributable to the Bowling Green WWTP (OEPA, 1975). A high degree of treatment is planned for the Bowling Green Wastewater Treatment Plant, including nitrification and filtration, and it is anticipated that this segment will meet the 1983 goals.

Segment	Name/Description	Mile Points
B-1-7	East Branch From Eagleville Road to the South Branch	7.4 - 0.0

There are minor D.O. and metals (copper and lead) violations in this segment due to inadequate treatment at the Fostoria Wastewater Treatment Plant (Balduf and Martin, 1977). Current facility planning is nearing completion and it is

assumed that the wastewater treatment plant construction will be completed by 1983. The completion of new facilities, along with the enforcement of required pretreatment regulations, should result in compliance with the 1983 goals.

STREAMS AND/OR SEGMENTS IN THE UPPER AND LOWER PORTAGE RIVER SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
B-1-8	Portage East Branch From Eagleville Rd. to the Fostoria WWTP	11.4 - 7.4

This section is severly degraded by the discharge from the Fostoria Wastewater Treatment Plant with D.O., ammonia, fecal coliform and metals (copper and lead) WWH standards being violated (OEPA, 1977). This is a zero flow stream above the Fostoria Sewage Treatment Plant and it is doubtful that U.S. EPA will fund the degree of treatment required to meet 1983 goals. The downstream effect is estimated to occur for approximately 4 miles.

Segment	Name/Description	Mile Points
B-1-9	Rocky Ford Creek From the Source to the Middle Branch	9.6 - 0.0

The flow in this section is low during dry weather and is severely impacted by residential systems in the village of Cygnet and a relatively poor municipal sewage treatment plant in the village of North Baltimore. Frequent D.O., ammonia and fecal coliform violations occur (OEPA, 1975). It is unlikely that any WWTP improvements that would improve water quality will be completed prior to 1983.

RECOMMENDATION

Water quality should be assessed in the Portage River Estuary.

REFERENCES

Balduf, T.J., and Martin, G.L. 1977 (unpublished). Water quality survey of the East Branch of the Portage River. Available from the Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1975. 303(e) report - modified waste load allocation report for the Portage River Basin. Available from the Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

SANDUSKY RIVER BASIN

TYMOCHTEE CREEK (C-1) AND SANDUSKY RIVER - (UPPER (C-2),

MIDDLE (C-3) AND LOWER (C-4) PORTIONS)

SUBBASINS

BASIN SUMMARY

The overall water quality of the Sandusky River Basin is fair to good. The major water quality problems are: high nutrient concentrations and transport, a heavy suspended solids load, high turbidity, excessive diurnal dissolved oxygen fluctuations associated with occasional, nuisance algal blooms, and high fecal coliform bacterial levels in many portions of the basin.

Approximately 71.9 stream miles in this basin are not expected to meet 1983 goals. The water quality problems are primarily the result of non-point source pollution and the inadequate treatment of municipal wastes. Combined sewer overflows and agricultural runoff are the major non-point source problems within the basin.

Many areas of the Sandusky River Basin are unsuitable for primary contact recreation at certain times because of high levels of fecal coliform bacteria. However, most areas sampled in the Sandusky River Basin appear to have water quality capable of supporting a diverse community of warm water fish.

STREAMS AND/OR SEGMENTS IN THE SANDUSKY RIVER BASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
C-4-2	Sandusky River From below Upper Sandusky to Fremont	78.7 - 15.4
C-4-4	Muskellunge Creek From the headwaters to the Sandusky River	18.3 - 0.0
C-4-5	Green Creek From the headwaters to the Sandusky River	15.0 - 0.0
C-4-6a	East Branch of Wolf Creek From the headwaters to Wolf Creek	19.5 - 0.0
C-4-6b	Wolf Creek From the headwaters to Bettsville	20.5 - 5.5

C-3-7	Honey Creek From the headwaters to the Sandusky River	27.0 - 0.0
C-1-8	Tymochtee Creek From the headwaters to the Sandusky River	52.5 - 0.0
C-2-10	Broken Sword Creek From the Red Run confluence to the Sandusky River	27.8 - 0.0

Evaluation of segments 4, 5, 6a, 6b, 7, 8, and 10 based upon OEPA, 1974.
Evaluation of segment 2 based upon OEPA, NWDO data, 1977, 1978, 1979.

STREAMS AND/OR SEGMENTS IN THE SANDUSKY RIVER BASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this basin presently fall into this category. However, water quality in a portion of this basin has not been determined.

STREAMS AND/OR SEGMENTS IN THE SANDUSKY RIVER BASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
C-4-1	Sandusky River From the S.R. 5 Bridge at Fremont to Lake Erie	15.4 - 0.0

This estuary region of the Sandusky River is subject to dissolved oxygen (D.O.) violations which generally occur between June and mid-November. Warmwater Habitat (WWH) violations for fecal coliforms and iron also occur (OEPA, NWDO, 1977-1979). The probable sources for both the D.O. and fecal coliform violations are the Fremont Wastewater Treatment Plant (WWTP) and combined sewer overflows from the city of Fremont. Although some improvement may be realized through operational modifications at the WWTP and some separation of sewers in Fremont, it is doubtful that significant improvements will occur before 1983. Also, nutrient enrichment from upstream sources will continue to be sufficient to create algal "blooms" and subsequent diurnal D.O. fluctuations in the often sluggish estuary region. The iron violations are only slightly above the 1 mg/l WWH limit and, due to the relatively high pH, are not considered toxic to aquatic life. Relatively high iron levels occur naturally throughout the basin as a result of ground water discharge.

Segment	Name/Description	Mile Points
C-2-3	Sandusky River From the headwaters to below the city of Upper Sandusky	130.2 - 78.7

Dissolved oxygen and fecal coliform violations occur in this segment (OEPA, NWDO data, 1977-1979). The dissolved oxygen violations below Upper Sandusky probably arise both from diurnal fluctuations due to algal "blooms", and from combined sewer overflows in Crestline, Bucyrus and Upper Sandusky. High algal populations result from a combination of non-point source and municipal nutrient input together with favorable growth conditions. The fecal coliform violations are caused primarily by combined sewer overflows. There are no programs in the three municipalities which will lead to the construction of sewers, or sewage treatment improvements, prior to 1983.

Segment	Name/Description	Mile Points
C-4-6	Wolf Creek From Bettsville to the Sandusky River	5.5 - 0.0

This section is subject to D.O. and fecal coliform violations resulting from septic tank discharges in the village of Bettsville, which has no central treatment facilities (OEPA, 1974a). It is unlikely that Bettsville will be sewered prior to 1983.

REFERENCES

Ohio Environmental Protection Agency. 1974 (unpublished). Draft 305(b) report available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1975. State of Ohio, Sandusky River Basin, modified 303(e) report. Ohio EPA, Columbus, Ohio. 201 pp.

HURON, VERMILION, BLACK, AND ROCKY RIVER BASIN

HURON RIVER SUBBASIN (D-2)

SUBBASIN SUMMARY

The Huron River is one of the highest quality streams in Northwest Ohio. Overall water quality is good, although high nutrient concentrations and violations of the fecal coliform standard are common throughout the subbasin. The fecal contamination and nutrient loading occur during storm runoff events because of widespread non-point source pollution. Combined sewer overflows, agricultural runoff, construction area erosion, and rural septic system leachates are among the non-point source problems in the Huron watershed.

STREAMS AND/OR SEGMENTS IN THE HURON RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-2-1	East Branch From the headwaters to the Norwalk Creek confluence	26.3 - 6.3
D-2-2	West Branch From the Marsh Run confluence to the East Branch	35.5 - 0
D-2-4	Huron River From Mudbrook Road to U.S. Route 6	11.7 - 0.6

Evaluation of segments 1 and 2 based upon previous reports (OEPA, 1976). Segment 4 was evaluated using current data (OEPA, NWDO data, 1977-1979).

STREAMS AND/OR SEGMENTS IN THE HURON RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
D-2-5	Huron River Estuary From U.S. Rt. 6 to Lake Erie	0.6 - 0.0

The city of Huron presently discharges poor quality effluent into the Huron River. Low dissolved oxygen concentrations are common in the deeper waters of the Huron River Estuary, along with violations of the fecal coliform standard (OEPA, 1976). The construction of improved secondary treatment facilities, and the elimination of combined sewer overflows, will substantially improve water quality in the Huron River Estuary and along the surrounding Lake Erie shoreline. Wastewater treatment plant improvements will include phosphorus removal and chlorination.

STREAMS AND/OR SEGMENTS IN THE HURON RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-2-6	Norwalk Creek From Old State Road to the East Branch	4.2 - 0.0

The heavy growth of periphytic algae in Norwalk Creek suggests an abundant supply of nutrients in this stream (OEPA, NWDO data, 1974). These nutrients originate from storm water runoff from the city of Norwalk, combined sewer overflows, and non-sewered treatment devices. This stream also receives the backwash water of the Norwalk Water Treatment Plant, and is the outflow stream from the Norwalk reservoirs east of the city.

Segment	Name/Description	Mile Points
D-2-3	Rattlesnake Creek From the Norwalk WWTP to Huron River	2.6 - 0.0

Rattlesnake Creek has standards violations for ammonia, MBAS, zinc, copper, lead, cyanide, fecal coliforms, phenolics, and mercury (OEPA, NWDO data, 1977-1979). It also has high phosphorus levels and occasional high nitrate levels. These violations are directly attributed to insufficient treatment at the Norwalk WWTP and inadequate, industrial pretreatment. Insufficient natural dilution water during low-flow stream conditions adds to the problem.

Segment	Name/Description	Mile Points
D-2-8	unnamed stream From the Shiloh WWTP to the West Branch	3.2 - 0.0

The small tributary which receives Shiloh's wastewater has very poor water quality and violates dissolved oxygen and fecal coliform standards (OEPA, NWDO data, 1974). The stream often consists entirely of wastewater and may cause a deleterious impact on the West Branch during low-flow stream conditions.

Segment	Name/Description	Mile Points
D-2-7	Holiday Lake Orgin and headwaters of Jacob Creek	3.3 - 2.9

A report by the National Eutrophication Survey indicated that Holiday Lake was eutrophic, with phosphorus limitations being indicated (U.S. EPA, 1975). Most of the lake's nutrient influx is from the Willard WWTP. The lake should be modeled to determine the impact of a phosphorus control program on lake water quality. The bottom sediment of the lake may be extensively contaminated by

oil, heavy metals, and other toxic substances. Further study of these sediments are required to determine the extent of contamination and the potential for downstream impacts. The outflow of Holiday Lake has standards violations for ammonia, fecal coliforms, MBAS and phenolics (OEPA, 1976).

REFERENCES

Ohio Environmental Protection Agency. 1976 (unpublished). Draft 305(b) report. Available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1974, 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

United States Environmental Protection Agency. 1974. Report on Holiday Lake, Huron County, Ohio, National Eutrophication Survey working paper No. 402. U.S. EPA, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

HURON, VERMILION, BLACK, AND ROCKY RIVER BASIN

VERMILION RIVER SUBBASIN (D-3)

SUBBASIN SUMMARY

The water quality in the Vermilion River Subbasin is generally good and has remained relatively unchanged for the last 10 years. There are few point source dischargers in the subbasin and none with a potential to create more than a localized problem. One segment which will not meet 1983 goals is impacted by inadequate treatment of municipal wastes from the village of New London.

STREAMS AND/OR SEGMENTS IN THE VERMILION RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-3-2	Vermilion River From the headwaters to confluence with the Southwest Branch	58.7 - 49.5
D-3-3	Southwest Branch From the headwaters to the Vermilion River	10.4 - 0.0
D-3-4	Vermilion River From the Southwest Branch confluence to the East Branch confluence	49.5 - 33.0
D-3-5	Vermilion River From the East Branch confluence to the East Fork confluence	33.0 -16.6
D-3-6	East Fork From the headwaters to the Vermilion River	9.3 - 0.0
D-3-7	Vermilion River From the East Fork confluence to Lake Erie	16.6 - 0.0

Evaluation of the above segments based upon previous 305(b) reports (OEPA, 1976).

STREAMS AND/OR SEGMENTS IN THE VERMILION RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE VERMILION RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-3-8	East Branch - Skellinger Creek From the headwaters to unknown	15.6 - unknown

This segment has dissolved oxygen, ammonia, and fecal coliform Warmwater Habitat violations in Skellinger Creek and the upper reaches of the East Branch (OEPA, NWDO data, 1977). Skellinger Creek receives the discharge from the New London Wastewater Treatment Plant. The East Branch is degraded by this discharge but further data is needed to delineate the zone of impact.

The village of New London is in the initial stage (Step I Facilities Planning) of the Construction Grants Program. It is inconceivable that the construction of wastewater treatment plant improvements could start prior to 1983.

REFERENCES

Ohio Environmental Protection Agency. 1976 (unpublished). Draft 305(b) report from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1977 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

HURON, VERMILION, BLACK, AND ROCKY RIVER BASIN

BLACK RIVER SUBBASIN (D-4)

SUBBASIN SUMMARY

Water quality conditions in the upper Black River subbasin are difficult to assess because of insufficient data. The East and West Branches of the Black River drain primarily rural land, and land-use conditions have changed little in recent years. Approximately 19.6 stream miles in this basin are not expected to meet 1983 goals. Ohio EPA samples indicate that water quality problems exist in Plum Creek below the city of Oberlin. Oberlin's tertiary Wastewater Treatment Plant (WWTP) operates efficiently most of the time. However, the sewer system has a severe infiltration and stormwater inflow problem which overloads the treatment plant during heavy rains. The inadequate treatment of sewage after runoff events causes ammonia and fecal coliform bacterial violations in Plum Creek. Ohio EPA files indicate that similar situations may occur downstream of Wellington and Grafton in Charlemont Creek and in the East Branch, respectively.

Water quality degradation of the mainstem of the Black River begins in Elyria. In general, the industries that discharge into this river segment meet their NPDES permit limits. However, there are discharges into Elyria's storm sewer system that are not under NPDES permits. One storm sewer that empties into the river at West Bridge Street contained high concentrations of solids, heavy metals and a high chemical oxygen demand when sampled in 1978 (Ohio EPA, NEDO data 1978). Besides urban runoff, other problems include sanitary sewer overflows and broken sewer siphons. The Elyria Health Department and the Ohio EPA have worked together to correct some of these problems.

The appearance of the Black River greatly improves as it begins to recover downstream from the city of Elyria. Before complete recovery, the river becomes severely degraded due to the Elyria WWTP discharge. The impact of this discharge is indicated by numerous water quality violations at the Ohio EPA and USGS sampling station at Ford Road (RM 10.4; STORET station No. 501510).

The lower 6.5 miles of the Black River form an estuary prior to discharging into Lake Erie. Water quality is degraded in this segment due to several pollution sources. French Creek enters the Black River in the estuary zone. This creek receives pollution from numerous point and non-point sources in and around the city of Avon. Limited sampling indicates that the problems associated with the upper portion of French Creek are not detectable in the creek near its mouth (OEPA, NEDO data, 1975-1979). The Ohio EPA is currently in litigation with the city of Avon to construct sewers and to tie them into the under-loaded French Creek WWTP. Effluents from the U.S. Steel - Lorain Works and the Lorain WWTP discharge into the Black River Estuary. U.S. EPA chemical and biological sampling of the estuary documented the impacts of these discharges within this segment (U.S. EPA, 1974).

STREAMS AND/OR SEGMENTS IN THE BLACK RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Compliance with 1983 water quality goals cannot be assured for the upstream segments (East and West Branches) of the Black River Basin because of insufficient data.

STREAMS AND/OR SEGMENTS IN THE BLACK RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of segments monitored in this subbasin presently fall into this category. However, water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE BLACK RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-4-1	Black River From the Elyria City Limits to the Elyria WWTP	19.7 - 10.7

This segment of the Black River is expected to continue to violate Ohio Warmwater Habitat (WWH) standards for fecal coliforms, heavy metals and phenolics (OEPA, NEDO data, 1977-1979). These violations are probably due to urban runoff, sanitary sewer overflows and industrial wastewater discharges. The industries in this segment under NPDES permits are currently meeting their effluent limits, but unauthorized discharges by these, and/or other companies, may be occurring. Elyria plans to eliminate these discharges and renovate portions of their sanitary sewers as funds become available.

Segment	Name/Description	Mile Points
D-4-2	Black River From the Elyria WWTP to the Estuary	10.7 - 6.5

This segment will continue to violate WWH standards for fecal coliforms, heavy metals, MBAS, dissolved oxygen, ammonia, and phenolics (OEPA, NEDO data, 1977-1979). The Elyria WWTP contributes to these violations. Although the treatment plant is not expected to be upgraded by 1983, a facilities plan has been prepared by Havens & Emerson (1979) for improving the entire system. Construction will begin pending final Ohio EPA approval and grant confirmations.

Segment	Name/Description	Mile Points
D-4-3	Black River Estuary	6.5 - 0.0

This segment is not expected to meet 1983 goals for heavy metals, dissolved oxygen, ammonia, and cyanide, based upon U.S. EPA sampling for the Black River Wasteload Allocation Report (1974). The estuary receives discharges from the U.S. Steel-Lorain Works and the Lorain WWTP. Upstream discharges, lake water intrusion and the French Creek tributary complicates water quality evaluations in this segment.

REFERENCES

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HURON, VERMILION, BLACK, AND ROCKY RIVER BASIN

ROCKY RIVER SUBBASIN (D-5)

SUBBASIN SUMMARY

The Rocky River drains approximately 290 square miles before flowing into Lake Erie. Land use within the subbasin is primarily rural, suburban, and urban residential. Municipal point source pollution degrades water quality in portions of the Rocky River subbasin.

The East Branch of the Rocky River generally meets water quality standards upstream from the city of Berea. The river is dammed at Berea and used for the city's drinking water supply. Water demands consume the entire flow of the river during the summer months. The Berea Wastewater Treatment Plant (WWTP) discharges below the water supply dam creating water quality violations, odors and nuisance algal growth.

Leachates from the Montville Landfill degrade a small tributary of the West Branch; below the mouth of this tributary, nuisance growths of bacteria (Sphaerotillus) have been found. Further downstream several municipal WWTPs discharge to the West Branch.

The Rocky River mainstem from the East and West Branch confluence is entirely within the Cleveland Metropolitan Park system. Upstream pollutant loading from the East Branch, the West Branch and Abrams Creek degrades the Rocky River. Of particular concern are the fecal coliform violations within this highly used recreational area.

The water quality of the Rocky River estuary is unknown due to the lack of data and the complex mixing of Lake Erie waters. Recreational uses of the river are heavy due to several boat launching ramps and marinas. The lower Rocky River is also used extensively for fishing, especially during the salmonid spawning runs.

STREAMS AND/OR SEGMENTS IN THE ROCKY RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

An accurate assessment as to which segments of the Rocky River will meet water quality goals is not possible with the data available.

STREAMS AND/OR SEGMENTS IN THE ROCKY RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
D-5-1	West Branch of Rocky River From near Weymouth Road to S.R. 303	40.4 - 25.0

Standards violations for dissolved oxygen, fecal coliforms, ammonia, phenolics, MBAS, cyanide, and heavy metals were recorded in this segment (RM 28; STORET station No. 501820)(OEPA, 1977-1979). A basin model prepared by Havens and Emerson (1975) showed that some of these violations extend downstream to river mile 25. The overloaded Medina No. 200 WWTP and Medina No. 100 WWTP are sources of these violations. Sewage from both these facilities will be diverted to the Medina No. 500 WWTP beginning in mid-1980. Water quality in this segment of the West Branch is expected to substantially improve, thereby allowing the attainment of 1983 goals.

STREAMS AND/OR SEGMENTS IN THE ROCKY RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-5-2	Unnamed tributary at Montville From the Montville Landfill to the West Branch	1.0 - 0.0

This tributary to the West Branch drains the Montville Landfill in Medina County. Leachate from this landfill creates water quality violations for dissolved solids, heavy metals, phenolics and ammonia. The Ohio EPA is actively involved in remedial enforcement action to have the leachate treated or to close the landfill. Because of lengthy legal proceedings, no definite action is expected before 1983.

Segment	Name/Description	Mile Points
D-5-3	East Branch From the Baldwin Lake Dam to the Rocky River	5.1 - 0.0

The East Branch is severely degraded below the Berea Water Supply Reservoir. During the summer months, the flow in this stream segment is composed primarily of effluent from the Berea WWTP and back wash from the Berea Water Treatment Plant. Instream sampling by Berea WWTP personnel revealed violations for fecal coliforms, dissolved oxygen, and ammonia. This plant will be upgraded or tied into Cleveland's southwest sewer intercepter, depending upon recommendations made in the facilities plan now in preparation.

Segment	Name/Description	Mile Points
D-5-4	Rocky River From the source to the estuary	12.4 - 0.5

This segment currently violates standards for fecal coliforms, phenolics and heavy metals according to Ohio EPA and USGS data (OEPA, NEDO data, 1977-1979; USGS, 1977-1978). The river receives pollution loads from the East Branch, Abrams Creek, the Lakewood WWTP and the North Olmstead WWTP. Pollution abatement programs will not be completed prior to 1983.

Segment	Name/Description	Mile Points
D-5-5	Abrams Creek From Sheldon Road to the Rocky River	3.7 - 0.0

Abrams Creek violates standards for ammonia, heavy metals and phenolics (OEPA, NEDO data, 1977-1979). These violations are due to discharges from the Middleburgh WWTP, the Brookpark WWTP, and the Foseco Corporation. Runoff from foundry sand which is used as fill material may also contribute to pollution problems. The Ohio EPA is working with Foseco to eliminate their dishcage which contributes to the phenolics violations. However, due to the other pollution sources on this zero low flow stream, 1983 water quality goals are not expected to be met.

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CUYAHOGA AND CHAGRIN RIVER BASIN

UPPER CUYAHOGA RIVER SUBBASIN (E-1) AND LOWER CUYAHOGA RIVER SUBBASIN (E-2)

SUBBASIN SUMMARY

The Cuyahoga River basin exhibits water quality conditions ranging from excellent to grossly polluted. The headwaters and upper reaches flow through farmland and sparsely populated areas. Limited data indicate there are occasional dissolved oxygen and fecal coliform violations, but the overall water quality in these reaches is very good. The upper Cuyahoga River above Lake Rockwell has the capacity to assimilate wastes from the small, widely dispersed sources of pollution.

The middle and lower Cuyahoga River receive considerable amounts of industrial and municipal wastes from Akron, Cleveland, and numerous other cities. The city of Akron diverts a substantial volume of water for its water supply at Lake Rockwell. Inadequate dilution water coupled with overwhelming point and non-point pollutant loading causes serious water quality problems beginning at the city of Kent. Several dams below the city of Kent create pools of very slow moving water. Dissolved oxygen concentrations in the dam pool areas violate the Warmwater Habitat (WWH) standard during the summer months.

The city of Akron, located in the middle portion of the Cuyahoga River Subbasin, has a major impact upon the river. Numerous industrial dischargers and the Akron Wastewater Treatment Plant (WWTP) effluent make up approximately 80% of the Cuyahoga River discharge during critical low-flow conditions. Urban runoff and combined sewer overflows are also a major problem in Akron.

The quality of the river shows some signs of improvement below Akron as a result of natural purification, but there are some areas with low dissolved oxygen concentrations during low-flow periods. Further downstream, Tinkers Creek delivers additional pollutants to the Cuyahoga River. This loading comes from urban runoff, combined sewer overflows, and several suburban municipal wastewater treatment plants. 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.

The water quality continues to worsen as the Cuyahoga River flows through Cleveland. Two urban tributaries, Mill Creek and Big Creek, 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 three steel mills (Jones and Laughlin Steel, Republic Steel, and United States Steel) and two chemical companies (DuPont and Harshaw). The Cleveland Southerly Wastewater Treatment Plant discharges 100 MGD of municipal wastes.

Significant improvement in the water quality of the Cuyahoga River is evident. Data downstream of Akron show an overall improvement in water quality since 1969, with a reduction of pollutants and an increase in dissolved oxygen levels. Further downstream, at Independence, increasing dissolved oxygen concentrations were also evident during the seventies. Aesthetic (i.e. visual) 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. Reports of greater numbers of fish in the lower Cuyahoga River are being received with increasing regularity.

The majority of the Cuyahoga River Subbasin is not expected to meet 1983 clean water goals. However, many major pollution abatement projects are currently under construction and many more are in the design stages throughout the subbasin. Water quality improvements will occur as a result of these pollution control programs during the mid and late 1980's.

STREAMS AND/OR SEGMENTS IN THE CUYAHOGA RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
E-1-2	Cuyahoga River From Hiram Rapids to Lake Rockwell	75 - 63

Compliance with 1983 water quality goals cannot be assured for the headwaters, rural tributaries and the mainstem of the Cuyahoga River from Hiram Rapids to Lake Rockwell due to insufficient data. Based on limited data, it appears that many of these areas are meeting Warmwater Habitat (WWH) standards except for rare violations for iron and fecal colifroms (OEPA, 1974; OEPA, NEDO data, 1975-1977).

STREAMS AND/OR SEGMENTS IN THE CUYAHOGA RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the streams fall into this category. However, water quality has not been determined in a portion of the subbasin.

STREAMS AND/OR SEGMENTS IN THE CUYAHOGA RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
E-1-1	Cuyahoga River From the East Branch Reservoir Dam to Hiram Rapids	88 - 75

Occasional water quality standards violations for fecal coliforms and dissolved oxygen have been reported in this portion of the Cuyahoga River (OEPA, NEDO data, 1973, 1974, 1976). Fecal coliform concentrations were elevated after heavy rains; septic tanks and/or agricultural runoff were the

probable sources of these violations. Dissolved oxygen violations occurred during low-flow, warm weather periods (OEPA, 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 swamps within the drainage.

Point source dischargers within this segment include the Middlefield WWTP, the Burton WWTP, and the Middlefield Swiss Cheese Company. Wastewater treatment improvements at the Burton WWTP and Middlefield Swiss Cheese Company have recently been completed. Facility plans for upgrading the Middlefield WWTP should be certified by 1981, and final construction should be completed by 1983. Even with these wastewater treatment improvements, the 1983 clean water goals will probably not be achieved. Fecal coliform and dissolved oxygen violations are expected to continue due to non-point pollution and natural background conditions.

Segment	Name/Description	Mile Points
E-1-6	Wahoo Ditch From the Ravena WWTP to Breakneck Creek	1.5 - 0.0

Wahoo Ditch, a tributary of Breakneck Creek, receives the discharge from the Ravenna WWTP. This intermittent stream experienced dissolved oxygen violations and high ammonia concentrations (OEPA, NEDO data, 1973, 1975, 1977). The Ravenna treatment facility was upgraded in 1975; additional improvements are planned but will not be completed prior to 1983.

Segment	Name/Description	Mile Points
E-1-3	Breakneck Creek From the Wahoo Ditch confluence to the Cuyahoga River	4.0 - 0.0

Water quality in this segment of Breakneck Creek is degraded by the Ravenna WWTP and the Franklin Hills WWTP. Standards violations for dissolved oxygen and fecal coliforms occurred near the mouth of Breakneck Creek (OEPA, NEDO data, 1973, 1975). The Franklin Hills WWTP is presently at BAT treatment levels and the Ravenna WWTP will be upgraded in 1984. Attainment of 1983 clean water goals is not expected prior to the upgrading of the Ravenna facility.

Segment	Name/Description	Mile Points
E-1-4	Cuyahoga River From Kent to the Little Cuyahoga River confluence	54 - 43

The Cuyahoga River below Lake Rockwell is greatly altered by man's activities. The city of Akron removes an average of 50 million gallons per day from Lake Rockwell for its water supply. This rate of removal exceeds the total discharge of the Cuyahoga River during dry weather conditions. Thus, the flow of the Cuyahoga River below Kent often consists of treated wastewater and some discharge from minor tributaries. Water quality problems are further complicated by the presence of five dams within this river segment. Dissolved

oxygen (D.O.) violations probably occur in all of these dam pools. Surveys during July 1975, revealed D.O. violations at the Kent Main Street Dam and the Munroe Falls Dam (OEPA, NEDO data, 1975). A dissolved oxygen stream model predicted that D.O. violations occur at all five dams during the warmer summer months (OEPA, 1974). This same model also suggested that a minimum D.O. concentration of 5 mg/l is not attainable, even with BAT treatment levels at the Kent WWTP (3 MGD) and at the Fish Creek WWTP (2.5 MGD).

An eighty foot dam is located in the downstream reach of this river segment. The reservoir pool is used by the Ohio Edison Company, Gorge Plant, for cooling water. The Cuyahoga River experiences temperature violations as a result of cooling water discharged by the Gorge Plant. A final decision on remedial measures for this thermal discharge awaits the completion of additional 316(a) studies by the company. Attainment of water quality standards is not expected in the foreseeable future.

Segment	Name/Description	Mile Points
E-1-5	Little Cuyahoga River From Akron to the Cuyahoga River	6.0 - 0.0

The Little Cuyahoga River flows through the densely populated urban and industrial area of Akron. Combined sewer overflows and severely damaged sewer mains create major water quality problems. Approximately 14 million gallons per day of raw sewage overflowed from a broken sewer main in the summer and fall of 1977. Standards violations for pH, ammonia, phenols, fecal coliforms, dissolved oxygen, MBAS, dissolved solids, and several heavy metals resulted (OEPA, NEDO data, 1977-1979).

The facilities plan addressing the combined sewer overflow problem in Akron should be certified by December 1980. A total of 36 overflow sites are being studied, most located in the Little Cuyahoga River drainage. Enlarged sewers and the construction of equalization tanks are planned, but this construction will not begin before 1983.

Segment	Name/Description	Mile Points
E-2-6	Mud Brook From the Summit County No. 6 WWTP to the Cuyahoga River	6.0 - 0.0

Standards violations for ammonia, dissolved oxygen, and fecal coliforms occurred in the upper reaches of Mud Brook (OEPA, NEDO data, 1975). These violations were caused by the Summit County No. 6 WWTP (1.5 MGD). This facility experiences extensive infiltration and periodically receives industrial effluent of variable quality. Legal action is in progress to force compliance with interim permit conditions. The Akron Facilities Plan will recommend phasing out the Summit County No. 6 WWTP and tying into the Fish Creek WWTP. This will probably not occur before 1984.

Segment	Name/Description	Mile Points
E-2-7	Cuyahoga River From the Little Cuyahoga River confluence to the Akron WWTP	43 - 38

Data collected by the Akron Water Quality Management Section (1977-1979) upstream of the Akron WWTP revealed water quality violations for dissolved oxygen, fecal coliforms, and lead during the past two years. The U.S. Geological Survey continuous water quality monitor at Old Portage indicated violations for temperature and dissolved oxygen (USGS 1977-1979). Combined sewer overflows and the thermal discharge from the Ohio Edison Gorge Plant are the major causes of degraded water quality in this segment of the Cuyahoga River.

The impact of the Little Cuyahoga River on the mainstem of the Cuyahoga River was very evident during the sewer main break in 1977. The number and severity of dissolved oxygen violations was substantially reduced after the repair of this sewer. Combined sewer overflow problems will not be corrected prior to 1983.

Segment	Name/Description	Mile Points
E-2-8	Brandywine Creek From Hudson to the Cuyahoga River	7.0 - 0.0

Water quality violations for fecal coliforms, phenolics, and dissolved oxygen occurred in Brandywine Creek (OEPA, NEDO data, 1973, 1975). Three significant point sources degrade this relatively small receiving stream: the Macedonia No. 15 WWTP, the Hudson Village WWTP, and the Macedonia No. 9 WWTP. Wastewater treatment facilities at the Macedonia No. 15 plant were upgraded during the summer of 1979. The plant now provides adequate treatment for BOD and suspended solids but does not provide nitrification. The Hudson Village WWTP should be upgraded to a secondary treatment plant by 1983. The facility plan for this area recommends that all these facilities be phased out and tied into the Cuyahoga Valley Interceptor when it is available, probably in 1986.

Segment	Name/Description	Mile Points
E-2-9	Tinkers Creek From Twinsburg to the Cuyahoga River	12.0 - 0.0

Tinkers Creek (drainage area 96 mi.) 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 municipal wastewater treatment plants include Twinsburg, Solon, Bedford Heights, Bedford, Maple Heights and Walton Hills.

Water quality is monitored at three sites on Tinkers Creek: Bedford (OEPA, STORET station No. 502220), Twinsburg (USGS station No. 04207100) and Independence (USGS station No. 04207300). Standards violations for fecal coliforms, iron, lead, phenolics, copper, dissolved oxygen, oil and grease, chromium, and ammonia have been reported (OEPA, NEDO data, 1977-1979; USGS, 1977-1979).

The Twinsburg, Bedford Heights, and Bedford Wastewater Treatment Plants are all in the facilites planning stages, and should receive certification during 1981. Nitrification and phosphorus removal should be added to each of these secondary plants by 1985. Construction of nitrification and phosphorus removal facilites is underway at the Solon WWTP. The Cuyahoga Valley Interceptor may eventually tie into these wastewater treatment plants. The Maple Heights and Walton Hills Wastewater Treatment Plants are to be phased out by December 1981 under Phase I of the Cuyahoga Valley Interceptor. No major improvements are planned at these sites prior to 1981.

Numerous small county and private sewage treatment plants discharge to the upper portions of Tinkers Creek. Although water quality data from these areas is very limited, it is probable that most of these discharges cause local water quality problems. Facility plans have been certified from the two plants that will serve these areas, Streetsboro Regional WWTP and Aurora Westerly WWTP. The plans call for advanced secondary treatment including nitrification, phosphorus removal, and filters. These advanced secondary treatment plants should be finished by 1983 if Federal funds are released.

Segment	Name/Description	Mile Points
E-2-10	Cuyahoga River From the Akron WWTP to the Tinkers Creek confluence	38 - 16

This segment of the Cuyahoga River is degraded by the combined sewer overflows in Akron and the Akron WWTP. Water quality violations include dissolved oxygen, fecal coliforms, ammonia, and lead (Akron Wastewater Quality Management Section, 1977-1979).

The Akron WWTP presently discharges an average of 90 million gallons per day. This discharge accounts for two-thirds of the total flow of the river during very dry weather. At the present time, this plant is by-passing secondary treatment ten to twelve hours per day. Further, overloading caused by infiltration results in extensive bypassing of primary treatment during wet weather.

Construction to alleviate some of these problems is currently in progress and is scheduled for completion by fall, 1980. Interim improvements include the addition of phosphorous removal facilities, improved chlorination, stand-by power, and flow equalization for secondary treatment of up to 100 million gallons per day. The Facilities Plan for Akron should be certified by December, 1980. As mentioned above, the sewers in Akron are in need of major repair. Construction to alleviate infiltration and overflow problems should begin by 1982 and be completed by 1984. Future improvements at the WWTP will include further reduction of BOD and suspended solids and possibly nitrification, depending upon advanced waste treatment funding by the Federal government. These improvements will not be made prior to 1985.

This segment of the Cuyahoga River flows though the center of the recently created Cuyahoga Valley National Recreational Area. The increased recreational use of the river valley should help to justify the expenditure of additional funds for advanced wastewater treatment.

Segment	Name/Description	Mile Points
E-2-11	Mill Creek From Maple Heights to the Cuyahoga River	7.0 - 0.0

Mill Creek is a relatively small tributary, but it carries significant amounts of pollutants to the Cuyahoga River. Combined sewer overflows, four industrial discharges, and leachate from several landfills along the banks of Mill Creek contribute to the pollution problems. Standards violations included ammonia, dissolved solids, phenolics, fecal coliforms, MBAS, and several heavy metals (OEPA, NEDO data, 1977-1979).

Certification of the Mill Creek Facilities Segmental Plan should occur in the spring of 1981. Construction to alleviate the combined sewer overflow problems should begin sometime during 1983. Improvements in the water quality of this stream will probably not occur prior to 1984.

Segment	Name/Description	Mile Points
E-2-12	Cuyahoga River From the Tinkers Creek confluence to the Cleveland Southerly WWTP	16 - 11

Data collected at Independence (STORET station No. 502020) indicated violations for temperature, phenolics, fecal coliforms, cyanide, copper, cadmium, iron, and lead during the past year (OEPA, NEDO data, 1978-1979). Dissolved oxygen violations also occurred in the Cuyahoga River at Independence (USGS, 1977-1979). Based upon very limited information, it appears that the degree of heavy metal contamination in this segment of the Cuyahoga River is greater than previous data indicated.

The concentration of metals and other conservative parameters in this river segment reflect the upstream point and non-point loadings from Akron and the Tinkers Creek watershed. Pollution abatement measures discussed above should lessen the impact of numerous upstream point source dischargers on this segment of the Cuyahoga River. However, the 1983 clean water goals may never be attained in this river segment because of widespread urban non-point pollution.

Segment	Name/Description	Mile Points
E-2-13	Big Creek From Brook Park to the Cuyahoga River	4 - 0

Urban non-point pollution and several industrial discharges cause water quality problems in Big Creek. Standards violations were reported for phenolics, oil and grease, fecal coliforms, MBAS, cadmium, copper, iron, zinc, and lead (OEPA, NEDO data, 1977-1979).

Industrial dischargers include Ford Motor Company, General Motors Corporation, Harshaw Chemical, Ohio Drum and the Cuyahoga Meat Company. The discharge of the Ford Motor Company has caused isolated water quality problems in the headwaters of Big Creek (OEPA, NEDO data, 1975-1976). However, water quality degradation results primarily from combined sewer overflows and illegal discharges or spills to storm sewers. Some of the undersized sewers overflow continuously. Sewer overflows and many industrial discharges will be eliminated with the construction of the Southwest Interceptor. Completion of this project will not occur before 1983.

Segment	Name/Description	Mile Points
E-2-14	Cuyahoga River From the Cleveland Southerly WWTP to Lake Erie	11 - 0

The lower Cuyahoga River exhibits very poor water quality, especially in the summer months. Warmwater Habitat standards violations for temperature, dissolved oxygen, ammonia, fecal coliforms, MBAS, phenolics, cyanide, oil and grease, lead, iron, and zinc have been reported at one or both monitoring sites (lower Harvard Ave., STORET station No. 502130; West Third St. Bridge, STORET station No. 502140) (OEPA, NEDO data, 1977-1979). This degradation is caused by a combination of upstream pollutant loading (i.e., from Akron, Tinkers Creek, Big Creek), major industrial and municipal discharges to the lower Cuyahoga River itself, and the physical configuration of the Cuyahoga River ship channel. Major discharges to this segment include United States Steel, Republic Steel, Jones and Laughlin Steel, Harshaw Chemical, DuPont Chemical and the Cleveland Southerly WWTP. All of the industries mentioned are presently meeting "Best Practical Treatment" as described by the Federal Effluent Guidelines. "Best Available Treatment" levels, which are to be met by 1983, have not been established by the U.S. EPA for these types of industries. Until these limits are established, design and construction of advanced treatment facilities will be further delayed.

The Cleveland Southerly WWTP is currently experiencing operational problems and is not meeting their interim permit conditions. Legal action against this entity is pending. However, extensive construction is underway for an advanced wastewater treatment plant at this facility. Phosphorus removal, nitrification and rapid sand filters should significantly improve the water quality of the lower Cuyahoga River. Completion of this construction is scheduled for 1983 but may be delayed until 1984.

WATER QUALITY TRENDS

Data used to assess water quality trends in the Cuyahoga River were furnished by the Arkon Wastewater Quality Management Field Group (1969-1979, unpublished data) and the U.S. Geological Survey (USGS, 1970-1979). The Akron Wastewater Quality Management Field Group sampled the Cuyahoga River below the Akron Wastewater Treatment Plant on a daily basis; a USGS gage (four parameters, continuous monitor) recorded water quality at Independence.

The current water quality of the Cuyahoga River below the Akron Wastewater Treatment Plant is better than the 1969 conditions. Annual average concentrations of ammonia, phosphorus, and chemical oxygen demand have

Table IV-3. Annual average water quality of the Cuyahoga River upstream (U) and downstream (D) of the Akron Wastewater Treatment Plant, 1969-1979 (from unpublished data of the Akron Wastewater Quality Management Field Group).

	Dissolved Oxygen mg/l		Dissolved Oxygen % Saturation		Ammonia mg/l		Nitrates mg/l		BOD mg/l		Total Phosphorus mg/l		COD mg/l	
	U	D	U	D	U	D	U	D	U	D	U	D	U	D
1969	8.1	7.4	72.3	67.4	1.00	5.66	0.79	9.57	3.3	13.7	0.28	1.73	28	72
1970	8.3	7.7	73.9	69.8	1.01	4.02	0.90	0.76	3.6	9.5	0.22	1.46	32	64
1971	9.2	8.4	78.8	75.9	1.13	3.22	0.75	0.72	2.9	5.8	0.22	1.00	29	59
1972	8.9	8.6	78.8	77.8	0.56	2.35	0.67	0.98	3.2	7.9	0.59	1.55	43	62
1973	-	8.8	-	82.6	-	1.75	-	1.11	-	10.1	-	0.69	-	34
1974	9.2	9.1	91.5	85.8	0.25	2.02	0.77	0.94	2.9	8.5	0.34	0.63	24	34
1975	10.4	9.8	95.3	89.4	0.21	1.07	0.77	1.22	3.0	6.0	0.13	0.39	24	32
1976	9.8	9.5	87.8	85.7	0.29	0.88	0.90	1.56	3.0	6.0	0.15	0.43	21	25
1977	8.6	8.5	76.4	76.1	0.59	1.61	0.94	1.62	4.0	7.0	0.19	0.44	26	32
1978	10.1	9.3	89.9	83.4	0.39	2.09	0.93	1.04	2.0	5.0	0.11	0.32	22	31
1979	10.1	9.4	86.8	81.0	0.33	1.77	1.02	1.10	3.0	7.0	0.12	0.39	25	36

Table IV-4. Dissolved oxygen data for the Cuyahoga River at Independence, 1970-1979 (from USGS, 1970-1979).

	Number of days with minimum values below 4 mg/l	Number of days with minimum values below 5 mg/l	Number of days missing data[a]	Average daily minimum concentrations mg/l[b]
1970	60	93	20	3.8
1971	82	110	23	3.0
1972	42	104	11	4.6
1973	28	80	0	4.2
1974	54	91	9	4.2
1975	3	33	14	5.8
1976	3	7	0	6.5
1977	17	49	0	5.7
1978	1	28	48	5.4
1979	11	50	10	5.0

a June through October data only.

b July through September data only.

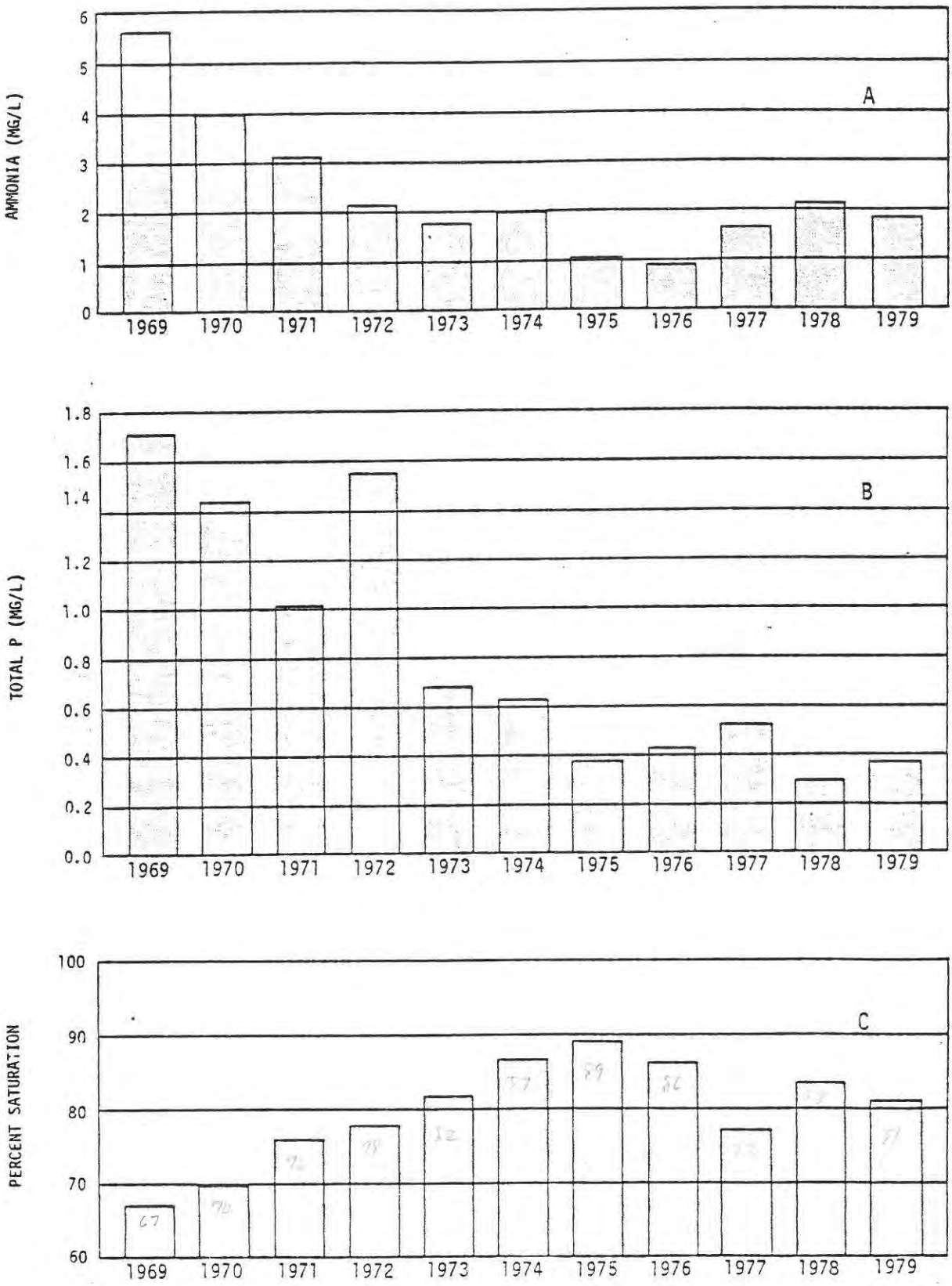

Figure IV-1. Average annual water quality of the Cuyahoga River below the Akron WWTP, 1969-1977; A, ammonia; B, total phosphorus; C, percent saturation of dissolved oxygen.

decreased substantially (Table IV-2, Figures IV-1A and IV-1B); the annual average biochemical oxygen demand concentration has decreased slightly but appears to be more variable than the other parameters. The annual average values for dissolved oxygen concentration and percent dissolved oxygen saturation have increased markedly (Table IV-2, Figure IV-1C). The leakage of 14 million gallons per day of raw sewage from a broken sewer main adjacent to the Little Cuyahoga River was probably responsible for noticably lower percent dissolved oxygen saturation values below the Akron WWTP in 1977 (Figure IV-1C). Solids handling problems and construction of facility improvements at the Akron WWTP reduced the wastewater treatment efficiency during 1978 and 1979. The WWTP effluent was of lower quality and the instream data reflected the additional pollutant loading. (Table IV-2, Figures IV-1A, IV-1B, and IV-1C).

Data for the Cuyahoga River at Independence showed greatly improved dissolved oxygen concentrations over the last decade. The average minimum daily dissolved oxygen concentration during July, August, and September has increased approximately 1 mg/l since 1970 (Table IV-3). The frequency of low dissolved oxygen concentrations has been sharply reduced, as indicated by the number of days per year when dissolved oxygen values below 4 mg/l or 5 mg/l were recorded (Table IV-3).

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CUYAHOGA AND CHAGRIN RIVER BASIN

CHAGRIN RIVER SUBBASIN (E-3)

SUBBASIN SUMMARY

The Chagrin River, which is 48 miles long and drains 264 square miles, is one of the most scenic rivers in Northeast Ohio. Land use is primarily rural and low density residential housing. Chagrin Falls and several of Cleveland's eastern suburbs are the only major urban centers. Based upon available information, water quality is generally good to excellent.

The Chagrin River meets Ohio's Exceptional Warmwater Habitat (EWH) criteria from the river's source to the Aurora Branch confluence based upon limited data (Ohio EPA, NEDO data 1975). Silver Creek, a tributary of the Chagrin within this segment, met its Coldwater Habitat use designation criteria for parameters sampled (Ohio EPA, NEDO data, 1976). This segment provides suitable habitat for endangered species, and game and pan fish (White, 1978).

The Aurora Branch had good water quality, with respect to major nutrients (nitrogen and phosphorus),(Ohio EPA, NEDO data, 1975). The recently constructed McFahrland Creek Wastewater Treatment Plant (WWTP) should ensure the maintenance of existing water quality by eliminating failing septic systems and package plants. A good biological community, including game and pan fish, is also found in this segment (White, 1978).

The Chagrin River from the Aurora Branch confluence to the East Branch confluence flows through primarily residential and park lands. Samples analyzed for nutrients show that this stream reach had acceptable levels of nitrogen and phosphorus (Ohio EPA, NEDO data, 1975). These 1975 samples are assumed to reflect current nutrient conditions, because there have been no major changes within subbasin.

The nutrient status of East Branch of the Chagrin River was also acceptable in 1975. The basin is comprised of parks, open land and low density residential housing and it contains only a few small point source dischargers. Endangered species and game and pan fish inhabit the segment (White, 1978).

The river from the East Branch confluence to the estuary does not meet 1983 goals. Warmwater Habitat standards violations for fecal coliforms, heavy metals (iron, lead and cadmium) and phenolics, were recorded at S.R. 84 (RM 5.0; STORET station No. 502400). Public water supply standards and EWH standards were also violated. Despite these violations, the river supports the most popular salmonid fishery in Ohio. Fishermen report taking brown trout, rainbow trout (steelhead), coho salmon and chinook salmon in the waters just below the Willoughby Water Treatment Plant Dam near S.R. 84.

The Ohio EPA does not have data for an accurate water quality assessment of the Chagrin River Estuary. The estuary receives pollutant loading from upstream sources as well as industrial effluent via an unnamed tributary. The industrial effluent may cause water quality violations in this low-flow tributary during dry weather conditions.

STREAMS AND/OR SEGMENTS IN THE CHAGRIN RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Compliance with 1983 water quality goals cannot be assured for the upper portion of the Chagrin River Basin because of insufficient data. Only nutrient parameters have been evaluated to date.

STREAMS AND/OR SEGMENTS IN THE CHAGRIN RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
E-3-1	Willey Creek From the Woodmere WWTP to the Chagrin River	3.5 - 0.0

Willey Creek currently violates WWH standards for fecal coliforms, dissolved oxygen and nitrogen ammonia due to the Woodmere WWTP discharge. Construction of tertiary facilities at this plant will be completed by 1983. According to the Ohio EPA wasteload allocation modeling, these improvements will insure the attainment of 1983 water quality goals.

STREAMS AND/OR SEGMENTS IN THE CHAGRIN RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
E-3-2	Chagrin River From S.R. 84 to the estuary	5.0 - 0.9

This segment of the Chagrin River is not expected to meet the water quality standards for fecal coliforms, iron, lead, cadmium and phenolics (OEPA, NEDO data, 1977-1979). The bacterial violations are probably due to upstream point sources and non-point source runoff. There are no point source discharges of heavy metals or phenolics, therefore, the problem is assumed to arise from non-point sources.

REFERENCES

Ohio Environmental Protection Agency. 1975-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

White, A.M. 1978. Analysis of Stream Habitats. Technical Appendix A-21, NOACA 208 Report. Cleveland, Ohio.

GRAND RIVER BASIN

GRAND RIVER SUBBASIN (F-1 and F-2)

SUBBASIN SUMMARY

Approximately 18.4 stream miles in this subbasin are not expected to meet 1983 goals. The Grand River flows for 98.5 miles through mostly wooded and agricultural lands before emptying into Lake Erie. The only major population center within the entire subbasin is Painesville near the river mouth. The Grand River's natural and scenic qualities are reflected by the numerous parks located within the subbasin and by the Ohio Department of Natural Resources Wild and and Scenic River designation for a large portion of the mainstem. The river also provides suitable habitat for game and pan fish and for several endangered plant and animal species.

The majority of the water quality problems that exist in the upper Grand River Subbasin are associated with sanitary sewer discharges to zero, low-flow streams which include: Mill Creek (near Jefferson), unnamed tributary to Mill Creek (Cemetery Creek), Rock Creek, and an unnamed tributary near Orwell. The headwaters of the Grand River near Parkman were sampled by the Ohio EPA in 1978. The few grab samples analyzed showed excellent 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 show very low nutrient levels in these creeks (OEPA, NEDO data, 1978-1979).

Nutrient levels in the Grand River near Harpersfield are also very low (Ohio EPA, NEDO data, 1979). The Ohio Water Service Company withdraws a substantial portion of the river for drinking water supplies at Harpersfield. This leaves very little dilution water for any nutrients that might enter the waterway. Therefore, any future development in this segment should be carefully planned. There have been no samples taken on the Grand River from Parkman to Harpersfield. The nutrient level in this reach is probably very low due to the absence of significant dischargers.

The lower Grand River from S.R. 2 to Lake Erie flows through an industrialized urban area which causes degraded water quality. Point sources within this segment, which may contribute to water quality standards violations, include: Republic Steel, Morton Salt, Painesville Municipal Electric, Fairport Harbor Wastewater Treatment Plant (WWTP) and the Painesville WWTP. The abandoned Diamond Shamrock properties are significant areas of non-point source pollution. Runoff samples from these areas contained concentrations of chromium as high as 34,500 ug/l and dissolved solids as high as 108,000 mg/l. (OEPA, NEDO data, 1979). There were no chromium violations in the river as a result of this runoff, but there are numerous dissolved solids violations. The elimination of and/or reduced loading from several discharges within this segment in the last several years has improved water quality. These changes have been verified through chemical analysis and reports from area residents and Ohio EPA officials.

STREAMS AND/OR SEGMENTS IN THE GRAND RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Compliance with 1983 water quality goals cannot be assured for many segments of the Grand River due to insufficient data.

STREAMS AND/OR SEGMENTS IN THE GRAND RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE GRAND RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
F-1-1	Unnamed tributary near Orwell From the source to the Grand River	2.0 - 0.0
F-1-2	Rock Creek From the Roaming Rock WWTP to the Grand River	2.6 - 0.0
F-2-3	Mill Creek Below the Ashtabula Joint Vocational School	17.2 - 14.0

According to the Ohio EPA wasteload allocation modeling, the above tributaries violate Warmwater Habitat standards for ammonia and dissolved oxygen. The model used plant effluent permit limits for stream chemical data, since these tributaries are zero, low-flow streams. Currently, there are no plans for upgrading these systems.

Segment	Name/Description	Mile Points
F-2-4	Unnamed tributary to Mill Creek (Cemetery Creek) From the Jefferson WWTP to the Grand River confluence	1.7 - 0.0

Cemetery Creek, a zero, low-flow stream, currently violates water quality standards for ammonia, dissolved oxygen and phenolics (OEPA, NEDO data, 1975-1979). The primary source of these violations is the Jefferson WWTP discharge; a small but concentrated discharge from the Poplar Oil Company also discharges to this stream. Poplar Oil is preparing plans for a treatment system. The Jefferson WWTP system is not expected to be upgraded.

Segment	Name/Description	Mile Points
F-2-5	Grand River From Big Creek confluence to Near Red Creek confluence	8.9 - 5.3

This segment of the Grand River violated WWH standards for fecal coliforms, phenolics and heavy metals (OEPA, NEDO data, 1975-1979). The fecal coliform violations were probably due to wastewater treatment plant discharges occurring just upstream from the sampling station (Heatherstone WWTP and the Chardon WWTP on Big Creek). The phenolics and metals sources are unknown; there are no industrial dischargers upstream of the sampling site.

Segment	Name/Description	Mile Points
F-2-6	Grand River From Near Red Creek confluence to Lake Erie	5.3 - 0.0

This segment violates WWH standards for fecal coliforms, dissolved oxygen, iron, phenolics, and total dissolved solids (TDS). The Painesville and Fairport Harbor WWTPs contribute to the bacterial, dissolved oxygen and TDS violations. The Painesville WWTP was upgraded to provide tertiary treatment beginning in the fall of 1979. Efforts are underway to connect the Fairport Harbor WWTP to either the Painesville facility, or to the Lake County regional plant in Mentor.

A major source of dissolved solids in the lower Grand River is an abandoned 350 acre waste lagoon formally owned by the Diamond Shamrock Chemical Company. The lagoon and surrounding area is also a known source of iron and chromium (OEPA, NEDO data, 1979). There are no current plans to control leaching and runoff from this waste disposal site. The source of the phenolics contamination is unknown.

WATER QUALITY TRENDS

The lower Grand River is one of the few systems in Northeastern Ohio which has had sufficient amounts of data collected to determine the effects of major discharges on water quality. The Diamond Shamrock Painesville works produced soda ash from 1912 to 1976. Wastewater from this process contained high amounts of dissolved solids which were discharged to the Grand River. The USGS gaging station downstream at S.R. 535 has monitored the dissolved solids concentrations through conductivity measurements since 1966 (USGS, 1966-1978). Figure IV-2 illustrates the reduction of conductivity (dissolved solids) following the elimination of the Diamond Shamrock discharge in 1976. The graph also indicates that dissolved solids leaching from the waste lagoon creates water quality violations whenever the flow of the river falls below approximately 3?0 cubic feet per second.

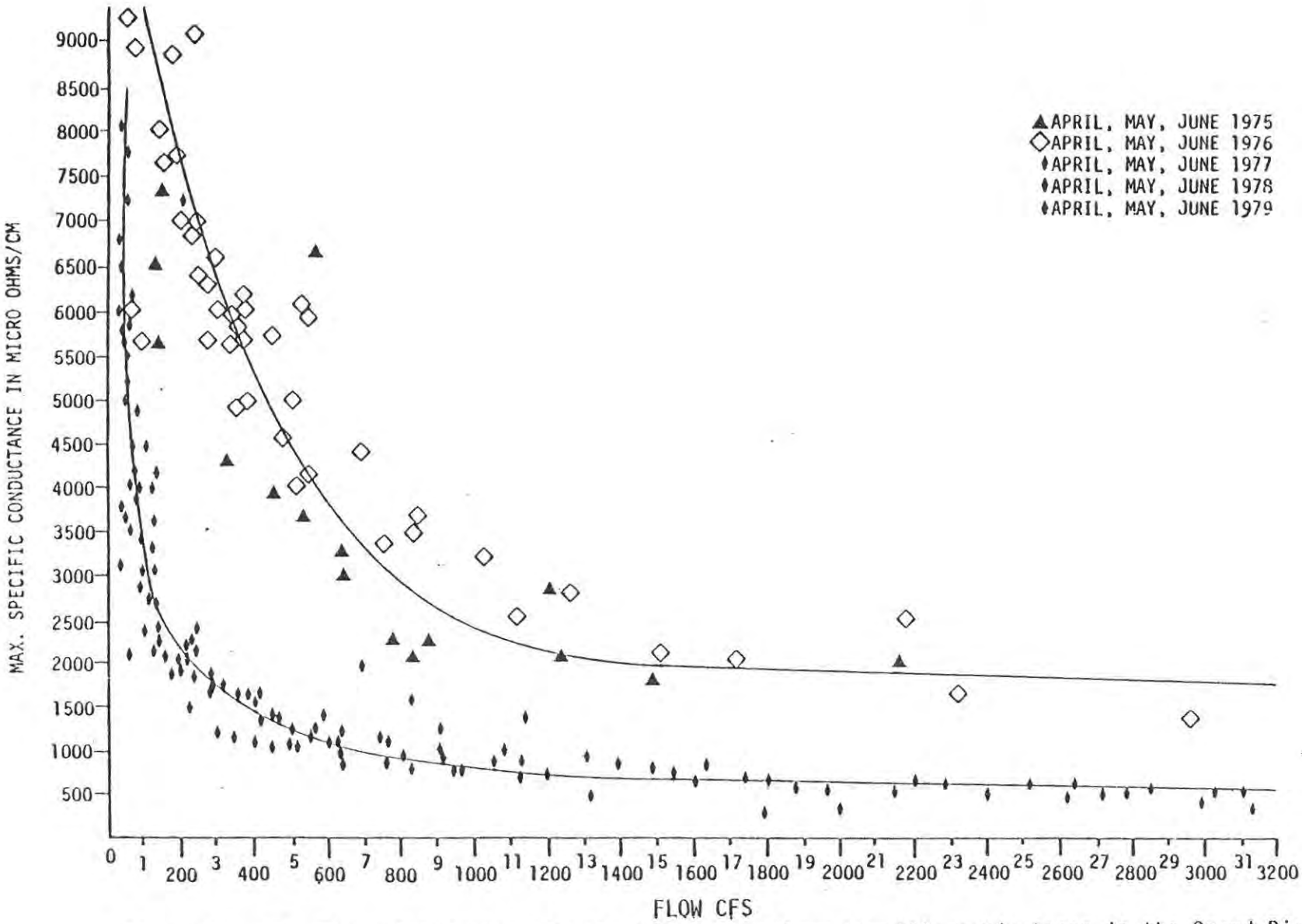

Figure IV - 2. The relationship between flow and maximum specific conductance in the Grand River near Painesville, Ohio, 1975 - 1979.

RECOMMENDATIONS

The 208 plan for the Grand River has recommended that a survey be initiated to provide information on the water quality of the Upper Grand River Subbasin. The report also recommends attempting to trace the source of violations of heavy metals found in the 1974 303(e) sampling (OEPA, 1974). These recommendations should be carried out as time permits.

REFERENCES

Ohio Environmental Protection Agency. 1974. Grand River Basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Northeast District Office, Twinsburg, Ohio.

Ohio Environmental Protection Agency. 1975-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

United States Geological Survey. 1966-1979. 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.

GRAND RIVER BASIN

CONNEAUT CREEK SUBBASIN (F-3)

SUBBASIN SUMMARY

Approximately 21.1 stream miles in this subbasin are not expected to meet 1983 goals. The lands within the Conneaut Creek Subbasin are rural, except for the Lakeshore area which contains the city of Conneaut and some suburban development. Water quality of Conneaut Creek above the city is generally good (Ohio EPA, NEDO data, 1977-1979). Occasional heavy metals violations (especially iron) occur from non-point sources, or from discharges and/or non-point sources in Pennsylvania. Other samples from the monthly monitoring site at Keefus Road (RM 6.4; STORET station No. 502870) revealed Coldwater Habitat (CWH) violations for phenolics. These violations do not exceed Warmwater Habitat (WWH) water quality standards.

Because of the complex nature of estuaries and the lack of data, no chemical water quality determinations can be made for the Conneaut Creek Estuary. However, the estuary receives coal pile storage runoff which has a low pH and a high (500-1000 mg/l) total iron concentration. This runoff often discolors the Conneaut Harbor. The Pittsburgh and Conneaut Dock Company, which owns the storage area, is currently working on plans to treat this runoff. Five outfalls were recently combined into one, as a first step in implementing this plan. Despite what appears to be adverse conditions in the estuary, Conneaut Creek supports a popular fishery, especially during the spring and fall salmonid migrations.

STREAMS AND/OR SEGMENTS IN THE CONNEAUT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE CONNEAUT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE CONNEAUT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
F-3-5	Conneaut Creek From the Ohio - Pa. Line to the Estuary	22.3 - 1.2

Conneaut Creek is not expected to meet 1983 water quality goals due to high, total iron concentrations. Since there are no known dischargers in Ohio upstream of the Ohio EPA sampling location, the violations are assumed to be from non-point sources, or from point and/or non-point sources in Pennsylvania.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

GRAND RIVER BASIN

ASHTABULA RIVER SUBBASIN (F-3)

SUBBASIN 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. Approximately 23.2 stream miles in this subbasin are not expected to meet 1983 goals. Major water quality problems are confined to the downstream river segments; the upper reaches are relatively pollution free (OEPA, NEDO data 1977-1979; USGS 1978, 1979). The upper segment has infrequent, heavy metals and phenolics violations. The source of this contamination is undocumented, but non-point sources are suspected.

The water quality of Hubbard Run, Red Brook, and Indian Creek, which are near the city of Ashtabula, has 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 upon completion of the recommendations of the facilities plan (Woodruff and Associates, 1979). This should eliminate the bacterial, ammonia, and dissolved oxygen problems in these segments.

Samples collected by the Ohio EPA, U.S. EPA, and the USGS indicate degraded water quality in the Ashtabula River Estuary. Discharges which contribute to water quality problems in this river segment include combined sewer overflows and industrial discharges to Field's Brook and Strong Brook. Sediments analyzed by the U.S. EPA in 1979 confirm water quality problems involving high concentrations of heavy metals and PCB's. Despite these water quality problems, the estuary of the Ashtabula River is an important spawning area for many important Lake Erie fishes. Fishermen and the U.S. Coast Guard report salmonid migrations and large numbers of white bass in this segment.

STREAMS AND/OR SEGMENTS IN THE ASHTABULA RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Compliance with 1983 water quality goals cannot be determined for the upstream segments of the Ashtabula River due to the absence of data. Other stream segments within this subbasin lack sufficient information to make accurate appraisals.

STREAMS AND/OR SEGMENTS IN THE ASHTABULA RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
F-3-1	Strong Brook From the headwaters to the Ashtabula River	1.4 - 0.0

Samples collected from Strong Brook revealed water quality violations for phenolics, iron, zinc and fecal coliform bacteria (OEPA, NEDO data, 1977, 1979). An investigation by the Ohio EPA concluded that the sources of these violations probably were accidental spills and/or unauthorized discharges into Ashtabula's storm sewers in the area of Benefit Avenue. The city and the Ohio EPA are currently working together to trace these discharges. Eliminating these sources should allow Strong Brook to meet 1983 water quality goals.

STREAMS AND/OR SEGMENTS IN THE ASHTABULA RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
F-3-2	Ashtabula River Between the Ashtabula City Limits	23.3 - 5.2

This segment of the Ashtabula River currently violates water quality standards for lead (OEPA, NEDO data, 1977-1979). The only known point sources affecting this segment are small package plants which discharge treated sanitary wastes. These wastes should contain no lead, therefore, the source of these violations are assumed to be non-point.

Segment	Name/Description	Mile Points
F-3-3	Fields Brook From Cook Road to the Ashtabula River	3.4 - 0.0

Field's Brook will not meet 1983 water quality goals for total residual chlorine, dissolved solids, iron and mercury. All industries that discharge to the brook have Best Practicable Technology (BPT), but their effluents comprise nearly the entire flow of Field's Brook during the dry summer months. This situation makes the attainment of 1983 water quality goals economically impossible. A proposal for a combined treatment plant, with a discharge to Lake Erie, is being considered by the Field's Brook industries.

Segment	Name/Description	Mile Points
F-3-4	Ashtabula River Ashtabula River Estuary	1.7 - 0.0

This segment of the Ashtabula River has had water quality violations for total dissolved solids and dissolved oxygen from 1970 to 1979 (USGS 1970-1979). Since the Ashtabula River has periods of zero flow during most years, any waste water generated within the subbasin comprises the total flow of the river and collects in the estuary. Combined sewer flows in Ashtabula will be eliminated with improvements to the city's sewer system, and should help to improve the dissolved oxygen levels within the estuary.

RECOMMENDATIONS

The Ashtabula 208 plan has made recommendations to conduct a short term survey to determine the water quality of the West and East Branches of the Ashtabula River. This recommendation should be carried out as time and manpower permits.

REFERENCES

Ohio Environmental Protection Agency. 1975-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

United States Geological Survey. 1970-1979. 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.

LAKE ERIE MINOR TRIBUTARIES

(PORTIONS OF BASINS D-3; E-2; F-3)

SUMMARY

Data for the Lake Erie minor tributaries is limited to a few grab samples and pollution complaint investigations. A few segments can be identified as water quality problem areas, but an accurate evaluation of many small Lake Erie tributaries is not possible due to insufficient data.

BEAVER CREEK (D-3)

STREAMS AND/OR SEGMENTS IN BEAVER CREEK THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
D-3-1	Beaver Creek From the Amherst WWTP to the Estuary	2.2 - 0.8

This segment of Beaver Creek is expected to violate 1983 water quality goals for fecal coliform bacteria, ammonia, MBAS and phenolics (OEPA, NEDO data, 1977). The bacterial, ammonia and MBAS violations are caused by the Amherst Wastewater Treatment Plant. The city is contesting orders from the Ohio EPA to eliminate the plant and tie its sewer system into the regional system. The source of the phenolics is unknown.

COWLES CREEK (F-3)

STREAMS AND/OR SEGMENTS IN COWLES CREEK THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
F-3-6	Cowles Creek From the Geneva WWTP to the Estuary	4.2 - 0.7

Samples collected by the Ohio EPA in 1975 and 1979 revealed water quality violations for ammonia and dissolved oxygen in Cowles Creek below the Geneva WWTP. Fish sampling by the Ohio EPA (1979) confirmed that water quality problems exist in the creek. According to an Ohio EPA stream model, additional nitrification facilities are needed at the Geneva WWTP for Cowles Creek to attain Warmwater Habitat (WWH) water quality standards. The city of Geneva is contesting the construction of these facilities.

RECOMMENDATIONS

The Ashtabula 208 plan has made recommendations to conduct water quality surveys in order to gather specific information. One recommendation was to determine the impact of Geneva's Wastewater Treatment Plant on Cowles Creek. That recommendation was carried out and showed an adverse impact of the WWTP effluent on Cowles Creek.

EUCLID CREEK (E-2)

STREAMS AND/OR SEGMENTS IN EUCLID CREEK THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
E-2-15	Euclid Creek From the West Tributary to the Estuary	3.1 - 0.5

Euclid Creek currently violates 1983 water quality goals for fecal coliform bacteria, phenolics, lead and iron (OEPA, NEDO data, 1977-1979). The bacterial violations are probably the result of combined sewer overflows, individual septic systems and/or the Scottish Highlands Wastewater Treatment Plant in Richmond Heights. The remaining violations are probably the result of drainage from a storm sewer near the Cleveland Metal Cleaning Company. Sewer inspections have determined that the sources of contamination in this storm sewer are primarily the result of leakage from the old Rosewood Sewer and seepage from a covered waste disposal site at Cleveland Metal Cleaning.

TURKEY CREEK (F-3)

STREAMS AND/OR SEGMENTS IN TURKEY CREEK THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
F-3-7	Turkey Creek From the Pennsylvania State Line to Lake Erie	1.3 - 0.0

Turkey Creek has violations for iron, cadmium, zinc and phenolics standards for the Coldwater Habitat Use Designation (OEPA, NEDO data, 1977-1979). Only the iron concentrations were high enough to violate Ohio's Warmwater Habitat (WWH) Standards. Since there are no point source discharges within this creek, the violations must orginate from non-point sources. Turkey Creek supports a successful salmonid stocking program run by The Ohio Department of Natural Resources.

REFERENCES

Ohio Environmental Protection Agency. 1975, 1977-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

WABASH RIVER BASIN (G)

BASIN SUMMARY

Water quality in the Ohio portion of the Wabash River Basin, with the exception of Beaver Creek, is generally good. Most areas have water quality capable of supporting diverse aquatic communities. Approximately 21.7 stream miles in this basin are not expected to meet 1983 goals. The major water quality problem in the Wabash Basin is high nutrient concentrations; violations of Warmwater Habitat (WWH) standards for fecal coliforms and total iron are also common. The resulting water quality is unsuitable for primary contact recreation for most of the year.

Non-point source pollution is a major contributor to the enrichment of the Wabash River and to the eutrophication of Grand Lake St. Marys. Approximately 96% of the land within the basin is agricultural. This high percentage suggests that agricultural runoff is a significant non-point source of pollution. Periodically, large areas of Grand Lake St. Marys have dense algal growths resulting in high turbidity, discoloration, and a decreased, aesthetic value. Algal blooms also reduce water quality for public, industrial, and agricultural water supplies. The diurnal fluctuations of dissolved oxygen associated with algal blooms in the lake are detrimental to other forms of aquatic life. The environmental and water quality problems contributing to the rapid eutrophication and degradation of Grand Lake St. Marys can be attributed to: (1) agricultural runoff, (2) shallowness of the lake, (3) periods of low water levels caused by lack of rainfall, (4) poorly constructed and/or maintained private and semi-public sewage systems, (5) large numbers of wild geese and ducks inhabitating the lake, and (6) algal blooms.

STREAMS AND/OR SEGMENTS IN THE WABASH RIVER BASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
G-1	Wabash River From the headwaters to Fort Recovery	41.7 - 20.0
G-2	Mississinewa River From the headwaters to the Ohio State Line	31.4 - 0
G-4	Wabash River From Fort Recovery to the Beaver Creek confluence	13.7 - 2.7

Land-use adjacent to segments 1 and 2 is entirely agricultural; Burkettsville and New Weston are the only incorporated communities. There are no significant point sources of pollution within these segments, therefore, any water quality

degradation is due to non-point sources (OEPA, 1974). There is little water quality information available for these segments. Evaluation of segment G-4 is based upon previous reports (OEPA, 1976a, 1977).

STREAMS AND/OR SEGMENTS IN THE WABASH RIVER BASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
G-3	Wabash River a segment located at Fort Recovery	20.0 - 13.7

According to the Wabash River Basin Waste Load Allocation Report (WLAR), September, 1978 (OEPA, 1978), "the result of the computer simulations using existing flow and the equivalent of secondary effluent did not show any Water Quality Standard violations for ... this segment." Significant decreases in the loading of ammonia, suspended solids, and BOD_5 occurred after the Schmitt Fur Farms discontinued its business. The remaining point source dischargers are having problems meeting their permit requirements. Hartwig Poultry Farm has an effluent with very high ammonia levels and occasional BOD_5 and suspended solids violations. Fort Recovery Industries has frequent permit violations for free cyanide, hexavalent chromium, zinc, BOD_5, suspended solids, and oil and grease. The correction of these problems should be sufficient to meet 1983 goals.

Segment	Name/Description	Mile Points
G-8	Coldwater Creek From the headwaters to Grand Lake St. Marys	8.7 - 0.0

Coldwater Creek is characterized as a low-flow stream. During periods of lowest flow, it consists almost entirely of point source discharges. Data from a previous report (OEPA, 1974) indicated ammonia and dissolved oxygen violations, along with high levels of suspended solids, BOD_5, phosphorus, and nitrates. WLAR modeling has indicated "... the present permit for the St. Henry Wastewater Treatment Plant (WWTP) is not stringent enough to enable Water Quality Standards to be met in Coldwater Creek" (OEPA 1978). Consequently, the village of St. Henry is planning to upgrade its facilities to include nitrification and filtration. With the high degree of treatment that is proposed, the St. Henry's WWTP effluent could meet the 1983 goals.

STREAMS AND/OR SEGMENTS IN THE WABASH RIVER BASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
G-7	Hardin Creek From the Coldwater WWTP to Beaver Creek	5.7 - 0

Hardin Creek is characterized as a low-flow, intermittent stream. During periods of lowest flow, it consists entirely of point source discharges. Data from the a previous report (OEPA, 1974) indicate ammonia and dissolved oxygen violations, along with high levels of BOD_5, phosphorus, total kjeldahl nitrogen, and nitrates. WLAR modeling has indicated "... more stringent effluent limitations are required to allow WWH Water Quality Standards to be met in Hardin Creek" (OEPA, 1978). With the high degree of treatment that is proposed, Coldwater's WWTP effluent could meet 1983 goals. However, it is unlikely that wastewater treatment improvements will be completed before 1983.

Segment	Name/Description	Mile Points
G-6	Beaver Creek From the Grand Lake St. Marys' Reservoir to the Wabash River	13.0 - 0

Beaver Creek has severe water quality problems. It is a low gradient, channelized stream with poor macroinvertebrate habitat diversity (OEPA, 1974). The substrate is mucky due to the sedimentation of solids discharged by the Celina WWTP. These factors result in an extremely low assimilative capacity in Beaver Creek. Both Grand Lake St. Marys and Hardin Creek discharge to Beaver Creek. There is rarely a flow contribution from the lake during dry periods of the summer.

There is no dilution of the Celina WWTP and the Coldwater WWTP effluents during dry weather conditions. Beaver Creek experiences very high levels of nutrients and low levels of dissolved oxygen throughout its entire length during these periods. WLAR modeling has indicated "... the present permit for the Celina Wastewater Treatment Plant is not stringent enough to enable Water Quality Standards to be met in Beaver Creek. Ammonia standards violations occur below the Celina Wastewater Treatment Plant to the confluence with the Wabash River. ... Dissolved oxygen standard violations also occurred with a minimum D.O. concentration of less than 0.1 mg/l at the sag point" (OEPA, 1978).

Segment	Name/Description	Mile Points
G-5	Wabash River From the Beaver Creek confluence to the Ohio State Line	2.7 - 0

Water quality in the Wabash River declines downstream from Beaver Creek because of increased nutrient and suspended solids loading (OEPA, NWDO data, 1976b). The appearance of the river changes dramatically as it becomes more turbid, more sluggish, and wider. The river bottom material becomes softer, and there are very few riffles. Water quality standard violations for dissolved oxygen occur at the Ohio State Line (OEPA, NWDO data, 1974-1977).

REFERENCES

Ohio Environmental Protection Agency. 1974-77 (unpublished). Data from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1974. State of Ohio-Wabash River (draft) waste load allocation report for the 303(e) continuing planning process for water quality management. Ohio EPA, Northwest District Office, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1976a (unpublished). Draft 305(b) report from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1976b (unpublished). Biological investigation field notes available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1978. Wabash River Basin waste load allocation report. Ohio EPA, Columbus, Ohio 31 pp.

GREAT MIAMI RIVER BASIN

UPPER GREAT MIAMI RIVER SUBBASIN (H-1)
AND
LORAMIE CREEK SUBBASIN (H-2)

SUBBASIN SUMMARY

The Upper Great Miami River is currently monitored at only one station which is situated at U.S. 33 (RM 156.5; STORET station No. 600000). Water quality at this station is generally good; however, a few water quality standards violations have occurred in the recent past.

The Loramie Creek Subbasin also has generally good water quality, but with some metals violations and elevated nutrient concentrations.

Bokengehalas Creek is still receiving high concentrations of copper, lead, zinc, nickel, cadmium, and chromium from the Bellefontaine Wastewater Treatment Plant (WWTP) which discharges to Possum Run. One standard violation for lead, taken during a routine compliance monitoring inspection, occurred in July, 1979, immediately downstream of the plant.

STREAMS AND/OR SEGMENTS IN THE UPPER GREAT MIAMI RIVER AND LORAMIE CREEK SUBBASINS THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE UPPER GREAT MIAMI RIVER AND LORAMIE CREEK SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into these categories. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE UPPER GREAT MIAMI RIVER AND LORAMIE CREEK SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-1-1	Great Miami River From Indian Lake to the confluence of Muchnippi Creek	156.7 - 151.6

High loadings of nitrogen and phosphorus from the Indian Lake area have caused occasional algal blooms which deplete oxygen levels below 5.0 mg/l (OEPA, SEDO data, 1977-1979). Agricultural runoff and faulty septic tanks are causes of the high nutrients levels. There are plans to sewer the Indian Lake area, but it is not known whether the completion of this project will sufficiently

reduce the nutrient levels to prevent, or lessen, the occurrence of algal blooms. Iron and fecal coliform levels are also occasionally higher than current water quality standards. Natural background conditions and non-point sources are probably the largest contributors of iron.

Segment	Name/Description	Mile Points
H-2-1	Loramie Creek From Hardin Wapak Road to the Great Miami River	1.7 - 0.0

Limited sampling has revealed frequent iron violations. Natural background levels and non-point source pollution cause these elevated iron concentrations. One lead violation was observed in the 1978-1979 sampling period and a steady increase in lead concentrations has occurred over the past three years (OEPa, SWDO data, 1977-1979). There are no known reasons for this increase.

RECOMMENDATION

The existing fixed sampling site on US 33 (STORET station No. 600000; RM 156.5) should be moved to SR 274 (STORET station No. 610100; RM 153.5) to include the combined flow of two spearate outlets from Indian Lake.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

GREAT MIAMI RIVER BASIN

UPPER MAD RIVER SUBBASIN (H-3)

SUBBASIN SUMMARY

There is one monthly monitoring station (RM 28.7; STORET station No. 610040) in this subbasin and water quality at this point is generally excellent. The Ohio Department of Natural Resources has successfully stocked the Upper Mad River with fingerling rainbow trout for the past seven years, thus supporting the classification of this segment as Coldwater Habitat. Suspended solids are usually very low, with only minimal increases occurring during elevated flow periods.

STREAMS AND/OR SEGMENTS IN THE UPPER MAD RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-3-1	Mad River From the headwaters to the confluence of Buck Creek	60.2 to 25.5

Data from this segment indicated one water quality violation for lead during the 1978-1979 reporting year (OEPA, SWDO data). This sample exceeded the water quality standard by only 1 ug/l. Nutrient levels in this segment are generally low, with a slight but significant decline in phosphorus levels over the past two years. The recent initiation of phosphorus removal by the Urbana Wastewater Treatment Plant (WWTP) may explain this improvement.

The city of West Liberty Water Treatment Plant has plans to eliminate their discharge of lime sludge to the Mad River. This discharge has resulted in several citizen complaints regarding the deposition of lime sludge in the stream bed. Although the presence of this sludge in the stream is aesthetically unpleasing and is a violation of water quality standards, it seems to have no chemical toxicity. The stream bed is severely affected for a distance of about 15-100 meters and slight lime deposits are noticable as far as 2 miles downstream from the outfall.

Past heavy metals problems in Dugan's Run will be relieved due to the recent connection of the ITE Imperial Company to the Urbana WWTP.

STREAMS AND/OR SEGMENTS IN THE UPPER MAD RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE UPPER MAD RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-3-2	Buck Creek From the Beaver Creek confluence to the Mad River	6.0 - 0.0

There were a total of five standards violations in this segment during the 1977-79 reporting years. Four of these violations were caused by elevated levels of fecal coliforms and one was caused by a slightly high lead concentration (OEPA, SWDO data, 1977-1979). The high fecal coliform levels are probably caused by non-point sources and by combined sewer overflows in this area. The single lead violation was only 1 ug/l higher than the WWH standard and the average lead concentration was 21 ug/l. The source of this metal is probably urban runoff, which is not expected to be corrected before 1983.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

GREAT MIAMI RIVER BASIN

MIDDLE GREAT MIAMI RIVER SUBBASIN

AND LOWER MAD RIVER SUBBASIN (H-4, 5)

SUBBASIN SUMMARY

There were two monthly sampling stations on the Great Miami River during the reporting period. One station, located just below Piqua (STORET station No. 600090; RM 110.3), was discontinued after December, 1978. Monitoring was begun at the Taylorsville station (STORET station No. 610050; RM 90.7) in October, 1978.

Water quality in the Mad River below Springfield begins to decline due to numerous industrial and municipal point sources, combined sewers, and urban runoff. Monthly monitoring reports from the Springfield Wastewater Treatment Plant (WWTP) show numerous violations for ammonia at the confluence of the Mad River and Buck Creek. Pollution loadings in some of the lower Mad River tributaries will be reduced by the S.W. Clark County Regional WWTP, which is currently under construction. This project will eliminate many smaller plants which are currently overloaded.

STREAMS AND/OR SEGMENTS IN THE MIDDLE GREAT MIAMI RIVER SUBBASIN AND THE LOWER MAD RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE MIDDLE GREAT MIAMI RIVER SUBBASIN AND THE LOWER MAD RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this basin presently fall into these categories. However, water quality in a some portions of this basin has not been determined.

STREAMS AND/OR SEGMENTS IN THE MIDDLE GREAT MIAMI RIVER SUBBASIN AND THE LOWER MAD RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET THE 1983 GOALS

Segment	Name/Description	Mile Points
H-5-1	Great Miami River From Piqua to Troy	112 - 105

Water quality data was collected 1.6 river miles below the Piqua WWTP. Because of this discharge, several standard violations have occurred for fecal coliforms and one violation occurred for both dissolved oxygen and ammonia (OEPA, SWDO data, 1977-1978). The Piqua WWTP is currently in the Construction Grant Program for upgrading the facility, but no changes are expected prior to 1983.

Iron levels will continue to be a problem in this segment due to natural background levels and/or non-point sources.

Segment	Name/Description	Mile Points
H-5-2	Great Miami River from Tipp City to the Ohio Surburban WWTP	95 - 86

Limited sampling suggests that iron will occasionally exceed Warmwater Habitat (WWH) standards in this segment (OEPA, SWDO data, 1977-1979). The source of this metal is probably non-point pollution, and is not expected to be controlled prior to 1983. Fecal coliforms will also continue to be a problem in this segment due to the proximity of the Vandalia WWTP. Plans are currently being developed to abandon this plant by tying into the proposed MCD North Regional WWTP. Completion of this project will not occur before 1983.

Segment	Name/Description	Mile Points
H-4-4	Mad River from the Fairborn WWTP to Eastwood Park	9.0 - 0.0

Several standard violations for dissolved oxygen occurred in the summer months of 1977 (USGS, 1977). Since that time, however, there have been no further violations for this parameter (USGS, 1978). Changes in the operation of the Fairborn Wastewater Treatment Plant (WWTP) and/or flow conditions may explain this improvement. The average fecal coliform count for this segment was acceptable; however, two standard violations occurred in 1978-79. These occasional violations will continue to occur until the Fairborn WWTP is upgraded sometime after 1983. The plant is located approximately 4 stream miles above the sampling station.

One iron violation occurred in this segment. Natural background levels and non-point sources were probably responsible for the violation, and no improvement is expected prior to 1983. Lead concentrations are generally high in this segment and there was one water quality violation for this parameter. Urban runoff is probably the main contributor, since there are no known point sources of this metal in this segment.

RECOMMENDATION

A special survey should be conducted on the lower Mad River between Springfield and Dayton to determine the impact of the Springfield WWTP on water quality in this segment.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

United States Geological Survey. 1977. Water resources data for Ohio, water year 1977, Vol. 1. Ohio River Basin. Water Data Report OH-77-1. U.S. Geological Survey, Columbus, Ohio.

United States Geological Survey. 1978. Water resources data for Ohio, water year 1978, Vol. 1. Ohio River Basin. Water Data Report OH-78-1. U.S. Geological Survey, Columbus, Ohio.

GREAT MIAMI RIVER BASIN

STILLWATER RIVER SUBBASIN (H-6, 7)

SUBBASIN SUMMARY

There are two sampling stations in this subbasin. One station is a quarterly site on Greenville Creek (RM 1.5; STORET station No. 600060), and the other is a monthly site located on the Stillwater River (RM 8.9; STORET station No. 600110) (sampling began in October, 1978). Overall water quality is similar to that in the Great Miami River drainage above Dayton.

STREAMS AND/OR SEGMENTS IN THE STILLWATER RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE STILLWATER RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin currently fall into these categories. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE STILLWATER RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-7-1	Greenville Creek From Gettysburg to the Stillwater River	10.0 - 0.0

Lead appears to be a significant problem in this stream. Fifty percent of the lead samples collected in this segment were in violation of the Warmwater Habitat standard. More sampling will be required to determine the source of pollution. A single violation for iron has also been recorded. This segment could meet the 1983 goals if these metal problems were eliminated, but corrective action prior to 1983 is unlikely.

Segment	Name/Description	Mile Points
H-6-1	Stillwater River From Martindale to the Englewood Dam	11.4 to 9.0

There were two standard violations for fecal coliforms in this section. One iron sample was also higher than the standard. Both of these violations are probably the result of non-point pollution. Water quality problems in this segment do not appear to be severe, and may not prevent the attainment of 1983 goals.

Segment	Name/Description	Mile Points
H-6-2	Brush Creek From the headwaters to Ludlow Creek	8.0 - 0.0

Water quality in Brush Creek has been severely degraded as result of the discharge from the K&S Circuits plant in Phillipsburg. Copper concentrations as high as 125,000 ug/l (monthly operation reports) have been discharged to Brush Creek via a storm sewer. A survey conducted by OEPA in the summer of 1979 indicated obvious signs of biological damage and sediment contamination for at least 5.0 miles downstream (OEPA, SWDO data, 1979). This discharge will be eliminated before 1983 and therefore significant improvements in water quality are expected. However, due to septic tank discharges, other non-point pollution, and the natural low flow of the stream, this stream segment is not expectred to meet 1983 goals.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

GREAT MIAMI RIVER BASIN

TWIN CREEK SUBBASIN (H-8)

SUBBASIN SUMMARY

Water quality in the Twin Creek Subbasin is generally good and the 1983 goals are expected to be met. However, heavy metal pollution of undetermined origin will keep this stream from attaining Exceptional Warmwater Habitat (EWH) standards. This subbasin is still largely rural, with agricultural runoff being a major source of nutrients. Point sources consist of small, secondary sewage treatment plants at Lewisburg, West Alexandria, and Farmersville. There are no known point source dischargers of heavy metals.

STREAMS AND/OR SEGMENTS IN THE TWIN CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-8-1	Twin Creek From the Bantas Fork confluence to the Great Miami River	22.3 - 0.0

In August, 1977, the Germantown Wastewater Treatment Plant (WWTP) was abandoned and connected to the Franklin WWTP. The water quality for Twin Creek at Dayton-Oxford Road (RM 0.8) after this date has improved (i.e., there have been no violations for fecal coliforms). However, there have been EWH standards violations for metals (copper, lead, and zinc) and for phenolics (OEPA, SWDO data, 1977-1979). Also, a special sampling of Twin Creek, in 1978, showed violations for copper at North Factory Road (RM 23.0) and at S.R. 4 (RM 5.8) (OEPA, SWDO data, 1978).

Twin Creek from Bantas Fork (RM 22.3) to the mouth will not meet EWH standards because of continued copper and lead violations. These violations are not severe enough to prevent attainment of 1983 goals.

STREAMS AND/OR SEGMENTS IN THE TWIN CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE TWIN CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in some portions of this subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

GREAT MIAMI RIVER BASIN (LOWER PART OF MIDDLE PORTION) (H-9)

SUBBASIN SUMMARY

Overall water quality in this part of the Great Miami River ranges from fair to poor. Water quality is fair upstream from the Dayton Wastewater Treatment Plant (WWTP), with occasional Warmwater Habitat (WWH) standards violations resulting from the Ohio Suburban WWTP and the discharge of the Dayton storm sewer system. There are numerous municipal and industrial discharges downstream from the Dayton WWTP. These discharges result in the most severe water quality degradation of any segment in the entire Great Miami Basin. Water quality improves between Franklin and Hamilton; however, frequent violations of water quality standards result in a rating of "poor". The Dicks Creek Subbasin is severely degraded as a result of persistent and non-persistent toxic substances discharged from Armco-Middletown Steel Works.

STREAMS AND/OR SEGMENTS IN THE GREAT MIAMI RIVER BASIN (LOWER PART OF MIDDLE PORTION) THAT CURRENTLY MEET 1983 GOALS

None of the segments monitored in this subbasin presently meet 1983 goals. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE GREAT MIAMI RIVER BASIN (LOWER PART OF MIDDLE PORTION) THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this basin presently fall into this category.

STREAMS AND/OR SEGMENTS IN THE GREAT MIAMI RIVER BASIN (LOWER PART OF MIDDLE PORTION) THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-9-1	Great Miami River From the Ohio Suburban WWTP to the Dayton WWTP	86.0 - 76.0

The areas drained by this segment are both rural and urban. The water quality in this segment is fair, with the main water quality problem resulting from the Ohio Suburban WWTP (RM 86.2). Urban runoff from the Dayton storm sewer network may also be a substantial problem. Water quality standards violations were noted for dissolved oxygen, fecal coliforms, and phenolics (OEPA, SWDO data, 1977-1979). Data from the U.S. Geological Survey (USGS) continuous monitor in Dayton (RM 78.0) indicated that daily minimum dissolved oxygen concentrations are occasionally below the 5.0 mg/l standard during summer months (USGS, 1977-1978).

The Miami Conservancy District's North Regional WWTP is planned to replace the Ohio Suburban WWTP (as well as the Vandalia and Tipp City Wastewater Treatment Plants) resulting in reduced organic loading. This project is entering Step II in the construction grant process and is not projected to be completed until after 1983. Therefore, this segment will not meet 1983 goals.

Segment	Name/Description	Mile Points
H-9-2	Great Miami River From the Dayton WWTP to Franklin	76.0 - 60.0

Land-use within this segment is predominately urban. Water quality is severely degraded as a result of numerous municipal and industrial dischargers. Major municipal dischargers include the Dayton, Moraine, West Carrollton, and Miamisburg Wastewater Treatment Plants. Major industrial dischargers include the Bergstrom Paper Company, Miami Paper Company, Dayton Power and Light - Tait Station, and Dayton Power and Light - Hutchings Station. The high density of dischargers in this segment results in the poorest water quality of any segment in the Great Miami Basin. Water quality standards violations were noted for dissolved oxygen, ammonia, fecal coliforms, and phenolics (OEPA, SWDO data, 1977-1979). Data from the USGS continuous monitor at Miamisburg (RM 66.4) indicated a severe dissolved oxygen and temperature problem. During summer months the daily maximum recorded value was frequently below 5.0 mg/l (USGS, 1977-1978).

Water quality improvements are expected in this segment in September, 1979, with the opening of the Montgomery County Western Regional WWTP. The Montgomery County Plant, which provides tertiary treatment, will replace the Moraine WWTP which is severely overloaded and in deteriorated condition. No decision has been made regarding the possible abandonment of the other treatment plants in this area. The Dayton WWTP is entering Step II of the construction grant process to upgrade their treatment facility. These planned improvements will not be completed prior to 1983. The abandonment of the Moraine WWTP will result in improved water quality with fewer dissolved oxygen, ammonia, and fecal coliform violations.

However, the wastewater treatment improvements cited above are insufficient, with respect to meeting 1983 goals. Parameters that will continue to violate water quality standards as a result of point sources include dissolved oxygen, temperature, fecal coliforms, and phenolics; iron and lead violations will continue from non-point sources.

Segment	Name/Description	Mile Points
H-9-3	Great Miami River From Franklin to Hamilton	60.0 - 36.0

The area drained by this segment is both urban and rural. Major municipal dischargers include the Franklin Regional, Middletown, and LeSourdsville Regional Wastewater Treatment Plants. Major industrial dischargers include Armco-Middletown Works and Crystal Tissue.

Limited data indicated water quality standards violations for phenolics, cyanide, iron, and lead (OEPA, SWDO, 1977-1979). In addition, data from the USGS continuous water quality monitor at Rockdale (RM 43.7) indicated frequent, daily minimum dissolved oxygen concentrations less than 5.0 mg/l during summer months (USGS, 1978). Occasional temperature violations were also noted at this monitor during 1977.

Water quality improvements should result from the addition of a clarifier and filtration unit on the 001 outfall of Armco-Middletown Works (RM 50.6) and the addition of a trickling filter to Crystal Tissue's wastewater treatment system (RM 47.0). However, the Miller Brewing Company is planning to build a brewery which will discharge at river mile 42.6. The additional organic loading from this discharge may result in more frequent dissolved oxygen violations.

Parameters that will continue to violate standards include dissolved oxygen, fecal coliforms, phenolics, iron, and lead.

Segment	Name/Description	Mile Points
H-9-4	Dicks Creek From the Armco Steel outfalls to the Great Miami River	6.0 - 0.0

This stream drains urban and rural areas surrounding the communities of Middletown and Monroe. Although the Monroe WWTP discharge results in localized degradation of Millers Creek, the main water quality problem in Dicks Creek is due to the four outfalls from the Armco-Middletown Works. These discharges resulted in water quality standards violations for cyanide, phenolics, ammonia, iron, cadmium and zinc; lead violations in this portion of the subbasin were most likely the result of urban runoff (OEPA, SWDO data, 1977-1979).

The Monroe WWTP will be connected to the LeSourdville Regional WWTP prior to 1983, eliminating localized degradation and reducing the number of point source related fecal coliform violations. Armco is presently upgrading treatment systems, as stated in their compliance schedule, which should result in an overall improvement in water quality. However, the combined effects of these point discharges, non-point sources, and little natural dilution will prevent Dicks Creek from meeting 1983 goals. Water quality standards for cyanide, phenolics, ammonia, fecal coliforms, iron, lead, and zinc will continue to be exceeded.

RECOMMENDATIONS

1. An updated certified wasteload allocation is needed for the entire segment between Dayton and Hamilton.
2. A new monthly monitoring station should be established on the Great Miami River below Middletown at RM 42.4.
3. The Dicks Creek monthly station at RM 2.5 should be changed to a quarterly monitoring station.
4. Additional baseline water quality data should be collected in the area of the future Miller Brewery discharge. This information will be important in determining the actual impact of this discharge once this plant is on line.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

United States Geological Survey. 1977. Water resources data for Ohio, water year 1977, Vol. 1. Ohio River Basin. Water Data Report OH-77-1. U.S. Geological Survey, Columbus, Ohio.

United States Geological Survey. 1978. Water resources data for Ohio, water year 1978, Vol. 1. Ohio River Basin. Water Data Report OH-78-1. U.S. Geological Survey, Columbus, Ohio.

GREAT MIAMI RIVER BASIN

FOUR MILE CREEK SUBBASIN (H-10)

SUBBASIN SUMMARY

In general, water quality in this subbasin ranges from excellent to poor. Approximately 15.0 stream miles in this subbasin are not expected to meet 1983 goals. Municipal wastewater treatment plants (WWTPs), package plants and agricultural runoff have major effects on water quality.

STREAMS AND/OR SEGMENTS IN THE FOUR MILE CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-10-1	Four Mile Creek From the Action Lake Dam to the Oxford WWTP	19.8 to 15.0

The Ohio EPA does not routinely monitor water quality in this segment. However, a grab sample taken upstream from the Oxford WWTP in May 1979 (OEPA Compliance Monitoring Report, SWDO data, 1979) indicated good water quality. Also, benthic populations of caddisfly larvae and mayfly nymphs were found at this location (OEPA, SWDO data, 1979).

Agricultural runoff contributes to moderate nutrient levels in this segment. Water quality may be degraded during low flow periods, because the Acton Lake Dam retains flow that would provide natural dilution.

Segment	Name/Description	Mile Points
H-10-2	Seven Mile Creek From the Big Cave Run confluence to Four Mile Creek	8.3 - 0.0

Water quality in this segment is generally excellent. Only two violations (fecal coliforms and cyanide) at Taylor School Road (RM 1.3; STORET station No. 600340) have been recorded (OEPA, SWDO data, 1977-1979). Most of this segment drains agricultural and rural areas, and these violations are most likely the result of non-point source pollution.

STREAMS AND/OR SEGMENTS IN THE FOUR MILE CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
H-10-3	Seven Mile Creek From the Eaton WWTP to the Beasley Run confluence	24.6 - 15.5

Water quality in this segment is poor due to ineffective sewage treatment at the Eaton WWTP. A 1975 survey of Seven Mile Creek indicated that significant degradation occurred downstream from the Eaton WWTP discharge to S.R. 127 (RM 23.0) (OEPA, SWDO data, 1975). The survey results indicated violations for fecal coliforms and ammonia. The city of Eaton has received a Step III Construction Grant for upgrading its WWTP to tertiary treatment (rapid sand filters and nitrification). The improved wastewater treatment should result in the attainment of 1983 goals in this segment of Seven Mile Creek.

STREAMS AND/OR SEGMENTS IN THE FOUR MILE CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-10-4	Four Mile Creek From the Oxford WWTP to the Great Miami River	15.0 - 0.0

Water quality in this segment is generally good, however, localized problems in Oxford and New Miami will keep this segment from attaining 1983 goals. Water quality data for Four Mile Creek at Jacksonburg Road (RM 0.4; STORET station NO. 600260) indicated violations for fecal coliforms, copper, and lead (OEPA, SWDO data, 1977-1979). The Cherokee Park WWTP (RM 0.5) in New Miami was the probable source of the fecal coliform violations. Upgrading of this plant will not occur before 1983.

The metals violations were the result of non-point sources, as there are no known industrial dischargers in this subbasin.

Water quality data for the upper portion of this segment are lacking, but problems occur as a result of the Oxford WWTP. During low flow periods, the WWTP discharge can result in depressed levels of dissolved oxygen and high concentrations of ammonia in Four Mile Creek. Upgrading of this plant will not occur before 1983.

Overall, this segment will not meet the 1983 goals because of fecal coliform and metals violations.

REFERENCES

Ohio Environmental Protection Agency. 1975, 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

GREAT MIAMI RIVER BASIN

LOWER GREAT MIAMI RIVER SUBBASIN (H-11)

SUBBASIN SUMMARY

Overall water quality in this portion of the Great Miami River Basin ranges from exceptional to poor. The water quality in the Great Miami River from Hamilton to the mouth is poor due to industrial, municipal and non-point source discharges. However, improvements in wastewater treatment at both industrial and municipal sources are resulting in an overall improvement in water quality. This improvement should continue with time. Water quality in the Indian Creek Subbasin and the Whitewater River is exceptional.

STREAMS AND/OR SEGMENTS IN THE LOWER GREAT MIAMI RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-11-1	Indian Creek From the Indiana/Ohio State Line to the Great Miami River	22.9 - 0.0

The area drained by this segment is mainly rural. Water quality in this subbasin over the past two years has been exceptional. Standards applied to this subbasin are more stringent than 1983 goals. During the past two years, the only violation of Exceptional Warmwater Habitat (EWH) water quality standards was for lead (OEPA, SWDO data, 1977-1979). The source of this violation has not been determined. This minor violation does not interfere with 1983 goals.

A small number of minor, point sources discharge into Indian Creek. No improvements or changes are planned at these discharges before 1983.

Segment	Name/Description	Mile Points
H-11-2	Whitewater River From the Indiana/Ohio State Line to the Great Miami River	6.0 - 0.0

Water quality in this segment has been exceptional, with only one violation of water quality standards noted during the past two years (OEPA, SWDO data, 1977-1979). The violation was for ammonia and the source of this violation has not been determined. No changes in water quality are expected before 1983.

STREAMS AND/OR SEGMENTS IN THE LOWER GREAT MIAMI RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE LOWER GREAT MIAMI RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
H-11-3	Great Miami River From Black Street Bridge to the Hamilton WWTP	36.2 - 33.0

Water quality in this segment is poor. The major point source discharger is the Armco - New Miami Works near Hamilton. Water quality standards violations have been noted for phenolics, cyanide, ammonia, iron, and copper (OEPA, SWDO data, 1977-1979). In mid-1979, Armco installed a biological treatment system to treat coke oven wastes. This system should reduce the overall loading of phenolics, cyanide, and ammonia to this segment resulting in an improvement in water quality.

Non-point sources, such as urban and agricultural runoff, are the most likely cause of lead, iron, and fecal coliform violations. Upstream municipal discharges also contribute to fecal coliform loadings.

Although considerable improvements are expected, this segment is not expected to meet 1983 goals. Parameters that will continue to result in water quality standards violations include phenolics, iron, lead, and fecal coliforms.

Segment	Name/Description	Mile Points
H-11-4	Great Miami River From the Fairfield WWTP to the Gulf Oil Refinery	31.0 - 8.5

The drainage area of this segment is both urban and rural. Dischargers in this segment include the Hamilton and Fairfield Wastewater Treatment Plants (WWTP) and the Department of Energy Feed Materials Production Center. Data for this segment were collected by the OEPA (SWDO data, 1977-1979) and USGS at New Baltimore (STORET station No. 600030; RM 20.8). Water quality in this segment is classified as poor, with water quality standards violations noted for dissolved oxygen, fecal coliforms, phenolics, cyanide, iron, and lead. Municipal discharges are the most probable cause of the dissolved oxygen and fecal coliform violations. The data from the USGS continuous monitor indicates that the daily, minimum dissolved oxygen concentrations are occasionally below the 5.0 mg/l standard during the summer months; temperature standards were also violated in 1977 (USGS, 1977, 1978).

Non-point runoff and/or natural background conditions are the most likely source of the iron violations. A large number of lead violations, one as high as 100 mg/l, have been noted in this segment. Although lead concentrations appear to increase near urban areas, violations of this magnitude are unusual. The source of these high levels is not known.

The Hamilton WWTP has undergone expansion in order to provide secondary treatment of the Champion Paper Company's 10 mgd industrial wastewater discharge, as well as to upgrade the treatment of municipal waste. This improvement should result in a significant reduction in the BOD and suspended solids loading to the Great Miami River. The expansion is completed, but solids handling problems have resulted in frequent discharges of primary, industrial effluent to the river. When these problems are solved, improvments in water quality, especially relating to dissolved oxygen, should be noted.

Although improvements in water quality are expected, this segment is not expected to meet 1983 goals. Water quality standards violations will continue to be noted for iron, lead, fecal coliforms and phenolics.

Segment	Name/Description	Mile Points
H-11-5	Great Miami River From the Gulf Oil Refinery to the Ohio River	8.5 - 0.0

The area drained by this segment is mainly rural with isolated industrial development. The only discharger in this segment is the Gulf Oil Refinery (RM 8.5). Water quality data for this segment were collected by the OEPA (OEPA, SWDO data 1977-1978) and the Ohio River Valley Water Sanitation Commission. Water quality in this segment is classified as poor, with water quality standards violations noted for cyanide, phenolics, fecal coliforms, iron, and lead. The phenolics violations may be related to the Gulf Oil discharge, although levels do not exceed those found in upstream segments. The other violations are most likely related to upstream dischargers and non-point sources, such as agricultural and urban runoff.

No changes are anticipated in the wastewater treatment systems in this segment before 1983. Therefore, this segment will not meet 1983 goals. Problem parameters include fecal coliforms, iron, lead and phenolics.

REFERENCES

Ohio Environemental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

United States Geological Survey. 1977. Water resources data for Ohio, water year 1977, Vol. 1. Ohio River Basin. Water Data Report OH-77-1. U.S. Geological Survey, Columbus, Ohio.

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MILL CREEK BASIN (J)

BASIN SUMMARY

Overall water quality in this basin ranges from fair to poor. Water quality in the upper segment is fair with water quality standards violations resulting from package sewage treatment plants and non-point sources. Water quality in the lower segment is severely degraded, primarily as a result of combined sewer overflows of municipal and industrial wastes. Additional sources of pollutants include urban runoff, and industrial and municipal dischargers.

STREAMS AND/OR SEGMENTS IN THE MILL CREEK BASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE MILL CREEK BASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this basin presently fall into these categories. However, water quality in some portions of this basin has not been determined.

STREAMS AND/OR SEGMENTS IN THE MILL CREEK BASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
J-1	Mill Creek From the headwaters to Sharon Road	28.1 - 16.8

The area drained by this segment is presently agricultural and residential in nature. Land use is rapidly being converted to residential subdivisions. Non-point pollution, such as urban and agricultural runoff, is probably a contributing factor in the Warmwater Habitat (WWH) violations for iron, lead, and fecal coliforms. Package sewage treatment plants discharge to several, small tributaries, resulting in localized degradation of the receiving streams. The streams recover fairly rapidly so that only fecal coliform and phenolics violations of WWH water quality standards have been recorded at Tylersville Road (RM 24.8; STORET station No. 600440) (OEPA, SWDO data, 1977-1979). Most of these package plants will be abandoned in the fall of 1980 with the opening of the Butler County Upper Mill Creek Regional Wastewater Treatment Plant. This plant will eliminate localized degradation and reduce the number of fecal coliform and phenolics violations.

Although the overall water quality in this segment is expected to improve, pollutants from non-point sources and the natural low flow of the stream will result in this segment not meeting 1983 goals. Parameters that will continue to result in occasional water quality standards violations include iron and fecal coliforms.

Segment	Name/Description	Mile Points
J-2	Mill Creek From Sharon Road to the Ohio River	16.8 - 0.0

The lower Mill Creek watershed is entirely urban, consisting of both residential and industrial developments. The stream is severely degraded as a result of combined sewer overflows, urban runoff, and municipal and industrial discharges.

Most of the lower Mill Creek drainage area is served by combined sewers which divert domestic and industrial wastewater to the Ohio River via the Mill Creek Wastewater Treatment Plant. However, during rain events, these sewers become overloaded and discharge into Mill Creek contributing to water quality standards violations for dissolved oxygen, fecal coliforms, MBAS, ammonia, cyanide, phenolics, chromium, copper, iron, and zinc. In accordance with U.S. EPA program requirements, combined sewer overflow studies have been initiated by the Metropolitan Sewer District to determine the most cost effective method of treating the overflows. No overall change in water quality from combined sewers is expected before 1983, despite minor sewer improvements under construction.

Urban runoff from the Cincinnati area is the most likely cause of lead and some oil and grease violations. Violations from this source are expected to continue. Discharges from municipal and industrial sources contribute to water quality standards violations of phenolics, ammonia, oil and grease, and some metals. Some improvements expected before 1983 include:

1. The city of Glendale is presently studying methods to improve the treatment of domestic wastewater.
2. The Formica Corporation is working on methods to reduce the concentration of phenolics in their cooling water discharges.
3. Discharges and runoff from the Pristine/Cincinnati Drum Facility represents a significant source of metals and organic compounds to Mill Creek. This source will either be eliminated or limited to appropriate NPDES permit limits by 1983.

The overall water quality in the lower Mill Creek segment is not expected to change significantly due to the severity of the combined sewer overflow problem. Therefore, this segment will not meet 1983 goals.

RECOMMENDATION

The monthly monitoring station located at Tylersville Road (RM 24.5) should be moved downstream to Sharon Road (RM 16.8) in order to better assess a larger portion of the headwaters. In addition, this station would be located downstream from the Butler County Upper Mill Creek Regional WWTP which will begin discharging in the fall of 1980.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

LITTLE MIAMI RIVER BASIN

UPPER LITTLE MIAMI RIVER SUBBASIN (K-1)

STREAMS AND/OR SEGMENTS IN THE UPPER LITTLE MIAMI RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-1-1	Little Miami River From the headwaters to Fairgrounds Road	105.5 - 75.4

Water quality in this segment is good. Occasional Warmwater Habitat (WWH) standards violations for iron and fecal coliforms and one violation for copper have occurred (OEPA, SWDO data, 1977-1979).

Non-point runoff and septic tank systems are the probable pollution sources. The South Charleston Wastewater Treatment Plant (WWTP) discharges into Gilroy Ditch, a tributary to the Upper Little Miami River. Water quality monitoring has revealed no WWH standards violations in Gilroy Ditch (OEPA, SWDO data, 1979), even though initial wasteload modeling indicates potential, dissolved oxygen (D.O.) and ammonia problems. Preliminary testing revealed high total residual chlorine concentrations in Gilroy Ditch below the WWTP; further study is needed to assess the degree of the problem. Based upon available data, it appears that this segment presently meets 1983 goals.

STREAMS AND/OR SEGMENTS IN THE UPPER LITTLE MIAMI RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
K-1-2	Massies Creek From the Central State University WWTP to the Little Miami River	4.5 - 0.0

Infrequent fecal coliform violations occurred in Massies Creek at RM 0.2 (STORET station No. 600560) due to Central State University WWTP's poor operation (OEPA, SWDO data, 1976-1977). The plant was originally designed for an average daily flow of 250,000 gallons and currently receives an estimated 350,000 gpd. The city of Xenia and Greene County have received a Step III Construction Grant for the construction of the Oldtown Creek and Wilberforce Community Interceptor, which will go to the Xenia Ford Road WWTP. The completion of this project will eliminate the Central State University WWTP and most of the individual on-lot disposal systems in this area. The project should improve the water quality of Massies Creek from RM 4.5 to 0.0, as well as the Little Miami River, prior to 1983.

STREAMS AND/OR SEGMENTS IN THE UPPER LITTLE MIAMI RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-1-3	Little Miami River From Fairgrounds Road to S.R. 725	75.4 - 64.1

This segment is degraded by three major municipal WWTP discharges (Xenia Road WWTP, Montgomery County Eastern Regional WWTP, and Greene County-Beavercreek WWTP) and urban runoff. Fecal coliforms, lead and iron violations occurred in the mainstem at Upper Bellbrook Road (OEPA, SWDO data, 1978-1979). The Ohio EPA found standards violations for dissolved oxygen, ammonia, lead, pH, and phenolics in Little Beaver Creek (RM 0.1) below the Montgomery County Eastern Regional Plant (OEPA, SWDO data, 1977). The Ohio EPA also responded to many citizen complaints in this area.

Violations for dissolved oxygen, fecal coliforms, metals (iron, mercury and zinc), MBAS, ammonia, and phenolics have been reported in Beaver Creek (RM 0.1) below the Green County-Beaver Creek WWTP, (OEPA, SWDO, 1977-1979). The Green County-Beaver Creek WWTP has tertiary treatment capability (microstrainers) but, because of maintanence problems, the plant usually has only secondary treatment. The point and non-point sources in this segment also cause high nutrient levels in the Little Miami River.

Segment	Name/Description	Mile Points
K-1-4	Little Miami River From S.R. 725 to confluence of Caesar Creek	64.1 - 50.2

Water quality in this segment is degraded from upstream loading, as well as from discharges from the Greene County Sugarcreek Regional WWTP and the Xenia Glady Run WWTP. The Greene County Sugarcreek Regional WWTP, which went on-line in October, 1977, has eliminated the Montgomery County Sugar Creek Regional WWTP, the Winterhaven WWTP, the Bellbrook WWTP and the Academy Heights WWTP. The Greene County Sugarcreek WWTP has tertiary treatment (Chemical addition; microstrainers, on-line June, 1979) but infiltration and inflow problems during periods of excessive flow have caused non-compliance with their NPDES permit.

Water quality data for the Little Miami River at Roxanna-New Burlington Road (RM 59.4; STORET station No. 600600) showed standards violations for total iron, fecal coliforms and phenolics (Ohio EPA, SWDO data, 1977-1979). As would be expected, nutrient levels were also high during this time. In addition to the Ohio EPA data, the U.S. Geological Survey (USGS) has a four parameter continuous water quality monitoring station at this location. USGS data shows that numerous dissolved oxygen violations occurred here in water years 1977 and 1978 (USGS, 1977-1978).

RECOMMENDATION

An updated certified wasteload allocation is needed for this segment. A major concern is nitrification justification for AST review.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

United States Geological Survey. 1977. Water resources data for Ohio, water year 1977, Vol. 1. Ohio River Basin. Water Data Report OH-77-1. U.S. Geological Survey, Columbus, Ohio.

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LITTLE MIAMI RIVER BASIN

CAESAR CREEK SUBBASIN (K-2)

STREAMS AND/OR SEGMENTS IN THE CAESAR CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-2-1	Caesar Creek Reservoir Dam to the Little Miami River	3.0 - 0.0

Water quality in this segment is very good based on data collected at Corwin Road (RM 0.2; STORET station No. 600550) (OEPA, SWDO data, 1977-1979). Only one violation of the standard for fecal coliforms occurred during two years of monitoring. The most salient change in the Caesar Creek Subbasin was the completion of the Caesar Creek Reservoir in May, 1978. This project has not affected downstream water quality. The Ohio EPA has not sampled the upper Caesar Creek basin, or the Caesar Creek Lake. The absence of any major point source discharges suggests the headwaters of the Caesar Creek Subbasin may meet 1983 goals.

STREAMS AND/OR SEGMENTS IN THE CAESAR CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE CAESAR CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin are expected to fall below the 1983 goals.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

LITTLE MIAMI RIVER BASIN

TODD FORK SUBBASIN (K-3)

SUBBASIN SUMMARY

STREAMS AND/OR SEGMENTS IN THE TODD FORK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-3-1	Todd Fork From the confluence of Lytle Creek to the Little Miami River	18.6 - 0.0

Water quality in Todd Fork ranges from good to excellent and the 1983 goals are currently being met. However, pollutant loading from Lytle Creek prevents this segment of Todd Fork from attaining the more stringent, Exceptional Warmwater Habitat (EWH) standards. Zinc, and perhaps other heavy metals, occur at slightly elevated concentrations due to industrial discharges in Wilmington (OEPA, SWDO data, 1978). Wastewater treatment improvements in the city of Wilmington are expected prior to 1983 which should result in EWH Standards being maintained in Todd Fork.

STREAMS AND/OR SEGMENTS IN THE TODD FORK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
K-3-2	Lytle Creek From the Wilmington WWTP to Todd Fork	7.3 - 0.0

Water quality problems occur in this segment because of the Wilmington Wastewater Treatment Plant (WWTP) and the concentration of industry in this area. Lytle Creek is severely degraded below the Wilmington WWTP, both chemically and biologically. A special study noted Warmwater Habitat (WWH) violations for ammonia, lead and zinc below the WWTP discharge (OEPA, SWDO data, 1978). A zinc violation of the Exceptional Warmwater Habitat standards also occurred at RM 0.2 of Todd Fork during this study. Quantitative benthic samples taken below the WWTP contained low numbers of taxa and low diversity indices. Industrial users, such as the Randall Company, the Irwin Auger and Bit Company, and others, are the contributing sources of the metals. On August 20, 1978, the city of Wilmington put an industrial pretreatment ordinance into effect to curb the high levels of metals entering the WWTP and, subsequently, into Lytle Creek. The water quality of Lytle Creek in Wilmington is also affected by the Crysteco Company, which discharges to an unnamed tributary of Lytle Creek. Standards violations in the tributary below Crysteco included pH, total chromium and hexavalent chromium. The discharge has not been eliminated at this time. It is assumed that this discharge will

eventually go to the sanitary sewer and be regulated under the city of Wilmington's Industrial Pretreatment Ordinance. Water quality in this segment should meet 1983 goals when all of the industries in the Wilmington area are on-line with their pretreatment systems.

STREAMS AND/OR SEGMENTS IN THE TODD FORK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-3-3	Second Creek From the Blanchester WWTP to Todd Fork	9.6 - 0.0

Local water quality problems occur in Second Creek below the Blanchester WWTP. A special study showed that the plant effluent resulted in standards violations for dissolved oxygen, fecal coliforms and total copper at RM 9.4 (OEPA, SWDO data, 1978). Benthic samples taken at this location were dominated by oligochates and chironomids, indicating biological degradation. The Blanchester WWTP will not be incorporating any changes in their treatment processes before 1983.

RECOMMENDATIONS

A special sampling of Todd Fork and Lytle Creek is needed to evaluate improvements made to the Wilmington WWTP and to assess the need for regional monitoring station.

REFERENCES

Ohio Environmental Protection Agency. 1978 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

LITTLE MIAMI RIVER BASIN

EAST FORK OF LITTLE MIAMI RIVER SUBBASIN (K-4)

STREAMS AND/OR SEGMENTS IN EAST FORK OF LITTLE MIAMI RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN EAST FORK OF THE LITTLE MIAMI RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN EAST FORK OF LITTLE MIAMI RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-4-1	East Fork of Little Miami River From I-275 to the Little Miami River	3.5 - 0.0

Water quality in this segment is generally good. Until November, 1977, the Ohio EPA maintained a monthly monitoring station at I-275 (RM 3.5; STORET station No. 600590) on the East Fork. Water quality data showed only fecal coliform violations from July 1977 to November 1977 (OEPA, SWDO data, 1977). The fecal coliform violations were probably the result of poor treatment by several package plants. In February, 1978, the Ohio EPA began sampling at RM 0.8 near Terrace Park in order to assess the impact of the Milford WWTP discharge. Water quality data for the East Fork at this station (STORET station No. 610530) indicated infrequent violations for fecal coliforms and frequent violations for total iron (OEPA, SWDO data, 1978-1979). On July 3, 1979, the Lower East Fork Regional Wastewater Treatment Plant (WWTP) went on-line and eliminated many package plants (Hall Run Sewage Treatment Plant (STP), Summerville STP, Viking Village STP, Sugar Camp Run STP, and the Shayler Run STP). The Lower East Fork Regional WWTP has secondary treatment in the form of rotation biological contactors and tertiary treatment via chemical addition and rapid sand filters. This plant should improve the water quality of this section of East Fork, especially with respect to bacterial contamination. However, iron violations will likely persist.

The East Fork Reservoir Project was completed in January, 1979.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

LITTLE MIAMI RIVER BASIN

LOWER LITTLE MIAMI RIVER SUBBASIN (K-5)

STREAMS AND/OR SEGMENTS IN THE LOWER LITTLE MIAMI RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-5-1	Little Miami River From the Caesar Creek confluence to the Todd Fork confluence	50.2 - 38.3

This segment of the Little Miami River has recovered from upstream pollutant loading, and water quality is generally good (OEPA, SWDO data, 1973, 1974).

Segment	Name/Description	Mile Points
K-5-2	Little Miami River From the Todd Fork confluence to the Muddy Creek confluence	38.3 - 33.0

Infrequent standards violations for fecal coliforms and iron have occurred in this river segment (OEPA, SWDO data, 1977-1979). These minor violations do not significantly impair the attainment of 1983 goals.

Segment	Name/Description	Mile Points
K-5-3	Little Miami River From the Muddy Creek confluence to the O'Bannon Creek confluence	33.0 - 24.1

Limited sampling of the Little Miami River at Foster revealed no Warmwater Habitat (WWH) water quality violations during the last six months of 1977 (OEPA, SWDO data). Numerous small package plants and septic tank systems discharge to the river, or to its tributaries, within this segment. The completion of the Lower Little Miami Regional Wastewater Treatment Plant (WWTP) will eliminate these discharges and improve the level of wastewater treatment.

STREAMS AND/OR SEGMENTS IN THE LOWER LITTLE MIAMI RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE LOWER LITTLE MIAMI RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
K-5-4	Little Miami River From the O'Bannon Creek confluence to the East Fork confluence	24.1 - 11.7

This river segment experienced WWH standards violations for dissolved oxygen, fecal coliforms, pH, iron, lead and mercury during 1977 and 1978 (OEPA, SWDO data, 1977; USGS 1978). Discharges from package sewage treatment plants and urban runoff from the Loveland area were probably the cause of these violations.

Even though the O'Bannon Creek Regional WWTP (to be completed prior to 1983) will improve water quality in this segment, other discharges (Loveland Kemper Road WWTP) and non-point source pollution will prevent attainment of the 1983 goals.

Segment	Name/Description	Mile Points
K-5-5	Little Miami River From the East Fork confluence to the Ohio River	11.7 - 0.0

Sewage bypasses of the Metropolitan Sewer District Little Miami WWTP degrade this segment of the river. The planned Newtown Interceptor will eliminate this problem and will also tie into homes currently on septic tank systems. However, this project will not be completed prior to 1983. Data collected in 1975 and 1976 suggests that the elimination of the sewage bypasses will enable water quality goals to be met (OEPA, SWDO data, 1975-1976).

RECOMMENDATIONS

1. An updated certified wasteload allocation is needed for this segment. A major concern is nitrification justification for AST review.
2. The OEPA sampling station at Beechmont Levy (RM 3.4) should be reactivated to better determine water quality near the mouth. Data for this station can be obtained from ORSANCO.

REFERENCES

Ohio Environmental Protection Agency. 1973-1979 (unpublished). Data available from Southwest District Office, Ohio EPA, Dayton, Ohio.

United States Geological Survey. 1978. Water resources data for Ohio, water year 1978, Vol. 1. Ohio River Basin. Water Data Report OH-78-1. U.S. Geological Survey, Columbus, Ohio.

SCIOTO RIVER BASIN

UPPER SCIOTO RIVER SUBBASIN (UPPER PORTION) (M-1)

SUBBASIN SUMMARY

The upper Scioto River Subbasin above the confluence with the Little Scioto River at Greencamp supports a well-balanced, aquatic community relative to the existing habitat. Sediment from non-point sources, along with channelization and siltation of substrates, is the major water quality problem creating relatively poor stream habitat. The Cottonwood Ditch, a stream segment of approximately 4.3 miles, often violates standards due to municipal sewage treatment plant discharges; it is not expected to meet the 1983 goal.

STREAMS AND/OR SEGMENTS IN THE UPPER PORTION OF THE UPPER SCIOTO RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-1-1	Scioto River From Kenton to the the Little Scioto River confluence	211.4 - 179.3
M-1-2	Scioto River From the headwaters to Kenton	238.2 - 211.4

Evaluations of these segments based upon current information (OEPA, NWDO data, 1977-1979) and Martin and Balduf, 1977.

STREAMS AND/OR SEGMENTS IN THE UPPER PORTION OF THE UPPER SCIOTO RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin fall into this category. However, a large portion of the subbasin has not been evaluated.

STREAMS AND/OR SEGMENTS IN THE UPPER PORTION OF THE UPPER SCIOTO RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-1-3	Cottonwood Ditch From McGuffey to the Scioto River	4.3 - 0.0

This section has dissolved oxygen and fecal coliform violations due to the inadequate and poorly operated primary sewage treatment plant serving the village of McGuffey (OEPA, NWDO data, 1977). Since the village is uncooperative, efforts to improve the plant are not being made, and it is unlikely that improvements will occur before 1983.

REFERENCES

Martin, G.L., and T.J. Balduf. 1977 (unpublished). A biological investigation of the effect of the Kenton STP on the Scioto River. Ohio Environmental Protection Agency, Northwest District Office. Mineo. 6 pp.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

SCIOTO RIVER BASIN

UPPER SCIOTO RIVER SUBBASIN (LOWER PORTION) (M-2)

SUBBASIN SUMMARY

Land-use in the Upper Scioto River Subbasin is predominantly agricultural, with Marion being the only major urban center. Current water quality data for the streams in this subbasin are limited. Much of the present evaluation is based on previous 303(e) and 305(b) water quality reports (Ohio EPA 1974, 1976, 1978, 1979).

Water quality in the Upper Scioto River Subbasin is generally good, with the exception of a portion of the Little Scioto River below Marion which is only fair. Prevailing land-use and agricultural runoff appear to exert a dominant influence on the water quality and stream biology of the Upper Scioto River Subbasin. An intensive physical/chemical and biological assessment of non-point agricultural runoff on receiving stream quality in the Upper Scioto River Subbasin is needed to fully assess this pollution source, as it relates to the 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE UPPER SCIOTO RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-2-1	Scioto River From Prospect to the Mill Creek confluence	165.5 - 150.7

Water quality sampling conducted below the city of Prospect from 1975-1977 showed no standards violations (OEPA, CDO data, 1975-1977). Water quality is believed to meet Warmwater Habitat (WWH) standards from Prospect to the Mill Creek confluence because no significant discharges exist in this segment. The Scioto River is a primary drinking water supply for the city of Columbus below its confluence with Mill Creek.

STREAMS AND/OR SEGMENTS IN THE UPPER SCIOTO RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-2-2	Little Scioto River From the Marion WWTP to the Scioto River	6.4 - 0.0

The Little Scioto River receives effluent from the Marion Wastewater Treatment Plant (WWTP), as well as industrial effluent from the Whirlpool Corporation via Rockswale Ditch. Previous surveys noted significant violations of water quality for dissolved oxygen, ammonia and fecal coliforms in this segment (OEPA, 1976). Recent reports have cited improvements in the water quality of

the Little Scioto River, since a new tertiary wastewater treatment facility at Marion came on line (OEPA, 1979). However, a definitive statement concerning the water quality of this segment cannot be made without an intensive survey. Based upon the limited information available, it appears that this segment of the Little Scioto River may meet 1983 goals.

STREAMS AND/OR SEGMENTS IN THE UPPER SCIOTO RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-2-3	Unnamed tributary to Bokes Creek From West Mansfield to Bokes Creek	Unknown - 0.0

The localized impact of a primary sewage treatment plant has been documented below West Mansfield (OEPA, 1974, 1976). Although no sampling has been conducted recently, this situation has not changed, and water quality violations for dissolved oxygen, ammonia and fecal coliforms continue to occur.

REFERENCES

Ohio Environmental Protection Agency. 1974. Scioto River basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Southeast District Office, Logan, Ohio.

Ohio Environmental Protection Agency. 1975-1977 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1976. Scioto River basin 305(b) annual water quality summary. Ohio EPA, Division of Surveillance and Lab Services, Columbus, Ohio.

Ohio Environmental Protection Agency. 1978. State of Ohio 305(b) annual water quality summary. Ohio EPA, Office of Wastewater, Division of Surveillance and Lab Services, Columbus, Ohio.

Ohio Environmental Protection Agency. (1979). Chapter 1, Existing water quality. In: Scioto River basin water quality management plan, part III, preliminary report, Ohio EPA, Columbus, Ohio.

SCIOTO RIVER BASIN

OLENTANGY RIVER SUBBASIN (M-3)

SUBBASIN SUMMARY

Water quality in the Olentangy River Subbasin ranges from good to poor. The upper reach near Galion is severely degraded due to a variety of reasons, including the variable effluent quality of the Galion Wastewater Treatment Plant (WWTP). Water quality in the lower reach is also degraded by combined sewer overflows and urban runoff from the Columbus metropolitan area. The middle reach of the Olentangy River generally has good water quality, with the exception of an occasional problem downstream from the Delaware WWTP.

Water quality in Whetstone Creek, a major tributary to the Olentangy River, is affected by municipal discharges from Mt. Gilead and Cardington as well as non-point source pollution. Water quality is generally good, except during extreme low-flow conditions.

STREAMS AND/OR SEGMENTS IN THE OLENTANGY RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-3-2	Olentangy River Below Galion to Near Delaware	76.2 - 32.1

Limited water quality data and the absence of any significant point source discharger suggest that this segment is currently meeting 1983 clean water goals. Caledonia (population 700) is the only urban area located on this river segment. Wastewater treatment in the community consists of septic tank systems and home aeration systems. Limited data collected five miles below Caledonia (U.S. Geological Survey, station No. 03223000) indicated no degradation of water quality (USGS, 1975-1977).

Water quality in the Delaware Reservoir was good except for relatively high nutrient levels (U.S. EPA, 1975). Water leaving the reservoir also appeared to be of good quality; ammonia and total phosphorus concentrations were generally lower in the outflow than in the incoming water, suggesting that the reservoir acts as a nutrient trap. However, it is interesting to note that BOD_5 levels were usually elevated below the reservoir. The BOD_5 concentrations usually ranged between 2 and 3 mg/l, but have been documented as high as 4 mg/l (OEPA, CDO data, 1977).

Segment	Name/Description	Mile Points
M-3-5	Whetstone Creek From the headwaters to Mt. Gilead	35.0 - 21.7

A review of the Mt. Gilead WWTP monthly operating reports indicated good water quality in Whetstone Creek above Mt. Gilead. This conclusion is substantiated by field observations made in June 1978 (OEPA, NWDO data, 1978).

STREAMS AND/OR SEGMENTS IN THE OLENTANGY RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-3-6	Whetstone creek From Mt. Gilead to the Delaware Reservoir	21.7 - 0.0

Warmwater Habitat (WWH) standards violations for ammonia, dissolved oxygen, and fecal coliforms occurred in this stream segment during periods of low flow (OEPA, NWDO data, 1976). Municipal wastewater discharges at Mt. Gilead and Cardington are the major pollution sources during the critical low-flow periods. Timely implementation of the Construction Grants Program and the attainment of the 1979 Wasteload Allocation Limitations should eliminate these problems prior to 1983.

Segment	Name/Description	Mile Points
M-3-3	Olentangy River From near Delaware to near Worthington	32.1 - 11.4

Water quality in the Olentangy River below Delaware ranges from good to fair. Violations of the WWH standard for dissolved oxygen occurred at least 1.9 miles downstream of the Delaware WWTP in May 1977 (OEPA, CDO data, 1977). A review of the sewage treatment plant's monthly operating reports revealed occasional downstream violations for fecal coliforms. Three sites farther downstream revealed no water quality standard violations (OEPA, CDO data, 1977).

Wasteload modeling of the Olentangy River determined that BOD_5 and ammonia concentrations of 9 mg/l and 2 mg/l, respectively, would be required in the Delaware WWTP effluent to assure compliance with WWH standards (OEPA, 1979b). Because Adjusted Wasteload Limits are applicable for this discharger, BOD_5 and ammonia limits of 10 mg/l and 1.7 mg/l, respectively, were given to the Delaware WWTP. This means that if and when the Adjusted Wasteload Limits are attained, dissolved oxygen violations will still occur, only with less frequency. It is believed that the degree of violations in the future will not impair 1983 clean water goals. The attainment of this level of wastewater treatment is contingent upon the completion of improvements to the Delaware WWTP, currently in step 1 of the Construction Grants Program.

STREAMS AND/OR SEGMENTS IN THE OLENTANGY RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983

Segment	Name/Description	Mile Points
M-3-1	Olentangy River From Galion to approximately RM 76.2	86.2 - 76.2

Water quality in the upper reach near Galion is generally poor. A study conducted during the summer and fall of 1979 revealed dissolved oxygen, fecal coliform, iron, and lead violations upstream and downstream of the Galion WWTP (OEPA, CDO data, 1979a). Cadmium and mercury violations were also found downstream of the WWTP. There is a lack of adequate dilution water in this segment of the Olentangy River to assimilate the organic loading from Galion. Dissolved oxygen violations extended for at least 1.9 miles downstream but the point at which the river fully recovers is unknown. For this reason, the ending mile point of this segment is estimated. This segment is not expected to meet 1983 goals because Adjusted Wasteload Limits will most likely be applied to the Galion WWTP.

Segment	Name/Description	Mile Points
M-3-4	Olentangy River From near Worthington to the Scioto River	11.4 - 0.0

Water quality in the lower Olentangy River is quite variable. Numerous violations of the WWH standard for fecal coliforms occurred at the fixed monitoring station located near Worthington (RM 11.4; STORET station No. 601290) (OEPA, CDO data, 1977-1979). In addition, one lead violation occurred within the last two reporting years. It appears that the fecal coliform violations may have been caused by the Worthington Hills WWTP. This county operated plant formerly discharged to Turkey Run, a small tributary to the Olentangy River located a short distance upstream of the fixed monitoring station. The Worthington Hills service area was tied into Columbus Sewage Collection System in April 1979, and the sewage treatment plant was taken off line. Since that time, fecal coliform concentrations at the monitoring site have not exceeded the standard.

However, there are numerous combined sewer overflows in the remainder of this reach. Combined sewer overflows and urban runoff periodically degrade water quality. A sanitary survey during 1978 and 1979 documented several violations of the fecal coliform standard (OEPA, CDO data, 1978-1979). It is very likely that the elevated fecal coliform levels are due to the combined sewer overflow and not an upstream discharger.

RECOMMENDATIONS

1. Evaluate the impact of a phosphorus control program (including both point and non-point loading reductions) on the quality of the Delaware Reservoir using the proposed Ohio EPA methodology (OEPA, 1979c).

2. Establish a regular schedule of sampling on the Olentangy River below Caledonia and in the reach in between Claridon and the Delaware Reservoir. This would help to assess the impact of non-point sources and the community of Caledonia on water quality in the mainstem.

3. Further studies should be conducted to determine the source(s) of the heavy metals violations in the Galion area.

4. Eliminate the combined sewer overflows from the Columbus Wastewater Collection System.

REFERENCES

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Ohio Environmental Protection Agency. 1977 (unpublished). Survey of Olentangy River. Data available from Central District Office, Ohio EPA, Columbus, Ohio.

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SCIOTO RIVER BASIN

BIG WALNUT CREEK SUBBASIN (M-4)

SUBBASIN SUMMARY

Water quality in the Big Walnut Creek Subbasin is good in the headwaters and upper portions of the drainage above the metropolitan Columbus area. Two reservoirs, Alum Creek and Hoover, are located in this portion of the subbasin and supply drinking water for the cities of Columbus and Westerville. The mid and lower portions of the subbasin are impacted by both urban point and non-point pollution. Further study is needed to accurately ascertain the extent of degradation of Alum and Big Walnut Creeks in the metropolitan Columbus area.

Blacklick Creek is seriously degraded below the Reynoldsburg and Blacklick Estates Wastewater Treatment Plants (WWTPs). Numerous violations of water quality standards for dissolved oxygen, ammonia and fecal coliforms occur in Blacklick Creek during low-flow conditions.

STREAMS AND/OR SEGMENTS IN THE BIG WALNUT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-4-1	Alum Creek From the headwaters to the Noble Run confluence	55.8 - 18.6
M-4-2	Big Walnut Creek From the headwaters to the Columbus Morse Road Water Treatment Plant	74.2 - 33.5

Physical/chemical quality of the Big Walnut Creek Subbasin headwaters is very good (OEPA, 1979). There are two water supply reservoirs for the city of Columbus (Alum Creek Reservoir and Hoover Reservoir) located within the upper subbasin. Downstream of these reservoirs the water quality of Alum Creek and Big Walnut Creek is degraded by both urban point and non-point pollution from the greater Columbus metropolitan area (OEPA, 1979). The attainment of 1983 goals cannot be ascertained for the lower segments of Alum Creek and Big Walnut Creek because of insufficient data. Previous sampling of lower Alum Creek revealed sporadic water quality violations for dissolved oxygen and total iron (OEPA, CDO data, 1975-1977). A major stormwater overflow for the city of Columbus Combined Sewer System is located at river mile 6.3.

Water quality data for lower Big Walnut Creek near the Scioto River showed high nutrient levels and elevated levels of MBAS (OEPA, CDO data, 1977-1979). No water quality standard violations occurred, but the data does reflect the impact of urban runoff from both point and non-point sources.

STREAMS AND/OR SEGMENTS IN THE BIG WALNUT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-4-3	Blacklick Creek From the Reynoldsburg WWTP to Big Walnut Creek	10.8 - 0.0

Serious Warmwater Habitat standards violations for dissolved oxygen, ammonia and fecal coliforms, occur in this segment of Blacklick Creek (Ohio EPA 1974, 1976, 1978). Degradation results from the combined effluents of the Reynoldsburg WWTP and the Blacklick Estates WWTP. The diversion of this sewerage to the Columbus Wastewater Collection System prior to 1983 will improve the water quality of Blacklick Creek, thereby allowing achievement of 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE BIG WALNUT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Based on available information no stream segments fall into this category.

REFERENCES

Ohio Environmental Protection Agency. 1974. Scioto River basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Southeast District office, Logan, Ohio.

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SCIOTO RIVER BASIN

MILL CREEK SUBBASIN
AND
A PORTION OF THE MIDDLE SCIOTO RIVER SUBBASIN (M-5)

SUBBASIN SUMMARY

Chemical/physical water quality and biological condition was studied in a 30 mile section of Mill Creek (Union County) during June, July, and September, 1978 (Yoder et al., 1980). Based on the results of chemical/physical sampling Mill Creek can be divided into four segments; 1) upstream from Marysville (MP 30.8 to 24.8) where no water quality standards (WQS) violations were observed, 2) in Marysville upstream from the Marysville WWTP outfall (MP 19.4 to 18.4) where WQS violations for iron, lead, nickel, cadmium, and zinc occurred, 3) downstream from the Marysville WWTP and Ray Lewis outfalls (MP 18.1 and 12.20 where values for dissolved oxygen, ammonia-nitrogen, iron, and occasionally cadmium and lead, were found in violation of WQS, and 4) downstream from MP 11.8 where infrequent violations of WQS for iron, cadmium, and lead were detected. The observed violations for dissolved oxygen and ammonia-nitrogen were attributed to wastewater discharged by the Marysville WWTP, whereas violations for iron, lead, nickel, and zinc were attributed to urban non-point source runoff and possibly atmospheric transport. Comparatively high ammonia-nitrogen (4.0-8.9 mg/l) and BOD_5 below the Marysville WWTP were attributed to the by-passing of untreated and partially treated wastewater into Mill Creek during September, 1978. This same by-passing incident was the probable cause of a fish kill.

Mill Creek was found to be capable of supporting permanent and healthy communities of aquatic life provided that water quality was not a limiting factor. Water quality degradation was found to be limiting for aquatic life downstream from the Marysville WWTP and Ray Lewis outfalls. Recovery of the aquatic communities gradually took place with increasing distance downstream from the Marysville area. A reduction in the loadings of ammonia-nitrogen, oxygen demanding wastes, and toxic substances, primarily from the Marysville WWTP and Ray Lewis facility, should result in improved water quality conditions in Mill Creek.

Water quality of the Scioto River between Mill Creek and the Olentangy River is good and supports abundant fish populations in two impoundments. Nutrient levels are high in the Scioto River but the high flushing rates of the reservoirs reduces the severity of algal blooms.

STREAMS AND/OR SEGMENTS IN THE MILL CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-5-1	Mill Creek From the headwaters to the Town Run confluence	37.8-18.9

The water quality of Mill Creek at two locations (MP 30.8 and 24.8) upstream from Marysville was good. Chemical/physical data revealed no water quality standards (WQS) violations and concentrations of all substances were well within accepted limits compatible with healthy communities of aquatic life. Biological sampling revealed that the aquatic communities were healthy and balanced. None of the downstream locations exhibited overall water quality equal to that found at these two locations. Chemical/physical sampling in the lower mile of this segment revealed violations for iron, lead and cadmium. Further investigations are warranted to determine the source and significance of this low level contamination in the Mill Creek Subbasin and adjacent rural areas (Darby Creek Subbasin and other areas in Southwest Ohio).

Segment	Name/Description	Mile Points
M-5-2	Mill Creek From Town Run confluence to the Marysville WWTP	18.9-18.3

Water quality in this segment ranges from good to fair. Nutrient levels are significantly increased below the confluence with Town Run during critical flow conditions (OEPA, CDO data, 1977-1979) due to loadings from the urban/industrial watershed of Town Run. Heavy metals from non-point sources were found in this segment with increasing frequency (Yoder et al., 1980).

Segment	Name/Description	Mile Points
M-5-5	Scioto River From the O'Shaugnessy Reservoir to the Olentangy River confluence	150.7-130.0

O'Shaugnessy Reservoir was rated the most eutrophic of 20 Ohio lakes sampled by the U.S. EPA in 1973 (U.S. EPA, 1975). Low levels of algal density were found despite relatively high nutrient loads, a condition that reflects the high flushing rate of O'Shaugnessy Reservoir. Water quality below O'Shaugnessy Reservoir, including Griggs Reservoir appears to be good with the exception of relatively high nutrient levels (OEPA, CDO data, 1978). The Scioto River in Columbus is affected by urban stormwater runoff, but water quality generally remains good (OEPA, CDO data, 1979).

STREAMS AND/OR SEGMENTS IN THE MILL CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-5-4	Mill Creek From the Blue Creek confluence to the Scioto River	3.9-0.0

Nearly complete recovery from the organic pollution from the Marysville WWTP was observed in this segment of Mill Creek (Yoder et al., 1980). However, infrequent violations for iron, cadmium, lead, and phenolics did occur. Water quality may be expected to improve in this segment, and possibly upstream, upon completion of wastewater treatment improvements at Ray Lewis and Sons and the Marysville WWTP.

STREAMS AND/OR SEGMENTS IN THE MILL CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-5-3	Mill Creek From the Marysville WWTP to Hinton Mill Road	18.3-3.9

Ray Lewis and Sons, a plumbing part and fixture manufacturer, discharged a moderately toxic effluent containing metals at MP 18.3 (Yoder et al., 1980). The company is currently planning to install a total recycle system, and once completed, water quality in this reach should improve.

The Marysville WWTP caused frequent and severe violations of Warmwater Habitat standards for dissolved oxygen and ammonia in this segment of Mill Creek (Yoder et al., 1980). The 1979 preliminary Wasteload Allocation indicated that attainment of the Adjusted Wasteload Limits by the Marysville WWTP will not eliminate standards violations, but will reduce their frequency and severity (OEPA, 1979).

REFERENCES

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SCIOTO RIVER BASIN

UPPER BIG DARBY CREEK SUBBASIN (M-6)

SUBBASIN SUMMARY

The Big Darby Creek Subbasin is characterized by good water quality and areas of excellent stream habitat. The entire Big Darby Creek drainage has been classified as Exceptional Warmwater Habitat (EWH) in the Ohio Water Quality Standards. Numerous endangered species are known to inhabit Big Darby Creek.

Land-use in the subbasin is predominately row-crop agriculture and the few point sources of pollution have only a minor impact on water quality. Concentrations of lead and cadmium violated EWH standards but the degree of the problem does not prevent attainment of 1983 clean water goals.

STREAMS AND SEGMENTS IN THE BIG DARBY CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-6	Big Darby Creek From the headwaters to the Little Darby Creek confluence	81.0 - 34.1

An intensive physical/chemical and biological survey of Big Darby Creek was conducted in 1979 (OEPA, CDO data, 1979a). Several preliminary findings suggested that agricultural land-use had the greatest influence on water quality. First, average nitrate concentrations increased from the headwaters to mile point 58.8. This stream segment drains an intensive agricultural area and tile drainage from such land-use is characteristically high in nitrates (Omernik, 1976). Second, a strong correlation of stream discharge with suspended sediment indicated that rainfall events and subsequent agricultural runoff were of primary importance in determining the concentrations of sediment and attached nutrients in Big Darby Creek (OEPA, 1979b). Finally, fecal coliforms concentrations were elevated after rainfall events suggesting non-point sources of contamination.

Water quality impacts from urban areas were minimal within this stream segment. Ineffective septic tank systems in the village of Milford Center caused slightly higher concentrations of fecal coliforms, total Kjeldahl nitrogen, phosphorus, and chemical oxygen demand. The sewage effluent had no substantial influence in the biological communities in Big Darby Creek.

Exceptional Warmwater Habitat violations for lead and cadmium, and iron concentrations in excess of the Warmwater Habitat standard, were recorded during the 1979 survey (OEPA, CDO data, 1979a). The cause of these heavy metal problems is unknown; further investigation is needed to assess the relative contributions from natural background sources, non-point pollution, and atmospheric transport.

Segment	Name/Description	Mile Points
M-6-2	Little Darby Creek From the headwaters to Big Darby Creek	38.0 - 0.0

Iron, lead, and cadmium Exceptional Warmwater Habitat standards violations were also noted in this stream segment (OEPA, CDO data, 1979a). These heavy metals were present at elevated concentrations in a substantial portion of the Big Darby Creek drainage as well as adjacent watersheds (see the Mill Creek Subbasin Report).

Little Darby Creek receives some point source pollution loading, but sampling in 1979 revealed minimal impact during higher than normal discharge conditions (OEPA, CDO data, 1979a). Wasteload modeling has indicated potential water quality problems below the Mechanicsburg Wastewater Treatment Plant (WWTP) and the West Jefferson WWTP at low-flow conditions (OEPA, 1979b). Advanced Waste Treatment was recommended for both these facilities. Isolated water quality problems existed in several drainage ditches in the Scenic Hills and Darby Crest subdivisions where numerous failing septic tank systems were found by Burgess and Niple (1978).

The city of West Jefferson is at step 1 of the Construction Grants Program. Water quality improvements in Little Darby Creek can be expected upon completion of wastewater treatment improvements. The Scenic Hills and Darby Crest subdivisions may be connected to the West Jefferson WWTP.

STREAMS AND/OR SEGMENTS IN THE UPPER BIG DARBY CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE UPPER BIG DARBY CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No segments fall into these categories. However, more sampling may be needed in some sections of the subbasin.

RECOMMENDATIONS

1. Further studies should be conducted to determine the source(s) of the heavy metal violations.

2. Establish a regular schedule of sampling on Big Darby Creek below Milford Center to assess the impact of the new Transportation Research Center Sewage Treatment Plant and the village of Milford Center on water quality.

3. Establish a regular schedule of sampling on Little Darby Creek near the mouth in order to provide a better data base.

REFERENCES

Burgess and Niple, Limited. 1978 (unpublished). West Jefferson Facilities Plan. Burgess and Niple, Columbus, Ohio.

Ohio Environmental Protection Agency. 1979a (unpublished). Survey of Big and Little Darby Creeks. Data available from Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. (1979b) Scioto River Basin water quality management plan, Part III, preliminary report. Ohio EPA, Columbus, Ohio.

Omernik, J.M. 1976. The influence of land use on stream nutrient levels. U.S. Environmental Protection Agency, Office of Research and Development, Corvallis, Oregon. EPA-600/3-76-014. 105 pp.

SCIOTO RIVER BASIN

DEER CREEK SUBBASIN (M-7)

SUBBASIN SUMMARY

The Deer Creek Subbasin is predominantly a rural area, with approximately 96% of the total land classified as vacant or agricultural (MORPC, 1979). The principal population centers are London, Mt. Sterling and Williamsport. Point source water quality problems are documented only for Oak Run below the London Correctional Institute.

In general, water quality is judged to be good, although an extensive data base is lacking. Sediment runoff with corresponding nutrient transport are the principal non-point pollution problems. The impact of agricultural non-point runoff on biological communties is uncertain. Limited field studies on sediment loads have been made by the U.S. Geological Survey, as part of the Deer Creek Reservoir Project. However, further biological sampling is needed to fully assess this pollution source as it relates to the 1983 clean water goals. In the interim, it is expected that the entire subbasin should meet the 1983 water quality goals.

STREAMS AND/OR SEGMENTS IN THE DEER CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-7-1	Deer Creek From the Madison Lake outlet to the Scioto River	62.3 - 0.0

Recent water quality data for the majority of the Deer Creek Subbasin is not available. Monthly water quality sampling conducted between 1973-1977, near the confluence of Deer Creek with the Scioto River, revealed no significant water quality violations (OEPA, CDO data, 1973-1977). Conditions have not substantially changed in the reach below Deer Creek Reservoir to warrant further investigation.

Deer Creek, between the village of Mt. Sterling and the Deer Creek Reservoir, was recently sampled by the Army Corps of Engineers. The data indicated infrequent ammonia violations in this segment of Deer Creek (OEPA, 1979). The Mt. Sterling Wastewater Treatment Plant (WWTP) was the probable cause of these violations. This municipality is currently completing facility plans for upgrading existing wastewater treatment, but it is unlikely that any improvements will be completed prior to 1983. The discharge does not seriously impact stream quality, and the minor WQS violations do not interfer with 1983 goals.

STREAMS AND/OR SEGMENTS IN THE DEER CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-7-2	Oak Run From the London Correctional Institute WWTP to Deer Creek	12.0 - 0.0

Significant point source degradation of water quality occurs in the headwaters of Oak Creek below the London Correctional Institute (LCI) WWTP and the city of London WWTP (Ohio EPA 1974, 1976, 1978a). Recent low-flow water quality sampling of Oak Run near LCI revealed substantial water quality degradation for nutrients, suspended solids, and dissolved oxygen (Ohio EPA, CDO data, 1978b). The 201 Facility Plan for the area recommends that LCI connect to the existing London Sanitary System. The currently degraded segment of Oak Run may meet 1983 water quality goals after the LCI WWTP is abandoned.

STREAMS AND/OR SEGMENTS IN THE DEER CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into this category, however, the water quality in a portion of this subbasin has not been determined.

REFERENCES

Mid-Ohio Regional Planning Commission. 1979. Existing conditions report for the central Scioto water quality management planning area.

Ohio Environmental Protection Agency. 1973-1977 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

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Ohio Environmental Protection Agency. (1979). Chapter 1, Existing water quality. In: Scioto River basin water quality management plan, part III, preliminary report. Ohio EPA, Columbus, Ohio.

SCIOTO RIVER BASIN

MIDDLE SCIOTO RIVER SUBBASIN (M-8)

SUBBASIN SUMMARY

Water quality in the 50 mile segment of the Scioto River below Columbus remains poor. Pollutant loading from the metropolitan Columbus area and the city of Circleville exceeds the assimilative capacity of the Scioto River, despite wastewater treatment improvements at several facilities. Municipal and industrial point sources and urban non-point sources play major roles in degrading this river segment. However, the diversion of upstream flow for public water supplies may be the single most important factor preventing the attainment of 1983 clean water goals in portions of the Scioto River.

Lower Big Darby Creek has excellent water quality and stretches of excellent stream habitat. An intensive survey of the Big Darby Creek drainage in 1979 (OEPA, CDO data) revealed that agricultural land-use influences water quality and that there are only minor point source pollution impacts (see the Big Darby Creek Subbasin report).

STREAMS AND/OR SEGMENTS IN THE MIDDLE SCIOTO RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-8-2	Big Darby Creek From the Little Darby Creek confluence to the Scioto River	34.1-0.0

Water quality is much the same as in Upper Big Darby Creek (see separate subbasin report). A single violation of the Exceptional Warmwater Habitat dissolved oxygen standard was observed in 61 samples (OEPA, CDO data, 1979a).

STREAMS AND/OR SEGMENTS IN THE MIDDLE SCIOTO RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in a portion of this subbasin has not been determined.

STREAM AND/OR SEGMENTS IN THE MIDDLE SCIOTO RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-8-1	Scioto River From the Olentangy River confluence to the Deer Creek confluence	130.0 - 81.1

Warmwater Habitat (WWH) standards violations for dissolved oxygen, ammonia, phenolics, and fecal coliforms were reported in this segment (OEPA, CDO data, 1977-1979). Combined sewer overflows, urban storm runoff, and point source pollution cause degradation of water quality (OEPA, 1979b). Major dischargers include the Columbus Jackson Pike Wastewater Treatment Plant (WWTP), the Columbus Southerly WWTP, the Circleville WWTP, the Container Corporation of America, the Dupont Company, and Pittsburgh Plate Glass Company. Solids handling problems at both Columbus facilities limit treatment efficiencies and cause sewage bypasses during periods of high incoming flow. A new incinerator at the Jackson WWTP and centrifuges at the Southerly WWTP will help alleviate the problem in the near future. However, further improvements at the Southerly WWTP are needed to completely eliminate sewage bypasses. Improvements are underway at the Container Corporation of America that will substantially reduce organic and suspend solids loadings.

These and other pollution abatement programs can be expected to improve the quality of the middle Scioto River. However, the diversion of upstream flows for public water supplies combined with the sheer volume of wastes generated in the metropolitan Columbus-Circleville area will likely prevent the attainment of 1983 goals in the foreseeable future.

RECOMMENDATION

Further studies should be conducted to determine the impact of combined sewer overflow and urban runoff from the Columbus area on water quality in the Scioto River.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

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SCIOTO RIVER BASIN

WALNUT CREEK SUBBASIN (M-9)

SUBBASIN SUMMARY

Extensive water quality sampling in the Walnut Creek Subbasin has not been conducted. Current water quality information noted violations for dissolved oxygen below the village of Baltimore on Walnut Creek. These violations were the result of the combined discharges of the Crown Zellarbach Corporation and the city of Baltimore Wastewater Treatment Plant. Surburban residential development has been extensive in the basin's northwestern quadrant. Many moderate sized (0.08 - 0.15 MGD) package wastewater treatment plants discharge to low-flow tributaries of Sycamore and Georges Creeks. The localized water quality impact of these facilities has not been extensively studied. Areas of the subbasin which are not expected to meet 1983 goals include Sycamore Creek below Pickerington and Walnut Creek below Baltimore.

STREAMS AND/OR SEGMENTS IN THE WALNUT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-9-1	Walnut Creek From the Georges Creek confluence to the Scioto River	21.3 - 0.0

A water quality sampling site near the mouth of Walnut Creek was maintained from 1973 to 1977. The data showed no substantial violations of water quality standards (OEPA, 1976,1978).

STREAMS AND/OR SEGMENTS IN THE WALNUT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

None of the segments monitored in this subbasin presently fall into this category. However, water quality in some portions of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE WALNUT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-9-2	Walnut Creek From the Paw Paw Creek confluence to the Sycamore Creek confluence	39.0 - 27.0

Walnut Creek below the village of Baltimore receives a substantial loading of treated pulp mill waste from the Crown Zellarbach Corporation, as well as secondary quality effluent from the Baltimore Wastewater Treatment Plant (WWTP).

The most recent water quality sampling below the village of Baltimore was conducted in September, 1978, as part of the low-flow sampling program in the Scioto River Basin. Results indicated water quality standard violations for dissolved oxygen (OEPA, CDO data, 1978). Wasteload modeling of this reach by the Ohio EPA, Division of Water Quality Planning and Assessment, has indicated that the Baltimore WWTP must meet a final effluent BOD_5 of less than 4.0 mg/l to achieve compliance with WWH Standards. Modeling has projected dissolved oxygen violations for approximately 12 miles before recovery (OEPA, 1979).

The Crown Zellarbach Corporation at Baltimore discharges to Paw Paw Creek. Wells that will augment stream flow in Paw Paw Creek during critical low-flow conditions have recently been completed. The village of Baltimore has undertaken the preparation of a Step 1 Facility Plan to upgrade its sewer and waste treatment systems. Continued levels of grant funding and timely execution of the grant process will determine 1983 compliance for this entity.

Segment	Name/Description	Mile Points
M-9-3	Sycamore Creek From the Pickerington WWTP to Walnut Creek	4.3 - 0.0

Dissolved oxygen, suspended solids and ammonia problems in the Pickerington reach of Sycamore Creek are the result of periodic overloads at the Pickerington WWTP. These overloads result from excessive inflow and infiltration problems, an increase in service area, and the addition of industrial dairy processing wastes from the Dri-Milk Company (personal communication, 1979). Alternatives to the present situation, which are being developed on a regional 201 planning basis for the municipalities of Pickerington, Canal Winchester and Lithopolis, have not been satisfactory, due to allegedly inadequate plans prepared by the consultant. No plan has been adopted to date. The completion of pollution control projects necessary to meet 1983 goals is remote in light of the extensive political problems of regional development projects.

REFERENCES

Ohio Environmental Protection Agency. 1976. Scioto River Basin 305(b) report: water quality summary. Ohio EPA, Central District Office, Office of Wastewater, Division of Surveillance, Columbus, Ohio. 87 p.

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Ohio Environmental Protection Agency. 1979. Water quality management plan, recommended point source waste load allocation, Scioto River Basin. Office of Wastewater, Division of Water Quality Planning and Assessment, Ohio EPA, Columbus, Ohio.

Personal Communication. 1979. Mike Fox, Supt., Pickerington Wastewater Treatment Plant, Pickerington, Ohio.

SCIOTO RIVER BASIN

SALT CREEK SUBBASIN (M-10)

SUBBASIN SUMMARY

The Salt Creek Subbasin is a forrested drainage with only two small urban areas (Tarlton and Laurelville). Wastewater treatment in these communities consists of individual septic tank systems. Some minor problems have been noted in the immediate vicinity of the septic tank outfalls, but there is no significant impact on Salt Creek. All streams in this subbasin meet 1983 goals based upon limited information. A single set of samples collected from each of the six segments listed below revealed no water quality standards violations (Ohio EPA, SEDO data, 1979).

STREAMS AND/OR SEGMENTS IN THE SALT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-10-1	Pike Run From the headwaters to Salt Creek	9.2-0.0
M-10-2	Pretty Run From the headwaters to Salt Creek	5.9-0.0
M-10-3	Queer Creek From the headwaters to Salt Creek	9.0-0.0
M-10-4	Pine Creek From the headwaters to Salt Creek	11.8-0.0
M-10-5	Laurel Run From the headwaters to Salt Creek	12.9-0.0
M-10-6	Salt Creek From the headwaters to the Scioto River	45.4-0.0

This evaluation of water quality is based upon limited data (OEPA, 1974; OEPA, SEDO data, 1979).

STREAM AND/OR SEGMENTS IN THE SALT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE SALT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories.

REFERENCES

Ohio Environmental Protection Agency. 1979 (unpublished). Data available From Southeast District Office, Ohio EPA, Logan, Ohio.

Ohio Environmental Protection Agency. 1974. Scioto River Basin 303(e) Wasteload Allocation Report. Ohio EPA, Division of Surveillance, Southeast Division Office, Logan, Ohio.

SCIOTO RIVER BASIN

LOWER SCIOTO RIVER SUBBASIN (M-11, M-15)

SUBBASIN SUMMARY

Forestry, agriculture, and urban development are the major land-uses in the lower Scioto River Basin. Population centers located along this portion of the Scioto include Chillicothe, Waverly, Piketon and Lucasville. Wastewater treatment plants serving these municipalities, the Mead Paper Corporation, and two other industries are the major point source dishcargers affecting water quality. In addition, pollutant loading from upstream sources (i.e., Circleville) continues to influence water quality in the lower Scioto River.

The resultant water quality has been described as fair to poor (OEPA, 1974). Prior to 1978, the data indicated serious degradation in the Scioto River between Paint Creek and Salt Creek. Standards violations for dissolved oxygen, fecal coliforms, and phenolics were common at monitoring sites at Chillicothe (RM 70.8; STORET station No. 601240) and at Higby (RM 56.3; STORET station No. 600770) (USGS, 1973-1977). However, recent improvements in wastewater treatment at the Mead Paper Corporation have substantially reduced organic pollution in the lower Scioto River. No dissolved oxygen violations were noted at the above stations during 1978-1979 (USGS, 1978), but it is uncertain as to whether the improved wastewater treatment at Mead Paper will be sufficient to protect water quality standards during low flows. For this reason, the segment of the Scioto River between Paint Creek and Salt Creek cannot be classified with respect to the attainability of the 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE LOWER SCIOTO RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-15-1	Scioto River From the Salt Creek confluence to the Ohio River	51.2-0.0

Water quality information is limited to data collected at the USGS-ORSANCO sampling station located at Lucasville (RM 14.2; STORET station No. 600800). Violations for fecal coliforms and lead have been noted (OEPA, SEDO data, 1978). Data from a previous report (OEPA, 1974) indicated no major water quality problems in this river segment. The lower Scioto River is assumed to meet 1983 clean water goals based upon this previous evaluation and knowledge that pollutant loading from upstream sources has declined.

STREAMS AND/OR SEGMENTS IN THE LOWER SCIOTO RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE LOWER SCIOTO RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No segments fall into these categories, however, portions of the subbasin have not been monitored.

REFERENCES

Ohio Environmental Protection Agency. 1974. Scioto River basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Southeast District Office, Ohio EPA, Logan, Ohio.

Ohio Environmental Protection Agency. 1978 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan Ohio.

United States Geological Survey. 1973-1978. Water resources data for Ohio. Volume 1. Ohio River Basin. U.S. Geological Survey Water - data reports OH-73-1 through OH-78-1. U.S. Geological Survey, Columbus, Ohio.

SCIOTO RIVER BASIN

LOWER PAINT CREEK SUBBASIN (M-12)

SUBBASIN SUMMARY

Water quality is good in a 30 mile segment of Paint Creek between the Paint Creek Reservoir and the North Fork confluence. The physical/chemical quality of the North Fork is unknown. The Mead Paper Company discharges pulp mill wastes into Paint Creek at mile point 3.3 which degrades the lower 3 miles of Paint Creek and a segment of the Scioto River. The installation of advanced wastewater treatment facilities at Mead Paper has substantially reduced loadings of BOD_5 and total suspended solids (84 percent reduction based upon monthly operating reports). Studies are needed to assess the impact of the reduced pollutant loading on the physical/chemical and biological quality of the receiving waters.

STREAMS AND/OR SEGMENTS IN THE LOWER PAINT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-12-1	Paint Creek From the Paint Creek Reservoir to the North Fork confluence	37.9-7.9

This segment is classified as Exceptional Warmwater Habitat (EWH). Chemical data from the monitoring station within this segment (STORET station No. 601320; RM 22.1) indicated generally good water quality. Minor violations of both the Warmwater Habitat (WWH) and EWH standards for pH, copper, lead, and iron occurred (OEPA, SEDO data, 1977-79). All occurred during elevated flow conditions; the iron violations were probably the result of non-point runoff, while the copper and lead violations may have come from industrial dischargers located on the upper reaches of Paint Creek or Rocky Fork Creek.

The minor standards violations noted above probably do not prevent the attainment of 1983 clean water goals.

STREAM AND/OR SEGMENTS IN THE LOWER PAINT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAM AND/OR SEGMENTS IN THE LOWER PAINT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No stream segments fall into these categories. However, water quality in a portion of the subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (Unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

SCIOTO RIVER BASIN

UPPER PAINT CREEK SUBBASIN (M-13)

SUBBASIN SUMMARY

Upper Paint Creek is predominantly an agricultural land-use area. Non-point source sediment runoff and associated nutrient transport have the greatest effect on stream quality. The Washington Court House (C.H.) wastewater treatment plant (WWTP) is the major point source discharger in the Upper Paint Creek Subbasin. Water quality downstream of Washington C.H. is adversely affected. This entity is currently upgrading both the sewer system and the wastewater treatment plant. All areas of this subbasin should meet 1983 goals.

STREAMS AND/OR SEGMENTS IN THE UPPER PAINT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-13-1	Paint Creek From the Sugar Run confluence to the Rocky Fork confluence	58.3 - 36.1

Paint Creek at the Sugar Run confluence has recovered from the point source degradation below Washington C.H. Water quality in this stream segment is considered good based on limited data from the U.S. Geological Survey Greenfield station (USGS, 1977-1978).

STREAMS AND/OR SEGMENTS IN THE UPPER PAINT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
M-13-2	Paint Creek From the Washington C.H. WWTP to the Sugar Run confluence	65.9 - 58.3

Current water quality data collected below Washington C.H. revealed standards violations for dissolved oxygen and total iron (OEPA, CDO data, 1977-1979). Previous studies by Ohio EPA noted these problems plus, violations for fecal coliforms and ammonia (OEPA, 1974, 1976).

Construction of a new sanitary sewer collection system for the city of Washington C.H. is 80 percent completed. A tertiary wastewater facility is nearing Step III funding and will replace an overloaded secondary wastewater plant when completed. All construction should be finished prior to 1983.

Recent wasteload modeling by the Ohio EPA, (Division of Water Quality Planning and Assessment) found that even with tertiary treatment, water quality standards could not be maintained in Paint Creek below Washington C.H.

Further evaluation of the problem is not warranted until after the new treatment facility is on line, at which time intensive surveys should determine the water quality status. Until these new studies are completed, it is assumed that 1983 goals can be attained in this segment of Paint Creek.

An intensive physical/chemical, biological assessment of the impact of non-point agricultural runoff on receiving stream quality in the Upper Paint Creek Subbasin has not been done. Limited field studies on sediment loads have been made by the U.S. Geological Survey as part of the Paint Creek Reservoir Project. However, further biological evaluation is needed to fully assess this pollution source as it relates to the 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE UPPER PAINT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Based on available information all areas in the subbasin will meet 1983 goals.

REFERENCES

Ohio Environmental Protection Agency. 1974. Scioto River basin 303(e) wasteload allocation report. Ohio EPA, Division of Surveillance, Southeast District Office, Logan, Ohio.

Ohio Environmental Protection Agency. 1976. Scioto River basin 305(b) annual water quality summary. Ohio EPA, Office of Wastewater, Division of Surveillance, Central District Office, Columbus, Ohio.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

United States Geological Survey. 1977-1978. Water resources data for Ohio, Volume I, Ohio River Basin. U.S. Geological Survey water-data reports OH-77-1 and OH-78-1. U.S. Geological Survey, Columbus, Ohio.

SCIOTO RIVER BASIN

ROCKY FORK AND RATTLESNAKE CREEK SUBBASIN (M-14)

SUBBASIN SUMMARY

Water quality in this subbasin ranges from excellent to poor. Portions of the drainage are classified as Exceptional Warmwater Habitat and limited chemical/physical data appears to substantiate this designation in the lower 7.5 miles of the Rocky Fork. Two reservoirs in this subbasin (Rocky Fork and Paint Creek) were surveyed and found to have good water quality (Tobin and Youger, 1975). The reservoirs support game fish populations and are heavily used for recreational activities.

The Hillsboro Wastewater Treatment Plant (WWTP) discharges to Clear Creek, a tributary to the Rocky Fork Reservoir. Water quality degradation is suspected during low-flow conditions because of relatively high wastewater loading rates (565,000 gpd, average BOD 18.4 mg/l, average ammonia 6.5 mg/l). Further investigation is needed to assess the impact of the Hillsboro WWTP on water quality in Clear Creek and the Rocky Fork Reservoir.

A special study of Rattlesnake Creek was recently completed by the United States Geological Survey (Evans and Tobin, 1979), but the results were not critically evaluated for this report. Water quality may be influenced by the Sabina Wastewater Treatment Plant and the Rattlesnake Sewer District WWTP. Critical evaluation of available information is essential in light of the Exceptional Warmwater Habitat use designation of Rattlesnake Creek.

STREAMS AND/OR SEGMENTS IN THE ROCKY FORK AND RATTLESNAKE CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-14-1	Rocky Fork From the Rocky Fork Reservoir to Paint Creek	7.5-0.0

Occasional minor standards violations for iron and copper occurred in Rocky Fork (RM 2.8; STORET station No. 610800) during the past two years (OEPA, SEDO data, 1977-1979). These violations do not substantially impair the 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE ROCKY FORK AND RATTLESNAKE CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE ROCKY FORK AND RATTLESNAKE CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No streams fall into these categories. However, portions of the subbasin lack adequate information for the evaluation.

REFERENCES

Evans, K.F. and R.L. Tobin. 1979. Water quality assessment of Rattlesnake Creek watershed, Ohio. Water Resources Investigations 79-17. Open-File Report. United States Geological Survey, Columbus, Ohio. 28 pp.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southest District Offices, Ohio EPA, Logan, Ohio.

Tobin, R.L., and J.D. Youger. 1977. Limnology of selected lakes in Ohio - 1975. Water Resources Investigations 77-105. United States Geological Survey, Columbus, Ohio. 205 pp.

SCIOTO RIVER BASIN

LITTLE SALT CREEK SUBBASIN (M-16)

SUBBASIN SUMMARY

The city of Jackson is the only urban area in this otherwise forrested watershed. The overloaded Jackson Wastewater Treatment Plant (WWTP) frequently bypasses raw sewage and severely degrades an eleven mile stretch of Little Salt Creek. Wastewater treatment facilities are not expected to be upgraded prior to 1983. Lead and zinc contamination from unknown sources has been noted in Little Salt Creek above the Jackson WWTP. Further data is needed to assess the severity of the problem. The lower mainstem of Little Salt Creek and its tributaries appear to meet 1983 goals based upon scant information.

STREAMS AND/OR SEGMENTS IN THE LITTLE SALT CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-16-1	Middle Fork From the headwaters to Little Salt Creek	21.2-0.0
M-16-2	Pigeon Creek From the headwaters to Middle Fork	14.0-0.0
M-16-3	Big Run From the headwaters to Little Salt Creek	11.0-0.0
M-16-4	Little Salt Creek From S.R. 35 to to Salt Creek	13.9-0.0

This evaluation of water quality is based upon limited data (OEPA, SEDO data, 1979; OEPA, 1974).

STREAMS AND/OR SEGMENTS IN THE LITTLE SALT CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

M-16-6	Little Salt Creek From the Jackson WWTP to S.R. 35	25.5-13.9

The Jackson WWTP has a major impact upon Little Salt Creek (OEPA, 1974) which is characterized by a septic zone below the outfall and large sludge deposits. Water quality standards violations include dissolved oxygen and fecal coliforms (OEPA, SEDO data, 1979). The Jackson WWTP has severe overloading problems and occasionally bypasses as much as 50 percent of incoming raw sewage to Little Salt Creek. The city of Jackson is involved in the Construction Grants Program but no wastewater treatment improvements will occur prior to 1983.

STREAMS AND/OR SEGMENTS IN THE LITTLE SALT CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored fall into this category. However, water quality in a portion of the subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1974. Scioto River Basin 303(e) Wasteload Allocation Report. Ohio EPA, Division of Surveillance, Southeast District Office, Logan, Ohio.

Ohio Environmental Protection Agency. 1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

SCIOTO RIVER BASIN

SCIOTO BRUSH CREEK SUBBASIN (M-17)

SUBBASIN SUMMARY

The Scioto Brush Creek Subbasin is an area of low population density with a predominantly forested, unglaciated terrain. Only two industrial point source dischargers are located in the subbasin and neither have a significant effect on water quality (OEPA, 1979). Water quality problems may develop in the subbasin if timber harvesting and the associated sawmill enterprises continue to expand. Sawdust disposal must be directed away from near-stream areas where siltation, suspended solids, and leachate problems can develop.

STREAMS AND/OR SEGMENTS IN THE SCIOTO BRUSH CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
M-17-1	Scioto Brush Creek From the headwaters to the Scioto River	36.0-0.0
M-17-2	South Fork From the headwaters to Scioto Brush Creek	18.2-0.0

Water quality sampling on a limited basis has been conducted in these two stream segments by the U.S. Geological Survey (USGS 1973-1977) and the Ohio EPA (OEPA, 1979). No standards violations were noted and very low concentrations of ammonia, nitrates, and phosphorus were found. Water quality appears to be excellent but more extensive sampling must be performed to evaluate if the Exceptional Warmwater Habitat use designation is justified.

STREAM AND/OR SEGMENTS IN THE SCIOTO BRUSH CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAM AND/OR SEGMENTS IN THE SCIOTO BRUSH CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No stream segments fall into these categories. However, water quality has not been accurately assessed in portions of the subbasin.

REFERENCES

Ohio Environmental Protection Agency. 1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

United States Geological Survey. 1973-1977. Water resources data for Ohio, Volume 1. Ohio River Basin. U.S. Geological Survey reports OH-73-1 through OH-77-1. U.S. Geological Survey, Columbus, Ohio.

HOCKING RIVER, SHADE RIVER, AND LEADING CREEK BASIN

UPPER HOCKING RIVER SUBBASIN (0-1)

SUBBASIN SUMMARY

Water quality in the Hocking River above Lancaster, in Clear Creek, and in Little Rush Creek is good and meets 1983 goals. Approximately 37.2 stream miles in this subbasin are not expected to meet 1983 goals. Urban point and non-point source pollution degrades water quality in the Hocking River in and below Lancaster. Frequent standards violations for ammonia, dissolved oxygen and fecal coliforms have been reported during low-flow conditions. The Lancaster Wastewater Treatment Plant (WWTP) currently receives a considerable load of unpretreated industrial wastewater which inhibits treatment efficiencies. Rush Creek is degraded throughout its length by acid mine drainage. Brine pit pollution also contributes to degraded water quality in both Rush Creek and the Hocking River below Lancaster.

STREAMS AND/OR SEGMENTS IN THE UPPER HOCKING RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
0-1-1	Clear Creek From the headwaters to the Hocking River	23.0 - 0.0
0-1-2	Little Rush Creek From the headwaters to Rush Creek	18.0 - 0.0
0-1-3	Hocking River From the headwaters to the Hunter's Run confluence	94.9 - 84.4

Data from previous water quality reports (Ohio EPA 1975, 1976, 1978a) have shown Clear Creek, Little Rush Creek, and the Upper Hocking River to be of high physical/chemical quality. Little if any changes have occurred in these watersheds to warrant further survey work at this time.

Oil and gas well brine pit seepage has, at times, degraded surface waters in the Upper Hocking River Subbasin. The problem arises from occasional operational and well maintenance difficulties; it is a sporadic, rather than continuous, non-point pollution problem. Energy exploration activity in the Upper Hocking River Valley is expected to increase and, as a result, background chloride concentrations will likely increase. Previous studies of Harper Run (Ohio EPA 1975, 1976) have shown high chloride levels due to brine pit seepage.

Segment	Name/Description	Mile Points
0-2-1	Hocking River From the Clear Creek confluence to the Monday Creek confluence	78.7 - 51.5

See the discussion in the Middle Hocking River Subbasin report.

STREAMS AND/OR SEGMENTS IN THE UPPER HOCKING RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
0-1-4	Hocking River From the Hunters Run confluence to the Clear Creek confluence	84.4 - 78.7

This segment is the major water quality problem area in the Upper Hocking River Subbasin. Degradation is the result of urban point and non-point source pollution from the city of Lancaster. Water quality data from the Ohio EPA monthly monitoring site below Lancaster (RM 86.7; STORET station No. 601550) showed violations for fecal coliforms, dissolved oxygen and iron (OEPA, CDO data, 1977-1979). Diurnal sampling during low-flow conditions in July 1978, recorded water quality standards violations for fecal coliforms, dissolved oxygen and ammonia (OEPA, SEDO data, 1978b). The sampling revealed a substantial dissolved oxygen sag extending downstream of the Lancaster WWTP for approximately 7.0 miles. These results coincide with previous studies in the same segment (Ohio EPA 1975, 1976).

The Lancaster WWTP, currently at Step II in the Construction Grant process, is periodically overloaded resulting in the bypassing of untreated sewage to the river. Plant expansion and an upgrading of wastewater treatment facilities are planned. Significant improvements in current water quality conditions prior to 1983 are expected, if the Construction Grant process can be completed in a timely manner. A second problem at the Lancaster WWTP is unpretreated industrial waste, principally oils and heavy metals, that inhibit wastewater treatment efficiencies. This problem can be solved if the city will actively enforce industrial pretreatment codes.

STREAMS AND/OR SEGMENTS IN THE UPPER HOCKING RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
0-1-5	Rush Creek From the headwaters to Hocking River	37.2 - 0.0

The headwaters of Rush Creek are severely degraded by mine drainage as a result of stripmining activity prior to the reclamation law. Water quality samples collected between 1975-1977 on Rush Creek below Junction city had an average pH of 3.4 S.U. (OEPA, 1976; OEPA, CDO data, 1975-1977). The neutralizing effect of the alkaline tributaries (Center Branch Creek, Little Rush Creek and Raccoon Run) downstream near Breman causes an increase in pH to a neutral to slightly acidic range. The mix of acid water with these tributaries causes extensive precipitation of metallic hydroxide flocs, which settle to the streambed throughout the entire length of the mainstem.

Existing conditions in this stream (i.e., extensive non-point mine drainage) will not allow the 1983 goals to be achieved, and the degradation will likely to continue well into the future.

REFERENCES

Ohio Environmental Protection Agency. 1975. Hocking River Basin 303(e) report. Ohio EPA, Division of Surveillance, Central District Office. Columbus, Ohio.

Ohio Environmental Protection Agency. 1975-1979 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1976. Hocking River Basin 305(b) report water quality summary. Ohio EPA, Division of Surveillance, Central District Office. Columbus, Ohio.

Ohio Environmental Protection Agency. 1978a. State of Ohio 305(b) water quality summary. Ohio EPA, Office of Wastewater, Division of Surveillance and Lab Services. Columbus, Ohio.

Ohio Environmental Protection Agency. 1978b. (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

HOCKING RIVER, SHADE RIVER, AND LEADING CREEK BASIN

MIDDLE HOCKING RIVER SUBBASIN (O-2)

Non-point pollution contributes to water quality degradation in portions of the Middle Hocking River Subbasin. Sunday Creek and Monday Creek are severely degraded by mine drainage (OEPA, 1979). Oldtown Creek has been contaminated by brine from oil and gas well drilling within the watershed (OEPA, SEDO data, 1975-1976). Seepage and spillage of brine elevates in-stream concentrations of dissolved solids and chlorides.

The Hocking River above Monday Creek generally has good water quality. However, occasional standards violations for some heavy metals, particularly mercury, suggest that further study is warranted. Industrial sources in Lancaster and/or non-point sources in the Rush Creek watershed should be investigated. Point sources located within this subbasin (Logan WWTP, Lucasville WWTP) probably do not substantially impact water quality (OEPA, 1974).

Margaret Creek, a tributary to the Hocking River, is classified as Exceptional Warmwater Habitat. Limited data supports this classification (OEPA, SEDO data, 1973-1976), but further data collection is necessary to accurately assess water quality in Margaret Creek.

STREAMS AND/OR SEGMENTS IN THE MIDDLE HOCKING RIVER RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
O-2-1	Hocking River From the Clear Creek confluence to the Monday Creek confluence	78.7 - 51.1

Data from the monthly monitoring site at Enterprise (RM 72.5; STORET station No. 601530) indicated infrequent standards violations for iron, copper, zinc, and mercury. Pollutant loading from upstream sources (i.e., Lancaster, Rush Creek watershed) may have been responsible. The Logan Wastewater Treatment Plant (WWTP) and the Nelsonville WWTP discharge to this segment of the Hocking River, but only minor water quality impacts occur (OEPA, 1974).

A more extensive study of the heavy metal contamination in this river segment is needed to insure that 1983 goals are not being impaired.

STREAMS AND/OR SEGMENTS IN THE MIDDLE HOCKING RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

No segments fall into this category. However, water quality has not been thoroughly evaluated in portions of the subbasin.

STREAMS AND/OR SEGMENTS IN THE MIDDLE HOCKING RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
0-2-2	Sunday Creek From the headwaters to the Hocking River	27.0 - 0.0
0-2-3	Monday Creek From the headwaters to the Hocking River	25.0 - 0.0

This evaluation is based upon the findings of Ohio EPA, 1979. Mine drainage, and possibly organic pollution from the small urban areas within the watersheds, severely degrade these two creeks.

Segment	Name/Description	Mile Points
0-2-4	Hocking River From the Monday Creek confluence to unknown	51.5 - unknown

Water quality is degraded in this stream segment by mine drainage pollution from Monday Creek and Sunday Creek. Standards violations for iron and lead were noted from 1977 to 1978 at the U.S. Rt. 33 station located at Athens (RM 39.6; STORET station No. 601650) (OEPA, SEDO data, 1977-1978). At the U.S. Geological Survey Station located below Athens, violations for iron, lead, pH, and dissolved oxygen were recorded (USGS, 1977-1979). Organic loading from the city of Athens WWTP and the channelized morphology of the Hocking River through Athens combine to create depressed dissolved oxygen levels. Chemical data for downstream reaches of the Hocking River is very scant; the point at which the river recovers from the pollutions effects cannot be ascertained with available data.

REFERENCES

Ohio Environmental Protection Agency. 1974. Hocking River Basin 303(e) wasteload allocation report. Division of Surveillance, Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1979. Hocking River Basin water quality management plan; Part III, preliminary report. Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1973-1979 (unpublished). Data available from Southeast District Office, Logan, Ohio.

United States Geological Survey. 1977-1978. Water resources data for Ohio, Volume I. Ohio River Basin. U.S. Geological Survey water data reports OH-77-1 and OH-78-1. U.S. Geological Survey, Columbus, Ohio.

HOCKING RIVER, SHADE RIVER, AND LEADING CREEK BASIN

LOWER HOCKING RIVER SUBBASIN (O-3)

Recent water quality data for the lower Hocking River Subbasin is very limited, thus preventing an accurate assessment of conditions. The Hocking River below Athens is degraded and is not expected to meet 1983 goals (see discussion in the Middle Hocking River Subbasin report). There are no major point sources of pollution downstream of Athens, but mine drainage from the Federal Creek watershed may influence water quality in the lower Hocking River.

Federal Creek appears to be only moderately affected by mine drainage as no pH violations were detected during sampling by Ohio EPA in 1977 (OEPA, SEDO data, 1977). Observations during that survey suggested that Sulfur Run, Marietta Run and Opposum Run were more significantly influenced by mine drainage than other tributaries to Federal Creek. A dairy operation west of Amesville substantially degraded McDougall Run, a tributary to Federal Creek. Additional study of the Federal Creek watershed is needed to accurately establish use designations. The majority of Federal Creek is classified as Mine Drainage but the headwaters are classified as Exceptional Warmwater Habitat.

REFERENCES

Ohio Environmental Protection Agency. 1977 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

HOCKING RIVER, SHADE RIVER, AND LEADING CREEK BASIN

SHADE RIVER AND LEADING CREEK SUBBASIN (O-4)

SUBBASIN SUMMARY

The Shade River mainstem, the Middle Branch, and the East Branch are classified Exceptional Warmwater Habitat, although supporting water quality data is very scant. A sample was collected a the low-flow monitoring site on the Shade River (RM 5.9; STORET station No. 609170) in 1978; there were no violations of Exceptional Warmwater Habitat standards (OEPA, SEDO data, 1978).

U.S. Geological Survey monitoring at Chester, Ohio from 1975 to 1977 revealed standards violations for dissolved oxygen, copper, zinc and mercury (USGS, 1975-1978). The village of Chester is the only population center along the Shade River and there are no point source dischargers. A more thorough water quality investigation is needed to substantiate the Exceptional Warmwater Habitat use designation in the Shade River drainage.

The West Branch of the Shade River is affected by mine drainage (OEPA, 1979). Low pH values, high manganese loadings, and moderate sulfate loadings have been noted. The same report noted severe sedimentation problems in the upper reaches of the West Branch. The Ohio Department of Natural Resources has completed an 87 acre demonstration project in the area which was aimed at controlling the sedimentation problem. To our knowledge no data is presently available to verify water quality improvements.

Several portions of the Leading Creek watershed also showed indications of mine drainage degradation. The State Water Quality Management Plan listed Thomas Fork, Little Leading Creek, Parker Run, and Ogden Run as being affected by area coal mines (OEPA, 1979). Data from July 1978 revealed a pH of 3.7 in Thomas Fork, strongly suggesting acid mine drainage; data directly indicating mine drainage impacts in the other three streams is lacking. Samples taken near the mouth of Leading Creek by the U.S. Geological Survey revealed no standards violations (USGS, 1976-1977). A sample from the low flow monitoring site (RM 1.4; STORET station No. 609160) in 1978 indicated a violation of the iron standard (OEPA, SEDO data, 1978).

The attainability of the 1983 goals in the Shade River and Leading Creek Subbasin is unknown becuse of insufficient data.

REFERENCES

Ohio Environmental Protection Agency. 1978 (Unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

Ohio Environmental Protection Agency. (1979). Southeast Ohio tributaries water quality management plan, Part III, preliminary report. Ohio EPA, Columbus, Ohio.

MUSKINGUM RIVER BASIN

BLACK AND CLEAR FORK SUBBASIN (P-1)
AND
LOWER MOHICAN RIVER SUBBASIN (P-2)

SUBBASIN SUMMARY

The Mohican River Subbasin is located in a scenic area of the state with rolling hills and swift flowing streams. The stream bed is sand or gravel, in most instances, resulting in an aesthetically pleasing appearance. Many of the stream segments are designated as State and National Resource Waters and are extensively used for canoeing.

Approximately 16.2 stream miles in these subbasins are not expected to meet 1983 goals. The major water quality problem in the Mohican River Subbasin is persistent toxicants, primarily heavy metals, which are present in the rivers below Mansfield, Ashland, and Shelby. Rocky Fork below Mansfield is the most severely polluted stream segment. It is believed that stringent pretreatment requirements at these three cities, plus municipal wastewater treatment plants (WWTP) improvements, will result in significant progress towards compliance with the 1983 goals. However, the Rocky Fork in and below Mansfield will continue to experience occasional water quality standards violations that will prevent attainment of 1983 goals.

STREAMS AND/OR SEGMENTS IN THE BLACK/CLEAR FORK AND LOWER MOHICAN RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-2-2	Lake Fork From the Mohicanville Reservoir Dam to the Mohican River	8.3 - 0.0
P-1-6	Clear Fork From the Pleasant Hill Reservoir Dam to the Mohican River	4.8 - 0.0
P-1-7	Clear Fork From Clear Fork Reservoir Dam to the Pleasant Hill Reservoir	28.6 - 9.2
P-1-4	Black Fork From the Charles Mill Reservoir Dam to the Rocky Fork confluence	17.6 - 13.6
P-2-10	Jerome Fork From near the source to Lang Creek	17.4 - 12.0
P-2-11	Muddy Fork From the headwaters to the Mohican Reservoir	25.0 - 0.0

The Upper Jerome Fork, above Lang Creek, and the Muddy Fork drain predominately agricultural land. No violations of water quality standards were noted in these segments (OEPA, NWDO data, 1977-1979). The Lake Fork, Clear Fork, and Black Fork segments were also free of violations (OEPA, NWDO data, 1974-1979).

STREAMS AND/OR SEGMENTS IN THE BLACK/CLEAR FORK AND LOWER MOHICAN RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-2-12	Jerome Fork From the Lang Creek confluence to the Lake Fork	12.0 - 0.0

Numerous violations occurred below the Lang Creek confluence, as a result of overflows and bypassing at the Ashland Municipal Wastewater Treatment Plant. The violations included dissolved oxygen (D.O.), ammonia, copper, zinc and fecal coliforms (OEPA, NWDO data, 1977-1979). A facility plan is nearing completion for the city of Ashland, and it is possible that improvements may be completed by 1983. Also, the city is making efforts to require pretreatment on the part of industrial dischargers who may be causing heavy metals violations.

Segment	Name/Description	Mile Points
P-2-1	Mohican River From the source to the Walhonding River	27.6 - 0

In 1977-1978, water quality violations were noted for copper, lead, zinc and iron (OEPA, NWDO data, 1977-1979). However, iron was the only metal violation recorded in the 1978-79 sampling period. This improvement may be related to the initiation of industrial waste pretreatment requirements in the cities of Mansfield and Ashland. Additional wastewater treatment improvements by the various industries are anticipated by 1983. Dissolved oxygen concentrations in the Mohican River are generally excellent (above 7 mg/l), although a single value of 4.3 mg/l was recorded. Sporadic occurrences of dissolved oxygen concentrations below 5 mg/l are not expected to prevent attainment of 1983 goals.

Segment	Name/Description	Mile Points
P-1-3	Black Fork From the Rocky Fork confluence to the Mohican River	13.6 - 0

This segment violated water quality criteria in 1978-79 for lead and zinc, probably as a result of industrial dischargers in Mansfield (OEPA, CDO and NWDO data, 1978, 1979). Improved treatment and pretreatment is expected from the industrial dischargers in the Rocky Fork drainage prior to 1983, and should permit the Black Fork to meet the 1983 goals.

Segment	Name/Description	Mile Points
P-1-5	Black Fork From the source to the Charles Mill Reservoir	58.4 - 20.2

This segment is generally good, but it was subject to occasional, minor metals violations and low D.O. as a result of discharges from the Shelby Municipal Sewage System (OEPA, NWDO data, 1978). Improvements to the sewage treatment plant and more stringent pretreatment standards should result in this segment meeting the 1983 goal.

STREAMS AND/OR SEGMENTS IN THE BLACK/CLEAR FORK AND LOWER MOHICAN RIVER SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-1-8	Rocky Fork From the Mansfield WWTP to the Black Fork	11.2 - 0.0

Inadequate treatment by the Mansfield WWTP resulted in standards violations for dissolved oxygen, fecal coliforms, phenolics, and ammonia (OEPA, NWDO data 1977-1979). Also, numerous metals violations can be traced to the Mansfield WWTP; these include chrome, copper, mercury, and nickel. The metals violations were a result of inadequate industrial pretreatment prior to discharge into the municipal collection system. A new pretreatment ordinance will require compliance with Federal guidelines by 1983, thus reducing the severity of metal contamination. However, dissolved oxygen and ammonia violations will persist until the Mansfield WWTP is upgraded. Eventually, this segment of the Rocky Fork may meet 1983 water quality goals, but WWTP improvements at Mansfield are not likely until 1985.

Segment	Name/Description	Mile Points
P-1-9	Rocky Fork From Bowman Street to the Mansfield WWTP	16.2 - 11.2

This segment traverses the industrial section of Mansfield. Most of the industries are in compliance with their NPDES discharge permits, but problems still exist. The drainage area of Rock Fork above this segment is small and delivers inadequate amounts of dilution water during low flow periods. The regulated discharges, plus occasional accidental discharges and storm runoff, will prevent this segment from meeting the 1983 goals (OEPA, NWDO data, 1978).

REFERENCES

Ohio Environmental Protection Agency. 1974-79 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1978-79 (unpublished). Field surveys, data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MUSKINGUM RIVER BASIN

UPPER KILLBUCK CREEK SUBBASIN (P-3)
AND
A PORTION OF THE WALHONDING RIVER SUBBASIN (P-4)

SUBBASIN SUMMARY

Land use in these subbasins is predominately agricultural. Moderate-sized population centers that contribute point source pollution include Creston, Westfield Center, Wooster, Shreve, Apple Creek, Millersburg and Killbuck. The discharge of the Wooster Wastewater Treatment Plant (WWTP) caused substantial degradation of Killbuck Creek (Havens and Emerson, 1975). Less severe degradation may occur below the other WWTPs in the Killbuck Creek Subbasin, but additional monitoring is needed to assess the impacts. Additional monitoring of Apple Creek is especially needed in light of its Coldwater Habitat use designation.

Water quality in the Walhonding River is generally good and currently meets 1983 goals. Mill Creek, a tributary to the Walhonding River is classified as a Mine Drainage stream. No standards violations have been reported (USGS, 1974-1977), but there is insufficient data to accurately assess water quality in Mill Creek.

STREAMS AND/OR SEGMENTS IN THE KILLBUCK CREEK AND WALHONDING RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-4-1	Walhonding River From the source to the Killbuck Creek confluence	23.5 - 6.5

Infrequent standards violations for iron and copper were reported at the monitoring sites at Nellie, Ohio (RM 14.7; STORET station No. 601910)(OEPA, SEDO data, 1977-1979). These minor violations do not appear to interfere with the attainability of the 1983 clean water goals. Water quality conditions in the lower 6.5 miles of the Walhonding River cannot be assessed due to a lack of data.

STREAMS AND/OR SEGMENTS IN THE KILLBUCK CREEK AND WALHONDING RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-3-1	Killbuck Creek Wooster WWTP to unknown	47.0 - unknown

Iron and copper standards violations have been noted in this stream segment at the low-flow monitoring site (RM 44.8; STORET station No. 601880)(OEPA, NEDO data, 1977-1979). The Havens and Emerson (1975) report also identified fecal coliform and dissolved oxygen problems below the Wooster WWTP. Killbuck Creek is expected to meet 1983 goals after the improvements to the Wooster WWTP are completed.

STREAMS AND/OR SEGMENTS IN THE KILLBUCK CREEK AND WALHONDING RIVER SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

No streams in these subbasins fall into this category. However, water quality in portions of the subbasin has not been assessed because of insufficient data.

REFERENCES

Havens and Emerson, Ltd. Environmental Consulting Engineers. 1975 (final document dated April 1976). Muskingum watershed water quality assessment and low flow analysis. Report prepared for Ohio EPA. n.p.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

MUSKINGUM BASIN

MIDDLE TUSCARAWAS RIVER AND SUGAR CREEK SUBBASIN (P-5), UPPER TUSCARAWAS RIVER SUBBASIN (P-6), AND SANDY CREEK SUBBASIN (P-7)

SUBBASIN SUMMARY

Water quality of the upper Tuscarawas River and its tributaries ranges from good to fair. Streams in the Sandy Creek Subbasin are degraded by point and non-point source pollution. Nimishillen Creek, a tributary to Sandy Creek, drains approximately 187 square miles of one of the most industrialized areas of Ohio. There are three municipal wastewater treatment plants (WWTP), eleven package plants operated by Stark County, and 58 private package plants under 25,000 GPD. Many headwater streams in the Nimishillen watershed have stream flows that are too low to assimilate this large volume of organic loading. Serious degradation of local water quality and potential human health hazards exist in the Nimishillen Creek watershed (NEFCO 1979).

Non-point source mine drainage pollution is another major water quality problem in the Sandy Creek Subbasin (NEFCO 1979). Approximately 20 percent of the watershed has experienced intensive strip mining activity (Havens and Emerson, 1975). Streams degraded by acid mine drainage include Little Sandy Creek, Muddy Fork, and Bear Run. Point source pollution impacts, other than those on Nimishillen Creek, are relatively minor (Havens and Emerson, 1975). Limited sampling of Sandy Creek above Waynesburg has revealed only one standard violation for total iron (OEPA, NEDO data 1977-1979).

There are numerous water quality problems within the Chippewa Creek watershed (drainage area 188 sq. miles). Repeated channelization has created a stream morphology that severely limits the organic waste assimilative capacity of Chippewa Creek. Five municipal wastewater treatment plants (WWTP) and two industrial discharges are located within the drainage. Agricultural land-use and failing septic tank systems may also contribute to significant non-point source pollution. A detailed wasteload study (Havens and Emerson, 1975) determined that the Medina No. 1 WWTP is the most significant discharger in the subbasin, with respect to impact on dissolved oxygen. Other major discharges include: Rittman WWTP, Wadsworth WWTP, Orrville WWTP, Doylestown WWTP, Kopper's Corporation and the Packaging Corporation of America. The Kopper's Corporation discharges pentachlorophenol and was responsible for Warmwater Habitat (WWH) phenolic standard violations in Little Chippewa Creek (OEPA, NEDO data, 1977-1979).

Water quality in the Sugar Creek watershed is generally good. Wastewater treatment plants at the villages of Smithville and Brewster are overloaded during wet weather periods because of infiltration problems. Only minor standards violations occur and no serious degradation of water quality exists. Every effort should be taken to maintain this good water quality because Sugar Creek recharges the aquifer supplying Canton's well field at Beach City.

The upper Tuscarawas River from the headwaters to below the Sandy Creek confluence is a very complex system. Over 290 point sources discharge to the river or its tributaries. Previous reports have outlined the major stream segments impacted by point source discharges (Havens and Emerson, 1975; NEFCO, 1979). The primary water quality problems in the Tuscarawas River mainstem are dissolved oxygen, ammonia, phenolics, and total dissolved solids. Improvements are expected in the Tuscarawas River above Barberton upon completions of several pollution control projects. However, the river below Barberton is not expected to meet 1983 goals in the foreseeable future.

STREAMS AND/OR SEGMENTS IN THE UPPER TUSCARAWAS RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-5-1	Sugar Creek From the headwaters to the Beach City Reservoir	45 - 12

Only minor violations for iron and fecal coliforms have been reported at monitoring sites upstream and downstream of the village of Brewster (OEPA, NEDO data, 1977-1979). The Brewster WWTP does experience difficulties during wet weather when infiltration overloads the plant causing inadequate disinfection of the effluent (NEFCO, 1979). The minor standards violations and the wastewater treatment difficulties do not substantially impair the 1983 clean water goals.

Segment	Name/Description	Mile Points
P-5-2	Sugar Creek From the Beach City Reservoir to the Broad Run Confluence	12.0 - 6.1

A monitoring station below Strasburg (RM 7.3; STORET station No. 611700) was sampled until 1977; only minor standards violations for iron and fecal coliforms were observed (OEPA, SEDO data, 1976-1977). These violations are not believed to impair the 1973 clean water goals.

Broad Run appears to be degraded by mine drainage as iron and pH violations were detected (OEPA, SEDO data, 1979). Further study is needed to assess the impact of Broad Run on Sugar Creek; the study should also investigate the source of chlorobenzenes that have been detected in the lower 6 miles of Sugar Creek (OEPA, SEDO data, 1978).

STREAMS AND/OR SEGMENTS IN THE UPPER TUSCARAWAS RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTORLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-7-1	East Branch Nimishillen Creek From the J & L discharge to Middle Branch Nimishillen Creek	5.8 - 0.0

Violations of WWH standards for MBAS, fecal coliforms, chromium, nickle, and iron are common in the East Branch of Nimishillen Creek (OEPA, NEDO data, 1977-1979). Two wastewater treatment plants operated by the city of Lousiville, the Jones and Laughlin Steel Plant, the Republic Steel Company, and the Ford Motor Company are the major discharges to this stream. Wastewater treatment improvements by all dischargers in this watershed should eliminate the above standards violations by 1983.

Segment	Name/Description	Mile Points
P-6-1	Tuscarawas River From the headwaters to Barberton WWTP	130 - 106

Low flows combined with a large number of point source dischargers create severe water quality standards violations for dissolved oxygen, iron, lead, fecal coliforms, and phenolics in the upper Tuscarawas River (OEPA, NEDO data, 1977-1979). NEFCO (1979) reported that most tributary streams to the upper Tuscarawas River violate the fecal coliform standard because of failing septic tank systems. Numerous small wastewater treatment plants and four major industrial dischargers are located on the river above the Wolf Creek confluence. Construction of the Springfield Township WWTP will eliminate the majority of the discharges, and will improve the level of wastewater treatment. This project and the improvements slated for the Wolf Creek drainage should enable the 1983 goals to be met.

Segment	Name/Description	Mile Points
P-6-2	Wolf Creek From Norton Ave. to the Tuscarawas River	1.8 - 0.0

Wolf Creek receives industrial and municipal effluents, along with runoff from a highly industrialized area of Barberton. Warmwater Habitat violations for dissolved oxygen, iron, and lead have occurred at the mouth of Wolf Creek (OEPA, NEDO data, 1977-1979). Bacterial contamination and elevated temperatures may cause problems in upstream segments (NEFCO 1979). It is assumed that pollution abatement activities completed prior to 1983 will alleviate the water quality violations in Wolf Creek.

Segment	Name/Description	Mile Points
P-5-3	Tuscarawas River From Navarre at Riverland Avenue to the confluence of Sandy Creek	80 - 73

Limited sampling in this segment has revealed WWH standards violations for phenolics and iron, along with high phosphorus concentrations (OEPA, NEDO data, 1977). The upgrading of the primary wastewater treatment facilities at Navarre, and reduced pollutant loading from the upper Tuscarawas River and Chippewa Creek, will improve water quality in this river segment.

STREAMS AND/OR SEGMENTS IN THE UPPER TUSCARAWAS RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-6-3	Chippewa Creek From confluence of River Styx to the Tuscarawas River	8.1 - 0.0

This segment of Chippewa Creek will continue to experience dissolved oxygen (D.O.) violations during low-flow conditions. Even after the application of stringent effluent criteria, minimal reaeration rates and natural organic loads in this segment will prevent the attainment of 1983 goals (Havens and Emerson, 1975). Limited sampling of Chippewa Creek near Easton has revealed D.O. and ammonia violations during low-flow conditions (OEPA, NEDO data, 1978).

Segment	Name/Description	Mile Points
P-7-2	Nimishillen Creek From Canton WWTP to Sandy Creek	10.1 - 0.0

The Canton WWTP and the pollutant loading delivered by tributary streams (i.e., Middle Branch, East Branch, Sherrick Run, and Hurford Run) severely degrade Nimishillen Creek. Municipal and industrial discharges make up 82 percent of the stream flow in this segment during low-flow conditions. Warmwater Habitat standards violations for fecal coliforms, iron, lead, phenolics, oil and grease, and pH have been reported for Nimishillen Creek below Canton at the North Industry USGS gaging site (RM 8.2; STORET station No. 601940) (OEPA, NEDO data, 1977-1979). Dissolved oxygen (D.O.) problems occur farther downstream within this segment of Nimishillen Creek. A D.O. concentration of 3.7 mg/l was recorded in September 1979. This stream segment is not expected to meet 1983 goals in the foreseeable future.

Segment	Name/Description	Mile Points
P-7-3	Swartz Ditch From the Hartville WWTP to Unknown	6.9 - Unknown

This is an extremely low-flow stream segment. NEFCO (1979) reported that the WWH D.O. standard is probably not attainable with the current level of wastewater treatment at Hartville. Upgrading of the Hartville WWTP is not likely prior to 1983.

Segment	Name/Description	Mile Points
P-5-4	Tuscarawas River From the Barberton WWTP to the city of Navarre	106 - 80

Major point source dischargers that degrade this segment of the Tuscarawas River include: Barberton WWTP, Canal Fulton WWTP, Massillon WWTP, the Pittsburgh Plate Glass Company (PPG) and the Republic Steel Company. Chippewa Creek and the abandoned PPG lagoons at Clinton also contribute pollutants. Monitoring at several sites has revealed numerous WWH standards violations: dissolved oxygen, ammonia, total dissolved solids, fecal coliforms, iron, phenolics, lead, chromium, oil and grease, and PCBs (OEPA, NEDO data, 1978-1979). Although water quality should improve due to wastewater treatment improvements, this segment of the Tuscarawas River is not expected to meet 1983 goals.

Segment	Name/Description	Mile Points
P-7-4	Hurford Run From the source to Nimishillen Creek	2.0 - 0.0

This small tributary receives discharges and runoff from a highly industrialized area. Warmwater Habitat standards violations for ammonia, chromium, iron, lead, and phenolics occur (OEPA, NEDO data, 1977-1978). Although improvements have recently been made in the treatment of industrial wastewater (i.e., at the Timken Company), it is felt that the 1983 goals will not be met in the foreseeable future.

Segment	Name/Description	Mile Points
P-5-5	Tuscarawas River From the confluence of Sandy Creek to Unknown	73 - Unknown

The added pollutant loading from Canton (via Nimishillen Creek and Sandy Creek) contributes to the already degraded quality of the Tuscarawas River in this segment. Warmwater Habitat violations for dissolved oxygen, iron, phenolics, fecal coliforms, and total dissolved solids have been recorded (OEPA, NEDO data, 1977-1979). Further study is needed to more accurately delineate this degraded zone.

REFERENCES

Havens and Emerson, Ltd., Environmental Consulting Engineers. 1975 (final report dated April 1976). Muskingum watershed water quality assessment and low flow analysis. Report prepared for Ohio EPA. Havens and Emerson, Ltd., Cleveland, Ohio. n.p.

Northeast Ohio Four County Regional Planning and Development Organization (NEFCO). 1979. Clean water plant revisions Part I and II. Report prepared for Ohio EPA.

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Northeast District Office, Ohio EPA, Twinsburg, Ohio.

MUSKINGUM RIVER BASIN

CONOTTON CREEK SUBBASIN (P-8)

Conotton Creek, a major tributary to the Tuscarawas River, has extensive strip mining activity throughout its watershed and is classified as a Mine Drainage stream from the headwaters to the city of Jewett. Further sampling of Conotton Creek and its tributaries is needed to determine the extent of mine drainage pollution and to identify specific sources. The Mineral City Wastewater Treatment Plant (WWTP) discharges approximately 25,000 gpd of sewage to Huff Run near its mouth; the city of Scio WWTP discharges approximately 180,000 gpd of sewage to the mainstem of Conotton Creek. The extent of stream degradation resulting from these two entities is not known. U.S. Geological Survey stream data at various sites on the mainstem indicated occasionally high sulfate concentrations but no water quality standards violations (USGS, 1971-1977). Streams in this subbasin cannot be evaluated with respect to meeting 1983 goals because of insufficient data.

REFERENCES

United States Geological Survey. 1971-1977. Water resources data for Ohio, Volume 1. Ohio River Basin. U.S. Geological Survey water data reports OH 71-1 through OH 77-1. U.S. Geological Survey, Columbus, Ohio.

MUSKINGUM RIVER BASIN

STILLWATER CREEK SUBBASIN (P-9)

Extensive coal mining operations are located throughouth the southern and southeastern sections of the Stillwater Creek Subbasin. Significant point source discharges in the subbasin include the Consolidated Coal Company, the Uhrichsville-Dennison Wastewater Treatment Plant (WWTP), and the Chessie System.

Ohio EPA collected water quality data on Stillwater Creek (RM 1.3; STORET station No. 611720) in 1976 and 1977 (OEPA, SEDO data, 1976-1977). Standards violations were noted for dissolved oxygen, fecal coliforms, and total iron. Concentrations of ammonia, sulfate, and manganese were observed to be relatively high, but not above standards. Dissolved oxygen and fecal coliform violations were attributable to the Uhrichsville-Dennison WWTP; iron, sulfate and manganese concentrations reflected the mine drainage problems in the watershed.

Stillwater Creek was not evaluated with regard to 1983 clean water goals due to an insufficient data base.

REFERENCES

Ohio Environmental Protection Agency. 1976-1977 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

MUSKINGUM RIVER BASIN

LOWER TUSCARAWAS RIVER SUBBASIN (P-10)

SUBBASIN SUMMARY

The water quality of the lower 45 miles of the Tuscarawas River ranges from good to fair. Pollutant loading from the Newcomerstown, New Philadelphia-Dover, and Coshocton areas, along with contributions from upstream sources, result in standards violations for dissolved oxygen, fecal coliforms, phenolics, and heavy metals. Recent water quality data is rather scant and the evaluations given below need to be substantiated by further investigations.

STREAMS AND/OR SEGMENTS IN THE LOWER TUSCARAWAS RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-10-1	Tuscarawas River From the Stillwater Creek confluence to the Newcomerstown WWTP	44.8 - 19.9

Monitoring at Newcomerstown (RM 21.3; STORET station No. 611790) revealed generally good water quality. Occasional iron violations, along with single violations for copper, lead, and zinc, were noted during the past two years (OEPA, SEDO data, 1977-1979).

These minor violations are not believed to interfere with the attainment of 1983 goals.

STREAMS AND/OR SEGMENTS IN THE LOWER TUSCARAWAS RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-10-2	Tuscarawas River From the Sugar Creek confluence to the Stillwater Creek confluence	55.2 - 44.8

Data collected in 1976 and 1977 at New Philadelphia (RM 49; STORET station No. 611710) revealed standards violations for dissolved oxygen, fecal coliforms, phenolics, and iron (OEPA, SEDO data, 1976-1977). Industrial and municipal wasteloads from the Dover-New Philadelphia area were the primary cause of water quality problems in this segment.

Recent water quality improvements at the New Philadelphia WWTP and the Union Camp Corporation are expected to measurably improve water quality in this segment of the Tuscarawas River. Additional monitoring is needed to verify that 1983 clean water goals are being attained.

Segment	Name/Description	Mile Points
P-10-3	Tuscarawas River From the Newcomerstown WWTP to the Muskingum River	19 9 - 0.0

Data collected at the mouth of the Tuscarawas River (RM 0.0; STORET station No. 611730) revealed numerous standards violations for iron, fecal coliforms, and phenolics (OEPA, SEDO data, 1976-1977). Concentrations of sulfates, chlorides, ammonia, suspended solids, and zinc were also elevated. The Stone Container Corporation is a major discharger to the lower mile of the Tuscarawas River; pollutant loading from the Newcomerstown WWTP and other upstream sources also influence water quality in this river segment. Wastewater treatment improvements planned or under construction at Stone Container and the Newcomerstown WWTP may eliminate the water quality violations. Further study will be needed to ascertain the status of this segment with regard to 1983 clean water goals.

STREAMS AND/OR SEGMENTS IN THE LOWER TUSCARAWAS RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored fall into this category. However, water quality in a portion of the subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1976-1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

MUSKINGUM RIVER BASIN

UPPER MUSKINGUM RIVER SUBBASIN (P-11)

SUBBASIN SUMMARY

Previous information (OEPA, SEDO data, 1976-1977) indicated that the upper Muskingum River was seriously degraded. However, water quality standards violations in the upper Muskingum River from its source (the confluence of the Walhonding and Tuscarawas Rivers) to Zanesville were substantially reduced during 1977-1979. It is not known whether this improvement can be attributed to any specific pollution abatement programs, but it appears that the 1983 clean water goals are achievable in this stream segment.

STREAMS AND/OR SEGMENTS IN THE UPPER MUSKINGUM RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE UPPER MUSKINGUM RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in a portion of this subbasin has not been determined.

STREAMS AND/OR SEGMENTS IN THE UPPER MUSKINGUM RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-11-1	Muskingum River From the source to the Ellis Dam	110 - 84

Data from monitoring stations at Coshocton (RM 107.3; STORET station No. 611740) and at Dresden (RM 91.3; STORET station No. 611750) indicated fair water quality during the past two years. Standards violations were noted for iron, fecal coliforms, and phenolics (OEPA, SEDO data, 1977-1979).

Point source dischargers to this river segment include the Coshocton Wastewater Treatment Plant (WWTP), the Dresden WWTP, the Columbus and Southern Electric Power Plant at Conesville, the Universal Cyclops Steel Company, the St. Regis Paper Company, and the General Electric Company. Improvements in wastewater effluent quality are being made. Construction of secondary treatment facilities is underway at the Dresden WWTP; the General Electric Company is phasing out the operations that generate phenolic wastes. These improvements, plus reduced pollutant loading via the Tuscarawas River, should result in the attainment of 1983 clean water goals.

REFERENCES

Ohio Environmental Protection Agency. 1976-1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

MUSKINGUM RIVER BASIN

KOKOSING RIVER SUBBASIN (P-12)

SUBBASIN SUMMARY

The water quality in the Kokosing River Subbasin is good, although there may be a few short sections (one mile or less) that show limited degradation. Relatively steep stream slopes provide ample reaeration, thus reducing the zone of impact below pollution sources. New secondary facilities at the village of Fredericktown are nearing completion, and will soon replace an inadequate primary plant. Heavy metals loads discharged to the Mt. Vernon Wastewater Treatment Plant (WWTP) have been reduced. These improvements should eliminate the several water quality violations that were noted (OEPA, NWDO data, 1976-1979).

STREAMS AND/OR SEGMENTS IN THE KOKOSING RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-12-1	Kokosing River From the headwaters to the North Branch confluence	50.2 - 29.1
P-12-2	Kokosing River From the North Branch confluence to the Waldhoning River	29.1 - 0
P-12-3	Jelloway Creek From the headwaters to the Kokosing River	8.9 - 0
P-12-4	Little Jelloway Creek From the headwaters to Jelloway Creek	9.3 - 0

STREAMS AND/OR SEGMENTS IN THE KOKOSING RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

and

STREAMS AND/OR SEGMENTS IN THE KOKOSING RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into these categories, however, the water quality in a portion fo this subbasin has not been determined.

REFERENCES

Ohio Environmental Protection Agency. 1976-79 (unpublished). Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

Ohio Environmental Protection Agency. 1979 (unpublished). Monthly operating reports - Howard Sewer district. Data available from Northwest District Office, Ohio EPA, Bowling Green, Ohio.

MUSKINGUM BASIN

LICKING RIVER SUBBASIN (P-13)

SUBBASIN SUMMARY

Water quality in the Licking River Subbasin ranges from good to poor. The upper portion of the North Fork of the Licking River is of good quality. The discharge from the city of Utica Wastewater Treatment Plant (WWTP) degrades water quality to some degree, but the stream recovers by the time it reaches the Newark Water Treatment Plant intake.

Severe degradation occurs below the city of Newark's Wastewater Treatment Plant. The full extent of this degradation is not known, but the stream appears to have recovered prior to entering Dillon Reservoir.

Water quality in the lower segment remains good until the final 2.1 miles, where several industries discharge to the Licking River. Their impact on the mainstem is variable depending on background flow conditions.

STREAMS AND/OR SEGMENTS IN THE LICKING RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-13-1	North Fork From the headwaters to the Utica WWTP	38.4-17.1

The water quality of the upper North Fork is good based on limited stream data in the Utica WWTP's monthly operating reports.

Segment	Name/Description	Mile Points
P-13-3	Licking River From the confluence of the North and South Forks to the Newark WWTP	29.1-28.6

Water quality in this segment is somewhat variable due to flow conditions and the effects of upstream dischargers. However, data indicate that this segment is generally of good quality (USGS, 1969-1976).

Segment	Name/Description	Mile Points
P-13-5	Licking River From Toboso to Zanesville	18.6-2.1

The mile point delineation of this segment is somewhat arbitrary because the zone of impact from the Newark WWTP is variable. The Dillon Reservoir, located in this river segment, was ranked the second most eutrophic lake of the 20 Ohio lakes sampled in 1973 (U.S. EPA, 1975). Dillon Reservoir

experiences very high phosphorus loading from point and non-point sources, and the lake should be modeled to determine what water quality benefits may result from phosphorus control programs.

Limited sampling below the reservoir outlet revealed no substantial water quality problems in the Licking River (USGS, 1965-1977).

STREAMS AND/OR SEGMENTS IN THE LICKING RIVER SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-13-2	North Fork From the Utica WWTP to the South Fork confluence	17.1-0.0

Point source discharges from the Utica WWTP and the Prescott Estates WWTP degrade this river segment. The Utica facility is overloaded and discharges poor quality effluent. The Warmwater Habitat (WWH) dissolved oxygen standard is not maintained in portions of this segment during low-flow conditions (OEPA, CDO data, 1977-1979).

The city of Utica is currently at Step 1 of the Construction Grants Program, and completion of new wastewater treatment facilities should dramatically improve water quality. The Prescott Estates WWTP discharges to the North Fork at mile point 7.7. Water quality in this reach should improve after the Newark trunk sewer is completed and this plant is taken offline. Completion of the Newark trunk sewer is expected within the next two years.

The city of Newark withdraws water from the North Fork at mile point 2.9. During dry weather there is virtually no flow downstream from this point due to the water demand. The lack of flow formerly posed a problem because Owens Corning had two outfalls located on the North Fork below the water treatment plant. The discharge from these outfalls is now diverted to the Newark WWTP. A third Owens Corning's outfall located on Log Pond Run, a small tributary that intersects the mainstem at mile point 0.86, has not discharged cooling water since 1978.

STREAMS AND/OR SEGMENTS IN THE LICKING RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-13-4	Licking River From the Newark WWTP to Toboso	28.6-18.6

The Newark WWTP receives large volumes of complex wastes from several industries. These wastes reduce wastewater treatment efficiencies and have an adverse effect on effluent quality. Warmwater habitat standards violations for cyanide, phenolics and MBAS have been recorded downstream from the Newark WWTP (RM 26.8; STORET station No. 601770) (OEPA, CDO data, 1977-1979).

Until the city of Newark passes adequate industrial pretreatment regulations, violations will continue to occur and the 1983 goals will not be attained.

RECOMMENDATIONS

1. The city of Newark should establish and enforce industrial pretreatment regulations.

2. Establish a regular schedule of sampling on the Licking River near the mouth to assess the impact of the industrial dischargers located in that final reach. The sampling would also give insight into the impact that urban runoff from the Zanesville area has on the mainstem.

REFERENCES

Ohio Environmental Protection Agency. 1977-1979 (unpublished). Data available from Central District Office, Ohio EPA, Columbus, Ohio.

United States Environmental Protection Agency. 1975. Report on Dillon Reservoir, Muskingum County, Ohio, National Eutrophication Survey Working Paper No. 400. U.S. EPA, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

United States Geological Survey. 1969-1977. Water resources data for Ohio, Volume 1. Ohio River basin. U.S. Geological Survey water-data reports OH-65-1 through OH-77-1. U.S. Geological Survey, Columbus, Ohio.

MUSKINGUM RIVER BASIN

SOUTH FORK LICKING RIVER SUBBASIN (P-14)

SUBBASIN SUMMARY

Water quality in the larger streams of this subbasin (South Fork and Raccoon Creek) ranges from good to fair. Segments impacted by point source dischargers include the lower 13 miles of the South Fork, and Raccoon Creek below Johnstown. Localized point source pollution may occur in some of the small tributaries in the subbasin because of insufficient dilution water.

STREAMS AND/OR SEGMENTS IN THE SOUTH FORK LICKING RIVER SUBBASIN THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-14-1	South Fork From the headwaters to the Licking River	33.9-0.0

The village of Pataskala is located near the headwaters of the South Fork. The Pataskala Wastewater Treatment Plant (WWTP) discharges a relatively high quality effluent (i.e., exceeds secondary treatment levels). Wasteload modeling conducted by Ohio EPA, Office of Water Quality Planning and Assessment, has indicated that secondary treatment levels are adequate to insure compliance with Warmwater Habitat (WWH) standards (OEPA, 1979b). Data from 1974 (OEPA, CDO data, 1974) and the monthly operating reports of the Pataskala WWTP revealed no substantial water quality problems.

Numerous small dischargers are located along the lower 13 miles of the South Fork. Water quality is slightly degraded (compared to upstream quality) but 1983 clean water goals are not contravened. Water quality in this segment should improve if the point source dischargers are upgraded through the Construction Grant Program, as planned.

Segment	Name/Description	Mile Points
P-14-2	Raccoon Creek From the headwaters to the Johnstown WWTP	27.5-23.8
P-14-4	Raccoon Creek From near Hazelton Corners to the South Fork	18.8-0.0

Water quality in these segments is generally good based upon stream data contained in the Johnstown and Granville WWTPs monthly operating reports and Ohio EPA, 1979a. Occasional fecal coliform violations were noted, along with high nutrient concentrations in segment P-14-4. These minor problems do not impair the 1983 clean water goals.

STREAM AND/OR SEGMENTS IN THE SOUTH FORK LICKING RIVER THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
P-14-3	Raccoon Creek Johnstown WWTP to near Hazelton Corners	23.8-18.8

The Johnstown WWTP degrades five to ten miles of Raccoon Creek, depending upon flow and operating conditions. The facility has some severe operational problems involving overloads due to infiltration and inadequate solids handling capabilities. In addition, there were several incidents of concentrated pollutants discharged to Raccoon Creek from the WWTP during 1976; less frequent incidents occurred in 1977, 1978, and 1979. A fish kill occurred below the sewage treatment plant in December 1974 when approximately 10,000 gallons of digester sludge were discharged. A study conducted during the summer of 1979 did not show any standards violations below the Johnstown WWTP (OEPA, 1979a); however, it should be noted that flows were above average and only a limited number of parameters were sampled.

Johnstown is in Step 2 of the Construction Grants Program. Hopefully, the wastewater treatment improvements will correct the problem at this plant.

STREAMS AND/OR SEGMENTS IN THE SOUTH FORK LICKING RIVER SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

None of the segments monitored in this subbasin presently fall into this category, however, the water quality in a portion of this subbasin has not been determined.

RECOMMENDATIONS

1. Establish a regular schedule of sampling on the lower portion of the South Fork to assess the impact of the discharges located in the lower segment.

2. Establish a regular schedule of sampling on Raccoon Creek below Granville to assess the impact of the Johnstown and Granville Wastewater Treatment Plants on the mainstem.

REFERENCES

Ohio Environmental Protection Agency. 1974 (unpublished). South Fork water quality survey. Data available from Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1979a (unpublished). Survey of Raccoon Creek. Data available from Central District Office, Ohio EPA, Columbus, Ohio.

Ohio Environmental Protection Agency. 1979b. Muskingum River basin - Initial proposal for wasteload allocation. Ohio EPA, Office of Wastewater Pollution Control, Division of Water Quality Planning and Assessment, Columbus, Ohio.

MUSKINGUM RIVER BASIN

MOXAHALA CREEK SUBBASIN (P-15)

SUBBASIN SUMMARY

Portions of the Moxahala Creek Subbasin have been characterized as some of the most severely impacted mine drainage streams in Ohio (OEPA, 1979). Upper Jonathan Creek is the only stream segment not seriously affected by mine drainage. The urban areas of Roseville and Crooksville may contribute point and non-point source pollution, but no data is available to assess the impact on water quality in Moxahala Creek.

STREAMS AND/OR SEGMENTS IN THE MOXAHALA CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE MOXAHALA CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

No segments fall into these categories. However, water quality has not been adequately monitored in portions of the subbasin.

STREAMS AND/OR SEGMENTS IN THE MOXAHALA CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
P-15-1	Moxahala Creek from the headwaters to the Muskingum River	29.2 - 0.0

Previous data revealed numerous standards violations for pH, iron, and zinc in this stream segment (OEPA, 1979). A recent sample collected by Ohio EPA, Southeast District Office, also revealed violations for the same three parameters (OEPA, SEDO data, 1979). The severity of mine drainage pollution will prevent attainment of 1983 clean water goals in the foreseeable future.

REFERENCES

Ohio Environmental Protection Agency. 1979 (unpublished). Data available from the Southeast District Office, Ohio EPA, Logan, Ohio.

Ohio Environmental Protection Agency. (1979). Muskingum River Basin water quality management plan. Part III, preliminary report. Ohio EPA, Columbus, Ohio.

MUSKINGUM RIVER BASIN

MIDDLE MUSKINGUM RIVER SUBBASIN (P-16) AND LOWER MUSKINGUM RIVER SUBBASIN (P-19)

These two subbasins encompass the Muskingum River from Zanesville to the Ohio River. An appraisal of water quality with regard to 1983 clean water goals is difficult because of the scarcity of data. Ohio EPA has collected water quality data at only two locations during 1977-1979: at McConnelsville (RM 48.2; STORET station No. 601860) and at Beverly (RM 23.7; STORET station No. 611780). Frequent standard violations for iron were noted at both stations reflecting background conditions and non-point source pollution. Minor violations for fecal coliforms and phenolics were recorded at Beverly. Occasional lead, cadmium, mercury, and zinc violations were observed at McConnelsville and may be attributable to the discharge of Gould Inc., Engine Parts Division (OEPA, SEDO data, 1976-1979).

Further data collection is advisable prior to assessing the attainability of the 1983 goals in the middle and lower Muskingum River. Major point source dischargers in the cities of Zanesville, Philco, McConnelsville, and Beverly may have substantial impacts on water quality. Agricultural and mining non-point source pollution may also degrade water quality. The limited data base available to Ohio EPA precludes evaluation these potential problem areas.

REFERENCES

Ohio Environmental Protection Agency, 1976-1979 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio

MUSKINGUM RIVER BASIN

WILLS CREEK SUBBASIN (P-17, P-18)

SUBBASIN SUMMARY

Recent water quality data for this subbasin is limited to grab samples taken at two low flow monitoring sites (RM 54.9; STORET station No. 611760, and RM 6.2; STORET station No. 611770) in 1978. This data, together with previous information, indicates degraded water quality below the Cambridge Wastewater Treatment Plant (WWTP), the Byesville WWTP, and the New Concord WWTP. Dissolved oxygen and fecal coliform standards violations were recorded in the receiving waters below all three WWTPs (OEPA, SEDO data, 1974-1978). Additional data is needed to assess the extent of water quality degradation from point source dischargers in the Wills Creek Subbasin.

Water quality in several tributaries to Wills Creek (Leatherwood Creek, White Eyes Creek, and Crooked Creek) appears to be influenced by mine drainage. Standards violations for iron and elevated concentrations of manganese and sulfate may be attributable to mine drainage impacts. (OEPA, SEDO data, 1974-1978).

REFERENCES

Ohio Environmental Protection Agency. 1974-1978 (unpublished). Data available from Southeast District Office, Ohio EPA, Logan, Ohio.

OHIO RIVER TRIBUTARIES

BASINS L, N, R AND S
(See subbasin list below)

SUMMARY

An accurate assessment of water quality in the minor Ohio River tributaries (Basins L, N, R, and S) is not possible at the present time because of insufficient data. A subjective evaluation of water quality conditions in the Ohio River tributaries was made based upon scant data and knowledge of pollution sources within the watershed. A few subbasins were not evaluated at all because of a complete lack of information.

General indications are that many Ohio River Tributaries may currently meet 1983 goals, but this judgement cannot be substantiated. Some streams are known to be impacted by mine drainage but the degree of degradation is uncertain. Further investigation may reveal stream segments that will not meet 1983 goals due to the mine drainage problem. For a more comprehensive evaluation of the mine drainage issue, the reader is referred to a separate document compiled by the Industrial Coal Operations Group of the Ohio EPA (Volume V of the 1980 305(b) report).

Ohio River Tributary Subbasins

Basin L

L-1	Whiteoak Creek Subbasin
L-2	Ohio Brush Creek Subbasin
L-3	Eagle Creek and Straight Creek Subbasin

Basin N

N-1	Upper Raccoon Creek Subbasin
N-2	Lower Raccoon Creek Subbasin
N-3	Symmes Creek Subbasin
N-4	Little Scioto River and Pine Creek Subbasin
N-5	Ice Creek and Indian Guyan Creek Subbasin

Basin R

R-1	Duck Creek Subbasin
R-2	Little Muskingum River Subbasin

Basin S

S-1	Little Beaver Creek Subbasin
S-2	Yellow Creek, Cross Creek, and McIntyre Creek Subbasin
S-3	Short Creek and Wheeling Creek Subbasin
S-4	McMahon Creek, Captina Creek, and Sunfish Creek Subbasin

WHITEOAK CREEK SUBBASIN (L-1)

Available water quality data was summarized in the State Water Quality Management Plan (OEPA, 1979a). Fecal coliforms and heavy metals (copper, zinc, cadmium, lead, iron, mercury, and nickel) were cited as possible water quality problems. The data are insufficient to assess the magnitude and sources of the fecal and heavy metal contamination. The status of Whiteoak Creek with respect to the 1983 clean water goals is unknown.

OHIO BRUSH CREEK SUBBASIN (L-2)

Overall water quality in the Ohio Brush Creek Subbasin appears to be excellent except for isolated degradation below four municipal wastewater treatment plants (WWTPs) and the Adams County Landfill. Some degradation occurs in three low-flow streams receiving effluent from the Seaman WWTP, Peebles WWTP and West Union WWTP. Beasley Fork, which receives waste from both the West Union WWTP and the Adams County Landfill, is seriously degraded during dry weather conditions. The West Union plant discharges 200,000 GPD, which causes high ammonia and total phosphorus concentrations in Beasley Fork. Leachate from the landfill has never been sampled comprehensively but does have high levels of iron, aluminum and slightly high levels of ammonia. Sampling at the fixed monitoring site (RM 13.1; STORET station No. 600660) has revealed standards violations for ammonia, fecal coliforms and heavy metals (OEPA, SEDO data, 1974-1979). For the majority of the basin, the severity of the violations probably do not interfere with 1983 clean water goals. Further investigation of Ohio Brush Creek is needed to determine if Exceptional Warmwater Habitat standards can be maintained in the mainstem and major tributaries.

EAGLE CREEK AND STRAIGHT CREEK SUBBASIN (L-3)

Recent data for Eagle Creek is limited to a single sample collected in August 1978 at the low-flow monitoring site (RM 3.7; STORET station No. 609120). There were no violations of the Exceptional Warmwater Habitat standards (OEPA, SEDO data, 1978). Data from 1972-1973 (OEPA, 1979a) showed violations for iron and chromium in the vicinity of the Copeland Refrigeration Corporation; recent sampling detected zinc violations below the Copeland discharge (OEPA, SEDO data, 1979). The Copeland Corporation also operates a small package wastewater treatment plant which has been found to be improperly maintained and operated during inspections by Ohio EPA Southeast District personnel. Localized dissolved oxygen and ammonia problems probably occur downstream from this package plant outfall.

Water quality data was collected in late 1979 in the Straight Creek drainage. This single set of samples revealed excellent water quality and no violations of the Exceptional Warmwater Habitat Standards (OEPA, SEDO data, 1979). No water quality problems are believed to exist because of the rural land-use and the absence of any significant point source pollution.

UPPER RACCOON CREEK SUBBASIN (N-1)

Mine drainage problems are prevalent in this subbasin. Water quality standards violations for pH, zinc, and iron, along with high manganese and sulfate concentrations, have been reported (USGS, 1976-1977; OEPA, SEDO data, 1974-1978). Severely degraded streams include Raccoon Creek from the East and West Branch confluence to the Little Raccoon Creek confluence, East Branch, Hewett Fork, Brushy Fork, Sandy Run, and Twomile Run. Streams affected by mine drainage to a lesser degree include the West Branch, Rockcamp Creek, Flatlick Run, Siverly Creek, Honey Fork, and Elk Fork.

The Lake Hope Mine Drainage Demonstration Project is located in the Sandy Run watershed. Underground mines are being sealed in an effort to reduce mine drainage pollution.

LOWER RACCOON CREEK SUBBASIN (N-2)

SUBBASIN SUMMARY

Severe mine drainage pollution in the Little Raccoon Creek watershed has been documented (FWPCA, 1967; Skelly and Loy, 1974). Frequent violations of the pH standard have occurred, thus impairing the attainment of the 1983 clean water goals. Municipal point source pollution is also a problem in segments of the subbasin.

STREAMS AND/OR SEGMENTS IN THE LOWER RACCOON CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE LOWER RACCOON CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

No segments fall into these categories. However, portions of the subbasin have not been adequately assessed because of insufficient data.

STREAMS AND/OR SEGMENTS IN THE LOWER RACCOON CREEK CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
N-2-1	Little Raccoon Creek From the headwaters to Raccoon Creek	36.5 - 0.0

Previous reports from the Federal Water Pollution Control Administration (1967) and Skelly and Loy (1974) listed standards violations for pH, iron, and zinc in Little Raccoon Creek.

These reports identified widespread mine drainage pollution in the tributaries of Raccoon Creek: Sand Run, Meadow Run, Mulga Run, Flint Run, Buffer Run, Tarcamp Run, Goose Run, Dickason Run, Spring Run and Keetor Run. Urban point and non-point pollution from the Wellston-Hamden area may also impact Little Raccoon Creek.

Segment	Name/Description	Mile Points
N-2-2	Meadow Run From the Wellston WWTP to Little Raccoon Creek	2.9 - 0.0

The low gradient segment of Meadow Run experiences severe dissolved oxygen problems due to the organic loading from the Wellston Wastewater Treatment Plants (OEPA, SEDO data, 1977). The city of Wellston is in the Construction Grants Program but no wastewater treatment improvements are anticipated prior to 1983.

Segment	Name/Description	Mile Points
N-2-3	Raccoon Creek From the Little Raccoon Creek confluence to U.S. Rt. 35	37 - 29.6

This segment is affected by mine drainage from upstream areas. Monthly water quality samples were collected at the lower end of this stream segment (RM 29.6: STORET station No. 601400). Frequent standards violations for pH and iron occurred as well as one violation for copper (OEPA, SEDO data, 1977-1979)

Indian Creek, a major tributary to this segment, is degraded below the city of Rio Grande Wastewater Treatment Plant. Nutrients and low dissolved oxygen were identified as the major problems (OEPA, SEDO data, 1979). The city of Rio Grande is on the Construction Grants list but improvements are not expected prior to 1983.

SYMMES CREEK SUBBASIN (N-3)

Very little data exists for the Symmes Creek mainstem and no data exists for its tributaries. Segments in this basin are affected by mine drainage. One sample taken near the mouth of Symmes Creek showed no water quality violations (OEPA, SEDO data, 1978). The Oak Hill Wastewater Treatment Plant discharges to Huntingcamp Creek, a tributary to Symmes Creek, and may cause occasional nutrient and dissolved oxygen violations.

LITTLE SCIOTO RIVER AND PINE CREEK SUBBASIN (N-4)

An accurate evaluation of water quality in this subbasin is not possible because of insufficient data. Preliminary observations and the results of one sample (OEPA, SEDO data, 1978) taken at mile point 2.2 on the Little Scioto River indicated good water quality. Two small wastewater treatment facilities serving Purtee Acres and the Tanglewood Subdivision discharge to tributaries of the Little Scioto River. The impact of these discharges, agricultural runoff, and failing septic tank systems on the water quality of the Little Scioto River is unknown.

A recent evaluation listed nine tributaries to Pine Creek as being influenced by mine drainage (OEPA, 1979b). A single sample collected by Ohio EPA revealed no problems (OEPA, SEDO data, 1978); however, monitoring by the U.S. Geological Survey recorded iron and pH standards violations (USGS, 1972-1978).

No recent data is available for the Storm Creek watershed. Previous reports have indicated good water quality (OEPA, 1976; OEPA, 1979b).

ICE CREEK AND INDIAN GUYAN CREEK SUBBASINS (N-5)

No statements can be made concerning water quality in Ice Creek because of insufficient data.

A substantial portion of Indian Guyan Creek flows through the Wayne National Forest. There are no point source discharges in the subbasin but water quality may be influenced by strip mining activity in the upper watershed and by a small amount of agricultural land-use. Water quality appears to be good; one of two Ohio EPA water samples collected near the village of Bradrick showed an iron violation (OEPA, SEDO data, 1978), while U.S. Geological Survey Data revealed no violations (USGS, 1974-1977).

DUCK CREEK SUBBASIN (R-1)

Portions of the Duck Creek Subbasin are degraded by mine drainage pollution. Severely impacted areas include the Middle Fork, the East Fork below the Middle Fork, the West Fork, and lower Duck Creek. Based upon limited data, the upper East Fork and several smaller tributaries in the subbasin have acceptable water quality (OEPA, SEDO data, 1976). The Caldwell Wastewater Treatment Plant may have a substantial impact on water quality but data is lacking.

LITTLE MUSKINGUM RIVER SUBBASIN (R-2)

The Little Muskingum River is classified as a State and National Resource Water and is considered one of the higher quality streams in the State. There are no point source discharges in the basin; two abandoned underground mines have an insignificant impact on water quality. Two minor water quality violations were detected: an iron violation on Rich Fork and a lead violation on the mainstem above Mill Run (OEPA, SEDO data, 1978-1979).

The streams in the Little Muskingum River Subbasin probably meet 1983 clean water goals, but an accurate assessment cannot be made without additional data.

LITTLE BEAVER CREEK SUBBASIN (S-1)

SUBBASIN SUMMARY

Water quality in the Little Beaver Creek Subbasin ranges from good to fair. The headwaters of the Middle Fork and segments of the East Branch and North Fork were degraded by municipal and industrial point source pollution. The urban areas of Salem, Leetonia, Washingtonville, Lisbon, East Palestine and New Waterford were responsible for localized water quality problems. Organic pollution and fecal coliform contamination were the most widespread problems below these municipalities (OEPA, NEDO data, 1977-1979).

Stateline Creek and Chemline Run, tributaries to the North Fork and West Fork respectively, were impacted by industrial waste disposal operations. Ammonia, pH, total dissolved solids, and phenolics violations were among the problems resulting from discharges and leachates from the disposal facilities. Segments of the North Fork and West Fork were degraded below the disposal sites during low-flow conditions. Numerous coal mining activities within the Little Beaver Creek Subbasin may also influence water quality.

Little Beaver Creek and the lower portions of the West Fork, Middle Fork and North Fork are relatively free from degradation and near-stream development. Thirty-three miles in the lower watershed are designated as a National Scenic River. Under the State designation system, 20 miles of the Little Beaver Creek system is classified as a Wild River and 16 miles are classified as a Scenic River (Ohio DNR, 1979).

STREAMS AND/OR SEGMENTS IN THE LITTLE BEAVER CREEK SUBBASIN THAT CURRENTLY MEET 1983 GOALS

and

STREAMS AND/OR SEGMENTS IN THE LITTLE BEAVER CREEK SUBBASIN THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

No segments fall into these categories. However, water quality has not been accurately assessed in portions of the subbasin.

STREAMS AND/OR SEGMENTS IN THE LITTLE BEAVER CREEK SUBBASIN THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
S-1-1	Middle Fork From the Salem WWTP to Unknown	53.9 - Unknown

Dissolved oxygen, fecal coliform, iron and phenolic standards violations occurred at the Allen Road sampling site (OEPA, NEDO data, 1977-1979). These violations can be attributed to the effluent of the Salem WWTP, which should have upgraded facilities prior to 1983. Farther downstream, runoff from the Stone Mill Run drainage contaminates the Middle Fork with heavy metals (i.e., lead). Further study is needed to determine the source and magnitude of this pollution.

Segment	Name/Description	Mile Points
S-1-2	Little Beaver Creek From the Source to the Ohio-Pennsylvania state line	14.8-1.5

Standards violations for iron, lead, phenolics and fecal coliforms were reported at the monthly monitoring site near East Liverpool (RM 4.6; STORET station No. 602000; OEPA, NEDO data, 1977-1979). Elevated fecal coliform concentrations can be attributed to upstream municipal WWTPs. The other violations may be partially attributable to the industrial waste disposal sites locted within the subbasin. The extent of degradation in Little Beaver Creek appears to be minimal, but further investigation is advisable. Attainment of 1983 clean water goals is dependent upon municipal wastewater treatment plant improvements and pollution abatement programs at the industrial waste disposal site.

Segment	Name/Description	Mile Points
S-1-3	East Branch From unknown point to the Middle Fork	Unknown - 0.0

This low gradient stream experiences dissolved oxygen problems (OEPA, NEDO data, 1977-1979) because of organic loading from the Leetonia WWTP and the Washingtonville WWTP. Additional monitoring is needed to better delineate the problem area.

Segment	Name/Description	Mile Points
S-1-4	West Fork immediately below the Chemline Run confluence	12.8-11.8

Ammonia, iron, lead, and phenolic violations were recorded in this stream segment (OEPA, NEDO data, 1977-1979). A single dissolved oxygen violation also occurred during low-flow conditions. Concentrations of the above pollutants in the West Fork increased slightly below the Chemline Run confluence, but further study is needed to accurately quantify the impact of the Chemline Corporation's waste disposal site on the West Fork.

Segment	Name/Description	Mile Points
S-1-6	North Fork From the Stateline Creek confluence to Little Beaver Creek	7.3-0.0

Industrial dischargers in the Stateline Creek drainage impact this segment of the North Fork. Sampling at two sites has revealed standards violations for lead, phenolics, and iron (OEPA, NEDO data, 1977-1979). These water quality problems are most evident during low-flow conditions. Industrial pollutant abatement measures may allow attainment of 1983 water quality goals by 1983.

Segment	Name/Description	Mile Points
S-1-5	Chemline Run From the Chemline Corp. Outfall to the West Fork	0.4-0.0

Industrial effluent will continue to cause violations for total dissolved solids, pH, ammonia, MBAS, iron, and cyanide. No improvement is likely in the foreseeable future.

Segment	Name/Description	Mile Points
S-1-7	Stateline Creek From the Cenco Corp. Outfall to the North Fork	1.5-0.0

Standards violations for total dissolved solids, ammonia, MBAS, iron and phenolics occurred in this stream segment due to the discharges of the Cenco Corporation and Brownings-Ferris Industries (OEPA, NEDO data, 1977-1979). No changes in water quality are anticipated.

YELLOW CREEK, CROSS CREEK, AND MCINTYRE CREEK SUBBASIN (S-2)

There is extensive mining activity in the Yellow Creek watershed and portions of the stream have been classified as Mine Drainage in the Ohio Water Quality Standards. Elkhorn Creek, a tributary to Yellow Creek, is designated as Exceptional Warmwater Habitat, although there is no data to substantiate this classification. U.S. Geological Survey data indicated high concentrations of sulfates and dissolved solids in Yellow Creek and the North Fork (USGS 1974-1978). A single low-flow sample taken by Ohio EPA near Hammondsville showed an iron violation (OEPA, SEDO data, 1978).

An upper segment of Cross Creek, from the headwaters to its confluence with McIntyre Creek, is classified as Cold Water Habitat (CWH), although stream data is lacking throughout this basin. There is considerable mining activity in the lower portion of this basin; high sulfates, total suspended solids, and conductivity, have been reported (USGS, 1974-1978). Two municipal wastewater treatment plants located in Winterville discharge to Dry Fork, a small intermittent stream near the mouth of Cross Creek. These facilities discharge 110,000 GPD and frequently violate NPDES permit limits for biochemical oxygen demand (BOD) and total suspended solids.

SHORT CREEK AND WHEELING CREEK SUBBASIN (S-3)

Approximately 80-95% of this subbasin has been affected by mine drainage and historical data revealed high concentrations of sulfate, dissolved solids, iron, manganese, and aluminum (OEPA, 1979c). A low-flow sample collected by Ohio EPA showed standards violations for iron and dissolved solids at mile point 1.5 on Wheeling Creek (OEPA, SEDO data, 1978). Violations for iron, lead, and dissolved solids were observed at the low-flow monitoring site on Short Creek (OEPA, SEDO data, 1978).

MCMAHON CREEK, CAPTINA CREEK, AND SUNFISH CREEK SUBBASIN (S-4)

Approximately 50 strip mines, both active and abandoned, and 1 underground mine impact the water quality of McMahon Creek. Most of McMahon Creek and Little McMahon Creek are not expected to meet 1983 goals. Although little chemical/physical data exists for this watershed, field observations and biological samples indicate good water quality in Little McMahon Creek above St. Clairsville and in McMahon Creek above Glencoe (OEPA, SEDO data, 1976-1977). Other segments in the watershed may not meet 1983 goals.

Captina Creek is significantly impacted by mine drainage for 22 miles below the North American Coal Company #6 mine to the Ohio River. Gob pile runoff, underground mine portal drainage, and active and inactive strip mines in the basin all combine to adversely affect water quality. The watershed contains 3 active underground mines, 6 active surface mines, 2 active deep mine portals and a coal preparation plant. An old gob pile, owned by Cravat Coal Company, is in the early stages of reclamation; the estimated completion date is late 1980. This gob pile has been a significant cause of mine drainage problems for many years. A good cover of clay, top soil, and plant growth should greatly reduce surface and sub-surface drainage problems. The Cravat Coal Company and North American Coal Company have operations on the Captina Creek mainstem which presently affect water quality. The Youghiogheny & Ohio Coal Company, located on Piney Creek, has little or no effect upon Piney Creek or the Captina Creek mainstem. Current gob pile reclamation projects are expected to eliminate approximately 75% of the mine drainage problems in this basin. The North American Coal Company should be in complete compliance with its discharge permit by 1983. The mainstem of Captina Creek is not expected to meet 1983 goals due to drainage from abandoned mines, but should be much closer to meeting them than at the present time.

The Bethesda and Barnesville municipal wastewater treatment plants (WWTP) also discharge the Captina Creek drainage. The Barnesville WWTP, located on the headwaters of the North Fork of Captina Creek, discharges an average of 920,000 GPD of secondary treated sewage. This plant is presently receiving almost twice the raw sewage it was designed to handle and, subsequently, has poor BOD and total suspended solids removal. Although data is unavailable, severe degradation during the summer months is probable. The Bethesda WWTP, located on the headwater of Bend Fork of Captina Creek, discharges an average of 111,000 GPD of secondary treated sewage. Physical/chemical data below the discharge is lacking but observations suggest a major impact; field inspections have revealed a septic zone and fish kills have been reported (OEPA, SEDO data, 1977-1978).

Sunfish Creek generally has excellent water quality. A lead violation occurred at the ambient site (RM 6.8; STORET station No. 609200) but was only 1 ug/l over the standard (OEPA, SEDO data, 1978). Standingstone Run receives effluent from Woodsfield WWTP and localized water quality problems may result from high organic loading to this low-flow stream. The Beallsville WWTP may cause similar degradation of the East Fork of Piney Fork but water quality data is lacking.

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MAHONING RIVER, PYMATUNING CREEK, AND YANKEE CREEK BASIN

UPPER, MIDDLE, AND LOWER MAHONING RIVER SUBBASINS (T-1, T-2, T-3)

SUBBASIN SUMMARY

The water quality of the Mahoning River ranges from good to grossly polluted. The upper and middle subbasins appear to be in generally good condition, although water quality data is scant. Point source pollution from the cities of Alliance and Sebring degrades portions of the upper Mahoning River and the Berlin Reservoir. Further study is needed to accurately assess the degree of degradation, especially with regard to eutrophication problems in the reservoir. In addition to Berlin Reservoir, four other reservoirs in the Mahoning River drainage provide recreational uses and/or public drinking water supplies. Eagle Creek, a tributary to the middle Mahoning River, receives effluent from municipal wastewater treatment plants (WWTPs) in Hiram, Garrettsville, and Windham. Limited sampling of Eagle Creek (OEPA, NEDO data, 1977-1979) revealed no standards violations; however, the data was insufficient to evaluate Eagle Creek with respect to the 1983 goals.

Urban and industrial land-use has a substantial impact on the water quality of the Mahoning River below the city of Warren. The sheer volume of wastewater generated combined with generally outdated wastewater treatment at municipal and industrial facilities creates a grossly polluted aquatic environment. Water quality improvements are anticipated following the termination of steel making operations at several plants in the Mahoning Valley, but the 1983 clean water goals are not expected to be attainable within the foreseeable future.

STREAMS AND/OR SEGMENTS IN THE MAHONING RIVER SUBBASINS THAT CURRENTLY MEET 1983 GOALS

Segment	Name/Description	Mile Points
T-2-1	West Branch From the headwaters to the Mahoning River	29.2 - 0.0

Limited data collected in 1977 (NEFCO, 1979) indicated no substantial water quality degradation in the West Branch. Fecal coliform concentrations were elevated at some locations, reflecting the increased housing development in the southeastern portion of the watershed. A single sample collected by Ohio EPA revealed no water quality standards violations (OEPA, NEDO data, 1979).

STREAMS AND/OR SEGMENTS IN THE MAHONING RIVER SUBBASINS THAT ARE EXPECTED TO MEET 1983 GOALS AFTER IMPLEMENTATION OF POLLUTION CONTROLS PRIOR TO 1983

Segment	Name/Description	Mile Points
T-2-2	Mahoning River From Newton Falls to Main Street in Warren	56 - 38

This segment of the Mahoning River is degraded by the Newton Falls WWTP and combined sewer overflows in the Newton Falls area. Sampling at Leavittsburg (RM 45.0; STORET station No. 602280) revealed standards violations for fecal coliforms, iron, lead, cyanide, and phenolics (OEPA, NEDO data, 1977-1979). Pollution abatement programs in Newton Falls are expected to improve sewage treatment and reduce the severity of the combined sewer overflow problem by 1983.

STREAMS AND/OR SEGMENTS IN THE MAHONING RIVER SUBBASINS THAT ARE NOT EXPECTED TO MEET 1983 GOALS

Segment	Name/Description	Mile Points
T-3-1	Mahoning River From Warren to the Ohio/Pennsylvania state line	38 - 11.2

The urban and industrial centers of the Mahoning Valley generate a wastewater volume three to five times the normal Mahoning River discharge. Many of the industrial and muncipal wastewater treatment facilities in the Mahoning Valley are old and produce poor quality effluent. The result is one of the most severely degraded stream segments in Ohio. Data from three monitoring sites (RM 37.4; STORET station No. 602400, RM 33.1; STORET station No. 602290, and RM 11.6; STORET station No. 602300) showed Warmwater Habitat standards violations for iron, lead, mercury, copper, zinc, phenolics, pH, cyanide, MBAS, fecal coliforms, and dissolved oxygen (OEPA, NEDO data, 1977-1979). Eight municipal wastewater treatment plants, six steel plants, and a power plant were among the major point sources of pollution causing the degradation. The termination of production at several steel plant facilities will reduce pollutant loading to the Mahoning River. However, improved wastewater treatment by the remaining dischargers must occur before 1983 clean water goals can be realized.

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emergency episode standards

OAC-3745-25 (former rule - AP-11)

A WATER QUALITY ANALYSIS OF OHIO SURFACE WATERS IN ABANDONED COAL MINE WATERSHEDS

305(b) Report
VOLUME V

Submitted Pursuant to the Requirements of
Section 305(b)
Federal Water Pollution Control Act
As Amended by Clean Water Act of 1977

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The Industrial Coal Operations Group

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May, 1980

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Office of Wastewater Pollution Control
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Introduction

Drainage from abandoned coal mines has adversely affected 980 miles of principal streams in 27 counties of southeastern Ohio and has resulted in Ohio Water Quality Standards violations for pH, sulfates, total iron, manganese, zinc and dissolved solids.

This report provides a water quality assessment of all streams and reservoirs which drain abandoned surface or underground coal mines and refuse piles based upon a compilation of all available water quality data from 1955 through 1979. The analysis provides a comprehensive review of these watersheds and evaluates the degree of degradation due to past mining activities. Data for major streams is usually adequate to make assessments, however, data for small tributary streams is quite sparse; in many cases only one or two samples per stream have been collected. Past, biological or chemical/physical data was included, if no current data was available to serve as a groundwork for further investigations. Historical water quality trends could not be evaluated in most instances due to incomplete or unavailable information.

Data was obtained from federal and state agencies, private engineering and consulting firms and special reports. These data sources include: Ohio EPA, Ohio Department of Natural Resources (DNR), U.S. EPA and its forerunner, the Federal Water Pollution Control Administration (FWPCA), the Federal Water Quality Administration (FWQA), U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS) and Soil Conservation Service (SCS), and U.S. Army Corps of Engineers (USCOE).

The abandoned mines referred to in this section are mines left without adequate reclamation prior to 1972. The sources used for locations of surface mines were maps produced for the Ohio Board on Unreclaimed Strip Mined Land's Land Reborn (1974) study prepared by Skelly and Loy Consultants, and for underground mines the Ohio DNR, Division of Geological Survey O'Neill maps. All abandoned mine locations and the geographic extent of disturbance is mapped on USGS 7.5° topographic maps available at Ohio EPA. Mines abandoned after enactment of the Ohio Strip Mine Law in 1972 are not included in the analysis, however, these areas probably contribute an insignificant amount of mine drainage relative to the pre-existing conditions.

Approximately 980 miles of primary streams (mainstems with greater than 100 square miles) are affected by abandoned coal mine drainage. The distribution of affected primary stream miles for each major river basin are as follows:

River Basin	Miles
Southeast Ohio River Tributaries Basin	295
Central Ohio River Tributaries Basin	210
Muskingum River Basin	210
Hocking River Basin	150
Scioto River Basin	81
Mahoning and Little Beaver River Basins	40

Contributing to the mine drainage are approximately 370,000 acres of abandoned strip mines, 7,000 acres of coal refuse piles (over one acre in area) and 3,000 underground mines. The geographic boundaries of the area affected by coal mining are the Ohio River to the east and south, the Akron and Youngstown area to the north, and a line from Akron through Columbus and Portsmouth to the west.

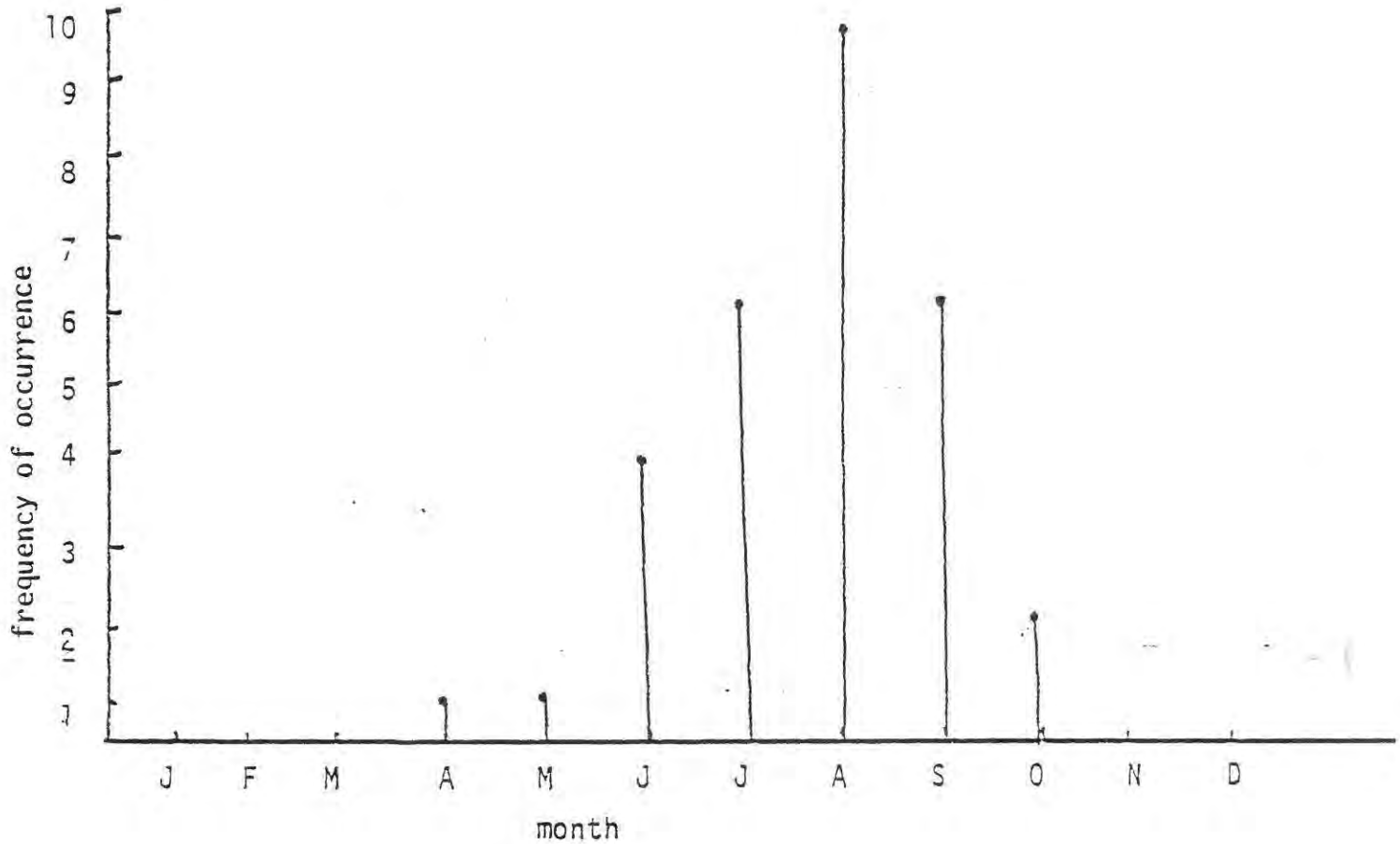
Fifteen Ohio surface public water supplies are affected by abandoned coal mines, to varying degrees. Levels of sulfates, manganese, iron and pH exceed Public Water Supply standards in the raw water at 13 of the 15 surface water supplies, and proposed secondary federal standards are exceeded in the treated water at 10 of these water supply plants. The sources of water for these supplies are primarily lakes or reservoirs. The effects of mine drainage are more difficult to reverse in lakes because they act as catchment basins for dissolved and suspended solids. Piedmont Reservoir was determined in 1975 by Ohio EPA to be unsuitable for public water supply due to excessive levels of sulfates as a result of surface mining activities in the watershed.

Thirty-one fish kills attributed to mining have been reported by Ohio DNR, Division of Wildlife between 1963-1978 (See Table). Of these, 27 occurred during the low flow months of June through September, and no fish kills were observed in the months of November though March. In contrast, fish kills resulting from non-mining industrial spills were distributed more evenly throughout the year. This data suggests fish kills are the result of an inadequate dilution of slugs of acidic mine water or sediment in the receiving streams during low flow conditions.

Fish Kills Attributable to
Mine Drainage 1966-1978
ODNR - Division of Wildlife

Date	County	Stream	No. Killed
07/12/78	Coshocton	Dickinson Run	10,184
08/29/78	Washington	Duck Creek	10
06/01/77	Meigs	Kingsberry Creek	121
06/03/76	Coshocton	Little Mill Creek	516
06/28/76	Jackson	Symmes Creek	596
10/03/76	Pike	Big Run	450
07/23/74	Washington	Duck Creek	13,580
08/08/72	Meigs	Leading Creek	482
09/08/72	Jackson	Symmes Creek	794
07/17/71	Columbiana	Leslie Run	208
07/23/71	Muskingum	Thompson Run	15,741
07/28/71	Athens	Hocking River	17
08/23/71	Noble	W. Fork Duck Creek	224
08/30/71	Washington	Duck Creek	47,250
09/28/71	Noble	E. Fork Duck Creek	32,678
04/30/70	Mahoning	Meander Creek	2,006
06/21/70	Mahoning	Meander Creek	120
07/29/70	Harrison	Middle Fork Short Creek	18,315
08/25/70	Jefferson	Yellow Creek	765
08/26/70	Meigs	Leading Creek	8
09/11/70	Jackson	Little Raccoon Creek	23
10/26/70	Tuscarawas	Tuscarawas River	54
09/11/68	Jefferson	Cross Creek	3,135
05/03/68	Mahoning	Meander Creek	57
08/16/68	Tuscarawas	Tuscarawas River	23
08/11/66	Belmont	Captina Creek	15,591
09/13/66	Carroll	Riley's Creek	84
08/21/66	Coshocton	Mill Creek	3,061
09/22/66	Muskingum	Muskingum River	20,860
08/31/66	Tuscarawas	Sugar Creek	50,680

Frequency and Periodicity of Fish Kills Resulting from
Mine Drainage in Southeast Ohio (1966-78)
ODNR - Division of Wildlife



The frequency of fish kills attributable to coal mine drainage were plotted by month for years in which reports were filed by the Ohio DNR, Division of Wildlife.

Past Ohio statutes did not require restoration of mined lands adequate to today's higher standards. Damages attributable to both abandoned surface and underground mines include sedimentation and chemical water pollution of streams. Thousands of acres remain in an unreclaimed condition allowing the effects of degraded water and sedimentation to render lands and water unsuitable for most purposes.

Ohio DNR, Division of Reclamation is responsible for reclaiming selected abandoned mine areas in Ohio through the Unreclaimed Lands Fund, the Strip Mine Reclamation Fund, the Strip Mining Administration and Reclamation Reserve Fund, and the Abandoned Mine Reclamation Fund created by Title IV of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) PL 95-87.

There are, in Ohio, approximately 210,000 acres of severely affected abandoned strip mine land, out of 370,000 estimated total acres, and 3,000 abandoned deep mines, out of 7,000 estimated total, requiring closure. The costs of reclamation were estimated in the Land Reborn (1974) report to be $290 million for strip mine reclamation and $440 million for underground mine sealing. By 1980, the cost has inflated to $2 billion for underground mines, at approximately $700,000 per seal and $2 billion for abandoned surface mine reclamation with costs per acre of $3,000 to $15,000. In addition, reclamation of coal refuse piles is estimated to cost an additional $70 million; special projects dealing with flooding, subsidence and other emergencies could add up to $15 million per year; and stream bed restoration could cost approximately $10,000 per stream mile. The projected funding available to Ohio is about $10 million per year for the next fifteen years. Within this framework water quality restoration will be a significant factor. As reclamation projects are completed on sites contributing to water quality problems, the receiving water quality should be sufficiently improved to warrant, in applicable situations, the reclassification of streams from Limited Warmwater Habitat to Warmwater Habitat. While the reclamation dollars available to Ohio are significant, they will by no means be adequate for reclamation of all problem areas in the State. A prioritization of sites, therefore, will be established annually by Ohio DNR. (More detailed information on costs and treatment techniques can be found in the Initial Water Quality Management Plan Part III, Mine Drainage Abatement Chapter IV).

Assessments of the effectiveness of abandoned mine drainage reclamation projects and an evaluation of the control techniques as they affect water quality are ongoing programs coordinated between Ohio EPA and DNR. In addition, an environmental assessment of recommendations made in the initial Water Quality Management Plan for abandoned mine drainage abatement is being undertaken this Spring by the Ohio EPA, Office of Planning Coordinator.

Summary of Hocking River Basin Analysis

Abandoned coal mines are probably the major source of pollution in the Hocking Basin. Severe, persistent concentrations of total iron, manganese, sulfates and acidity are found in the Sunday, Monday and Rush Creek watersheds. All three watersheds are extensively strip and deep mined in the Nos. 5 and 6 coals which have high pollution potentials for both surface and underground mining.

Sunday Creek has very marked, seasonal fluctuations in water quality with pH values below 3.5 S.U. during June through October rising to approximately 7.0 S.U. the remainder of the year. Fish kills have been reported in the Hocking River due to slugging from both Sunday and Monday Creeks.

Manganese concentrations occasionally exceed Public Water Supply (PWS) standards in streams which do not drain abandoned mines. Aluminum concentrations were alarmingly high in the most extensively mined watersheds, however, no water quality standard concentration has been set for this constituent. Total zinc concentrations were found in acceptable levels in this Basin.

Summary of Southeast Ohio River Tributaries Basin Analysis

Abandoned coal mines are probably the most persistent source of pollution in the Southeast Ohio River Tributaries Basin. The highest concentrations of mine drainage pollutants in this Basin are found in the Little Raccoon Creek, Upper Raccoon Creek and Leading Creek watersheds. These same watersheds contain the highest density of abandoned underground and surface coal mines.

The majority of streams evaluated contain total manganese concentrations in excess of Public Water Supply standards. Concentrations exceeding the Public Water Supply standard occurred independent of the presence or absence of abandoned coal mines but were much higher where mine drainage was present. Total aluminum in alarmingly high concentrations was found in watersheds drained by abandoned mines, however, no water quality standard concentration has been set for this constituent. Total zinc concentrations were usually found to be within the Warmwater Habitat (WWH) standard in this Basin.

The underground mines abandoned up to 50 years ago and longer still appear to be discharging acidic water. This is most apparent in the Raccoon Creek watershed. While all coal seams of economic importance in this basin have a high pollution potential for surface and/or underground mining, the greatest pollution appears to emanate from mines in the Nos. 5 and 6 coals.

Summary of Scioto River Basin Analysis

The Little Salt Creek and Little Scioto River watersheds contain a few scattered, abandoned mines. The extent of past mining is reflected by only minor problems in stream quality from mine drainage constituents. The Little Scioto and Little Salt Creek drainages differ from other abandoned mine watersheds in Ohio by virtue of lower than expected sulfate concentrations. The No. 4 coal, which was principally mined, contains a lower percent sulfur by weight than coals mined in adjacent Basins and has a low pollution potential due to calcareous overburden. Only one or two water quality samples

have been obtained for many streams draining coal mines in these areas; therefore, the addition of new information may alter the degree of affect estimated in this report.

Summary of Central Ohio River Tributaries Basin Analysis

Abandoned coal mines are probably the major source of pollution in the Central Ohio River Tributaries Basin. The highest concentrations of total iron, sulfates and dissolved solids are found in Duck Creek, Wheeling Creek, Short Creek, Cross Creek, and Yellow Creek. These same watersheds contain the highest densities of abandoned underground and surface coal mines. However, McMahon Creek drainage which was extensively mined does not exhibit severely degraded water quality.

The streams in the Central Basin are very well buffered. The major mine drainage problems are severe sulfate and total iron concentrations especially in Wheeling Creek and Short Creek. Total iron concentrations usually exceed the WWH standard even though pH values and alkalinities are high. The Nos. 8 and 9 coal seams have been extensively mined in these two watersheds and in portions of the Cross Creek, McMahon Creek and Yellow Creek watersheds. The presence of the Redstone limestone in conjunction with the No. 8 coal seam provides excellent buffering for these streams.

The No. 8 coal seam has also been mined in the Duck Creek watershed, but the limestone neutralizer is not as extensive. As a result, Duck Creek, especially the East Fork, does not have an adequate buffering capacity.

Manganese concentrations exceed PWS standards occasionally in streams with abandoned mines in their drainages. Zinc concentrations do not exceed standards. Aluminum concentrations are occasionally very high.

Sunfish Creek and the Little Muskingum River contain no detectable amounts of coal mine drainage pollution and contain only a few small abandoned surface and underground workings. Captina Creek has only minor mine drainage problems near its confluence with the Ohio River. The small tributaries draining into the Ohio River contain water quality problems similar to adjacent primary streams.

Explanation of Format

Primary streams affected by mine drainage are discussed alphabetically by major river basin and the tributaries are listed below in serial order from mouth to headwaters. Parenthesized stream names indicate the stream is a tributary to the preceeding stream. Following the stream description is a brief discussion of geological, geographical, physical, chemical and, where available, biological aspects of the affected stream and its tributaries. Significant industrial and municipal point sources and uses of the land within the watershed are noted along with the type of abandoned mines in the area, the coal seam(s) mined and the associated pollution potential. The classification of Ohio's coal beds relative to their pollution potential is based upon 1) the sulfur content of the coal and overburden; 2) the nature of the pyrite found in the coal seam and the overburden (Euhedral grains, coarse grained replacing plant material, cleats, and framboidal); and 3) upon the quality of water draining the mines and/or the success of revegetation on surface mines.

Chemical-physical water quality data summary tables were compiled for all primary streams and are followed by similar summary tables for tributary streams. Reported in the first column of the primary stream tables are the miles of affected stream and the total length of the stream, the water use designation from the Ohio Water Quality Standards, and the sources of mine drainage pollution. Some streams are dually classified along portions of their length. Abbreviations for Use Designations are:

WWH -	Warmwater Habitat
EWH -	Exceptional Warmwater Habitat
CWH -	Coldwater Habitat
PWS -	Public Water Supply

Pollution sources are distinguished by abbreviations indicating abandoned surface (S) and underground (U) coal mines, coal refuse piles (R) and upstream effects (Up) from these sources. If other pertinent sources are known they may be written below the source identification. The absence of abandoned mines is indicated by (NM).

The second column lists ten problem constituents typical to mine drainage; pH, alkalinity, acidity, sulfate, conductivity, TDS, total iron, manganese, zinc and aluminum. All units of concentration are in mg/l, except conductivity which is reported in umhos/cm at 25°C and pH which is in Standard Units (S.U.).

In column three, the number of samples of each constituent in excess of water quality standards is listed first and the total number of samples collected is reported second. A review of applicable Ohio Water Quality Standards appears below.

The months samples were collected, the number of years of observation and the period of record for the sampling site are reported in Columns 4, 5 and 6, respectively. Statistical summaries of chemical data include arithmetic mean, maximum and minimum values; modes were used for pH instead of means when sample size was greater than 10. A modal pH is defined as the most commonly observed value and is a better estimator of "average" stream conditions.

Degree of Problem of each constituent is evaluated in the last Column of the Major Stream Summary Tables and below the number of samples in the tributary tables. Degree of Problem was qualitatively determined for each mine drainage constituent based on mean concentration and number of observations in excess of Standards. The following table defines the limits of each degree of effect from "none detectable" to "severe" 0 to 3 respectively.

	Degree of Problem				
	Insufficient Data "X"	No detectable effects "0"	Minor effects "1"	Moderate effects "2"	Severe effects "3"
pH (S.U.)		6.5 - 9.0	5.5 - 6.4	4.5 - 5.4	0.0 - 4.5
Total Fe (mg/l)		0 - 1.0	1.1 - 5.0	5.1 - 10	above 10
TDS (mg/l)		1500	1500 - 2500	2501 - 3500	above 3500
Total Mn (mg/l)		0 - 0.05	0.06 - 2.0	2.1 - 4.0	above 4.1
Sulfate (mg/l) for PWS		250	251 - 600	601 - 960	above 961

"-" in tributary stream data tables indicates Degree of Problem is not applicable due to lack of Standard.

Summary of Ohio Water Quality Standards for Mine Drainage Constituents

	Warmwater Habitat	Exceptional Warmwater Habitat	Coldwater Habitat	Public Water Supply
Total Dissolved Solids (TDS)	1500 mg/l or	1500 mg/l or	1500 mg/l or	500 mg/l monthly average; 750 mg/l daily maximum or
	2400 micromhos/cm at 25°C	2400 micromhos/cm at 25°C	2400 micromhos/cm at 25°C	800 micromhos/cm at 25°C monthly average 1200 micromhos/cm at 25°C maximum
pH	6.5-9.0 S.U.	6.5-9.0 S.U.	6.5-9.0 S.U.	No standard
Sulfates	No standard	No standard	No standard	250 mg/l
Iron	1.0 mg/l (total Fe)	1.0 mg/l (total Fe)	1.0 mg/l (total Fe)	0.3 mg/l (issolved Fe)
Total Manganese	No standard	No standard	No standard	0.050 mg/l
Total Zinc	Based on Hardness - See Standards	0.030 mg/l	0.030 mg/l	5.0 mg/l
Total Aluminum	No standard	No standard	No standard	No standard

The pH range of "no detectable effect" is set by the WWH standard of 6.5 to 9.0 S.U. Minor effects were defined to be in the range of 5.5 to 6.4 S.U. and correspond loosely to the pH values of weakly acidic waters. Moderate pH problems are defined by the lower limit of 4.5 S.U., the approximate point at which insignificant concentrations of the bicarbonate ion (buffering capacity) are present. pH values below 4.5 S.U. are considered to have a severe affect because the buffering capacity has been exhausted. Alkalinity concentrations in the range of 0-25 mg/l in general, represents limited buffering capacity, 25-50 mg/l adequate, and greater than 50 mg/l excellent.

The degree of severity of the concentrations of metals which comprise mine drainage are dependent on pH conditions. Therefore, the ranges for degrees of effect were empirically determined by comparing stream concentrations from several areas throughout the Ohio coal region and the pH ranges in which they occurred. The same method was used to determine the severity of net acidity and TDS concentrations. A minor degree of effect of sulfate concentrations was based on the PWS standard of 250 mg/l; moderate and severe ranges were defined by literature values for fish toxicity.

Water quality trends for each constituent is identified below the Degree of Problem in the last column of the major stream tables, and to the right of the Degree of Problem symbol in the tributary stream tables. An analysis of trends in mine drainage water quality was impossible to determine for all but a few streams in which continuous monitoring data was available. Trends, when undetermined due to lack of data, are represented by an (*), (+) indicates an improvement in water quality, (-) a degradation, and (=) indicates no change has occurred.

In the tributary tables chronological information has been modified to report only year of sampling, and only maximum and minimum values were reported. Streams are listed in the table in serial order from the mouth to the headwaters of the mainstem. The stream length in the far left column represents the entire length rather than affected length. When the stream miles is within parentheses, the mileage has been estimated.

Southeast Ohio River Tributaries Basin

Campaign Creek - from the confluence with Wolf Run to the confluence with the Ohio River and tributaries:

Little Campaign Creek, Little White Oak Creek (White Oak-Poplar Hollow), and Wolf Run.

Campaign Creek is 19.2 miles long and drains 46.25 miles^2 in Gallia County. Most of the abandoned strip mines in its watershed are in the No. 8a coal which has a high pollution potential for surface and underground coal mining. Water samples for Campaign Creek and its tributaries were collected by Skelly and Loy and USGS in 1973, 1976-77 and 1979. The months of sample collection were April, July, August and October.

The Campaign Creek, Little Campaign Creek and Little White Oak Creek watersheds contain extensive abandoned strip mines in poor condition and only a few, small, abandoned underground workings. pH and acidity are usually not problematic on the mainstem and buffering capacity is adequate. Little Campaign Creek, Little White Oak Creek and White Oak-Poplar Hollow contained severe acidity concentrations and no buffering capacity during the sampling period. The range of values for the tributaries is not known due to the number of small samples.

Observations of sulfate concentrations on the mainstem indicated occasional, minor problems. Mean total iron and manganese concentrations were in the minor to moderate problem range. Concentrations of sulfate and total iron were often severe in the tributaries. In general, water quality in the tributaries of Campaign Creek was more degraded than in the mainstem.

No seasonal or year to year changes could be detected due to the small amount of available data.

Mine drainage constituent concentrations in water samples from the unmined watershed of White Oak Creek were well below the problem levels found in adjacent, affected streams.

Streams without abandoned mines include Flatfork Run, and Whiteoak Creek.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Campaign Creek 19.2 WWH U, S, Up (U,S)	pH	2/8		April July August October	4	1973 1976-77 1979	6.9	7.3	6.2	0 *	
	Alkalinity	-/8		April July August October	4	1973 1976-77 1979	58.8	81	5	*	
	Acidity	-/3		July	1	1973	0.0	0.0	0.0	0 *	
	Sulfates	3/8		April July August October	4	1973 1976-77 1979	192	290	28	0 *	
	Conductivity	-/4		April July October	3	1976-77 1979	582	640	525	*	
	Total Iron	2/5		April, July, October	2	1973 1979	1.75	4.6	0.29	1 *	
	Total Manganese	2/2		April, October	1	1979	3.75	4.7	2.8	2 *	

Skelly and Loy (1973)
USGS (1976, 1977 and 1979)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Campaign Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Little Campaign Creek	1	1	4.2	1	0	1	115	1	1	1000						1	1	17.6									1973
3.6	X	*			*	X	*	X	*							X	*										
U,S																											
Little White Oak Creek	1	1	4.8	1	0	1	186	1	1	1800						1	1	8.8									1973
3.7	X	*			*	X	*	X	*							X	*										
WWH																											
U,S																											
White Oak - Poplar Hollow	1	1	3.6	1	0	1	285	1	1	270						1	1	6.3									1973
WWH	X	*			*	X	*	X	*							X	*										
S																											
White Oak Creek	1	2	7.55	1	75	1	0	0	1	82				1	462							0	1	0.03			1973
4.6	0	*			*	X	*	X	*						*							X	*				1978
WWH																											
NM																											

Skelly & Loy, (1973)
USGS, (1978)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Ice Creek - from the confluence with Turkey Fork to the confluence with the Ohio River and tributaries:

Hog Run, (Polecat Branch), Little Ice Creek, Sugar Run (unnamed east branch of Sugar Run), Justice Hollow and Turkey Run.

Ice Creek is 14.5 miles long and drains 3.8 miles^2 in Lawrence County. Ice Creek, Little Ice Creek and tributareis are classified EWH from the headwaters to Cemetery Road in Ironton by the Ohio EPAAbandoned underground mines are located predominantly near the mouth of Ice Creek above the confluence wih Turkey Fork. Two small strip mines and a large underground mine are located in the Little Ice Creek drainage. Coal seams in the watershed are the No. 5 with a high pollution potential for surface and underground mining and the No. 6 with a high pollution potential for underground mining.

Ice Creek and 3 of its 5 tributaries were sampled once in July, 1973 by Skelly and Loy. In 1979, USGS sampled Dog Fork and Little Ice Creek twice, once in April and October. Skelly and Loy data usually represents low flow conditions. In general, pH conditions met EWH standards or were only a minor problem, buffering capacities ranged from adequate to excellent, and no acidity concentrations were reported in the entire watershed of Ice Creek. However, due to the small number of observations, this analysis can only be regarded as rudimentary.

Total iron exceeded the EWH standards in 1973 in the east branch of Sugar Creek but other stations were well below the EWH standard of 1 mg/l. Sulfates were higher in the east branch of Sugar Creek, in Sugar Creek and in Little Ice Creek than in Turkey or Dog Forks. More data is needed to evaluate this area.

Tributaries which have no abandoned mines are Ned Fork, Dog Fork and Spring Branch of Turkey Creek.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Ice Creek 5/14.5 EWH/SRW U, S, Up (U,S)	pH	1/3		July	1	1973	6.4	6.5	6.2	1 *	
	Alkalinity	-/3		July	1	1973	101.3	113	85	*	
	Acidity	-/3		July	1	1973	0	0	0	0 *	
	Total Iron	1/3		July	1	1973	0.66	1.4	0.3	0 *	
	Sulfates	-0/3		July	1	1973	84.7	134	56	0 *	

USGS (1979)
Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Ice Creek Tribu ies

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc PWS	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Little Ice Creek	0	2	6.95	2	78.5	1	0	0	2	151				1	430	0	2	0.3	1	1	0.14					1973
8.8	0	*			*	X	*	0		*					*		0	*	X		*					1979
WWH																										
U,S																										
Sugar Creek	0	1	6.5	1	94	1	0	1	1	122						0	1	0.3								1973
2.1	X		*		*	X	*	X		*							X	*								
WWH																										
Up (U)																										
Unnamed tributary	1	1	6.2	1	76	1	0	1	1	280						1	1	2.3								1973
to Sugar Creek	X		*		*	X	*	X		*						X		*								
1																										
WWH																										
U																										
Turkey Fork	0	1	6.5	1	92	1	0	0	1	72						0	1	0.1								1973
2.0	X		*		*	X	*	X		*							X	*								
WWH																										
U																										
Dog Fork	0	3	7.56	3	97	1	0	0	3	76.7				2	403	0	3	0.21								1973
4.6	0	*			*	X	*	0		*					*		0	*								1979
EWH																										
NM																										

USGS (1979)
Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Indian Guyan Creek - from the source to the confluence with the Ohio River and tributaries:

Little Indian Guyan Creek (Trace Creek, Perkins Branch, Watson Creek, Big Spring Creek), William's Creek, George's Creek, Garland Creek, Perigen Creek (Little Perigen Creek), Rocky Fork and John's Fork.

The Indian Guyan Creek is 31.5 miles in length and drains 76.5 miles^2. The watershed of Indian Guyan Creek contains predominantly abandoned strip mines except in the Little Indian Creek headwaters where there are three, small abandoned underground mines. The No. 5 coal which is mined in this area has a high pollution potential for surface and underground mining. The most concentrated areas of abandoned mines are in the drainages of Little Perigen Creek and Little Indian Guyan Creek.

The Indian Guyan Creek mainstem was sampled discontinuously from 1972 to 1979 primarily in June, July, September and October by USGS and Skelly and Loy. Tributaries except Little Indian Guyan were sampled only once in July 1973 by Skelly and Loy. Data reported in July should be representative of low flow conditions.

No observed pH values were less than WWH standards on the Indian Guyan Creek mainstem. Alkalinity exceeded acidity on all observed dates and the mean value can be considered adequate for buffering the present levels of acidic mine pollution. pH values in the tributaries of Indian Guyan Creek receiving abandoned mine drainage ranged from 4.37 S.U. to 7.0 S.U. Buffering capacity was limited on Little Indian Guyan Creek but net acidities may occur occasionally. All other reported tributaries contained adequate buffering capacity.

Sulfate concentration was a good indicator of coal mine drainage pollution in the Indian Guyan Creek watershed. Tributaries with no mining had sulfate values less than 85 mg/l, streams with mining had sulfate values well over 100 mg/l. Total iron concentrations in Indian Guyan Creek and affected tributaries were in the range of 0.1 to 1.0 mg/l. Two samples from Little Indian Guyan Creek indicate total manganese, zinc and aluminum may be present in larger than desirable quantities where abandoned mines are located.

The largest contributor of mine drainage to Indian Guyan Creek appears to be Little Indian Guyan Creek. Indian Guyan Creek assimilates acidic drainages adequately. Total iron and manganese concentrations are minor problems but exceeded standards in the majority of observations.

Unaffected tribuaries exhibited slightly below standard pH values, but all had acceptable levels of sulfates and total iron. Because of the limited amount of data, it is difficult to adequately assess streams in the drainage. Tributaries with no abandoned mines in their watersheds include: Bent Creek, Bear Creek, Four Mile Creek, Five Mile Creek, Slate Run, Wolf Creek, Wagner Branch, Lanes Branch and Drake Fork.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Indian Guyan Creek -/131.5 WWH U, S, Up (U,S)	pH	0/11		June, July, September, October	6	1972-77 1979	7.3	8.1	6.5	0 =	
	Alkalinity	-/13		June, July, September, October	6	1972-77	70.9	87	54	=	
	Acidity	-/1		July	1	1978	13.0	N/A	N/A	0 *	
	Total Iron	3/5		July, March,	3	1973 1978 1979	1.39	2.68	1.2	1 *	
	Total Manganese	4/4		June, October	1	1975	0.41	0.58	0.19	1 *	
	Total Zinc	0/4		March, June, September, October	2	1975 1978	0.02	0.03	0.01	0 *	
	Total Aluminum	-/2		June, October	1	1975	0.26	0.35	0.17	*	
	Conductivity	-/11		June, July, September, October	7	1972-79	382.3	700	276	=	

(Continued on next page)

Stream Name (Al ssment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
ndian uyan Creek (Continued)	Sulfate	0/13		June, July, September, October	7	1972-79	101.4	240	52	0 -	

USGS (1972-79)
Skelly and Loy (1973)
Concentrations in mg/l;
Conductivity in umhos/cm;
pH in S.U.

Indian Guyan Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
ent Creek	1	1	5.7	1	118	1	0	0	1	52						0	1	0.1									1973
3.5	X		*		*	X	*	X		*						X		*									
WWH																											
MH																											
ive Mile	1	1	6.2	1	108	1	0	1	1	18						0	1	0.6									1973
Creek	X		*		*	X	*	X	*							X		*									
WWH																											
MH																											
olf Creek	1	1	6.2	1	66	1	0	0	1	34						0	1	0.1									1973
3.5	X		*		*	X	*	X		*						X		*									
WWH																											
U																											
ittle Indian	1	3	4.37	3	5	3	1.67	2	3	303.3				2	755	0	3	0.63	2	2	6.8	1	2	0.26	2	6.1	1973
Guyan Cr.	X		*		*	X	*	X		*					*	X		*	X		*	X		*	X	*	1975
5.4																											
WWH																											
S, U (few)																											
/illiam Creek	1	1	6.2	1	77	1	0	0	1	230						0	1	0.3									1973
WWH	X		*		*	X	*	X		*						X		*									
S																											

(Continued on next page)

Skelly and Loy (1973)
USGS (1975)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Indian Guyan Creek Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
George's Creek	0	2	6.75	1	89.5	2	0	0	2	140						0	2	0.35									1973
2.4	X	*			*	X	*	X		*						X		*									
WWH																											
NH																											
Rocky Fork	1	1	6.2	1	74	1	0	0	1	80						0	1	0.3									1973
3.5	X		*		*	X	*	X	*							X		*									
WWH																											
NH																											
Drake Fork	1	1	6.2	1	85	1	0	0	1	48						0	1	0.2									1973
1.9	X		*		*	X	*	X		*							X	*									
WWH																											
NH																											
Perigen Creek	0	1	7.0																								1973
1.7	X		*																								
5.4																											
WWH																											
Up (S)																											

Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Leading Creek - source to confluence with Ohio River and tributaries:

Thomas Fork (Hysell Run, Bailey Run, East Branch Thomas Fork, Ball Run, Wolfpen Run), Little Leading Creek, Grass Run, Dexter Run, and Mud Fork.

Leading Creek is 29.5 miles long and drains 151.08 miles^2 in Meigs, Gallia and Athens counties. The abandoned coal mines are unevenly distributed with the majority of mines occurring near the banks of the mainstem from mid-stream to mouth. One large surface mine was abandoned near the mainstem source. The majority of the northern and eastern tributaries entering Leading Creek in its downstream reaches are affected by numerous abandoned strip and underground mines. The coal mined in the drainage is the No. 8a which has a high pollution potential for surface and underground mining. Data has been collected on Leading Creek and its tributaries by USGS, FWPCA, Ohio EPA OWPC and OLPC, and Skelly and Loy. Sampling was accomplished in July and November for 10 years discontinuously over the period 1966 to 1979.

The mainstem of Leading Creek was sampled near the mouth and at the confluence with Little Leading Creek. The modal pH value of 7.0 S.U. and mean alkalinity of 65.1 indicate adequate buffering capacity. Occasional pH values in the 5.5 to 6.5 S.U. range accompanied by minor net acidities were observed.

Sulfate values increased downstream. The low value of 28 mg/l was obtained near the mainstem source. Values as high as 950 mg/l were found near the mainstem mouth. The mean sulfate value of 226.7 mg/l does not exceed the PWS standard. Mean total iron concentration exceeded the WWH standard but only 2 of 11 observations were actually in excess. Total manganese was the only constituent which was present in severely high concentrations. TDS concentrations were well within the WWH range.

Two fish kills, resulting from acid mine drainage were reported on August 8, 1972 and August 26, 1970 by Ohio DNR, Division of Wildlife. These incidents are probably evidence that slugging occurs along the mainstem when heavy precipitation events occur during low flow periods.

Thomas Fork and Bailey Run contained the poorest water quality of Leading Creek tributaries. They were characterized by a deficit in buffering capacity, moderate to severe pH, net acidity, total iron and manganese problems. Bailey Run contained total zinc concentrations which exceeded the WWH standard. Total aluminum concentrations up to 22.9 mg/l were encountered in Bailey Run.

Tributaries with minor to no pH problems and limited to adequate buffering capacity were the East Branch of Thomas Fork, Little Leading Creek, Dexter Run, and Mud Fork. Sulfate concentrations were below 250 mg/l but minor total iron problems were evident. Total manganese concentrations occurred in the minor to moderate problem range, but were twice as high as in streams without abandoned mines.

Tributaries which contain no abandoned mines entered the mainstem near its source. These are Ogden Run, Sisson Run, Five Mile Run and an unnamed tributary on the West bank of Leading Creek near Five Mile Run. Occasional pH values below the WWH standard were found as well as minor total iron problems. Sulfates were less than 60 mg/l except on Ogden Run where they were 123 mg/l. Most of these tributaries were only sampled once.

An Ohio DNR reclamation project (located in Scipio Township of Meigs County will restore 168 acres of stripped land bordering Little Leading Creek which has caused flooding in the Harrisonville area.

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Leading Creek 29/29.5 RM U, S, Up (U,S)	pH	2/19		July - November	10	1966-69 1971-75 1978	7.0 (mode)	7.8	5.5	0 *	Ohio DNR Reclamation Project
	Alkalinity	-/18		July - November	8	1968-69 1971-75 1978	65.1	118	7	*	
	Acidity	-/2		N	1	1968	26	37	15	0 *	
	Sulfate	2/19		July - November	8	1967-69 1971-75	226.7	950	28	0 *	
	Conductivity	-/13		July - November	10	1966-69 1971-75 1978	571.9	867	460	*	
	TDS (180°C)	0/7		August - October	7	1966-69 1971-73	399.1	697	294	0 *	
	Total Iron	2/11		July, November	4	1968 1973 1975 1978	1.36	3.2	0.57	0-1 *	
	Total Manganese	N/6		N	1	1968	5.0	6.2	2.8	3 *	

(Continued on next page)

Stream Name / RMI / Segment mi/Total mi / Use Designation / Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Leading Creek (Continued)	Total Zinc (mg/l)	0/7		July, November	2	1975 1978	0.018	0.03	0.009	0 *	
	Total Aluminum	-/6		July, November	2	1968 1975	1.03	3.6	0.30	*	

USGS (1966-69, 1971-75, 1978)
FWPCA (1968)
Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Leading Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Thomas Fork	5	5	3.96	5	0	5	7.96	5	5	550				2	1100	4	4	4.0				N	2	0.31	2	8.0	1973
(Dirt Creek)		3	*		*	2	*		1	*					*	1		*								*	1975
10.2																											
WWH																											
U, S, Up																											
Bailey Run	3	3	3.32	4	0	4	297	3	4	494	4	4	2577.5	4	2700	4	4	19.5	4	4	8.96	4	4	0.63	4	22.9	1979
2.3		3	*		*	3	*		1	*		2	*		*		3	*		3	*		1	*		*	
WWH																											
U,S,R																											
East Branch	0	2	6.6	2	40	2	0	1	2	245				2	695	2	2	1.9	2	2	2.05						1979
Thomas Fork		0	*		*	0	*		0-1	*					*		1	*		1-2	*						
7.2																											
WWH																											
S																											
Little Leading	3	5	6.02	5	36.8	5	9.0	0	5	160				2	577.5	1	3	2.07	1	2	0.97						1973
Creek		1	*		*	0	*		0	*					*		1	*		1	*						1979
10.6																											
WWH																											
U,S																											
Dexter Run	0	1	6.5	1	49	1	0	0	1	240						1	1	2.5									1973
5.3		X	*		*		X *		X	*							X	*									
WWH																											
S																											

(Continued on next page)

USGS (1975, 1978, 1979)[1]
Ohio OLPC (1979)[2]
Skelly and Loy (1973)
Ohio EPA OWPC (1975)[1]

Leading Creek Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Mud Fork	0	2	7.3	2	72	1	0	0	2	177				1	470	1	2	1.125	1	1	0.29						1973
7.9	0	*			*	X	*		0	*					*	1		*	X		*						1979
WWH																											
S																											
Ogden Run	0	1	6.5	1	100	1	0	0	1	123						1	1	3.7									1973
4.8	X	*			*	X	*	X		*						X		*									
WWH																											
SM																											
Sisson Run	1	1	6.2	1	78	1	0	0	1	38						1	1	1.9									1973
3.2	X	*			*	X	*	X	*							X		*									
WWH																											
NM																											
Unnamed Tributary	0	1	6.5	1	84	1	0	0	1	52						0	1	1.0									1973
West Bank of	X	*			*	X	*	X		*						X		*									
Leading Creek																											
WWH																											
NM																											
Five Mile Run	1	1	6.2	1	137	1	0	0	1	48						0	1	0.8									1973
4.2	X	*			*	X	*	X		*						X		*									
WWH																											
NM																											

USGS (1979)

Skelly and Loy (1973)

concentrations in mg/l;

conductivity in umhos/cm;

pH in S.U.

Kyger Creek - from the confluence with Bell Lick Run to the confluence with the Ohio River and tributaries:

Little Kyger Creek, Turkey Run, Stingy Run, Jessie Creek, and unnamed run near the city of Kyger.

Kyger Creek is 11.8 miles long and drains 30.08 miles^2 in Gallia and Meigs counties. Within the watershed there are 11 miles^2 affected by abandoned surface mines and 0.5 miles^2 affected by abandoned underground coal mines. The No. 8a coal mined in the area has a high pollution potential for surface and underground mining. Data was collected by Skelly and Loy, USGS, and Ohio EPA SEDO in the months of June, July, October and November representing predominantly the low flow periods of 1973, 1975 and 1977.

Abandoned strip mines are numerous along Kyger Creek from the area near the source, and downstream of Bell Lick Run. Little Kyger Creek and Jesse Run are affected along their entire lengths.

Currently Ohio DNR is planning to reclaim portions of the Little Kyger Creek watershed in Addison Township to reduce off-site damage from toxic spoil and sedimentation.

In 4 of 8 samples, pH values in the Kyger Creek mainstem were below the WWH standard. Mean alkalinity was lower than mean acidity indicating a minor net acidity problem and a loss of buffering capacity in most observations. Sulfates were a moderate to severe problem in all samples. The range of total iron values was 0.32 to 7.2 mg/l and 5 of 8 values exceeded the WWH standard. The mean total iron concentration indicated a moderate problem. Total manganese ceoncentrations observed were in the moderate problem range. Total zinc was usually below the WWH standard and mean total aluminum was 7.35 mg/l.

pH conditions in the Kyger Creek tributaries ranged from severe to moderate. Buffering capacity was depleted on Little Kyger Creek and Jesse Run and probably on the unnamed tributary. Sulfate concentrations were a severe problem in Little Kyger Creek and minor to moderate elsewhere. Total iron and manganese were moderate and severe respectively, and aluminum was found in concentrations up to 44 mg/l on Little Kyger Creek and Jesse Run.

Little Kyger Creek and Jesse Run are the main tributaries releasing acid mine drainage into Kyger Creek. Kyger Creek contains many strip mines along its floodplain which undoubtedly contribute directly to the mine drainage stream condition as well.

Bell Lick Run is the only tributary without abandoned mines in the drainage.

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Kyger Creek /11.8 RM U,S	pH	4/8	June, July, November	3	1973 1975 1977	6.09 (mode)	8.9	4.0	1 *	Reclamation Project on Little Kyger Creek
	Alkalinity	-/8	June, July, November	3	1973 1975 1977	32.8	95	0	*	
	Acidity	-/4	June, July	2	1973 1977	58.5	236	0	2 *	
	Sulfates	8/8	June, July, November	3	1973 1975 1977	789.9	1600	460	2 *	
	Conductivity	-/2	July, November	1	1975	1785	2500	1070	*	
	Total Iron	5/8	June, July, November	3	1973 1975 1977	7.20	40.5	0.32	2 *	
	Total Manganese	2/2	June	1	1977	3.09	3.91	2.26	2 *	
	Total Zinc	1/4	June, July, October	2	1975 1977	0.17	0.48	0.02	0 *	
	Total Aluminum	-/4	June, July, October	2	1975 1977	7.35	18.0	1.4	*	

Skelly and Loy (1973)
USGS (1975)
Ohio EPA SEDO (1977)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Kyger
~~Ice~~ Creek Tributaries

ream Name / Ies / e Designation / llution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc PWS	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
ttle Kyger	4	4	3.45	4	0	4	264	4	4	1240	1	1	1170	2	2685	4	4	6.83	1	1	28.2	3	3	0.89	3	35.0	1973
Creek		3	*		*	3	*		3	*	X		*		*		2	*	X		*		1	*		*	1975
4.4																											1977
WWH																											
U,S																											
ingy Run	0	1	6.6	1	32	1	14	1	1	780	0	1	1140			0	1	0.74	0	1	0.1	0	1	0.03	1	1.1	1977
2.4		X	*		*	X	*	X	*		X		*				X	*		X	*		X	*	X	*	
WWH																											
U,S																											
sse Run	4	4	4.9	4	2.25	2	195.5	4	4	497.5	1	1	1200	2	650	3	4	7.25	3	3	8.97	1	1	0.73	1	44.0	1973
1.4		2	*		*	3	*	1		*		X	*		*		2	*		3	*	X		*		*	1975
WWH																											1977
U,S																											
nmed	1	1	3.9	1	0	1	149	1	1	930						1	1	4.3									1973
Tributary 1 mi.	X		*		*	X	*		X	*							X	*									
above Kyger																											
WWH																											
S																											

kelly and Loy (1973)
SGS (1975)
hio SEDO (1977)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Ohio River Tributaries:

Norman Run, Osburn Run, Storms Creek (Little Storms Creek, Yellow Branch), Lick Creek, Swan Creek, Teens Run, Burrels Run, Long Run, Clark Run, Evans Run, Stores "Storys" Run (Silver Run), Forest Run (Kerr Run), Jesse Run, Norman Run, Winkler Hollow Run. (Streams named from west to east.)

The Ohio River tributaries are short streams (less than 20 miles long) with few or no tributaries that enter the Ohio River in Scioto, Lawrence, Gallia, and Meigs counties. The coal bed mined in the drainages of Storms Creek, Lick Creek, east to Stores Run is predominantly the No. 5, but outcrops of the Nos. 6, 7 and 8 also occur. The region near Pomeroy in the Forest Run, Jesse Run, Norman Run and Winkler Hollow Run areas was mined for the No. 8a coal. The No. 8a coal is associated with a highly erodable sandstone which causes sedimentation problems on unreclaimed strip mines. The Nos. 5, 6 and 8a coals have high pollution potentials for surface and underground mining.

Storms Creek and tributaries are classified EWH, from the headwaters to the 3rd Street bridge in Ironton by the Ohio EPA. The Little Storms Creek and adjacent Osburn Run drainages are characterized by severe pH, acidity and total manganese problems where unreclaimed strip mines and abandoned underground mines occur. Water quality data for total iron concentrations were at the minor to moderate problem levels and total aluminum may be present up to 21 mg/l in these streams. Streams in the area without abandoned mines usually had pH values within the WWH range, adequate to excellent buffering capacities, sulfate concentrations less than 100 mg/l, total iron concentrations below the WWH EWH standard, but total manganese exceeding the PWS standard.

Lake Vesuvius, an impoundment of Storms Creek, is characterized by adequate buffering capacity with no mines, reported sulfate concentrations less than 75 mg/l and total iron below but near the EWH and PWS standard. This lake could be sensitive to acid inputs from both improperly managed coal mines or acid precipitation.

The Lick Creek and Ice Creek drainages are adjacent and have qualitatively similar water quality problems from abandoned mining but to different degrees. pH, sulfates and total iron were minor problems and buffering capacity was adequate to excellent on Lick Creek. Nearby streams without abandoned mines had pH values below or just within the WWH standard range, excellent buffering capacity, sulfates equal to or less than 100 mg/l, but total iron concentrations which exceeded the WWH standard. Significant industrial and municipal point source dischargers situated along the Ohio River may affect the lower 1 to 1.5 miles of the above streams.

Swan Creek and Teens Run enter the Ohio River adjacent to the western edge of the Raccoon Creek watershed. However, most of the abandoned mines are underground rather than surface as in the lower Raccoon Creek drainage. Water quality of Swan Creek and Teens Run exhibits no effects to minor pH problems and excellent buffering capacity. No other problem parameters were noted from the limited available data. Streams without abandoned mines had similar water quality to those affected and to neighboring Raccoon Creek tributaries.

Long Run and Clark Run enter the Ohio River south of Gallipolis, adjacent to the eastern border of the Raccoon Creek drainage. The only problematic parameters were total iron and possibly pH. However, incomplete data hinders further analysis.

Chickamauga Creek and the drainages of its tributaries contain no abandoned coal mines, however, moderate water quality problems associated with total iron may be the result of numerous clay quarries.

Storys Run and Kerr Run drain an area adjacent to Leading Creek watershed. Severe pH, acidity, sulfate and total iron concentrations characterize water quality in Storys Run; while moderate to minor problems with the above parameters occur in Kerr Run. The No. 8a coal has a high pollution potential for underground mining in this area, and the degree of water quality problems are similar to those found in Leading Creek.

Forked Run and its impoundment Forked Run Lake are located to the east of the Shade River watershed in Meigs County. There are no abandoned mines in the drainage. The stream and lake have alkalinities of 69 and 24 mg/l, respectively, indicating adequate to limited buffering capacities with no mining. No other mining constituents were problematic. Forked Run and Lake constitutes an ecologically sensitive area which could respond to acidic inputs from coal mining and acid rain.

In summary, only 3 of 10 tributaries; Osburn Run, Little Storms Creek, and Storys Run, contained severe levels of acid mine drainage. Moderate and minor levels were noted in Kerr Run and Lick Creek. Total iron, pH and total manganese often occurred in excess of WWH, EWH and PWS standards in tributaries with no abandoned mines. These levels are either naturally occurring or emanate from cultural sources which have not been identified.

Patton Run, Ginat Run, Geruais Run, Storms Creek above Little Storms Creek (Hecla Branch, Lake Vesuvius, Paddle Creek), Salliday Creek, Willow Creek, Charley Creek, Buffalo Creek, Paddy Creek, Twomile Run, Federal Creek (Clean Fork, Dirty Fork), Stillhouse Branch, Little Swan Creek, Peters Branch, Hildebrand Run, Sardis Run, Chickamauga Creek (Paint Creek, Little Chickamauga Creek), Mill Creek and George Creek do not have abandoned surface or deep mines in their drainages.

Ohio River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Ginat Creek	1	2	6.35	2	43.5	2	0	0	2	48				1	185	0	2	0.49	1	1	0.22						1973
8.5		1	*		*	0	*		0	*					*		0	*		X	*						1979
WWH																											
NM																											
Osburn Run	1	1	3.3					1	1	640	0	1	1060			1	1	3.2	1	1	11.3	1	1	0.6	1	21.0	1977
3.2		X	*						X	*		X	*				X	*		X	*		X	*		*	
WWH																											
U,S																											
Storms Creek	2	5	6.52	4	70.8	2	14.0	0	4	97.7				3	267.3	2	2	0.3									1973
15.5		0-1	*		*	0	*		0	*					*		0	*									1975
EWH																											1978
U,S																											
Little Storms Creek 5.0	2	2	3.8	1	0	2	132	1	2	385.5				1	900	1	1	2.7									1973
EWH		X	*		*	3	*	1		*					*		X	*									1978
U,S																											
Lake Vesuvius	9	18	7.0	5	49.8	1	0	0	1	42	0	1	103	14	155.7	1	2	0.95				0	1	0.02			1973
EWH/PWS		0-1	*		*	X	*	X		*	X		*		*		0-1	*					X	*			1975
N																											
NM																											
Paddle Creek	0	3	7.33	3	84.7	1	14	0	3	67.6						0	2	0.19	1	2	0.65						1978
4.2		0	*		*	0	*		0	*							0	*		0-1	*						1979
WWH																											
NM																											

Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Ohio EPA SEDO (1977)
USGS (1975, USDA FS, 1978 1979)

Ohio River Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Lick Creek	1	1	5.9	1	82	1	0	1	1	590						1	1	1.9									1973
4.8	X		*		*	X	*	X		*						X		*									
WWH																											
U																											
Salliday Creek	1	1	5.9	1	30	1	0	0	1	76						0	1	0.5									1973
7.4	X	*			*	X	*		X	*						X		*									
WWH																											
NM																											
Willow Creek	0	1	6.5	1	128			0	1	100						0	1	0.2									1973
U	X		*		*			X		*						X		*									
WWH																											
NM																											
Charley Creek	1	1	5.9	1	106	1	0	0	1	20						1	1	28.0									1973
5.0	X		*		*		*	X		*						X		*									
WWH																											
NM																											
Buffalo Creek	1	1	5.9	1	159	1	0	0	1	56						1	1	1.6									1973
5.8	X		*		*	X	*	X		*						X		*									
WWH																											
NM																											
Paddy Creek	1	1	6.2	1	101	1	0	0	1	32						1	1	1.7									1973
4.2	X		*	X	*	X	*	X		*						X		*									
WWH																											
NM																											

Skelly and Loy (1973)
concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Ohio River Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Swan Creek	0	5	6.82	5	88.2	3	0	0	5	93.8				2	322.5	1	5	0.88	2	2	0.165						1973
10.6	0		*		*	0	*	0		*					*	0		*	1	*							1979
WWH																											
US																											
Hildebrand Run	1	1	6.2	1	114	1	0	0	1	78						0	1	0.3									1973
2.0	X	*			*	X	*	X		*						X		*									
WWH																											
MA																											
Teens Run	1	1	6.0	1	94	1	0	0	1	160						0	1	0.2									1973
3.1	X		*		*	X	*	X		*						X		*									
WWH																											
U,S																											
Long Run	0	1	6.5	1	112	1	0	0	1	96						1	1	1.6									1973
2.9	X		*		*	X	*	X		*						X		*									
WWH																											
S																											
Clark Run	1	1	6.2	1	41	1	0	1	1	260						1	1	2.4									1973
2.0	X		*		*	X	*	X		*						X		*									
WWH																											
S																											

Skelly and Loy (1973) Ohio EPA SEDO (1977)
USGS (1975, USDA FS 1978, 1979)
concentrations in mg/l
conductivity in umhos/cm
pH in S.U.

Ohio River Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Chickamunga	1	4	7.2	4	89.3			0	4	54.8				2	430	2	4	9.85	2	2	0.145						1973
Creek	0		*		*			0		*					*	2-3		*	1		*						1979
9.4																High values											
WWH																near clay											
NM,																pits											
(clay pits in headwaters)																											
Little	0	2	7.0	2	140	2	0	0	2	94						0	2	0.45									1973
Chickamauga	0		*		*	0	*	0		*						0		*									
Creek																											
4.5																											
WWH																											
NM																											
Mill Creek	0	1	7.0	1	96	1	0	1	1	160						1	1	1.1									1973
3.0	X		*		*	X	*	X		*						X		*									
WWH																											
NM (gas wells)																											
George Creek	1	1	6.2	1	105	1	0	0	1	46						1	1	18.7									1973
4.1	X		*		*	X	*	X		*						X		*									
WWH																											
NM (gas wells)																											
Storys Run	1	1	3.0			1	267	1	1	1200						1	1	14.0									1973
2.9	X		*			X	*	X		*						X		*									
WWH																											
NM																											
Kerr Run	2	2	5.4	2	11.5			1	2	235				2	710.5	2	2	4.35				0	2	0.105	2	3.5	1975
1.6	2		*		*			0-1		*						1		*				0		*		*	
WWH																											
U,S																											

USGS (1975, 1978, 1979)
Skelly and Loy (1973)
Concentrations in mg/l
conductivity in umhos/cm
pH in S.U.

1 Surface samples
2 Bottom samples

Ohio River Tributaries (Continued)

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Forked Run	0	2	7.6	2	69.5			0	2	26.5						0	2	0.63	2	2	0.23						1979
8.4	0		*		*			0		*						0		*	1		*						
EWH/PWS																											
NM																											
Forked Run	2	12	7.4[1]	2	24.5			0	1	26				12	143.3	0	1	0.39				0	1	0.02			1978
Lake	0		*		*			X		*					*	X		*				X		*			
N																											
EWH/PWS																											
NM																											

Skelly and Loy (1973)
Concentrations in mg/l
conductivity in umhos/cm
pH in S.U.

Pine Creek - from the confluence with Painter Creek to confluence with the Ohio River and tributaries:

Lick Run, Sperry Fork (Union Branch), Little Pine Creek (Darby Creek, Ellisonville Creek, Crazy Creek, Cannons Creek, Tar Kin Run), Bear Run, Turkeyfoot Run, Hales Creek (Bloom Furnace Creek, Brady Run), Buckhorn Hollow, Brushy Fork, Olive Creek, Kimble Creek, Negro Creek and Painter Creek.

Pine Creek extends 48.0 miles and drains 184.7 miles^2 in Lawrence and Scioto Counties. Coal beds mined in the watershed include the Nos. 4a, 5 and 6, all having high pollution potentials for surface and underground mining. A large number of abandoned underground and strip mines occur in the drainages of Little Pine Creek and its tributaries Darby Creek, Ellisonville Creek, Crazy Creek and Cannons Creek. Numerous abandoned mines also occur in the Sperry Fork and Union Branch drainages. Hales and Bear Creeks may be affected by drainage from clay pits as well as coal strip mines.

Pine Creek and its tributaries have been sampled in the years 1972-75 and 1977-79, however, only pH, total alkalinity, acidity and conductivity have been consistently monitored and data on metals is sparse. Data sources include the USDA Forest Service, USGS, Ohio EPA and Skelly and Loy. pH, alkalinity, acidity and conductivity were sampled over the entire year while metal information was collected primarily in June through October.

The pH in the mainstem of Pine Creek was below the WWH standard of6.5 S.U. in 10 of 42 samples. Minor pH problems in the range 5.5 to 6.4 S.U. were found in 9 of the 10 samples which exceeded the WWH standard. One observation of 3.8 S.U. was made near Wheelersburg, near the mouth, although pH values this low were uncommon. Minor infractions of the WWH standard for pH occurred in Little Pine Creek, Cannons Creek, Brady Run and Brushy Fork. Severe pH conditions and a deficit in buffering capacity were observed in Sperry Fork, Ellisonville Creek, Crazy Creek and Negro Creek. Streams with severe pH conditions also had moderate to severe levels of net acidity, and sulfates greater than 60 mg/l. Turkeyfoot Run and Saw Mill Run contained no abandoned mines but one sample pH value for each fell below WWH standards net alkalinities from 60 to 130 mg/l $CaCO_3$ were reported for these streamsand buffering capacity was excellent.

Total iron concentrations exceeded the WWH standard in Pine Creek and its tributaries to a minor degree, with the exception of Negro Creek where conditions were severe. Although infrequently reported, total manganese concentrations were moderate problems in Pine Creek and tributaries (up to 4.9 mg/l). Zinc and aluminum do not appear to be problematic but the data is insufficient for determination.

The only parameters for which water quality trends were determinable from available data were pH, alkalinity acidity and conductivity. These four parameters appear to remain fairly constant from year to year.

The most degraded stream quality emanated from streams with abandoned, underground mines including Sperry Fork and Cannons Creek. Streams with abandoned surface mines did not exhibit a similar degree of effect.

Tributaries of Pine Creek with no abandoned mines are the Sugar Creek and North Fork of Lick Run, Duck Creek and Poplar Fork, Cooney Branch, Turkeyfoot Run, Salters Creek, Howard Run, Jackson Fork, Youngs Branch, Hope Hollow Creek, and Saw Mill Creek.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Sap	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Pine Creek 748.0 RMH/SHRW U, S, Up (S,U,R)	pH	10/42		January - December	7	1972-75 1977-79	6.7 (mode)	7.7	3.8	0 =	
	Total Alkalinity	-/33		Jan.-Aug. Sept.-Nov.	8	1972-79	44.9	108	4	=	
	Total Acidity	-/29		Feb.-Aug. Sept.-Nov.	7	1972-75 1977-79	12.6	55	3	1 =	
	Conductivity	-/33		Jan.-Dec.	7	1972-75 1977-79	477.3	789	220	= *	
	Total Iron	6/10		June, August September October	2	1973 1975	1.43	3.3	0.5	1 *	
	Total Manganese	3/3		June October	1	1975	1.82	3.7	0.77	2 *	
	Total Zinc	0/4		September June	2	1975 1978	0.093	0.23	0.02	0 *	
	Total Aluminum	-/3		June October	1	1975	2.73	6.6	0.76	1 *	

USDA Forest Service (1972-78)
USGS (1972-77) Ohio EPA (1972-78)
Skelly and Loy (1973)

concentrations in mg/l
conductivity in umhos/cm
pH in S.U.

Pine Creek Creek Tributaries

ream Name / Ta / e Designation / llution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
ck Run	3	5	6.66	5	60.2	3	0	0	5	49.2				2	279	0	5	0.44	2	2	0.16						1973
6.6	0		=		*	0	*	0		*					*	0		*	1		*						1979
WWH																											
S																											
erry Fork	1	1	3.7	1	0	1	118	1	1	850						1	1	1.8									1973
5.2	X		*		*	X	*	X		*						X		*									
WWH																											
U,S																											
Union Branch	0	2	6.9	2	44.5			2	2	365						0	2	0.63	2	2	0.91	0	2	0.02	2	0.1	1975
3.7	0		*		*			1		*						0		*	1		*	0		*		*	
WWH																											
S																											
ttle Pine	1	2	6.4	2	61	2	0	1	1	475						0	1	0.3	1	1	2.1						1973
Creek	1		*		*	0	*	X		*						X		*	X		*						1979
10.2																											
WWH																											
U,S Up (U S)																											
Darby Creek	1	1	4.7	1	5	1	23	1	1	760						1	2	0.75									1973
2.2	X		*		*	X	*	X		*						0		*									
WWH																											
U,S																											

elly and Loy (1973)
GS (1979)
ncentrations in mg/l
nductivity in umhos/cm
l in S.U.

Pine Creek Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Ellisonville	2	2	3.55	2	0			2	2	340						2	2	2.55	2	2	4.9	2	2	0.28	2	5.03	1975
Creek	3		*		*			1		*						1		*	3		*	0		*		*	
N																											
WWH																											
U S																											
Crazy Creek	26	26	4.10			26	176.1	24	24	860.4						N	5	1.66									1972-75
N	3		=			3	=	2		=						1		=									1977-79
WWH																											
U S																											
Cannons Creek	1	1	5.9	1	78	1	0	0	1	136						0	1	1.0									1973
4.7	X		*		*	X	*	X		*						X		*	1								
WWH																											
U few small																											
Tar Kin	0	1	6.5	1	100	1	0	1	1	403						0	1	0.4									1973
Run	X		*		*	X	*	X		*						X		*									
2.2																											
WWH																											
U S																											
Bear Run	0	3	7.5	3	162			3	3	525						1	3	3.39	2	2	4.25	0	2	0.015	2	0.165	1973
4.4	0		*		*			1		*						1		*	3		*	0		*		*	1975
WWH																											
S																											
Turkeyfoot Run	1	1	5.9	1	56			0	1	58						0	1	0.04									1973
10.2	X		*		*			X		*						X		*									1979
WWH																											
NM																											

Skelly and Loy (1973) concentrations in mg/l

USGS (1972-1975) conductivity in umhos/cm

USDA FS (1987in1978)

Pine Creek Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Hales Creek	1	1	5.9	1	45	1	0	0	1	86						0	1	1.0									1973
9.9	X		*		*	X	*	X		*						X		*									
WWH																											
U S (some scattered, small)																											
Bloom Furnace	1	1	6.2	1	65	1	0	0	1	52						0	1	0.4									1973
Creek	X		*		*	X	*	X		*						X		*									
7																											
WWH																											
U S few																											
Brady Run	1	3	6.27	3	49	2	7.5	0	3	132						2	3	1.5	2	2	0.72						1973
5.3	1		*		*	0	*	0		*						1		*	1		*						1979
WWH																											
U and clay																											
Buckhorn	1	30	7.16	20	65.6	30	9.28	0	1	74						1	1	3.4									1972-75
Hollow	X				*	0	*	0		*						X		*									1977-79
N																											
WWH																											
S																											
Brushy Fork	18	30	6.17	16	19.7	30	12.5	0	21	99						N	15	0.48									1972-75
3.7	1		=		*	0-1	=	0		=						0		=									1977-79
WWH																											
U S																											

USDA FS (1972-75, 1977, 1979)
Skelly and Loy (1973)

concentrations in mg/l
conductivity in umhos/cm
pH in S.U.

Pine Creek Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mode	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Olive Creek	9	29	6.6	17	33.5	29	10.8	0	3	110.7																	1972-75
3.3	0		=		=	0	=	0		=																	1977-79
WWH																											
U																											
Kimble Creek	9	54	6.8	36	29.5	54	8.4	0	4	70.5						0	1	0.8									1972-75
N	0		=		=	0	=	0		*						X		*									1977-79
WWH																											
U S few small																											
Negro Creek	29	30	3.2			31	316.3	27	27	675.5						23	23	24.1									1972-75
2.3	3		=			3	=	1		=						3		=									1977-79
WWH																											
U S																											
Painter	20	29	6.3	11	30.5	34	12.4	4	31	139.2				27	374	N	25	0.85	3	4	0.16	0	4	1t0.03	4	0.1	1972-75
Creek	1		=		*	0-1	=		0	=					*		0	=		1	=	0		=		*	1977-79
N																											
WWH																											
Sawmill Run	1	1	6.2	1	130	1	0	0	1	210						0	1	0.4									1973
N	X		*	X	*	X	*	X		*						X		*									
WWH																											
NM																											

USDA FS (1972-75, 1977 - 1979) concentrations in mg/l

Skelly and Loy (1973)

Raccoon Creek - from the source to confluence with Ohio River and tributaries:

Bear Run, Bullskin Creek (Burnt Run, Little Bullskin Creek), Claylick Creek (Little Claylick Creek, Long Run), Garner's Ford Bridge Run, Barren Creek, Flatlick Run, Karr Run, Indian Camp Run (South Fork Indian Camp Run), Rockcamp Run, Hogg Run, Pierce Run, Elk Fork (Wolf Run, Puncheon Fork), Brushy Creek (Brushy Fork, Pumkin Hollow, Mitchell Hollow), Onion Creek, Hewett Fork (Trace Run, Grass Run, Pine Run, Carbondale Creek, Mud Lick Run, Yost Creek), Sandy Run (Little Sandy Run, Hull Hollow, Big Four Hollow, East Fork Big Four Hollow, Lake Hope), Brushy Fork, Rocky Branch, Two Mile Run, Red Run, West Branch (Honey Fork, unnamed tributary), East Branch (Tick Fork, East Branch Starr Run, West Branch Starr Run, Starr Run, unnamed creek, Coonville Creek).

Raccoon Creek is 109 miles long and drains 683.5 miles^2 in Athens, Hocking, Meigs, Vinton, Jackson and Gallia counties. Coal seams with high pollution potential in the drainage are the 4a, 5, 6, 7 and 8a for surface and underground mining. Raccoon Creek is the most completely studied mine drainage effected stream in Ohio.

For clarity, water quality in the Raccoon Creek drainage will be discussed in four, separate units; lower Raccoon Creek (from the confluence with Trace Run to the Ohio River), middle Raccoon Creek (from the confluence with Elk Fork to Trace Run), Little Raccoon Creek (source to confluence with Raccoon Creek), and upper Raccoon Creek (headwaters to confluence with Elk Fork).

Lower Raccoon Creek

Abandoned coal mines in the lower Raccoon Creek area are exemplified almost exclusively by abandoned strip mines. The most intensely mined, abandoned areas are located near the mouth of Raccoon Creek within the watersheds of Bullskin Creek and Claylick Run. No abandoned mines exist between Adamsville and Northrup. The lower Raccoon Creek receives water low in pH and high in dissolved solids and acidity from the middle and upper reaches which are affected by numerous abandoned underground mines.

Lower Raccoon Creek water quality has been monitored upstream at Adamsville from 1959 to 1979 the present by USGS, and was also monitored by the FWPCA, Ohio EPA and Skelly and Loy. Total dissolved solids (TDS), sulfates and pH conditions have remained relatively constant over the 21 year span. However, seasonal concentrations of mine drainage constituents are significantly higher and pH is lower from July through October. Concentrations of sulfate and TDS are approximately two times lower from March through May. Buffering capacity is exhausted and net acidities approach 126 mg/l during low fow conditions. The small number of total iron, manganese and zinc samples preclude a similar evaluation.

The concentrations of mine drainage constituents in lower Raccoon Creek are much higher than in its local tributaries including those receiving abandoned mine drainage. Bullskin Creek, Claylick Run and Barren Creek all contain neutral pH conditions, net alkalinities and total iron and manganese concentrations similar to drainages without abandoned mines. Only Indian Creek and Clear Fork exhibited total iron values in excess of the WWH standard although neither appear to have abandoned mines. Total manganese exceeded the PWS standard in all but one sample on all reported tributaries. Those

tributaries with abandoned mines had much higher sulfate concentrations, up to 400 mg/l, while streams without were under 100 mg/l.

Tycoon Lake is an impoundment of an unnamed tributary to Raccoon Creek below Trace Run at Vinton. Neutral pH values, alkalinities less than 50 mg/l, sulfates of 20 mg/l and total metal concentrations well below the EWH and PWS standards are characteristic. This impoundment has a adequate buffering capacity with no abandoned mines. Tycoon Lake could be sensitive to moderate additions of acidic water which could drive the pH below standards.

Lower Raccoon Creek tributaries appear to have an ameliorating effect on the mainstem water quality. A few samples obtained near the mainstem's mouth at Thinever indicated low net alkalinities, limited buffering capacity, higher pH values and lower sulfates compared to upstream stations.

Tributaries of lower Raccoon Creek which have no abandoned mines are Clear Fork, Indian Creek, Little Indian Creek and Trace Run.

Middle Raccoon Creek

Abandoned coal mines in the middle Raccoon Creek drainage are of the small underground as well as small surface type. The southern portion of this segment receives severely mine drainage affected water from Little Raccoon Creek. The middle Raccoon Creek also receives lower quality water from upper Raccoon Creek.

The extent of mine drainage water quality information collected by USGS, FWPCA, Ohio EPA and Skelly and Loy on middle Raccoon Creek is less than on the lower or upper portions. Seasonal trends were difficult to detect although probably exist as in the lower reaches of the stream. Over the period of record, no apparent changes in stream quality occurred.

pH values are consistently below the WWH standard range in the middle Raccoon Creek. The segment exhibits continuous net acidities and no buffering capacity. Mean sulfate and total iron concentrations in middle Raccoon Creek were not considered at problem levels, and individual observations of both exceeded WWH and PWS standards in 4 of 19 observations, respectively. Mean total zinc was not problematic and exceeded the WWH standard at an even lower frequency. Total manganese concentrations were a moderate problem. Total aluminum was above 1 mg/l in all samples collected from middle Raccoon Creek.

Water quality data was minimal for some middle Raccoon Creek tributaries. With the exception of severe pH conditions in Wolf Run and moderate pH problems in Pierce Run, pH in all other abandoned mine affected tributaries was in the minor problem range of 5.50 to 6.49 S.U. Pierce Run and Elk Fork had moderate to severe total iron concentrations but in general other tributaries with or without mining had total iron in concentrations slightly exceeding 1 mg/l. Streams with no abandoned mines had sulfate concentrations less than 50 mg/l, while mine drainage streams had higher sulfates (up to 500 mg/l). All observed total manganese concentrations were higher than the PWS standard in all tributaries. Total zinc, aluminum and moderate manganese problems occurred in Pierce Run. Elk Fork also contained moderate levels of manganese.

Stream Name PWI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Raccoon Creek (Lower)	pH	154/169	January-December	13	1960 1964-1970 1973-77	4.2 (mode)	7.5	3.1	3 =	
	Alkalinity December	-/128	January-	13	1965-77	1.64	50 =	0	3	
W.M/SMW U S Up (U,S,R)	Acidity	-/27	March April June July September		1965-66 1972-73 1975	39.4	126	0	1 =	
	Sulfates	29/270	January-December	13	1964-77	167.7	950	38	1 =	
	TDS Filt. Residue (180oC)	1/231	January-December	10	1964-73	344.5	1780	68	0 =	
	Conductivity at 25oC	1/265	January-December	13	1964-77	536.1	2930	122	0 =	
	Total Iron	4/13	March April June July September	5	1965 1966 1973 1975 1977	1.76	7.1	0.2	1 =	
	Manganese	8/8	March April June July September	4	1965 1966 1974 1975	3.24	6.5	0.4	2 *	

(Continued on next page)

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Raccoon Creek (Lower)	Zinc	3/7		March July August	3	1975-77	0.116	0.18	0.05	0-1 *	
	Aluminum	-/4		N	2	1974-75	1.01	2.10	0.24	*	

FWPCA (1965, 1966)
Skelly and Loy (1973)
Ohio EPA SEDO (1975)
USGS (1960-77)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Lower) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Bullskin Creek	0	2	7.2	2	58.5			2	2	395				2	862.5	0	2	0.345	2	2	0.945						1979
6.2	0		*		*			1		*					*	0		*	1		*						
WWH																											
S																											
Clear Fork	0	1	6.5	1	147	1	0	0	1	96						1	1	7.1									1973
3.8	X		*		*	X	*	X		*						X		*									
WWH																											
NM																											
Claylick Run	0	3	7.4	3	104			1	3	266.7				2	610	0	3	0.237	1	2	0.06						1973
4.7	0		*		*			1		*					*	0		*	0		*						1979
WWH																											
S																											
Little Claylick	1	1	5.9	1	61	1	0	1	1	360						0	1	0.3									1973
Run	X		*		*	X	*	X		*						X		*									
2.5																											
WWH																											
S																											
Rocky Fork	0	1	6.5	1	138	1	0	0	1	56						0	1	0.3									1973
2.4	X		*		*	X	*	X		*						X		*									
WWH																											
"																											
Beaver Creek	1	1	4.7	1	3	1	6	0	1	160						0	1	0.6									1973
"	X		*		*	X	*	X		*						X		*									
WWH																											
"																											

USDA FS (1977-78)
Skelly and Loy (1973)
USGS (1979)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Lower) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Indian Creek	N	14	6.8	14	40	14	5.0	0	14	34.7				14	194.6	N	14	1.4	14	14	1.1						1965-66
9.1	0		*		*	0	*	0		*					*	1		*	1		*						
WWH																											
NM																											
Little Indian	1	3	6.5	3	45	2	2.5	0	3	24.7				2	150	0	3	0.6	2	2	0.23						1973
Creek	0		*		*	0	*	0		*					*	0		*	1		*						1979
8.9																											
WWH																											
NM																											
Barren Creek	0	2	7.25	2	99.5			0	2	41.5						0	2	0.86	2	2	0.27						1973
3.7	0		*		*			0		*						0		*	1		*						1979
WWH																											
S																											
Tycoon Lake	1	9	7.0	3	48.7	2	0	0	2	20				8	103.8	0	2	0.2				0	1	0.03			1973
N	0		*		*	0	*	0		*					*	0		*				X		*			1978
EWH/PWS																											
NM																											
Trace Run	1	1	5.9	1	90	1	0	0	1	28						0	1	0.3									1973
2.7	X		*		*	X	*	X		*						X		*									
WWH																											
NM																											

USGS (1979)
Skelly and Loy (1973)
FWPCA (1965-66)
Ohio EPA SEDO (1978)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Middle Raccoon Creek tributaries entering the upstream portions of the mainstem had the most extensive areas of abandoned mines. However, pH values in most tributaries were notably higher than in the mainstem. Elk Fork, Wolf Run and Pierce Run appear to be the most important contributors of acid mine drainage to middle Raccoon Creek. Little Raccoon Creek enters near the most downstream portion of the mainstem and mostly effects lower Raccoon Creek.

Tributaries with no abandoned mines in their watersheds are Robinson Run, Strongs Run and Zinn Run. Strongs Run is classified EWH.

Little Raccoon Creek

Little Raccoon Creek is 36.5 miles long and drains 157.8 miles^2. It contains roughly 15 miles^2 of abandoned strip mines and 9 miles^2 of underground mines. Coal beds having high pollution potential in the area are the Nos. 4a and 5 for surface and underground mining.

The Little Raccoon Creek drainage area contains abandoned surface and underground mines from its headwaters to mouth. The mainstem of Little Raccoon Creek was sampled up to 102 times between 1957 and 1979 by USGS, OWPCB, FWPCA, Ohio EPA and Skelly and Loy. Water quality samples were taken in 1952-53 by Ohio DNR but sample values were not included in this analysis. Samples were collected from February through October encompassing both high and low flow conditions.

Water quality in Little Raccoon Creek declines due to mine drainage from the headwaters to the mouth as the number and extent of abandoned mines increases. The pH values observed along the mainstem were consistently below the WWH standard in 60 of 67 observations spanning 1957 to 1979. The modal pH values calculated for Little Raccoon Creek above and below Lake Alma were 6.15 and 3.7 S.U., respectively. Below Lake Alma, Little Raccoon Creek is influenced by several degraded tributaries such as Mulga Run, Buffer Run, Rich Run and Flint Run. Net acidity on the segment below Lake Alma averaged 79.3 mg/l and buffering capacity was depleted. Above Lake Alma, mean alkalinity slightly exceeding mean acidity, therefore, buffering capacity was limited. From the headwaters to Lake Alma, Little Raccoon Creek is classified EWH.

Data for total iron, manganese, zinc and aluminum was available for Little Raccoon Creek below Lake Alma. Total iron and total manganese were moderate to severe problems in the lower segment of Little Raccoon Creek. Total aluminum occurred in the same general concentration range as total manganese. Total zinc exceeded the WWH standard in 2 of 4 observations but only by a few tenths of a milligram per liter.

Degradation of water quality may have occurred in Little Raccoon Creek between 1952 and 1966. The 1952-53 study by Ohio DNR noted that pH in Little Raccoon near the mouth was neutral to alkaline during high flow periods. More recent data suggests that near its mouth, Little Raccoon Creek is continuously acidic throughout the year.

Within 500 yards of the Wellston public water supply intake near Lake Alma, Little Raccoon Creek must meet PWS standards. Auxilliary potable water is taken from Lake Alma, constructed in the early 1900's and Lake Rupert newly construct in 1973. The only available data for Little Raccoon Creek near the Wellston PWS intake was collected in 1957 by the Ohio Water Pollution Control

Board (OWPCB) and in 1974 by Ohio EPA. Alkalinities from both years were similar respectively, at 12.3 and 13.0 mg/l. pH and acidity were reported only in 1957 and averaged 5.91 S.U. and 11.5 mg/l respectively. In 1974, sulfates and total iron were well within the acceptable ranges for PWS but total dissolved solids approached the standard at 400 mg/l and total manganese exceed the standard by 25 times at 1.25 mg/l.

Lake Alma averaged 4.35 and 3.1 mg/l for alkalinity and acidity, respectively, and pH was 5.89 S.U. in 1957. 1974 investigations did not report pH but average alkalinity was 15.5 and acidity 3.1 mg/l. Sulfates, TDS and total iron were well within the PWS standards Total manganese exceeded the PWS standard by a factor of 7. Lake Alma has two abandoned deep and strip mines in the southern portion of its watershed. As early as 1951, hydrated lime was used to neutralize the main feeder stream to the lake (Ohio DNR, 1954) which drains the mined areas. In March 1974 this feeder stream entering from the east contained a net acidity of 2 mg/l, no buffering capacity, and total manganese concentrations 12 times higher than the PWS standard. The feeder stream is probably the main source of acid mine drainage to Lake Alma.

Lake Rupert may be affected by a few small abandoned strip mines in the northern periphery of its watershed and a few small drift mines. Several active strip mines and two strip mine applications indicate the level of activity in the area may be increasing. Total manganese could be a moderate problem at 2.5 mg/l according to 1979 information.

Most of the tributaries of Little Raccoon Creek contain abandoned mines in their watersheds but are affected to varying degrees. Tributaries having severe pH conditions also had severe levels of acidity and no buffering capacity. These include Dixon Run, Goose Run, Buffer Run, Flint Run and Mulga Run. These streams were also characterized by severe concentrations of total iron (up to 100 mg/l) and total aluminum (up to 27 mg/l). In the 1952-53 Ohio DNR and 1965-66 FWPCA studies Rich Run, Dickason Run and Mulga Run were considered the most polluted. Recent data suggests improvement in the former two may have occurred between 1957 and 1979.

Tributaries containing moderate pH problems are characterized by minor to moderate net acidities and no buffering capacity. These tributaries including Dickason Run, Tarcamp Run and Rich Run, also had minor to moderate total iron problems and total aluminum concentrations less than 3 mg/l. Manganese was moderately problematic for both severe and moderate pH limited streams.

Streams with minor pH problems including Keeton Run, Spring Run, Meadow Run and Sand Run had net alkalinities ranging from 20 to 117 mg/l.

Sulfates were highest in streams with lowest pH values. In severely low pH conditions, total zinc exceeded the WWH standard frequently.

A few streams remain which do not receive abandoned coal mine drainage, these are Deer Creek, Johnson Run and Tripp Run. McConnel Run, a tributary to Lake Rupert is classified EWH although it received abandoned mine drainage.

Upper Raccoon Creek

The mainstem of upper Raccoon Creek was sampled 46 times between 1965 and 1978 by the USDA Forest Service, Ohio DNR, USGS, FWPCA, Ohio EPA and Skelly and Loy. Samples were obtained in March, April, June, September and October on

the mainstem and reflect both high and low flow conditions. Sandy Run and Big Four Hollow have been extensively monitored by USGS from 1959-1979. An earlier survey of water quality was made by Ohio DNR in 1952-53 and some qualitative comparisons will be made based on this information.

Upper Raccoon Creek has the highest concentration of abandoned mines in the entire basin. Most of them are abandoned shaft and drift mines but strip mining was common on the East and West Forks.

The water quality in upper Raccoon Creek mainstem is characterized by severely low pH, and severely high acidity and total manganese levels, and minor problems with sulfate, total iron and total zinc concentrations. Total aluminum was in the range of 4 to 10 mg/l. The modal pH value of 3.95 S.U. fell close to the minimum, and net acidities averaged 116.7 mg/l indicating a large deficit in buffering capacity. Total manganese concentrations were three times higher on the average than total iron. Total zinc concentrations were also problematic.

Water quality in the upper Raccoon Creek tributaries was often more degraded than in the mainstem. However, tributaries entering the downstream portions of the mainstem had fewer abandoned mines and better water quality than those entering near the source.

Severe, low pH conditions accompanied by severe acidities were characteristic of Hewett Fork, Yost Creek, Sandy Run, Big Four Hollow (at the mouth), Brushy Fork, Red Run, East Branch and Coonville Creek. Streams with only one sample which suggested severe conditions were Rocky Branch and Two Mile Run. These streams have no buffering capacity. Total iron and aluminum were highest in Sandy Run, East Branch and in Red Run downstream from a refuse pile. Streams with modal pH values below 4.5 S.U. (severe levels) had sulfate concentrations in excess of the PWS standard of 250 mg/l and occasionally as high as 1000 mg/l. Total manganese levels on these streams ranged from minor to severe independent of other factors. Brushy Fork, although severely degraded, is classified EWH in the Ohio Water Quality Standards.

Streams found to contain severe pH and acidity problems in the Ohio DNR 1952-53 study were West Branch, Honey Fork, East Branch, Brushy Fork, Hewett Fork, Puncheon Fork and Pierce Run. Elk Fork was considered a major source of acid mine drainage by virtue of loading rather than concentration. Limestone in the area may ameliorate some acid problems. If the 1952 information on stream conditions is reliable, then water quality in Sandy Run has deteriorated since the early 1950's but the West Fork and its tributary Honey Fork have improved.

Tributaries with moderate pH problems and moderate to minor net acidities and no buffering capacity were Hull Hollow, East Fork of Big Four Hollow, Big Four Hollow above its east fork, Lake Hope, West Branch and the West Branch of Starr Run. These streams and reservoir were typified by sulfate concentrations less than 150 mg/l, total manganese values less than 5 mg/l, acceptable zinc concentrations and aluminum concentrations less than 3 mg/l. Big Four Hollow above its East Fork was higher in total iron and aluminum concentrations.

In 1952 the West Branch of Raccoon Creek had pH values in the range 3.3 to 4.5 S.U. with acidities from 16-144 mg/l. Two pH samples from 1973 and 1979 averaged 5.0 S.U. and 11.5 mg/l acidity. Further investigations are needed to confirm if improvement has occurred. Improvement may be occurring in Wheelabout Creek, which is classified EWH by Ohio EPA.

Data for Sandy Run and its tributaries were collected by USGS in conjunction with the Ohio DNR reclamation project designed to seal the deep mine complex in Big Four Hollow. The highest levels of mine drainage constituents occurred at the mouth of Big Four Hollow. Some improvement in water quality in Sandy Run takes place before it forms Lake Hope, probably as a result of contributions of higher quality water from unmined hollows below Big Four Hollow. TDS was above the WWH standard at Big Four Hollow, but in only 25 of 241 samples. Seasonal water quality concentrations vary and are most severe during low flow periods at Big Four Hollow. This trend is less dramatic in Sandy Run above Lake Hope.

Four active drift mines in the No. 6 coal were identified on Sandy Run in the FWPCA (1965-66) study. Three were on the east bank of Sandy Run opposite the Todd-Hope Hollow complex above Big Four Hollow, the other was located near the Loper Mine on Big Four Hollow below the east branch. These additional mines active in 1965-66, if not active prior to 1952, could have been responsible for the higher acidity and lower pH values observed in Sandy Run in recent years.

Water quality in Lake Hope is degraded by numerous upstream underground abandoned mines and to a lesser extent by abandoned strip mines. Buffering capacity is probably non-existent in Lake Hope during spring and autumn as runoff has mean alkalinity and acidity values which are nearly equal. pH conditions are moderately problematic. The lake was less acidic during the summer months in 1965 (FWPCA) and 1975 (USGS). Sulfates, TDS and total zinc do not appear to be problematic, however, higher concentrations of these constituents were observed in the hypolimnion during periods of thermal stratification. Total iron and manganese exceeded EWH and PWS standards at minor to moderate levels. Recovery of Lake Hope from acid mine drainage could be impaired by acid rain due to naturally low alkalinities and buffering capacity in the soils and runoff entering the lake.

Tributaries to Upper Raccoon Creek with no abandoned mines include Flat Run, an unnamed tributary at Vales Mills, Russell Run, Tendroe Run, Onion Creek, Laurel Run, Mud Lick Run, Rockcamp Creek, Dunkle Creek and Silvery Creek, and an unnamed tributary to the East Branch 1.6 miles southwest of Starr. These streams often exhibited pH values less than 6.5 S.U. but only in 1973 Skelly and Loy samples. An underestimation of pH may have occurred. However, all streams in the Upper Raccoon Creek drainage exhibited total manganese concentrations above the PWS standard and some streams without abandoned mines exhibited total iron concentrations above the WWH standard.

The most recent biological study (1976) which investigated the effects of mine pollution on the meiofauna of mine drainage affected streams identified upper Raccoon Creek near C.R. 325 and Sandy Run at Big Four Hollow as severely affected by mine drainage by virtue of the paucity of species and numbers of individuals. The authors plan to continue this investigation to evaluate the effects of mine sealing in the Big Four Hollow deep mine complex on the meiofauna of Sandy Run and Lake Hope.

Summary

In a 1953 survey, Ohio DNR identified 60 strip mines and 275 underground mines with 582 openings in the Raccoon Creek drainage. The FWPCA in 1966 estimated that 300 of the 582 openings to underground mine sites discharge continuous acid water to the streams of the Raccoon Creek Watershed. The total number of sources including intermittent discharges, and seepage areas was estimated at 3 to 4 times the 300 figure. The 1967 report determined that only one-quarter of the total acid load measured in the Raccoon Creek watershed, emanated as strip mine drainage. Undoubtedly, the number of abandoned mines has increased beyond the 1952 figure.

Large scale production of coal in the Raccoon Creek drainage began prior to 1856. No underground mines in the Raccoon Creek Watershed were abandoned prior to 1892, and most of the underground mines were abandoned just after World War I. Mines abandoned up to 40 years prior to the 1952 study were still discharging acid water.

The probability that Raccoon Creek will reverse its present state of degradation in the near future without massive surface and underground reclamation efforts is small.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Raccoon Creek (Middle) WWH/PWS[A]	pH	19/21	(33)	March-July September November	6	1965 1966 1973-75 1979	4.5 (mode)	7.4	3.5	2 *	
U, S, Up (S,U,R)	Alkalinity		-12 (25)	March-July September November	5	1965 1966 1973-75	4.92	15	0	*	
	Acidity		-/18 (36)	March-July September	6	1965 1966 1973-75	27.2	107	8	1 *	
	Sulfates		4/19 (40)	March-July September November	6	1965 1966 1973-75 1979	186.3	510	88	0 *	
	TDS		0/1		1	1974	309	-	-	N *	
	Conductivity		-/13 (15)	March-July September November	3	1965 1966 1975	493.3	890	240	N *	

(Continued on next page)

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Raccoon Creek (Middle) (Continued)	Total Iron	4/19	(40)	March-July September November	6	1965-66 1973-75 1979	0.71	3.2	0.2	0 *	
	Total Manganese	2/15	(35)	March-July September November	5	1965-66 1974-75 1979	2.78	6.0	0.0	2 *	
	Total Zinc	1/11	(14)	November	3	1974-75 1979	0.065	0.13	0.03	0 *	
	Total Aluminum	-/12	(22)	November	3	1974-75 1979	1.47	2.8	0.18	*	

FWPCA (1965-66)
Skelly and Loy (1973)
Ohio EPA SEDO (1974)

USGS (1975, 79)

(Middle) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al			Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	PWS # Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean		
Robinson Run	0	1	6.9	1	54			0	1	28						0	1	0.85	1	1	0.59	0	1	lt 0.03	1	lt.0.02		1979
2.9	X		*					X		*						X		*	X		*	X		*		*		
WWH																												
NM																												
Strongs Run	0	2	6.9	2	43.5	1	15	0	2	28				2	172.5	1	2	1.05	2	2	0.37							1979
10.4	X		*	X	*	X	*	X		*				X	*	X		*	X		*							
WWH																												
NM																												
Flat Lick	1	2	6.4	2	41.5	1	0	0	2	31.5						2	2	1.11	1	1	0.67	0	1	lt.0.03	1	lt 0.02		1973
Run	1		*		*	X	*	0		*						1		*	0		*	0		*		*		1979
5.1																												
WWH																												
S																												
Unnamed	1	1	5.9	1	25	1	0	0	1	116						0	1	0.4										1973
tributary	X		*			X	*	X		*						X		*										
at Minerton																												
N																												
WWH																												
US																												
Indian Camp	1	1	5.9	1	25	1	0	0	1	116						0	1	0.4										1973
Run	X		*		*	X	*	X		*						X		*										
2.2																												
WWH																												
U, Up (S)																												
Unnamed trib.	1	1	5.7	1	32	1	0	0	1	82						1	1	2.4										1973
Across from	X		*		*	X	*	X		*						X		*										
Rockcamp Run																												
N																												
WWH																												
S																												

Ohio EPA SEDO (1979)
USGS (1979)

(Middle) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Rockcamp Run	1	1	5.7	1	19	1	0	0	1	154						0	1	0.9									1973
2.0	X		*		*	X	*	X		*						X		*									
WWH																											
U,S																											
Zinn Run	1	1	5.7	1	60	1	0	0	1	46						0	1	0.8									1973
N	X		*		*	X	*	X		*						X		*									1979
WWH																											
NH																											
Pierce Run	9	9	4.47	9	2	9	57.3	3	9	245						7	9	6.6	8	8	2.99	2	6	0.14	6	5.3	1973
7.3	2		=		=	2	=	0-1		=						2		=	2		*	0-1		*		*	1979
WWH																											
U,S,R,																											
Elk Fork	8	11	5.62	7	17	8	96.6	4	10	405.2	0	4	101.25	2	890	5	10	7.09	6	6	2.09	0	4	0.04	4	0.63	1965-66
18.6		(19)			(18)		(19)		(22)		0		*				(22)						(5)		(5)		1973
WWH	1		+		=	2	+	1		+						2		+	2		+	0		*		*	1975
																											1978-79
U.S. Up (U,S)																											
Puncheon Fork	3	4	5.9	4	19.5	4	7.8	1	4	182.5				2	345	2	4	1.36	2	2	1.7						1973
5.6	1		*		*	0	*	0		*					*	1		*	1		*						1979
WWH																											
U,S																											
Wolf Run	1	1	4.0	1	0	1	17	1	1	500						0	1	0.3									1973
7.1	X		*		*	X	*	X		*						X		*									
WWH																											
S																											

Ohio EPA, OLPC (1979
Skelly and Loy (1973)
Ohio EPA SEDO (1975)

FWPCA (1965-66)
USGS (1978-79)

tream Name MI egment mi/Total mi se Designation ollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
ittle Raccoon reek /36.5 T/PWS*/EWH**	pH	18/19 (54)		March-September November	7	1965-66 1972-75 1979	3.7 (mode)	7.1	3.0	3 -	all stations 1952 date not shown
		39/45		February-March May, July	2	1957,73	6.1	6.8	4.8	1 =	above Lake Alma
, S, Up (S,U,R)	Alkalinity	-/16 (50)		March-September November	6	1965-66 1972-75	15.4	124	0	=	all stations
		-/45		February-March May, July	2	1957,73	14.0	147.5	0	*	above Lake Alma
500 yds. of ellston Plant intake * from the source o Lake Alma	Acidity	-/19 (54)		March-September November	7	1965-66 1972-75 1979	79.3	580	0	2 =	1 all stations
		-/45		February-March May, July	2	1957,73	11.72	207.8	0	0-1 *	above Lake Alma
	Sulfate	8/20 (54)		March-September November	7	1965-66 1972-75 1979	225.7	400	65	0-1 =	
	TDS	-/2		August	2	1972 1974	383.5	468	299	0 *	
	Conductivity	-/10 (43)		March-September November	6	1965-66 1972-75	596.6	1050	240	0 =	

(Continued on next page)

Stream Name RM Stream Mi/Total Mi Use Designation Pollution Source	Const (Unit)	No Exc/Samp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Little Raccoon Creek (Continued)	Total Iron	7/18 (51)		March-September November	7	1965-66 1972-75 1979	22.64	320	0.1	3 =	
	Total Manganese	11/11 (44)		March-September November	7	1965-66 1973-75 1979	3.69	7.3	0.21	2 =	
	Total Zinc	2/4		November	2	1975 1979	0.14	0.2	0.08	N *	
	Total Aluminum	-/5		November	3	1974-75 1979	3.9	8.8	0.0	*	

USGS (1972-79)
Skelly and Loy (1973)

Little Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Keeton Run	1	2	6.2	1	40	2	0.5	0	2	101.5				1	170	0	2	0.64	1	1	0.67	0	1	lt.	1	0.31	1973
2.3	1	*			*	0	*	0		*				X	*	0		*	X		*			0.03		*	1979[2]
WWH																						X		*			
S																											
Spring Run	1	2	6.35	1	23	2	0	0	2	76				1	110	2	2	3.69	1	1	0.86	0	1	lt.	1	lt.	1973
4.6	X		*		*	0	*	0	*					X	*	1		*	X		*			0.03		0.02	1979[2]
WWH																						X		*		*	
S																											
Dickason Run	7	7	4.76	6	10.7	7	70.9	2	7	223	0	1	236	6	338	5	7	2.28	5	5	4.28	1	1	0.09	1	0.7	1965-66
8.4			(18)		(18)		(18)			(18)	X		*		*18)			(18)			(18)						1973
WWH	2		*		*	2	*	0		*					*	1		*	3		*	X		*		*	1979[1]
U,S, Up (U,S)																											
Dixon Run	1	1	3.8	1	0	1	103	1	1	650						1	1	13.6									1973
N	X		*		*	X	*	X		*						X		*									
WWH																											
U,S																											
Tarcamp Run	2	2	5.2	1	5	2	1.5	0	2	34.5	0	1	99	1	100	1	2	1.35	1	1	0.85	0	1	lt.	1	0.5	1973
2.1	2	*			*	1	*	0		*	X		*	X	*	1		*	X		*			0.03	X	*	1979[2]
WWH																						X		*			
U, S																											
Goose Run	1	1	2.7	1	0	2	523	2	2	840	0	1	1200			2	2	100.9	1	1	6.5	1	1	0.56	1	48.0	1973
1.5	3	*			*	3	*	2	*				*			3		*	X		*	X		*		*	1979
WWH																											
U,S																											

Ohio EPA SEDO (1979)
Skelly and Loy (1973)
USGS (1979)

Little Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Buffer Run	1	1	2.9			1	330	1	1	840	0	1	1300	1	1300	1	1	94.0	1	1	10.2	1	1	0.38	1	27.0	1973
2.4	X		*			X	*	X		*	X		*	X	*	X		*	X		*	X		X	X	*	1979
WWH																											
U,S																											
Flint Run	1	1	3.5	1	23	2	0	0	2	76				1	110	2	2	3.69	1	1	0.86	0	1	lt.	1	lt.	1973
2.2	X		*		*	0	*	0		*				X	*	1		*	X		*	X		0.03		0.02	1979
WWH																								*		*	
S																											
Rich Run	5	7	5.49	7	26.0	7	45.1	2	7	189	0	1	598	7	436	5	7	9.65	7	7	1.41	1	7	0.28	7	3.03	1979
4.0	1		*		*	1	*	0		*		X	*		*	3		*	1		*	0		*	N	*	(1952-53
WWH																											not
																											included)
U,S,R																											
Mulga Run	3	3	3.1			3	204.3	3	3	686.6	0	1	714			3	3	13.96	1	1	5.05	0	1	0.22	1	11.0	1973
4.7	3		*			3	*	2		*						3		*	X		*	X		*		*	1979
WWH																											
U,S,R																											
Sugar Run						1	65	1	1	290	0	1	471			1	1	2.9	1	1	6.2				1	5.8	1974
11							*	X		*	X		*			1		*	X		*				X	*	1979
WWH																											
U,S																											
Up (PWS)																											

Ohio EPA SEDO (1974)

Little Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	PWS # Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Lake Alma	[1]6	6	5.89	2	15.5	[1]6	3.1	0	3	75	0	2	270			0	2	0.35	2	2	0.79				2	0.0	1974
72.5 acres	1		*		*	0	*	0		*		0	*			0		*	1		*					*	[1]1957
EWH/PWS																											only
U,S																											
Unnamed				1	22	1	0	0	1	68	0	1	127			0	1	0.0	0	1	0.0				1	0.0	1974
tributary					*	X	*	X		*						X		*	X		*					*	
South Shore																											
EWH/PWS																											
S																											
Unnamed				1	13	1	15	0	1	103	0	1	193			0	1	0.0	0	1	0.58				1	0.60	1974
tributary					*	X	*	X		*	X		*			X		*	X		*				X	*	
East Shore																											
EWH/PWS																											
U,S																											
Meadow Run	3	6	5.77	4	117	3	78.7	2	6	236.3						1	3	0.93	2	2	0.52						1974
4.6	1		*		*	0-1	*	0-1		*						0-1		*	1		*						1978
EWH																											1979
U,S,																											
Sand Run	1	1	5.7	1	58	1	0	0	1	80						1	1	2.7									1973
4.7	X		*		*	X	*	X		*						X		*									
WWH																											
U,																											

USGS (1979 Skelly and Loy (1973)

Ohio EPA SEDO (1974, 1978-79)

OWPCB (1957)

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Upper Raccoon Creek	pH	27/28	(46)	March, April June-October	9	1965-68 1971 1973 1975 1977-78	3.95 (mode)	6.7	3.1	3 -	Reclamation Mine Sealing Project in Sandy Run drainage
MWH/SNRW U,S,R, Up (U,S,R)	Alkalinity	1/17	(38)	March, April October	9	1965-68 1971 1973 1975 1977-78	5.16	35	0	=	
	Acidity	-/24	(46)	March, April September	8	1965-68 1973 1975 1977-78	116.7	420	5	3 =	
	Sulfates	17/28	(54)	June-October March,	9	1965-68 1971 1973 1975 1977-78	382.9	797	105	1 =	
	TDS	0/6		June August-September March April	5	1966-68 1971 1975	569.3	882	376	0 *	
	Conductivity at 25°	1/10	(40)	March April June-October	8	1965-68 1971 1975 1977-78	992.5	4000	280	0 =	

(Continued on next page)

Stream Name / RMI / Segment mi/Total mi / Use Designation / Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Upper Raccoon Creek (Continued)	Total Iron	10/17	(39)	March April June July October	5	1965-66 1968 1973 1975	2.16	11.0	0.1	1 +	
	Total Manganese	10/12	(34)	March April November	4	1965-66 1968 1975	6.89	18.2	0.0	3 =	
	Total Zinc	4/6	(7)	July October	1	1975	0.215	0.3	0.14	1 *	
	Total Aluminum	-/6	(7)	July October	1	1975	7.07	10.0	4.1	*	

USDA Forest Service (1966-68, 1971), Skelly and Loy (1973)
USGS (1975, 1977-78), Ohio EPA SEDO (1975), FWPCA (1965-66, 1968)

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Unnamed trib.	0	13	6.8	13	56.5	13	0.4	0	13	55.5				13	254	N	13	1.6	13	13	1.0					1965-66
at Vales Mill to	0		*		*	0	*	0		*				0	*	1		*	1		*					
W. bank Raccoon																										
Creek																										
N																										
WWH																										
NM																										
Flat Run	1	1	5.7	1	66	1	0	0	1	60						1	1	1.5								1973
6.8	X		*		*	X	*	X		*						X		*								
WWH																										
NM																										
Russell Run	1	1	5.4	1	26	1	0	0	1	100						1	1	8.4								1973
2.4	X		*		*	X	*	X		*						X		*								
WWH																										
NM																										
Tendroe Run	1	1	5.3	1	20	1	0	0	1	58						1	1	6.9								1973
1.7	X		*		*	X	*	X		*						X		*								
WWH																										
U.S. Up (U,S)																										
Onion Creek	N	11	6.6	13	54	13	4.4	0	13	60.2				13	248	N	13	1.2	13	13	1.3					1965-66
5.9	0		*		*	0	*	0		*					*	1		*	1		*					1979
WWH																										
NM																										
Laurel Run	1	1	5.0																							1973
2.3	X		*																							
WWH																										
NM																										

FWPCA (1965-66)
Skelly and Loy (1973)
USGS (1979)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Hewett Fork	12	12	3.4	4	9.5	12	80.5	8	12	381.5	0	4	497.8	7	534	10	10	5.39	8	8	3.39	1	4	0.16	4	8.5	1965-66
15.4		mode																									1973
WWH	3		=		=	2	=	1		=	0		*		=	2		=	2		=	0		*		*	1975
U,S, Up (U,S)																											1977-79
Mud Lick Run	0	1	7.2			1	lt.1.0	0	1	51						0	1	0.73	1	1	0.32	0	1	lt.0.03	1	0.2	1979
N	X		*				*	X		*						X		*	X		*	X		*		*	
WWH																											
NM																											
Rockcamp Creek	0	1	6.9			1	lt.1.0	0	1	39				1	166	0	1	1.03	1	1	0.58	0	1	lt.0.03	1	0.2	1979
4.4	X		*				*	X		*					*	X		*	X		*	X		*		*	
WWH																											
NM																											
Yost Creek	3	3	3.33			2	662	3	3	1513				2	2033												1977-78
N	3		*			3	*	3		*					*												
WWH																											
U,S																											

Ohio EPA SEDO (1975-79)
FWPCA (1965-66)
Skelly and Loy (1973)
USDA Forest Service (1977-78)
USGS (1979)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Sandy Run 6.0 WWH U,S, Up (S,U)	pH	342/342		January-	12	1959-61	2.81	6.2	2.6	3	1) at Big Four Hollow
			(351)	December		1970-79	3.72	5.3	3.0	3	2) near Lake Hope inflow 1952-53 data not included
	Alkalinity	-/303	(318)	January-December	12	1959-60 1968-79	0.19	21	0	-	1952-53 data not included
	Acidity	-/124	(139)	January December	6	1972-79 1973	166.2	646	10	3 -	1952-53 data not included
	Sulfates	141/314		January-	15	1959-61	362.51	1800	31	1	all stations
			(329)	December		1965-66	227.4412	945	31	0	near Lake Lake Hope
						1968-79	577.63	1800	86	1-2	Big Four Hollow
	TDS	25/241		January-December	13	1960 1965-66 1968-77	616.0	2600	93	0 -	
	Conductivity	-/340	(355)	January December	15	1959-61 1965-66 1968-77	821.5	2930	85	-	

(Continued on next page)

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Sandy Run (Continued)	Total Iron	29/31		March April	7	1965-66 1975-79	16.3	90.0	0.65	3 =	
	Total Manganese	4/4 (21)		March April May June October November	3	1965-66 1979	4.31	7.7	0.09	3 =	
	Total Zinc	14/23 (24)		January-December	8	1970-78	0.32	2.2	0.06	1 -	
	Total Aluminum	-/5		October November	1	1978	6.92	12.0	2.9	*	

USGS (1959-79)
FWPCA (1965-66)

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mode	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Sandy Run:	2	2	5.9	2	13			0	2	51.0	0	2	97.5	2	160	0	2	0.115				0	2	0.015	2	0.085	1978
Hull Hollow	1		*		*			0		*	0		*		*	0		*				0		*		*	1979
N																											
WWH																											
U																											
Big Four	120	120	3.2	118	0.03	53	116	69	122	379	3	115	603	122	913	4	4	3.48				7	9	0.16	3	4.98	1970-78
Hollow	3		=		=	2	=	1		=	0		=		=	1		*				1		=		*	
N																											
WWH																											
U																											
Big Four Hollow	3	3	4.7	3	1.0	1	35	0	3	46	0	3	237	3	363	3	3	10.77				0	3	0.03	3	33.5	1978
above East Fork	2		*		*	X	*	0		*	0		*		*	3		*				0		*		*	
N																											
WWH																											
U,S																											
East Fork of	4	5	5.9	5	15.4			0	5	101.6				5	274	4	5	3.39				1	5	0.04	5	0.41	1978
Big Four Hollow	1		*		*			0		*					*	1		*				0		*		*	
N																											
WWH																											
U																											
Lake Hope	2	26	4.9	5	26.4	2	25.5	0	4	64.8	0	1	81	28	149.5	2	5	5.37	2	2	1.7	0	3	0.023			1965-66
120 acres	2		=		*	0	*	0		*	X		*		*	2		*	1		*	0		*			1975
N																											(total iron
EWH/PWS																											exceeds WWH
Up (U,S)																											only in
																											hypolimnion)

USGS (1970-78)
FWPCA (1965-66)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc PWS	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Wheelabout	1	3	6.23	3	26.7	3	6	0	3	64.7				2	240	1	3	1.0	4	4	1.9					1973
Creek		(5)		(5)		(5)			(5)						*		(5)									1965-66
4.4	1		*		*	0	*	0		*						0-1		*	1		*					(1952-53 data
EWH																										not shown)
U.S.																										
Brushy Fork	3	8	3.85	18	0.03	16	186.1	3	8	273.4				16	1481.3	8	8	4.78	4	4	6.38	2	2	0.145	2	2.85	1965-66
16.8		(16)			=	3	=		(18)						=		(18)			(14)			1	*		*	1973
EWH	3		=					0		=						2		=	2		=						1975
																											1979
U,S, Up (U)																										
Dunkle Cr.	1	1	5.5	1	28			0	1	36						1	1	1.1									1973
N	X		*		*			X		*						X		*									
WWH																											
possibility of mines																											
Silvery Cr.	1	1	5.3	1	26			0	1	28						0	1	0.7									1973
N	X		*		*			X		*						X		*									
WWH																											
possibility of mines																											
Rocky Branch	1	1	3.6			1	77	1	1	270						1	1	4.5									1973
1.4	X		*			X	*	X		*						X		*									
WWH																											
Up (U,S)																										

Skelly and Loy (1973)
USGS (1975, 1979)
FWPCA (1965-66)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Twomile Run	1	1	3.6			1	65	1	1	500						1	1	1.1									1973
3.2	X		*				*	X		*						X		*									
WWH																											
S																											
Red Run	6	6	3.31	6	0	5	376.2	5	6	620.7	2	4	1260	6	1071.7	6	6	53.25	4	4	6.51	5	6	0.54	6	38.05	1975
N	3		=		=	3	=	2		=	0-1		*		=	3		=	3		*		1	=		=	1979
WWH																											
S, R																											
West Branch	2	2	5.0	1	5	2	11.5	0	2	145.5						1	2	0.96									1973
8.1	2		+		*	1	+	0		*						0		*									1979
WWH																											(1952-53 data
S, Up (S,R)																											not included)
Honey Fork	3	7	6.65	15	40.9	16	3.4	0	16	44.4	0	1	188	14	270.4	3	7	1.24	14	14	1.93	1		0.03	1	0.2	1965-66
5.8		(15)			+	0	+	0		*	X		*		*		(16)		1-2		*	X		*		*	1973
WWH	0		+													1		*									1979
S a few small																											
Unnamed trib.	4	4	5.24	4	3	4	46	0	4	109.3	4	0	197.3	4	165	3	4	6.01	4	4	3.03	4	4	0.68	2	2.48	1979
to W. Br.	2		*		*	1	*	0		*	0		*		*	2		*	2		*						
N																											
WWH																											
R, S																											
East Branch	8	8	3.49	6	0	5	532.4	7	8	1821.3	0	1	586	7	1240.7	4	4	61.95	3	3	9.77	1	1	0.26	1	14.0	1973
7.7	3		=		=	3	=	3		=	X		*		*	3		+	3		*	X		*		*	1977-79
WWH																											
U, S (ext)																											

Skelly and Loy (1973)
USGS (1975, 1977, 1979)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

(Upper) Raccoon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
(E. Br.)	2	2	6.25	2	10.0	2	10.5	0	2	48.5				2	175												1977
Tick Fork	1		*		*	0-1	*	0		*					*												1978
N																											
WWH																											
S																											
(E. Br.)	2	2	4.97			2	52.5	2	2	328.3				2	522.5												1977
Starr Run	2		*			2	*	1		*					*												1978
N																											
WWH																											
S																											
W. Br. Starr	2	2	5.8	1	3	2	22	0	2	50.5				2	145												1977
Run	2		+		*	1	+	0		*																	1978
N																											
WWH																											
S																											
Unnamed Creek	2	2	5.9	1	11	2	32	0	2	61.7				2	175												1977
1.6 mi. SW Starr	1		*		*	1	*	0		*					*												1978
N																											
WWH																											
NM																											
Coonville Creek	2	2	3.7			2	284	2	2	847.5				2	1000												1977
N	3		*			3	*	1		*					*												1978
WWH																											
U,S																											

USDA FS (1977-78)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Shade River: confluence of West and Middle Branches to confluence with East Branch, and tributaries; Middle Branch (Pratts Fork, Long Run, Spring Branch), West Branch (Kingsbury Run).

The Shade River is 38.2 miles in length and drains 220.6 $mi.^2$ in Meigs and Athens counties. The coal mined is the No. 8a which has a high pollution potential for surface mining in the area. Most of the abandoned mines are strip mines located in the drainages of the West Branch and Kingsbury Creek. A few mines were abandoned in the East Branch drainage and its tributary Pratts Fork. Water quality data was collected by USGS, Ohio EPA, FWPCA and Skelly and Loy for up to 14 years over the period 1965-78. Sample months include January, March, and May through December, encompassing both high and low flow periods.

Water quality conditions appear to have improved on the mainstem over the period of record. Yearly modal pH values increased while mean sulfate concentrations and conductivity decreased. Other constituents were not sufficiently observed to make similar determinations. Buffering capacity on the mainstem is excellent. Total iron and manganese were minor and moderately problematic parameters, respectively. Total aluminum ranged from 0.4 to 9.2 mg/l.

The West Branch of the Shade River had minor pH and total iron problems and limited buffering capacity. However all other tributaries including those with abandoned mines appeared to have no pH problems and adequate to excellent buffering capacity. Mean sulfate concentrations did not exceed the PWS standard. Those watersheds with no abandoned mines contained sulfate concentrations less than 50 mg/l.

Total manganese concentrations exceeded the PWS standard in all tributaries except Horse Cave Creek.

The highly erodable Pomeroy Sandstone has caused sedimentation problems on the West Branch. Erosion has directly affected an estimated 2000 acres from five to ten miles downstream. The West Shade River Sand Abatement Project will reclaim 87 acres in section 24 of Scipio Township, Meigs County in an attempt to rectify this problem.

Tributaries without abandoned mines include Spruce Run, Big Run, East Branch (Spicer Creek, Barney Fork, Lickskillet Run, Big Run, Joes Creek, Meigs Creek, Koppel Hollow, Guthrie Creek, Polk Hollow, Dog Hollow, Sugar Run, Horse Cave Creek, Aumiller Creek), Elk Run, Wolfpen Run, Long Run (Spring Branch) and Peach Fork. The Shade River including the Middle and East Branches is classified EWH by Ohio EPA.

Stream Name RMI Segment mi/total mi Use Designation Pollution Source	Const (Unit)	PWS WWH No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Shade River -/38.2 EWH S	pH	6/35	January March May-December	14	1965-78	7.55 (mode)	8.3	4.0	0 +	Reclamation Project on West Branch
	Alkalinity	-/19	March May-October	9	1968 1970-77	64.7	105	0	=	
	Sulfate	2/31	January March May-December	10	1968-77	116.4	750	20	0 +	
	Conductivity	-/142	January March May December	13	1965-77	405.8	830	180	+	
	TDS (180°C)	0/8	August-October	8	1965-72	379.5	664	234	0 *	
	Total Iron	2/6	July	2	1968 1973	1.02	3.8	0.00	0-1 *	
	Total Manganese	6/6	N	1	1968	3.4	9.2	0.4	2 *	

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	PWS WWH No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Shade River (Continued)	Total Zinc		2/5	March June August September	3	1975-77	0.048	0.08	0.02	0 *	
	Total Aluminum		-/6	"	1	1968	3.6	9.2	0.4	*	

USGS (1965-77)
FWPCA (1968)
Ohio EPA (1978)
Skelly and Loy (1973)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Shade River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
East Branch	0	4	7.28	4	167.8			0	4	40.8				2	357.5	1	4	1.26	2	2	0.17						1979
21.9	0		*		*			0		*					*	1		*	1		*						1973
EWH																											
WM																											
Horse Cave Creek	1	2	6.85	2	74	1	0	0	2	34.5				1	260	1	2	0.75	0	1	0.04						1973
3.0	0-1		*		*		*	0		*					*	0-1		*	X		*						1979
WWH																											
NM																											
Middle Branch	0	1	7.0	1	144	1	0	0	1	130						0	1	0.2									1973
28.5	X		*		*	X	*	X		*						X		*									
EWH																											
U,S																											
Pratts	0	4	7.3	4	125.3	2	0	0	4	75.0				2	480	0	3	0.26	2	2	0.16						1973
Fork	0		*		*	X	*	0		*					*	0		*	1		*						1979
8.4																											
WWH																											
S																											
Long Run	0	3	7.3	3	115	2	0	0	3	166.7				660	2	0	3	0.16	2	2	0.09						1973
5.3	0		*		*		*	0		*					*	0		*	1		*						1979
WWH																											
U,S																											

(Continued on next page)

Skelly and Loy (1973)
USGS (1979)

Shade River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
West Branch	5	5	5.32	5	31.8	4	8.75	0	5	216				2	650	3	5	1.68				1	2	0.084	2	1.55	1973
20.8	2		*		*	0-1	*	0		*					*	1		*				0-1		*		*	1975
WWH																											
S																											
Kingsbury	2	4	6.75	4	49	2	0	0	4	99.8				2	345	0	4	0.59	2	2	0.48						1973
Creek	0		*		*		*	0		*					*	0		*	1		*						1979
12.0																											
WWH																											
S																											
Peach Fork	0	1	6.5																								1973
4.0	X		*																								
WWH																											
NH																											

USGS (1979)
Ohio EPA (1975)
Skelly and Loy (1973)

Concentration in mg/l
Conductivity in umhos/cm
pH in S.U.

Symmes Creek - from the confluence with Sugar Run to the confluence with the Ohio River and tributaries: Sharps Creek, Aaron Creek, Long Creek (Buckeye Creek), Buck Creek, John's Creek, Pigeon Creek (North Branch Piegeon Creek), Coffee Tea Creek, Sand Fork (Peters Cave Creek, Turkey Creek), Black Fork, Dick's Creek, Huntingcamp Creek, Cackley Swamp, Hewitt Run, Cub Run.

Symmes Creek is 70 miles long and drains an area of 355.7 sq. mi. in Gallia and Lawrence counties. Abandoned coal mines in the Nos. 4a, 5 and 6 coals are located in the areas draining the Symmes Creek tributaries from the Cackley Swamp area near the Symmes Creek source to Sharps Creek, just above Aid. The most concentrated areas of abandoned coal mines are located in the drainages of Black Fork, Pigeon Creek and Cackley Swamp. All three coals mined in the Symmes Creek drainage have high pollution potentials for surface and underground mining.

The mainstem of Symmes Creek was sampled up to 20 times over the period 1968-1978. Data sources include the FWPCA (1968), Skelly and Loy (1973) and USGS (1978). Most observations were taken in the months of January, June, July and October, representing both low and high flow periods. Little or no information was collected on manganese, zinc, aluminum or TDS.

Only one sample of 16 exceeded the WWH standard for pH on the Symmes Creek mainstem. Minor pH problems occurred on several tributaries including streams with no abandoned mines. Pigeon Creek and Cackley Swamp, which both contain abandoned strip and underground mines contained the only severe pH drainage and severe net acidities. The buffering capacity of Symmes Creek is limited with a mean alkalinity of 29.6 mg/l $CaCO_3$. No net acidities were observed in the mainstem of Symmes Creek.

Total iron exceeded WWH standards within the range of 1 to 2 mg/l on the mainstem of Symmes Creek at Aid and below Cackley Swamp. The mainstem dilutes the moderate iron concentrations entering Symmes Creek from Cackley Swamp and Pigeon Creek.

Most of the Symmes Creek tributaries for which data was reported do not contain more than one to four abandoned strip mines and water quality can be described as having no detectable to minor effects. Pigeon Creek and Cackley Swamp are probably the main sources of acid mine drainage to Symmes Creek, however, only one sample taken in 1973 was available for each of these streams. Black Fork has surprisingly good water quality considering the number of surface mines abandoned in the drainage. Slugging may occur during precipitation events. Possible evidence supporting this are the fish kills attributed to mining reported on June 28, 1976 and September 8, 1972 by the Ohio DNR, Division of Wildlife.

Tributaries to Symmes Creek which contain no mines are Big Creek, Rankin Creek, McKinney Creek, Leatherwood Creek, Venisonham Creek, and DeLoss Creek, all located below the confluence of Sharp Creek at Aid. Elkins Creek, S. branch of Pigeon Creek, Buffalo Creek, Camp Creek and Dirtyface Creek contain no abandoned mines and enter Symmes Creek where it is most affected, between the confluence with Cackley Swamp and Sharps Creek. These streams appear to have a positive effect on upstream Symmes Creek water quality. Total iron often exceeded WWH standards in these streams with concentrations up to 1.5 mg/l, but this may be the natural background condition. The absence of abandoned mines in these areas is supported by the consistency of low sulfate concentrations (less than 70 m/l) and pH values greater than 6.5.

Stream Name / RMI / Segment mi/Total mi / Use Designation / Pollution Source	Const (Unit)	PWS WWH No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Symmes Creek 70/70	pH	5/28	January June July September October	4	1968 1973 1975	7.33	7.8	5.7	1 =	violation at Sharps Cr. Cackley Sub.
WWH/SNRW	Alkalinity	-/123	January- June July October	4	1968 1973 1975 1978	41.4	70	14	=	
US Up (U,S,R)	Acidity	-/20	January July	3	1968 1973 1978	5.15	28	0	0 =	
	Total Iron	10/18	June July October	3	1968 1973 1975	1.67	8.7	0.4	1 *	
	Total Manganese	10/10	June July October	3	1968 1973 1975	1.28	2.8	0.29	1-2 =	
	Total Zinc	0/2	June October	1	1975	0.01	0.01	0.10	0 *	
	Total Aluminum	/10	June October	2	1968 1975	4.58	10.5	0.4	*	
	Sulfates	0/23	January June July October	4	1968 1973 1975 1978	90.2	210	38	0 =	

Stream Name GAI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Symmes Creek (Continued)	Conductivity	-/7	January June July October	2	1975 1978	242	295	150	*	

FWPCA (1968)
Skelly and Loy (1973)
USGS (1975, 1978)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Stream Name RM Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	PWS WWH No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Symmes Creek 70/70	pH	5/28	January June July September October	4	1968 1973 1975	7.33	7.8	5.7	1 =	violation at Sharps Cr. Cackley Sub.
WWH/SNRW	Alkalinity	-/123	January- June July October	4	1968 1973 1975 1978	41.4	70	14	=	
US Up (U,S,R)	Acidity	-/20	January July	3	1968 1973 1978	5.15	28	0	0 =	
	Total Iron	10/18	June July October	3	1968 1973 1975	1.67	8.7	0.4	1 *	
	Total Manganese	10/10	June July October	3	1968 1973 1975	1.28	2.8	0.29	1-2 =	
	Total Zinc	0/2	June October	1	1975	0.01	0.01	0.10	0 *	
	Total Aluminum	/10	June October	2	1968 1975	4.58	10.5	0.4	*	
	Sulfates	0/23	January June July October	4	1968 1973 1975 1978	90.2	210	38	0 =	

tream Name H egment mi/Total mi se Designation ollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
ymmes Creek (Continued)	Conductivity		-/7	January June July October	2	1975 1978	242	295	150	*	

WPCA (1968)
Kelly and Loy (1973)
SGS (1975, 1978)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Symmes Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Big Creek	1	1	6.2	1	113	1	0	0	1	50						0	1	0.2								1973
3.2	X		*		*	X	*	X		*						X		*								
WWH																										
NM																										
McKinney Creek	0	1	6.5	1	95	1	0	0	1	44						0	1	0.3								1973
4.5	X		*	X	*	X	*	X		*						X		*								
WWH																										
NM																										
Rankin Creek	0	1	6.5	1	94	1	0	0	1	42						0	1	0.2								1973
4.3	X		*		*	X	*	X		*						X		*								
WWH																										
NM																										
Leatherwood Cr.	0	4	7.1	4	101	2	0	0	4	68.5				2	382.5	0	4	0.14	1	2	0.055					1968
3.7	0		1		*	0	*	0		*					*	0		*	0-1		*					1973
WWH																										
NM																										
Venisonham Cr.	1	1	6.2	1	82	1	0	0	1	50						0	1	0.5								1973
3.2	X		*		*	X	*	X		*						X		*								
WWH																										
NM																										

Skelly and Loy (1973)
FWPCA, (1968)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Symmes Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
DeLoss Cr.	0	1	6.5	1	96	1	0	0	1	58						0	1	0.2									1973
N	X		*		*	X	*	X		*						X		*									
WWH																											
NM																											
Shakas Cr.	1	5	7.16	5	67.4	3	2.3	0	5	76.9				4	329	1	3	1.61	0	2	0.02						1968
4.0	0		*		*	X	*	0		*					*	1		*	0		*						1973
WWH																											1978
NM																											
Elkins Cr.	0	3	7.07	3	61	2	3.5	0	3	63				2	290	0	1	0.5									1968
3.6	0		*		*	0	*	0		*					*	X		*									1973
WWH																											1978
NM																											
Aaron Cr.	0	5	7.29	5	88.6	2	4.5	0	5	126				4	476	0	3	0.52	2	2	0.02						1968
6.5	0		*		*	0	*	0		*					*	0		*	1		*						1973
WWH																											1978
S																											
Long Cr.	0	4	7.11	4	79.3	1	0	0	4	72				3	333	1	3	0.57	2	2	0.24						1968
6.1	0		*		*	X	*	0		*					*	0		*	1		*						1973
WWH																											1978
Up (S)																											
Buckeye Cr.	0	2	7.2	2	61			0	2	48				2	233	0	2	0.43	2	2	0.35						1968
3.0	0		*		*			0		*					*	X		*	1		*						
WWH																											
S																											

Skelly and Loy (1973)
FWPCA, (1968)
USGS (1978)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Symmes Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn PWS			Total Zinc			Total Al		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Buck Cr.	0	1	7.0	1	96	1	0	0	1	58						0	1	0.3									1973
3.4	X		*		*	X	*	X		*						X		*									
WWH																											
S																											
John Cr.	1	3	6.87	3	57	2	3	0	3	62				2	280	0	1	1.0	0	1	0.02						1973
9.6	0		*		*	0	*	0		*					*	X		*	0		*						1978
WWH																											
Up (S)																											
Pigeon Cr.	1	1	3.2	1	0	1	71	1	1	710						1	1	9.5									1973
2.7	X		*		*	X	*	X		*						X		*									
U S Up																											
South Br.	1	1	6.2	1	74	1	0	0	1	46						0	1	0.4									1973
Pigeon Creek	X		*		*	X	*	X		*						X		*									
N																											
WWH																											
NM																											
North Br.	1	1	4.2	1	0	1	62	1	1	380						1	1	2.7									1973
Pigeon Cr.	X		*		*	X	*	X		*						X		*									
N																											
WWH																											
S																											
Buffalo Cr.	0	3	6.73	3	47	2	4	0	3	39.8				2	185	0	1	1.0									1973
7.5	0		*		*	0	*	0		*					*	X		*									1978
WWH																											
NM																											

Skelly and Loy (1973)
USGS (1978)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Symmes Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Camp Cr.	0	3	6.73	3	47.7	2	3.5	0	3	49.4				2	210	0	1	0.2									1973
4.4	0		*		*	0	*	0		*					*	X		*									1978
WWH																											
NM																											
Sand Fork	1	4	6.95	4	46.8	2	5.5	0	4	73.2				1	300	0	3	1.81									1973
18.1	0		*		*	0	*	0		*					*	1		*									1975
WWH																											1979
S																											
Black Fork	2	5	6.63	3	28.3	2	12.5	0	4	65.1				5	238	1	1	1.1	1	1	0.7	0	1	0.03	1	0.02	1975
17.0	0		*		*	X	*	0		*					*	X		*	X		*	X		*		*	1978
WWH																											
S Up (S,U)																											
Dirtyface	1	5	6.67	5	43.4	5	17.4	0	5	23.6				4	147.5	1	3	0.81	2	2	0.22						1973
Creek	0		=			0	=	0		=					*	0		*	1		*						1978
7.4																											1979
WWH																											
NM																											
Kokeene	1	1	5.7	1	57	1	0	0	1	12						0	1	0.5									1973
Hollow	X		*	X	*	X	*	X		*						X		*									
N																											
WWH																											
NM																											
Cackley Swamp	6	6	4.78	6	19.5	5	98	4	5	784						4	5	11.9									1973
N	2		*		*	2	*	2		*						2		*									
WWH																											
S																											

Skelly and Loy (1973)
USGS (1975, 1978, 1979)

Concentrations in mg/l
Conductivity in umhos/cm
pH in S.U.

Federal Creek - headwaters to mouth and tributaries:

Marietta Run, Sharps Fork (Sulphur Run, North tributary to Sulphur Run, Opossum Run, East tributary across from McElfresh Run, Anderson Hollow tributary), McDougall Branch (Bryson Branch), Linscott Run (Ewing Run), Hyde Fork, Miners Fork (Smith Run).

Federal Creek is 23.8 miles long and drains an area of 145 square miles in Athens, Washington, and Morgan Counties. Abandoned mines are concentrated in the northeastern half of the watershed where the No. 8 coal seam was both surface and underground mined. These mines affect mainly the Lower Federal Creek, Marietta Run, and Sharps Fork drainages. One large abandoned underground mine in the No. 6 coal is located in the western part of the watershed and affects the McDougall Branch drainage. Both the No. 6 and 8 coal seams have a high pollution potential for surface and underground mining.

The mainstem of Federal Creek was sampled up to 30 times over the period of record 1966-1977. Data sources include the FWPCA (1968), Skelly and Loy (1973), USGS (1966-73 and 1975), and Ohio EPA (1973-75, 1977 and 1979).

The Federal Creek mainstem is divided into two segments; upstream of its confluence with Sharps Fork it is classified EWH, and the downstream segment is classified WWH. The downstream portion of the creek has been sampled over a period of years, during most months of the year, and during both low and high flow periods. The upstream segment has been sampled less extensively, once in July of 1973 and in August and December of 1975. The apparent lower quality of water in the upstream segment of Federal Creek may be an artifact of this limited sampling, rather than reflect an actual difference in water quality between the two segments.

Samples of both segments show Federal Creek to have adequate buffering capacity to assimulate present levels of mine drainage, although one sample taken during the 1968 FWPCA study on the lower segment showed a net acidity of 14 mg/l. Two of 31 samples on the lower segment and one of three samples on the upper segment exceeded the WWH standard for pH.

Sulfate concentrations exceeded PWS standards in 7 of 29 samples on the lower segment, but in none of the upper segment samples. Manganese concentrations have a minor effect on both segments of the creek.

Occasional high iron and other metal concentrations, high sulfate concentrations, net acidities and low pH values encountered during the sampling may indicate slugging occurs occasionally on the mainstem of Federal Creek. The FWPCA 1968 study and the September 1969 USGS samples both show high mine drainage constituent concentrations.

The tributaries of Federal Creek have been sampled by Skelly and Loy in 1973, by the Ohio EPA, SEDO in 1977 and 78, and by USGS in 1979.

The available data indicate Marietta Run and Sharps Fork and its tributaries are the major sources of mine drainage to Federal Creek. The Sharps Fork and Marietta Run drainages contain most of the strip mines in the Federal Creek watershed.

While the buffering capacities of both Sharps Fork and Marietta Run are adequate, iron and manganese concentrations show minor effects on water quality.

Sulphur Run, a tributary to Sharps Fork, has exceptionally poor water quality. Iron concentrations show severe effects on water quality, and sulfate and manganese concentrations show moderate effects. This tributary received a large amount of acidic mine drainage when an auger mining operation intercepted an abandoned deep mine full of water.

There is little data available for the tributaries to the upper segment of Federal Creek, however, the available data indicate Miners Fork may be affected by mine drainage.

Tributaries to Federal Creek which have no abandoned mines in their drainages are Sharps Run, Herrold Run, Big Run, and Spring Run on the lower segment and the McDougall Branch tributaries, Wyatt Run and Mush Run, on the upper segment. Data is available for Mush Run which indicates background sulfate concentrations are less than 60 mg/l, alkalinities are more than 150 mg/l, and iron concentrations are less than 0.3 mg/l, but manganese concentrations may normally exceed the PWS standard of 0.05 mg/l, as indicated by the two sample values of 0.06 and 0.08 mg/l.

BIOLOGICAL PARAMETERS

Station	Benthic Invertebrates Pollution Tolerant %	Facultative %	Pollution Sensitive %	Number of taxa	Total No. organisms	No./ Sq. Ft.
Federal Creek - below Sharpsburg, S.R. 16[1]	0	0	100	1	1	1
Federal Creek - near confluence with Hocking River[2]	7	28	65	7	40	40

Source: FWPCA, 1969
(Collected 1966-1977)
Method of Collection:
1. Peterson Dredge Sample
2. Surber Sample

The benthic macroinvertebrate community of Federal Creek was sampled once at two stations in 1966 and 1967. Although only one taxon and one organism was found at the station near Sharpsburg, it was considered a pollution sensitive form. At the station near the mouth of Federal Creek, pollution sensitive organisms also dominated the biota, but the abundance of organisms was still relatively low.

In 1977, the Ohio EPA, SEDO field crew recorded minnows, crayfish, damselflies and dragonflies in the Sharps Fork of Federal Creek near the mouth at S.R. 329. Marietta Run at Marietta Road was observed to contain small bass, minnows, suckers and darters. Opossum Run at Athens C.R. 49 contained abundant minnows. No fish or macrobenthos were observed in Sulphur Run.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Federal Creek-Confluence with Sharp's Fork to mouth	pH (S.U.)	2/31	Jan-Dec	10	1966-77	7.7 (mode)	8.1	5.0	0 =	
9.3/23.8	Alkalinity (mg/l)	-/16	April-Oct, Dec	7	1968-75	130	172	66	+	
WWH	Acidity (mg/l)	-/14	April-Oct, Dec	7	1968-57	8	100	0	0 =	
U.S.Up	Sulfate (mg/l)	7/29	Jan-Dec	8	1967-75	202	510	93	0 =	
	Total Dissolved Solids (mg/l)	0/5	March-July	2	1974-75	410	576	334	0 *	
	Conductivity (umhos/cm)	-/24	Jan-Dec	10	1966-77	638	1260	275	=	
	Iron (mg/l)	1/21	Jan-Dec	4	1968-75	0.6	1.8	0.1	0 =	
	Manganese (mg/l)	6/6	May, July Oct	3	1968-75	0.9	3.3	0.15	1 *	
	Zinc (mg/l)	0/3	May, Oct	2	1974-75	0.02	0.03	0	0 *	
	Aluminum (mg/l)	1/9	Feb, April-Aug, Oct	3	1968-75	1.4	6.7	0.2	+	

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Federal Creek - headwaters to Confluence with Sharp's Fork	pH (S.U.)	1/3	July, Aug, Dec	2	1973-75	6.6	6.9	6.2	0 *	
(6) /23.8	Alkalinity (mg/l)	-/3	July, Aug, Dec	2	1973-75	118	158	90	*	
	Acid (mg/l)	-/3	July, Aug, Dec	2	1973-75	0	0	0	0 *	
	Sulfate (mg/l)	0/3	July, Aug, Dec	2	1973-75	128	198	75	0 *	
	Conductivity (umhos/cm)	0/2	Aug, Dec	1	1975	472	520	425	*	
EWH	Iron (mg/l)	1/3	July, Aug, Dec	2	1973-75	2.3	6.3	0.3	X *	
S, Up	Manganese (mg/l)	2/2	Aug, Dec	1	1975	0.18	0.25	0.12	1 *	
	Zinc (mg/l)	0/2	Aug, Dec	1	1975	0.025	0.03	0.02	0 *	
	Aluminum (mg/l)	-/2	Aug, Dec	1	1975	2.04	3.9	0.18	*	

(OEPA, 1973-75)
FWPCA, 1968)
(OEPA, SEDO data, 1977)
USGS, 1966-73, 1975)
(Skelly & Loy, 1973)

Federal Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity				Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Marietta Run	1	5	6.9	3	132	1	0	1	5	143	0	2	304	2	505	3	5	1.2	4	4	1.0				2	0.2	1973,[1]
5.8	0	*			*	X	*	0	*		X	*			*	1	*		1	*						*	1977,[2]
WWH																											1979[3]
S, U																											
Sharps Fork	1	14	7.0	8	126	6	0	2	8	230	0	5	452	9	529	6	9	2.5	7	7	0.60	0	6	0.02	7	1.8	1973,[1]
14.5	0	*			*	0	*	0	*		0	*			*	1	*		1	*		0	*			*	1977-78,[2]
WWH																											1975[3]
S,U,R																											
Sulphur Run	2	11	6.5	10	99	10	0.7	10	11	671	1	10	1064	9	1127	11	11	10.9	11	11	2.5	0	10	0.02	11	0.6	1977-78,[2]
(2)	0	=			+	0	+	2	=		0	=			=	3	+		2	+		0	+			+	1979[4]
WWH																											
S,U																											
North tributary	0	11	7.1	1	102	1	0	0	1	34	0	1	1150	1	2244	0	1	0.7	1	1	0.07	0	1	0.03	1	0.5	1977[2]
to Sulphur Run	X	*			*	X	*	X	*		X	*			*	X	*		X	*		X	*			*	
(0.5)																											
WWH																											
U																											
Opossum Run	1	10	7.0	7	144	6	6.8	4	9	249	0	4	870	7	660	3	9	2.3	7	7	1.2	0	4	0.04	5	1.4	1973,[1]
5.7	0	=			*	0	*	1	*		X	*			*	1	*		1	*		0	*			*	1977,[2]
WWH																											1979[4]
S,U,R																											
East tributary	0	1	7.3					0	1	54	0	1	309			0	1	0.13	0	1	0				1	0.2	1977[2]
to Sharp's Fork	X	*						X	*		X	*				X	*		X	*						*	
across from																											
McElfresh Run																											
(0.5)																											
WWH																											
S																											

Concentrations in mg/l Conductivity in umhos/cm pH in S.U.

1 (Skelly & Loy, 1973)
2 (Ohio EPA, SEDO data, 1977-78)
3 (USGS, 1975-979)
4 (Ohio [illegible] C, 1979)

Federal Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Anderson Hollow	1	1	6.0					1	1	1270	1	1	1816			0	1	0.1	1	1	13.5				1	1.0	1977,[1]
Tributary to	X		*					X		*	X		*			X		*	X		*				X		
Sharps Fork																											
(1.0)																											
WWH																											
S																											
McDougall Branch	2	2	6.2																								1973[2]
7.9	X		*																								
EWH																											
IU																											
Mush Run	1	3	7.2	3	184	1	0	0	3	42				2	455	0	3	0.19	2	2	0.07						1973[2]
5.3	X		*		*	X	*	X		*					*	X		*	X		*						1979[3]
EWH																											
No mines																											
Bryson Branch																											
5.4																											
EWH																											
IS, U																											
Linscott Run	0	1	7.0	1	189	1	0	0	1	124						0	1	0.1									1973[2]
5.5	X		*		*	X	*	X		*						X		*									
EWH																											
S																											
Ewing Run																											
2.4																											
EWH																											
IS																											

Concentrations in mg/l Conductivity in umhos/cm pH in S.U.

1 (OEPA, SEDO, 1977)

2 (Skelly and Loy, 1973)

3 (USGS, 1979)

Federal Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Hyde Fork	0	1	6.5	1	142	1	0	0	1	64						0	1	0.2									1973[1]
9.1	X		*		*	X	*	X		*						X		*									
EWH																											
IS																											
Miners Fork	1	3	7.0	3	77	1	0	1	3	303				2	560	0	3	0.3	1	2	0.17						1973[1]
6.2	X		*		*	X	*	X		*					*	X		*	X		*						1979[2]
EWH																											
S, IU																											
Smith Run																											
(2.5)																											
EWH																											
S																											

Concentrations in mg/l Conductivity in umhos/cm pH in S.U.

1 (Skelly & Loy, 1973)

2 (USGS, 1979)

Hocking River - confluence with Rush Creek to mouth, and its minor tributaries:

Rocky Run, Canaanville Run, Margaret Creek (Factory Creek, Little Factory Creek, Biddle Creek), Sugar creek (Mill Creek), Salt Creek, Coal Run, Hamley Run, Substation Run, Minkers Run (Bennett Hollow Tributary), Dorr Run, Laurel Run (West Laurel Run), Walnut Run, Fivemile Creek, Threemile Creek, Oldtown Creek, Scott Creek (Metz Hollow Tributary).

The Hocking River Basin extends over 1,197 square miles of Southeastern Ohio and is tributary to the Ohio River. Its headwaters lie in the glacial deposits of Fairfield County, about thirty-five miles southeast of Columbus. The mainstem of the river flows in a southeasterly direction approximately ninety-five (95) miles to its mouth at Hocking Port. The principal tributaries include Clear, Rush, Monday, Sunday and Federal Creeks. All of these except Clear Creek enter the mainstem from the north. The basin covers substantial portions of Fairfield, Perry, Hocking, Athens and Morgan counties; and minor sections of Meigs and Washington Counties.

Extensive coal mining is conducted in the Hocking River Basin and the associated drainage constitutes the predominant stream water quality problem within the basin. Clear Creek is the only one of the five principal tributaries which is not affected by mining. Rush, Monday, Sunday, and Federal Creeks, the other four principal tributaries, are discussed separately in this report.

The Hocking River mainstem is divided into three segments; the upper segment from the headwaters to the confluence with Rush Creek, the middle segment from the confluence with Rush Creek to the confluence with Federal Creek, and the lower segment from the confluence with Federal Creek to the mouth.

The upper basin of the Hocking River is primarily agricultural and has no abandoned mines. The city of Lancaster is located along this segment and encompasses 92 sq. miles; 11% of which is urban use, 36% residential use, and 10% industrial use. The city of Lancaster has a secondary sewer system, the effluent of which enters the Hocking River. Anchor-Hocking is also a major pollution point source in Lancaster.

The middle basin supports mineral extraction and marginal agricultural uses. The population is predominantly rural, however there are three urban centers located along the middle segment: Logan (pop. 7,000), Nelsonville (pop. 4397), and Athens (pop. 18,643). The major pollution point sources for this segment are MPP Corporation, the Carborundum Co., and Goodyear Tire and Rubber Co. Wastewater Treatment Plant discharges are from the Logan, Nelsonville, Chauncey, the Plains, and Athens WWTPs. The major water quality problems in this segment however, are due to extensive abandoned surface and underground mining, both along its banks and from upstream sources on its tributaries. In York Township alone, 6.5 percent of the land is used for mining. The Nos. 5, 6, 7, and 8 coal seams have a high pollution potential for surface mining and the Nos. 6 and 7 for both surface and underground mining in the basin.

The lower basin has no major urban centers and supports marginal agricultural uses. No abandoned mines are located in the basin. There are no major point sources and only one wastewater treatment plant, the Coolville plant.

The Hocking River has been much more extensively sampled than any of its tributaries. It has been sampled up to 292 times over the period of record 1964-1979. Data sources include Ohio EPA and USGS (1964-79), FWPCA (1968), and Skelly and Loy (1973).

The Hocking River and its affected minor tributaries are classified WWH, except for Margaret Creek and Scott Creek and its tributary Duck Creek, which are classified Exceptional Warmwater Habitat.

Despite the heavy loadings of mine drainage constitutents which enter the Hocking River, the only mine drainage problems revealed by the data are due to iron and manganese concentrations. Although alkalinities decrease downstream, even the minimum reached is adequate to assimilate present levels of mine drainage and there are few samples with acid concentrations above zero. The mean pH for all three segments of the river is 7.4 S.U.

Minor iron problems are shown in the lower and middle segments, and manganese concentrations are a minor problem in the upper and lower segments and a moderate problem in the middle segment. Most of the iron and manganeses problems are due to mining, although the minor manganese problem in the upper basin must have a different source, since there are no abandoned mines present.

The city of Nelsonville obtains 80% of its water supply from the Hocking River. Data for the raw water entering the treatment plant shows Public Water Supply Standards were exceeded for sulfate, iron, and manganese concentrations.

The minor tributaries to the Hocking River have been sampled by Skelly and Loy (1973), USGS (1979), U.S. Forest Service (1977-78), and Ohio EPA (1964-73). The limited available data indicate Substation Run, Minkers Run, Dorr Run, Laurel Run, West Laurel Run, and Walnut Run are affected by mine drainage. These tirbutaries are all located in the middle Hocking River Basin near Nelsonville, between Logan and Athens. All of these tributaries have little to no buffering capacities and mean acid concentrations ranging from 26 to 293 mg/l. Sulfate concentrations pose minor to severe problems. Data on metals concentrations were available only for Dorr Run, which showed minor iron and zinc problems and moderate manganese problems.

No data was available for the following tributaries: Rocky Run, Canaanville Run, Little Factory Creek, Mill Creek, Salt Creek, and Metz Hollow. Data is available for the West Branch of Margaret Creek, Duck Creek, and Pleasant Run, none of which have abandoned mines in their drainages. The data show mean alkalinities on these unaffected tributaries ranging from 34 to 190 mg/l, with zero acid concentrations and mean sulfate concentrations between 37 and 52 mg/l.

BIOLOGICAL PARAMETERS

No.	Station	Benthic Invertebrates Pollution Tolerant %	Facultative %	Pollution Sensitive %	Number of taxa	Total No. organisms	No./ Sq. Ft.
1	Hocking River - above Lancaster[1]	0	79	21	9	58	58
2	Hocking River below Lancaster[1]	93	7	0	3	3264	3264
6	Hocking River below Logan[1]	0	0	100	2	29	29
14	Hocking River - above Athens[2]	0	100	0	1	22	22
15	Hocking River at Athens[1]	0	93	7	6	126	63
18	Hocking River near Coolville[1]	3	29	68	9	130	130

Source: FWPCA, 1969 (Collected 1966-67)
Method of Collection:
1. Surber Sample
2. Peterson Dredge Sample

Six stations were sampled on the mainstem of the Hocking River in 1966 and 1967. The aquatic biota at most of these stations was indicative of waters of moderate pollution. At stations 6, 14, and 15, both the number of organisms and varieties were low. Station 1 had a small number of organisms but a greater variety while at station 18 both number of organisms and variety were high. Downstream from Lancaster, Ohio, (station 2) the number of organisms was high and the variety was low. The percentage composition at this station was 0% sensitive, 7% tolerant and 93% very tolerant. These conditions are indicateive of domestic sewage pollution. The variety of organisms found reached a minimum of one at station 14, upstream from Athens, Ohio. There was considerable evidence of mine drainage at this station. Station 6, downstream from Logan, Ohio, had only two types of organisms present. This station is located downstream from several industrial plants. Stations 1 and 15 were predominated by tolerant organisms while station 18, nearest the mouth was predominated by sensitive forms.

Fish kills in the Hocking River in the late 1950's and in 1961, 1964, and 1965 have been attributed to slugs of highly acidic water entering the Hocking from Sunday, Monday, and Rush Creeks (Siebert, 1966). Since the water quality of these two tributaries has not improved, these acid slugs are probably still affecting the biology of the Hocking River, even though they are not reflected in the chemical data.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Hocking River - headwaters to confluence with Rush Creek	pH	2/287	Jan - Dec	16	1964-79	7.5	8.3	6.3	0 =	
/94.9 WWH No Mines	Alkalinity	-/244	Jan-Dec	14	1964-77	235	337	77	=	
	Acidity	-/6	Feb, May July, Aug	3	1973-77	2.7	8.0	0	0 *	
	Sulfate	0/278	Jan-Dec	14	1964-77	68	132	15	0 =	
	Conductivity	0/283	Jan-Dec	14	1964-77	912	1810	265	0	
	Iron	7/16	Feb-Aug, Dec	5	1973-79	0.9	5.8	0.45	0 =	
	Manganese	6/6	Feb, May June, Aug	2	1976-77	0.22	0.6	0.1	1 *	
	Zinc	0/11	Feb, Mar May, Sept Dec	6	1974-79	0.07	0.23	0.03	0 *	
	Aluminum	-/1	Sept	1	1973	0	0	0	*	

OEPA, 1964-79)
Skelly and Loy, 1973)

Stream Name Segment mi/Total mi Use Designation Pollution Source	Constituent (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Hocking River - confluence with Rush Creek to confluence with Federal Creek /94.9 WWH S, U, Upst	pH	2/292		Jan - Dec	15	1964-79	7.4	8.2	5.7	0 =	
	Alkalinity	-/238		Jan-Dec	15	1964-79	124	244	30	=	
	Acidity	-/13		Feb-Oct	4	1968-77	3.6	28	0	0 *	
	Sulfate	3/288		Jan-Dec	15	1964-79	107	340	15	0 =	
	Conductivity	0/285		Jan-Dec	15	1964-79	612	1125	232	0 =	
	Iron	11/17		Jan-Nov	8	1968-79	2.6	20	0.3	1 *	
	Manganese	12/12		Feb-Nov	5	1968-79	2.4	13.8	0.5	2 *	
	Zinc	0/9		Feb, Mar May, Aug, Oct, Nov	5	1974-79	0.04	0.12	0	0 *	
	Aluminum	-/15		Apr-Oct	4	1968-78	0.04	0.12	0	0 *	

(FWPCA, 1968) OEPA, 1964-79) Skelly and Loy, 1973)

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Hocking River - confluence with Federal Creek to mouth /94.9 WWH S, U, Upst	pH	1/34	Jan - Dec	4	1968-75	7.4	8.7	6.4	0 =	
	Alkalinity	-/5	May-Oct	3	1968-75	81	170	60	*	
	Acidity	-/5	May-Oct	2	1968-73	6.2	25	0	0 *	
	Sulfate	2/21	Jan-Dec	4	1968-75	164	340	80	0 =	
	Total Dissolved Solids	0/6	Mar-Aug	4	1973-75	450	652	334	0 =	
	Conductivity	-/15	Jan-Dec	3	1973-75	529	750	235	=	
	Iron	3/14	Feb-Mar, May-Oct, Dec	4	1968-75	1.1	6.2	0.3	0-1 =	
	Manganese	4/4	May-Oct	3	1968-75	1.6	4.4	0.2	1 *	
	Zinc	0/3	July, Oct	2	1974-75	0.02	0.03	0	0 =	
	Aluminum	-/11	Feb, Mar May-Oct	3	1968-75	1.1	6.8	0	*	

(FWPCA, 1968) OEPA, 1964-79) Skelly and Loy, 1973)

Hocking River Minor Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity			Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean		# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Rocky Run																												
1.2																												
WWH																												
S																												
Canaanville Run																												
2.0																												
WWH																												
U																												
Margaret Creek	1	2	6.4	2	103	2	0		0	2	87						1	2	2.8									1973[1]
12.9	X	*		-	*	X	*		X	*							X	*										
EWH, WWH																												
S, Upst																												
Factory Creek	0	2	7.3	2	76.5				0	2	63				2	300	0	2	0.36	2	2	0.12						1979[2]
6.3	X	*		-	*				X	*					-	*	X	*		X	*							
WWH																												
U																												
Little Factory Creek																												
3.8																												
WWH																												
U																												
West Branch	0	3	7.0	3	73	1	0		0	3	37				2	228	1	3	0.8	2	2	0.24						1973[1]
5.5	X	*		-	*	X	*		X	*					-	*	X	*		X	*							1979[2]
WWH																												
No Mines																												

1 (Skelly & Loy, 1973) 2 (USGS, 1979)

Hocking River Minor Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity		Sulfates			TDS		Conductivity	Total Iron Manganese			Total		Total Zinc		Total Aluminum	Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Biddle Creek	0	1	6.5	1	79	1	0	0	1	172				0	1	0.5								1973[1]
(3.5)	X	*		-	*	X	*	X	*					X	*									
WWH																								
S																								
Sugar Creek	0	1	6.7	1	171	1	0	0	1	210				1	1	1.2								1973[1]
5.0	X	*		-	*	X	*	X	*					X	*									
EWH, WWH																								
S, Upst																								
Mill Creek																								
2.0																								
WWH																								
U																								
Salt Creek																								
(1)																								
WWH																								
U																								
Coal Run	1	1	5.9	1	109	1	0	1	1	377				0	1	0.46								1973[1]
(1.2)	X	*		-	*	X	*	X	*					X	*									
WWH																								
U																								
Hamley Run	1	1	5.9	1	29	1	0	1	1	1536				1	1	4.3								1973[1]
5.8	X	*		-	*	X	*	X	*					X	*									
WWH																								
S,U																								

[1] (Skelly & Loy, 1973)

Hocking River Minor Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity			Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Substation Run	1	1	4.7			1		94						1	480													1978[1]
(3.5)	X	*				X	*							-	*													
WWH																												
S,U																												
Minkers Run	4	4	5.7	1	4	4		26	4	4	383				4	575												1977-78[1]
3.6	1	*		-	*	X	*		1	*					-	*												
WWH																												
S, U																												
Bennett Hollow	1	2	6.6	1	41	2		21.5	0	2	177				2	338												1977-78[1,2]
(1.5)	X	*		-	*	X	*		X	*					-	*												
WWH																												
S,U																												
Dorr Run	5	5	2.9	1	21	5		278	5	5	1125	0	1	1230	5	1940	1	2	4.1	2	2	4.1	1	1	0.52	2	10	1977-78[1,2]
2.8	3	*		-	*	3	*		3	*		X	*		-	*	X	*		X	*		X	*		-	*	
WWH																												
S,U																												
Laurel Run	1	1	6.0	1	18	1		16	1	1	312				1	540												1978[1]
(1)	X	*		-	*	X	*		X	*					-	*												
WWH																												
S																												
W. Laurel Run	2	2	4.4						2	2	451				2	900												1977-78[1]
(0.8)	X	*							X	*					-	*												
WWH																												
S																												

[1] (U.S. Forest Service, 1977-78) [2] (OEPA, SEDO data, 1977)

Hocking River Minor Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Walnut Run	4	4	3.0			4	293	4	4	880				4	1700												1977-78[1]
(2)		3	*			3	*		2	*				-	*												
WWH																											
S,U																											
Fivemile Creek	1	1	5.7	1	30	1	0	0	1	210						0	1	0.3									1973[2]
7.0		X	*	-	*	X	*		X	*							X	*									
WWH																											
S, U																											
Threemile Creek	0	1	6.5	1	84	1	0	0	1	56						0	1	0.8									1973[2]
5.6		X	*	-	*	X	*		X	*							X	*									
WWH																											
S																											
Old Town Creek	0	212	7.2	203	60	1	0	0	213	59				210	2594	1	3	0.78	2	2	0.7						1973[2]
7.0		0	=	-	=	X	*		0	=				-	=		X	*		X	*						1964-73[3]
WWH																											1979[4]
S																											
Scott Creek	1	2	6.6	2	38	1	0	0	2	61				1	270	0	2	0.68	1	1	0.27						1973[2]
9.0		X	*	-	*	X	*		X	*				-	*		X	*		X	*						1979[4]
EWH																											
S																											
Duck Creek	1	3	6.4	3	34	1	0	0	3	42				2	152	0	3	0.51	0	2	0.02						1973[2]
4.7		X	*	-	*	X	*		X	*				-	*		X	*		X	*						1979[4]
EWH																											
No Mines																											

[1] (U.S. Forest Service, 1977-78) [2] (Skelly and Loy, 1973) [3] (OEPA, 1964-73) [4] (USGS, 1979)

Hocking River Minor Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Metz Hollow																											
(2)																											
WWH																											
S																											
Pleasant Run	0	3	7.5	3	190	1	0	0	3	54				2	498	1	3	0.87	2	2	0.18						1973[1]
10.7	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[2]
WWH																											
S, U																											

[1] (Skelly and Loy, 1973) [2] (USGS, 1979)

Monday Creek - headwaters to mouth and tributaries:

Snow Fork (Long Hollow Creek, Goose Run, Orbiston Tributary, Brush Fork, Spencer Hollow Creek, Sycamore Hollow Creek, Salem Hollow Fork), Dixson Run, South Carbon Hill tributary, Sand Run, Kitchen Run, Little Monday Creek (Gore Run, North tributary East of Gore, Temperance Hollow Creek), Lost Run, tributary Southwest of Oreville, Oreville Run, Salt Run, Rock Run, Shawnee Creek, Dixie Hollow.

Monday Creek is 27.0 miles long and drains an area of 116 square miles in Athens, Hocking and Perry counties. Abandoned underground mines underlie the southern and eastern portions of the watershed, while extensive abandoned surface mines are located in all but the east central portion of the basin. Coal seams present in the watershed are the Nos. 5, 6, and 7. The No. 5 coal has a high pollution potential in this area for surface mining, and the Nos. 6 and 7 for both surface and underground mining.

The mainstem of Monday Creek has been sampled up to 63 times during the period of record 1966 to 1978. Data source include the USGS (1966-75), FWPCA (1968), Skelly and Loy (1973), Ohio EPA (1973-78), USFS (1977-78), and Ohio EPA, SEDO (1977-78).

Monday Creek and all its tributaries are classified WWH, although the water quality in most of the watershed often exceeds WWH standards. The Monday Creek mainstem has little to no buffering capacity; only 2 of 30 samples showed any alkalinity, while acidity averaged 148 mg/l. pH samples were taken during all months of the year and showed all pH values exceeded WWH standards, with the mode falling at 3.3 S.U. Sulfate concentrations are a minor to moderate problem, with a mean of 535 mg/l. Manganese and iron concentrations pose severe and moderate problems, respectively. Aluminum concentrations averaged 18.3 mg/l, which is exceptionally high.

The tributaries of Monday Creek were sampled during June to September by Skelly and Loy, (1973), U.S. Forest Service (1977-78), USGS (1976-77, 1979), and Ohio EPA, Office of Land Pollution Control (1979).

The data indicate Snow Fork, a major tributary to Monday Creek, and its tributaries Long Hollow Creek, Orbiston Tributary, Brush Fork, Spencer Hollow Creek, Sycamore Hollow Creek, and Salem Hollow Creek, are major contributors of mine drainage to Monday Creek. Snow Fork has no buffering capacity and severe acid and pH problems. Of the listed tributaries, only Salem Hollow Creek has a limited buffering capacity and a mean pH above 4.0 S.U. Sulfate concentrations are a moderate problem in Snow Fork and sulfate problems in the tributaries range from minor to severe. Metals data, available only for Snow Fork and Sycamore Hollow Creek, show moderate to severe iron and manganese problems. Aluminum concentrations in Snow Fork averaged 20.3 mg/l, which is exceptionally high.

The data from Little Monday Creek, the other major tributary to Monday Creek, show only minor effects from mine drainage, even though its headwaters have been extensively strip mined. It has a limited buffering capacity with a mean pH of 5.7 S.U. Manganese concentrations pose a severe problem, however, and aluminum concentrations, while not as high as those of Monday Creek and Snow Fork, are high (mean 7.4 mg/l). Little data is available on the Little Monday Creek tributaries.

The limited data available on the minor Monday Creek tributaries indicate South Carbon Hill tributary, Sand Run, Lost Run, Oreville Run, Rock Run, Shawnee Creek, and Dixie Hollow all have no buffering capacity and acid and pH problems, while Dixson Run, Kitchen Run, tributary Southwest of Oreville, and Salt Run have limited buffering capacities and pH values near 6.0 S.U. The major difference between these two groups of tributaries appears to be the extent of mining in their basins; the more extensive the mining, the more severe the water quality problems. There are no completely unaffected tributaries in the Monday Creek watershed.

BIOLOGICAL PARAMETERS

Station	Benthic Invertebrates Pollution Tolerant %	Facultative %	Pollution Sensitive %	Number of taxa	Total No. organisms	No./ Sq. Ft.
Monday Creek - at source above Orville, Ohio[1]	97	3	0	2	35	35
at Rt. 278 Bridge[2]	100	0	0	2	230	230
at confluence with Hocking River[2]	100	0	0	1	15	15

Source: FWPCA, 1969 (Collected 1966)
Method of Collection:
1. Peterson Dredge Sample
2. Surber Sample

The benthic macroinvertebrate community of Monday Creek was sampled once in 1966. The benthic community at all three stations was dominated by a few pollution tolerant forms. At the time of sampling, Monday Creek contained a very sparse and pollution tolerant benthic community. More data is needed to better define existing conditions.

Causes of fish kills in the Hocking River in the late 1950's were attributed to slugs of low pH water entering the Hocking from both Monday and Sunday Creeks after heavy rains in their basins (Seibert, 1966)

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Samp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Monday Creek- 27.0/27.0 WWH S,U,Up	pH	63/63	Jan-Dec	13	1966-78	3.3 (mode)	5.4	2.6	3 =	Similar for entire year
	Alkalinity	-/30	May-Oct, Dec	11	1968-78	3	71	0	=	Only 2 samples over 0
	Acidity	-/47	Mar-Jan	8	1968-78	148	579	10	3 =	
	Sulfates	55/59	Jan-Dec	13	1966-78	535	1070	98	1 =	
	TDS	0/1		1		646	646	646		
	Conductivity	-/44	Jan-Dec	13	1966-78	1220	2170	490	=	
	Iron	50/50	Jan-Dec	5	1968-78	7.6	48	1.2	2 =	
	Manganese	35/35	Mar-Dec	6	1966-78	5.4	13	2.8	3 =	
	Zinc	3/17	May-Dec	4	1974-78	0.29	1.1	0.10	*	
	Aluminum	-/29	Feb-Dec	6	1968-78	18.3	39	2.6	*	Very high

(USGS, 1966-75)
(FWPCA, 1968)
(Skelly and Loy, 1973)
(Ohio EPA, 1973-78)
(USFS, 1977-78)
(Ohio EPA, SEDO Data, 1977-78)

Monday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH	Alkalinity Acidity	Sulfates	TDS	Conductivity	Total Iron Manganese	Total	Total Zinc	Total Aluminum	Period of Record
	# Exc WWH / # Smp / Mean	# Smp / Mean	# Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	# Exc WWH / # Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	
Snow Fork	11 11 2.9	5 0	11 220	11 11 663		10 1407	9 9 15	6 6 4.6	2 4 0.36	4 20.3	1975,
10.7	3 =	*	3 =	2 =		=	3 =	3 *	X *	X *	1978,[1,2,3]
WWH											
R,S,U, Upstr											
Long Hollow Creek	2 2 2.7		2 533	2 2 1164		2 1950					1977-78[3]
(2)	(3) *		(3) *	(3) *		*					
WWH											
S,U											
Goose Run											
(1.3)											
WWH											
S,U											
Orbitson											
Tributary	1 1 3.1		1 654	1 3 1135		1 2000					1978[3]
(1)	X *		X *	X *		*					
(WWH)											
S,U											
Brush Fork	3 3 2.8		3 338	3 3 1296		2 1285	1 1 16.8				1973[2]
(4.2)	(3) *		X *	(3) *		*	X *				1977-78[3]
WWH											
S,U											
Spencer Hollow	3 3 3.4		3 99	3 3 453		2 1075	1 1 2.3				1973[2]
(4.2)	(3) *		X *	X *		*	X *				1977-78[3]
WWH											
S,U											

[1] (USGS, 1975, 1979) [2] (Skelly & Loy, 1973) [3] (USFS, 1977-78)

Monday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH	Alkalinity	Acidity	Sulfates	TDS	Conductivity	Total Iron	Manganese	Total	Total Zinc	Total Aluminum	Period of Record
	# Exc / # Smp / Mean	# Smp / Mean	# Smp / Mean	# Exc / # Smp / Mean	# Exc / # Smp / Mean	# Smp / Mean	# Exc / # Smp / Mean		# Exc / # Smp / Mean	# Exc / # Smp / Mean	# Smp / Mean	
Sycamore Hollow Creek	3 3 4.0		3 64	3 3 486		2 925	1 1 6.3					1973[1], 1977-78[2]
2.7	3 *		X *	(1) *		*	X *					
WWH												
S,U												
Salem Hollow Fork	6 9 5.9	7 42	8 31	6 9 349	0 4 423	8 622	6 7 6.8		4 4 2.1	0 4 0.025	4 3.4	1973[1]
5.1	1 =	*	0-1 *	1 +	X *	=	2 *		2 *	0 *	*	1976-79
WWH												2,3,4
S,U												
Dixson Run	0 1 6.5		1 60	1 1 1000		1 1300						1978[2]
(0.8)	X *		X *	X *		*						
WWH												
S,U												
South Carbon Hill Tributary	1 1 3.0		1 395	1 1 316		1 1300						1978[2]
(1)	X *		X *	X *		*						
(WWH)												
S,U												
Sand Run	2 2 4.9		2 20	2 2 374		2 813						1977-78[2]
3.1	(2) *		X *	X *		*						
WWH												
S,U												
Kitchen Run	1 3 6.1	2 74	1 12	0 2 52		2 465						1973[1]
3.2	(1) *	*	X *	X *		*						1977-78[2]
WWH												
S												

[1] (Skelly & Loy, 1973) [2] (USFS, 1977-78) [3] (USGS, 1976) [4] (OEPA, OLPC data, 1979)

Monday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity				Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Little Monday	10	13	5.7	10	37	12	28	9	13	348				8	1541	2	7	2.6	3	3	7.8	0	2	0.27	2	7.4	1973[1],
Creek	1	*			*	1	*	1	*						*	1	*		(3)		*	X		*		*	1977-79[2,3]
14.3																											
WWH																											
S,U																											
Gore Run	0	4	6.6	4	60	3	11	0	4	93				4	482												1977-78[2]
(5.1)	0	*			*	X	*	0	*						*												
WWH																											
S																											
North Tributary	1	1	5.4	1	28	1	0	0	1	100						0	1	0.6									1973[1]
E. of Gore	X	*			*	X	*	X	*							X		*									
WWH																											
S																											
Temperance Hollow																											
Creek	1	1	5.9	1	39	1	0	0	1	100						0	1	0.2									1973[1]
(3)	X	*			*	X	*	X	*							X		*									
(WWH)																											
S																											
Lost Run	3	3	3.0			3	254	3	3	949				2	1190	1	1	16.2									1973[1]
1.2	(3)	*				(3)	*	(3)	*						*	(3)	*										1977-78[2]
WWH																											
S,U																											
Tributary SW of																											
Oreville	1	1	5.4	1	26	1	0	0	1	158						1	1	1.5									1973[1]
(3)	X	*			*	X	*	X	*							X		*									
WWH																											
S																											

1 (Skelly & Loy, 1973) 2 (USGS, 1977, 1979) 3 (USGS, 1977, 1979)

Monday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Oreville Run (2.5) WWH S,U	2 (2)	2 *	4.6			2 X	33 *	2 (1)	2 *	559				2 *	1035												1977-78[2]
Salt Run 2.8 WWH S,U	1 (0)	3 *	6.5	3 *	47	2 X	17 *	1 (0)	3 *	220				2 *	1225	0 (0)	1 *	0.3									1973[1] 1977-78[2]
Rock Run (2) WWH S,U	4 3	4 *	4.4			4 X	36 *	2 X	4 *	392				4 *	1378												1977-78[2]
Shawnee Creek 1.6 WWH S,U	2 X	2 *	4.7	1 *	36	2 X	51 *	2 X	2 *	495				2 *	870												1977-78[2]
Dixie Hollow (3) WWH S,U	2 (3)	2 *	3.2			2 X	139 *	2 (2)	2 *	634				2 *	1250												1977-78[2]

[1] (Skelly & Loy, 1973) [2] (USFS, 1977-78)

Rush Creek from source to confluence with the Hocking River and tributaries;

Center Branch, Clouse Lake, unnamed South tributary opposite Center Branch, Dry Run, Turkey Run, unnamed tributary 2 miles east of Junction City, unnamed tributary one mile west of New Lexington Reservoir outflow tributary at New Lexington (Old Reservoir, New Reservoir (West branch of New Reservoir above reservoir)), unnamed south tributary at New Lexington, unnamed south tributary at east side of New Lexington, unnamed north tributary 1.2 miles east of New Lexington.

Rush Creek is 37.2 miles long and drains 235.6 square miles of which 35 square miles are affected by extensive surface and small, scattered underground mines in the Nos. 5 and 6 coals. Both have high pollution potentials for surface and underground mining in the area.

Water quality information has been collected in Rush Creek for up to 14 years from 1964 to 1978. pH, alkalinity, sulfate, conductivity and total iron were sampled in all months while other mine drainage constituents were sampled primarily from April through November. Collection agencies are USGS, Ohio EPA, USEPA, USDA-SCS, and Skelly and Loy.

Rush Creek may be divided into two segments from the confluence with Little Rush Creek to the mouth (lower) and to the source (upper). Rush Creek is continuously affected by mine drainage contaminants in the upper segment but only periodically affected in the lower segment. Comparative modal pH values from upper and lower segments are drastically different at 3.2 and 7.4 S.U., respectively. However, minimum values for both segments are similar suggesting slugs of water low in pH are occasionally transported as far as Sugar Grove (near the mouth) without much dilution. Lower Rush Creek contains adequate to excellent buffering capacity at most times but there is evidence that buffering capacity is depleted during slugging. Upper portions of Rush Creek never exhibited any buffering capacity in 39 samples over four years during high or low flow months. Net acidities were uncommon but were reported in concentrations up to 427 mg/l in lower Rush Creek. Upper Rush Creek displayed continuous net acidities as high as 1135 mg/l.

Dilution of severely high sulfate concentrations occurred downstream and concentrations were a minor problem at Sugar Grove. Other mine drainage constituents behaving similarly were total manganese and total iron, although the latter two were reduced to only moderate problem levels downstream. Dissolved solids concentrations exceeded the WWH standard at minor to severe levels in the upper reaches. Total zinc was not problematic, but total aluminum was present in concentrations up to 55 mg/l and 11.1 mg/l in the upper and lower reaches, respectively. The most highly concentrated mine drainage constituents were found in samples taken at New Lexington. Undoubtedly, the tributaries entering Rush Creek from Little Rush Creek to the mouth had a positive effect on water quality in the mainstem.

Most of the abandoned mines can be found bordering the tributaries of Rush Creek near New Lexington. This portion of the Rush Creek watershed is adjacent to the Moxahala Creek and Sunday Creek watersheds and has similar, severe mine drainage problems from the same two coal seams, the Nos. 5 and 6.

Abandoned surface mines occur in the Center Branch drainage near Clouse Lake and in an unnamed tributary but do not seriously affect water quality. Total iron is the only parameter which exceeds WWH standards. Buffering capacity is adequate. Farther upstream Dry Run and Turkey Run exhibit severe pH conditions and moderate to severe acidities from abandoned strip mines. Sulfates and total iron were severe problems in Dry Run but minor problems in Turkey Run.

Tributaries located just west of New Lexington had moderate to minor pH, acidity, sulfate and total iron problems, while tributaries entering Rush Creek east of New Lexington had severe levels of mine drainage constituents and no buffering capacity. Reported values of sulfates, total iron and acidity were exceptionally high, while pH was exceptionally low. These severely affected tributaries are influenced by more numerous underground mines than tributaries to the west. The most serious sources of mine drainage occur in the small area of the Rush Creek watershed east of New Lexington.

The city of New Lexington obtains its drinking water from two reservoirs located northeast of the city. The New Reservoir watershed encompasses 225 acres upon which both unreclaimed and partially reclaimed lands are located. The Old Reservoir, from which 80 to 100% of New Lexington's water supply is taken, was built between 1900 and 1910. The New Reservoir which serves as an auxilliary supply was built in 1974.

The New Reservoir has the poorest water quality of all other sources of public water supply in the State which obtain water from surface waters affected by mine drainage. For typical mine drainage constituents, the New Reservoir has the lowest minimum (4.9 S.U.) and average (5.6 S.U.) pH value and the highest maximum (7.5 mg/l) and average (7.3 mg/l) manganese concentrations. Sulfates, total dissolved solids and total iron are other minor problematic constituents.

The quality of water from the Old Reservoir is fairly good, although buffering capacity is limited to adequate and there is a minor manganese problem. Only a limited amount of water from the New Reservoir can be used to augment the New Lexington water supply due to its poor quality. This presents a serious problem to the village of New Lexington since the supply from the Old Reservoir is inadequate to meet current community needs during drought conditions. The New Reservoir watershed is currently being considered for a reclamation project to be funded by the Board on Unreclaimed Strip Mined Lands.

BIOLOGICAL PARAMETERS

Station	Benthic Invertebrates Pollution Tolerant %	Facultative %	Pollution Sensitive %	Number of taxa	Total No. organisms	No./ Sq. Ft.
Rush Creek - just above Bremen	16	34	50	3	4	4
above confluence with Hocking River	75	0	25	-	-	-

Source: FWPCA, 1969 (Collected 1966-1977)
Method of Collection: Surber Sample

Biological water quality data was collected once in 1966 on Rush Creek just above Bremen and above its confluence with the Hocking River. The macrobenthic community of Rush Creek at Bremen appeared to be less affected, being dominated by more pollution sensitive organisms than the sample taken above the Hocking confluence. However, other sources of pollution emanating from municipal WWTP's at Bremen and New Lexington could affect the benthos at the selected stations on Rush Creek indistinguishably from periodic slugs of mine pollutants emanating from the headwaters of Rush Creek. The small number of taxa observed indicates a limited benthic community at both stations. More biological monitoring is needed to update this information.

Data on mine drainage constituents in the Rush Creek watershed indicate that the severe effects near New Lexington were ameliorated by downstream tributaries with no abandoned mines, including Durbin Run, Turkey Run, Raccoon Run, and Little Rush Creek. Water quality in these streams was well within WWH standards with the exception of values for total iron concentrations. Total iron concentrations up to 2.5 mg/l may be indicative of natural background conditions since no point sources are located in these areas and land use is primarily agricultural.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Rush Creek 37.2/37.2 WWH U,S,Up	pH	7/57	Jan - Dec	14	1964 1966-78	7.4	7.8	2.8	0 =	Segment below Little Rush Creek
		39/39	April, July	4	1970 1973-75	3.2	4.2	2.3	3 *	Segment above Little Rush Creek
	Alkalinity	-/38	Jan-Dec	10	1968-77	67.5	154	0	=	below Little Rush Creek
		-/39	April July-Nov	4	1970	0	0	0	*	above Little Rush Creek
	Acidity	-/17	Jan-June	11	1968-78	35.2	427	0	0-1 =	below Little Rush Creek
		-/17	April, July-Nov.	4	1970 1973-75	464.1	1135	74	3 *	above Little Rush Creek
	Sulfate	15/53	Jan-Dec	14	1964 1966-78	397.5	1050	25	1 =	below Little Rush Creek
		37/39	Aril, July-Nov	4	1970 1973-75	1136.8	2500	210	3 *	above Little Rush Creek
	Conductivity	0/70	Jan-Dec	14	1964 1966-78	527.9	2360	190	=	below Little Rush Creek
		0/9	July, Sept, Oct	2	1970 1975	1878.9	3000	1060	*	above Little Rush Creek

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Rush Creek (Continued)	TDS	1/12	Aug, Sept, Oct.	8	1964 1966-69 1971-72 1975	781.7	1570	451	0 =	below L. Rush Creek
		17/13	April, July-Nov.	2	1974-75	1948.4	4355	456	1 *	above Little Rush Creek
	Total Iron	26/46	Jan-Dec	7	1968 1970 1973-77	4.47	62.5	0.20	2 =	below Little Rush Creek
		40/40	April July-Nov	4	1970 1973-75	71.35	210.0	1.2	3 =	above Little Rush Creek
	Total Manganese	6/6	N	1	1968	2.1	13.8	1.6	1-2 *	below Little Rush Creek
		27/27	April, July-Oct	2	1974-75	12.10	67.5	0.73	3 *	above Little Rush Creek
	Total Zinc	3/12	April, May July-Dec	5	1974-78	0.166	0.75	0.00	0 *	below Little Rush Creek
		6/7	April July-Sept	2	1974-75	0.816	1.20	0.20	1 *	above Little Rush Creek
	Total Aluminum	-/13	Mar-May, July-Oct	4	1968, 1970 1974-75	3.60	11.1	0.0	=	below Little Rush Creek
		-/16	April July-Nov	3	1970 1974-75	21.54	55.0	0.8	=	above Little Rush Creek

USGS (1964-78) USEPA (1970) SCS (1974) Ohio EPA (1973-78) Skelly and Loy (1973)

Rush Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Durbin Run	0	1	8.0	1	120	1	0	0	1	26	0	1	172	1	260	1	1	2.5									1974
3.2	X		*		*	X	*	X		*	X		*		*	X		*									
WWH																											
NM																											
Turkey Run	1	2	7.1	2	61.5	2	0	0	2	38	0	1	514	1	660	1	2	1.55									1973
4.5	0		*		*	0	*	0		*	X		*		*	1		*									1974
WWH																											
NM																											
Raccoon Run	0	6	7.23	6	187.3	6	0	0	6	36.2	0	4	284	4	413.8	2	6	0.92									1973
8.0	0		*		*	0	*	0		*	0		*		*	0		*									1974
WWH																											
NM																											
Little Rush Creek	0	8	7.13	8	165.3	8	0	0	6	42.6	0	5	273.6	5	443.6	3	8	1.26									
18.0	0		*		*	0	*	0		*	0		*		*	0-1		*									
WWH																											
NM																											
Center Branch	3	9	6.86	9	55.3	9	0	0	9	59.6	0	4	434.3	8	475.5	3	9	1.82	2	2	0.23						1973
8.5	0		*		*	0	*	0		*	0		*		*	0-1		*		1	*						1974
																											1979
S																											
Clouse Lake	0	1	7.3	1	50	1	0	0	1	95	0	1	48.4		800	0	1	0.08									1974
EWH/PWS	X		*		*			X		*			*		*	X		*									
U,S																											

USDA SCS (1974) Skelly and Loy (1973) USGS (1979)

Rush Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Unnamed trib. opposite Center Branch	1	1	5.7	1	59	1	0	0	1	76						1	1	1.3									1973
WWH	X		*		*	X	*	X		*						X		*									
S																											
Dry Run	3	3	3.2	3	0	3	555	3	3	1496.7						3	3	19.8									1973
WWH	3		*		*	3	*	3		*						3		*									
U,S																											
Turkey Run	4	4	4.0	4	5.25	3	77.8	3	4	587	0	1	1393	1	1550	3	4	2.65									1973
4.5	3		*		*	3	*	1		*	X		*		*	1		*									1974
WWH																											
U,S																											
Unnamed tributary 2 mile east of Junction City (S+L #27)	1	1	5.2	1	10	1	0	0	1	150						1	1	1.4									1973
	X		*		*	X	*	X		*						X		*									
WWH																											
U,S																											
Unnamed tributary 1 mile west of New Lexington (S+L #28)	2	2	5.15	2	4	2	15	2	2	295	0	1	576	1	480	0	2	1.0									1973
	1		*		*	1	*	1		*	X		*		*	0-1		*									1974
WWH																											
U,S																											

Skelly and Loy (1973) SCS (1974)

Rush Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
New Reservoir	3	3	4.5	3	4	3	44	2	2	530	0	2	713	2	1472	1	3	1.03	2	2	9.1	0	2	0.06	2	3.3	1973
in flow	2-3		*		*	1	*	1		*	0-1		*	0-1	*	0-1		*	3		*		0	*		*	1979
EWH/PWS	(PWS)							(PWS)			(PWS)			(PWS)		(PWS)			(PWS)								1975
U,S																											
West branch above confluence with New Reservoir	0	1	6.8	1	30	1	0	0	1	34	0	1	198	1	190	0	1	0.33									1974
WWH	X		*		*	X	*	X		*	X		*		*	X		*									1979
U,S																											
New Reservoir discharge	4	4	5.6	4	65	1	32	4	4	343	0	3	571	2	885	0	4	0.17	4	4	7.4	0	2	0.07	3	1.2	1976
PWS/EWH	1		*		*	X	*	1		*	1		*		*	X		*	3		*	0		*		*	1977
																											1979
U,S																											
Old Reservoir inflow	0	1	7.0	1	25	1	0	0	1	20	0	1	100	1	120	0	1	0.94									1974
PWS/EWH	X		*		*	X	*	X		*	X		*		*	X		*									
S																											
Old Reservoir Discharge	1	5	6.86	6	30.6	5	0	0	5	35.6	5	0	125.8	5	993.4	0	6	0.3	5	5	0.29	0	3	0.01	4	0.1	1974
PWS(EWH)	0		*		*	X	*	0		*	0		*		*	0		*	1		*	0		*		*	1977
S																											

Ohio EPA (1976, 77, 79) SCS (1974) Skelly and Loy (1973)

Rush Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Reservoir's outflow tributary at New Lexington	1	1	4.4	1	0	1	64	1	1	590						0	1	0.5										1973
WWH	1	*		*		1	*	1	*							0-1	*											
Up																												
Unnamed south tributary at New Lexington	1	1	3.0	1	0	1	550	1	1	2200						1	1	12.9										1973
WWH	X	*		*		X	*	X	*							X	*											
U,S																												
Unnamed south tributary at east side of New Lexington	1	1	2.6	1	0	1	1740	1	1	6000						1	1	226										1973
WWH	X	*		*		X	*	X	*							X	*											
U,S																												
Unnamed north tributary 1.2 mi. east of New Lexington	3	3	2.83	3	0	3	828.3	3	3	2550	1	1	3619	1	3050	3	3	100.6										1973 1974
WWH	3	*		*		3	*	3	*		X	*		*		3	*											
U,S																												

Sunday Creek - headwaters to mouth and tributaries:

Big Bailey Run (Carr Bailey Run), Jackson Run, Greens Run (Little Greens Run), Congress Run, West Branch (Mud Fork, Johnson Run, Indian Run, Happy Hollow Run, Congo Run, Hemlock Run, Pine Run), East Branch (Burr Oak Reservoir, Cedar Run, San Toy Creek), Dotson Creek, Eighteen Run.

Sunday Creek is 27.2 miles long and drains an area of 139 sq. mi. in Athens, Perry, and Morgan Counties. Abandoned underground mines underlie most of the lower Sunday Creek watershed south of Glouster but there are very few surface mines. The northwestern portion of the basin, drained by the west branch of Sunday Creek, has been extensively mined by both surface and underground methods. Coal seams present in both of these areas are the Nos. 5, 6, and 7. No. 6 and 7 coals have a high pollution potential for surface and underground mining and the No. 5 for surface mining.

The mainstem of Sunday Creek has been sampled up to 81 times over the period of record 1964 to 1978. Data sources include the FWPCA (1968), Skelly and Loy (1973), USGS (1964-77), Ohio EPA (1973-77 and 1979), U.S. Forest Service (1977-78), and U.S. Army Corps of Engineers (1974-75).

Sunday Creek and all its tributaries are classified WWH, although water quality in most of the watershed, except for the East Branch and its tributaries, often exceeds WWH standards especially during low flow periods. Sunday Creek has a severe acid problem, especially during the low flow months of the year, and little to no buffering capacity the remainder of the year.

Fifty-five of 73 samples taken from Sunday Creek exceed WWH standards for pH. Low pH values occurred consistently during the low flow months of June - September, while pH values in the 6.0 to 7.3 S.U. range occurred during the remainder of the year.

Sulfate concentrations in Sunday Creek pose a minor to moderate problem with exceedance of PWS standards in 53 of 81 samples. Iron and manganese concentrations exceeded standards in all samples and have a severe effect on Sunday Creek.

The tributaries of Sunday Creek were sampled during June to September by Skelly and Loy (1973), U.S. Forest Service (1977-78), USGS (1975-1979), and U.S. Army Corps of Engineers (1974-76).

The available data indicate West Fork and its tributaries, Mud Fork, Congo Run, and Pine Run, and the headwaters of the mainstem are the major sources of mine drainage to Sunday Creek. These tributaries are moderately to severely affected; they have little or no buffering capacity and exceed pH, sulfate, iron, and manganese concentrations in many samples. The other West branch tributaries, Johnson Run, Indian Run, Happy Hollow Run, and Hemlock Run show minor to no effects, have limited to adequate buffering capacities, pH values around 6.5 S.U., and iron concentrations which occasionally exceed WWH standards.

The extensive underground mines along the lower mainstem may also be contributing to its extremely poor water quality, as it is much worse than the tributaries Big Bailey Run, Carr Bailey Run, Greens Run and Little Greens Run. These tributaries have limited buffering capacities and pH values around

6.5 S.U. Sulfate concentrations usually do not exceed PWS standards, however, both Big Bailey Run and Greens Run had one sample each which indicated high iron concentrations may be a severe problem.

The East branch of Sunday Creek and its tributaries and Burr Oak Reservoir have good water quality and few abandoned mines in the drainages. Data from Eels Run, a tributary with no abandoned mines, indicate alkalinities and pH values may be naturally low. Burr Oak Reservoir is a source of Public Water Supply for many communities in the area. Manganese concentrations often exceed PWS standards in the lake, but no other PWS standards for mine drainage constituents are exceeded.

BIOLOGICAL PARAMETERS

Station	Benthic Invertebrates Pollution Tolerant %	Facultative %	Pollution Sensitive %	Number of taxa	Total No. organisms	No./ Sq. Ft.
West Branch of Sunday Creek - at Rt. 13 Bridge	100	0	0	1	5	5
Sunday Creek - Above West Branch at Glouster	100	0	0	1	70	70
Sunday Creek - Below West Branch	100	0	0	1	-	-
Sunday Creek - near confluence with Hocking River	100	0	0	1	7	7

Source: FWPCA, 1969, (Collected 1966-67)
Method of Collection: Surber Sampler

The benthic macroinvertebrate fauna of Sunday Creek was sampled once in 1966. At all stations only one taxon of organisms was found. The number of organisms at all stations was very small. Sunday Creek and its West Branch had a very restricted aquatic community in 1966-67 primarily as a result of persistent acid mine drainage.

Causes of fish kills in the late 1950's in the Hocking River were attributed to slugs of low pH water entering the Hocking from Monday and Sunday Creeks after heavy rains in their basins (Seibert, 1966). A survey of Sunday Creek revealed the sources of acidic water to be an active underground mine on Carr Bailey Run, an abandoned underground mine on Sunday Creek at Corning, and refuse piles on Sunday Creek north of Rendville, and on Pine Run at Sulphur Springs and at Carrington. With the exception of Carr Bailey Run, these same areas are still major sources of acidic water today. However, during this study fish were seined from Mud Fork, which according to recent data has the most acidic water of all the Sunday Creek tributaries.

Stream Name Segment mi/Total mi Use Designation Pollution Source	Constituent (Unit)	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Sunday Creek-mouth to confluence with West Branch 13/27.2 MWH U,Up	pH	29/37	Jan-Dec	7	68-78	2.9 for June-Sept. 6.8 for Oct-May	6.9	2.6	3 =	Marked diff in pH between high and low flow
	Alkalinity	-/14	April-Oct, Dec	5	68-78	15.0	56	0	=	
	Acidity	-/32	Jan-Dec	7	68-78	190	1000	0	3 =	Usually worst during June-Oct
	Sulfates	30/45	Jan-Dec	7	68-78	569	1560	22	1 =	
	Conductivity	-/28	Jan-Dec	7	68-78	866	2600	230	=	
	Iron	43/43	Jan-Dec	7	68-78	35.6	168	1.36	3 =	
	Manganese	27/27	Mar-Dec	7	68-78	4.1	13.8	0.32	3 =	
	Zinc	0/17	May-Oct	4	74-78	0.13	0.29	0	0 =	
	Aluminum	-/25	Feb-Oct Dec	7	68-78	2.8	9.3	0.2	=	

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Sunday Creek confluence with West Branch to Headwaters	pH	26/36	March Dec	12	64-78	2.8 for June-Sept. 7.0 for Oct-May	7.3	2.6	3 =	
(14)/27.2 WWH S, U, Upst	Alkalinity	-/17	May-Oct, Mar	12	64-78	14	52	0	=	
	Acidity	-/7	June-Oct	5	67-78	205	646	0	3 =	
	Sulfate	23/36	March-Jan	15	64-78	734	2290	50	2 =	
	Conductivity	-/45	Jan-Dec	15	64-78	1568	4700	301	=	
	Iron	7/7	June-Nov	5	64-73	22.7	72	2.8	3 *	
	Manganese	4/4	June-Nov	3	64-68	11.1	24	2.8	3 *	
	Zinc	1/5	Mar, Jun-Aug	3	75-77	0.21	0.47	0.05	*	
	Aluminum	-/3	Sept	2	64-68	54.5	123.8	3.7	*	

(USGS, 1964-77) (OEPA, 1973-77) US Army Corps of Engineers, 1974-75) (OEPA, SEDO data, 1974, 1977-78) USFS, 1977-78 (Skelly & Loy, 1973), (FWPCA, 1968)

Sunday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity		Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Big Bailey Run	1	2	6.2	2	34	3	30	1	3	218				2	405	1	1	18.9									1973[1]
2.8	X	*		*		X	*	X	*					*		X	*										1977-78[2]
WWH																											
S,U																											
Carr Bailey Run	1	4	6.2	3	32	2	20	1	4	210				4	496	0	2	0.4	2	2	2.1	0	2	0.04	2	1.8	1975[1]
3.4	X	*		*		X	*	X	*					*		X	*		X	*		X	*		*		1977-78[2]
WWH																											
U																											
Jackson Run																											
(2)																											
WWH																											
S,U																											
Greens Run	0	3	6.7	3	68	3	13	0	3	107				2	415	1	1	12.4									1973[1]
3.0	X	*		*		X	*	X	*					*		X	*										1977-78[2]
WWH																											
S,U																											
Little Greens Run	0	2	6.8	1	90	2	18	0	2	70				2	375												1977-78[2]
3.2	X	*		*		X	*	X	*					*													
WWH																											
U																											
Congress Run																											
3.3																											
WWH																											
U																											

[1] (Skelly & Loy, 1973) [2] (USFS, 1977-78)

Sunday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron Manganese # Exc WWH	Total Iron Manganese # Smp	Total Iron Manganese Mean	Total # Exc PWS	Total # Smp	Total Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
West Branch	7	9	4.9	8	39	10	43	9	11	489	0	4	531	7	682	7	9	9.0	6	6	1.6	0	6	0.06	6	2.0	1973[1]
14.0	2	*		*		1	*	1	*		0	*		*		2	*		1	*		1	*		*	1975[2]
WWH																											1977-78[3]
																											1979[2]
S,U,R																											
Mud Fork	5	5	5.4	5	5.6	3	269	5	5	1950				4	2842	3	3	456	2	2	12.5	2	2	0.67	2	18	1973[1]
4.8	1	*		*		X	*	3	*					*		X	*		X	*		X	*		*	1975[2]
WWH																											1977-78[3]
U																											
Johnson Run	0	2	6.8	2	15	2	16	0	2	89				2	460												1977-78[3]
3.5	X	*		*		X	*	X	*					*													
WWH																											
S,U																											
Indian Run	2	4	6.3	3	57	4	7.5	0	4	53				2	330	2	2	1.9									1973[1]
3.5	X	*		*		X	*	0	*					*		X	*										1977-78[3]
WWH																											
U																											
Happy Hollow Run	1	2	6.5	2	14	2	10	2	2	295				2	768	1	2	2.0									1979[2]
(1.2)	X	*		*		X	*	X	*					*		X	*										
WWH																											
U																											
Congo Run	4	4	4.4	4	3	4	105	4	4	689				2	1290	0	2	0.4									1973[1]
(3.5)	3	*		*		X	*	2	*					*		X	*										
WWH																											
S,U																											

1 (Skelly & Loy, 1973) 2 (USGS, 1975, 1979) 3 (USFS, 1977-78)

Sunday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity			Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Hemlock Run	2	3	6.3	3	70	3	8	0	3	153				2	430	0	1	0.8										1973[1]
(2)	X	*		*		X	*	X	*					*		X	*											1977-78[2]
WWH																												
U																												
Pine Run	4	4	3.8	4	0	4	119	4	4	500				4	1249	2	2	30.5	2	2	2.4	0	2	0.3	2	9.3		1975[3]
6.6	3	*		*		2	*	1	*					*		X	*		X	*		X	*		*			1977-78[2]
WWH																												
S,U																												
East Branch	2	19	6.9	14	68	2	32	0	16	40	0	8	16	18	264	5	13	1.1	13	13	0.28	0	3	0.04	2	0.24		1974-79
15.5	0	=		=		0	*	0	=		0	=		=		1	*		1	=		X	*		*			2,3,4
WWH																												
S, Upst																												
Burr Oak Reservoir	0	134	7.3	27	50			0	21	32	0	1	107	134	222	5	24	0.8	18	24	0.80	0	19	0.024	1	1.0		1974-76[4]
PWS,	0	*		*				0	*		X	*		*		0	*		1	*		0	*		*			
EWH																												
S, Upst																												
Eels Run	1	2	6.6	1	43	2	22	0	2	48				2	222													1977-78[2]
(1)	X	*		*		X	*	X	*					*														
WWH																												
No mines																												
Cedar Run	0	2	7.0	2	25	2	14	0	2	47				2	275													1977-78[2]
2.7	X	*		*		X	*	X	*					*														
WWH																												
U																												

1 (Skelly & Loy, 1973) 2 (USFS, 1977-78) 3 (USGS, 1975-76, 1979) 4 (U.S. Army Corps of Engineers, 74-76)

Sunday Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron Manganese			Total			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
San Toy Creek	1	3	6.4	3	46	3	12	0	3	77				2	253	1	1	4.9									1973[1]
(6)	X	*		*		X	*	X	*					*		X	*										1977-78[2]
WWH																											
S,U																											
Dotson Creek	1	5	6.8	4	54	2	17	0	5	45				4	283	1	3	2.6	2	2	0.26						1973[1]
6.6	0	*		*		X	*	0	*					*		X	*		X	*							1977-78[2]
WWH																											1797[3]
V																											
Eighteen Run	0	2	6.8	2	94	1	14	1	1	376				2	450												1977-78[2]
(2)	X	*		*		X	*	X	*					*													
WWH																											
S, U																											

[1] (Skelly & Loy, 1973) [2] (USFS, 1977-78) [3] (USGS, 1979)

Little Salt Creek - below the confluence with Sand Run to the confluence with the Scioto River and tributaries;

Middle Fork Salt Creek (Pigeon Creek, Buttermilk Hollow, Skunk Hollow, Kelly Branch and Allensville tributary), Pigeon Creek (Poplar Run, Big Run, Dry Run), Sour Run, Buckeye Creek (Lake Katherine, Buckeye Swamp, Hammertown Lake), Jisco Lake Creek, Horse Creek, Sugar Run and Sand Run.

Little Salt Creek is 28.6 miles long and drains 246.7 miles^2 in Jackson, Pike and Ross counties. Coals mined in the area are the Nos. 4a and 5 which have high pollution potentials for surface mining, and the former has a high pollution potential for underground mining. Available water quality data has been collected by USGS (1979), FWPCA (1970), the Ohio EPA (1976), the Ohio Biological Survey (1975) and Skelly and Loy (1973). Samples were collected in April, July and October. The 1975 survey did not report sample months. Little Salt Creek and tributaries are classified EWH.

Typical abandoned surface mining operations are very small throughout much of the drainages of Pigeon Creek (of Little Salt Creek), Middle Fork of Salt Creek and Pigeon Creek. Large underground mines were abandoned in the headwaters of Pigeon Creek (Middle Fork) which lies adjacent to Meadow Run of the Little Raccoon Creek drainage. Smaller, scattered, abandoned underground mines are also located in the Buckeye Creek drainage and the drainages of four lakes in its vicinity; Hammertown Lake (PWS for Jackson), Jisco Lake, Buckeye Swamp and Lake Katherine

A limited amount of data is available for Little Salt Creek. Three of six pH samples fell below the EWH standard range. Buffering capacity was adequate in the presence of abandoned mines and no acidity was detected. Little Salt Creek sulfate concentrations were quite low with a mean of 66.8 mg/l emanating from areas of abandoned mines of which some are in very early stages of natural recovery. No problems were observed in TDS. Total iron concentrations were a minor problem and exceeded the WWH standard in all four samples.

Most tributaries to Little Salt Creek contained similar water qualities and degress of problems. The Middle Fork exhibited a modal pH of 6.5 S.U. and 4 of 10 observations fell below the EWH standard range, buffering capacity was adequate with a mean alkalinity of 36.7 mg/l. Net acidities are probably an uncommon phenomenon. Total iron was the only problematic parameter in 60% of the samples. Total manganese was sampled once and was below the 0.01 mg/l detection limit. Pigeon Creek, the largest tributary to the Middle Fork also contains the most extensive network of large, abandoned underground mines. Water quality declined from mouth to source, however, pH was a minor problem overall, and buffering capacity, while lower in the headwaters was adequate. No net acidities were observed. Total concentrations iron were a minor problem and sulfate concentrations were less than 100 mg/l except near the headwaters.

Buttermilk and Skunk Hollows contain only abandoned surface mines in their drainages and exhibited moderate to minor pH problems, limited to adequate buffering capacities, and no to minor total iron problems. Sulfate concentrations were less than 40 mg/l.

Riley Run and an unnamed tributary of the Middle Fork near Allensville contained abandoned strip mines and limited to adequate buffering capacity. The Allensville tributary probably contains total iron in minor excess of the WWH standard.

Little Salt Creek is affected by abandoned surface mines in the northern, downstream portions and abandoned underground mines upstream near the City of Jackson. Only minor pH problems were detected in Pigeon Creek, and the upstream tributaries; Jisco Lake Creek and Fourmile Creek. Minor to moderate pH problems were noted in the downstream and midstream tributaries of Poplar Run, Buckeye Creek and Big Run. No water quality data is available for Lake Katherine or Buckeye Swamp. Buckeye Creek and Jisco Lake and their tributaries are classified EWH. The only problematic parameter in the Little Salt Creek tributaries was total iron for which concentrations usually exceeded the EWH standard to a minor degree. The higher than expected concentrations of total iron found throughout the Little Salt Creek watershed in streams with and without abandoned mine drainage effects could be the result of outcrops of the Waverly and Maxville shale formations along the edge of the glacial boundary.

Hammertown Lake is the drinking water supply reservoir for the City of Jackson. Hammertown Hollow was impounded in 1954 to create the 210 acre reservoir. Water quality information obtained from raw water at the treatment plant indicates pH conditions often fall below the EWH range and buffering capacity is limited due to low alkalinities. Sulfate concentrations ranged from 27 to 31 mg/l, suggesting little or no mine drainage pollution. Total manganese occurs in concentrations in the minor problem range. Total iron was not problematic. Reports by the Jackson Water Department suggest the lake water is of high quality.

Biological data was collected by the FWPCA for two stations in Little Salt Creek and one in Middle Fork in 1968 and 1969. The benthic sample collected in Little Salt Creek below Jackson contained the highest percent pollution tolerant individuals and the highest overall total abundance. The Middle Fork station above Little Salt Creek contained 50% pollution intolerant individuals but had the lowest total abundance and fewest taxa. Little Salt Creek above the Middle Fork was about midway in abundance of pollution intolerant forms and had the highest number of taxa of the three stations.

Station	Biological Parameters					
	% Pollution Intolerant	% Tolerant	% Very Tolerant	No. Organisms	No. Taxa.	No. Sq.Ft.
[1,2]Middle Fork Salt Creek above Little Salt Creek	50	25	25	4	4	4
[1,2]Little Salt Creek below Jackson	0	69	31	411	8	206
[1,2]Little Salt Creek above Middle Fork	18	73	9	81	10	41

[1] FWPCA, 1970
(Collected in 1968 and 69)

[2] Surber sampler

The following paragraph was the analysis presented by the FWPCA from their 1968-69 study.

Little Salt Creek was very degraded downstream from Jackson, Ohio. The stream receives a considerable amount of organic pollution from sewage. Poor substrate conditions may have been responsible for the extremely limited biota collected from the Middle Fork of Salt Creek.

In conclusion, Salt Creek differs from other watersheds with abandoned mines in southern Ohio by virtue of low sulfate concentrations. The surface mines abandoned in the area appeared to be contributing pollutants to a greater degree than the underground mines, a distinctly different pattern than that observed in watersheds to the east. The geology of the Little Salt Creek area may contribute to the high background concentrations of total iron.

Tributaries with no abandoned mines include Long Branch, Glade Run and Stevens Branch of the Middle Fork, Riley Run, Rock Run and Fourmile Creek. Little Salt Creek from headwaters to the confluence with Salt Creek and tributaries are classified EWH in the Ohio Water Quality Standards.

Stream Name RMI Segment mi/Total mi Use Designation Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Little Salt Creek -20/28.6 EWH/SRAW Up(U,S)	pH	3/6		July	2	1973 1976	6.62	7.4	5.7	0-1 *	
	Alkalinity	-/6		July	2	1973 1976	44.8	81	27	*	
	Acidity	-/4		July	1	1973	0.0	0.0	0.0	*	
	Sulfate	0/6		July	2	1973 1976	66.8	110	26	0 *	
	Conductivity	-/2		N	1	1976	335	365	305	*	
	TDS	0/2		N	1	1976	228	237	218	0 *	
	Total Iron	4/4		July	1	1973	2.83	4.5	1.4	1 *	

Skelly and Loy (1973)
Ohio Biological Survey (1975)
Ohio EPA (1976)

Little Salt Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Middle Fork																											
Salt Creek	4	12	6.59	9	35.3	1	14.0	0	8	39.2	0	4	104	6	153.2	7	12	1.82	2	3	0.15						1973
21.2	0		*		*	X	*	0		*	0		*		*	1		*	1		*						1976
EWH																											1979
S, UP(S)																											
Pigeon Creek	2	4	6.33	4	78	4	0	0	4	66.5				3	432	1	2	1.4									1973
14.0	0-1		*		*	0	*	0		*					*	0-1		*									1976
EWH																											
U,S																											
Buttermilk Hollow	1	1	4.8	1	15	1	0	0	1	38						1	1	1.6									1973
N	X		*		*	X	*	X		*						X		*									
EWH																											
S																											
Skunk Hollow	1	1	5.3	1	30	1	0	0	1	36						0	1	0.6									1973
N	X		*		*	X	*	X		*						X		*									
EWH																											
S																											
Riley Run	1	1	5.9	1	24	1	0	0	1	82						0	1	0.3									1973
3.2	X		*		*	X	*	X		*						X		*									
EWH																											
S																											
South bank tributary near Allensville	1	1	4.7	1	5	1	0	0	1	128						1	1	1.2									1973
	X		*		*	X	*	X		*						X		*									
N																											
EWH																											
S																											

Skelly and Loy (1973)

Ohio Biological Survey (1976)

Little Salt Creek Tributaries

eam Name	pH			Alkalin-ity		Acidity		Sulfates			TDS			Conduc-tivity		Total Iron			Total Mn			Total Zinc			Total Al		
es	#							#			#					#			#			#					Period
Designation	Exc	#		#		#		Exc	#		Exc	#		#		Exc	#		Exc	#		Exc	#		#		of
lution Source	WWH	Smp	Mean	Smp	Mean	Smp	Mean	PWS	Smp	Mean	WWH	Smp	Mean	Smp	Mean	WWH	Smp	Mean	WWH	Smp	Mean	WWH	Smp	Mean	Smp	Mean	Record
lar Run	1	1	5.5	1	30	1	0	0	1	32						0	1	0.8									1973
0	X		*		*	X	*	X		*						X		*									
II																											
Up(S)																											
eon Creek	1	5	6.92	1	22	1	0	0	1	20	0	4	112	4	166	3	4	2.86									1973
	0		*		*	X	*	X		*	0		*		*	1		*									1976
II																											
g Run	1	1	5.0	1	21	3	0	0	1	28						1	1	1.3									1973
6	X		*		*	X	*	X		*						X		*									
II																											
keye Creek	1	3	6.47	3	25	1	0	0	1	46				2	57.5	1	3	0.78	2	2	0.14						1973
7	1		*		*	X	*	X		*					*	0		*	1		*						1979
II																											
mertown Lake	2	4	6.35	4	31.5			0	4	38.3						0	4	0.23	4	4	0.55				1	1.5	1974-77
9 Acres	0-1		*		*			0		*						0		*	1		*					*	
II																											
sco Lake Creek	1	1	6.2	1	119	1	0	0	1	86						1	1	1.9									1973
	X		*		*	X	*	X		*						X		*									
II																											
S																											

elly and Loy (1973)
lo EPA (1976)

Little Salt Creek Tributaries

Stream Name	pH			Alkalin-ity		Acidity		Sulfates			TDS			Conduc-tivity		Total Iron			Total Mn			Total Zinc			Total Al		
																			PWS								
Miles	#							#			#					#			#			#					Period
Use Designation	Exc	#		#		#		Exc	#		Exc	#		#		Exc	#		Exc	#		Exc	#		#		of
Pollution Source	WWH	Smp	Mean	Smp	Mean	Smp	Mean	PWS	Smp	Mean	WWH	Smp	Mean	Smp	Mean	WWH	Smp	Mean	WWH	Smp	Mean	WWH	Smp	Mean	Smp	Mean	Record
Fourmile Creek	1	3	6.8	3	37.3	1	0	0	3	34.3						1	2	1.44	1	1	0.31						1973
6.5	0		*		*	X	*	0		*						0-1		*	X		*						1979
EWH																											
U																											
Sugar Run	0	2	7.25	2	59			0	2	64.5				2	282.5	0	2	0.53	2	2	0.27						1979
N	0		*		*			0		*					*	1		*	1		*						
EWH																											
U,S																											

Skelly and Loy (1973)

Ohio EPA SEDO (1976)

Ohio EPA OPWS (1974-77)

Little Scioto River - from the confluence with McDowell Creek to the confluence with Wards Run and tributaries:

Wards Run, Frederick Creek, Laurel Lick Run (Skull Creek), Blue Ash Run (Bear Run), Holland Fork (Jackson Furnace Creek, West Branch Holland Fork), Millstone Run, Sugarcamp Creek, and McDowell Creek.

The Little Scioto River is 41.3 miles long and drains 232.6 miles^2 in Scioto, Jackson and Pike counties. The coals mined in the area are the Nos. 4a and 5 which have high pollution potentials for surface mining. Skelly and Loy are the only available data source for the mainstem, however, Skelly and Loy, and USGS, have collected samples from the tributaries. Sampling was conducted in the months of April, July and October, in only two years, 1973 and 1979. In all cases no more than four observations were made on any stream segment. The following characterization of water quality may easily change with the addition of new information.

Water quality is probably affected to a minor degree by mine drainage in the Little Scioto River and its tributaries. Most of the abandoned mines are small, subsurface and sparsely distributed throughout the eastern portion of the main watershed. pH appeared to be a minor problem in the mainstem, in Munn Run, Rocky Fork, Sugarcamp Creek and Brushy Fork, however, buffering capacities for all reported streams were adequate to excellent. No net acidities were found in any segment.

As in the Little Salt Creek watershed, sulfate concentrations were lower than expected and their magnitude appeared to be independent of the presence of abandoned mines. However, more data is required to establish if this is the pattern.

Conductivity and alkalinity appeared to increase in downstream tributaries but was not associated with any similar trend in mine drainage constituents. Total iron exceeded the WWH standard on both streams with and without abandoned mines. However, mean total iron values did not exceed 1.5 mg/l and were rarely as high as the 5.4 mg/l reported on the mainstem. Total manganese levels usually exceeded the PWS standard but, like total iron, concentrations were not higher on streams with known abandoned mine areas.

Streams in the Little Scioto River watershed without abandoned mines are Swauger Valley Run (Bonser Run), Munn Run, Plum Fork (Oven Lick, Dry Run), Slab Run, Rocky Fork and all tributaries, Scaffold Lick and Laurel Fork, Bucklick, Little Bucklick creeks and Tattle Creek of Holland Furnace Creek, Jacko Run of Sugarcamp Creek, Dry Run of Millstone Run, Glade Run, Buckhorn Creek and Brushy Fork. The Little Scioto from the headwaters to the confluence with the Ohio River (and all tributaries) are classified EWH in the Ohio Water Quality Standards.

Stream Name / RMI / Segment mi/Total mi / Use Designation / Pollution Source	Const (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem	Remarks
Little Scioto River	pH	3/4		July	1	1973	5.83	7.0	5.3	1 *	
/41.3 LWH/SNRW Up(U,S)	Alkalinity	-/4		July	1	1973	25.5	31	23	*	
	Acidity	-/4		July	1	1973	0.0	0.0	0.0	0 *	
	Sulfate	0/4		July	1	1973	64.5	130	42	0 *	
	Total Iron	3/4		July	1	1973	2.93	5.4	0.6	1 *	

Little Scioto River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Mn PWS # Exc WWH	Total Mn # Smp	Total Mn Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Al # Smp	Total Al Mean	Period of Record
Munn Run	1	1	6.2	1	93	1	0	0	1	105						1	1	1.5									1973
3	X		*		*	X	*	X		*						X		*									pt. source
EWH																											at New
NM																											Boston
Wards Run	0	2	7.3	2	51			0	2	61				2	299	0	2	0.4	2	2	0.12						1979
3	0		*		*			0		*					*	0		*	1		X						
EWH																											
U																											
Frederick Creek	1	3	7.03	3	46	1	0	0	3	86				2	340	0	3	0.43	2	2	0.12						1979
N	0		*		*	X	*	0		*					*	0		*	1		X						
EWH																											
U																											
Rocky Fork	2	2	5.85	1	47	1	0	0	1	100						0	1	0.5									1973
13.9	1		*		*	X	*	X		*						X		*									
EWH																											
NM																											
Long Run	1	3	6.83	3	48.3	1	0	0	3	39				2	208	0	3	0.57	1	2	0.06						1979
9.8	0		*		*	X	*	0		*					*	0		*	0-1		X						
EWH																											
NM																											
McConnel Run	0	2	7.0	2	29	1	5	0	2	23.5				2	160	1	2	1.1	2	2	0.165						1979
5.3	0		*		*	X	*	0		*					*	0-1		*	1		X						
EWH																											
NM																											

Skelly and Loy (1973)

USGS (1979)

Little Scioto River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Mn			Total Zinc			Total Al			Period of Record
	#			#		#		#			#			#		#			# PWS			#			#			
	Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	Exc PWS	# Smp	Mean	Exc WWH	# Smp	Mean	# Smp	Mean	Exc WWH	# Smp	Mean	Exc WWH	# Smp	Mean	Exc WWH	# Smp	Mean	# Smp	Mean	
Holland Fork	1	3	6.67	3	26.3	1	0	0	3	47.7				2	187.5	0	3	0.55	2	2	0.21							1973
8.0	0		*		*	X	*	0		*					*	0		*	1		*							1979
EWH																												
Up (U)																												
Bucklick Creek	0	2	6.85	2	27.5	1	10	0	2	35.5				2	165	0	2	0.51	2	2	0.275							1979
5.7	0		*		*	X	*	0		*					*	0		*	1		X							
EWH																												
NM																												
Sugarcamp Creek	1	3	6.27	3	24.3	2	5	0	3	54.3				2	168.5	1	3	1.25	2	2	0.18							1973
8.6	0-1		*		*	0	*	0		*					*	0-1		*	1		*							1979
EWH																												
U																												
McDowell Creek	1	3	6.37	3	20.7	2	2.5	0	3	26.3				2	107.5	1	3	0.61	1	2	0.055							1973
6.5	0-1		*		*	0	*	0		*					*	0		*	0-1		*							1979
EWH																												
S																												
Brushy Fork	1	1	5.7	1	31	1	0	0	1	36						1	1	1.1										1973
6.3	X		*		*	X	*	0		*						X		*										
EWH																												
NM																												

Skelly and Loy (1973)

USGS (1979)

Captina Creek - confluence of North and South Forks to mouth, and tributaries:

NACCO #1 tributary, Rocky Fork, Bend Fork, Crabapple Creek, Piney Creek (Long Run), South Fork (Brushy Creek, Flag Run), North Fork (Long Run).

Captina Creek is 38.6 miles long and drains an area of 180 square miles in Belmont and Monroe Counties.

The headwaters form along the eastern boundary of the sub-basin, draining two reservoirs south of the Village of Barnesville. The Barnesville wastewater treatment plant and water plant discharge into the North Fork of Captina Creek. The major land uses in this area are beef cattle and dairy farming and forestry.

Captina Creek continues along a southeasterly course through timberlands. It receives discharge from the Bethesda wastewater treatment plant and water plant via Bend Fork. Directly east of the confluence with Bend Fork, it receives discharge from the Youghiogheny & Ohio Coal Corporation's Allison Mine. It continues southeast, toward Powhatan Point, receiving discharges from two North American Coal Corporation mines. Captina Creek empties into the Ohio River at Powhatan Point. The Powhatan Point wastewater treatment plant discharges into the Ohio River.

The majority of the abandoned mines in the watershed are underground mines in the Nos. 8 and 9 coal seams. The underground mines are concentrated near the mouth of Captina Creek; only scattered drift mines are located upstream of Armstrongs Mills. There are few surface mines in the watershed; they are also located near the mouth, with the exception of one large surface mine on Long Run, a tributary of the North Fork. There are also several large refuse piles near the mouth of Captina Creek. Both the Nos. 8 and 9 coal seams have a high pollution potential in the watershed. Captina Creek and all its tributaries are classified WWH.

The mainstem of Captina Creek has been sampled up to 18 times over the period of record 1968-79. Data sources include Skelly and Loy (1973), USGS (1964-78), FWPCA (1968), U.S. Army Corps of Engineers (1978), and Ohio EPA (1977, 1979).

The mainstem of Captina Creek can be divided into two segments, one above and one below its confluence with Rocky Fork. The lower segment is affected by several active and abandoned underground mines and refuse piles, while the upper segment has very few abandoned mines.

The upper segment has excellent buffering capacity and zero acidity, with a pH mode of 8.0 S.U. The lower segment has an adequate buffering capacity to assimilate its acid load, and a pH mode of 6.8 S.U. Iron and manganese concentrations are minor problems in the lower segment, but all other mine drainage constituents have no noticeable effects in either segment.

The tributaries of Captina Creek have not been extensively sampled, but limited data is available for most of the streams from Skelly and Loy (1973), USGS (1975, 1979), and the U.S. Army Corps of Engineers (1978).

Data on the Captina Creek tributaries show excellent buffering capacities and zero acidities, except for the unnamed tributary near the mouth, where the

North American Coal Company's No. 1 mine is located. pH values are generally above 6.5 S.U. except in Rocky Fork, which has two abandoned underground mines in its drainage, and in Moore Run and Mikes Run, two tributaries which have no abandoned mines in their drainages.

Sulfate concentrations average below 70 mg/l for unaffected tributaries. In affected tributaries concentrations average between 85 and 170 mg/l, well below the PWS standard, except in Hunter Run, which has no abandoned mines. Iron concentrations exceed WWH standards in NACCO #1 tributary, Cat Run (no abandoned mines) Rocky Fork, Hunter Run (no abandoned mines), Slope Creek (no abanded mines), and Jakes Run (no abandoned mines). Manganese concentrations exceeded PWS standards on Cat Run (no abandoned mines), Hunter Run (no abandoned mines), Long Run of Piney Creek, and Flag Run. The data for the streams sampled for zinc and aluminum concentrations showed no violations of the zinc WWH standard, but the aluminum concentrations in Cat Run were high, averaging 4.5 mg/l.

The data indicate the NACCO No. 1 tributary, Cat Run, Rocky Run, and Hunter Run are affected by mine drainage. Information from the FWPCA (1968) and Corps of Engineers Metro-Wheeling (1979) studies indicate the NACCO No. 1 tributary and Cat Run are affected by active mines. Hunter Run has no abandoned mines in its drainage, and no information is available as to other sources on this stream.

The Metro-Wheeling study concluded the major source of mine drainage constituents to Captina Creek is the abandoned Oglebay-Norton refuse pile located on the Creek just downstream of its confluence with Pea Vine Creek. This refuse pile is contributing 82% of the net acid load, 70% of the total iron load, and 53% of the sulfate load to Captina Creek. An abatement project for this site has been funded by the Board on Unreclaimed Strip Mined Lands.

Data is available for the following streams in the Captina Creek watershed which have no abandoned mines in their basins - Cat Run, Moore Run, Peavine Creek, Anderson Run, Hunter Run, Mikes Run, Slope Creek, Jakes Run, and unnamed west tributary to North Fork. Other than those previously mentioned, these tributaries have excellent buffering capacities, neutral pH values, and low sulfate and metals concentratons.

Captina Creek and its North Fork were sampled once at each of 3 stations between October and December, 1977 (Table 1) to characterize the fish and benthic insect communities. All three sites contained moderately high numbers of benthic insects and relatively high numbers of taxa. Most of the benthic insects encountered were pollution sensitive or tolerant. Only a small percent represented facultative forms. This dichotomy may be an artifact of the classification system since organisms were identified to family and no finer distinctions were made. Fish were abundant at all three stations although very few gamefish were found (see Table 2). A major fish kill attributed to mine drainage was reported in Captina Creek by the Ohio DNR, Division of Wildlife in 1966. None have been reported since that time, which may suggest improving conditions.

Captina Creek, although affected by mining, supported an abundant freshwater insect and fish community at the time of sampling. This is probably the result of neutral to alkaline stream conditions.

Table 1 - Biological Parameters

Station	Benthic Invertebrates					
	% Pollution Tolerant	% Pollution Facultative	% Pollution Sensitive	No. of Taxa	Total No. Organisms	No./ sq. ft.
C1 North Fork of Captina Creek - downstream of confluence with Long Run	31.6	1.7	66.7	14	231	25.6
C2 Captina Creek - downstream of confluence of North and South Forks	46.9	1.8	52.3	9	113	12.5
C3 Captina Creek at Captina	44.4	3.6	50.0	13	144	16.0

Source: U.S. Army Corps of Engineers, 1979
Metro Wheeling Draft Study (Sampled in 1977);sampling method not reported.

Table 2 - Fish Collection Summary Data

Captina Creek

TAXON Scientific Name	Common Name	C1 No. of Individuals	C2 No. of Individuals	C3 No. of Individuals
Micropterus dolomieu	Smallmouth Bass		4	
Lepomis macrochirus	Bluegill	1	1	
Catostamus commersoni	White Sucker	6		
Hypentelium nigricans	Northern Hog Sucker	28	6	7
Moxostoma crythrurum	Golden Redhorse Sucker	3		
Noturus flavus	Stonecats	10	8	1
Notropis atherinoides	Emerald Shiners	1		4
Notropis stramincus	Sand Shiners	4		6
Notropis cornutus	Common Shiners	2	68	66
Pimephales notatus	Bluntnose Minnow	77	48	49
Percina caprodes	Logperch	1		
Etheostoma flabellare	Faintail Darter	17	2	2
Etheostoma caeruleum	Rainbow Darter	49	27	1
Etheostoma blennoides	Greenside Darter	4	12	2
Etheostoma variatum	Variegate Darter	4	9	3
Etheostoma nigrum	Johnny Darter	2	1	
Campostoma anomalum	Stonerollers	52	72	39
Rhinichthys atratulus	Blacknose Dace	3		
Nocomis biguttatus	Hornyhead Chub	6	22	1
Fricymba buccata	Silverjaw Minnow		1	
Semolitus atromaculatus	Creek Chub	44	13	6
Total Number of Individuals:		314	293	187
Total Number of Species:		19	14	13

Source: U.S. Army Corps of Engineers Metro Wheeling Urban Draft Study, 1979

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constitutent	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Captina Creek - confluence with Rocky Fork to mouth	pH	2/17	Feb - Nov	5	1968-79	6.8 (mode)	7.7	5.3	0 +	
(5.0)/24.6	Alkalinity	-/18	Feb - Nov	5	1968-79	92	159	5	+	
WWH										
S,U,R, Up	Acidity	1/15	Feb - Oct	4	1968-79	7	61	0	0 +	
	Sulfates	2/17	Feb - Nov	5	1968-79	93	500	42	0 +	
	TDS	0/11	Feb - May, Sept, Oct	2	1978-79	384	633	212	0 *	
	Conductivity	-/14	Feb - Oct	3	1975-79	510	1155	385	*	
	Iron	10/18	Feb - Oct	5	1968-79	3.4	19.2	0.4	1 =	
	Manganese	8/8	May - Nov	3	1968-79	0.89	2.9	0.06	1 *	
	Zinc	0/7	July - Oct	3	1975-79	0.008	0.03	0	0 *	
	Aluminum	-/8	May - Nov	3	1968-79	2.0	4.4	0.2	*	

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Captina Creek - confluence of North and South Forks to confluence with Rocky Fork	pH	0/31		Jan - Dec	12	1965-77	8.0 (mode)	8.5	7.1	0 =	
(5.0)/24.6	Alkalinity	-/18		Feb - Apr July - Nov	9	1968-77	128	171	73	=	
WWH	Acidity	-/2		July	1	1973	0	0	0	0 *	
U, Up	Sulfates	0/30		Jan - Dec	11	1965-77	62	176	40	0 =	
	Conductivity	-/42		Jan - Dec	13	1965-77	387	528	249	=	
	Iron	0/4		July, Nov	2	1973-75	0.17	0.29	0.08	0 *	
	Manganese	0/3		July, Sept, Nov	2	1965-75	0.03	0.05	0.01	0 *	
	Zinc	0/7		Feb - Mar, July - Aug, Nov	3	1975-77	0.02	0.04	0.01	0 *	
	Aluminum	-/2		July, Nov	1	1975	0.1	0.19	0	*	

(Skelly and Loy, 1973)
(US Army Corps of Engineers, 1978)
(USGS, 1964-78)
(FWPCA, 1968)
(Ohio EPA, 1977)
(Ohio EPA, OLPC, 1979)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Captina Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
NACCO #1 Trib	0	4	7.2	4	86	4	10	0	4	99	0	4	240	4	574	4	1	5.1									1978,[1]
(1)	X	*		-	*	X	*	X	*		X	*		-	*	X	*										
WWH																											
U																											
Cat Run	2	7	7.1	7	112	1	0	2	7	169				6	600	2	7	10.8	4	6	0.31	0	4	0.1	4	4.5	1973,[2]
7.2	0	*		-	*	X	*	0	*					-	*	2	*		1	*		X	*		-	*	1975,[3]
WWH																											1979[4]
No Mines																											
Moore Run	1	1	6.4	1	162	1	0	0	1	176						0	1	0.3									1973[2]
4.0	X	*		-	+	X	*	X	*							X	*										
WWH																											
No Mines																											
Peavine Creek	0	3	7.9	1	156	1	0	0	3	50				2	420	0	3	0.12	0	2	0.01						1973,[2]
6.6	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[4]
WWH																											
No Mines																											
Rocky Fork	1	1	6.2	1	167	1	0									1	1	72									1973,[2]
3.9	X	*		-	*	X	*									X	*										
WWH																											
U																											
Anderson Run	1	1	6.9	1	138	1	0	0	1	52						0	1	0.3									1973[2]
4.6	X	*		-	*	X	*	X	*							X	*										
WWH																											
No Mines																											

1 (U.S. Army Corps of Engineers, Metro-Wheeling Study, 1978)
2 (Skelly & Loy, 1973)
3 (USGS, 1975)
4 (USGS, 1979)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Captina Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Bend Fork	0	4	7.8	4	123	2	0	0	1	44				1	350	0	1	0.26	0	2	0.02						1973,[1]
13.0	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[2]
WWH																											
U																											
Crabapple Creek	0	1	7.0	1	107	1	0	0	1	60						0	1	0.01									1973,[1]
2.2	X	*		-	*	X	*	X	*							X	*										
WWH																											
U																											
Hunter Run	0	2	7.8	2	156			2	2	909				2	3150	2	2	1.9	2	2	0.65	0	2	0.04	2	0.58	1975[3]
(1.9)	X	*		-	*			X	*					-	*	X	*		X	*		X	*		-	*	
WWH																											
No Mines																											
Piney Creek	0	2	8.2	2	128			0	2	129				2	550	0	2	0.24	0	2	0.02						1979,[2]
7.1	X	*		-	*			X	*					-	*	X	*		X	*							
WWH																											
Upst																											
Long Run	0	2	7.95	2	147.5			0	2	135				2	590	0	2	0.32	2	2	0.25						1979,[2]
3.9	X	*		-	*			X	*					-	*	X	*		X	*							
WWH																											
U																											

1 (Skelly & Loy, 1973)
2 (USGS, 1979)
3 (USGS, 1975)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Captina Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Mikes Run	1	1	6.4	1	218	1	0	0	1	56						0	1	0.3									1973,[1]
3.7	X	*		-	*	X	*	X	*							X	*										1979[2]
WWH																											
No Mines																											
South Fork	0	3	8.0	3	103	1	0	0	3	30				2	295	0	3	0.16	0	2	0.015						1973,[1]
14.0	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[2]
WWH																											
U																											
Brushy Creek																											
3.2																											
WWH																											
U																											
Flag Run	0	2	7.55	2	95			0	2	106				2	440	0	2	0.18	2	2	0.36	0	2	0.005	2	0.24	1975,[3]
2.9	X	*		-	*			X	*					-	*	X	*		X	*		X	*		-	*	
WWH																											
U																											
Slope Creek	0	1	6.8	1	122	1	0	0	1	29						1	1	2.6									1973,[1]
4.4	X	*		-	*	X	*	X	*							X	*										
WWH																											
No Mines																											

1 (Skelly & Loy, 1973)
2 (USGS, 1979)
3 (USGS, 1975)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Captina Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum			Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean		
North Fork	0	1	8.2	1	121	1	0	0	1	68						0	1	0.1										1973[1]
10.5	X	*		-	*	X	*	X	*							X	*											
WWH																												
U																												
Jakes Run	0	1	6.8	1	104	1	0	0	1	38						1	1	1.2										1973[1]
5.0	X	*		-	*	X	*	X	*							X	*											
WWH																												
No Mines																												
Long Run	0	5	7.2	1	88	4	0	0	5	85	0	4	328	4	419	2	5	0.74										1973,[1]
6.0	X	*		-	*	0	*	0	*		0	*		-	*	0	*											1978[2]
WWH																												
U,S																												
Unnamed W. Trib	0	2	8.4	2	131			0	2	29				2	368	0	2	0.42	1	2	0.04							1979,[3]
(3.0)	X	*		-	*			X	*					-	*	X	*		X	*								
WWH																												
No Mines																												

1 (Skelly & Loy, 1973)
2 (U.S. Army Corps of Engineers, Metro-Wheeling Study, 1978)
3 (USGS, 1979)

concentrations in mg/l;
conductivity in umhos/cm;
pH in S.U.

Cross Creek - headwaters to mouth and all tributaries:

Dry Fork, McIntyre Creek (Longs Run, Polecat Hollow, Slabcamp Creek, Slab Run, Little McIntyre Creek, McIntyre Tributary, Consol Run), Cedar Lick Run, Cedar Lick Creek, Clay Lick Creek, Salem Creek (Grassy Run, Lea Branch), Pine Run, South Branch Tributary, North Branch.

Cross Creek is 27.4 miles long and drains an area of 128 square miles in Harrison and Jefferson Counties. Its headwaters are located in eastern Harrison County, from where it flows east into Jefferson County, passing through rugged, wooded terrain. In the eastern part of the county, Cross Creek flows through rural contryside and empties into the Ohio River south of Steubenville.

Abandoned surface mines in the Nos. 6 and 7 coal seams are located in the southern portion of the basin. Several areas of abandoned surface mines in the No. 5 coal seam are located in the northern headwaters. The No. 5 coal seam has a probable high pollution potential in this area. The only abandoned underground mines in the watershed are located near the mouth, south of Steubenville. These mines are in the No. 8 coal seam, which underlies all of the watershed and has a high pollution potential for underground mining in this area.

Cross Creek from its confluence with McIntyre Creek to its mouth and McIntyre Creek and its tributaries are classified WWH. The remainder of the watershed is classified CWH.

The mainstem of Cross Creek has been sampled up to 19 times over the period of record, 1964 to 1975. Data sources include USGS (1964-75), Skelly and Loy (1973), and FWPCA (1968).

Cross Creek has an adequate buffering capacity and no net acidity. The pH mode is neutral, with slight fluctuations to both the acidic and alkaline ranges.

Sulfate concentrations are the principal problem in Cross Creek. They pose a moderate problem. Total dissolved solids, iron, zinc, and aluminum concentrations pose no problems, while manganese concentrations are a minor problem.

Limited data is available for the Cross Creek tributaries. Sources include USGS (1978-79), Skelly and Loy (1973), and Ohio EPA, OPWS (1975-77).

McIntyre Creek and its tributaries, and Dry Fork appear to be the major sources of mine drainage constituents to Cross Creek. Dry Fork drains the portion of the watershed near the mouth which contains many underground mines in the No. 8 coal seam. The limited available data indicate it has no buffering capacity and is acidic, with a pH value of 5.0. Sulfate and iron concentrations are severe problems. McIntyre Creek and its tributaries drain the southern portion of the basin where most of the abandoned surface mines in the Nos. 6 and 7 coal seams are located. The available data for this drainage area show excellent buffering capacities and neutral pH values; however, sulfate concentrations are severely high and occasional minor iron and manganese problems occur.

The remaining tributaries for which data is available - Cedar Lick Run, Cedar Lick Creek, Salem Creek, and North Branch - all have excellent buffering capacities and neutral pH values. Sulfate is the ony mine drainage constituent which causes problems in these tributaries, and the problems are minor to moderate.

The Hopedale Public Water Supply Reservoir is located on South Branch Tributary and has three abandoned surface mines in its drainage area. The data indicate, however, that occasional exceedance of PWS standards for manganese is the only mine drainage problem.

The excellent buffering capacities and lack of problems in a large portion of the Cross Creek watershed are probably due to the presence of a neutralizing strata. The Redstone Limestone occurs a short distance above the No. 8 coal and is available to neutralize spoil in surface mines, but it cannot neutralize water draining from underground mines (Skelly and Loy, 1973). The presence of this strata explains why most of the watershed has relatively few problems, while Dry Fork is so severely affected. Ohio DNR, Division of Wildlife, has reported a fish kill attributable to mine drainage in Cross Creek on September 11, 1968. Three thousand, one hundred thirty-five fish were killed.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Cross Creek 27.4	pH	1/19		June - Nov	10	1964-75	7.2 (mode)	8.0	6.4	0 =	
WWH (Downstream of confluence with McIntyre Creek)	Alkalinity	-/16		June - Nov	7	1968-75	95	133	51	+	
CWH (upstream of confluence with McIntyre Creek)	Acidity	-/7		June - Nov	2	1968-75	3.5	22	0	0 *	
S, U, Up	Sulfates	17/19		June - Nov	10	1964-75	747	1700	190	2 =	Values increase downstream
	TDS	3/9		Aug - Sept	9	1964-73	1490	1640	1320	0 -	
	Conductivity	-/12		July - Nov	10	1964-75	1507	1802	625	=	
	Iron	3/9		June - Nov	3	1968-75	0.45	2.4	0.2	0 *	
	Manganese	5/6		June - Nov	3	1964-75	0.77	2.4	0.3	1 *	
	Zinc	0/3		July, Oct - Nov	1	1975	0.02	0.04	0.01	0 *	
	Aluminum	-/5		June - Nov	2	1968-75	1.48	8.1	0	*	

(USGS, 1964-75)
(FWPCA, 1968)
(Skelly and Loy, 1973)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Cross Cr/ Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Dry Fork	1	1	5.0			1	172	1	1	1900						1	1	21.3									1973,[1]
5.2	X	*				X	*	X	*							X	*										
WWH																											
S,U																											
McIntyre Creek	0	4	7.4	4	140	2	0	4	4	1610				2	1950	0	4	0.42	1	2	0.085						1973,[1]
12.7	0	*		-	*	0	*	3	*					-	*	0	*		1	*							1979[2]
WWH																											
S,U Upst																											
Longs Run	0	1	6.9	1	116	1	0	1	1	1175						1	1	2.7									1973[1]
4.2	X	*		-	+	X	*	X	*							X	*										
WWH																											
S																											
Polecat Hollow																											
1.2																											
WWH																											
S																											
Stabcamp Creek																											
3.6																											
WWH																											
S																											
Slab Run																											
3.0																											
WWH																											
S																											

1 (Skelly & Loy, 1973)
2 (USGS, 1979)
3 (USGS, 1975)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Cross Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Little McIntyre Creek 4.0 WWH S,U																											
McIntyre Trib (2.2) WWH S																											
Consol Run (1.7) WWH S	0	1	7.3	1	221			1	1	530				1	1200	0	1	0.4	1	1	1.1				1	0.12	1978,[1]
	X	*		-	*	X	*	X	*					X	*	X	*		X	*					X	*	
Cedar Lick Run 3.6 CWH S,U	0	1	7.0	1	152	1	0	1	1	310						0	1	0.2									1973,[2]
	X	*		-	*	X	*	X	*							X	*										
Cedar Lick Creek 5.3 CWH S	0	2	8.3	2	142			0	2	240				2	798	0	2	0.2	0	2	0.025						1979[1]
	X	*		-	*			X	*					X	*	X	*		X	*							
Clay Lick Creek 6.5 CWH S																											

1 (USGS, 1978, 1979)
2 (Skelly and Loy, (1973)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Cross Cr[illegible] Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	# Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Salem Creek	0	3	7.8	1	113	1	0	1	3	283				2	592	0	3	0.18	0	2	0.035						1973,[1]
8.3	X	*		-	*	X	*	X	*					X	*	X	*		X	*							1979[2]
CWH																											
S,Upst.																											
Grassy Run																											
4.6																											
CWH																											
S																											
Lea Branch																											
4.2																											
CWH																											
S																											
Pine Run																											
(2.2)																											
CWH																											
S																											
South Branch Tributary																											
(2.3)																											
CWH																											
S																											
Hopedale PWS	1	3	7.2	3	80			1	3	222	0	3	424	1	530	0	3	0.07	1	3	0.07	0	1	0	1	0	1975-77[2]
-	X	*		-	*			X	*		X	*		-	*	X	*		X	*		X	*		-	*	
PWH																											
S																											
North Branch	0	3	7.6	3	152	1	0	3	3	888				2	1575	0	3	0.32	2	2	0.25						1973,[1]
6.4	X	*		-	*			X	*					-	*	X	*		X	*							1979[2]
CWH																											
S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)
3 (Ohio EPA, OWPS, 1975-77)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek - confluence of West and East Forks to mouth;
East Fork Duck Creek - headwaters to confluence with West Fork, and tributaries:

Lower Salem North tributary, Pawpaw Creek, Unnamed North tributary, Unnamed East tributary, Unnamed North tributary, Unnamed South tributary, Unnamed North tributary, Middle Fork Duck Creek (all tributaries including Otterslide Run, Mare Run, and Camp Run), Unnamed North tributary, Rocky Run, Creighton Run, Road Fork, Schwab Run, Elk Fork (Greasy Run), and Barnes Run;

West Fork - headwaters to confluence with East Fork, and tributaries:

All tributaries from confluence to Dexter City, including Goose Hollow and Buffalo Run, Warren Run, 2 unnamed East tributaries north of Warren Run, Dog Run below Caldwell Lake, Wolf Run and Coal Run.

Duck Creek is 51.5 miles long and drains an area of 286 square miles in Noble, Washington, Monroe, and Guernsey Counties. Duck Creek originates near the Guernsey-Noble County line. The land adjacent the creek in northern Noble County has been extensively strip and deep mined. Acid mine drainage continues to degrade the water quality in the creek.

The West Fork of Duck Creek flows south through the Village of Belle Valley, which serves the deep mining activities in the area. Wolf Run State Park is located east of Belle Valley. It is one of several recreational areas in the vicinity.

From Belle Valley, West Fork flows south to the Village of Caldwell. The Caldwell water plant and wastewater treatment plant discharge into the West Fork of Duck Creek. Caldwell Lake provides recreational activity for this area; however, the lake area has not been fully developed because of contamination hazards associated with the public water supply. From Caldwell, West Fork flows south through the small mining town of Dexter City and into the heavily strip mined lands of southern Noble County.

The East Fork of Duck Creek has several tributaries, including Middle and West Fork (of East Fork) Creeks as well as Barnes Run, Elf Fork and Schwab Run. From areas of hilly forested terrain in east-central Noble County, these tributaries flow south into extensively strip mined lands.

The East and West Forks of Duck Creek merge in northern Washington County to form the mainstem of Duck Creek. Before reaching Marietta, Duck Creek receives direct discharge from the American Cyanide Company.

Duck Creek enters the Ohio River at Marietta. It flows along the eastern edge of the city, near the strip industrial and residential development. Marietta (population 16,663) is a major urban center. It is situated at the mouth of the Muskingum River and is part of the Muskingum River Basin.

Abandoned surface mines in the Nos. 8 and 9 coal seams extensively cover the middle portion of the watershed, while an area of extensive abandoned underground mines in the No. 7 coal seam lies northwest of Caldwell. There are no abandoned underground mines in the lower portion of the watershed south of the confluence of the East and West Forks. Both the No. 7 and 8 coal seams have a high pollution potential in this watershed.

Duck Creek and all of its tributaries are classified WWH, although water quality in many of the tributaries often exceeds WWH standards.

The Duck Creek mainstem has been sampled up to 17 times over the period of record 1964 to 1978. Data sources include USGS (1964-75), Ohio EPA (1978), and Skelly and Loy (1973).

Duck Creek has a limited buffering capacity and a minor pH problem. Any additional acidic drainage could cause major problems. Sulfate concentrations are a minor problem, and manganese concentrations a moderate problem, although iron and zinc concentrations were well below the limitations.

There are no abandoned mines on the mainstem of Duck Creek. The source of mine drainage is the mines on the upstream tributaries. The East Fork appears to be the major contributor of mine drainage to Duck Creek. It also has a limited buffering capacity and a minor pH problem. Sulfate and iron concentrations both are minor problems, while manganese concentrations are moderately problematic. In contrast, the West Fork has an excellent buffering capacity and a mean pH value of 7.2 mg/l. Manganese concentrations are a minor problem, while none of the other mine drainage constituents caused problems.

The difference in water quality between the East and West Forks appears to be due to the difference in the number of abandoned mines in the two watershed, and not to a difference in the type or amount of pollution from each individual source. Data on the tributaries of both Forks obtained by Skelly and Loy (1973) and USGS (1975, 1979) show many of them have very poor water quality. There are many small, unnamed tributaries, especially in the lower portions of both watersheds, which have been extensively strip mined and are contributing heavy loads of mine drainage constituents to both the East and West Forks. These tributaries are generally acidic with no buffering capacity and have pH values between 2.5 and 4.5 S.U. Sulfate and iron concentrations are indicated to be major problems by the limited available data. No data is available for the other constituents. The area which has been extensively underground mined has few mine drainage problems. These underground mines are not, at present, contributing substantially to the problems of Duck Creek.

The data indicate the possible presence of a neutralizing strata which provides a high alkalinity to Duck Creek and its tributaries. This alkalinity maintains a good buffering capacity and good water quality until it is depleted by the addition of large amounts of acid. Once buffering capacity is depleted, water quality rapidly deteriorates.

Tributaries in the Duck Creek watershed with no abandoned mines in their drainages are: Killwell Run (Burch's Run, Nigger Run), Sugar Creek, Reeds Run, and Whipple Run, tributaries to Duck Creek mainstem; McBride Run, Wolfpen Run, and West Fork of the East Fork; and Elk Run, Salt Run, Otter Run, Johnny Woods River, Patty Creek Run, and Lick Run. Data is available for Whipple Run and Elk Run which show excellent buffering capacities, pH values around 7.5, and sulfate concentrations around 50 mg/l.

The city of Caldwell obtains its water from Caldwell Lake, an impoundment on Dog Run. There are no abandoned mines in the drainage above the lake. Wolf Run Lake is an impoundment on Wolf Run. There are several underground mines in its drainage, but they appear to have little or no effect on the water quality of the lake.

The Ohio DNR, Division of Reclamation has completed an extensive reclamation project funded by the Board on Unreclaimed Strip Mine Lands in Enoch Township, Noble County. The area was a direct cause of extensive sedimentation to Duck Creek. The project was completed at a cost of $293,852.

Several fish kills on Duck Creek attributable to mine drainage have been reported by Ohio DNR in 1978, 1974 and 1971. Fish kills were also reported on the East and West Forks in 1971. The number of fish killed has decreased over the span of years, possibly indicating an improvement of the situation.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	No Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Duck Creek 51.5 WWH Up	pH	8/17	June - Sept, Nov	11	1964-75	6.2	7.6	4.5	1 +	
	Alkalinity	-/10	June - Sept, Nov	7	1968-75	39	109	2	*	
	Acidity	-/3	July	1	1973	6.7	20	0 *	0	
	Sulfates	14/16	June - Sept, Nov	11	1964-75	480	770	220	1 *	
	Conductivity	-/14	June - Sept, Nov	12	1964-78	960	1310	749	=	
	Iron	0/6	June - Aug, Nov	3	1973-78	0.30	0.58	0	0 =	
	Manganese	4/4	June, Sept, Nov	3	1964-75	3.38	7.8	0.22	2 *	
	Zinc	0/3	June, Aug, Nov	2	1975-78	0.03	0.04	0.02	0 *	
	Aluminum	-/2	June, Nov	1	1975	0.9	1.0	0.8	*	

(USGS, 1964-75)
(Skelly and Loy, 1973)
(Ohio EPA, 1978)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
East Fork Duck Creek 29.5 WWH S,Up	pH	5/14	May, July-Sept	6	1972-77	6.0	7.4	2.3	1 *	
	Alkalinity	-/11	May, July-Sept	6	1972-77	63	146	0	*	
	Acidity	-/6	July - Aug	1	1973	8.4	44	0	1 *	
	Sulfates	10/13	May, July-Sept	6	1972-77	464	1250	75	1 *	
	Conductivity	-/18	May, July-Sept	6	1972-77	967	1550	680	*	
	Iron	2/6	May, July, Aug	2	1973-75	1.1	2.3	0.5	1 *	
	Manganese	1/1	May	1	1975-79	3.2	-	-	2 *	
	Zinc	0/1	May	1	1975	0.04	-	-	0 *	
	Aluminum	-/1	May	1	1975	1.0	-	-	*	

(USGS, 1966-77)
(Skelly and Loy, 1973)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
West Fork Duck Creek 36.5 WWH S,U,Up	pH	3/25	April - Nov	9	1966-79	7.2	7.8	5.9	0 =	
	Alkalinity	-/22	April - Nov	7	1968-79	132	214	74	-	
	Acidity	-/7	July	1	1973	0	0	0	0 *	
	Sulfates	10/24	April - Nov	8	1967-79	243	560	44	0 -	
	Conductivity	-/18	April - Nov	3	1966-79	700	887	390	=	
	Iron	3/17	April - July Sept - Oct	3	1973-79	0.66	3.2	0.1	0 *	
	Manganese	10/10	Apr - June Sept - Nov	2	1975-79	0.68	2.0	0.7	1 *	
	Zinc	0/8	May, June Sept, Nov	1	1975	0.03	0.06	0.01	0 *	
	Aluminum	-/8	May, June Sept, Nov	1	1975	0.03	2.6	0.91	*	

(USGS, 1966-77)
(Skelly and Loy, 1973)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Whipple Run	0	5	7.6	5	173	1	0	0	5	68				4	460	1	5	0.6	3	4	0.12	0	2	0.015	2	0.09	1973,
6.5	0	*		-	*	X	*	0	*					-	*	X	*		1	*		0	*		-	*	1975
WWH																											1979
No mines																											
East Fork (see previous table)																											
Lower Salem	1	1	3.9	1	0	1	440	1	1	2550						1	1	6.6									1973
N Tributary	X	*		-	X	X	*	X	*							X	*										
(1)																											
WWH																											
S																											
Pawpaw Creek	2	4	6.9	4	114	2	0	0	4	85				2	335	0	4	0.35	2	2	0.09						1973
11.6	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979
WWH																											
S																											
Unnamed N Trib.	1	1	4.2			1	76	1	1	1400						0	1	0.4									1973
(2)	X	*				X	*	X	*							X	*										
WWH																											
S																											
Unnamed N Trib.	1	1	3.5			1	176	1	1	1750						1	1	1.7									1973
(3)	X	*				X	*	X	*							X	*										
WWH																											
S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1975, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Unnamed S Trib.	1	1	4.3			1	127	1		1	1450			0	1	0.7									1973
0.7	X	*				X	*	X		*				X	*										
WWH																									
S																									
Unnamed N Trib.	1	1	2.8			1	1630	1		1	6200			1	1	86.4									1973
(1)	X	*				X	*	X		*				X	*										
(WWH)																									
S																									
Middle Fork	2	8	5.2	5	63	5	105	6	7		502		4	926	6	7	4.4	4	4	5.7	0	2	0.17	2	7.0	1973,
Duck Creek	2	*		-	X	2	*	1	*				-	*	1	*		3	*		X	*		-	*	1975,
13.8																									
WWH																									
S, Upst																									
Unnamed S Trib.	1	1	4.4			1	242	1		1	1500			1	1	1.9									1973
(0.9)	X	*				X	*	X		*				X	*										
WWH																									
S																									
Otterslide Run	1	1	2.5			1	425	1		1	1100			1	1	12.4									1973
3.0	X	*				X	*	X		*				X	*										
WWH																									
S																									
Unnamed N Trib.	1	1	3.0			1	660	1		1	2900			1	1	26.3									1973
(1)	X	*				X	*	X		*				X	*										
WWH																									
S																									

1 (Skelly and Loy, 1973)
2 (USGS, 1975)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Mare Run	1	1	4.5			1	42	1	1	600						1	1	2.9									1973
3.7	X	*				X	*	X	*							X	*										
WWH																											
S																											
Camp Run																											
2.9																											
WWH																											
S																											
Unnamed N Trib.	1	1	5.6	1	52	1	0	1	1	1100						0	1	0.2									1973
(1.8)	X	*		-	X	X	*	X	*							X	*										
WWH																											
S																											
Rocky Run	1	1	5.8	1	39	1	5	1	1	750						1	1	5.4									1973
2.6	X	*		-	*	X	*	X	*							X	*										
WWH																											
S																											
Creighton Run	0	1	6.8	1	157	1	0	0	1	72						0	1	0.2									1973
3.5	X	*		X	*	X	*	X	*							X	*										
WWH																											
S																											
Road Fork	1	3	7.0			1	0	0	3	97				2	520	1	3	0.86	2	2	0.26	0	2	0.015	2	0.32	1973
3.8	X	*				X	*	X	*					-	*	X	*		X	*		X	*		-	*	1975
WWH																											
S, U																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Schwab Run	1	3	7.3	3	158	1	0	0	3	135				2	528	1	3	0.74	2	2	0.11						1973
4.6	X	*		-	*	X	*	X	*					X	*	X	*		X	*							1979
WWH																											
S																											
Elk Fork	0	1	6.9	1	186	1	0	0	1	90						0	1	0.6									1973
4.2	X	*		-	X	X	*	X	*							X	*										
WWH																											
S																											
Greasy Run	0	1	7.2	1	173	1	0	0	1	42						0	1	0.5									1973
2.9	X	*		-	X	X	*	X	*							X	*										
WWH																											
S																											
Barnes Run	0	1	7.6	1	146	1	0	0	1	140						0	1	0.4									1973
4.5	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
West Fork (See previous table)																											
Unnamed E Trib.	1	1	3.5			1	392	1	1	2300						1	1	1.7									1973
(0.5)	X	*				X	*	X	*							X	*										
WWH																											
S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Unnamed E trib.	1	1	3.5			1	764	1		1	2650			1	1	11.0									1973
(1)	X	*				X	*	X		*				X	*										
WWH																									
S																									
Unnamed E trib.	1	1	2.5			1	630	1		1	1950			1	1	30.4									1973
(0.7)	X					X	*	X		*				X	*										
WWH																									
S, U																									
Elba Tributary	1	1	4.0			1	84	1		1	680			0	1	0.3									1973
(3)	X	*				X	*	X		*				X	*										
WWH																									
S																									
Unnamed E Trib.	1	1	3.0			1	564	1		1	1850			1	1	18.1									1973
(0.5)	X	*				X	*	X		*				X	*										
WWH																									
S																									
Unnamed N Trib.	1	1	3.5			1	303	1		1	1550			1	1	4.5									1973
(1)	X	*				X	*	X		*				X	*										
WWH																									
S																									
Goose Hollow	3	3	3.7	2	0	3	169	3		3	997			2	1495	3	3	4.2	2	2	7.6	1	2	0.36	2	17.0	1973,
2.4	X	*		-	*	X	*	X		*				-	*	X	*		X	*		X	*		X	*	1975
WWH																											
S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1975)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Duck Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Buffalo Run	3	3	3.9	2	0	3	164	3	3	1143			2	1540	2	3	1.8	2	2	8.1	1	2	0.37	2	15.5	1973,
3.5	X	*		-	*	X	*	X	*				-	*	X	*		X	*		X	*		X	*	1975
WWH																										
S, U																										
Warren Run	1	1	4.5			1	65	1	1	1300					0	1	0.7									1973
2.7	X		*			X	*	X	*						X	*										
WWH																										
S																										
Unnamed W Trib.	0	1	6.5	1	218	1	0	0	1	50					0	1	0.1									1973
(1.5)	X	*		X	*	X	*	X	*						X	*										
WWH																										
No Mines																										
Elk Run	1	1	6.2	1	200	1	0	0	1	44					1	1	1.5									1973
0.9	X	*				X	*	X	*						X	*										
WWH																										
No Mines																										
Dog Run																										
4.4																										
WWH, PWS																										
S																										
Wolf Run Lake	0	22	7.8	4	80			0	1	53			22	284	0	1	0.11	1	1	0.15	0	1	0			1976
4.0	0	*		-	*			X	*				-	*	X	*		X	*		X	*				
WWH																										
U																										
Coal Run	0	2	7.7	2	146			2	2	785			2	1620	0	2	0.46	2	2	1.75	0	2	0.035	2	1.07	1975
(5.5)	X	*		X	*			X	*				-	*	X	*		X	*		X	*		X	*	
WWH																										
S, U																										

1 (Skelly and Loy, 1973)
2 (USGS, 1975)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Little Muskingum River tributaries:

Moss Run and Clear Fork.

The Little Muskingum River is 69.7 miles long and drains 314.5 miles^2 in Washington and Monroe Counties. Most of the watershed lies in Wayne National Forest. The Nos. 8 and 9 coals occur in the area. The No. 9 has a high pollution potential for surface and underground mining. The No. 8 has a high pollution potential for underground mining in a relatively small, central portion of the deposit. The Little Muskingum River drainage has only three abandoned mines, and few active surface or underground mines. Oil and gas are the most important natural resources in the area.

Data has been collected by USGS (1964-79), Ohio EPA (1978), USDA Forest Service (1977-78) and Skelly and Loy (1973) in the months of January through December in the mainstem of the Little Muskingum River and in April, July, September, and October in the tributaries.

The Little Muskingum River and its tributaries are characterized by pH values ranging from 6.5 to 7.4 S.U. with infrequent departures from this range. Buffering capacities are adequate in Witten Fork, Witten Run and Moss Run and excellent in all other reported streams. All sulfate concentrations are below 70 mg/l and many are under 40 mg/l, with the exception of Moss Run at 140 mg/l below the abandoned surface and underground mines.

Archer's Fork contains total iron concentrations in excess of the WWH standard. The problem in Archer's Fork may originate from the many gas and oil wells in its drainage. No other stations reported total iron in excess of 1 mg/l. Total zinc and manganese concentrations did not exceed the standards where data was available, with the exception of Moss Run for manganese.

The abandoned surface mine occurring near the Clear Fork headwaters does not appear to have any noticeable effect on water quality. Two promiscuous dumps drain into Clear Fork and may contribute some pollutants. The one abandoned surface and one underground mine near the mouth of Moss Run did elevate total iron, sulfate, manganese and zinc concentrations. However, buffering capacity appears to be adequate. All other tributaries to the Little Muskingum River were without abandoned mines.

Background concentrations of most mine drainage constituents have not changed over the period of record in the mainstem of the Little Muskingum River. Data was not complete enough to determine any trends for total iron and TDS in the mainstem or in the tributaries for any constituent.

The Little Muskingum River is classified as a SNRW along its entire length. Water quality is not detectably affected by abandoned coal mine drainage and no point source dischargers are located anywhere along its length.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Little Muskingum River 0/69.7 WWH/SNRW NM	pH	7/52	Jan - Oct Dec	15	1964-78	7.8	8.4	5.7	0 =	
	Alkalinity	-/39	Mar April July - Oct	10	1968-77	100.6	158	31	=	
	Acidity	/13	July	2	1973 1978	2.62	12	0	0 *	
	Sulfates	0/55	Jan - Oct Dec	15	1964-77	35.2	132	21	0 =	
	Conductivity	-/68	Jan - Dec	15	1964-77	383.5	752	170	=	
	TDS	0/9	Aug - Oct	9	1964-72	305.5	462	186	0 *	
	Total Zinc	0/6	Mar July Aug	4	1975-78	0.022	0.03	0.01	0 *	

Skelly and Loy, (1973)
USGS, (1964-77)
USDA FS, (1977-78)

Ohio EPA, (1978)

Little Muskingum Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Eightmile Creek	1	1	6.0	1	143	1	0	0	1	66						0	1	0.2									1973
4.4	X	*		*		X	*	X	*							X	*										
WWH																											
NM																											
Moss Run	0	2	6.85	2	63.5			0	2	140				2	457.5	2	2	2.85	2	2	1.39	0	2	0.45	2	2.55	1975
3.0	0		*	*				0	*						*	1	*		1		*	0		*		*	below source
WWH																											
U, S at mouth	0	2	7.05	2	64			0	2	67				2	307.5	0	2	0.45	2	2	0.275	0	2	0.035	2	0.975	1975
	0		*	*				0	*					1	*	0	*		1		*	0		*		*	above source
Eightmile Creek	1	1	6.0	1	143			0	1	66						0	1	0.2									1973
4.4	X	*		*				X	*							X	*										
WWH																											
NM																											
Fifteen Mile	0	5	7.62	5	94.9	1	8	0	5	46.5				5	408.9	0	2	0.35	0	2	0.03						1977-79
Creek	0	*		*		X	*	0	*						*	0	*		0	*							
9.1																											
WWH																											
NM																											
Archer's Fork	1	6	7.16	6	81.9	2	6.5	0	6	36.5				5	224.9	1	3	2.30	0	2	0.03						1973
9.9	0		*	*		0	*	0		*					*	0-1		*	0	*							1977-79
WWH																											
NM oil & gas wells																											

USGS (1979)
Skelly and Loy (1973)

USDA FS (1977-78)

Little Muskingum Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Haught Run	1	1	6.0	1	164	1	0	0	1	54						0	1	0.2									1973
1.4	X	*		*		X	*	X	*							X	*										
WWH																											
NM																											
Sackett Run	0	1	6.8	1	165	1	0	0	1	33						0	1	0.2									1973
2.2	X		*	*		X	*	X	*							X	*										
WWH																											
NM																											
Tice Run	0	1	6.2	1	155	1	0	0	1	38						0	1	0.3									1973
2.0	X	*		*		X	*	X	*							X	*										
WWH																											
NM																											
Wilson Run	0	1	6.6	1	144	1	0	0	1	27						0	1	0.7									1973
2.1	X	*		*		X	*	X	*							X	*										
WWH																											
NM																											
Clear Fork	0	7	7.36	7	147.3	3	5	0	7	45.6				5	375.8	0	4	0.36									1973
23.7	0	*		*		0	*	0	*							0	*										1977-79
WWH																											
S																											
Witten Run	1	4	6.9	4	68.5	2	6	0	4	34.8				3	293.3	0	1	0.3									1973
6.6	0		*	*		0	*	0	*							X	*										1977-78
WWH																											
NM																											

Skelly and Loy (1973)
USGS (1979)

Little Muskingum Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conduc-tivity # Smp	Conduc-tivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Straight Fork	1	6	7.47	6	157.8	4	4.25	0	6	37.0				5	642.6	0	3	0.24	0	2	0.035						1973
9.8	0	*			*	0	*	0		*					*	0	*		0		*						1979
WWH																											
NM																											
Witten Fork	1	1	6.0	1	64	1	0	0	1	28						0	1	0.6									1973
11.2																											
WWH																											
NM																											
Wolfpen Run	0	1	6.7	1	167	1	0									0	1	0.4									1973
3.6	X	*		X	*	X	*																				
Town Fork	0	2	8.0	2	140			0	2	35.5				2	342.5	0	2	0.23	0	2	0.02						1979
6.7	0		*		*			0		*					*	0		*	0		*						
WWH																											
NM																											

Skelly and Loy (1973)
USDA FS (1977-78)
USGS (1975, 1979)

Little Muskingum Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Rich Fork	0	5	7.46	5	124.2	1	12	0	5	32.8				5	349	0	2	0.21	0	2	0.025	0	2	0.02	2	0.065	1977-79
6.5	0	*		*		X	*	0	*						*	0	*		0	*		0	*			*	
WWH																											
NM																											
Cranenest Fork	0	5	7.4	5	94.6	1	14.0	0	5	36.8				5	334	0	2	0.195	0	2	0.04	0	2	0.015	2	0.115	1975
13.7	0		*		*	X	*	0	*						*	0	*		0		*	0		*		*	1977-78
WWH																											
NM																											

USDA FS (1977-78)
USGS (1975, 1979)

McMahon Creek - from source to confluence with Ohio River and tributaries:

Brooks Run, Trough Run, Moss Run, Little McMahon Creek (Stillhouse Run, Kings Run, Aults Run), Williams Run, Tar Run, Cumberland Run, Welsh Run, Williams Creek, Porterfield Run, Neffs Run, Hutchinson Run, Brush Run, Roberts Run and Barkcamp Creek.

McMahon Creek is 28.1 miles long and drains 91.2 miles^2 in Belmont County. The coals mines in the drainage are the Nos. 8, 9 and to a small extent the No. 11. Both Nos. 8 and 9 have high pollution potentials for underground mining in this area. The Redstone Limestone which lies just above the No. 8 and the calcareous strata above the No. 9 are effective neutralizers for surface mines but due to their stratigraphic position above the coal seams, they do not neutralize underground mine drainage. The eastern third of the watershed has extensive underground mines underlying about 80% of the area. There are roughly 4 miles^2 of strip mines in the drainage.

Data for McMahon Creek and tributaries was collected by USGS (1975, 1978-79), Dept. of the Army, Corps of Engineers (1975, 1978), FWPCA (1968), FWQA (1969), USEPA (1970), Ohio EPA (1975, 1979) and Skelly and Loy (1973). Most parameters were reported in the months of March, May and June through September.

For the purposes of this presentation, McMahon Creek was divided into two segments of different water quality and different sources of abandoned mine pollution. The segment from Neffs to the mouth is typified by drainage from numerous, abandoned underground mines and refuse piles. The segment from Neffs to the source contains numerically few mines most of which are surface operations. Above Warnock the only abandoned mines are old stripped areas. Tributaries with numerous abandoned underground mines include Williams Creek, Little McMahon Creek (below the PWS reservoir), Trough Run, Brooks Run, and Moss Run. Streams with numerous or large strip mines are Kings Run, Brush Run and Barkamp Run.

Water quality in the mainstem is characterized by minor mine drainage constituent problems. pH is a minor problem in the mainstem below Neffs. Above Neffs the mainstem appears to be continuously alkaline although one acidity value of 30 mg/l was reported in 1968. Buffering capacity can be depleted below Neffs as the statistics show that mean total acidity exceeds mean total alkalinity concentrations.

Sulfate concentrations are quite variable above Neffs but the mean does not exceed the PWS standard. Below Neffs, mean sulfate concentration exceeds 250 mg/l. Minor problems with total iron and manganese are observed at all stations in McMahon Creek. Total zinc is not problematic, but mean total aluminum reached 1.45 mg/l and 9.5 mg/l in up and downstream segments, respectively.

Tributaries of McMahon Creek which have minor pH problems but adequate to limited buffering capacity are Moss Run and Stillhouse Run. Kings Run exhibits severe pH and acidity problems and is atypical of the watershed conditions. All other reported tributary pH conditions are alkaline and buffering capacities are excellent.

Sulfate concentrations up to 1600 mg/l are typical of drainages containing abandoned mines. Sulfate levels exceed the PWS standard in all abandoned mine affected tributaries downstream of Bull Run near Glencoe. Minor sulfate problems are evident in Brooks Run, Trough Run, Little McMahon Creek, Aults Run and Bull Run. Moderate to severe sulfate problems typify Moss Run, Stillhouse Run and Kings Run. Little McMahon Creek Reservoir and Anderson Run are not affected by mines and limited data suggests sulfate concentrations are less than 100 mg/l.

Total iron exceeds the WWH standard in McMahon Creek tributaries. Severe levels of total iron up to 133 mg/l occur in Kings Run and up to 85.0 mg/l occur in Stillhouse Run. Moderate total iron levels occur in Brooks Run and Moss Run, minor levels in Williams Creek and Brush Run. Some streams were sampled only once. Total manganese is a minor problem according to the reported data in Little McMahon Creek, Kings Run and Brush Run, independent of levels of other mine drainage parameters.

The city of St. Clairesville obtains its water from three sources, two surface impoundments and the Belmont County Water Authority (wells). The yields from the two surface impoundments no longer meet the needs of the city and Belmont Lake, an impoundment of Barkcamp Creek is being considered as an additional source. No water quality data was available for Belmont Lake.

Little McMahon Creek was impounded in 1929 to form the 15 acre water supply for the city of St. Clairesville. This reservoir lies above the coal seams in the area and has no abandoned mines in its drainage. Provident Reservoir was added to the system in the early 1960's. This reservoir was formed in the early 1900's when the Provident Coal Company impounded Jug Run, northwest of the city for an industrial supply. The reservoir contains two strip mines in its drainage and receives its main water supply from two upstream strip pits. Provident Reservoir lies in the Wheeling Creek drainage.

When strip mining began in the Provident Reservoir drainage in the late 1960's and early 1970's concern was expressed by the residents of St. Clairesville that contamination would occur. Both reservoirs and their sources were sampled once in 1975 by the Ohio EPA Office of Public Water Supply. pH conditions in Little McMahon Creek Reservoir, Provident Reservoir, and the Marietta and Cravat strip pit sources were neutral to slightly alkaline and buffering capacities were excellent. Highest concentrations for all constituents of mine drainage occurred in the Marietta Coal pond, but both ponds contained total iron and total manganese concentrations in excess of PWS standards. Provident and Little McMahon Creek Reservoirs contained total manganese concentrations two and five times higher than the PWS standard, respectively. Sediment accumulation may be a problem in the reservoirs and dredging to increase their holding capacities has been recently (1978) suggested.

Several point sources contribute to the pollution levels in the McMahon Creek watershed. A small wastewater treatment plant (WWTP) dishcarges into Barkcamp Creek and three WWTP's discharge into Little McMahon Creek near St. Clairesville. Beef and dairy farming are important land use practices in the drainage.

Biological Parameters[1,2]

Station	Benthic Invertebrates % Pollution Tolerant	% Pollution Facultative	% Pollution Sensitive	No. of Taxa	Total No. Organisms	No./ sq. ft.
1 - McMahon Creek at confluence with Little McMahon Creek	10.9	3.4	85.7	14	265	29.4
2 - McMahon Creek above Glencoe	23.1	15.4	38.5	6	13	1.4
3 - McMahon Creek above Neffs	14.3	28.6	57.1	13	7	0.8

1 COE, 1979 Metro Wheeling Draft Study
2 (sampled in 1977)

Anderson Run, a tributary of Neffs Run is the only stream without abandoned mines in its drainage area.

McMahon Creek at Little McMahon Creek and above Glencoe and Neffs Ohio were sampled once between October and December, 1977 to characterize the fish and benthic insect communities.

The benthic insect community at station #1 is dominated by pollution sensitive forms, has a high number of taxa and higher densities than upstream stations despite the number of mines in the area. The benthic insect community samples from the two upstream stations (2 & 3) exhibit fewer taxa and smaller densities than the downstream station, however, differences in flow and other physical characteristics of the stream probably account for some of the changes in community structure.

McMahon Creek at St. Clairesville contains abundant fish and benthic insects and does not appear to be seriously affected by mine drainage. Alkaline conditions are likely to be of prime importance to the maintenance of fish and insects in McMahon Creek.

Fish Collection Data1,2

(no. of individuals)

Species	McMahon Creek at Little McMahon	McMahon Creek above Glencoe	McMahon Creek above Neffs
Ambloplitesrupestris (Rock Bass)	1		
Castostomus commersoni (White Sucker)	10	1	
Hypentelium nigricans (Northern Hog Sucker)	28		
Moxostoma crythrurum (Golden Redhorse Sucker)		1	
Notropis atherinoides (Emerald Shiner)			10
Notropis Stramineus (Sand Shiners)		3	76
Notropis Spilapterus (Spotfin Shiner	272	4	2
Notropis cornutus (Common Shiner)		5	7
Pimephales notatus (Bluntnose minnow)	170	6	
Etheostoma flabellare (Fantail Darter)	10		
Etheostoma caeruleum (Rainbow Darter)	10	1	
Etheostoma blennoides (Greenside Darter)	10		
Etheostoma nigra (Johnny Darter)	3		
Campostoma anolmalum (Stoneroller)	208	14	5

(Continued on next page

Fish Collection Data (Continued)

(no. of individuals)

Species	McMahon Creek at Little McMahon	McMahon Creek above Glencoe	McMahon Creek above Neffs
Rhinichthys atratulus (Blacknose Dace)	1		2
Ericymba buccata (Silverjaw Minnow)	16		
Semotilus atromaculatus (Creek Chub)	10	9	5
Total number of individuals	749	44	107
Total number of species	13	9	7

1 Metro Wheeling Study (Draft) 1979, COE

2 Collections made 1977

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
McMahon Creek 28.1/28.1 WWH U,S,R, Up (U,S,R)	pH	N/18	Mar May Aug Nov	4	1968-69 1973 1978	6.24	7.8	5.3	0-1 *	below Neffs
		-/19	Mar May Aug Sept	5	1969 1973 1975 1978-79	7.81	8.3	7.0	0 =	above Neffs
	Alkalinity	-/19	Mar May Aug Sept Nov	3	1968 1973 1975	29.7	164	28	*	below Neffs
		-/12	Mar May June July Sept Oct	5	1969 1973 1975 1978 1979	143.8	163	98	=	above Neffs
	Acidity	-/9	Mar May July Sept	2	1968 1973	48.6	73	0	0-1 *	below Neffs
		-/10	Mar May June July Sept	4	1969 1973 1975 1979	3	30	0	0 *	above Neffs
	Sulfates	N/18	Mar May Aug Nov	4	1963-69 1973 1978	254.9	410	159	1 *	below Neffs
		4/18	Mar May Aug Sept	5	1969 1973 1975 1978-79	188.61	820	48	0 *	above Neffs

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
McMahon Creek - (cont'd)	Conductivity	-/11	Mar May Aug Sept	5	1969 1973 1975 1978-79	599.8	1525	200	=	above Neffs
	Total Iron	N/18	Mar May Aug Nov	4	1968-69 1973 1975	3.84	7.08	0.41	1 =	below Neffs
		13/18	Mar May Aug Sept	5	1969 1973 1975 1978-79	4.38	32.0	0.23	1 =	above Neffs
	Total Manganese	N/7	Nov	2	1968 1978	1.32	1.5	0.21	1 *	below Neffs
		7/10	June July Sept Oct	2	1975 1979	0.18	0.82	0.02	1 *	above Neffs
	Total Zinc	0/3	Mar Aug Nov	1	1978	0.050	0.08	0.02	0 *	below Neffs
		0/10	July - Oct	2	1975 1979	0.042	0.13	0.02	0 *	above Neffs
	Total Aluminum	-/7	Mar May Sept Nov	2	1968 1978	9.50	11.0	0.53	*	below Neffs
		-/10	July - Oct	2	1975 1979	1.45	9.5	0.2	*	above Neffs

USGS (1975, 1978-79)
USCOE (1978)
FWPCA (1968)
USEPA (1969)
FWQA (1969)
Ohio EPA OLPC (1979)
Skelly & Loy (1973)

McMahon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Brooks Run	N	4	7.3	4	102	4	10	N	4	254	N	4	1899	4	664	N	4	5.2									1978
2.8	0	*		*		0	*	1	*		1	*		*		2	*										
WWH																											
U, S																											
Trough Run	1	6	7.05	5	104.8	5	72	N	5	434	N	4	524	4	621	N	5	34.64									1969
3.2	0		*	*		0-1	*	1	*		0	*		*		3	*										1973
WWH																											1978
U, S																											
Moss Run	N	6	5.8	6	120	6	2	N	7	904.7	N	4	611	4	721	N	7	7.19									1973
N	1	*		*		0	*	2	*		0	*		*		2	*										1978
WWH																											
U, S																											
Little McMahon	N	12	7.37	8	142.5	4	8	N	12	436.3	N	4	1546	6	948.7	N	12	14.63	2	2	0.22						1969
Creek	X	*				X	*	X	*							X	*										1973
8.3																											1975
WWH/PWS																											1978, 79
U, S, R																											
Stillhouse Run	1	1	5.5	1	0	1	100	1	1	950						1	1	85.0									1973
1.9	X	*		*		X	*	X	*							X	*										
WWH																											
U, S																											

USCOE (1975, 1978)
FWQA (1969)
USGS (1979)

McMahon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity			Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum		Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Little McMahon	0	1	7.1	1	112			0	1	80				1	510	0	1	0.25	1	1	0.27	0	1	0.00	1	0.00	1975
Creek Reservoir	X		*		*			X		*					*	X		*	X		*	X		*	X	*	
15 acres																											
PWS/EWH																											
HM																											
Provident	0	1	7.7	1	132			0	1	122				1	455	0	1	0.19	0	1	0.09	0	1	0.00	1	0.00	1975
Reservoir	X		*		*			X		*					*	X		*	X		*	X		*		*	
10 acres																											
RWS/EWH																											
S																											
Marietta Coal	0	1	7.6	1	193			0	1	154				1	600	1	1	2.02	1	1	1.49	0	1	0.05	1	1.3	1975
Strip Pit	X		*		*			X		*					*	X		*	X		*	X		*		*	
N																											
WWH																											
S																											
Cravat Coal	0	1	7.3	1	125			0	1	112				1	435	1	1	2.06	1	1	0.13	0	1	0.04	1	1.4	1975
Strip Pit	X		*					X		*						X		*									
N																											
WWH																											
S																											

Ohio EPA, OPWS (1975)

McMahon Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Kings Run	3	3	3.9	3	8.3	2	1340	3	3	1623.3				2	2050	3	3	133.3	2	2	2.95	2	2	0.91			1973
2.2	0	*		*		0	*	1	*					*		2	*										1975
WWH																											
U, S																											
Aults Run	0	1	6.9	1	251	1	0	1	1	330						1	1	3.1									1973
3.1	X		*	*		X	*	X	*							X	*										
WWH																											
U, S (WWTP)																											
Bull Run	0	1	6.7	1	138	1	0	1	1	550						1	1	26.0									1973
N	X	*		*		X	*	X	*							X	*										
WWH																											
U, S																											
Williams Creek	0	4	7.68	4	134.8	2	0	0	4	66.5				2	395	1	4	1.54	0	2	0.005						1973
8.0	0	*		*		0	*	0	*					*		0-1	*		0	*							1979
WWH																											
U																											
Anderson Run	0	1	7.0	1	143	1	0	0	1	54						0	1	1.0									1973
1.9	X	*		*		X	*	X	*							X	*										
WWH																											
UM																											
Brush Run	0	3	7.07	3	143	1	0	1	3	128				2	715	2	3	1.18	2	2	2.46	0	2	0.025	2	0.58	1973
3.2	X	*		*		X	*	0	*					*		1	*		2	*		0	*			*	1975
WWH																											
S																											

Skelly & Loy (1973)
USGS (1975)

Minor Ohio River Tributaries:

Newell Run below (Bolivian Run), Bares Run, Little Captina Creek, Narrows Run, Pipe Creek, Lockwood Run, Big Run, Wegee Creek, Pinch Creek, Indian Run, Whiskey Run, Moore Run, Dandelion Hollow Run, Glenns Run, Patton Run, Deep Run, Little Rush Run, Rush Run (Blues Run, Plum Run, Salt Run, Little Salt Run), Riddles Run, Tarrs Run (McKims Run), Georges Run, Permars Run (Wells Run), Wills Creek (North Fork), Rush Run, Island Creek (Egypt Hollow, Shelley Run), Jeddo Run, Croxton Run (Wildcat Hollow, Righthand Fork), Jeremy Run, Goose Run, Brimstone Run, Rocky Run, McQueen Run; Little Yellow Creek below Highlandtown Reservoir (Bailey Run, Alder Run,) Wells Run and Carpenter Run, (named south to north).

The small tributaries of the Ohio River located in Washington, Monroe, Belmont, Jefferson and Columbiana Counties drain 1106.4 square miles adjacent to the Ohio River. The coal seams mined throughout the area are the Nos. 8 and 9. The No. 6 is mined in the western portions of Jefferson and Columbiana Counties while the No. 11 was mined in southeastern Belmont County. The No. 6 is not associated with any neutralizing strata and has a high pollution potential over its entire range for surface and underground mining. The Nos. 8 and 9 have high pollution potential for underground mining because the associated neutralizing strata lies above the coal seam. In general, the southern drainages in Washington and Monroe Counties have very few abandoned mines. The drainages of streams in Belmont, Jefferson and Columbiana Counties contain numerous abandoned strip and deep mines.

Data has been collected by USGS (1975-79) Skelly and Loy (1973) and Ohio EPA OLPC (1979) and OPWS (1974-77). Most sampling was conducted from April through October. Many streams were sampled only once.

Water quality in Newell Run and Bares Run the two streams draining abandoned mine areas in Washington and Monroe Counties, is characterized by pH values which can be slightly acidic within the range of 5.7 to 6.5 S.U. Buffering capacities, however, range from adequate to excellent (33 to 80 mg/l). Total iron concentration exceeds the WWH standard in Newell Run to a minor degree but is not a problem in Bares Run. No other parameters were reported.

Streams draining areas in Washington and Monroe Counties without abandoned mines have similar water quality to those with abandoned mines. Buffering capacities in Sheets Run, Bells Run, Reynolds Run, Davis Run, Reas Run, Leith Run, Sheets Run, Jims Run, Miller Run, Havely Run and Opossum Creek, are excellent. Danas Run and Mill Creek contain adequate buffering capacities. Total iron concentrations exceed the WWH standard to a minor degree in Bells, Newell and Danas Runs, and in Mill Creek. A severely high total iron value was observed in Sheets Run at the mouth. No known source could be identified.

Sulfate concentrations are usually less than 75 mg/l except in Sheets Run and Mills Creek. Sheets Run contains unexpectedly high sulfate values at 300 mg/l. Total manganese concentrations are less than the PWS standards in Leith Run and Opossum Creek.

No other constituents were reported and none of the streams were sampled more than once.

Mine drainage streams adjacent to Sunfish Creek, Captina Creek and McMahon Creek drainages are located in Monroe and Belmont Counties. The streams are characterized by minor mine drainage problems. All contain excellent buffering capacities and only Little Captina Creek and Big Run which are affected by underground mines, have minor pH problems with values below the WWH standard. One acidity of 50 mg/l was reported in Big Run in 1973 near the abandoned mine pollution source. However, there are two Big Runs in the area, one with and one without abandoned mines.

Sulfate concentrations are variable in streams draining abandoned mines in this area. Big Run and Wegee Run have minor problems while all other streams contain acceptable sulfate concentrations. Severe total iron concentrations are present in Big Run (which drains the mined area). Minor total iron problems occur in Big Run (without mining) and Wegee Creek. Total manganese concentrations exceed PWS standards in Wegee Creek. Total aluminum may be problematic but was only reported once in Wegee Creek. In general, streams draining mined vs unmined watersheds had slightly higher concentrations of mine drainage constituents.

Stream draining areas adjacent to Wheeling Creek, Short Creek and Cross Creek have very different mine drainage chemistry than streams entering the Ohio River to the north and south. Most streams reported contain severe levels of total iron and sulfate. Nearly all streams in the area have either abandoned surface or underground mines within their drainages.

pH values were variable from stream to stream. Deep Run and Nixon Run contain severely depressed pH conditions and severe net acidities. Pinch Run and Patton Run contain moderate pH problems and severe net acidities. Minor depressions of pH are found in Indian Run and Deep Run along with moderate net acidities. All other streams were neutral to alkaline. All streams having minor to no pH problems had no net acidities and excellent buffering capacities. Naturally excellent buffering capacities are probably characteristic of most streams draining this geologic region. Therefore, the formation of net acidities and depletion of buffering capacity in streams implies very concentrated acidic drainage from some sources.

Total iron and sulfate are severe problems in Pinch Run, Indian Run, Glenns Run, Nixon Run, Patton Run, and Deep Run. Streams with minor to moderate total iron problems contain minor to moderate sulfate concentrations, including Whiskey Run, Rush Run and Wills Creek. Salt Run is the exception because it contains severe total iron concentrations but only minor sulfate problems. Total manganese is reported at minor problem levels. Eight of 11 streams in the area were sampled once and additional information may change the degree to which it is currently thought these streams are affected by mine drainage.

Glenns Run is being considered as a site for a gob pile reclamation and stabilization project using federal dollars. The project would be located in Pease Township of Belmont County.

The streams entering the Ohio River near Yellow Creek drain mines abandoned in the Nos. 6 and 8 coals. Therefore, alkalinities can vary from none to excellent. The streams for which data is available have limited to excellent alkalinities and no detectable acidity. Island Creek has sulfates which are at minor problem levels, but total iron, manganese, aluminum and zinc are well below appropriate water quality standards.

Little Yellow Creek is impounded at Wellsville to form the Wellsville Reservoir, a public water supply. Several abandoned strip mines are located in the watershed and upstream. The only water quality problems for the reservoir are total manganese concentrations which exceed PWS standards by a factor of 40 and pH which falls below the EWH range to a minor degree. The City of Wellsville often augments their water supply during dry periods from Highlandtown Reservoir. The limited data suggests that mine drainage is not a problem in the reservoir.

Tributaries not polluted by coal mine drainage in Washington and Monroe Counties include Coal Run, Sheets Run, Allen Run, Burns Run, Bells Run, Newell Run above Bolivian Run (Northrup Run, Peggs Fork, Kerr Run, Porter Run), Danas Run (Kesselring Run, West Branch), Ferguson Run, Reynolds Run, Davis Run, Reas Run, Leith Run (Elephant Run), Sheets Run, Collins Run, Mill Creek (North Fork), Jims Run, Miller Run, Deadhorse Run, Parker Run, Barnes Run, Narrows Run, Pool Run (Patton Run), Havely Run, Texas Creek, Fisher Run above Bares Run, Veltsh Run, Narrows Run, Litman Run, Muhleman Run, Opposum Creek (Gilmore Run, Alum Run, Pine Run, Watkins Run, Oliver Run, Wildcat Run), and Bishop Run.

In Belmont County Gardner Run, Stillhouse Run, Walden Run, Yost Run, Johnson Run, Blair Run and Big Run (Bearwallow Run) are unaffected. In Jefferson and Columbiana Counties Little Island Creek, Jethroe Run and East End Run contain no mines in their drainages.

Ohio River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	# Smp	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Sheets Run	1	1	5.4	1	53	1	0	1	1	300					1	1	33.1									1973
1.7	X	*			*	X	*	X	*						X	*										
WWH																										
No Mines																										
Bells Run	0	1	6.6	1	131	1	0	0	1	54					1	1	1.4									1973
2.4	X	*			*	X	*	X	*						X	*										
WWH																										
No Mines																										
Newell Run	1	1	5.7	1	33	1	0	0	1	180					1	1	2.6									1973
5.0	X	*			*	X	*	X	*						X	*										
WWH																										
No Mines																										
Danas Run	1	1	5.7	1	45	1	0	0	1	76					1	1	1.5									1973
5.5	X	*			*	X	*	X	*						X	*										
WWH																										
No Mines																										
Reynolds Run	1	1	6.1	1	131	1	0	0	1	38					0	1	0.4									1973
3.4	X	*			*	X	*	X	*						X	*										
WWH																										
No Mines																										
Davis Run	1	1	6.3		97	1	0	0	1	28					0	1	0.5									1973
2.5	X	*		X	*	X	*	X	*						X	*										
WWH																										
No Mines																										

(Skelly & Loy, 1973)
(USGS, 1979)

Ohio River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Reas Run	1	1	6.2	1	125	1	0	0	1	42						0	1	0.1									1973
2.2	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Leith Run	0	3	7.23	3	91.3	1	0	0	3	34.3				2	238	0	3	0.14	0	2	0.01						1973
8.4	0	*			*	X	*	0	*						*	0	*		0	*							1979
WWH																											
No Mines																											
Sheets Run	1	1	6.3	1	121	1	0	0	1	40						0	1	0.1									1973
5.2	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Mill Creek	1	1	5.6	1	29	1	0	0	1	132						1	1	1.5									1973
5.3	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Jims Run	1	1	6.2	1	107	1	0	0	1	52						0	1	0.2									1973
3.3	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Miller Run	1	1	6.4	1	102	1	0	0	1	40						0	1	1.0									1973
3.6	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											

(Skelly & Loy 1973)
(USGS 1979)

Ohio River Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Hively Run	1	1	5.8	1	65	1	0	0	1	52						0	1	0.1									1973
3.1	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Bares Run	1	1	6.2	1	80	1	0	0	1	50						0	1	0.3									1973
3.4	X	*			*	X	*	X	*							X	*										
WWH																											
S																											
Opossum Creek	1	3	7.43	3	84.3	1	0	0	2	32				2	217.5	1	3	0.65	0	2	0.01						1979
12.3	0	*			*	X	*	0	*						*	0	*		0	*							
WWH																											
No Mines																											
Stillhouse Run	1	1	6.6	1	124	1	0	0	1	66						0	1	0.4									1973
4.6	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Blair Run	0	1	6.8	1	143	1	0	0	1	110						0	1	0.3									1973
4.3	X	*			*	X	*	X	*							X	*										
WWH																											
No Mines																											
Big Run	0	1	6.9	1	159	1	0	0	1	74						1	1	1.2									1973
4.6	X	*		X	*	X	*	X	*							X	*										
WWH																											
No Mines																											

(Skelly & Loy, 1973)
(USGS, 1979)

Captina to McMahon

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Little Captina	1	1	6.4	1	197	1	0	0	1	170						0	1	0.5									1973
Creek	X	*			*	X	*	X	*							X	*										
3.3																											
WWH																											
U																											
Pipe Creek	0	3	7.76	3	163.3	1	0	0	3	64						0	3	0.34	0	2	0.02						1973
7.2	0	*			*		*	0	*							0	*		0	*							1979
WWH																											
U																											
Lockwood Run	0	1	7.0	1	270	1	0	0	1	210						0	1	0.7									1973
3	X	*			*	X	*	X	*							0	*										
WWH																											
U																											
Big Run	0	1	6.1	1	70	1	50	1	1	550						1	1	54.7									1973
4.5	0	*			*	X	*	X	*							X	*										
WWH																											
U																											
Wegee Creek	2	9	7.2	9	129.8	7	0	2	9	286.7	0	4	379.8	6	465.5	2	4	1.74	2	4	0.16	1	4	0.05	4	3.23	1973
7.6	0	*			*	0	*	0-1	*		0	*			*	1	*		1	*		0	*			*	1979[1]
WWH																											
U, R																											
Stone Coal Run	0	1	6.9	1	227			0	1	100						0	1	0.1									1973
6.0	X	*		X	*			X	*							X	*										
WWH																											
U,S																											

(USGS, 1979)
(Skelly & Loy, 1973)
1 Ohio EPA OLPC (1979)

McMahon-Wheeling

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Pinch Run	1	1	5.0	1	0	1	650	1	1	2250						1	1	298									1973
3.5	X	*			*	X	*	X	*							X	*										
WWH																											
U																											
Indian Run	1	1	5.7	1	9	1	60	1	1	2250						1	1	146									1973
2.5	X	*			*	X	*	X	*							X	*										
WWH																											
U																											
Whiskey Run	0	1	7.0	1	204	1	0	1	1	550						0	1	0.8									1973
2.8	X	*			*	X	*	X	*							0	*										
WWH																											
U																											
Glenns Run	0	2	7.05	2	105	2	20	2	2	900				2	2050	2	2	39.5	2	2	0.63						1979
6.4	0	*			*	0-1	*	2-3	*						*	3	*		1	*							
WWH																											
U, OR																											
Nixon Run	1	1	4.5	1	0	2	220	1	1	2950						1	1	158									1973
1.8	X	*			*	X	*	X	*							X	*										
WWH																											
U,S																											
Buckeye Run	0	1	7.0	1	232	1	0	0	1	210						0	1	0.3									1973
2.1	X	*			*	X	*	X	*							X	*										
WWH																											
U,S																											

(Skelly & Loy, 1973)
(USGS, 1979)

Short - Cross

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Patton Run	1	1	4.8			1	360	1	1	2600						1	1	200									1973
2.4	X	*				X	*	X	*							X	*										
WWH																											
U																											
Deep Run	1	1	6.2	1	170	1	0	1	1	670						0	1	0.1									1973
5.5	X	*			*	X	*	X	*							X	*										above
WWH																											mines
U,S	1	1	3.6	1	0	1	200	1	1	1950						1	1	90.0									1973
	X	*			*	X	*	X	*							0	*										below
																											mines
Rush Run	1	4	7.3	4	216.3			4	4	622.5				2	1400	3	4	1.53	2	2	0.25						1973
8.2	0	*			*			2	*						*	1	*		1	*							1979
WWH																											
U,S																											
Salt Run	0	1	6.8	1	174	1	0	1	1	450						1	1	34.6									1973
4.6	0	*			*	X	*	X	*							3	*										1979
WWH																											
S																											
Wills Creek	1	4	7.38	4	149	2	0	4	4	435				2	1105	2	4	8.34	0	2	0.025						1973
6.2	0-1	*			*	0	*	1	*						*	2	*		0	*							1979
WWH																											
U,S																											

(Skelly & Loy, 1973)
(USGS, 1979)

Cross - Yellow

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Island Creek	0	6	7.92	6	134.9			6	6	371.5				6	1013.3	1	4	0.59	1	4	0.033	0	2	0.02	2	0.34	1975-77
9.9	0	*		*				1	*					*		0	*		0	*		0	*		*		1979
WWH																											
U,S																											

USGS (1975-77, 1979)

Yellow Creek - L. Yellow Creek

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Little Yellow Cr.	1	5	6.96	3	28.7	3	0	0	3	151				4	360	1	3	0.53	2	2	0.34						1973
11.3	0	*			*	0	*	0	*						*	0	*		1		*						1978-79
WWH/PWS																											
U, S																											
Wellsville	2	3	6.37	3	24.7			0	3	95.3	0	2	191	2	252.2	0	3	0.12	3	3	1.95	1	2	0.05	2	0.15	1974
Reservoir	1	*			*			0	*		0	*			*	0	*		1-2		*	0-1		*		*	1976
26 acres																											
PWS/EWH																											
S,U, Up(S.U.)																											
Highlandtown	1	11	7.05	2	23			0	1	36				11	179.6	0	1	0.27				0	1	0.01			1978
Reservoir	0	*			*			X	*						*	X	*					X	*				Combined sur-
275 acres																											face and bottom
EWH/PWS																											samples
NM																											

Short Creek - from source to confluence with the Ohio River and tributaries:

Williamson Run, Little Short Creek (Parkers Run, Coal Run), Jug Run, Old Farm Run, Dry Fork (Crow Hollow Run), Piney Fork (Cabbage Run, Henderson Run, Thompson Run, Little Piney Fork, Harrah Run), Long Run, Perrin Run, Goose Run, North Fork (Rose Valley Run, Harmon Run), Flag Run, Middle Fork (Sally Buffalo Creek, Liming Creek, Tanback Creek), and South Fork.

Short Creek is 29.4 miles in length and drains 125.9 miles2 in Jefferson and Harrison counties. It is estimated that between 80% and 90% of the Short Creek watershed has been either strip or underground mined. Coal beds having high pollution potentials in the drainage include the No. 9 coal in the southern half of the watershed for underground mining, the No. 8 for underground mining in the entire watershed and the No. 6 for both surface and underground mining in the northwest portion of the watershed.

Data has been collected by USGS (1964-79), Ohio EPA OPWS and OWPC (1974-78) and Skelly and Loy (1973). In the mainstem, mine drainage constituents were sampled during high and low flow periods. Tributaries were principally sampled in the low flow months of June through September.

The Short Creek watershed is affected by alkaline mine drainage. There are only 3 observations in 83 total samples for the area which have pH values below 6.5 S.U. Most pH values are greater than 7.0 S.U. Another predominant characteristic of mine drainage affected stream quality in the Short Creek watershed are severely high sulfate concentrations often in excess of 1100 mg/l. Total iron is problematic in approximately 10 of 16 mine drainage affected streams but the degree of problem appears to be independent of pH or sulfate levels. Manganese is a minor problem at most stations.

Specifically, the Short Creek mainstem contains alkaline conditions and excellent buffering capacities. Stream concentrations of total alkalinity are among the highest reported in the coal region of Ohio. Noncarbonate hardness, although not presented, comprises from 80 to 90% of total hardness. Sulfate concentrations often at severe levels, exceed the PWS standard in all 40 observations in the mainstem. Sulfate is probably the main constituent of non-carbonate hardness in these waters. Total iron ranges from 0.09 to 16.8 mg/l but 10 of 12 samples exceed the WWH standard. Manganese concentrations occur at none to minor levels. Total zinc is not problematic, but total aluminum was detected from 0.14 to 16.2 mg/l.

Seasonal trends in conductivity and sulfate concentrations are found in the Short Creek mainstem. The highest levels of these parameters occur in August and September. Alkalinity concentrations appear stable throughout the year, but additional data may disclose seasonal changes.

Short Creek tributaries contain water quality similar to the mainstem. pH fell below the WWH standard once in Piney Fork and Sally Buffalo Creek, at all other times, pH values range between 6.5 and 8.5 S.U. Buffering capacities are excellent in all tributaries.

Sulfate concentrations reach severe levels in Crow Hollow Run, Cabbage Fork, Perrin Run, Rose Valley Run, Harmon Creek, Middle Fork, and South Fork. The South Fork contains the highest sulfate concentrations and flows through the most extensively stripped portion of the drainage. Moderate sulfate problems are noted in Dry Fork, Piney Fork, Old Farm Run, Sally Buffalo Creek, Long Run, North Fork and Flag Run. However, several of these streams were observed only once and additional data may change the degree to which they appear to be affected.

The city of Cadiz obtains approximately 66% of its drinking water supply from Sparrow Reservoir located on Tanback Creek, a tributary of Liming Creek which flows into Sally Buffalo Creek of the Middle Fork. The reservoir was impounded in 1949. Major areas of strip mining occur in the watershed. The abandoned areas are fairly well revegetated. Samples of raw water were taken by Ohio EPA, OPWS in 1974-77. pH is alkaline and buffering capacity excellent with mean alkalinity concentrations of 144.3 mg/l. Sulfates, TDS, total iron and total manganese all exceed the PWS standards to a minor degree. Total zinc and aluminum do not appear to be problematic.

There are no major tributaries to Short Creek which do not drain abandoned mines. Only a few, unnamed, intermittent tributaries to Liming Creek remain free of abandoned mines.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Short Creek 29.4/29.4 WWH U.S. Up (U,S)	pH	1/36	Jan - Dec	15	1964 - 1978	8.0	8.2	6.2	0 =	
	Alkalinity	-/25	Feb - Apr June - Nov	15	1968 - 1978	152.4	267	75	=	
	Acidity	-/9	Mar - May Aug - Sept	2	1968 1973	0.56	15	0	0 *	
	Sulfate	40/40	Jan - Dec	15	1964 - 1978	1120.3	2250	500	3 =	
	Conductivity	-/55	Jan - Dec	15	1964 - 1978	2153.1	3080	846	=	
	Total Iron	10/12	Mar - June Aug - Sept Nov	5	1968 1973 1975 1978	4.63	16.8	0.09	2 *	
	Total Manganese	9/9	Mar - May July Sept Nov	3	1964 1968 1975	0.90	1.20	0.11	1 *	
	Total Zinc	0/8	Feb - Apr July - Sept Nov	4	1975 - 1978	0.04	0.10	0.01	0 *	

(Continued on next page)

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent (Unit)	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Short Creek (Continued)	Total Aluminum	-/8		Mar - June Nov	2	1968 1975	7.54	16.2	0.14	*	
	TDS	7/7		Aug Sept Oct Nov	9	1964-1972	2445.6	2720	2030	1 *	

USGS (1964-79)
Skelly & Loy (1973)
Ohio EPA (1978)

Short Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Little Short	0	2	7.7	2	162	2	0	2	2	545				1	1350	2	2	9.65	2	2	0.33						1979
Creek	0	*		*		0	*	1	*						*	2-3	*		1	*							
10.6																											
WWH																											
U, S																											
Dry Fork	0	1	8.0	1	250	1	0	1	1	900						0	1	0.2									1973
6.1	X		*	*		X	*	X	*							X	*										
WWH																											
U, S																											
Crow Hollow	0	1	7.0	1	242	1	0	1	1	1450						0	1	0.2									1973
Run	X	*		*		X	*	X	*							X	*										
4																											
WWH																											
U, S																											
Piney Fork	1	7	7.41	7	162.3	5	0	7	7	847.9				2	1460	4	7	6.38	4	4	0.50				2	5.05	1973
13.4	0	*		*		0	*	2	*						*	2	*		1		*					*	1975
WWH																											1979
U, S, R																											
Cabbage Fork	0	1	6.8	1	316	1	0	1	1	1000						0	1	0.5									1973
2.8	X	*		*		X	*	X	*							X	*										
WWH																											
U, S																											
Old Farm Run	0	2	7.95	2	273			2	2	730				2	2200	1	2	5.21	2	2	0.18	0	2	0.02	2	0.16	1975
1.5	0	*		*				2	*						*	1-2	*		1		*	0	*			*	
WWH																											
U, S																											

Skelly and Loy (1973)
USGS (1975, 1979)

Concentrations in mg/l
Conductivity in umhos/cm at 25°C
pH in S.U.

Short Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Long Run	0	2	7.1	2	171.5	2	0	1		2	634			1	2	34.9									1973
4.0	0	*			*	0	*	2		*				3	*										
WWH																									
U, S																									
Perrin Run	0	1	6.9	1	155	1	0	1		1	1550			1	1	4.1									1973
6.1	X		*		*	X	*	X		*				X	*										
WWH																									
U, S																									
North Fork of	0	4	7.53	4	150.3			4		4	912.5			4	2270	3	4	3.45	4	4	0.75	0	2	0.07	2	1.32	1975
Short Creek	0	*			*			2		*				*		1	*		1	*		0	*		*		1979
9.8																											
WWH																											
U, S, Up (U, S)																											
Rose Valley Run	0	1	7.4	1	172	1	0	1		1	1050			1	1	1.0									1973
2.0	X	*			*	X	*	X		*				X	*										
WWH																									
U, S																									
Harmon Creek	0	1	6.8	1	183	1	0	1		1	1675			0	1	0.7									1973
2.0	X	*			*	X	*	X		*				X	*										
WWH																									
U, S																									
Flag Run	0	1	6.8	1	156	1	0	1		1	700			1	1	2.7									1973
4.2	X	*			*	X	*	X		*				X	*										
WWH																									
U, S																									

Skelly and Loy (1973)
USGS (1975, 1979)

Concentrations in mg/l
Conductivity in umhos/cm at 25°C
pH in S.U.

Short Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity		Acidity		Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum			Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Middle Fork	0	3	8.07	2	190.5	1	0	2	2	973				2	2070	0	2	0.18	1	2	0.1							1973
Short Creek	0	*		*		X	*	2-3	*					*		0	*		0-1	*								1979
9.3																												
WWH																												
U, S																												
Sally Buffalo	1	1	6.2	1	108	1	0	1	1	850						1	1	1.5										1973
Creek	X		*	*		X	*	X	*							X	*											
5.0																												
WWH																												
U, S																												
Sparrow	0	4	7.55	4	144.3			4	4	368	0	4	734.3	2	815	1	3	1.05	4	4	0.34	0	2	0.00	2	0.00		1974-77
Reservoir	0	*		*				1	*		0-1	*		*		0-1	*		1	*		0	*		*			
17.8 acres																												
PWS/EWH																												
S																												
South Fork	0	15	7.9	14	322.4	4	0	14	14	2157.1				11	3560	1	14	1.21	6	6	0.52	0	6	0.03	6	1.01		1973
Short Creek	0	*		*		0	*	3	*					*		0-1	*		1	*		0	*		*			1975
7.9	(mode)																											1976
WWH																												
U, S																												

Skelly and Loy (1973
1 Ohio EPA OPWS (1974-77)
USGS (1975, 1976, 1979)

Concentrations in mg/l
Conductivity in umhos/cm at 25°C
pH in S.U.

Sunfish Creek - 2.5 miles above confluence with Piney Fork to confluence with Ohio River and tributaries:

Nigger Run, Paine Run, Ackerson Run and Piney Fork.

Sunfish Creek is 31.4 miles long and drains 113.8 miles^2 in Monroe County. Six of the seven abandoned areas are underground drift mines and one is a small strip mine. The coals mines in the watershed are the Nos. 8 and 9 of which only the No. 8 has a high pollution potential for underground mining. Oil and gas wells are scattered throughout the watershed.

Data collection has been accomplished by USGS (1966-78) and Skelly and Loy (1973). Most sampling was done in the low flow months of July through September but March and November samples were also available.

Sunfish Creek and tributaries exhibit few detectable effects from the abandoned coal mines in the watershed. The only mine drainage constituent to exceed WWH standards is pH in 3 of 18 samples from the mainstem. Only Skelly and Loy reported pH values below 6.5 S.U. in both the mainstem and the tributaries. All tributaries (with more than one pH sample value) had average pH values above 7.0 S.U. Buffering capacity is excellent at all stations. One sample of 13 in the mainstem contained an alkalinity concentration less than 75 mg/l.

Sulfate concentrations are less than 100 mg/l in all of the Sunfish Creek tributaries regardless of mining pressure, and are usually less than 100 mg/l in the mainstem. All reported total manganese and total zinc concentrations are within the standards for PWS and WWH, respectively. Total iron exceeds the PWS standard in Whittenbrook Run, which forms the surface public water supply for Woodsfield. No mining was observed in the drainage, however, oil and gas wells were common.

Water quality problems from abandoned mines probably have not changed from year to year over the period of record in Sunfish Creek. Ranges of mine drainage parameters are relatively narrow compared to other watersheds. The concentrations of sulfates, total iron, and pH, and conductivity values are higher at the mainstem mouth than at upstream stations. The only major point source in the watershed is the Woodsfield WWTP which drains into Standingstone Run.

Tributaries with no abandoned mines include Paine Run, East Fork of Piney Fork Standingstone Run, Death Creek, Grassy Creek, Baker Fork (Monroe Lake), Whittenbrook Run (Woodsfield Reservoir), Wheeler Run and all unnamed tributaries west of Piney Fork.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Sunfish Creek 16/31.4 WWH/SMRW U, S	pH	3/18		July Aug Sept Nov	10	1966-75 1978	7.29	8.3	5.6	0 *	
	Alkalinity	-/13		July Aug Nov	8	1968-75	126.3	150	28	*	
	Sulfate	0/15		July Sept Nov	9	1967-75	47.9	150	27	0 *	
	Conductivity	-/15		July Aug Sept Nov	11	1966-75 1978	434.7	579	340	*	
	Total Iron	0/9		Mar July Sept Nov	2	1973 1975 1978	0.19	0.50	0.03	0 *	
	Total Manganese	0/4		July Nov	1	1975	0.03	0.04	0.02	0 *	
	Total Zinc	0/7		Mar July Aug Sept Nov	2	1975 1978	0.021	0.03	0.01	0 *	
	Total Aluminum	-/4		July Nov	1	1975	0.135	0.15	0.12	*	

Sunfish Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH	Alkalinity	Acidity	Sulfates	TDS	Conductivity	Total Iron	Total Manganese	Total Zinc	Total Aluminum	Period of Record
	# Exc WWH / # Smp / Mean	# Smp / Mean	# Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	# Exc WWH / # Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	
Nigger Run	1 1 6.3	1 114	1 0	0 1 63			0 1 0.2				1973
5.4	X *	*	X *	X *			X *				
WWH											
U											
Paine Run	1 1 6.4	1 147	1 0	0 1 51			0 1 0.1				1973
6.3	X *	*	X *	X *			X *				
WWH											
U											
Ackerson Run	0 3 7.6	3 138	3 0	0 3 69.7		2 358.5	0 3 0.14	0 2 0.00			1973
6.4	0 *	*	0 *	0 *		*	0 *	0 *			1979
WWH											
U											
Flat Run	0 2 7.25	2 122.5		0 2 80.5		2 410	0 2 0.37	0 2 0.015	0 2 0.01	2 0.245	1975
2.0	0 *	*		0 *		*	0 *	0 *	0 *	*	
WWH											
NM											
Piney Fork	0 3 7.67	3 106.7	1 0	0 3 34.7		2 260	0 3 0.15	0 2 0.02			1973
6.8	0 *	*	*	0 *		*	0 *	0 *			1979
WWH											
S											
Death Creek	0 1 6.8	1 108	1 0	0 1 17			0 1 0.4				1973
3.8	X *	- *	*	X *			X *				
WWH											
NM (oil and gas wells)											

USGS (1975, 1979)
Skelly and Loy (1973)

Sunfish Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Baker Fork	1	3	7.4	3	88.7	3	0	0	3	28.0				2	231	0	3	0.18	0	2	0.025						1973
6.7	0	*			*		*	0	*						*	0	*		0	*							1979
WWH																											
NM (oil and gas wells)																											
Inflow of	0	1	6.0	1	59	1	0	0	1	26						1	1	2.3									1973
Woodsfield Res.	X	*			*	X	*	X	*							X	*										
(Whittenbrook Run)																											
EWH/PWS																											
NM (oil and gas wells)																											
Wheeler Run	1	3	7.43	3	63.3	1	0	0	3	31.3				2	387	0	3	0.16	0	2	0.015						1973
5.2	0	*			*			X	*							0	*		0	*							1979
WWH																											
NM																											

(Skelly and Loy, 1973)
(USGS, 1979)

Wheeling Creek - headwaters to mouth, and all tributaries::

Frazier Run, Slaughterhouse Run, Mutton Hollow Run, Soaptown Hollow Run, Flat Run, McMonies Run, Steep Run, Town Run, Fall Run, Jug Run, Sloan Run, Cox Run (Patton Run), Pogue Run, Loves Run, McCracken Run, Crabapple Creek (Campbell Creek), Bannock Tributary, Oco South Tributary, South Branch (West Branch).

Wheeling Creek is 30.2 miles long and drains an area of 108 square miles in Belmont, Harrison, and Jefferson counties.

Wheeling Creek empties into the Ohio River below Martins Ferry. Its headwaters are located near the small village of Flushing in northern Belmont County. The Flushing wastewater treatment plant discharges indirectly into Wheeling Creek via an unnamed tributary. From Flushing, Wheeling Creek continues east, through steeply sloping topography, toward the Village of Bridgeport (population 2913). Bridgeport is located south of Martins Ferry, on the flatlands along the Ohio River. The Belmont County Plum Street wastewater treatment plant discharges directly into Wheeling Creek.

The general topography of the watershed has been significantly altered by widespread strip mining. As a result, nonpoint source pollution in the forms of acid mine drainage and surface runoff present problems in most of the watershed's streams. Wheeling Creek and all its tributaries are classified WWH.

The entire watershed has been extensively surface and underground mined in the Nos. 8 and 9 coal seams. Both of these coal seams have a high pollution potential for underground mining, the No. 8 seam in the entire watershed, and the no. 9 seam in the western half of the watershed. A neutralizing strata, the Redstone limestone, lies above the No. 8 coal seam and effectively neutralizes drainage from surface mines. However, since it lies above the coal seam, it cannot neutralize drainage from underground mines.

The mainstem of Wheeling Creek has been sampled up to 38 times over the period of record 1958 to 1979. Data sources include Skelly and Loy (1973), FWPCA (1968), USGS (1966-73, 1975, 1978, 1979), Ohio DNR, Division of Water (1958), and Ohio EPA, OLPC (1979).

Wheeling Creek has an excellent buffering capacity and very little to no acidity. The mode of the pH values is 8.0 S.U., which demonstrates the excellent neutralizing potential of the strata.

Sulfate concentrations, however, are a severe problem, and total dissolved solids, iron, and manganese concentrations are minor problems. Aluminum concentrations are occasionally quite high.

Limited data is available for most of the tributaries of Wheeling Creek. It was collected by Skelly and Loy (1973), USGS (1975), and Ohio EPA, OLPC (1979).

Most of the tributaries of Wheeling Creek have the same general characteristics. They have excellent buffering capacities, zero acidities, and pH values above 6.5 S.U. However, they often have moderate to severe sulfate problems and minor to severe iron problems.

Town Run and Jug Run have lower buffering capacities but no acidity, and pH values of 6.0. Steep Run has a good buffering capacity, but a moderate acid problem and a mean pH value of 6.4 S.U. Sulfate concentrations are a moderate problem, while iron concentraions are a severe problem. Flat Run is severely affected, with an acid concentration of 920 mg/l, pH value of 5.5 S.U., sulfate concentration of 3700 mg/l, and iron concentration of 285 mg/l.

All of the major tributaries of Wheeling Creek have abandoned mines in their basins. No data on unaffected tributaries is available.

The only surface PWS in the watershed is one of the St. Clairsville reservoirs located on Jug Run. It is discussed under the McMahon Creek watershed.

No biological data is available for the Wheeling Creek watershed.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constitutent	No Exc/No Smp	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Wheeling Creek 30.2/30.2 WWH S,U,R, Upst	pH	1/38	Apr June - Oct	12	1958-79	8.0 (mode)	8.3	6.4	0 =	
	Alkalinity	-/34	June - Oct	9	1968-79	180	292	41	+	
	Acidity	1/25	June - Oct	3	1968-79	0.4	11	0	0 +	
	Sulfate	37/37	Apr June-Oct	11	1958-79	1092	1850	300	3 =	
	TDS	21/24	Apr June-Oct	10	1958-79	2078	2890	1120	1 =	
	Conductivity	-/31	Apr June-Oct	12	1958-79	1839	3200	230	=	
	Iron	27/31	March-April, June-Oct	6	1958-79	5.0	20.0	0.2	1 =	
	Manganese	23/23	June-July Sept-Oct	5	1968-79	0.53	1.1	0.11	1 =	
	Zinc	0/21	March, June-Oct	3	1975-79	0.016	0.09	0	0 =	
	Aluminum	-/21	June-July Sept-Oct	3	1968-79	2.4	21.8	0	+	

Skell nd Loy, 1973
FWPCA 968

Ohio DNR, DOW, 1958
Ohio EPA, OLPC, 1979

Wheeling Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH			Alkalinity Acidity			Sulfates			TDS			Conductivity		Total Iron			Total Manganese			Total Zinc			Total Aluminum			Period of Record
	# Exc WWH	# Smp	Mean	# Smp	Mean	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	# Exc WWH	# Smp	Mean	# Exc PWS	# Smp	Mean	# Exc WWH	# Smp	Mean	# Smp	Mean	
Frazier Run	0	1	6.6	1	331	1	0	1	1	3000						1	1	16.6									1973[1]
2.2	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
Slaughterhouse	0	1	6.8	1	198	1	0	1	1	640						1	1	1.1									1973,[1]
Run	X	*		-	*	X	*	X	*							X	*										
1.7																											
WWH																											
U																											
Mutton Hollow	0	1	6.8	1	177	1	0	0	1	760						1	1	4									1973[1]
Run	X	*		-	*	X	*	X	*							X	*										
(2.0)																											
WWH																											
S, U																											
Soaptown Hollow	0	1	6.9	1	201	1	0	0	1	2250						1	1	3.0									1973,[1]
Run	X	*		-	*	X	*	X	*							X	*										
(2.1)																											
WWH																											
S, U																											
Flat Run	1	1	5.5			1	920	1	1	3700						1	1	285									1973,[1]
3.5	X	*				X	*	X	*							X	*										
WWH																											
S, U																											
McHonles Run	0	1	7.0	1	257	1	0	1	1	380						1	1	1.4									1973[1]
2.1	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											

1 (Skelly & Loy, 1973)

Wheeling Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Steep Run	2	7	6.4	6	154	5	160	3	7	731	0	4	68	4	2148	7	7	41.6	4	4	0.49	0	4	0.105	4	10.8	1973[1]
2.6	1	*		-	*	2	*	2	*		0		*	-	*	3	*		1	*		0	*		-	*	1979[2]
WWH																											
S, U																											
Town Run	1	1	6.0	1	64	1	0	1	1	550						1	1	5.8									1973,[1]
3.2	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
Fall Run	0	2	6.6	2	104	2	0	2	2	1975						2	2	30.4									1973[1]
3.4	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
Jug Run	1	1	6.0	2	140	2	0	1	2	231						0	2	0.4									1973,[1]
3.8	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U, R																											
Sloan Run	0	1	7.3	1	264	1	0	1	1	950						0	1	0.3									1973,[1]
4.2	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
Cox Run	0	4	7.45	4	255	2	0	4	4	848				2	1480	1	4	0.86	2	2	0.22	0	2	0.035	2	0.3	1973[1]
5.2	0	*		-	*	0	*	2	*					-	*	0	*		1	*		0	*		-	*	1975[3]
WWH																											
S, U, R																											

1 (Skelly & Loy, 1973)
2 (Ohio EPA, OLPC, 1979)
3 (USGS, 1975)

Wheeling Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Patton Run																											
2.4																											
WWH																											
S, U																											
Pogue Run	0	2	6.9	1	216	1	0	1	1	420						0	1	0.1									1973,[1]
4.5	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
Loves Run	0	1	7.0	1	188	1	0	1	1	2050						1	1	3.6									1973[1]
2.4	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											
McCracken Run	0	6	7.1	6	175	2	0	6	6	1130				4	2227	5	6	25.3	4	4	0.47	0	4	0.095	4	2.9	1973,[1]
4.9	0	*		-	*	0	*	3	*					-	*	3	*		1	*		0	*		-	*	1975[2]
WWH																											
S, U																											
Crabapple Creek	0	4	7.1	4	178	2	0	4	4	1302				2	2760	3	4	2.2	2	2	1.1	0	2	0.105	2	5.75	1973,[1]
8.0	0	*		-	*	X	*	3	*					-	*	1	*		X	*		X	*		-	*	1975[2]
WWH																											
S, U, R																											
Campbell Creek	1	0	6.5	1	144	1	0	1	1	2550						0	1	0.4									1973[1]
6.3	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U,																											

1 (Skelly & Loy, 1973)
2 (USGS, 1975)

Wheeling Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Bannock Trib.	0	1	6.8	1	213	1	0	1	1	400						1	1	2.1									1973[1]
(2)	X		*	-	*	X	*	X		*						X		*									
WWH																											
S, U																											
Oco South Trib.	0	1	6.7	1	222	1	0	1	1	1000						0	1	1.8									1973,[1]
(2.3)	X		*	-	*	X	*	X		*						X		*									
WWH																											
S, U																											
South Branch	0	1	7.5	1	201	1	0	1	1	1400						0	1	0.2									1973[1]
(2.2)	X		*	-	*	X	*	X		*						X		*									
WWH																											
S																											
West Branch	0	1	6.5	1	80	1	0	1	1	1150						1	1	1.1									1973,[1]
(2.0)	X		*	-	*	X	*	X		*						X		*									
WWH																											
S																											

[1] (Skelly & Loy, 1973)

Yellow Creek - headwaters to mouth, and tributaries:

Rocky Run, Hollow Rock Run (Tarburner Run, Carter Run), North Fork (Salt Run, Salisbury Run, Randolph Run, Nancy Run, Riley Run), Brush Creek (Dennis Run, Roach Run), Town Fork (Dry Run, Austin Lake, Culp Run, Jefferson Lake), Long Run (Hildebrand Run), Roach Run, Ralston Run (Mathews Run), Upper North Fork (Hump Run (Burgett Run, Carroll Run)), Elkhorn Creek (Strawcamp Run, Center Fork (Trail Run, Frog Run)), Wolf Creek, Goose Creek, Elk Lick.

Yellow Creek is 34.0 miles long and drains an area of 236 square miles. It originates in Carroll County and flows east into Jefferson County and the Village of Amsterdam, which is located at the county line. Amsterdam (population 844) is a small mining town, and residential uses account for over 60 percent of the village's total land. Only one percent of the land is used for commercial purposes. About 16 percent of the land is taken up by the village's streets and highways, and about 14 percent of the land is undeveloped. There are no point source dischargers within the village; however, the North American Coal Corporation discharges indirectly into Yellow Creek via Wolf Run, just east of Amsterdam.

From Amsterdam, Yellow Creek flows north through the Village of Berghloz (population 925). The creek borders Bergholz on the northern and western sides. Like Amsterdam, it is a small mining town. Approximately 52 percent of the village's land is residential. Less than one percent is used for commercial purposes. The streets and highways take up about nine percent of the land, while 33 percent is undeveloped.

Yellow Creek turns east at Bergholz and flows through the heavily forested hills of northern Jefferson County. North Fork Yellow Creek joins Yellow Creek at Hammondsville. North Fork orginates in southern Columbiana County, near Salineville (population 1966). The Salineville water plant discharges into North Fork.

From Salineville, North Fork flows southeast to where it joins the mainstem at Hammondsville. From there, Yellow Creek continues east and empties into the Ohio, below Wellsville. The Swank Refractories Company discharges indirectly into Yellow Creek, before it empties into the Ohio.

Yellow Creek and its tributaries are classified WWH, except for Elkhorn Creek and its tributaries - Strawcamp Run, Center Fork, Trail Run, and Frog Run, which are classified EWH.

The Nos. 5 and 6 coal seams are surface and underground mined in the eastern portion of the watershed, the No. 7 in the northern portion, and the No. 8 in the southern portion. All of these coal seams have a high pollution potential for underground mining in this basin.

The Yellow Creek mainstem has been sampled up to 44 times over the period of record 1965-79. Data sources include Skelly and Loy (1973), USGS (1965-72, 1975), FWPCA (1968), and Ohio EPA, OLPC (1979).

Yellow Creek has an adequate buffering capacity most of the time, but it occasionally is acidic. The mode of the pH values is 7.3 S.U., but the

minimum value is 3.0 S.U. The mean sulfate concentration is slightly lower than the PWS standard. Iron and manganese concentrations cause minor problems in Yellow Creek.

The tributaries of Yellow Creek have been sampled by Skelly and Loy (1973), USGS (1966-75, 1979), and Ohio EPA, OLPC, 1979). Many of the smaller tributaries have not been sampled, although most of the larger ones have been sampled at least once. Because the watershed is so large, the groups of tributaries will be discussed separately.

Hollow Rock Run and its tributary Tarburner Run, located near the mouth of Yellow Creek, have excellent buffering capacities but minor sulfate problems.

The North Fork of Yellow Creek and its tributaries drain most of the northern portion of the watershed. These creeks have limited to adequate buffering capacities and minor to no sulfate, iron, and manganese problems. Dry Run, which has no abandoned mines in its drainage, has an excellent buffering capacity and no problems. Salisbury Run, which has been extensively surface and underground mined, has severe acid and iron problems, moderate pH problems, and minor sulfate problems.

At present, Irondale obtains its water from a reservoir on Salt Run which has abandoned mines in its drainage, but they have been under orders for several years from Ohio EPA to switch to the Jefferson County water system. No water quality data is available for either the reservoir or Salt Run. Salineville obtains its water from an impoundment on Riley Run. The watershed of the impoundment has been extensively surface and underground mined and the city has had mine-related water problems in the past. The available data, however, show no problems.

Brush Creek has an adequate buffering capacity and no problems. There is no data available for its tributaries.

Town Fork has an excellent buffering capacity and no problems except for minor iron exceedances. Austin Lake and Jefferson Lake are impoundments of Town Fork which have abandoned mines in their drainages, but there is no data available for these lakes.

Long Run has an adequate buffering capacity and no mining-related problems, but Roach Run and Ralston Run, which are in the same area, do have problems. Roach Run has the worst water quality in the Yellow Creek watershed, with zero buffering capacity and a mean acidity of 508 mg/l. Sulfate and iron concentrations cause severe problems, while manganese is a moderate problem. Ralston Run has adequate buffering capacity but minor pH and sulfate problems.

The tributaries in the western portion of the watershed all have good buffering capacities, no acidity, and few mine drainage problems. Goose Creek has a minor sulfate problem, the Upper north Fork has a minor iron problem, and Upper North Fork, Center Fork, Goose Creek, and Elk Lick all have minor manganese problems.

There is no biological data available for the Yellow Creek watershed, but Ohio DNR, Division of Wildlife reported a fish kill in Yellow Creek on August 25, 1970. Seven hundred sixty-five fish were killed.

Stream Name / Segment mi/Total mi / Use Designation / Pollution Source	Constituent	No Exc/Smp	No	Sample Months	No Yrs	Period of Record	Mean	Max	Min	Degree of Problem Trend	Remarks
Yellow Creek 34.0 WWH S, U, R, Up.	pH	7/29		Jan-Feb Apr July-Nov	11	1965-79 1978	7.3 (mode)	7.8	3.0	0 =	
	Alkalinity	-/19		July-Oct	8	1968-79	38	76	7	=	
	Acidity	-/11		July-Oct	3	1968-79	11	111	0	1 *	
	Sulfate	12/29		Jan-Feb Apr July-Nov	11	1965-79	241	580	67	0 =	
	TDS	0/4		Sept-Oct	1	1979	468	977	276	0 *	
	Conductivity	-/44		Jan-Dec	10	1965-79	544	989	297	=	
	Iron	10/14		July-Oct	4	1968-79	1.6	4.9	0.5	1 =	
	Manganese	-8/8		July-Oct	3	1968-79	0.51	1.0	0.31	1 *	
	Zinc	1/6		July Sept-Oct	2	1975-79	0.03	0.1	0	0 *	
	Aluminum	-/10		July-Oct	3	1968-79	1.26	7.7	0.2	*	

(Skelly and Loy, 1973)
(FWPCA, 1968)
(USGS, 1965-72, 1975)
(Ohio EPA, OLPC, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH	Alkalinity	Acidity	Sulfates	TDS	Conductivity	Total Iron	Total Manganese	Total Zinc	Total Aluminum	Period of Record
	# Exc WWH / # Smp / Mean	# Smp / Mean	# Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	# Exc WWH / # Smp / Mean	# Exc PWS / # Smp / Mean	# Exc WWH / # Smp / Mean	# Smp / Mean	
Rocky Run											
3.6											
WWH											
S, U											
Hollow Rock Run	0 / 1 / 6.5	1 / 101	1 / 0	0 / 1 / 480			0 / 1 / 0.1				1973[1]
6.4	X / *	- / *	X / *	X / *			X / *				
WWH											
S, U											
Tarburner Run	0 / 1 / 6.6	1 / 149	1 / 0	1 / 1 / 490			1 / 1 / 1.1				1973[1]
2.5	X / *	- / *	X / *	X / *			X / *				
WWH											
S											
Carter Run											
1.5											
WWH											
S											
North Fork	7.9										
10.5	0 / 10 / 7.0	7 / 49		9 / 10 / 283	0 / 7 / 545	10 / 768		1 / 1 / 0.12			1966-74[2]
WWH	0 / *	- / *		1 / *	0 / *	- / *		X / *			
S, U, Upst.											
Dry Run	0 / 1 / 6.8	1 / 122	1 / 0	1 / 1 / 86			0 / 1 / 0.5				1973[1]
2.3	X / *	- / *	X / *	X / *			X / *				
WWH											
No Mines											

1 (Skelly and Loy, 1973)
2 (USGS, 1966-74)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Salt Run																											
4.6																											
WWH, PWS																											
U																											
Irondale																											
PWS*																											
Salisbury Run	1	1	4.8			1	170	1	1	550						1	1	52									1973[1]
2.5	X	*				X	*	X	*							X	*										
WWH																											
S, U																											
Randolph Run	1	1	6.1	1	37	1	0	1	1	320						1	1	3.4									1973[1]
2.8	X		*	-	*	X	*	X	*							X		*									
WWH																											
S																											
Nancy Run	1	1	6.3																								1973[1]
5.3	X		*																								
WWH																											
S																											
Riley Run	1	2	6.6	2	31	1	0	1	2	205				1	320	2	2	1.8	0	1	0.3						1973[1]
7.5	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[2]
WWH, PWS																											
S, U																											
Salineville	1	3	6.7	3	44			0	3	101	0	1	226	1	320	0	3	0.54	3	3	0.35	0	1	0	3	0	1975-77[3]
PWS	X	*		-	*			X	*		X	*		-	*	X	*		X	*		X	*		-	*	
raw water																											
at treatment plant																											

* No data; they under orders to switch to county water supply

1 (Skelly and Loy, 1973)
2 (USGS, 1979)
3 (Ohio EPA, OPWS, 1975-77)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Brush Creek	1	3	7.3	3	57	1	0	1	3	178				2	330	1	3	1.04	0	2	0.03						1973[1]
11.0	X		*	-	*	X	*	X		*				-	*	X		*	X		*						1979[2]
WWH																											
S, U																											
Dennis Run																											
1.5																											
WWH																											
S																											
Roach Run																											
3.1																											
WWH																											
S																											
Rose Run																											
3.1																											
WWH																											
S																											
Allman Run																											
(2.0)																											
WWH																											
S																											
Town Fork	0	2	8.6	2	93			0	2	160				2	545	1	2	1.32	1	2	0.05						1979[2]
12.4	X		*	-	*			X		*				-	*	X		*	X		*						
WWH																											
U, S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	Sulfates # Smp	Sulfates Mean	Sulfates # Exc PWS	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Dry Run																									
1.3																									
WWH																									
S																									
Austin Lake																									
on Town Fork																									
PWS Up.																									
Jefferson Lake																									
on Town Fork																									
PWS																									
S, Up.																									
Long Run	1	3	7.2	3	65	1	0	0	3	84		2	260	0	3	0.37	1	2	0.065						1973[1]
9.0	X		*	-	*	X	*	X	*			-	*	X		*	X		*						1979[2]
WWH																									
S, U																									
Hildebrand Run																									
2.2																									
WWH																									
S																									
Roach Run	3	3	2.6	2	0	3	508	3	3	1123		2	1555	3	3	162	2	2	3.35						1973[1]
2.2	3		*	-	*	3	*	3		*		-	*	3		*	2		*						1975[2]
WWH																									
R, U																									

1 (Skelly and Loy, 1973)
2 (USGS, 1975, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Ralston Run	1	1	5.8	1	47	1	0	1	1	290						0	1	0.3									1973[1]
4.3	X		*	-	*	X	*	X		*						X		*									
WWH																											
S																											
Mathews Run																											
1.8																											
WWH																											
S																											
Upper North Fork	0	2	7.8	2	60			0	2	37.5				2	215	1	2	1.35	1	2	0.14						1979[2]
8.4	X		*	-	*			X		*				-	*	X		*	X		*						
WWH																											
S, U																											
Hump Run																											
4.2																											
WWH																											
Upst																											
Burgett Run																											
2.5																											
WWH																											
U																											
Carroll Run																											
2.8																											
WWH																											
S																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity Acidity # Smp	Alkalinity Acidity Mean	# Smp	# Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Elkhorn Creek	1	1	6.3	1	76	1	0	0	1	74						0	1	0.8									1973[1]
0.9	X	*		-	*	X	*	X	*							X	*										
EWH																											
S, U, R																											
Strawcamp Run	1	3	7.3	3	67	1	0	0	3	35				2	210	1	3	0.57	0	2	0.045						1973[1]
4.8	X	*		-	*	X	*	X	*					-	*	X	*		X		*						1979[2]
EWH																											
S																											
Center Fork	1	3	7.7	3	82	1	0	0	3	99				2	385	0	3	0.35	2	2	0.075						1973[1]
5.0	0	*			*	0	*	0	*						*	0	*		0	*							1979[2]
EWH																											
S, Up																											
Trail Run																											
1.9																											
EWH																											
S, U																											
Frog Run																											
2.5																											
EWH																											
S																											
Wolf Creek	1	1	6.3	1	79	1	0	0	1	160						0	1	0.4									1973[1]
4.5	X	*		-	*	X	*	X	*							X	*										
WWH																											
S, U																											

1 (Skelly and Loy, 1973)
2 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

Yellow Creek Tributaries

Stream Name / Miles / Use Designation / Pollution Source	pH # Exc WWH	pH # Smp	pH Mean	Alkalinity # Smp	Alkalinity Mean	Acidity # Smp	Acidity Mean	Sulfates # Exc PWS	Sulfates # Smp	Sulfates Mean	TDS # Exc WWH	TDS # Smp	TDS Mean	Conductivity # Smp	Conductivity Mean	Total Iron # Exc WWH	Total Iron # Smp	Total Iron Mean	Total Manganese # Exc PWS	Total Manganese # Smp	Total Manganese Mean	Total Zinc # Exc WWH	Total Zinc # Smp	Total Zinc Mean	Total Aluminum # Smp	Total Aluminum Mean	Period of Record
Goose Creek	0	5	7.2	5	90	5	0	1	5	286	0	4	401	4	364	1	5	0.46	4	4	0.245	0	4	0	4	0.22	1979[1]
3.8	0	*		-	*	0	*	0-1	*		0	*		-	*	0	*		1	*		0		*	-	*	
WWH																											
S, U																											
Elk Fork	0	1	7.0	1	76	1	0	0	1	42						0	1	0.7									1973[2]
3.4	X	*		-	*	X	*	X	*							X	*										
WWH																											
No Mines																											
Elk Lick	0	3	7.6	3	90	1	0	0	3	155				2	480	1	3	0.79	2	2	0.17						1973[2]
3.6	X	*		-	*	X	*	X	*					-	*	X	*		X	*							1979[3]
WWH																											
S, U																											

1 (Ohio EPA, OLPC, 1979)
2 (Skelly and Loy, 1973)
3 (USGS, 1979)

Concentrations in mg/l,
Conductivity in umhos/cm,
pH in S.U.

GLOSSARY

Abatement - Elimination of pollutional effects upon the aquatic environment caused by mine drainage.

Alkaline - Having the qualities of a base; i.e., a pH above 7.0.

Aquatic - Of or relating to water.

Aquifer - A water-bearing stratum of permeable rock, sand, or gravel.

Auger - Any drilling device in which the cuttings are mechanically and continuously removed from a borehole without the use of fluids.

Benthos - Organisms that inhabit the bottom substrate of lakes, ponds and streams. These organisms may be artifically divided into two major groups - macrobenthos and microbenthos. Macrobenthos consist of organisms retained by a No. 30 U.S. Series sieve.

CWH - Coldwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Deep Mine - An underground mine.

DNR - Department of Natural Resources - A State of Ohio agency.

Drainage - The area drained by a particular stream.

Drift - A deep mine entry driven directly into a horizontal or near horizontal mineral seam or vein when it outcrops or is exposed at the ground surface.

Effluent - Any water flowing out of the ground or from an enclosure to the surface flow network.

EPA - Abbreviation for Environmental Protection Agency.

Erosion - Process whereby solids are removed from their original location on the land surface by hydraulic or wind action.

EWH - Exceptional Warmwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Gob - Rock that has a high carbon content - usually referring to dark colored mining waste material.

Haul Road - A road built to carry heavily loaded trucks. The grade is limited on this type of road and usually kept to less than 17 percent of climb in the direction of load movement.

Head (of water) - Water pressure expressed as the feet of elevation difference between the top of the water and the point at which the pressure is exerted.

Highwall - The exposed vertical or near vertical wall associated with strip or area surface mines.

Hydrology - The science that relates to the water systems of the earth.

Impoundment - A body of water formed by collecting and confining water, as in a reservoir.

Infiltration - Water entering the gound water system through the land surface.

Leaching - Extraction of a mineral from an ore by selectively dissolving it in a suitable solvent.

Meiofauna - Microbenthos of the interstitial sediments of lakes and streams.

Mining - The process of obtaining useful minerals from the earth's crust which includes both underground excavations and surface workings.

Neutralization - The process of adding an acid or alkaline material to wastewater to adjust its pH to a neutral position.

Outcrop - The surface exposure of bedrock or strata.

Outslope - The face of a strip mine bench or spoil pile opposite the highwall.

Overburden - The nonsalable rock material that overlies a mineable mineral.

Parameter - Any of a set of physical properties whose values determine the characteristics or behavior of something.

pH - The negative logarithm to the base ten of the hydrogen ion activity. pH 7 is considered neutral. Above 7 is basic - below 7 is acidic.

PWS - An abbreviation for Public Water Supply, an office of Ohio EPA.

Pyrites - Any of various metallic-looking sulfides of which Ferrous Sulfide (Pyrite) is the most common.

Reclamation - The procedures by which a disturbed area can be reworked to make it productive, useful, non-polluting or aesthetically pleasing. Reclamation does not necessarily imply return of the land to its original physical state or condition.

Refuse - Rock that has a high carbon content - usually refers to the dark colored mining waste extracted from underground mines.

Reserve - That portion of the actual identified resource material which can be economically and legally extracted at the time of determination.

Resource - Material known to exist in the earth's crust or judged by geologic inference and extrapolation as likely to exist.

Runoff - That part of precipitation that flows over the land surface from the area upon which it falls.

Sediment - Solid material settled from suspension in a liquid medium.

SEDO - Southeast District Office, an office of Ohio EPA.

Settling Pond - A holding or retention pond which provides sufficient residence time to allow the precipitation of suspended solids.

Silt (Sediment) - Solid material settled from suspension of a liquid medium.

Slope Stability - The resistance of any inclined surface, as the wall of an open pit or cut, to failure by sliding or collapsing.

Slugging - The sudden increase in concentration of stream pollutants, such as silt, acid, iron, or sulfate, resulting from heavy rainfall rapidly washing the leached pollutants from the land surface and underground mines.

Spoil Material - The waste material removed from the strip cut that is not considered a useful product.

Spoil Pile - The area where mine waste or spoil materials are disposed or piled.

STORET - U.S. EPA's data storage and retrieval system.

Strip Mine - A surface mine where the overburden is removed to expose the mineable material.

Stripping - The removal of earth or non-ore rock material as required to gain access to the ore or mineral materials wanted; the process of removing overburden or waste material in a surface mining operation.

Subsidence - The surface depression over an underground mine that has been created by subsurface caving.

Surface Mine - A mine facility that is generally conducted from the land surface. It does not have a mineral roof.

TDS - An abbreviation for total dissolved solids.

Watershed - Surface region or area contributing to the supply of a stream or lake; drainage area, drainage basin, catchment area.

WWH - Warmwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Yellowboy - The unsightly, orange-red or yellow precipitate of ferric sulfate and hydroxide observed in many streams polluted by mine drainage.

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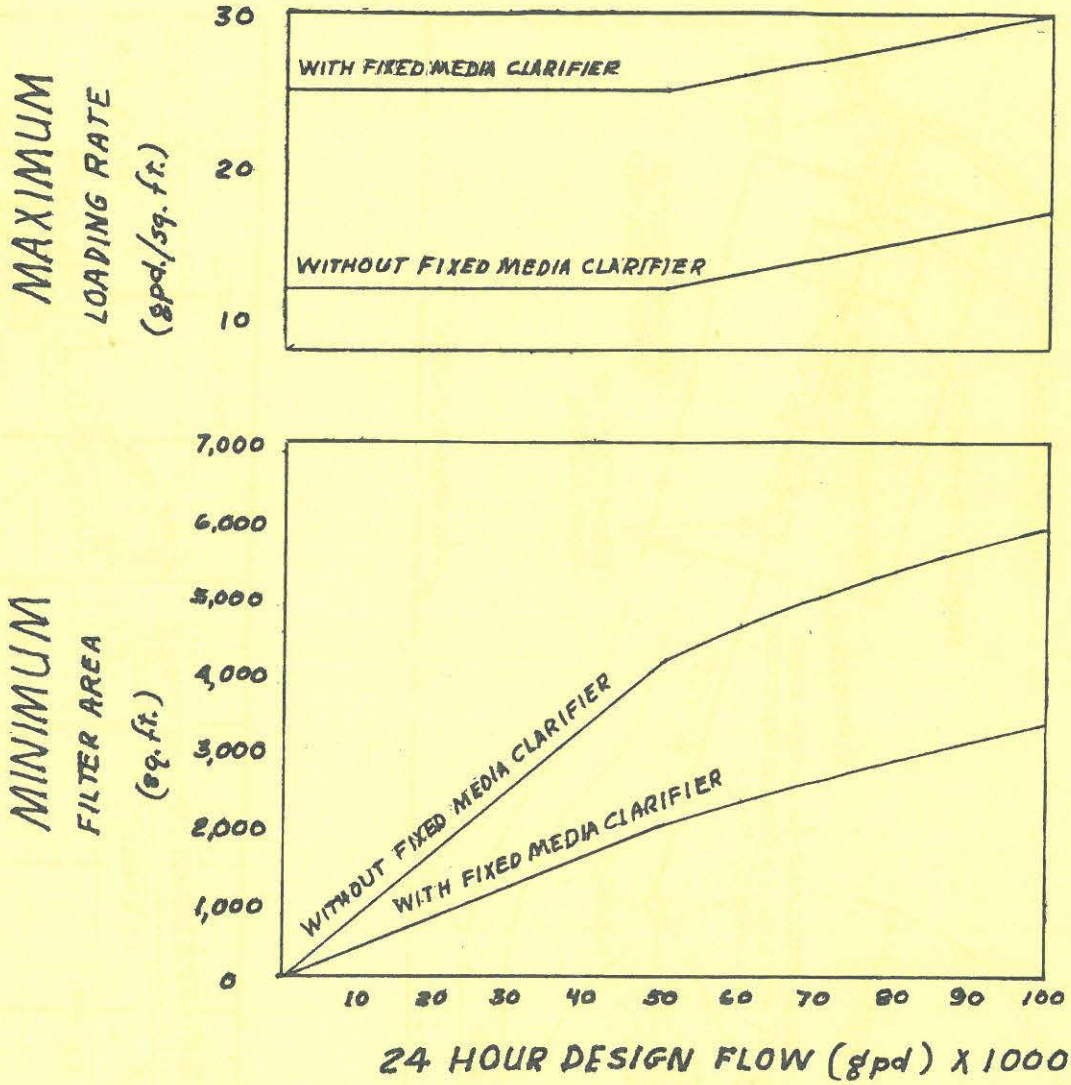
APPENDIX



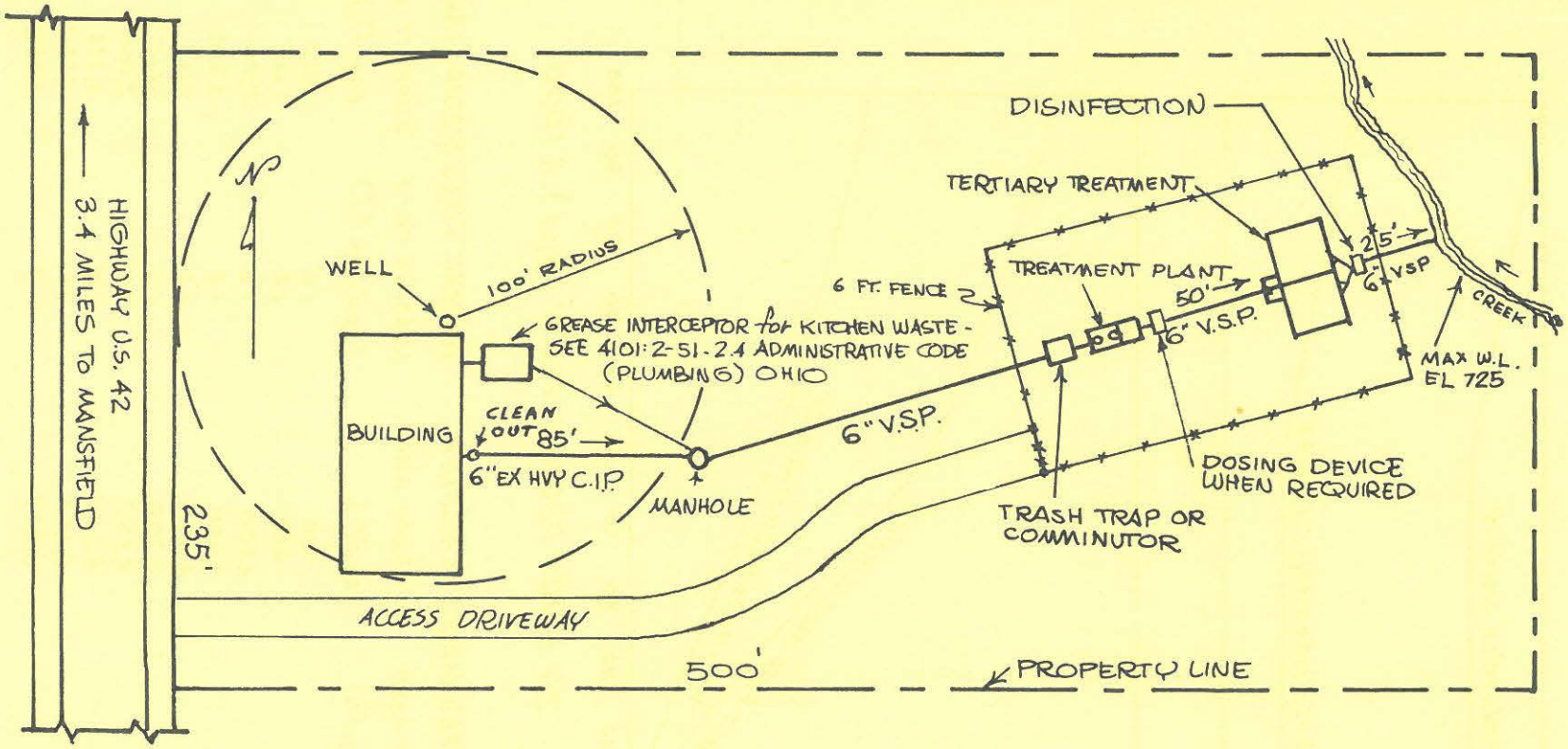
24 HOUR DESIGN FLOW (gpd)	WITH FIXED MEDIA CLARIFIER		WITHOUT FIXED MEDIA CLARIFIER	
	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)
10,000	25	400	12	833
20,000	25	800	12	1,667
30,000	25	1,200	12	2,500
40,000	25	1,600	12	3,333
50,000	25	2,000	12	4,167
60,000	26	2,308	13	4,615
70,000	27	2,593	14	5,000
80,000	28	2,857	15	5,333
90,000	29	3,103	16	5,625
100,000	30	3,333	17	5,882

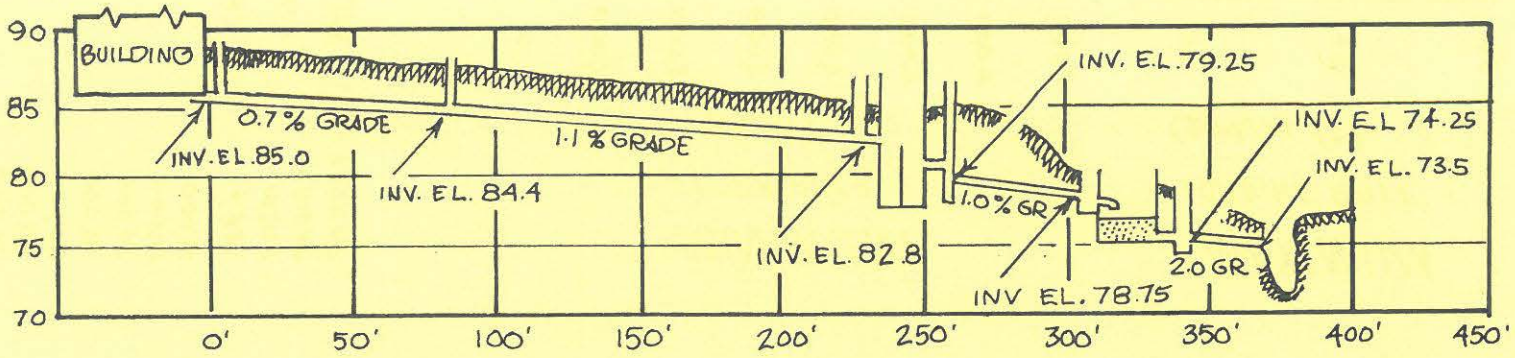
SLOW SAND FILTERS - LOADING RATE AND AREA

(SEE PAGE 16)

TYPICAL SITE PLAN AND PROFILE

(SEE PAGES 3 & 9)
DRAWING No. 1





BIOLOGICAL EVALUATIONS

1980 305(b) Report
Volume VI

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Biological Evaluation

Summary

The following document is the result of a compilation of biological data collected during the years 1974 to 1978 by personnel of the Biomonitoring Section of the Ohio Environmental Protection Agency. Included are water quality evaluations based on analyses of benthic macroinvertebrate communities at sites on streams and rivers across the State of Ohio. Site selection was limited to stations located near entities found on the Ohio Major Dischargers List, stations that were included in the National Stream Quality Accounting Network (NASQAN) or the National Water Quality Surveillance System (NWQSS). Evaluations were made based on biological parameters generated from the benthic data collected. These included the types and numbers of taxa present, diversity indices, and, where applicable, coefficients of variation for replicate samples.

The document consists of four sections: the introduction, the methods, the water quality evaluation, and the results and discussion. Section I (Introduction) deals with a brief overview of the advantages of using benthic macroinvertebrate communities in assessments of water quality. Section II (Methods) is divided into field and laboratory components consisting of detailed descriptions of the collection, processing, and analysis of the benthic samples. Section III (Water Quality Evaluation) is devoted to an explanation of the procedure used to assign the sampling sites to their respective water quality classifications. Section IV (Results and Discussion) is a basin-by-basin report of the location of each sampling site, the date(s) it was sampled, the water quality classification decided upon, why that classification was assigned, and, where applicable, an assessment of the impact of a specific major discharger. Summary tables of benthic data for all sites are found throughout the text, and complete tabulated data for all the stations are found in Reference Document (RD) 3.

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MACROBENTHOS

I. INTRODUCTION

Benthic macroinvertebrates have been widely used to evaluate the quality of flowing water. These organisms have a number of qualities that make their use in pollution oriented studies particularly advantageous. The species composition and community structure of benthic communities in a given stream are determined by environmental factors which have existed during the life span of the organisms. They are sensitive to most types of pollution and even a short term exposure to unfavorable conditions may alter the community structure.

The benthic community, therefore, is a reflection of past environmental conditions, as well as what is occurring at the moment the sample is taken. In addition, these organisms form permanent or semi-permanent stream communities, are less transient than fish, are less sporadic in occurrence than micro- organisms, and usually occur in statistically significant numbers even in small streams.

Benthic macroinvertebrates can be defined by location; i.e., those organisms living on or interacting with the substrate, or by size; i.e., those organisms retained in a screen of a certain size. They cannot be defined by position in the trophic structure since they occupy virtually all levels. They may be omnivores, carnivores, or herbivores, and in a well balanced system, all types will likely be present. They include detritus feeders, parasites, scavengers, grazers, and predators. In streams exhibiting high water quality, a stable and diverse benthic community will usually exist consisting of a great many species but due to competition no single species will occur in great numbers. When the water quality is adversely affected, the more pollution sensitive forms will decline in number or be eliminated. The remaining pollution tolerant species may increase, resulting in a population imbalance where fewer types exist but with some occurring in great numbers. The nature and magnitude of the community alteration depend upon the nature and severity of the environmental change.

II. METHODS

A. Field

The primary sampling equipment used for the collection of benthos was the modified Hester-Dendy multiple-plate artificial substrate sampler. The sampler was constructed of 1/8 inch tempered hardboard cut into three inch square plates and one inch square spacers. A total of eight plates and twelve spacers were used for each sampler. The plates and spacers were placed on a 1/4 inch eyebolt so that there were three single spaces, three double spaces, and one triple space between the plates. The total surface area of the sampler, excluding the eyebolt, was 145.65 square inches.

When the samplers were established in streams they were tied to a concrete construction block which anchored them in place and also prevented the multiple-plates from coming into contact with the natural substrate. In water deeper than four feet, a float (1 qt. cubitainer) was attached to the samplers

to keep them within the upper four feet of the water column. The samplers were placed in runs rather than pools or riffles and an attempt was made to establish stations in as similar an ecological situation as possible. The samplers were exposed for a six week period. In streams greater than 60 feet in width, one set of multiple-plates was established approximately 20 feet from each bank. At National Ambient Monitoring Stations, a set of samplers consisted of three multiple-plates (three square feet) and at major discharger stations, five multiple-plates. Most biological field sampling was conducted from June 15 to September 15th. Composite samples, i.e., five multiple-plates, were used in station evaluations for routine monitoring. However, replicate samples (three multiple-plates) were analyzed for National Ambient Monitoring Network Stations.

When the samplers were retrieved, each was placed in a one quart plastic container while still submerged. The line was then cut and the plates removed from the stream. Formalin was added to each container to approximately equal a 10% solution. Qualitative samples were collected from the natural substrate at the time of retrieval of the multiple-plates. In shallow water, dip net samples were taken in a segment approximately 20 yards long in the area where the samplers were exposed. In deep water, grab samplers were used. Qualitative sampling continued until, by gross examination, no new taxa were being taken.

B. Laboratory

The multiple-plates were dismantled in the laboratory and the material washed through a U.S. Standard Testing Sieve number 40 (0.425 mm openings). Larger organisms were hand picked from the screens; smaller material was washed into a jar containing 70% alcohol. Where the number of organisms collected was so large that identification of each individual was impractical, a Folsom sample splitter was used to obtain a subsample. Identifications and counts were made using dissecting and compound microscopes. Dipterans of the family Chironomidae were prepared following the methods described by Mason (1973). Identifications were made using the following taxonomic keys: Beck and Beck (1966), Brown (1972), Burch (1972), Burks (1953), Frison (1935) Harman and Berg (1971), Hilsenhoff (1970), Hobbs (1972), Holsinger (1972), Klemm (1972), Lewis (1974), Pennak (1953), Roback (1957), Ross (1944), Usinger (1956), Walker (1958), Walker and Corbett (1975), Ward and Whipple (1959), and Williams (1972). After the benthic organisms had been identified and counted, the Shannon diversity index ($\bar{d}$) was calculated using the formula:

$$\bar{d} = -\sum\left(\frac{ni}{n}\right) \log_2 \left(\frac{ni}{n}\right)$$

In those cases where replicate analyses were conducted, coefficients of variation (CV) were determined following the procedures outlined by Li (1974) using the formula:

$$CV = \frac{\text{standard deviation}}{\text{mean}} \times 100$$

III. WATER QUALITY EVALUATION

The biological criteria used to evaluate water quality were (1) the types of organisms present, (2) the number of taxa colonizing the artificial substrate samplers, and (3) the Shannon information theory derived diversity index ($\bar{d}$).

Certain types of organisms have been historically associated with good water quality areas. Examples of more pollution sensitive groups would include stoneflies, mayflies, and caddisflies. Organisms usually dominating polluted stream segments include oligochaetes, pulmonate snails, and many types of diptera. Organisms are usually divided into three categories based on their sensitivity to pollution: tolerant, intermediate (facultative), or sensitive. These terms may be defined as follows:

> Tolerant - organisms usually associated with gross contamination and may be capable of thriving under very low dissolved oxygen concentrations.
>
> Intermediate - organisms having a wide range of tolerance and are frequently associated with moderate levels of contamination.
>
> Sensitive - organisms usually not found associated with even moderate levels of contamination and are generally intolerant of even moderate reductions in dissolved oxygen.

There are inherent problems in using aquatic organisms in this manner. Some species may be very tolerant to one type of stress and sensitive to another. For example, oligochaetes are tolerant of low levels of dissolved oxygen but are relatively sensitive to heavy metals. The environmental requirements of many species are not known and contrary opinions exist as to the pollutional sensitivity of many others. In addition, many organisms must be identified to the species level and this is not always possible. Though no attempt was made to use the "indicator species" concept as such, the presence, or perhaps more importantly, the absence of some major taxonomic groups from particular stations was considered significant. While there are exceptions, an association of mayflies, stoneflies, and caddisflies in a stream is indicative of good water quality conditions, and their absence denotes the presence of contaminants, or low dissolved oxygen levels, or both. Usually the presence or absence of other gill breathing organisms has similar indicator significance.

From numerous stream water quality investigations, we have found that the number of different taxa colonizing multiple-plate samplers range from three in grossly polluted areas, to over 40 in very high water quality stream segments. The analysis of many hundreds of multiple-plate samplers has shown that it is a very rare occurrence that more than 20 taxa will be collected on samplers established in streams known to be grossly polluted. Likewise, in streams known to be pollution free, usually more than 30 taxa colonize the multiple-plates. These observations were made on samplers established throughout the State of Ohio on streams greater than first order, with an exposure period of six weeks, and sampled primarily from early June through late October.

The Shannon index $\bar{d}$ is a function of numbers of taxa, total number of individuals, and most importantly, the distribution of the individuals among the taxa. Unlike some diversity indices, $\bar{d}$ distinguishes among species of different abundance. This index is a strong reflection of a population imbalance that, in some cases, may not be readily apparent in tabulated data. Previous investigations of Ohio's streams have revealed a range of index values from a low of 0.009, in a grossly polluted area, to 4.120 in a stream exhibiting very high water quality. Usually, the indices derived from data collected on multiple-plate samplers were greater than 3.0 in streams exhibiting high water quality and less than 2.0 in those areas known to be severely degraded.

For the purposes of this report, we have integrated the indicator concept and Shannon index with our observations upon the relationship between the number and type of taxa and degree of pollution. This enabled us to categorize stream water quality based on an analysis of the benthic data which was both qualitative and quantitative. The four categories are Class I (Excellent), Class II (Good), Class III (Fair), and Class IV (Poor). Table VI-1 summarizes the criteria used in formulating these classifications.

Class I streams have an abundance of sensitive species. Intermediate and tolerant species are present in low numbers. The number of taxa exceeds 30 and the Shannon index exceeds 3.0.

Class II streams have sensitive and intermediate species present in moderate numbers. Tolerant species may be present in low numbers. Usually the number of taxa ranges from 25 to 30 and the Shannon index 2.5 to 3.0. Many Class II streams have mild organic pollution.

Class III streams have intermediate species present in abundance with tolerant species present in moderate numbers. Sensitive species may be present in low numbers. The number of taxa usually ranges from 20 to 25 and the Shannon index 2.0 to 2.5.

Class IV streams may have tolerant species in abundance, intermediate species in low numbers or absent, and no sensitive species present. All types of organisms may be absent if extreme toxic conditions exist. The number of taxa will be less than 20 and the Shannon index less than 2.0.

In some instances a stream will meet some but not all criteria for a given classification. The class assigned will usually be that in which all criteria are met. However, there may be circumstances where, based on the experience and judgment of the investigator, a higher class will be assigned.

There are inherent weaknesses in the above scheme and interpretation for purposes other than an overview should be made with caution. The terms abundant, moderate, and low are relative and, due to intersite variations, past attempts to determine absolute values for these terms met with failure. The difference between stations assigned to successive classes, in some cases, may be slight. In addition, considerable variation in water quality may exist in segments assigned to the same class. This can be particularly misleading in stream segments where some degree of recovery has taken place, but the degree of recovery is not sufficient to justify a higher classification.

Table VI-1. Criteria used to Formulate Stream Class Based on the Benthic Biota

Class I (Excellent)	Class II (Good)	Class III (Fair)	Class IV (Poor)
Pollution sensitive species abundant	Pollution sensitive species present in moderate numbers	Pollution sensitive species present in low numbers	Pollution sensitive species absent
Intermediate species present in low numbers	Intermediate species present in moderate numbers	Intermediate species abundant	Intermediate species present in low numbers or absent
Tolerant species present in low numbers	Tolerant species present in low numbers	Tolerant species present in moderate numbers	Tolerant species abundant (all types may be absent if extreme toxic conditions exist)
Number of taxa $>$ 30	Number of taxa 25-30	Number of taxa 20-25	Number of taxa $<$ 20
Exceptional diversity Shannon index $>$ 3.0	High diversity Shannon index 2.5-3.0	Moderate diversity Shannon index 2.0-2.5	Low diversity Shannon index $<$ 2.0

IV. RESULTS AND DISCUSSION

The benthic data presented and discussed in this section were collected from 1974 to 1978. One program element was designed to assess the impact of specific major dischargers on water quality determined by the benthic community. Stations were located upstream and downstream from entities selected from the Ohio Major Dischargers List by OEPA district surveillance personnel. The entities were chosen on the basis of a recognized pollution problem, and where, through the NPDES permit system, improvement in waste treatment has been requested. Data generated from the stations measure the effectiveness of the Agency's water pollution control programs and the recovery of biological communities as degraded segments of streams are improved. Tabulated data collected relative to these entities can be found in Reference Document (RD) 3. A summary of the benthic data can be found after the discussion of each discharger.

Fixed single station monitoring was also conducted at various locations throughout the State of Ohio during this time. Some of these stations coincided with the National Stream Quality Accounting Network (NASQAN) and, therefore, were located at USGS gaging stations. Twenty of the sites are part of the National Water Quality Surveillance System (NWQSS) and are monitored for various biological parameters once each year. The analysis of data generated from these sites will contribute to long-term trend analysis and will provide a long-term measure of the effectiveness of State water quality standards in developing chemical/physical conditions satisfactory to support balanced indigenous aquatic communities. Tabulated data collected from these stations can be found in RD 3. A summary of the benthic data can be found in Table VI-2. In most cases, the present biological data base from these stations is insufficient to warrant a detailed discussion.

TABLE VI-2: Benthic Data Summary and Evaluation, Water Quality Monitoring Network Stations

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
			Great Miami River Basin					
Great Miami (H-9)	Dayton (87.1)[a]	10/78	3	28	19	3.02	706	III
		7/77	3	22	8	2.16	798	III
		9/76	5	17	16	2.22	5803	III
Great Miami (H-9)	Miamisburg (67.7)							
	West Bank	7/77	3	12	9	2.86	35	IV
	East Bank	9/76	5	7	9	1.22	929	IV
	West Bank	9/76	5	11	9	1.33	2264	IV
Great Miami (H-11)	New Baltimore (22.1)[a]							
		7/77	3	20	2	2.47	339	III
		9/76	5	15	11	2.51	1531	III
Mad (H-3)	West Liberty (54.9)	8/76	5	40	25	2.92	374	II
Mad (H-4)	Dayton (9.9)	8/77	3	31	12	3.48	403	II
		10/76	5	20	9	2.95	450	III
Mud (H-4)	I-70 (1.4)	8/74	5	23	15	2.49	850	III
Stillwater (H-6)	Dayton (1.9)	7/77	5	23	12	3.27	353	II
		9/76	5	29	14	3.33	472	II
Sevenmile (H-10)	Eaton (23.2)	7/77	5	18	11	2.88	193	III
		8/75	5	21	12	3.48	137	III

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TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
			Mill Creek Basin					
Mill (J)	Cincinnati (0.6)	7/77	5	3	1	0.07	52	IV
			Little Miami River Basin					
Little Miami (K-1)	Oldtown (80.0)[a]	8/78	3	32	9	3.46	239	II
		7/77	5	28	13	3.45	161	II
Little Miami (K-1)	Spring Valley (63.4)	7/77	3	30	11	3.87	325	III
Little Miami (K-5)	Milford (13.3)[a]	9/76	5	27	10	2.00	915	III
			Ohio Brush Creek Basin					
Ohio Brush Creek (L-2)	West Union (16.5)[a]	9/78	3	41	33	3.95	337	I
			Scioto River Basin					
Scioto (M-2)	Prospect (169.2)	9/77	3	25	11	3.06	436	II
		8/76	5	19	11	2.02	293	III
Scioto (M-5)	Dublin (147.8)	8/77	5	14	6	2.57	1547	IV
Scioto (M-5)	Above Southerly (119.2) East Bank	8/74	4	7	9	2.06	2110	IV

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TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
Scioto (M-8)	Below Southerly (117.3)							
	East Bank	8/77	5	14	-	2.78	164	IV
	West Bank	8/77	5	14	-	2.63	162	IV
	East Bank	8/74	4	5	6	0.11	986	IV
	West Bank	8/74	4	9	10	0.13	33101	IV
Scioto (M-8)	Below Walnut (116.8)							
	East Bank	8/74	5	7	6	0.10	4589	IV
	West Bank	8/74	5	7	8	0.10	42769	IV
Scioto (M-8)	Circleville (100.8)[a]							
	East Bank	8/77	3	17	-	1.30	1046	IV
	West Bank	8/77	3	20	-	2.21	475	IV
	West Bank	8/76	5	19	-	3.10	309	IV
	East Bank	8/74	5	9	14	2.29	870	IV
	West Bank	8/74	5	19	5	3.11	360	IV
Scioto (M-8)	Above Deer (85.4)							
	East Bank	8/74	5	14	12	2.61	227	IV
	West Bank	8/74	5	13	12	2.37	212	IV
Scioto (M-11)	Chillicothe (78.3)							
	West Bank	8/74	5	31	18	3.41	192	II
Scioto (M-11)	Richmondale (56.2)[a]							
	East Bank	9/78	3	28	12	2.40	1368	III
	East Bank	7/77	5	23	6	3.31	655	III
	West Bank	7/77	5	22	6	3.11	1344	III
	East Bank	8/76	5	20	13	2.55	464	III
Scioto (M-11)	Above Salt (52.1)							
	East Bank	8/74	5	34	14	3.56	189	II

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TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
Scioto (M-15)	Below Scioto Brush (8.4)							
	East Bank	8/74	5	12	11	2.92	223	III
	West Bank	8/74	5	16	17	2.46	928	III
Olentangy (M-3)	Worthington (12.3)[a]	8/77	4	17	5	2.86	283	III
Olentangy (M-3)	Columbus (0.4)							
	East Bank	8/74	5	13	8	0.79	139	IV
	West Bank	8/74	5	8	10	0.28	144	IV
Little Walnut (M-9)	Mouth (0.7)	8/74	5	27	10	2.93	193	II
Paw Paw (M-9)	Baltimore (0.6)	8/74	5	19	8	2.04	416	IV
Big Darby (M-8)	Darbyville (13.2)[a]	8/77	5	26	14	3.54	247	II
Deer (M-7)	Mouth (1.1)	8/74	5	29	17	2.76	436	II
Paint (M-12)	Bourneville (21.6)	7/77	5	29	20	3.36	500	II
Paint (M-12)	Chillicothe (1.9)	8/74	5	11	7	0.53	2403	IV
Salt (M-10)	Mouth (0.1)	8/74	5	18	11	0.49	1413	III
Scioto Brush (M-17)	Mouth (0.2)	8/74	4	32	16	3.79	151	I

(Continued on next page)

TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
			Hocking River Basin					
Hocking River (0-1)	Enterprise (73.4)	9/77	5	17	13	3.10	74	III
Hocking (0-1)	Lancaster (47.0)	8/74	5	13	12	0.73	1178	IV
Hocking (0-1)	Athens (33.1)[a]	9/77	5	22	9	3.30	184	III
Clear Creek (0-1)	USGS Gage (2.1)	10/77	5	28	13	3.21	298	II
		10/76	5	36	15	3.55	707	II
			Muskingum River Basin					
Muskingum (P-11)	Coshocton (108.1)[a]	11/77	5	15	7	1.74	703	IV
Muskingum (P-11)	Dresden (91.1)							
	East Bank	9/77	5	20	11	2.50	2983	III
	West Bank	9/77	5	18	11	2.00	2830	III
	East Bank	9/76	5	22	15	3.30	708	III
Muskingum (P-16)	McConnelsville (47.7)[a]							
	East Bank	10/78	3	25	10	1.66	2708	III
	West Bank	10/78	2	22	11	2.44	346	III
	East Bank	9/77	3	23	13	2.51	3005	III
	West Bank	9/77	3	21	13	2.60	465	III
Muskingum (P-19)	Beverly (24.0)	9/76	10	14	15	2.17	613	III
Tuscarawas (P-5)	Massilon (87.4)[a]	9/77	3	17	7	1.20	451	IV

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TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
Sugar (P-5)	Dover (0.6)	10/76	5	18	19	2.92	353	III
Mohican (P-2)	Greer (16.7)[a]							
	East Bank	9/78	3	24	12	2.41	1828	II
	West Bank	9/78	3	31	12	2.70	1280	II
	West Bank	9/77	3	30	7	2.05	2002	II
Rocky Fork (P-1)	Mansfield (14.4)	8/74	5	7	3	2.21	814	IV
Black Fork (P-1)	Shelby (53.0)	8/74	5	14	10	2.52	87	IV
Wills (P-17)	Cambridge (58.5)	10/77	5	15	7	1.94	402	IV
Wills (P-17)	Wills Creek Dam (5.9)	9/76	4	13	16	2.07	603	III
Crooked (P-17)	Cambridge (2.6)	8/75	5	14	10	2.94	93	III
			Maumee River Basin					
Maumee (A-11)	Waterville (21.0)[a]							
	East Bank	7/78	3	20	22	2.80	859	III
	West Bank	7/78	3	18	22	2.47	2340	III
	East Bank	9/77	3	22	12	2.13	1813	III
	West Bank	9/77	3	20	11	2.32	1642	III
	West Bank	8/76	5	19	10	2.79	3094	III

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TABLE VI-2: Continued

Stream (Basin Code)	Location (RM)	Sampling Date	Number of Samplers	Quantitative Taxa	Qualitative Taxa	Index	Average Organisms/Ft.^{2}	Class
Town (A-2)	Van Wert (3.7)	9/77	5	16	10	2.19	121	IV
		8/74	5	11	15	1.73	381	IV
			Portage River Basin					
Portage (B-1)	Woodville (27.8)[a]	7/78	2	25	20	3.08	270	II
		9/77	3	30	9	2.92	521	II
			Sandusky River Basin					
Sandusky (C-4)	Fremont (23.4)[a]	9/77	3	39	11	3.35	722	I
			Black River Basin					
Black (D-4)	Elyria (14.9)[a]	8/78	3	18	9	2.71	291	IV
		7/77	5	14	6	2.54	77	IV
Black (D-4)	Below Elyria (9.4)	7/77	3	10	8	2.26	91	IV
			Cuyahoga River Basin					
Cuyahoga (E-2)	Independence (14.2)[a]	8/78	3	20	12	1.23	706	IV
		8/77	3	28	9	2.08	510	IV

[a]National Water Quality Monitoring Network Station.

A. Great Miami River Basin

Biological monitoring was conducted to determine the impact of two major dischargers in the Great Miami River Basin. Benthic samples were collected in 1977 relative to the Sidney Wastewater Treatment Plant (WWTP), which discharges to the Great Miami River. Samples were collected from Dick's Creek in 1974 and 1975 relative to the Armco Steel Corporation. Fixed station monitoring in the basin consisted of 16 sets of samples collected from eight data points. The samples were collected between June, 1974 and October, 1978. Streams sampled included the Great Miami River, Mad River, Stillwater River, Mud Creek, and Sevenmile Creek.

Great Miami River - H-2
(Sidney Wastewater Treatment Plant)

In October 1977, benthic data were collected from the Great Miami River to determine the impact of the Sidney Wastewater and Water Treatment Plants. Four stations were established at river miles 130.4, 130.0, 127.7, and 126.2. The Sidney sewage and water treatment plants are located at river miles 128.7 and 130.2 respectively. A summary of the data can be found in Table IV-3. The tabulated data can be found in RD 3-1.

The upstream station (RM 130.4) was found to have a diverse benthic community as evidenced by the presence of 28 taxa and a diversity index of 3.89. The river at this station was considered to have good water quality (Class II). The station located immediately below the water treatment plant at river mile 130.0 also exhibited good water quality which indicated that this discharge had no measurable deleterious effect. The classification of the stream at river mile 127.7, located about one mile below the WWTP, declined to a fair condition (Class III). This deterioriation was noted by a reduction in the number of pollution sensitive taxa and by a slight decrease in the diversity index (3.20) and number of taxa (26) colonizing the artificial substrate samplers. The substrate was apparently degraded in this segment because no organisms were collected in the qualitative sample. The station located at river mile 126.2 reflected good water quality as demonstrated by the increase in pollution sensitive forms and a rise in the diversity index (3.33).

The Sidney WWTP had a deleterious effect on the water quality of the Great Miami River, as determined by the benthic biota. The stream apparently recovered from this effect less than 2.5 miles downstream.

Dick's Creek - H-9
(Armco Steel Corporation)

In August, 1975 and 1974, three stations were established on Dick's Creek to determine the impact of Armco Steel discharges. In 1974 these stations were located at river miles 5.0, 3.9, and 2.4. In 1975, the station at river mile 2.4 was replaced by a station at river mile 0.9. The five discharges of Armco Steel Corporation are located at river miles 4.8, 3.9, 3.5, 2.7, and 2.5. A summary of the data can be found in Tables VI-4 and VI-5. The tabulated data can be found in RD 3-2 and 3-3.

In 1974, the station at river mile 5.0 produced only 17 taxa and a low diversity index (1.94). The sample was devoid of pollution sensitive organisms which demonstrated that the water quality was poor (Class IV). In 1975 this same station exhibited fair water quality (Class III) as determined by the presence of mayflies and caddisflies, a diversity index of 3.21 and 21 taxa. In both 1974 and 1975, the water quality at river mile 3.9 was found to be severely degraded. The numbers of taxa for 1974 and 1975 were six and two respectively, and the diversity index for 1975 was 0.009, one of the lowest encountered. In 1974, there was an inadequate number of individuals to calculate the index. The 1974 station at river mile 2.4 and the 1975 station at river mile 0.9 showed similar results in diversity (0.37, 0.36) and number of taxa (7, 4). Both stations reflected very poor water quality (Class IV).

The water quality of Dick's Creek, as determined by the benthic biota, was fair to poor above Armco Steel Corporation. However, the water quality underwent further degradation below the Armco discharge.

Fixed Stations Monitoring

Three stations were located on the Great Miami mainstem at Dayton (RM 87.1), Miamisburg (RM 67.7), and New Baltimore (RM 22.1). Stations at Dayton and New Baltimore were National Ambient Stations. Water quality at the sites was evaluated as follows:

Dayton - Fair (Class III) in October 1978, July 1977, and September 1976 (RD 3-4, 3-5, and 3.6).

Miamisburg - Poor (Class IV) in July 1977 and September 1976 (RD 3-7 and 3-8).

New Baltimore - Fair (Class III) in July 1977 and September 1976 (RD 3-9 and 3-10).

There were indications of improvement in water quality at Dayton in 1978, based on an increase in the diversity index, an increase in the number of taxa, and improved species composition.

The Mad River was sampled at two locations. One station, located at river mile 54.9 near West Liberty was sampled in August 1976 (RD 3-11). The other site, at Dayton (RM 9.9), was sampled in August 1977 and October 1976 (RD 3-12 and 3-13). Good water quality (Class II) was found at West Liberty. Water quality at Dayton was good (Class II) in 1977 and fair (Class III) in 1976. The improvement was based on an increase in the number of taxa, an increase in the diversity index, and improved species composition.

Table VI-3: Summary of Benthic Data Collected from the Great Miami River Relative to the Sidney Wastewater Treatment Plant (WWTP) and Water Treatment Plant (WTP) Discharges, October 1977[a]

	Station (RM)			
	130.4	130.0	127.7	126.2
Number of Samplers	5	5	5	5
Quantitative Taxa	28	32	26	26
Qualitative Taxa	13	12	0	10
Organisms/Ft^2	302	117	228	435
Index ($\overline{d}$)	3.89	3.97	3.20	3.30
Evaluation (Class)	II	II	III	II

(a) The Sidney WWTP discharge is located at RM 128.7. The Sidney WTP is located at RM 130.2.

Table VI-4: Summary of Benthic Data Collected from Dick's Creek Relative to the Armco Steel Discharge, August, 1975[a]

	Station (RM)		
	5.0	3.9	0.9
Number of Samplers	5	5	5
Quantitative Taxa	21	2	4
Qualitative Taxa	9	2	3
Organisms/Ft^2	111	34	68
Index ($\overline{d}$)	3.21	0.009	0.36
Evaluation (Class)	III	IV	IV

(a) The Armco Steel discharges are located at RM's 4.8, 3.9, 3.5, 2.7, and 2.5.

Table VI-5: Summary of Benthic Data Collected from Dick's Creek Relative to the Armco Steel Discharge, August, 1974[a]

	Station (RM)		
	5.0	3.9	2.4
Number of Samplers	5	4	5
Quantitative Taxa	17	6	7
Qualitative Taxa	6	0	0
Organisms/Ft^2	65	3	59
Index ($\overline{d}$)	1.94	(b)	0.37
Evaluation (Class)	IV	IV	IV

(a) The Armco Steel discharges are located at RM's 4.8, 3.9, 3.5, 2.7, and 2.5.

(b) Inadequate number of individuals to calculate d.

Evaluations of other tributaries in the Great Miami River Basin included:

Mud Creek near I-70 (RM 1.4) - Fair (Class III) in August 1974 (RD 3-14).

Stillwater River at Dayton (RM 1.9) - Good (Class II) in July 1977 and September 1976 (RD 3-15 and 3-16).

Sevenmile Creek at Eaton (RM 23.2) - Fair (Class III) in July 1977 and August 1975 (RD 3-17 and 3-18).

The fair water quality designation in Sevenmile Creek was considered marginal (i.e., Class III and Class IV) because of low numbers of taxa and unfavorable species composition.

B. Little Miami River Basin

Fixed Stations Monitoring

Fixed station monitoring in the Little Miami River Basin consisted of four sets of samples collected from the Little Miami River. The stations were located at Oldtown (RM 80.00), Spring Valley below the Xenia WWTP (RM 63.4), and at Milford (RM 13.3). The sites at Oldtown and Milford were National Ambient Stations. Water quality at the sites was evaluated as follows:

Oldtown - Good (Class II) in August 1978 and July 1977 (RD 3-19 and 3-20).

Spring Valley - Fair (Class III) in July 1977 (RD 3-21).

Milford - Fair (Class III) in September 1977 (RD 3-22).

Despite the large number of taxa (30) and high diversity index (3.87) at Spring Valley, the site received a fair (Class III) evaluation because of the predominance of chironomids both in total numbers and number of taxa. At Milford, chironomids were not present in large numbers, but diversity was poor due to great numbers of two genera, Baetis and Symphitopsyche. Consequently, the Little Miami at Milford received a fair (Class III) evaluation.

C. Mill Creek Basin

Fixed Stations Monitoring

Fixed station monitoring in the Mill Creek River Basin consisted of one set of samples collected from Mill Creek at Cincinnati (RM 0.6) in July 1977 (RD 3-23). Water quality was poor (Class IV) demonstrated by an extremely low diversity index (0.07) and low number of taxa (3). This site was one of the most degraded of those evaluated.

D. Ohio Brush Creek Basin

Fixed Stations Monitoring

Fixed station monitoring in the Ohio Brush Creek Basin consisted of one set of samples collected from Ohio Brush Creek near West Union (RM 16.5) in September 1978 (RD 3-24). Water quality was excellent (Class I). All criteria in the Class I category were met at this site.

E. Scioto River Basin

Biological monitoring was conducted to determine the impact of several major dischargers in the Scioto River Basin. These were:

1. Marion WWTP in 1977, 1976, and 1974 which discharges to the Little Scioto River.

2. Marysville WWTP and Ray Lewis and Sons in 1978 which discharge to Mill Creek.

3. Mt. Gilead WWTP and Koering Corporation in 1973 which discharge to Whetstone Creek.

4. Delaware WWTP in 1977 which discharges to the Olentangy River.

5. Ranco in 1975 which discharges to Big Darby Creek.

6. PPG Industries in 1977 which discharges to Scippo Creek.

7. Washington Court House WWTP and Armco Steel in 1975 which discharge to Paint Creek.

Fixed station monitoring in the Scioto River Basin consisted of 36 sets of samples collected from 21 data points. The samples were collected between August 1974 and September 1978. Streams sampled included the Scioto River, Olentangy River, Little Walnut Creek, Paw Paw Creek, Big Darby Creek, Deer Creek, Paint Creek, Salt Creek, and Scioto Brush Creek.

Little Scioto River - M-2
(Marion Wastewater Treatment Plant)

Three stations were sampled on the Little Scioto River during the years 1977, 1976, and 1974 to monitor the effect of the Marion WWTP. During this interim, the Marion WWTP underwent treatment improvements, therefore, special attention was given to any possible change in the stream during the three year sampling period. These stations were located at river miles 9.3, 4.4, and 2.1. The Marion WWTP discharges to the Little Scioto River at river mile 6.4. A summary of the data can be found in Table VI-6, VI-7, and VI-8. The tabulated data can be found in RD 3-25, 3-26, and 3-27.

At the station located at river mile 9.3 the condition of the stream ranged from poor (Class IV) in 1974 to fair (Class III) in 1976 and 1977. The poor water quality in 1974 was reflected by the lack of pollution sensitive forms, a diversity index of 2.17, and a low number of taxa (12). In 1976 and 1977 the numbers of taxa (22,23) were similar, while the diversity indices (2.57, 3.17) were varied; both years data illustrated fair water quality. The reason for the change in water quality at this upstream station is not known. The station located immediately downstream from the Marion WWTP, river mile 4.4, was considered to have poor water quality for all three sampling periods. However, some improvements were noted in the 1976 and 1977 samples at this site. The 1974 sample reflected very poor water quality as evidenced by the extremely low number of taxa (2) and diversity index (0.08). In 1976 and 1977, there were marked increases in both numbers of taxa (16,11) and diversity indices (1.19, 2.27) which showed a definite improvement at this station. The furthest downstream station, at river mile 2.1, was also found to have poor water quality throughout the three year sampling period, but again, improvement was noted. The 1974 data revealed very poor water quality, as illustrated by the low number of taxa (4) and low diversity index (0.35). Increases in numbers of taxa (10, 18) and diversity indices (2.76, 3.12) were found in 1976 and 1977.

The Little Scioto River, was considered to have fair water quality above the Marion WWTP but underwent notable stress below the plant and did not appear to recover before reaching the confluence with the Scioto River. There were, however, significant improvements in the two downstream stations in 1976 and 1977, as reflected by the benthic biota. It may be of interest to note that in 1976 and 1977 there was a curious reduction in the number of oligochaetes at the two downstream stations. In 1974, there were 356 oligochaetes collected at river mile 4.4 and 5052 at river mile 2.1. In 1976, the oligochaetes were completely absent at both stations, while in 1977, they were present in only limited numbers, (23 at river mile 4.4 and 37 at river mile 2.1.)

Table VI-6: Summary of Benthic Data Collected from the Little Scioto River Relative to the Marion Wastewater Treatment Plant (WWTP), October, 1977[a]

	Station (RM)		
	9.3	4.4	2.1
Number of Samplers	5	5	5
Quantitative Taxa	23	11	18
Qualitative Taxa	11	5	12
Organisms/Ft^2	277	210	165
Index ($\overline{d}$)	3.17	2.27	3.12
Evaluation (Class)	III	IV	IV

[a] The Marion WWTP discharge is located at RM 6.4.

Table VI-7: Summary of Benthic Data Collected from the Little Scioto River Relative to the Marion Wastewater Treatment Plant (WWTP), November, 1976[a]

	Station (RM)		
	9.3	4.4	2.1
Number of Samplers	5	5	5
Quantitative Taxa	22	16	10
Qualitative Taxa	9	5	4
Organisms/Ft^2	223	593	104
Index ($\overline{d}$)	2.57	1.19	2.76
Evaluation (Class)	III	IV	IV

[a] The Marion WWTP discharge is located at RM 6.4.

Table VI-8: Summary of Benthic Data Collected from the Little Scioto River Relative to the Marion Wastewater Treatment Plant (WWTP), August, 1974[a]

	Station (RM)		
	9.3	4.4	2.1
Number of Samplers	5	5	5
Quantitative Taxa	12	2	4
Qualitative Taxa	15	3	7
Organisms/Ft^2	229	76	1069
Index ($\overline{d}$)	2.17	0.08	0.35
Evaluation (Class)	IV	IV	IV

[a] The Marion WWTP discharge is located at RM 6.4.

Mill Creek - M-5
(Marysville Wastewater Treatment Plant - Ray Lewis and Sons, Inc.)

In June 1978, six sampling stations were established on Mill Creek to determine the impact of the Marysville WWTP and Ray Lewis and Sons discharges. These six stations were located at river miles 24.8, 16.8, 12.2, 11.6, 7.1, and 1.7. The Marysville WWTP and Ray Lewis and Sons both discharge to Mill Creek at river mile 18.3. A summary of the data can be found in Table VI-9. The tabulated data can be found in RD 3-28.

The control station (RM 24.8) was considered to have good water quality (Class II) as determined by a high number of taxa (34) and a high diversity index (3.90). The next two stations, river miles 16.8 and 12.2, were located below the two discharges and exhibited similar results in regard to numbers of taxa (21, 20) and diversity indices (2.87, 2.82). There was, however, a marked difference in community composition between the two sites. The station at river mile 16.8 was almost completely dominated by chironomids, while the sample from river mile 12.2 contained large numbers of the intermediate mayflies, Stenacron interpunctatum and Caenis sp. The predominance of tolerant taxa at river mile 16.8 and the low number of taxa at river mile 12.2 were the primary reasons for designating both sites fair (Class III). The next two stations (RM 11.6 and RM 7.1) were also given a fair evaluation due primarily to the lack of pollution sensitive forms and the moderate number of taxa (25, 20). The most downstream station (RM 1.7) had an increase in number of taxa (28) but a marked decrease in the diversity index (1.78). The poor diversity was caused by the presence of the intermediate mayfly Stenacron interpunctatum which accounted for 77% of the sample. This station was still regarded to have fair water quality (Class III).

This survey indicated that either the Marysville WWTP or Ray Lewis and Sons discharge, or both had a definite impact on Mill Creek, as determined by the benthic biota. The river showed gradual improvement downstream, but at no point did it reach the water quality of the station sampled above Marysville.

Table VI-9: Summary of Benthic Data Collected from Mill Creek Relative to the Marysville Wastewater Treatment Plant (WWTP) Ray Lewis and Sons Discharges, July 1978[a]

	Station (RM)					
	24.8	16.8	12.2	11.6	7.1	1.7
Number of Samplers	5	5	5	4	5	5
Quantitative Taxa	34	21	20	25	20	28
Qualitative Taxa	18	8	16	19	10	18
Organisms/Ft^2	187	350	110	278	47	212
Index ($\overline{d}$)	3.90	2.87	2.82	3.51	3.26	1.78
Evaluation (Class)	II	III	III	III	III	III

[a] The Marysville WWTP and Ray Lewis and Sons discharges are located at RM 18.3.

Whetstone Creek - M-3
(Mt. Gilead Wastewater Treatment Plant - Koering Corporation)

In September 1973, three stations were established on Whetstone Creek in an effort to determine the impact of the Mt. Gilead WWTP and Koering discharges. The stations were located at river miles 25.8, 21.2, and 16.2. The Mt. Gilead WWTP and Koering Corporation discharges are located at river miles 21.7 and 21.4, respectively. A summary of the data can be found in Table VI-10. The tabulated data can be found in RD 3-29.

A high diversity index (3.71) was found at the station at river mile 25.8, but a marginal number of taxa (25) and low number of pollution sensitive organisms indicated fair water quality (Class III). The data from river mile 21.2, below the dischargers, suggested organic enrichment reflected by the low diversity index (0.74). The cause of the low index was a marked increase in the number of oligochaetes, which skewed the balance of the community. Despite the low index, the water quality was considered fair due to the large number of taxa (27) and the presence of a few pollution sensitive organisms. The downstream station, (RM 16.2) had 32 taxa and a diversity index of 2.67, and was apparently recovering from the enrichment encountered at the previous site. This station was considered to have fair water quality.

Although all three stations were considered to have fair water quality, Whetstone Creek did receive an enrichment effect from either the Mt. Gilead WWTP or the Koering Corporation discharges, or both.

Table VI-10: Summary of Benthic Data Collected from Whetstone Creek Relative to the Mt. Gilead Wastewater Treatment Plant (WWTP) and Koering Corporation Discharges, October, 1973[a]

	Station (RM)		
	25.8	21.2	16.2
Number of Samplers	5	5	5
Quantitative Taxa	25	27	32
Organisms/Ft^2	102	723	226
Index ($\overline{d}$)	3.71	0.74	2.67
Evaluation (Class)	III	III	III

[a] The Mt. Gilead WWTP discharge is located at RM 21.7. The Koering Corporation discharge is located at RM 21.4.

Olentangy River - M-3
(Delaware Wastewater Treatment Plant)

In July 1977, three biological sampling stations were established on the Olentangy River to determine the impact of the Delaware WWTP. These stations were located at river miles 28.3, 22.5, and 18.2. The Delaware WWTP discharges to the Olentangy River at river mile 24.85. A summary of the data can be found in Table VI-11. The tabulated data is listed in RD 3-30.

The data from the upstream station at river mile 28.3 showed a relatively high diversity index (3.23) and a low number of taxa (21). The water quality at this site was considered fair (Class III) due primarily to the number of taxa. The next station (RM 22.5) revealed a decline in the diversity index (2.46) and an increase in number of taxa (24). This data indicated a slight organic enrichment, but no significant change in water quality. The most downstream station (RM 18.3) displayed increases in both numbers of taxa (20) and diversity (3.44). These improvements indicated that the river had probably recovered from the slight enrichment it had received, but it was still considered to have only fair water qualty at this point.

According to this survey the Delaware WWTP discharge had a negligible impact on the Olentangy River.

Table VI-11: Summary of Benthic Data Collected from the Olentangy River Relative to the Delaware Wastewater Treatment Plant (WWTP) Discharge, August, 1977[a]

	Station (RM)		
	28.3	22.5	18.3
Number of Samplers	5	5	5
Quantitative Taxa	21	24	26
Qualitative Taxa	13	15	13
Organisms/Ft^2	250	24	26
Index ($\overline{d}$)	3.23	2.46	3.44
Evaluation (Class)	III	III	III

[a] The Delaware WWTP discharge is located at RM 24.85.

Big Darby Creek - M-6
(Ranco Corporation)

In August 1975, three stations were sampled on Big Darby Creek to determine the impact of the Ranco discharge. These stations were located at river miles 54.2, 53.2, and 52.4. The Ranco discharge is located at river mile 54.1. A summary of the data can be found in Table VI-12. The tabulated data can be found in RD 3-31.

The upstream station, (RM 54.2), and the station immediately below the Ranco discharge, (RM 53.2), exhibited similar results in numbers of taxa (27, 28) and diversity indices (3.37, 3.72). These stations were only evaluated as fair (Class III), however, because of the sparsity of pollution sensitive organisms. The stream at river mile 52.4 declined in water quality. The stream at this station, although still considered to be in fair condition (Class III), declined to some degree as evidenced by decreases in both number of taxa (20) and diversity index (2.68).

The Ranco discharge apparently had no major impact on Big Darby Creek, as reflected by the benthic biota.

Table VI-12: Summary of Benthic Data Collected from Big Darby Creek Relative to the Ranco Discharge, August, 1975[a]

	Station (RM)		
	54.2	53.2	52.4
Number of Samplers	5	5	5
Quantitative Taxa	27	28	20
Qualitative Taxa	17	15	8
Organisms/Ft^2	105	113	61
Index ($\overline{d}$)	3.37	3.72	2.68
Evaluation (Class)	III	III	III

[a] The Ranco discharge is located at RM 54.1.

Scippo Creek - M-8
(PPG Industries)

Data were collected from three stations established on Scippo Creek in July 1977, to determine the impact of the PPG Industries discharge. Stations were established at river miles 4.9, 4.4, and 2.25. The PPG discharge enters Scippo Creek at river mile 4.7. The benthic data collected at the three stations can be found in RD 3-32. A summary of the data can be found in Table VI-13.

The number of taxa (27) and diversity index (3.48) found at river mile 4.9 located above the discharge, indicated good water quality (Class II). The water quality at station 4.4, located below the discharge, was poor (Class IV). The number of taxa was reduced to 12 and the diversity index was 2.50. There was also a reduction in both numbers and types of mayflies at this station. The number of taxa (26) and the diversity index (3.81) increased at river mile 2.25 and the species composition was similar to that found at the station above the outfall.

The PPG Industries effluent had a major deleterious effect on the water quality of Scippo Creek, but the stream recovered approximately 2.4 miles below the discharge.

Table VI-13: Summary of Benthic Data Collected from Scippo Creek Relative to the PPG Discharge, July, 1977[a]

	Station (RM)		
	4.9	4.4	2.2
Number of Samplers	5	5	5
Quantitative Taxa	27	12	26
Qualitative Taxa	14	6	19
Organisms/Ft^2	294	64	364
Index ($\overline{d}$)	3.48	2.50	3.81
Evaluation (Class)	II	IV	II

[a] The PPG discharge is located at RM 4.7.

Paint Creek - M-12
(Washington Court House Wastewater Treatment Plant - Armco Steel Corporation)

In July 1975, four stations on Paint Creek and one on the East Fork of Paint Creek were established to determine the impact of the Washington Court House WWTP and Armco Steel discharges. The four stations in Paint Creek were located at river miles 81.7, 67.8, 63.5, and 59.8. The station in the East Fork was located at river mile 2.8. The Washington Court House WWTP and Armco Steel discharges enter Paint Creek at river miles 69.4 and 67.7, respectively. A summary can be found in Table VI-14. The tabulated data can be found in RD 3-33.

There were two control stations: the upstream station in Paint Creek (RM 81.7) and the East Fork station (RM 2.8). The water quality at these stations was considered to be fair (Class III) as determined by the numbers of taxa (13,16) and moderate diversity indices (2.34, 3.14). The station at river mile 67.8, located below both discharges, produced only two taxa and a diversity index of 0.34, which indicated very poor water quality (Class IV). The next downstream station, (RM 63.5), showed signs of improvement as reflected by increases in numbers of taxa (15) and diversity index (2.54). The lack of pollution sensitive organisms and abundance of oligochaetes, however, indicated poor water quality at this point. In spite of the high diversity index (3.77), the station at river mile 59.8 exhibited only fair water quality due to the number of taxa (22).

Paint Creek underwent severe water quality degradation at river mile 67.8 attributable to either the Washington Court House WWTP or Armco Steel discharges, or both. The river recovered approximately eight miles below this point.

Table VI-14: Summary of Benthic Data Collected from Paint Creek and East Fork Relative to the Washington Court House Wastewater Treatment Plant (WWTP) and Armco Steel Discharges, August, 1975[a]

	Station (RM)				
	East Fork		Paint Creek		
	2.8	81.7	67.8	63.5	59.8
Number of Samplers	5	4	5	4	5
Quantitative Taxa	16	13	2	15	22
Qualitative Taxa	12	10	7	9	12
Organisms/Ft^2	53	48	975	999	101
Index ($\overline{d}$)	3.14	2.34	0.34	2.54	3.77
Evaluation (Class)	III	III	IV	IV	III

[a] The Washington Court House WWTP discharge is located at RM 69.4. The Armco Steel discharge is located at RM 67.7.

Fixed Stations Monitoring

Stations on the Scioto mainstem were located at Prospect (RM 169.2), at Dublin (RM 147.8), above Southerly WWTP (RM 119.2), below Southerly WWTP (RM 117.3), below Walnut Creek (RM 116.8), at Circleville (RM 100.8), above Deer Creek (RM 85.4), at Chillicothe (RM 78.3), at Richmondale (RM 56.2), above Salt Creek (RM 52.1), and below Scioto Brush Creek (RM 8.4). The sites at Circleville and Richmondale were National Ambient Stations. Water quality at the stations was evaluated as follows:

Prospect - Good (Class II) in September 1977 (RD 3-34); Fair (Class III) in August 1976 (RD 3-35).

Dublin - Poor (Class IV) in August 1974 (RD 3-36).

Above Southerly WWTP - Poor (Class IV) in August 1974 (RD 3-37).

Below Southerly WWTP - Poor (Class IV) in August 1977 and 1974 (RD 3-38 and 3-39).

Below Walnut Creek - Poor (Class IV) in August 1974 (RD-40).

Circleville - Poor (Class IV) in August 1977, 1976, and 1974 (RD 3-41, 3-42; 3-43 and 3-44).

Above Deer Creek - Poor (Class IV) in August 1974 (RD 3-45).

Chillicothe - Good (Class II) in August 1974 (RD 3-46).

Richmondale - Fair (Class III) in September 1978, July 1977, August 1976 (RD 3-47, 3-48 and 3-49).

Above Salt Creek - Good (Class II) in August 1974 (RD 3-50).

Below Scioto Brush Creek - Fair (Class III) in August 1974 (RD 3-51).

Water quality on the Scioto mainstem at each station from Dublin (RM 147.8) to Deer Creek (RM 85.4) was classified as poor (Class IV). This stretch included six data points and fourteen sample sets collected between August 1974 and September 1978. Despite similar evaluations, in at least one instance there was a noticeable change in the benthic community from year to year. In 1974, samplers immediately below the Southerly WWTP were almost completely dominated by oligochaetes, which in some instances numbered in the hundreds of thousands (RD 3-39). Diversity indices at this site were very low (0.11 East Bank, 0.13 West Bank), as were the number of taxa (5 East Bank, 9 West Bank). In 1977, the total number of oligochaetes dropped to 197 on two sets of samples. Diversity indices (2.78 East Bank, 2.63 West Bank) and number of taxa (14 East Bank, 14 West Bank) increased compared to the 1974 data. Even with these improvements, the water quality evaluation remained poor (Class IV). However,

improvement was noticeable beween 1974 and 1977. No significant changes in the benthic community were observed and water quality evaluations did not vary with time in the remaining Class IV sites on the mainstem.

All stations below Deer Creek were fair (Class III) with the exceptions of Chillicothe (RM 78.3) and above Salt Creek (RM 52.1) which were designated Class II. This stretch, from river mile 78.3 to 8.4 included four data points and eight sample sets. The two sites designated as Class II were marginal between Class II and Class III.

The Olentangy River was monitored at Worthington (RM 12.3) and Columbus (RM 0.4) in August 1977 and August 1974, respectively (RD 3-52 and 3-53). The site at Worthington was a National Ambient Station. Water quality was fair (Class III) at the Worthington station and poor (Class IV) at the Columbus station.

Evaluations on other selected tributaries of the Scioto River included:

Little Walnut Creek at mouth (RM 0.7) - Good (Class II) in August 1974 (RD 3-54).

Big Darby Creek at Darbyville (RM 13.2) - Good (Class II) in August 1977 (RD 3-55).

Paw Paw Creek below Crown Zellerback (RM 0.6) - Poor (Class IV) in August 1974 (RD 3-56).

Deer Creek at mouth (RM 1.1) - Good (Class II) in August 1974 (RD 3-57).

Paint Creek at Bourneville (RM 21.6) - Good (Class II) in July 1977 (RD 3-58).

Paint Creek below Mead Paper (RM 1.9) - Poor (Class IV) in August 1974 (RD 3-59).

Salt Creek at mouth (RM 0.1) - Fair (Class III) in August 1974 (RD 3-60).

Scioto Brush Creek at mouth (RM 0.2) - Excellent (Class I) in August 1974 (RD 3-61).

The station on Big Darby Creek at Darbyville was a National Ambient Station.

F. Hocking River Basin

Fixed Stations Monitoring

Fixed station monitoring in the Hocking River Basin consisted of five sets of samples collected from four data points. The samples were collected between August 1974 and October 1977. The Hocking River and a tributary, Clear Creek, were the streams sampled.

Hocking mainstem stations were located at Enterprise (RM 73.4), Lancaster below the WWTP (RM 47.0), and at Athens (RM 33.1). The site at Athens was a National Ambient Station. Water quality evaluations at the sites were as follows:

Enterprise - Fair (Class III) in September 1977 (RD 3-62).

Lancaster - Poor (Class IV) in August 1974 (RD 3-63).

Athens - Fair (Class III) in September 1977 (RD 3-64).

The stations at Enterprise and Athens were determined to have only fair water quality even though diversity indices were greater than 3.0 in both cases. The low numbers of taxa at Enterprise (17) and Athens (22) were the compromising factors in the evaluations.

Clear Creek was sampled at river mile 2.1 in October 1977 and then again in October 1976 (RD 3-65 and 3-66). Water quality was good (Class II) during both sampling periods.

G. Muskingum River Basin

Biological monitoring was conducted to determine the impact of two major dischargers in the Muskingum River Basin. Benthic samples were collected in 1977 relative to the Ashland WWTP which discharges to Jerome Fork of the Mohican River. Also in 1977, data was collected relative to the Mt. Vernon WWTP which discharges to the Kokosing River.

Fixed station monitoring in the basin consisted of 18 sets of samples collected from 12 data points. Streams sampled included the Muskingum River, Tuscarawas River, Mohican River, Sugar Creek, Black Fork of the Mohican, Rocky Fork of the Mohican, Crooked Creek, and Wills Creek.

Jerome Fork - P-2
(Ashland Wastewater Treatment Plant)

In August 1977, three stations were established on the Jerome Fork of the Mohican River. The purpose was to monitor the impact of the Ashland WWTP on Jerome Fork. These stations were located at river miles 14.0, 9.1 and 0.9. The Ashland WWTP discharges to Lang Creek about 0.25 mile from its confluence with Jerome Fork. Lang Creek enters Jerome Fork at river mile 12.3. A summary of the data can be found in Table VI-15. The tabulated data can be found in RD 3-67.

The upstream station (RM 14.0) was found to have a high diversity index (3.67) but only a marginal number of taxa (25) which indicated fair water quality (Class III). The station at river mile 9.1, located below Lang Creek, exhibited a decrease in number of taxa (20), diversity (2.72), and pollution sensitive organisms. The water quality at this point was still considered fair even though the data demonstrated a degree of degradation. The station at river mile 0.9 had increases in both number of taxa (30) and diversity (3.50) which indicated an apparent recovery, but still received a fair (Class III) evaluation.

All three stations on Jerome Fork were considered to have fair water quality. However, the Ashland WWTP did have a moderate deleterious impact on Jerome Fork, as evidenced by the benthic biota.

Table VI-15: Summary of Benthic Data Collected from Jerome Fork Relative to the Ashland Wastewater Treatment Plant (WWTP) Discharge, September, 1977[a]

	Station (RM)		
	14.0	9.1	0.9
Number of Samplers	5	5	5
Quantitative Taxa	25	20	30
Qualitative Taxa	5	9	5
Organisms/Ft^2	274	107	210
Index ($\overline{d}$)	3.67	2.72	3.50
Evaluation (Class)	III	III	III

[a] The Ashland WWTP discharge is located near the mouth of Lang Creek which enters Jerome Fork at RM 12.3.

Kokosing River - P-12
(Mt. Vernon Wastewater Treatment Plant)

In August 1977 four stations were established on the Kokosing River to determine the impact of the Mt. Vernon WWTP. These stations were located at river miles 29.6, 23.3, 20.6, and 11.6. The Mt. Vernon WWTP effluent enters the Kokosing River at river mile 24.9. A summary of the data can be found in Table VI-16. The tabulated data can be found in RD 3-68.

The upstream station (RM 29.6) displayed excellent water quality (Class I) illustrated by an abundance of pollution sensitive organisms, a large number of taxa (33), and a diversity index of 3.18. Below the Mt. Vernon WWTP the station at river mile 23.3 exhibited an increase in diversity (3.97) along with the same number of taxa (33) as the previous station. A reduction in the number of pollution sensitive taxa, however, was the basis for lowering the water quality consideration at this site to good (Class II). The next two stations, (RM 20.6 and 11.6), both expressed similar results in number of taxa (26, 34), diversity indices (3.34, 3.20) and abundance of pollution sensitive organisms.

The Kokosing River, considered to have excellent water quality upstream, underwent a negligible impact as a result of the Mt. Vernon WWTP discharge.

Fixed Stations Monitoring

Four stations were located on the Muskingum mainstem at Coshocton (RM 108.1), Dresden (RM 91.1), McConnelsville (RM 47.7), and Beverly (RM 24.0). The sites at Coshocton and McConnelsville were National Ambient Stations. Water Quality at the sites was evaluated as follows:

Coshocton - Poor (Class IV) in November 1977 (RD 3-69).

Dresden - Fair (Class III) in September 1977 and 1976 (RD 3-70 and 3-71).

McConnelsville - Fair (Class III) in October 1978 and September 1977 (RD 3-72, 3-73; 3-74, 3-75).

Beverly - Fair (Class III) in September, 1976 (RD 3-76).

The site at Coshocton, located below the WWTP, was evaluated as poor despite the presence of six species of mayflies and caddisflies. The presence of numerous oligochaetes (2,331), low diversity index (1.74), and low number of taxa (15) were the deciding factors. The site at Beverly was only marginally fair. The presence of mayflies, hellgramites, and large numbers of caddisflies (5,216) were the determining factors in this evaluation, even though the number of taxa was low (14).

Table VI-16: Summary of Benthic Data Collected from the Kokosing River Relative to the Mt. Vernon Wastewater Treatment Plant (WWTP) Discharge, September, 1977[a]

	Station (RM)			
	29.6	23.3	20.6	11.6
Number of Samplers	5	5	5	5
Quantitative Taxa	33	33	26	34
Qualitative Taxa	9	6	12	13
Organisms/Ft^2	857	188	558	1056
Index ($\overline{d}$)	3.18	3.97	3.34	3.20
Evaluation (Class)	I	II	II	II

[a] The Mt. Vernon WWTP discharge is located at RM 24.9.

One station was located on the Tuscarawas River at river mile 87.4 below the Massilon WWTP (RD 3-77). The site sampled in September 1977, was a National Ambient station. Water quality at this site was poor (Class IV) due to a low number of taxa (17), a low diversity index (1.20), and the near absence of pollution sensitive organisms.

Sugar Creek, a tributary of the Tuscarawas River, was sampled at river mile 0.6 near Dover in October 1976. Tabulated data can be found in RD 3-78. The site was evaluated as fair (Class III).

In the Mohican River drainage basin, fixed stations were sampled on the Mohican mainstem at Greer (RM 16.7), Black Fork of the Mohican at Shelby (RM 53.0), and Rocky Fork of the Mohican at Mansfield (RM 14.4). The site at Greer was a National Ambient Station. The sites at Shelby and Mansfield were located below Ohio Steel Tube and Empire Detroit Steel, respectively. Water quality at the sites was evaluated as follows:

Greer - Good (Class II) in September 1978 and 1977 (RD 3-79, 3-80; 3-81).

Shelby - Poor (Class IV) in August 1974 (RD 3-82).

Mansfield - Poor (Class IV) in August 1974 (RD 3-83).

In the Wills Creek drainage basin, fixed stations were sampled on the Wills mainstem at Cambridge below the WWTP (RM 58.5) and below the Wills Creek dam (RM 5.9). A tributary, Crooked Creek, was also sampled near Champion Spark Plug (RM 2.6). Water quality at the sites was evaluated as follows:

Cambridge - Poor (Class IV) in October 1977 (RD 3-84).

Wills Creek Dam - Fair (Class III) in September 1976 (RD 3-85).

Crooked Creek - Fair (Class III) in August 1975 (RD 3-86).

Both sites on the mainstem were considered marginal in their class designation.

H. Mahoning River Basin

Mahoning River - T-2
(North American Rockwell)

In October 1974, four stations were sampled on the Mahoning River to monitor the effect from the North American Rockwell discharge. Three stations were located on the Mahoning River mainstem and one station on the West Branch of the Mahoning. The West Branch location was at river mile 1.9. The three mainstem stations were located at river miles 54.8, 51.8, and 47.5. North American Rockwell discharges to the Mahoning River at river mile 53.9. A summary of the data can be found in Table VI-17. The tabulated data can be found in RD 3-87.

The West Branch station (RM 1.8) and the upstream Mahoning River station (RM 54.8) were control stations and both were considered to have fair water quality (Class III). The number of taxa (23,27) and numbers of pollution sensitive organisms from each station were the basis of the evaluation. The station below North American Rockwell (RM 51.8) was found to have a diversity index of 2.90 and 18 taxa. Water quality was fair (Class III). However, the decrease in number of taxa and a further reduction of pollution sensitive forms suggested some degradation had occurred. The station at river mile 47.5 was found to have marked decreases in number of taxa (11) and diversity (2.29) indicating a further reduction in water quality to a poor (Class IV) evaluation.

The discharge of North American Rockwell had a slight impact on the water quality of the Mahoning River at river mile 51.8, as determined by the benthic biota. The reason for the further reduction in water qualty at river mile 47.5 cannot be determined at this time.

Table VI-17: Summary of Benthic Data Collected from the Mahoning River Relative to the North American Rockwell Discharge, October, 1974[a]

	Station (RM)			
	West Branch 1.9	Mahoning 54.8	Mahoning 51.8	Mahoning 47.5
Number of Samplers	5	5	5	5
Quantitative Taxa	23	27	18	11
Qualitative Taxa	20	15	10	8
Organisms/Ft^2	116	368	236	72
Index ($\overline{d}$)	3.71	3.25	2.90	2.29
Evaluation (Class)	III	III	III	IV

[a] The North American Rockwell discharge is located at RM 53.9.

I. Maumee River Basin

Biological monitoring was conducted in two streams to determine the impact of four major dischargers in the Maumee River Basin. Benthic samples were collected in 1974, 1976, and 1977 relative to the Lima WWTP, the Standard Oil Company and the Vistron Corporation all of which discharge to the Ottawa River. Samples were collected from the St. Joseph River in 1975, to monitor the effects of the Edgerton Metals Incorporated discharge.

Fixed station monitoring in the basin consisted of seven sets of samples collected from two data points. The samples were collected between August 1974 and July 1978. Streams sampled were the Maumee River and Town Creek, a tributary of the Little Auglaize River.

St. Joseph River - A-9
(Edgerton Metals)

Three stations were established in July 1975, on the St. Joseph River to monitor the effect of the Edgerton Metals discharge. These stations were located at river miles 51.3, 49.8, and 42.3. The Edgerton Metals discharge enters the St. Joseph River at river mile 50.92. A summary of the data can be found in Table VI-18. The tabulated data can be found in RD 3-88.

The data from all three stations demonstrated good water quality (Class II). Stations 51.3 and 49.8 had moderately high numbers of taxa (26, 27) and reflected healthy conditions demonstrated by the abundance of pollution sensitive taxa. Mayflies, stoneflies, and caddisflies comprised approximately 40% of the taxa from each station. The furthest downstream station, at river mile 42.3, displayed similar good water quality with a high number of taxa (32) and a high diversity index (3.19).

The results of this survey showed that the Edgerton Metals discharge did not induce any detectable impact on the St. Joseph River.

Table VI-18: Summary of Benthic Data Collected from the St. Joseph River Relative to the Edgerton Metals Discharge, August, 1975[a]

	Station (RM)		
	51.3	49.8	42.3
Number of Samplers	5	5	5
Quantitative Taxa	26	27	32
Qualitative Taxa	15	10	12
Organisms/Ft^2	190	168	154
Index ($\bar{d}$)	3.14	3.54	3.19
Evaluation (Class)	II	II	II

[a] The Edgerton Metals discharge is located at RM 50.9.

Ottawa River - A-4
(Lima Wastewater Treatment Plant -
Standard Oil Company - Vistron Corporation)

In August of 1977, 1976, and 1974, benthic sampling was conducted on the Ottawa River to determine the impact of the Lima WWTP, Standard Oil Company, and Vistron Corporation discharges. Six stations sampled in 1974 were located at river miles 46.0, 37.7, 37.4, 36.8, 32.6, and 28.8. Two additional stations were established in 1976 at river miles 16.0 and 1.0. During 1977, a new station was established at river mile 22.1. Other stations remained the same as in 1976, except the station at river mile 16.0 was not sampled. In addition, two stations were established on the Auglaize River in 1977 above and below the confluence with the Ottawa at river miles 34.6 and 28.5. Summaries of the data can be found in Tables VI-19, VI-20, and VI-21. The tabulated data can be found in RD 3-89, 3-90, and 3-91.

Station 46.0 consistently had the highest number of taxa (17, 28, 27) and diversity indices (3.35, 3.16, 3,44) during the three sampling periods. The number of pollution sensitive taxa, however, was never greater than 17% of the total numbers of taxa which indicated fair water quality (Class III) for this station. The next downstream station (RM 37.7) deteriorated to a poor water quality (Class IV) situation as illustrated by the elimination of pollution sensitive forms and marked decreases in number of taxa (9, 8, 9) and diversity indices (1.50, 2.03, 1.62). This station is located above any major discharge and was apparently affected by combined sewer overflows from the City of Lima. The water quality of the Ottawa was considered poor from immediately below the major discharges to its confluence with the Auglaize River. This 37 mile stream segment was found to have the poorest conditions at stations 32.6 and 28.8. In 1974 the station at river mile 28.8 produced only four taxa and a diversity index of 0.11. In 1976, worse conditions were found at station 32.6 which were demonstrated by a very low diversity index (0.01) and number of taxa (2). The station located at river mile 16.0, sampled only in 1976, was similar to the preceeding station in regard to the number of taxa (14) and diversity index (2.27). Improvement was noted by the appearance of the mayfly Callibaetis in the quantitative sample. This was the first mayfly found in the multiple-plate samplers since river mile 46.0. However, the river at this point, approximately 20 miles below Lima, represented a substantially stressed environment. The most downstream station (RM 1.0) sampled in the Ottawa River (sampled in 1976 and 1977), showed further improvement by increases in diversity (3.10, 2.20) and numbers of taxa (18, 14). Though improvement in water quality was demonstrated here, the low numbers of taxa and pollution sensitive organisms still indicated poor water quality.

Two stations sampled in the Auglaize River in 1977 (RM 34.6 and 28.5) were both found to exhibit good water quality (Class II) demonstrated by good representation from the pollution sensitive groups, numbers of taxa (30, 24) and diversity indices of 3.27 and 3.37.

The Lima WWTP, Standard Oil Company, and Vistron Corporation discharges were found to have a dramatic impact upon the Ottawa River, as determined by the benthic biota. The Ottawa River was not found to have any significant effect on the Auglaize River. A more detailed account of this study can be found in Martin et al (1979).

Table VI-19: Summary of Benthic Data Collected from the Ottawa and Auglaize Rivers Relative to the Lima Wastewater Treatment Plant (WWTP), Standard Oil Company, and Vistron Corporation Discharges, August, 1977[a]

	Station (RM)									
	Ottawa River							Auglaize River		
	46.0	37.7	37.4	36.8	32.6	28.8	22.1	1.0	28.5	34.6
Number of Samplers	5	5	5	5	5	5	5	5	5	5
Quantitative Taxa	27	9	14	11	8	5	14	14	30	24
Qualitative Taxa	15	17	13	12	12	13	19	14	18	22
Organisms/Ft^2	198	520	746	109	438	346	143	183	213	150
Index ($\overline{d}$)	3.44	1.62	1.90	1.96	2.04	0.29	1.87	2.20	3.27	3.37
Evaluation (Class)	III	IV	IV	IV	IV	IV	IV	IV	II	II

[a] The Lima WWTP, Standard Oil Company, and Vistron Corporation discharges are located at RM's 37.6, 37.2, and 36.9, respectively.

Table VI-20: Summary of Benthic Data Collected from the Ottawa River Relative to the Lima Wastewater Treatment Plant (WWTP), Standard Oil Company, and Vistron Corporation Discharges, August, 1976[a]

	Station (RM)							
	46.0	37.7	37.4	36.8	32.6	28.8	16.0	1.0
Number of Samplers	5	4	5	5	5	5	5	5
Quantitative Taxa	28	8	11	7	2	5	14	18
Qualitative Taxa	8	9	5	5	5	6	7	5
Organisms/Ft^2	84	27	417	254	2327	812	85	91
Index ($\bar{d}$)	3.16	2.03	2.31	1.73	0.01	0.32	2.27	3.10
Evaluation (Class)	III	IV	IV	IV	IV	IV	IV	IV

[a] The Lima WWTP, Standard Oil Company, and Vistron Corporation discharges are located at RM's 37.6, 37.2, and 36.9, respectively.

Table VI-21: Summary of Benthic Data Collected from the Ottawa River Relative to the Lima Wastewater Treatment Plant (WWTP), Standard Oil Company, and Vistron Corporation Discharges, August, 1974[a]

	Station (RM)					
	46.0	37.7	37.4	36.8	32.6	28.8
Number of Samplers	5	4	5	5	5	5
Quantitative Taxa	17	9	4	4	5	4
Qualitative Taxa	33	14	1	9	11	14
Organisms/Ft^2	27	1321	3	105	1038	2107
Index ($\bar{d}$)	3.35	1.50	(b)	1.17	1.78	0.11
Evaluation (Class)	III	IV	IV	IV	IV	IV

(a) The Lima WWTP, Standard Oil Company, and Vistron Corporation discharges are located at RM's 37.6, 37.2, and 36.9, respectively.

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

Fixed Stations Monitoring

A National Ambient Station located on the Maumee mainstem at Waterville (RM 21.0) was sampled in July 1978, September 1977, and August 1976. Tabulated data can be found in RD 3-92, 3-93 (1978); 3-94, 3-95 (1977); and 3-96 (1976). Water quality was evaluated as fair (Class III) on all dates sampled. No significant change in water quality was observed over the three years of sampling.

Town Creek was sampled at Van Wert below the WWTP (RM 3.7) in September 1977, and August 1974 (RD 3-97 and 3-98). Water quality was poor (Class IV) during both sampling periods.

J. Portage River Basin

Biological monitoring was conducted to determine the impact of one major discharger in the Portage River Basin. Benthic samples were collected from the Portage River in 1974 to monitor the effect of discharges from Brush Wellman.

Fixed station monitoring in the basin consisted of two sets of samples collected from one data point on the Portage River in 1977 and 1978.

Portage River - B-2
(Brush Wellman)

Two stations were established in 1974 on the Portage River to determine the impact of the Brush Wellman discharge. These two stations were located at river miles 17.3 and 15.8. Brush Wellman discharges to the Portage River at river mile 16.6. A summary of the data can be found in Table VI-22. The tabulated data can be found in RD 3-99.

The control station (RM 17.3) produced 21 taxa and a diversity index of 3.02. The water quality was evaluated as fair (Class III). The station at river mile 15.8, located below the discharge, was sampled on both banks due to the increased width of the river. The data here showed a major deterioration in water quality as demonstrated by the dramatic reductions in number of taxa (5,8), diversity index (0.42, 1.01), and pollution sensitive organisms. Subsequent to the completion of the survey, this work group was made aware of the fact that estuary conditions may periodically exist at river mile 15.8. Therefore, whether the deterioriation is due to the influx of Lake Erie water or the Brush Wellman discharge is not known.

Fixed Stations Monitoring

A National Ambient Station located on the Portage mainstem at Woodville (RM 27.8) was sampled in July 1978 and September 1977. Tabulated data can be found in RD 3-100 and 3-101. Water quality was good (Class II) during both sampling periods.

K. Sandusky River Basin

Fixed Stations Monitoring

Fixed station monitoring in the Sandusky River Basin consisted of one set of samples collected from the Sandusky River above Fremont (RM 23.4) in September, 1977 (RD 3-102). The site was a National Ambient Station. Water quality was excellent (Class I) based on the high number of taxa, a high diversity index, and an abundance of pollution sensitive organisms.

Table VI-22: Summary of Benthic Data Collected from the Portage River Relative to the Brush Wellman Discharge, August, 1974[a]

	Station (RM)		
	17.3	East Bank 15.8	West Bank 15.8
Number of Samplers	5	5	5
Quantitative Taxa	21	5	8
Qualitative Taxa	32	11	2
Organisms/Ft^2	466	9246	4321
Index ($\bar{d}$)	3.02	0.42	1.01
Evaluation (Class)	III	IV	IV

[a] The Brush Wellman discharge is located at RM 16.6.

L. Black River Basin

Fixed Stations Monitoring

Fixed station monitoring in the Black River Basin consisted of three sets of samples collected from two data points. The stations were located on the Black River below the Elyria WWTP (RM 9.4) and at Elyria (RM 14.9). The site at Elyria was a National Ambient Station. Water quality at the sites was evaluated as follows:

Elyria - Poor (Class IV) in August 1978 and July 1977 (RD 3-103, and 3-104).

Below Elyria - Poor (Class IV) in July 1977 (RD 3-105).

M. Cuyahoga River Basin

Fixed Stations Monitoring

Fixed station monitoring in the Cuyahoga River Basin consisted of two sets of samples collected from the Cuyahoga River at Independence (RM 14.2) in August 1978 and 1977 (RD 3-106 and 3-107). The site was a National Ambient Station. Water quality was poor (Class IV) during both sampling periods.

V. FISH EVALUATIONS

Fish are useful indicators of water quality. They are the end product of most aquatic food webs and, therefore, are integrators of community response, with their biomass being dependent on the primary and secondary productivity of the aquatic community. Fish also constitute a conspicuous part of the aquatic biota, generally reproduce once per year, are sensitive to a wide range of substances and conditions, and there is an abundance of information about their life history, environmental requirements, and geographical distribution.

Ohio EPA includes fish relative abundance and distribution assessments as part of the biological sampling program associated with intensive surveys. Fish sampling as part of the intensive surveys was fully implemented during 1979, with previous efforts in the Ottawa River and Mill Creek described in Martin et al. (1979) and Yoder et al. (1980), respectively. The 1979 fish data will be included in the intensive survey reports to be published in 1980.

All fish relative abundance data are entered into the Fish Information System (FINS) which was developed by the Ohio EPA for the purposes of storage and analysis. Data are stored by date, basin-river code, and river mile (RM) and analyzed for both community (all species included) and population (single species) parameters. Community parameters include relative abundance, diversity indices, percent composition, and similarity coefficients. Population parameters include relative abundance (number and weight), length frequency, and condition factor.

FISH KILL INFORMATION

The Ohio Department of Natural Resources, Division of Wildlife investigates and has statutory jurisdicition over incidents involving kills of wild animals, including fish. The Division of Wildlife publishes a yearly report entitled "Water Pollution, Fish Kills, and Stream Litter Investigations..." These reports contain the following information.

1) A yearly summary of investigations.

2) Identification of the sources of pollution causing wild animal kills.

3) Summaries of each specific fish kill or stream litter investigation by date, county, water body, suspected pollutant, number of wild animals killed, and type of operation responsible for each incident.

These annual reports are available from the Ohio Department of Natural Resources, Division of Wildlife, Fountain Square, Columbus, Ohio 43224.

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OHIO LAKES AND RESERVIORS

1980 305(b) Report
Volume VII

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Ohio Lakes and Reservoirs

I. SUMMARY

This section includes a general description of the Ohio EPA's lake sampling program, morphological, chemical/physical and biological summaries for 45 lakes sampled by Ohio EPA/U.S. Geological Survey (1975 to 1977), an evaluation of lake water quality problems (mine drainage, elevated metal concentrations, sanitary and urban related water quality problems) and a trophic level (nutrient) evaluation for 83 lakes and reservoirs. A method described by Carlson (1977), which uses chlorophyll a, secchi disc, or total phosphorus to calculate a Trophic State Index, was used to determine trophic level. Table VII-1 is an inventory of 210 public lakes with a surface area greater than 15 acres. Major and minor basins of the Ohio River and Lake Erie are grouped separately and arranged in order from west to east (Figure VII-1). Lakes and reservoirs within basins are arranged alphabetically.

Table VII-1 also includes lake location (county, longitude, latitude and map codes), morphometric data, trophic level determination and chemical parameters which exceed Ohio's water quality standards.

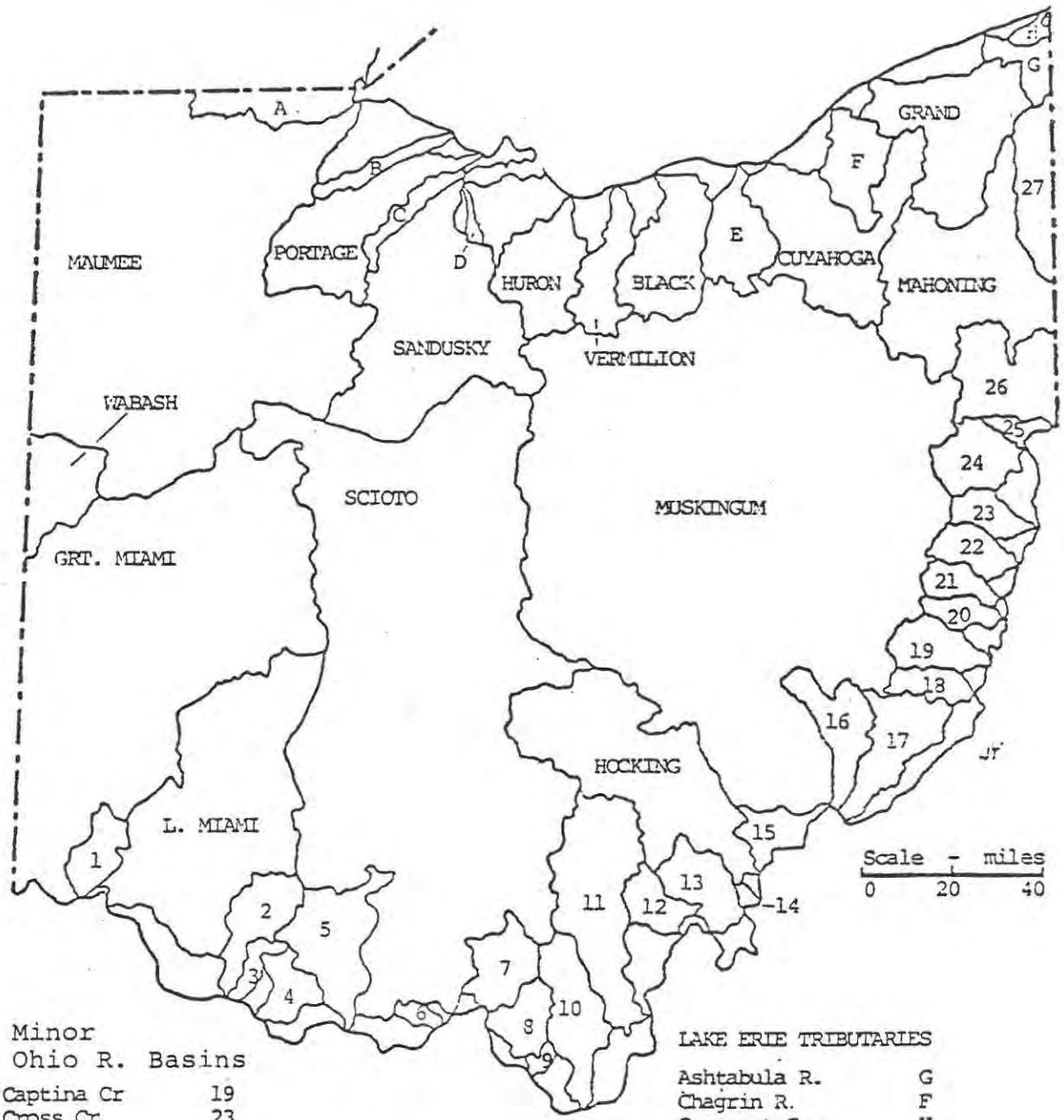
II. INTRODUCTION

Ohio has more than 200 publicly owned lakes and reservoirs greater than 15 acres in surface area, for a combined surface area of more than 100,000 acres. Table VII-1 is an inventory of these lakes and reservoirs, and summarizes location, orgin, use, morphometric characteristics, trophic classification, and availability of scientific data for each lake and reservoir. Lakes and reservoirs are listed alphabetically within the drainage basin in which they are located. The major and minor basins of the Ohio River and Lake Erie watersheds are grouped separately and arranged in order from west to east (Figure VII-1).

The Ohio Department of Natural Resources has compiled an inventory of Ohio's lakes, public and private, greater than five acres (Bowell, 1980). Information provided for each lake includes, latitude and longitude, location by county and township, lake type, drainage basin, purpose, and surface area.

An ongoing cooperative program between the Ohio EPA and U.S. Geological Survey (USGS) was initiated in 1975 to determine the water quality of Ohio's publicly owned lakes and reservoirs. The program is designed to provide baseline data on a wide spectrum of parameters, while providing sufficient information for trophic level determination. Sampling occurs in early spring, before thermal stratification, and again in late summer during peak stratification. Physical and chemical profile measurements are made at primary stations established in the deepest part of each lake. Secondary stations are established in larger lakes to detect horizontal differences in water quality. Sampling stations are also located on the principal tributaries of each lake to determine inflow water quality. Table VII-2 lists the parameters measured and sampling regime for both lake and inflow stations.

Figure VII-1. Major and Minor Basins of Lake Erie and the Ohio River.[a]



Minor Ohio R. Basins

Captina Cr	19		
Cross Cr	23		
Duck Cr	16		
Eagle Cr	4	Raccoon Cr	11
Forked Run	14	Shade R	13
Leading Cr	12	Shenango R	27
L. Beaver Cr	26	Short Cr	22
L. Hocking R	15	Straight Cr	3
L. Muskingum R	17	Storms Cr	9
L. Scioto R	7	Sunfish Cr	18
L. Yellow Cr	25	Symmes Cr	10
McMahan Cr	20	Turkey Cr	6
Mill Cr	1	Wheeling Cr	21
Ohio Brush Cr	5	White Oak Cr	2
Pine Cr	8	Yellow Cr	24

LAKE ERIE TRIBUTARIES

Ashtabula R.	G
Chagrin R.	F
Conneaut Cr.	H
Muddy Cr.	C
Ottawa R.	A
Raccoon Cr.	D
Rocky R.	E
Toussaint Cr.	B

[a] Major basins are named on map, minor basins are numbered, or lettered.

Table VII-1A: Inventory of Lakes and Reservoirs;
Morphometric data and literature references

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Wabash R. Basin										
Wabash River Conservancy Reservoir #1	Darke	Wabash	140	-	984	-	1012	1964	-	-
Great Miami R. Basin										
Acton Lake	Butler	Fourmile Crk	625	99	9400	8	863	1956	1975	-
Bass Lake	Greene	Unnamed	40	12	-	-	-	-	-	-
Buck Creek Lake (Clarence J. Brown Lake)	Clark	Buck Creek	2120	82	36900	10	1012	1974	1977	-
Clark Lake	Clark	Sinking Crk	100	6.7	507	3	-	1957	1979	-
Eastwood Lake	Montgomery	Mad River	125	-	-	-	-	-	-	-
Echo Lake	Miami	Unnamed	15	2.1	-	-	-	-	-	-
Englewood Reservoir (a dry dam)	Montgomery	Stillwater River	130	651	-	-	816	1922	-	-
Grand Lake St. Marys	See Maumee River Basin									
Huffman Reservoir (a dry dam)	Greene	Mad River	43	671	-	-	777	1922	-	-
Indian Lake	Logan	N. Fork Grt Miami River	6134	110	45900	29	998	1852	1977	USEPA, 75
Kiser Lake	Champaign	Mosquito Crk	380	98	3215	5	1067	1940	1977	-
L. Loramie	Shelby	Loramie Crk	785	70	13000	30	-	1844	1975	USEPA, 75
Miami-Whitewater Lake	Hamilton	Unnamed	85	-	-	-	-	1967	-	-
Old Reid Memorial Pk. Lake	Clark	Unnamed	15	-	-	-	-	-	-	-
Rush Run Lake	Preble	Rush Run	54	-	820	-	965	1969	-	-
Swift Run Lake	Miami	Patterson Run	40	7.3	-	2.1	903	1950	-	-

Table VII-1A (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
L. Miami R. Basin										
Caesar Creek Lake	Warren	Caesar Crk	2830	237	102000	-	849	1977	1978	-
Cowan Lake	Clinton	Cowan Crk	720	51	12000	17	960	1947	1975	-
East Fork Lake	Clermont	E. Fork L. Miami	2120	342	90400	-	733	1978	1979	-
Lake Isabella	Hamilton		23	-	-	-	-	-	-	-
New Wilmington Reservoir	Clinton	Upground	54	NA	1013	-	1070	1963	-	-
Spring Valley Lake	Warren	Unnamed	79	-	87	2	-	1936	-	-
Stonelick Lake Creek	Clermont	Stonelick	171	23	1750	9.5	875	1949	1977	-
Wilmington Res	Clinton	Upground	-	-	276	NA	1070	1945	-	-
Scioto R. Basin										
Alum Creek Lake	Delaware	Alum Creek	3387	123	-	46	888	1975	1976	-
Amann Reservoir	Morrow	Rocky Fk of Olentangy R	24	11	200	-	-	1943	-	-
Amicks Reservoir	Morrow	Upground	49	NA	1515	-	-	1968	-	-
Deer Creek Lake	Pickaway	Deer Creek	1277	278	21029	-	810	1968	1975	USEPA, 1975
Delaware Lake	Delaware	Olentangy R	1300	381	14000	35	915	1951	-	USEPA, 1975
Griggs Reservoir	Franklin	Scioto R	385	1052	4563	15	-	1905	1979	-
Hammertown Lake (Jackson City Reservoir)	Jackson	Unnamed	186	3.1	4200	8.4	690	1955	1979	-
Hargus Lake	Pickaway	Hargus Crk	146	6.5	2325	5	822	1956	1978	-
Hillsboro Reservoir	Highland	Spring Brk	22	1.0	212	-	1018	1947	-	-

Table VII-1A (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Scioto R. Basin (Continued)										
Hoover Reservoir	Franklin	Big Walnut Creek	2825	190	60470	45	890	1955	1975	USEPA, 1975
L. Katharine	Jackson	Rock Run	51	-	-	-	662	1940	-	-
Madison Lake	Madison	Deer Crk	106	57.2	594	4	965	1946	1979	-
Mount Gilead Lake	Morrow	Sams Crk	-	-	-	1.3	-	1930	-	USEPA, 1975
O'Shaughnessy Reservoir	Delaware	Scioto R	829	997	13120	17	845	1925	-	USEPA, 1975
Paint Creek Lake	Highland	Paint Creek	1190	573	20300	30	798	1973	1975	-
Pine Lake	Ross	Tar Hollow Creek	14	2.4	134	0.9	792	1938	-	-
Powers Reservoir	Crawford	Upground	29	NA	460	-	1159	1957	-	-
Richwood Lake	Union	Dugout	15	NA	-	1	-	1940's	-	-
Rocky Fork Lake	Highland	Rocky Fork Creek	2020	114	34100	30	880	1953	1975	USEPA, 1975
Ross Lake	Ross	Unnamed	140	-	-	-	-	1968	1979	-
Washington C.H. Reservoir	Fayette	Upground	32	NA	614	1	995	1955	-	-
Westerville Reservoir	Delaware	Unnamed	53	2.7	780	-	877	1960	-	-
L. White	Pike	Pee Pee Crk	337	37	3734	8.3	570	1935	1979	-
Hocking R. Basin										
Burr Oak Lake (Tom Jenkins Reservoir)	Athens	E Branch of Sunday Crk	664	33	9300	20	721	1952	1976	-
Clouse Lake	Perry	Center Branch L. Brush Crk	42	-	234	1.5	852	1948	-	-

Table VII-1A (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Hocking R. Basin (Continued)										
Corning Reservoir	Perry		16	-	-	-	-	-	-	-
Dow Lake	Athens	Strouds Run	153	7.3	1844	7	660	1884	1978	-
Essington Lake	Perry	Unnamed	16	0.7	120	-	958	1945	-	-
Fox Lake	Athens	Unnamed	48	4.0	465	-	694	1967	-	-
Greenfield Lake	Fairfield	Unnamed	14	0.9	80	-	923	1961	-	-
L. Logan (Hocking Lake)	Hocking	Clear Fk	341	14.0	3142	10	-	1955	1976	-
Margaret Creek Conservancy District Structure #4	Athens	Biddle Crk	28	4.2	105	-	696	1971	-	-
New Lexington Reservoir	Perry	Unnamed	27	0.8	344	-	912	1936	-	-
Oakthorpe Res. (Rush Run Conservancy District #VI-D)	Fairfield		43	-	795	-	915	1975	-	-
Rock Mill Lake (Hunters Run Conservancy District #9)	Fairfield	Unnamed	20	8.0	150	-	910	1960	-	-
Rush Creek Conversancy Dist. Structures										
IV A	Perry	Unnamed	44	1.2	536	-	936	1975	-	-
IV C	Perry		32	-	-	-	-	-	-	-
V A	Fairfield	Unnamed	20	2.3	85	-	817	1970	-	-
VII C	Fairfield	Raccoon Run	15	-	-	-	-	-	-	-
Snowden Lake (Margaret Crk Conservancy District #2)	Athens	Unnamed	137	4.0	2120	-	739	1972	1979	-

Table VII-1A (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Muskingum R. Basin										
Atwood Lake	Tuscarawas	Indian Fk	1540	70	23600	27.6	928	1937	1976	USEPA, 1975
Barberton Reservoir	Summit	Wolf Creek	196	27	2056	-	996	1927	-	-
Beach City Reservoir	Tuscarawas	Sugar Creek	420	300	1700	-	948	1937	-	-
Buckeye Lake	Licking	S. Fork of Licking R.	3136 -	49.2 -	19940 -	32 -	893 -	1832 -	1975 1978	USEPA, 1975 -
Cambridge City Reservoir	Guernsey	Unnamed	26	-	614	-	832	1908	-	-
Charles Mill Reservoir	Ashland	Black Fork	1350	215	7400	33	-	1936	1978	USEPA, 1975
Clear Fork Reservoir	Richland	Clear Fork	997	34	13176	14	997	1949	1975	-
Clendening Lake	Harrison	Brushy Fk	1800	69.	27900	44	898	1939	1976	-
Crooksville Reservoir. #3	Perry	Black Fork	15	-	142	-	822	1956	-	-
Cutler Lake (Blue Rock Lake)	Muskingum	Salt Creek	18	1.6	163	1.2	829	1937	-	-
Dillon Lake	Muskingum	Licking R.	1325	748	13170	-	734	1959	1977	USEPA, 1975
East Reservoir (a Portage Lake)	Summit	Natural Lake	243	-	-	5.6	989	Nat	-	-
Firestone Reservoir (Tuscarawas R. Diversion Dam)	Summit	Tuscarawas	98	34.8	491	-	995	1957	-	-
Knox Lake	Knox	E. Branch of Kokosing	495	31.4	3502	12	1100	1953	1977	-
Leesville Lake	Carroll	McGuire Crk	1000	48.3	19500	27	963	1936	1976	-
Lime Kiln Lake	Tuscarawas	Unnamed	30	-	76	-	916	-	-	-
Long Lake (a Portage Lake)	Summit	Natural Lake	166	-	-	2.3	988	Nat.	1977	-
Munroe Basin	Muskingum	Wakatomika Creek	17	-	-	-	-	-	-	-
M.W.C.D. - Chippewa Subdivision Reservoir	Wayne	L. Chippewa Creek	34	14.4	141	-	991	1974	-	-

Table VII-xx (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Muskingum R. Basin (Continued)										
Nimisila Reservoir	Summit	Nimisila Crk.	811	17	9400	16	985	1938	1977	-
N. Branch of Kokosing River	Knox	N. Branch Kokosing	154	44	-	-	1146	1971	1979	-
North Reservoir (a Portage Lake	Summit	Natural	-	-	-	-	976	Nat	-	-
Piedmont Lake	Harrison	Stillwater Creek	2310	86	34500	36.5	913	1937	1977	-
Pleasant Hill Reservoir	Ashland	Clear Fork	850	197	13500	13.4	1020	1936	-	USEPA, 1975
Salt Fork Reservoir	Guernsey	Salt Fork	2952	160	42085	-	-	1968	1975	-
Senecaville Lake (Seneca Lake)	Guernsey	Seneca Fork	3550	121	43500	47	832	1937	1976	-
Shreve Lake	Wayne	Unnamed	58	1.1	174	-	944	1966	-	-
Tappan Lake	Harrison	L. Still-water Creek	2350	71	35100	41	899	1936	1976	USEPA, 1975
Turkey Foot Lake (a Portage Lake)	Summit	Natural Lake	-	-	-	-	-	Nat.	1977	-
West Reservoir (a Portage Lake)	Summit	Natural Lake	115	-	-	-	-	Nat.	-	-
Wills Creek Lake	Coshocton	Wills Creek	900	842	6000	-	742	1939	1976	-
Mahoning R. Basin										
Berlin Lake	Portage	Mahoning R	2200	249	35400	21	1017	1943	1975	USEPA, 1975
Crystal Lake	Portage	Unnamed	25	0.4	-	-	1075	-	-	-
Dale Walburn Reservoir	Stark	Deer Crk	670	32	5860	-	1093	1971	-	-
Deer Creek Reservoir	Stark	Deer Crk	303	36	3069	8	1040	1954	1977	-
Meander Creek Reservoir	Trumbull	Meander Crk	2010	86	30675	-	905	1932	1979	-
L. Milton	Mahoning	Mahoning R	1685	280	29200	21	951	1916	1979	-

Table VII-1A (Continued)

Major Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Mahoning R. Basin (Continued)										
Mosquito Creek Lake	Trumbull	Mosquito Cr	7850	98	69400	40	901	1944	1976	USEPA, 1975
Newport Lake	Mahoning	Mill Creek	105	67	920	-	983	1962	-	-
Lake Park	Mahoning	Unnamed	20	0.23	50	1.2	1055	1900's	-	-
West Branch Reservoir (M.J. Kirwan Reservoir)	Portage	W. Branch Mahoning R.	2650	80.5	52900	-	986	1966	1977	-
Westville Reservoir	Columbiana	Naylor Ditch	90	7.8	934	-	1101	1913	-	-
Shenango R. Basin										
Pymatuning Reservoir	Ashtabula	Pymatuning River	20580	158	200000	77	-	1933	-	USEPA, 1975

Table VII (Continued)

Minor Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Mill Creek Basin										
Sharon Lake	Hamilton	Unnamed	38	4.9	-	-	-	1936	-	-
West Fork Mill Crk. L. (Winton Lake)	Hamilton	W. Fork Mill Crk.	183	30	1531	-	675	1952	1978	-
White Oak Creek Basin										
Grant Lake	Brown	Sterling Crk.	181	25	1140	7.9	906	1948	-	USEPA, 1975
Ohio Brush Creek Basin										
Adams Lake	Adams	Lick Fork	38	4.5	32	2.5	760	1947	-	-
Turkey Creek Basin										
Roosevelt Lake	Scioto	Turkey Crk.	16	16	-	1.5	-	1935	-	-
Turkey Crk. Lake	Scioto	Turkey Crk.	51	-	-	-	-	1967	-	-
Storms Creek Basin										
Vesuvius Lake	Lawrence	Storms Crk.	105	10.9	-	6.4	-	1937	1975	-
Sunfish Creek Basin										
Monroe Lake	Monroe	Sunfish Crk.	39	-	-	3.0	-	-	-	-
Symmes Creek Basin										
Jackson Lake	Jackson	Black Fork Creek	243	19	-	11	700	1940	1978	-
Raccoon Creek Basin										
Alma Lake	Vinton	Pigeon Crk.	63	0.8	774	-	690	1901	-	-
Lake Hope	Vinton	Sandy Run	126	9.9	1555	5.4	716	1939	1975 1978	-
Lake Rupert	Vinton	L. Raccoon Crk.	325	-	2400	-	-	1968	1979	-
Tycoon Lake	Gallia	Raccoon Crk.	204	-	-	3.5	-	1960	1978	-

Table VII-1A (Continued)

Minor Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Forked Run Basin										
Forked Run Lake	Meigs	Forked Run	107	-	-	8.5	601	1952	1978	-
L. Hocking Basin										
Veto Lake	Washington	L. Hocking R.	158	20	-	6.0	-	1953	1978	-
Duck Creek Basin										
Caldwell Lake	Noble	Dog Run	27	4.8	343	-	-	1935	-	-
Wolf Run Lake	Noble	Wolf Run	203	-	-	-	-	1966	1976	-
Captina Creek Basin										
Barnesville Reservoir #1	Belmont	Unnamed	23	1.0	263	-	1163	1904	-	-
Barnesville Reservoir #3	Belmont	Slope Crk.	98	5.7	1491	-	1092	1965	-	-
McMahon Basin										
Belmont Lake (Barkcamp Lake)	Belmont	Barkcamp Crk.	117	4.7	1935	-	1085	1961	-	-
Yellow Creek Basin										
Friendship Park Lake	Jefferson	Town Fork	85	3.1	1993	-	1035	1972	-	-
Jefferson Lake	Jefferson	Town Fork	25	7.5	200	1.0	955	1935	-	-
L. Yellow Creek Basin										
Highlandtown Lake	Columbiana	L. Yellow Crk.	170	6.0	1230	6.5	1076	1968	1978	-

Table VII-1A (Continued)

Minor Basins Tributary to the Ohio River

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
L. Beaver Creek Basin										
Guilford Lake	Columbiana	West Fork L. Beaver Creek	396	.10	2510	6.4	1136	1932	1978	-
Salem Reservoir	Columbiana	Unnamed	97	0.8	1100	-	1168	1952	-	-
Zepernick Lake	Columbiana	Unnamed	36	0.1	180	1	1245	1950	-	-

Table VII-1A (Continued)

Major Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Maumee R. Basin										
Archbold Reservoir #1	Fulton	Upground	20	NA	233	-	744	1951	-	-
Archbold Reservoir #2	Fulton	Upground	49	NA	853	-	750	1961	-	-
Bresler Reservoir (Spencerville Reservoir)	Allen	Upground	610	NA	15222	3.7	850	1969	-	-
Delta Reservoir	Fulton	Upground	39	NA	331	1.1	750	1933	-	-
Deshler Reservoir	Henry	Unnamed	20	-	-	-	-	-	-	-
Ferguson Lake	Allen	Upground	304	NA	7672	3.0	921	1958	-	-
Old Findlay Reservoir #1	Hancock	Upground	186	NA	4143	2	808	1950	-	-
New Findlay Reservoir #2	Hancock	Upground	640	NA	16879	4.5	815	1970	1979	-
Forty Acre Pond	Auglaize	Unnamed	106	-	-	-	-	1845	-	-
Fulton Pond	Fulton	Dugout	15	-	-	-	-	-	-	-
Grand Lake St. Marys	Auglaize	(a)	11000	118	106605	60	-	1845	1975	USEPA, 1975
Harrison Lake	Fulton	Mill Crk.	97	37	991	3.5	770	1941	1975	-
Independence Dam (a low head dam)	Defiance	Maumee R	600	56	2000	-	660	-	-	-
Leipsic Reservoir	Putnam	Upground	27	NA	130	-	744	-	-	-
Lima Lake Reservoir	Allen	Upground	85	NA	428	-	878	1947	-	-
Metzger Reservoir	Allen	Upground	167	NA	3682	2	920	1946	-	-
Nettle Lake	Williams	Natural	94	-	-	-	945	Nat	1978	-
Ottawa Reservoir	Putnam	Upground	20	NA	-	-	-	-	-	-
Oxbow Lake	Defiance	Upground	36	NA	145	1.5	689	1953	-	-

Table VII-... (Continued)

Major Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Maumee R. Basin (Continued)										
Paulding Reservoir	Paulding	Upground	62	NA	-	1.2	-	1965	-	-
Providence Dam (a low head dam)	Lucas	Maumee R	80	6058	-	-	-	-	-	-
Saulisberry Park Lake	Hardin	Dugout	50	NA	-	-	-	-	-	-
Schoonover Lake	Allen	Upground	22	NA	50	1.0	852	1937	-	-
Spencerville Res - see Bresler Reservoir										
State Fish Hatchery Lake	Auglaize	Upground	56	NA						
Swanton Reservoir	Lucas	Upground	25	NA	270	-	667	1937	-	-
Twin Lakes Reservoir	Allen	Upground	26	NA	426	-	866	1886	-	-
Van Wert City Reservoir #1	Van Wert	Upground	60	NA	-	1.3	-	1952	-	-
Van Wert City Reservoir #2	Van Wert	Upground	60	NA	-	-	-	1960	-	-
Wauseon Reservoir #1	Fulton	Upground	49	NA	215	-	756	1938	-	-
Wauseon Reservoir #2	Fulton	Upground	17	NA	184	-	752	1921	-	-
Portage Basin										
Aldrich Pond	Sandusky	Upground	35	NA	-	-	-	-	-	-
Lake Lacomte (Fostoria Reservoir No. 5)	Hancock	Upground	128	NA	2256	-	808	1958	-	-
Lake Lamberjack	Hancock	Upground	30	NA	400	-	775	1919	-	-
Lake Mosier	Hancock	Upground	91	NA	924	-	786	1941	-	-
N. Baltimore Reservoir	Wood	Upground	29	NA	430	-	-	1969	-	-
Van Buren Lake	Hancock	Rocky Fork Creek	53	23	248	2.1	756	1939	-	-

Table VII-1A (Continued)

Major Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Sandusky Basin										
Bucyrus Reservoir #1	Crawford	Unnamed	31	3.5	215	-	1007	1900	-	-
Bucyrus Reservoir #2	Crawford	Unnamed	36	2.8	218	-	1003	1919	-	-
Clyde Reservoir (Beaver Creek Res)	Seneca	Upground	110	NA	-	-	-	1970	-	-
Killdeer Ponds	Wyandot	Unnamed	970	-	-	-	-	1970	-	-
Killdeer Reservoir	Wyandot	Upground	253	NA	6674	2.2	902	1972	1977	-
Riley Reservoir	Crawford	Upground	30	NA	450	-	1026	1955	-	-
Upper Sandusky	Wyandot	Unnamed	33	-	344	-	832	1957	-	-
Huron R. Basin										
Bellevue Reservoir #5	Huron	Upground	87	NA	-	1.3	804	1946	-	-
Celeryville Reservoir	Crawford	Upground	75	NA	1050	-	954	1963	-	-
Norwalk Reservoir #1 (Upper)	Huron	Norwalk Crk.	28	7.3	-	-	-	-	-	-
Norwalk Reservoir #2 (Lower)	Huron	Norwalk Crk.	51	7.3	-	-	-	-	-	-
Norwalk Reservoir #3 (Memorial)	Huron	Norwalk Crk.	96	7.3	-	-	-	1953	-	-
Willard City Reservoir	Huron	Upground	215	NA	7740	2.3	-	1971	1979	-
Vermilion R. Basin										
Kipton Reservoir	Lorain	Unnamed	200	-	-	1.0	-	1950	-	-
New London Reservoir	Huron	Upground	221	-	-	2.6	-	1975	-	-

Table VII-.. (Continued)

Major Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Black R. Basin										
Findley Lake	Lorain	Wellington Creek	83	6.5	760	4.0	880	1956	-	NOACA, 1978
Oberlin Reservoir	Lorain	Upground	56	NA	-	-	-	1960	-	-
Spencer Lake	Medina	Unnamed	51	-	136	1.9	847	1958	-	NOACA, 1978
Wellington Reservoir (Upper)	Lorain	Unnamed	31	-	-	-	-	1931	-	-
Wellington Upground Reservoir (Lower)	Lorain	Upground	185	NA	-	-	-	1972	-	-
Rocky River Basin										
Baldwin Lake (a low head dam)	Cuyahoga	E. Branch Rocky River	32	64.6	40	1.3	766	1930	-	NOACA, 1978
Coe Lake	Cuyahoga	Dugout	15	NA	-	-	-	-	-	-
Hinckley Lake	Medina	E. Branch Rocky River	88	22	616	2.8	921	1938	-	NOACA, 1978
Medina Lake	Medina	Unnamed	109	0.7	1770	-	930	1966	-	-
Wallace Lake	Cuyahoga	Dugout	15	-	83	3.3	-	-	-	NOACA, 1978
Cuyahoga R. Basin										
Aquilla Lake	Geauga	Natural L	25	11	246	1.2	1135	Nat	-	NOACA, 1978
Brady Lake	Portage	Unnamed	70	-	-	-	-	-	-	-
E. Branch Reservoir	Geauga	E. Branch Cuyahoga R.	420	17	4604	-	1132	1940	1977	-
Geauga Lake	Geauga	Unnamed	50	0.39	-	-	1009	Nat	-	-
Gorge Metro. Park Lake	Summit	Cuyahoga R.	34	-	589	-	900	1932	-	-
Hodgson Lake (Muddy Lake)	Portage	Unnamed	190	-	3300	4.1	-	1840's	-	NOACA, 1978
La Due Reservoir	Geauga	Bridge Crk.	1500	35.1	14000	-	1125	1960	1978	-
Lower Shaker Lake	Cuyahoga	Doan Brk..	16	-	96	1.0	903	1850's	-	NOACA, 1978

Table VII-1A (Continued)

Major Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Cuyahoga R. Basin (Continued)										
Meadowbrook Lake	Summit	Powers Brk.	24	5.6	88	-	-	1948	-	-
Mogadore Reservoir	Portage	L. Cuyahoga River	900	13	7040	19	1090	1938	1976	-
Muzzy Lake	Portage	Unnamed	82	1.7	-	-	-	-	-	-
Lake Pippen	Portage	Natural L	96	0.5	-	-	-	Nat	-	-
Punderson Lake	Geauga	Natural L	101	1.7	-	2.6	1143	Nat	1975	-
L. Rockwell	Portage	Cuyahoga R.	769	207	-	-	-	1914	1976	-
Summit Lake	Summit	Natural L (on Ohio Canal)	90	-	-	-	965	Nat	1976	-
Sunny Lake (Harmons Pond)	Portage	Unnamed	63	-	-	-	-	-	-	-
Grand River Basin										
Geneva Lake (a low head dam)	Ashtabula	Grand R.	36	-	250	-	744	1900's	-	-
Lampson Reservoir (Jefferson Reservoir)	Ashtabula	Upground	22	NA	200	1.0	839	1950	-	-

Table VII-1A (Continued)

Minor Basins Tributary to Lake Erie

Name	Location (County)	Impounded Stream	Surface Area (Acres)	Drainage Area (sq mi)	Capacity (acre ft)	Shoreline (mi)	Surface Elev. (ft)	Date Const.	OEPA/USGS Data	Additional Data
Raccoon Creek Basin										
Clyde Reservoir (Raccoon Crk. Reservoir)	Sandusky	Upground	35	NA	-	0.9	-	1950	-	-
Ottawa River Basin										
Molander Lake	Lucas	Dugout	20	NA	-	-	665	-	-	-

Table VII-1B: Inventory of Ohio Lakes and Reservoirs;
location, trophic classification, use and chemical parameters at or above State water quality limits

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical parameters at or above WQS (2)
Wabash R. Basin											
Wabash River Conservancy Reservoir #1	40°18'57"	84°38'05"	G	Darke	Rossburg	FCR	-	-	-	-	-
Great Miami R. Basin											
Acton Lake	39°33'27"	84°44'03"	H-10	Butler	Oxford	R	-	65	81	Eutrophic	Cu-T
Bass Lake	39°49'50"	84°03'10"	H- 4	Greene	Fairborn	R	-	-	-	-	-
Buck Creek Lake (Clarence J. Brown Lake)	39°57'02"	83°44'50"	H- 3	Clark	New Moorfield	FCR	65	54	57	Eutrophic	-
Clark Lake	39°56'53"	83°39'38"	H- 3	Clark	New Moorfield	R	39	49	-	Eutrophic	-
Eastwood Lake	39°47'00"	84°08'20"	H- 4	Montgomery	Dayton North	R	-	-	-	-	-
Echo Lake	40°09'22"	84°15'37"	H- 2	Miami	Piqua East	RWS	-	-	-	-	-
Englewood Reservoir (a dry dam)	39°52'13"	84°17'08"	H- 6	Montgomery	Trotwood	FCR	-	-	-	-	-
Huffman Reservoir (a dry dam)	39°37'50"	84°05'26"	H- 4	Greene	Fairborn	FCR	-	-	-	-	-
Indian Lake	40°28'03"	83°52'32"	H- 1	Logan	Russells Point	R	75	71	71	Hypereutrophic	-
Kiser Lake	40°11'50"	83°58'55"	H- 2	Champaign	St. Paris	R	80	75	65	Hypereutrophic	-
L. Loramie	40°21'27"	84°21'32"	H- 2	Shelby	Fort Loramie	R	-	83	83	Hypereutrophic	
Miami-Whitewater Lake	39°15'35"	84°44'45"	H-11	Hamilton	Shandon	R	-	-	-	-	-
Old Reid Memorial Pk. Lake	39°56'43"	83°45'30"	H- 3	Clark	Springfield	R	-	-	-	-	-
Rush Run Lake	39°35'42"	84°36'46"	H-10	Preble	West Elkton	R	-	-	-	-	-
Swift Run Lake	40°10'35"	84°15"48"	H- 2	Miami	Piqua West	RWS	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
L. Miami R. Basin											
Caesar Creek Lake	-	-	K- 3	Warren	Oregonia	FCR	52	39	73	Eutrophic	-
Cowan Lake	39°23'18"	83°55'30"	K -3	Clinton	Clarksville	WSR	-	68	73	Eutrophic	Cu-T
East Fork Lake	39°01'23"	84°08'59"	K- 4	Clermont	Batavia	FCR	68	58	-	Eutrophic	-
Lake Isabella	39°14'37"	84°18'18"	K- 5	Hamilton	Madeira	R	-	-	-	-	-
New Wilmington Reservoir	39°24'32"	83°48'30"	K- 3	Clinton	Wilmington	WS	-	-	-	-	-
Spring Valley Lake	39°33'50"	84°01'14"	K	Warren	Waynesville	R	-	-	-	-	-
Stonelick Lake	39°12'57"	84°05'01"	K- 4	Clermont	Newtonsville	R	61	59	74	Eutrophic	Fe-T
Wilmington Res	39°24'33"	83°49'00"	K- 3	Clinton	Wilmington	WS	-	-	-	-	-
Scioto R. Basin											
Alum Creek Lake	40°11'03"	82°57'50"	M- 4	Delaware	Galena	FCRWS	-	43	53	Mesotrophic	-
Amann Reservoir	40°42'45"	82°49'21"	M- 3	Morrow	Galion	RWS	-	-	-	-	-
Amicks Reservoir	40°42'11"	82°49'22"	M- 3	Morrow	Galion	RWS	-	-	-	-	-
Deer Creek Lake	39°36'20"	83°14'42"	M- 7	Pickaway	Clarksburg	FCR	-	71	65	Eutrophic	Cu-T
Delaware Lake	40°21'30"	83°04'08"	M- 3	Delaware	Delaware	FCRWS	-	-	-	Eutrophic (3)	-
Griggs Reservoir	40°00'56"	83°05'38" Columbus	M- 5	Franklin	Northwest	RWS	67	66	-	Eutrophic	-
Hammertown Lake (Jackson City Reservoir)	39°03'23"	82°41'05"	M-16	Jackson	Jackson	RWS	40	38	-	Mesotrophic	
Hargus Lake	39°37'36"	82°53'15"	M- 8	Pickaway	Ashville	R	43	51	61	Mesotrophic	Cd-T
Hillsboro Reservoir	39°14"46"	83°36'00"	M-16	Highland	Hillsboro	RWS	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Scioto R. Basin (Continued)											
Hoover Reservoir	40°05'58"	82°52'53"	M- 4	Franklin	NE Columbus	FCRWS	-	57	71	Eutrophic	Cu-T
L. Katharine	39°05'05"	82°40'22"		Jackson	Jackson	A	-	-	-	-	-
Madison Lake	39°51'58"	83°22'35"	M- 7	Madison	Walnut Run	R	63	69	-	Eutrophic	
O'Shaughnessy Reservoir	40°09'12"	83°07'33"	M- 5	Delaware	Shawnee Hills	RWS	-	-	-	-	-
Paint Creek Lake	39°15'03"	83°21'15"	M-13	Highland	Bainbridge	FCR	-	61	75	Eutrophic	
Pine Lake	39°23'03"	82°44'57"	M- 3	Ross	Laurelville	R	-	-	-	-	-
Powers Reservoir	40°43'05"	82°48'12"	M- 3	Crawford	Galion	WS	-	-	-	-	-
Richwood Lake	40°25'44"	83°17'56"	M- 2	Union	Richwood		-	-	-	-	-
Rocky Fork Lake				Highland	Rainsboro	RWS	-	62	61	Eutrophic	Cu-T
Ross Lake	39°20'05"	82°54'20"	M-11	Ross	Chillicothe	R	45	44	-	Mesotrophic	-
Washington C.H. Reservoir	39°32'29"	83°27'22"	M-13	Fayette	Washington C.H.	WS	-	-	-	-	-
Westerville Reservoir	40°09'31"	82°56'25"	M- 4	Delaware	Galena	WS	-	-	-	-	-
L. White	39°06'05"	83°00'50"		Pike	Piketon	R	53	53	-	Eutrophic	-
Hocking R. Basin											
Burr Oak Lake (Tom Jenkins Reservoir)	39°32'30"	82°03'28"	O- 2	Athens	Corning	FCRWS	-	55	53	Eutrophic	-
Clouse Lake	39°45'54"	82°18'12"	O- 1	Perry	Somerset	R	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Hocking R. Basin (Continued)											
Corning Reservoir	39°35'47"	82°04'19"	0- 2	Perry	Corning	WS	-	-	-	-	-
Dow Lake	39°20'07"	82°01'04"	0- 3	Athens	Athens	R	48	44	37	Mesotrophic	Cd-T
Essington Lake	39°45'28"	82°12'32"	P-15	Perry	Fultonham	-	-	-	-	-	-
Fox Lake	39°18'00"	82°11'32"	0- 2	Athens	The Plains	FCR	-	-	-	-	-
Greenfield Lake	39°46'15"	82°37'57"	0- 1	Fairfield	Carroll	FCR	-	-	-	-	-
L. Logan (Hocking Lake)	39°32'03"	82°27'03"	0- 2	Hocking	Logan	R	-	67	57	Eutrophic	-
Margaret Creek Conservancy District Structure #4	39°15'10"	82°07'28"	0- 2	Athens	Athens	FC	-	-	-	-	-
New Lexington Reservoir	39°44'00"	82°12'55"	0- 1	Perry	New Lexington	RWS	-	-	-	-	-
Oakthorpe Res. (Rush Run Conservancy Dist. #VI-D)	39°48'33"	82°26'55"	0- 1	Fairfield	Rushville	FCR	-	-	-	-	-
Rock Mill Lake (Hunters Run Conservancy Dist. #9)	39°44'20"	82°41'56"	0- 1	Fairfield	Amanda	FCR	-	-	-	-	-
Rush Creek Conversancy Dist. Structures											
IV-A	-	-	0	Perry	New Lexington	FC	-	-	-	-	-
IV-C	-	-	0	Perry	-	FC	-	-	-	-	-
V-A	39°44'09"	82°22'26"	0- 1	Fairfield	Junction City	FC	-	-	-	-	-
VII-C	-	-	0- 1	Fairfield	Bremen	FC	-	-	-	-	-
Snowden Lake (Margaret Crk Conservancy District #2)	39°15'00"	82°11'17"	0- 2	Athens	Albany	FCRWS	58	51	-	Eutrophic	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Muskingum R. Basin											
Atwood Lake	40°31'36"	81°18'03"	P- 8	Tuscarawas	Mineral City	FCR	-	61	53	Mesotrophic	-
Barberton Reservoir	41°02'54"	81°32'38"	-	Summit	Akron West	WS	-	-	-	-	-
Beach City Reservoir	-	-	-	Tuscarawas	Navarre	FC	-	-	-	-	-
Buckeye Lake	39°55'40"	82°29'18"	P-14	Licking	Millersport	R	71	58	76	Hypereutrophic	Cu-T, Pb-T
Cambridge City Reservoir	40°00'17"	81°33'31"	P-18	Guernsey	Cambridge	RWS	-	-	-	-	-
Charles Mill Reservoir	40°44'27"	82°21'58"	P- 2	Ashland	Perrysville	FCR	72	76	72	Hypereutrophic	Fe-T, Pb-T
Clear Fork Reservoir	40°41'53"	82°36'23"	P- 1	Richland	Mansfield	RWS	72	60	57	Eutrophic	Cu-T
Clendening Lake	40°16'08"	81°16'36"	P- 9	Harrison	Tippecanoe	FCR	-	60	57	Eutrophic	-
Crooksville Reservoir. #3	39°42'05"	82°04'28"	P-15	Perry	Deavertown	WS	-	-	-	-	-
Cutler Lake (Blue Rock Lake)	39°49'02"	81°51'63"	P-16	Muskingum	Ruraldale	RWS	-	-	-	-	-
Dillon Lake	40°00'00"	82°07'30"	P-13	Muskingum	Zanesville West	FCR	67	66	69	Eutrophic	Fe-T
East Reservoir (a Portage Lake)	41°00'04"	81°31'53"	-	Summit	Canal Fulton	R	-	-	-	-	-
Firestone Reservoir (Tuscarawas R. Diversion Dam)	41°00'39"	81°30'52"	-	Summit	Akron West	WS	-	-	-	-	-
Knox Lake	40°29'47"	82°31'36"	-	Knox	Fredericktown	R	66	67	53	Eutrophic	-
Leesville Lake	40°28'07"	81°11'41"	-	Carroll	Bowerston	FCR	-	53	53	Eutrophic	-
Lime Kiln Lake	40°36'50"	81°24'57"	P- 5	Tuscarawas	Dover	R	-	-	-	-	-
Long Lake (a Portage Lake)	41°00'54"	81°32'36"	-	Summit	Akron West	R	71	64	65	Eutrophic	-
Munroe Basin	40°09'12"	81°57'18"	P- 4	Muskingum	Conesville	R	-	-	-	-	-
M.W.C.D. - Chippewa Subdivision Reservoir	40°53'05"	81°47'50'	P- 6	Wayne	Rittman	FC	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Muskingum R. Basin (Continued)											
Nimisila Reservoir	40°55'28"	81°30'56"	-	Summit	Fulton	RWS	68	61	61	Eutrophic	-
N. Branch of Kokosing R.	40°30'23"	82°34'31"	P-12	Knox	Bellville	FCR	-	69	-	Eutrophic	-
N. Reservoir (a Portage Lake)	41°00'05"	81°32'34"	-	Summit	Akron West	R	-	-	-	-	-
Piedmont Lake	40°11'25"	81°12'48"	P- 9	Harrison	Piedmont	FCR	65	62	47	Eutrophic	-
Pleasant Hill Reservoir	40°37'22"	82°19'30"	P- 2	Ashland	Jelloway	FCR				Eutrophic (3)	-
Salt Fork Reservoir	40°06'17"	81°33'26"	P-17	Guernsey	Cambridge	FCRWS	-	61	47	Eutrophic	Cu-T
Senecaville Lake (Seneca Lake)	-	-	P-18	Guernsey	Senecaville	FCR	-	59	57	Eutrophic	-
Shreve Lake	40°41'03"	82°02'37"	P- 4	Wayne	Shreve	R		-	-	-	-
Tappan Lake	40°21'33"	81°13'34"	P- 9	Harrison	Deersville	FCR	-	58	57	Eutrophic	-
Turkey Foot Lake (a Portage Lake)	40°58'09"	81°32'38"	-	Summit	Canal Fulton	R	65	58	69	Eutrophic	-
West Reservoir (a Portage Lake)	40°58'49"	81°32'07"	-	Summit	Canal Fulton	R	-	-	-	-	-
Wills Creek Lake	40°09'26"	81°51'02"	P-17	Coshocton	Wills Creek	FCR	-	71	67	Hypereutrophic	-
Mahoning R. Basin											
Berlin Lake	41°02'02"	80°59'51"	-	Portage	Deerfield	FCRWS	-	64	47	Eutrophic	Cu-T
Crystal Lake	41°07'59'	81°14'02"	T- 2	Portage	Ravenna	RWS	-	-	-	-	-
Dale Walburn Reservoir	40°58'23"	81°10'40"	T- 1	Stark	Limaville	WS	-	-	-	-	-
Deer Creek Reservoir	40°58'07"	81°07'00"	T- 1	Stark	Alliance	RWS	62	64	57	Eutrophic	-
Meander Creek Reservoir	41°09'12"	80°48'45"	T- 3	Trumbull	Warren	RWS	53	52	-	Eutrophic	-
L. Milton	41°07'38"	80°58'40"	T- 1	Mahoning	Newton Falls	RWS	57	58	-	Eutrophic	-

Table VII-1B (Continued)

Major Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Mahoning R. Basin (Continued)											
Mosquito Creek Lake	41°18'06"	80°45'68"	-	Trumbull	Champion	FCRWS	-	67	63	Eutrophic	-
Newport Lake	41°03'52"	80°40'43"	T- 3	Mahoning	Youngstown	WS	-	-	-	-	-
Lake Park	40°54'43"	81°03'52"	T- 1	Mahoning	Alliance	R	-	-	-	-	-
West Branch Reservoir (M.J. Kirwan Reservoir)	41°09'21"	81°04'58"	-	Portage	Windham	FCRWS	49	55	37	Eutrophic	Cu-T
Westville Reservoir	40°53'28"	81°00'20"	T- 1	Columbiana	Alliance	WS	-	-	-	-	-
Shenango R. Basin											
Pymatuning Reservoir	41°31'01"	80°30'05"	T- 4	Ashtabula	-	FCR				Eutrophic (3)	-

Table VII-.. (Continued)

Minor Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Mill Creek Basin											
Sharon Lake	39°16'57"	84°23'23"	J	Hamilton	Glendale	R	-	-	--	-	-
West Fork Mill Crk. L. (Winton Lake)	39°15'29"	84°29'42"	J	Hamilton	Glendale	FCR	66	69	72	Eutrophic	Pb-T
White Oak Creek Basin											
Grant Lake	38°55'13"	83°55'44"	L- 1	Brown	Mt. Orab	R	-	-	-	Eutrophic (3)	-
Ohio Brush Creek Basin											
Adams Lake	38°48'50"	83°30'58"	L	Adams	West Union	RWS	-	-	-	-	-
Turkey Creek Basin											
Roosevelt Lake	38°43'33"	83°10'32"	M-17	Scioto	Pond Run	R	-	-	-	-	-
Turkey Crk. Lake	38°44'00"	83°11'22"	M-17	Scioto	Pond Run	R	-	-	-	-	-
Storms Creek Basin											
Vesuvius Lake	38°36'23"	82°37'50"	N- 5	Lawrence	Ironton	R	-	45	47	Mesotrophic	-
Sunfish Creek Basin											
Monroe Lake	39°49'05"	81°08'17"	R- 4	Monroe	Lewisville		-	-	-	-	-
Symmes Creek Basin											
Jackson Lake	38°53'30"	82°36'09"	N- 3	Jackson	Oak Hill	R	53	59	47	Eutrophic	
Raccoon Creek Basin											
Alma Lake	39°08'40"	82°31'05"	N- 2	Vinton	Hamden	R	-	-	-	-	-
Lake Hope	39°19'12"	82°21'23"	N- 1	Vinton	Mineral	R	43	51	-	Mesotrophic	Cd-T, Pb-T
Lake Rupert	39°10'35"	82°31'15"	N- 2	Vinton	Hamden	RWS	50	54	-	Eutrophic	-
Tycoon Lake	38°55'18"	82°21'12"	N- 2	Gallia	Vinton	R	53	51	47	Eutrophic	Cd-T, Cu-T, Ni-T

Table VII-18 (Continued)

Minor Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Forked Run Basin											
Forked Run Lake	39°05'30"	81°46'04"	O- 4	Meigs	Portland	R	-	48	37	Mesotrophic	Cd-T, Ni-T
L. Hocking Basin											
Veto Lake	39°20'42"	81°38'48"	P	Washington	L. Hocking	R	57	67	65	Eutrophic	-
Duck Creek Basin											
Caldwell Lake	39°46'32"	81°31'39"	R- 1	Noble	Caldwell N.	RWS	-	-	-	-	-
Wolf Run Lake	39°47'26"	81°32'54"	R- 1	Noble	Caldwell N.	FCR	-	43	47	Mesotrophic	-
Captina Creek Basin											
Barnesville Reservoir #1	39°57'52"	81°10'00"	S- 4	Belmont	Barnesville	WS	-	-	-	-	-
Barnesville Reservoir #3	39°54'32"	81°09'37"	S- 4	Belmont	Barnesville	WS	-	-	-	-	-
McMahon Basin											
Belmont Lake (Barkcamp Lake)	40°02'01"	81°00'33"	S- 4	Belmont	Bethesda	R	-	-	-	-	-
Yellow Creek Basin											
Friendship Park Lake	40°17'02"	80°45'55"	S- 2	Jefferson	Smithfield	R	-	-	-	-	-
Jefferson Lake	40°27'38"	80°47'40"	S- 2	Jefferson	Richmond	R	-	-	-	-	-
L. Yellow Creek Basin											
Highlandtown Lake	40°38'16"	80°44'55"	S- 1	Columbiana	Wellsville	R	67	51	47	Eutrophic	-

Table VII - (Continued)

Minor Basins Tributary to the Ohio River

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
L. Beaver Creek Basin											
Guilford Lake	40°47'42"	80°52'20"	S- 1	Columbiana	Lisbon	R	-	61	57	Eutrophic	Cu-T
Salem Reservoir	40°48'47"	80°50'10"	S- 1	Columbiana	Lisbon	WS	-	-	-	-	-
Zepernick Lake	40°47'19"	80°58'42"	P- 7	Columbiana	Hanoverton	R	-	-	-	-	-

Table VII-18 (Continued)

Major Basins Tributary to Lake Erie

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Maumee R. Basin											
Archbold Reservoir #1	41°31'15"	84°17'38"	A- 8	Fulton	Archbold	RWS	-	-	-	-	-
Archbold Reservoir #2	41°31'06"	84°17'38"	A- 8	Fulton	Archbold	RWS	-	-	-	-	-
Bresler Reservoir (Spencervilie Reservoir)	40°43'47"	84°14'10"	A	Allen	Criders-ville	WS	-	-	-	-	-
Delta Reservoir	41°35'22"	84°00'44"	A-11	Fulton	Delta	RWS	-	-	-	-	-
Deshler Reservoir	41°12'03"	83°54'04"	A-11	Henry	Deshler						
Fe-Trguson Lake	40°43'55"	84°02'43"	A- 4	Allen	Lima	RWS	-	-	-	-	-
Old Findlay Reservoir #1	41°00'30"	83°33'56"	A- 6	Hancock	Arcadia	AWS	-	-	-	-	-
New Findlay Reservoir #2	41°00'36"	83°34'18"	A- 6	Hancock	Arcadia	RWS	59	55	-	Eutrophic	-
Forty Acre Pond	40°34'58"	84°23'24"	A- 1	Auglaize	St. Marys	R	-	-	-	-	-
Fulton Pond	41°35'48"	83°55'34"	A-12	Fulton	Swanton	R	-	-	-	-	-
Grand Lake St. Marys	40°31'17	84°25'18"	A- 1	Auglaize	Celina	RWS	-	76	76	Hypereutrophic	-
Harrison Lake	41°38'22"	84°21'40"	-	Fulton	Fayette	R	-	70	69	Eutrophic	Cu-T
Independence Dam (a low head dam)	-	-	-	Defiance	Defiance East	WS	-	-	-	-	-
Leipsic Reservoir	41°06'23"	83°55'44"		Putnam	Leipsic	WS	-	-	-	-	-
Lima Lake Reservoir	40°45'12"	84°02'52"	A- 4	Allen	Lima	RWS	-	-	-	-	-
Metzger Reservoir	40°44'18"	84°02'50"	A- 4	Allen	Lima	WS	-	-	-	-	-
Nettle Lake	41°40'37"	84°43'41"	A- 9	Williams	Nettle Lake	R	60	58	57	Eutrophic	-
Ottawa Reservoir	41°00'40"	84°01'14"	A- 5	Putnam	Ottawa	WS	-	-	-	-	-
Oxbow Lake	41°20'38"	84°26'30"	A- 8	Defiance	Defiance West	R	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to Lake Erie

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Maumee R. Basin (Continued)											
Paulding Reservoir	41°07'12"	84°35'16"	A- 7	Paulding	Latty	WS	-	-	-	-	-
Providence Dam (a low head dam)	-	-	-	Lucas Rapids	Grand	R	-	-	-	-	-
Saulisberry Park Lake	40°37'04"	83°38'13"	M- 1	Hardin	Silver Creek	R	-	-	-	-	-
Schoonover Lake	40°44'50"	84°05'50"	A- 4	Allen	Lima	R	-	-	-	-	-
Spencerville Res - see Bresler Reservoir	-	-	-								
State Fish Hatchery Lake	40°31'24"	84°25'06"	A- 1	Auglaize	St. Marys	-	-	-	-	-	-
Swanton Reservoir	41°34'08"	83°52'26"	A-12	Lucas	Swanton	RWS	-	-	-	-	-
Twin Lakes Reservoir	40°44'28"	84°05'00"	A- 4	Allen	Lima	RWS	-	-	-	-	-
Van Wert City Reservoir #1	40°50'14"	84°34'30"	A- 2	Van Wert	Van Wert	RWS	-	-	-	-	-
Van Wert City Reservoir #2	40°50'30"	84°34'24"	A- 2	Van Wert	Van Wert	RWS	-	-	-	-	-
Wauseon Reservoir #1	41°30'42"	84°09'00"	A-10	Fulton	Wauseon	RWS	-	-	-	-	-
Wauseon Reservoir #2	41°30'41"	84°09'00"	A-10	Fulton	Wauseon	RWS	-	-	-	-	-
Portage Basin											
Aldrich Pond	41°24'20"	83°15'02"	B- 2	Sandusky	Elmore	R	-	-	-	-	-
Lake Lacomte (Fostoria Reservoir No. 5)	41°08'20"	83°25'40"	B- 1	Hancock	Alvada	RWS	-	-	-	-	-
Lake Lamberjack	41°09'23"	83°25'55"	B- 1	Hancock	Fostoria	RWS	-	-	-	-	-
Lake Mosier	41°08'20"	83°25'40"	B- 2	Hancock	Fostoria	RWS	-	-	-	-	-
N. Baltimore Reservoir	41°10'05"	83°40'10"	B- 1	Wood	N. Baltimore	RWS	-	-	-	-	-
Van Buren Lake	41°08'02"	83°38'40"	B- 1	Hancock	N. Baltimore	R	-	-	-	-	-

Table VII-1B (Continued)

Major Basins Tributary to Lake Erie

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Sandusky Basin											
Bucyrus Reservoir #1	40°49'38"	82°56'18"	C- 2	Crawford	Bucyrus	RWS	-	-	-	-	-
Bucyrus Reservoir #2	40°49'12"	82°55'35"	C- 2	Crawford	Bucyrus	RWS	-	-	-	-	-
Clyde Reservoir (Beaver Creek Reservoir)	41°14'08"	83°01'13"	C- 4	Seneca	Watson	WS	-	-	-	-	-
Killdeer Reservoir	40°41'55"	83°22'46"	C- 1	Wyandot	Marseilles	WS	47	51	37	Mesotrophic	-
Riley Reservoir	40°49'38"	82°56'00"	C- 2	Crawford	Bucyrus	RWS	-	-	-	-	-
Upper Sandusky	40°49'13"	83°16'19"	C- 1	Wyandot	U. Sandusky	RWS	-	-	-	-	-
Huron R. Basin											
Bellevue Reservoir #5	41°12'42"	82°46'35"	-	Huron	Flat Rock	RWS	-	-	-	-	-
Celeryville Reservoir	40°59'22"	82°44'05"	D- 2	Crawford	Shelby	WS	-	-	-	-	-
Norwalk Reservoir #1 (Upper)	41°14'18"	82°35'24"	D- 2	Huron	Norwalk	AWS	-	-	-	-	-
Norwalk Reservoir #2 (Lower)	41°14'02"	82°34'58"	D- 2	Huron	Norwalk	AWS	-	-	-	-	-
Norwalk Reservoir #3 (Memorial)	41°14'04"	82°35'26"	D- 2	Huron	Norwalk	AWS	-	-	-	-	-
Willard City Reservoir	41°03'26"	82°39'55"	D- 2	Huron	Willard	RWS	52	54	-	Eutrophic	
Vermilion R. Basin											
Kipton Reservoir	41°15'15"	82°18'22"	D- 3	Lorain	Kipton	RWS	-	-	-	-	-
New London Reservoir	41°03'58"	82°25'30"	D-	Huron	New London	WS	-	-	-	-	-

Table VII-10 (Continued)

Major Basins Tributary to Lake Erie

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Black R. Basin											
Findley Lake	41°08'15"	82°12'30"	D- 4	Lorain	Wellington	R	-	-	-	Eutrophic (4)	-
Oberlin Reservoir	41°16'30"	82°10'42"	D- 4	Lorain	Oberlin	RWS	-	-	-	-	-
Spencer Lake	41°05'27"	82°07'31"	D- 4	Medina	Lodi	WS	-	-	-	Eutrophic (4)	-
Wellington Reservoir (Upper)	41°08'34"	82°14'01"	-	Lorain	Wellington	WS	-	-	-	-	-
Wellington Upground Reservoir (Lower)	41°08'55"	82°14'23"	-	Lorain	Wellington	RWS	-	-	-	-	-
Rocky River Basin											
Baldwin Lake (a low head dam)	41°21'47"	81°51'20"	D- 5	Cuyahoga	Berea	RWS	-	-	-	Eutrophic (4)	-
Coe Lake	41°21'40"	81°51'06"	D- 5	Cuyahoga	Berea	-	-	-	-	-	-
Hinckley Lake	41°13'35"	81°43'13"	D- 5	Medina	W. Richfield	R	-	-	-	Eutrophic (4)	-
Medina Lake	41°08'21"	81°49'20"	-	Medina	Medina	RWS	-	-	-	-	-
Wallace Lake	41°21'52"	81°51'30"	D- 5	Cuyahoga	Berea	RWS	-	-	-	Eutrophic (4)	-
Cuyahoga R. Basin											
Aquilla Lake	41°32'46"	81°10'12"	F- 1	Geauga	Chardon	R	-	-	-	Eutrophic (4)	-
Brady Lake	41°10'66"	81°13'54"	E- 1	Portage	Kent	R					
E. Branch Reservoir	41°30'13"	81°05'38"	E- 1	Geauga	E. Claridon	RWS	64	61	57	Eutrophic	-
Geauga Lake	41°20'54"	81°22'06"	E- 2	Geauga	Aurora	R	-	-	-	-	-
Gorge Metro. Park Lake	-	-	-	Summit	Akron East	R	-	-	-	-	-
Hodgson Lake (Muddy Lake)	-	-	-	Portage	Kent	WS	-	-	-	Eutrophic (4)	-
La Due Reservoir	41°24'25"	81°11'12"	E- 1	Geauga	Burton	WS	54	51	61	Eutrophic	-
Lower Shaker Lake	41°29'24"	81°34'54"	E- 2	Cuyahoga	Shaker Hgts.	R	-	-	-	Eutrophic (4)	-

Table VII-1B (Continued)

Major Basins Tributary to Lake Erie

Name	Latitude	Longitude	Map Reference Number(1)	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Cuyahoga R. Basin (Continued)											
Meadowbrook Lake	41°12'03"	81°27'18"	E- 2	Summit	Hudson	R	-	-	-	-	-
Mogadore Reservoir	41°03'28"	81°22'50"	E- 1	Portage	Akron E.	RWS	-	54	53	Eutrophic	-
Muzzy Lake	41°06'51"	81°15'04"	E- 1	Portage	Suffield	WS	-	-	-	-	-
Lake Pippen	41°10'26"	81°13'42"	E- 1	Portage	Kent	-	-	-	-	-	-
Punderson Lake	41°26'51"	81°12'27"	E- 1	Geauga	Burton	R	-	56	53	Eutrophic	-
L. Rockwell	41°10'58"	81°19'52"	E- 1	Portage	Kent	WS	-	60	61	Eutrophic	Cu-T
Summit Lake	41°02'54"	81°32'38"	P- 6	Summit	Akron W.	RWS	-	66	65	Eutrophic	-
Sunny Lake (Harmons Pond)	41°17'53"	81°18'55"	E- 2	Portage	Aurora	R	-	-	-	-	-
Grand River Basin											
Geneva Lake (a low head dam)	-	-	-	Ashtabula	Geneva	-	-	-	-	-	-
Lampson Reservoir (Jefferson Reservoir)	41°45'08"	80°47'50"	F-	Ashtabula	Ashtabula South	RWS	-	-	-	-	-

Table VII-1B (Continued)

Minor Basins Tributary to Lake Erie

Name	Longitude	Latitude	Map Reference Number	Location (County)	7 1/2 Min Quad	Use	Trophic State Index Chla	SD	P	Trophic Classification	Chemical Parameters at or above WQS (2)
Raccoon Creek Basin											
Clyde Reservoir (Raccoon Crk. Reservoir)	41°17'15"	82°58'35"	D- 1	Sandusky	Clyde	WS	-	-	-	-	-
Ottawa River Basin											
Molander Lake	41°41'26"	83°42'32"	A-12	Lucas	Sylvania	R	-	-	-	-	-

Key to Symbols:

Use

FC - Flood Control
R - Recreation
WS - Water Supply
A - Angling

Chemical Parameters

Cadmium, Total - Cd-T
Copper, Total - Cu-T
Iron, Total - Fe-T
Lead, Total - Pb-T
Nickel, Total - Ni-T

Footnotes:

1. - Map Reference Number referes to specific "Underground Water Resource Map" on which the lake is located. See the Publications booklet, Division of Water, Ohio Dept. of Natural Resources, Columbus, Ohio, 43224.
2. - OEPA Water Quality standards (Chapter 3745.1 of the Administrative Code, 1978.)
3. - U.S. Environmental Protection Agency, Working paper from the National Eutrophication Survey, NERC Corvallis, Oregon, 1975.
4. - In report prepared for Northeast Ohio Areawide Coordinating Agency by Biotest Laboratory, University of Akron, 1978.

Table VII-2A: Lake Sampling Locations and Parameter Sampling Schedules - Lake Stations

	Station Location[a]		Sampling Period[b]			Sampling Depth[c]		
PARAMETER (Chemical/Physical)	1	2	Sp	Su	P	Sur	Bot	I
Acidity, Total, $CaCO_3$	X		X	X		X	X	
Alkalinity, Total, $CaCO_3$	X		X	X		X	X	
Arsenic, Total, As	X		X					X
Barium, Total, Ba	X		X					X
BOD, 5 day	X		X	X		X	X	
Boron, Total, B	X		X					X
Cadmium, Total, Cd	X		X					X
Calcium, Total, Ca	X		X					X
Carbon, Total Org., C	X		X	X			X	
Chloride, Cl	X		X					X
Chromium, Total, Cr	X		X					X
Cobalt, Total, Co	X		X					X
COD	X		X	X		X	X	
Color	X		X	X		X	X	
Conductivity (field)	X	X	X	X	X			
Copper, Total, Cu	X		X					X
Dissolved Oxygen (field)	X	X	X	X	X			
Fecal Coli, Total, MF	X		X	X		X	X	
Fecal Strep, Total, MF	X		X	X		X	X	
Fluoride, Diss., F	X		X					X
Hydrogen Sulfide, H_2S	X		X	X			X	
Iron, Total, Fe	X		X					X
Lead, Total, Pb	X		X					X
Magnesium, Total, Mg	X		X					X
Manganese, Total, Mn	X		X					X
MBAS	X		X					X
Mercury, Total, Hg	X		X					X
Molybdenum, Total, Mo	X		X					X
Nickel, Total, Ni	X		X					X
Nitrate, NO_3 as N	X		X	X		X	X	
Nitrite, NO_2 as N	X		X	X		X	X	

Table VII-2A: (Continued)

PARAMETER (Chemical/Physical)	Station Location[a] 1	2	Sampling Period[b] Sp	Su	Sampling Depth[c] P	Sur	Bot	I
Nitrogen, Ammonia, N	X		X	X		X	X	
pH (field)	X	X	X	X	X			
Phosphorus, Dissolved, P	X		X	X		X	X	
Phosphorus, Total, P	X		X	X		X	X	
Potassium, Total, K	X		X					X
Residue, Total Flt., TDS	X		X					X
Residue, Total Nflt., TSS	X		X					X
Secchi Disc	X	X	X	X				
Selenium, Total, Se	X		X					X
Silica, Total (Diss), SiO_2	X		X	X		X	X	
Silver, Total, Ag	X		X					X
Sodium, Total, Na	X		X					X
Sulfate, SO_4	X		X					X
Total Kjeldahl Nitrogen	X		X	X		X	X	
Turbidity	X		X	X		X	X	
Water Temperature (field)	X	X	X	X	X			
Zinc, Total, Zn	X		X					X
PARAMETER (Biological)								
Phytoplankton								
Total Count	X		X	X				X
Identification (Principal Genera)	X		X	X				X
Chlorophyll *a*	X		X	X				
Macrophyte Observations			X	X				

a. Primary lake stations (1); secondary lake stations (2)

b. Spring (Sp); Summer (Su)

c. Profile (P); Surface (Sur) samples are taken at a depth of 2 feet; Bottom (Bot); Integrated (I)

Table VII-2B: Lake Survey Station Locations and Parameter Sampling Schedules - Inflow Stream Stations[d]

PARAMETER	PARAMETER
Carbon, Total Org., C	Nitrite, NO_2 as N
Color	pH (field)
Conductivity (field)	Phosphorus, Total, P
Dissolved Oxygen (field)	Total Kjeldahl Nitrogen
Flow (USGS)	Turbidity
Nitrate, NO_3 as N	Water Temperature (field)

d. All parameters are sampled in spring and summer, and are taken at a depth of 6 inches (surface).

III. WATER QUALITY

A. General Lake Water Quality

In general, the water quality of most of the lakes surveyed was generally good. Tables VII-3 to VII-5 summarize chemical/physical and biological water quality data for 45 Ohio lakes surveyed by Ohio EPA/USGS from 1975 through 1977. Comprehensive data from the first three surveys, are available in two reports (Tobin and Youger, 1977; Tobin and Youger, 1979). Two reports for 28 lakes surveyed during 1978 and 1979 are in preparation. The following paragraphs summarize conditions in selected problem categories.

1) Sanitary Water Quality

Sanitary water quality in the lakes surveyed was very good (Tobin and Youger, 1977, Tobin and Youger, 1979). High fecal coliform and/or fecal streptococcus counts, when observed, were always associated with storm runoff events. Counts that exceeded applicable Ohio water quality standards were never found during both the spring and summer samplings.

2) Metal Concentrations

Seventeen of the 71 Ohio lakes surveyed since 1975 exceeded Ohio water quality standards (Chapter 3745-1 of the Administrative Code) for one metal, 4 lakes exceeded standards for 2 metals and one lake exceeded standards for 3 metals (Tables VII-6 and VII-1B).

Table VII-6: The number of Ohio lakes with metal concentrations exceeding water quality standards (Ohio EPA/USGS Lake Surveys - 1975 to 1979).[a]

Metal	Cu	Pd	Cd	Fe	Ni
Lakes	13	4	5	4	2

[a] For the names of specific lakes, see Table VII-1B.

Copper was the metal that most frequently exceeded Ohio water quality standards. The use of copper sulfate for the control of algae in these lakes could be a contributing factor to these high values. Five public water supply reservoirs, (Hoover, Clear Fork, Berlin, and West Branch Reservoirs and Lake Rockwell) had elevated copper concentrations. A possible source of copper contamination in Harrison Lake (Fulton Co.) was effluent from a metal plating company discharged into an unnamed tributary.

Table VII-3A. Morphometric data for lakes sampled in Ohio, 1975. [a]

Name and primary site identification number	Location county(ies)	Type	Date of origin	Use	Morphology: Surface area (acres)	Morphology: Depth: Maximum (feet)	Morphology: Depth: Mean (feet)	Morphology: Shoreline (miles)	Morphology: Capacity (acre-feet)	Drainage area (miles)	Mean annual inflow (acre-feet)	Capacity inflow ratio C/I
Acton Lake 393353084441400	Preble Butler	Re	1956	Rec	625	36	15	8.0	9400	98.9	71,600	0.13
Berlin Lake 410202080595100	Stark Portage Mahoning	Re	1942	Fc, Ws,Rec	5500	74	17		91,150			0.56
					3590	66	16	68.5	56,600	248	163,600	0.35
Buckeye Lake 395548082274300	Licking Fairfield Perry	Re	1832	Rec	3140	13	8.7	32	27,300	47	30,700	0.89
Clearfork Reservoir 404152082363300	Morrow Richland	Re	1949	Ws,Rec	977	23	11	14	10,740	33.7	23,320	0.46
Cowan Lake 392317083552100	Clinton	Re	1948	Rec	648	40	19	17	12,000	50.5	43,800	0.27
Deer Creek Lake 393717083150200	Fayette Pickaway	Re	1968	Fc, Rec,Ws	4046	79	25	--	102,540			0.52
					1277	45	16	19.4	21,030	277	196,900	0.11
Grand Lake St.Marys 403135084291400	Auglaize Mercer	Re	1841	Rec	13,440	10	6.8	52	92,000	112	69,000	1.3
Guilford Lake 404746080520900	Columbiana	Re	1932	Rec	380	25	--	6.4	--	11.2	7340	--
Harrison Lake 413819084214500	Fulton	Re	1941	Rec	97	24	10	3.5	991	37.2	18,600	0.05
Hoover Reservoir 400636082530200	Delaware Franklin	Re	1954	Ws,Rec	2825	63	21	45	60,340	190	131,800	0.46
Lake Hope 391914082211800	Vinton	Re	1939	Rec	126	20	12	5.4	1555	10	7750	0.20
Lake Loramie 402201084212800	Auglaize Shelby	Re	1844	Rec	1700	8	7.6	30	13,000	77.7	48,570	0.27
Lake Vesuvius 383624082375300	Lawrence	Re	1937	Rec	125	28	12	6.4	1489	10.9	8850	0.17
Paint Creek Lake 391450083212200	Ross Highland	Re	1974	Fc, Rec	4760	97	30	--	145,000			0.34
					1190	50	17	30	20,310	570	422,100	0.05
Punderson Lake 412718081122600	Geauga	Lk	--	Rec	101	60	--	2.6	--	1.27	960	--
Rocky Fork Lake 391111083263200	Highland	Re	1952	Rec	2000	45	17	30	34,100	114	86,000	0.39
Salt Fork Lake 400617081331600	Guernsey	Re	1967	Fc,Rec	2952	38	15	74	43,200	159	120,000	0.36

Type: Re - Reservoir; Lk - Lake.
Use: Fc - flood control; Ws - water supply; Rec - recreation.
C/I ratio: Capacity divided by mean annual inflow - decreasing values indicate shorter hydraulic retention time.

[a] Modified from Tobin and Youger, 1977.

Table VII-3B. Summary of physical and chemical characteristics of selected lakes in Ohio, 1975.[a]

Lake name and site location	Maximum observed depth (feet)	Secchi disk transparency (inches)		Thermal stratification		Dissolved oxygen ranges* (mg/L)		pH range*		BOD ranges* (mg/L)		TOC range* (mg/L)	
		spring	summer	spring	summer	spring	summer	spring	summer	spring	summer	spring	summer
Acton Lake above dam (L-1)	30	5	28	partial	yes	9.8-9.4	8.2-0.0	7.9-7.7	7.9-6.5	1.7-3.2	4.0->7.0	6.3-15	4.8-11
Berlin Lake above dam (L-1)	50	59	30	yes	no	8.2-4.0	0.7-0.0	8.3-6.9	7.5-6.8	1.1-0.5	1.4-3.5	16-4.2	10
Buckeye Lake at midpoint (L-1)	13	19	17	partial	no	12.3-4.5	7.0-4.2	9.0-7.9	8.2-7.0	5.0-6.1	7.4-6.7	7.5-9.8	11-9.2
Clear Fork Reservoir above dam (L-1)	23	41	41	yes	partial	13.2-0.0	8.5-0.0	9.1-7.2	8.2-6.7	5.7-1.1	2.3-2.5	11-4.0	2.6-9.2
Cowan Lake above dam (L-1)	38	11	23	no	yes	9.0-8.7	8.8-0.0	8.2-7.9	8.1-6.7	1.0-1.4	4.4	6.6-11	5.7-9.1
Deer Creek Lake above dam (L-1)	44	10	18	no	no	11.0-9.7	5.0-3.7	8.2-7.7	7.4-7.3	1.0-1.2	2.0	8.0-8.5	4.8-5.7
Grand Lake St.Marys near midpoint (L-1)	8	17	13	no	no	9.6-8.2	10.2-5.4	9.3-9.0	8.9-8.4	7.0->8.0	15-7.5	12-20	12-13
Guilford Lake above dam (L-1)	23	34	30	yes	yes	15.8-0.0	8.2-0.0	9.2-7.3	8.5-6.5	7.2-1.7	3.5-2.5	6.8-3.5	9.5-7.4
Harrison Lake at east end (L-1)	17	25	20	yes	partial	13.6-0.0	11.7-0.0	8.8-7.0	8.3-7.0	5.8-3.5	4.3-6.5	9.5-12	10-13
Hoover Reservoir above dam (L-1)	60	18	49	partial	yes	11.6-9.4	0.8-0.0	8.3-7.3	7.6-6.4	3.3-2.9	1.3-3.1	7.0-5.9	9.8-7.6
Lake Hope above dam (L-1)	20	41	113	yes	yes	9.5-3.2	11.6-0.0	5.1-4.2	6.3-5.0	0.4-0.3	1.1-0.5	4.0-7.1	4.7-13
Lake Loramie above dam (L-1)	7	11	8	no	no	10.0-7.2	8.1-3.5	8.6-8.3	8.2-7.5	7.0-5.6	6.7-5.8	8.3-13	13-17
Lake Vesuvius above dam (L-1)	24	32	110	yes	yes	9.6-3.6	7.3-0.0	7.3-5.0	7.0-6.0	1.3-0.5	0.8-1.0	3.6-5.7	5.5-8.1
Paint Creek Lake above dam (L-1)	45	26	36	partial	partial	20.8-4.1	6.8-0.0	8.6-6.8	7.9-6.8	>8.2-2.5	3.2-1.7	11-9.9	6.5-1.3
Punderson Lake at midpoint (L-1)	50	91	52	yes	yes	12.8-1.1	11.3-0.0	8.4-6.6	8.6-6.8	1.6-2.2	2.2	9.9-5.8	11-9.0
Rocky Fork Lake above dam (L-1)	45	25	34	partial	yes	12.9-0.8	6.2-0.0	8.5-7.5	7.7-6.6	4.2-1.5	3.3-2.7	12-7.9	12-21
Salt Fork Lake above dam (L-1)	38	65	36	yes	yes	10.6-1.3	9.6-0.0	7.8-6.2	8.4-6.5	1.3-1.2	2.6-2.4	8.1-4.9	4.8-4.4

* Water column data - near surface values shown first.
** National Academy of Sciences, 1972.
*** Ohio EPA Regulation EP-1 Water Quality Standards.

Lake name and site location	Specific conductance range* (umho)		Chemical typing (spring only)		Substances at or above accepted limits		Total N (maximum concentration in mg/L)	Total P (maximum concentration in mg/L)	H_2S present
	spring	summer	hardness	major ions	pesticides**	metals***			
Acton Lake above dam (L-1)	377-227	337-502	hard	Ca Mg HCO_3	yes (Aldrin)	yes (Cu)	9.9	0.55	yes
Berlin Lake above dam (L-1)	357-382	403-415	hard	Ca SO_4	no	yes (Cu)	1.7	0.08	yes
Buckeye Lake at midpoint (L-1)	320-310	285-287	hard	Ca HCO_3 SO_4	no	yes (Cu)	2.0	0.14	no
Clear Fork Reservoir above dam (L-1)	262-310	297-347	mod. hard	Ca HCO_3 SO_4	no	yes (Cu)	1.6	0.21	yes
Cowan Lake above dam (L-1)	358	311-458	hard	Ca HCO_3	no	no	7.0	0.24	yes
Deer Creek Lake above dam (L-1)	510	450-457	very hard	Ca HCO_3	no	no	2.9	0.12	no
Grand Lake St.Marys near midpoint (L-1)	304	311-308	mod. hard	Mg Ca SO_4 HCO_3	no	no	3.3	0.19	no
Guilford Lake above dam (L-1)	220-295	243-335	mod. hard	Ca HCO_3 SO_4	no	yes (Cu)	8.6	0.34	yes
Harrison Lake at east end (L-1)	405-336	435-465	very hard	Ca HCO_3	no	yes(Cu Mg Ag)	3.9	0.21	no
Hoover Reservoir above dam (L-1)	295-270	363-305	mod. hard	Ca HCO_3	no	yes (Cu)	2.5	0.10	no
Lake Hope above dam (L-1)	137-128	134-199	soft	Ca SO_4	no	no	2.4	0.03	yes
Lake Loramie above dam (L-1)	331-338	360-365	hard	Ca Mg SO_4 HCO_3	no	no	2.3	0.25	no
Lake Vesuvius above dam (L-1)	157-132	152-185	soft	Ca SO_4	no	yes (Cu)	0.61	0.05	no
Paint Creek Lake above dam (L-1)	410-460	390-450	very hard	Ca HCO_3	no	no	5.2	0.17	yes
Punderson Lake at midpoint (L-1)	355-365	330-375	hard	Ca HCO_3	no	yes (Cu)	3.2	0.55	yes
Rocky Fork Lake above dam (L-1)	335-360	305-407	very hard	Ca HCO_3	no	yes (Ag)	9.1	0.18	yes
Salt Fork Lake above dam (L-1)	235-255	250-287	mod. hard	Ca SO_4	no	yes (Cu)	1.8	0.13	yes

[a] Modified from Tobin and Youger, 1977.

Table VII-3C. Summary of biological characteristics of selected lakes in Ohio, 1975. [a]

Lake name and site location	Bacteria*				Phytoplankton			
					Composites from euphotic zone (spring)		Samples from zones of maximum dissolved oxygen (summer)	
	Fecal coliform (colonies per 100 ml)		Fecal streptococci (colonies per 100 ml)		Cells per ml	Dominant phylum and percent (%) of total cell count	Cells per ml	Dominant phylum and percent (%) of total cell count
	spring	summer	spring	summer				
Acton Lake above dam (L-1) -------	1900-12,500	3-<2	4050-12,500	2-5	1600	Chrysophyta (95)	660,000	Cyanophyta (99)
Berlin Lake above dam (L-1) -------	3-<3	<2-6	<3	<2-3	150	Chrysophyta (100)	2300	Cyanophyta (95)
Buckeye Lake at midpoint (L-1) --	4-6	29-48	2-<3	3-6	190,000	Cyanophyta (79)	1,200,000	Cyanophyta (94)
Clear Fork Reservoir above dam (L-1) ----------	<3	<2-3	3-<3	<2	12,000	Cyanophyta (64)	140,000	Cyanophyta (96)
Cowan Lake above dam (L-1) -------	500-600	2-8	170-300	<2	2700	Chrysophyta (100)	360,000	Cyanophyta (97)
Deer Creek Lake above dam (L-1) -	18-8	26-9	28-84	56-100	13,000	Chrysophyta (77)	48,000	Cyanophyta (78)
Grand Lake St. Marys near midpoint (L-1) --	<3-3	<3	<3	<3	2,830,000	Cyanophyta (99)	2,400,000	Cyanophyta (99)
Guilford Lake above dam (L-1) -	<3	4-8	<3-3	6-4	19,000	Cyanophyta (66)	160,000	Cyanophyta (85)
Harrison Lake at East end (L-1) --	16-400	100-152	20-1100	100-160	19,000	Chlorophyta (53)	130,000	Cyanophyta (97)
Hoover Reservoir at dam (L-1) ----	6-<3	2-168	3	<2-60	10,000	Chrysophyta (100)	3500	Cyanophyta (92)
Lake Hope above dam (L-1) -------	<3-12	2-3	<3-30	26-<3	2200	Chlorophyta (90)	4200	Chlorophyta (95)
Lake Loramie above dam (L-1) -------	<3	3-9	<3-3	320-328	46,000	Chrysophyta (49)	450,000	Cyanophyta (91)
Lake Vesuvius above dam (L-1) -	3-36	<2-5	<3-32	2-14	420	Cyanophyta (73)	13,000	Cyanophyta (80)
Paint Creek Lake above dam (L-1) -	3-36	2-72	<3-28	2-52	70,000	Chrysophyta (92)	420,000	Cyanophyta (97)
Punderson Lake at midpoint (L-1) --	24-2	2-<2	8-<3	2-<2	52,000	Cyanophyta (99)	300,000	Cyanophyta (100)
Rocky Fork Lake above dam (L-1) -	3	90-70	<3	40-24	14,000	Chrysophyta (84)	160,000	Cyanophyta (93)
Salt Fork Lake above dam (L-1) -	<2	<2-5	<2	2	21,000	Cyanophyta (81)	410,000	Cyanophyta (100)

* Water column data - near surface values shown first.

[a] Modified from Tobin and Youger, 1977.

Table VII-4A. Morphometric data for lakes sampled in Ohio, 1976. [a]

Type: Res - reservoir.
Use: FC - flood control; WS - water supply; Rec - recreation.
C/I: capacity divided by mean annual inflow - decreasing values indicate shorter hydraulic retention time.

Name and primary site identification number	Location (county)	Type (a)	Date of origin	Use (b)	Morphology: Surface area (acres)	Morphology: Depth: Maximum (feet)	Morphology: Depth: Mean (feet)	Morphology: Shore-line (miles)	Capacity (acre-feet)	Drain-age area (miles)	Mean annual inflow (acre-feet)	Capacity inflow ratio C/I (c)
Alum Creek Lake 401121082575100	Delaware	Res	1974	FC	4852	78	28		134,800	123	80,400	1.68
				Rec WS	3387	65	24		81,730			1.02
Atwood Lake 403141081165900	Tuscarawas Carroll	Res	1937	FC	2460	51	20		49,700	70	51,100	0.97
				Rec	1540	38	15	27.6	23,600			0.46
Burr Oak Res 393226082031900	Athens Morgan	Res	1952	FC	1192	57	23		26,900	33.1	23,900	1.13
				Rec WS	664	38	14	20	9,300			0.39
Clendening Lake 401612081164000	Harrison	Res	1937	FC	2620	52	21		54,000	69.3	52,200	1.03
				Rec	1800	40	15	43.6	26,500			0.51
Lake Logan 393208082270200	Hocking	Res	1955	Rec	342	24	9	10	3,080	14.8	10,800	0.29
Lake Rockwell 411059081194900	Portage	Res	1914	WS	769	25	9.2	10.6	7,060	208	157,000	0.04
Leesville Lake 402814081113500	Carroll	Res	1937	FC	1470	58	25		37,400	48.3	37,900	0.99
				Rec	1000	43	20	27.6	19,500			0.51
Mogadore Res 410331081223900	Portage	Res	1939	WS Rec	1000	25	6.9	19	6,900	13.2	9,090	0.76
Mosquito Creek Lake 411806080452800	Trumbull	Res	1943	FC	8900	34	12		104,100	97.5	71,600	1.45
				Rec WS	7850	31	10	39.9	82,400			1.15
Senecaville Lake 395530081255600	Guernsey Noble	Res	1937	FC	5170	39	17		88,500	118	94,800	0.93
				Rec	3550	29	12	47	43,500			0.46
Summit Lake 410323081324700	Summit	Res		WS	115	40	--	1.8	--	--	--	--
Tappan Lake 402129081133200	Harrison	Res	1936	FC	3100	44	20		61,600	71.1	54,200	1.14
				Rec	2350	34	15	41	35,100			0.65
Wills Creek Lake 400918081510200	Muskingum Coshocton	Res	1937	FC	11,450	59	17		196,000	842	657,000	0.30
				Rec	900	22	6.7	16.2	6,000			0.01
Wolf Run Lake 394727081324600	Noble	Res		WS Rec	220	55	33	8.5	7,200	5.7	4,290	1.68

[a] Modified from Tobin and Youger, 1979.

Table VII-4B. Summary of physical and chemical characteristics of selected lakes in Ohio, 1976. [a]

Lake name and site location	Maximum observed depth (feet)	Secchi disk transparency (feet)		Thermal stratification		Dissolved oxygen range [1] (mg/L)		pH range [1]		5-Day BOD range [1] (mg/L)		TOC range [1] (mg/L)	
		spring	summer	spring	summer	spring	summer	spring	summer	spring	summer	spring	summer
Alum Creek Lake above dam	68	8.5	11	no	yes	11.2-10.2	8.0-0.0	8.3-8.1	7.8-7.1	1.0-1.1	0.7-1.1	6.8-7.1	5.8-8.1
Atwood Lake above dam	30	4.1	3.0	slight	partial	10.2-4.5	8.1-0.0	8.0-6.6	8.0-6.7	1.6-2.4	2.5-1.9	6.2-5.1	6.1-10
Burr Oak Reservoir above dam	35	6.4	4.5	yes	partial	12.9-2.3	9.6-0.0	8.7-6.9	8.5-6.5	1.2	3.0-2.5	3.4-6.0	6.9-12
Clendening Lake above dam	35	3.3	3.3	slight	partial	11.7-1.5	8.0-0.0	8.6-7.2	8.5-7.1	2.7-1.7	2.5->8.8	6.9-10	6.1-12
Lake Logan above dam	24	3.7	2.0	yes	yes	10.9-8.0	9.2-0.0	8.0-7.0	6.3-6.8	1.9-1.5	4.9	5.4-2.5	7.9-11
Lake Rockwell above dam	23	4.1	3.3	slight	partial	10.4-7.2	12.3-0.0	8.1-7.4	8.7-6.9	2.0-1.6	3.0-2.2	7.4-7.9	7.2-7.6
Leesville Lake above dam	38	4.5	5.2	yes	partial	9.9-3.0	8.3-0.0	7.8-6.5	8.1-6.5	1.6-0.8	2.1-1.6	4.4-3.3	4.1-8.5
Mogadore Reservoir above dam	23	21	5.1	no	yes	8.8-6.6	12.4-0.0	7.5	9.0-7.1	0.8-0.6	2.0-0.8	3.8-4.1	7.3-8.1
Mosquito Creek Lake above dam	24	2.7	2.0	no	partial	10.3-10.0	9.1-0.0	7.9-7.8	8.4-6.6	1.8-1.0	4.0-1.8	7.3-7.0	7.8-8.0
Senecaville Lake above dam	22	5.2	2.6	yes	slight	14.6-5.7	10.2-0.0	8.7-7.7	8.4-7.1	2.2-1.9	2.7-1.8	4.6-7.0	4.7-6.8
Summit Lake near midpoint	38	2.8	2.1	yes	partial	10.5-0.0	17.8-0.0	8.4-7.3	8.8-7.1	3.8-4.2	6.2-8.1	6.8-6.0	---
Tappan Lake above dam	28	3.5	3.7	slight	partial	7.7-0.8	8.0-0.0	7.9-7.3	8.3-7.1	2.3-1.6	2.5-1.9	2.4-3.7	6.5-9.9
Wills Creek Lake above dam	15	1.5	1.5	partial	yes	13.6-11.0	12.5-2.4	8.6-7.9	8.5-7.1	4.0-4.6	4.0-2.2	11	5.8-7.1
Wolf Run Lake above dam	50	6.4	11	partial	yes	12.4-6.5	8.5-0.0	8.5-7.6	8.3-6.9	1.5-0.7	0.8-0.7	3.9-3.3	3.5-6.8

1 Water column data--near surface values shown first; single value used when near-surface and near-bottom values were equal.
2 Refer to table 3.
3 National Academy of Sciences, 1972.
4 Ohio EPA Regulation EP-1 Water Quality Standards.

Lake name and site location	Specific conductance range [1] (umhos)		Chemical typing (spring only) [2]		Substances at or above accepted limits		Total N (maximum concentration in mg/L)	Total P (maximum concentration in mg/L)	H_2S present
	spring	summer	hardness	major ions	pesticides [3]	metals [4]			
Alum Creek Lake above dam	435	460-492	hard	$CaHCO_3SO_4$	no	no	2.2	0.15	yes
Atwood Lake above dam	222-220	255-285	mod. hard	$CaMgSO_4Cl$	no	no	1.6	0.28	yes
Burr Oak Reservoir above dam	190-180	198-160	mod. hard	$CaSO_4HCO_3$	no	no	2.7	0.11	yes
Clendening Lake above dam	605-655	718-810	very hard	$CaSO_4$	no	no	3.2	0.42	yes
Lake Logan above dam	130	162-287	mod. hard	$CaHCO_3SO_4$	no	no	5.8	0.23	yes
Lake Rockwell above dam	300-295	288-345	mod. hard	$CaHCO_3Cl$	no	yes (Cu)	1.4	0.16	yes
Leesville Lake above dam	155-158	170-202	mod. hard	$CaHCO_3SO_4$	no	no	2.3	0.24	yes
Mogadore Reservoir above dam	318	265-320	hard	$CaHCO_3$	no	no	0.76	0.17	yes
Mosquito Creek Lake above dam	220	240-283	mod. hard	$CaNaHCO_3SO_4$	no	no	0.98	0.08	no
Senecaville Lake above dam	325-350	340-365	hard	$CaHCO_3$	no	no	1.1	0.11	yes
Summit Lake near midpoint	915-1250	850-1150	very hard	NaCl	no	no	12	0.74	yes
Tappan Lake above dam	620-635	625-668	very hard	CaSO4	no	no	1.7	0.26	yes
Wills Creek Lake above dam	590-620	522-557	very hard	CaSO4	no	no	0.91	0.12	no
Wolf Run Lake above dam	280-305	265-305	mod. hard	$CaHCO_3$	no	no	1.0	0.05	yes

[a] Modified from Tobin and Youger, 1979.

Table VII-4C. Summary of biological characteristics of selected lakes in Ohio, 1976. [a]

Lake name and site location	Bacteria[1]				Phytoplankton											
					Dominant phylum and genus, and percent of total cell count											
					Spring						Summer					
	Fecal coliform (colonies per 100 ml)		Fecal streptococci (colonies per 100 ml)		Cells per ml	Composites from euphotic zone		Cells per ml	Samples from zone of maximum dissolved oxygen		Cells per ml	Composites from euphotic zone		Cells per ml	Samples from zone of maximum dissolved oxygen	
	spring	summer	spring	summer												
Alum Creek Lake above dam ----------	<2	<2-2	<2	54-2	590	Chrysophyta Cyclotella	80% 40%				2,100	Chlorophyta Sphaerocystic	65% 42%	3,400	Cyanophyta Aphanizomenon	72% 18%
Atwood Lake above dam ----------	<2	<3	<2-4	<3-3	65,000	Cyanophyta Oscillatoria	77% 54%				190,000	Cyanophyta Oscillatoria	95% 52%	220,000	Cyanophyta Cylindrospermum	95% 40%
Burr Oak Reservoir above dam --------	<2-46	2-12	<2	<2-2	1,900	Cyanophyta Oscillatoria	46% 46%	1,600	Chrysophyta Melosira	47% 34%	130,000	Cyanophyta Lyngbya	> 99% 67%	120,000	Cyanophyta Aphanizomenon	100% 75%
Clendening Lake above dam ----------	<2	<2	<2	<2-2	210,000	Cyanophyta Oscillatoria	95% 95%				1,100,000	Cyanophyta Oscillatoria	> 99% 55%	340,000	Cyanophyta Cylindrospermum	98% 92%
Lake Logan above dam ----------	<2	3-6	<2	3-43	11,000	Cyanophyta Arthrospira	60% 56%				270,000	Cyanophyta Agmenellum	99% 71%	64,000	Cyanophyta Cylindrospermum	98% 64%
Lake Rockwell above dam ----------	<2-2	<2-2	<2	<2	20,000	Chrysophyta Cyclotella	48% 18%				96,000	Cyanophyta Raphidiopsis	65% 36%	70,000	Cyanophyta Oscillatoria	65% 48%
Leesville Lake above dam ----------	<2-18	<3-3	2-4	<3	42,000	Cyanophyta Oscillatoria	94% 94%				73,000	Cyanophyta Oscillatoria	98% 69%	49,000	Cyanophyta Aphanizomenon	96% 48%
Mogadore Reservoir above dam --------	<2	<2-12	<2	<2-50	1,000	Chlorophyta Schroederia	83% 83%				22,000	Cyanophyta Aphanizomenon	89% 33%	54,000	Cyanophyta Anabaena	87% 29%
Mosquito Creek Lake above dam -------	<2-2	<2-2	<2	2-8	51,000	Cyanophyta Anacystis	50% 46%				230,000	Cyanophyta Oscillatoria	89% 53%	650,000	Cyanophyta Oscillatoria	96% 76%
Senecaville Lake above dam ----------	<2	8-18	<2-2	<2-18	56,000	Cyanophyta Oscillatoria	53% 31%	62,000	Cyanophyta Oscillatoria	68% 68%	630,000	Cyanophyta Oscillatoria	90% 71%	260,000	Cyanophyta Oscillatoria	95% 64%
Summit Lake near midpoint ----------	48-4	240-77	72-12	<2-72	440,000	Cyanophyta Oscillatoria	95% 94%				300,000	Cyanophyta Oscillatoria	94% 75%	550,000	Cyanophyta Oscillatoria	94% 65%
Tappan Lake above dam ----------	<2	2-<2	<2	2	110,000	Cyanophyta Oscillatoria	82% 81%				650,000	Cyanophyta Cylindrospermum	99% 70%	490,000	Cyanophyta Cylindrospermum	> 99% 56%
Wills Creek Lake above dam ----------	8	2-6	<2	2-12	72,000	Cyanophyta Oscillatoria	54% 43%				37,000	Cyanophyta Oscillatoria	92% 86%	95,000	Cyanophyta Oscillatoria	89% 65%
Wolf Run Lake above dam ----------	<2-2	2-12	<2	<2	2,500	Chrysophyta Dinobryon	100% 59%				8,700	Cyanophyta Aphanizomenon	83% 46%	4,100	Chrysophyta Fragilaria	59% 55%

[a] Modified from Tobin and Youger, 1979.

Table VII-5A. Morphometric data for lakes sampled in Ohio, 1977. [a]

Type: Res - reservoir; Lk - lake.
Use: FC - flood control; WS - water supply; Rec - recreation.
C/I: capacity divided by mean annual inflow - decreasing values indicate shorter hydraulic retention time.

Name and primary site identification number	Location (county)	Type (a)	Date of origin	Use (b)	Morphology: Surface area (acres)	Depth: Maximum (feet)	Depth: Mean (feet)	Shoreline (miles)	Capacity (acre-feet)	Drainage area (miles)	Mean annual inflow (acre-feet)	Capacity inflow ratio C/I (c)
C.J. Brown Res 395702083443800	Clark	Res	1974	FC	2,720	58	23		63,700	82	46,480	1.37
				Rec WS	2,120	47	17	11	36,900			0.79
Deer Creek Res 405815081071400	Stark	Res	1954	WS Rec	313	20	9.8	8	3,070	38	25,560	0.12
Dillon Lake 395939082050500	Muskingum	Res	1960	FC	10,280	69	27		274,000	742	567,600	0.48
				Rec	1,560	32	11	21.2	17,500			0.03
East Branch Res 413016081054200	Geauga	Res	1939	WS Rec	416	20	11	7.6	4,659	17.5	13,720	0.34
Indian Lake 402931083514700	Logan	Res	1853	WS Rec	6,130	12	7.6	29	46,300	99.8	61,540	0.75
Killdeer Res 404202083225800	Wyandot	Res	1972	WS Rec	253	38	26	2.4	6,670	--	--	--
Kiser Lake 401144083584700	Champaign	Res	1940	Rec	374	17	8.6	5.3	3,215	8.7	5,590	0.58
Knox Lake 402942082313100	Knox	Res	1954	Rec	474	25	6.9	12	3,280	31.4	23,900	0.14
Long Lake 410032081323000	Summit	Lk-Res	1830's	WS Rec	166	38	--	4.4	--	--	--	--
M.J. Kirwan Res 410921081045800	Portage	Res	1966	FC	3,240	57	24		78,700	80.5	77,460	1.02
				WS Rec	2,650	49	20	20	52,900			0.68
Nimisila Res 405544081313700	Summit	Res	1939	WS Rec	811	30	12	16	9,400	17.4	11,400	0.82
Piedmont Lake 401116081125500	Harrison Belmont Guernsey	Res	1937	FC	3,270	49	20		66,700	85.9	69,900	0.95
				Rec	2,270	38	15	36	34,500			0.49
Stonelick Lake 391258084045900	Clarmont	Res	1948	Rec	171	21	10	9.5	1,750	23.3	18,900	0.09
Turkeyfoot Lake 405747081321700	Summit	Lk-Res	1830's	WS Rec	450	60	--	6.1	--	--	--	--

[a] Modified from Tobin and Youger, 1979.

Table VII-5B. Summary of physical and chemical characteristics of selected lakes in Ohio, 1977. [a]

Lake name and site location	Maximum observed depth (feet)	Secchi disk transparency (feet)		Thermal stratification		Dissolved oxygen range [1] (mg/L)		pH range [1]		5-Day BOD range [1] (mg/L)		TOC range [1] (mg/L)	
		spring	summer	spring	summer	spring	summer	spring	summer	spring	summer	spring	summer
C.J. Brown Reservoir above dam	40	4.0	5.0	no	yes	11.5-10.9	7.2-0.0	6.3	8.0-7.1	2.1-1.8	4.2-7.5	6.0-4.1	4.2-7.7
Deer Creek Reservoir above dam	20	3.0	2.4	yes	slight	11.5-0.2	7.7-0.0	8.5-6.8	7.9-7.0	3.4-1.6	1.9-2.3	5.7-4.1	7.0-6.4
Dillon Lake above dam	46	1.5	2.2	slight	slight	8.7-7.8	10.1-0.0	7.5-7.3	8.2-6.9	1.0-1.4	6.0-5.6	4.6-5.2	7.5-8.1
East Branch Reservoir above dam	70	2.8	3.0	no	partial	9.1-9.0	10.5-0.0	7.1	8.4-6.4	2.0-1.6	5.5-4.8	2.1-5.7	6.2-9.1
Indian Lake near Shawee Island	16	1.0	1.5	no	slight	9.5-9.1	9.3-5.4	8.3-8.2	8.3-7.7	7.6-7.5	6.1-5.5	5.2-4.7	7.4-6.1
Killdeer Reservoir at southwest corner	35	19	6.3	slight	yes	9.5-2.3	8.3-0.0	8.0-7.4	8.2-7.1	0.7-1.0	1.1-2.3	4.2-5.6	5.0-8.4
Kiser Lake above dam	12	2.1	1.2	no	slight	12.8-12.7	10.9-4.2	8.5	8.4-7.5	6.3	8.8-7.6	4.2-4.4	7.9-10
Knox Lake above dam	25	2.9	2.0	yes	partial	12.2-0.0	12.5-0.0	8.7-6.7	8.7-7.0	4.0-3.2	4.8-4.2	6.3-6.2	6.0-8.1
Long Lake at midpoint	58	2.8	2.4	yes	yes	10.6-0.3	10.9-0.0	8.8-7.3	8.4-6.8	6.4-1.9	3.7-4.2	2.8-3.6	7.2-6.5
M.J. Kirwan Reservoir above dam	50	3.5	4.5	slight	yes	11.9-9.6	8.6-0.0	7.9-7.4	7.9-6.7	1.0	9.3	3.8-3.0	4.9-6.0
Nimisila Reservoir above dam (L-1)	30	2.2	3.0	slight	yes	10.8-0.0	8.7-0.0	8.3-7.1	8.5-6.7	3.9-5.0	3.4->17	5.9-9.1	6.9-7.4
Piedmont Lake above dam	52	4.5	2.8	slight	yes	12.4-9.8	10.2-0.0	8.5-8.1	8.6-7.1	1.8-1.7	3.3-4.9	6.0-4.9	7.5-6.2
Stonelick Lake above dam	21	0.8	3.5	yes	yes	11.5-2.0	13.2-0.8	8.1-6.9	9.0-6.6	4.7-2.4	5.6-4.0	7.3-6.4	7.3-6.2
Turkeyfoot Lake at midpoint	68	2.1	3.7	yes	yes	18.4-0.4	8.5-0.0	8.9-7.4	8.2-6.9	7.5-5.3	2.8-4.8	7.1-6.9	7.6-9.1

1 Water column data--near surface values shown first; single value used when near-surface and near-bottom values were equal.
2 Refer to table 3.
3 National Academy of Sciences, 1972.
4 Ohio EPA Regulation EP-1 Water Quality Standards.

Lake name and site location	Specific conductance range [1] (umhos)		Chemical typing (spring only) [2]		Substances at or above accepted limits		Total N (maximum concentration in mg/L)	Total P (maximum concentration in mg/L)	H_2S present
	spring	summer	hardness	major ions	pesticides [3]	metals [4]			
C.J. Brown Reservoir above dam	565	470-620	very hard	$CaHCO_3$	no	no	5.7	0.55	yes
Deer Creek Reservoir above dam	340-365	370-400	hard	$CaHCO_3SO_4$	no	no	3.3	0.06	yes
Dillon Lake above dam	320-295	475-398	hard	$CaHCO_3$	no	no	3.3	0.23	yes
East Branch Reservoir above dam	185	235-167	hard	$CaHCO_3SO_4$	no	no	2.3	0.11	yes
Indian Lake near Shawee Island	395	425-430	very hard	$CaMgHCO_3$	no	no	2.9	0.14	no
Killdeer Reservoir at southwest corner	480-498	473-510	very hard	$CaHCO_3SO_4$	no	no	2.0	0.02	yes
Kiser Lake above dam	370	368-380	very hard	$MgCaHCO_3$	no	no	4.3	0.12	no
Knox Lake above dam	240-222	275-350	mod. hard	$CaHCO_3$	no	no	11	0.85	yes
Long Lake at midpoint	475-555	470-595	very hard	$CaHCO_3$	no	no	5.7	0.77	yes
M.J. Kirwan Reservoir above dam	358-365	380-385	hard	$CaMgHCO_3SO_4$	no	no	1.2	0.04	yes
Nimisila Reservoir above dam (L-1)	390-420	355-480	hard	$CaHCO_3$	no	no	7.3	0.60	yes
Piedmont Lake above dam	990-1010	1000-1055	very hard	$CaSO_4$	no	no	1.7	0.29	yes
Stonelick Lake above dam	290-275	265-488	mod. hard	$CaHCO_3$	no	no	12	3.2	yes
Turkeyfoot Lake at midpoint	410-475	420-515	hard	$CaHCO_3$	no	no	4.2	0.71	yes

[a] Modified from Tobin and Youger, 1979.

Table VII-5C. Summary of biological characteristics of selected lakes in Ohio, 1977. [a]

Lake name and site location	Bacteria[1]				Phytoplankton															
					Dominant phylum and genus, and percent of total cell count															
					Spring								Summer							
	Fecal coliform (colonies per 100 ml)		Fecal streptococci (colonies per 100 ml)		Cells per ml	Chlorophyll a (ug/L)	Composites from euphotic zone		Cells per ml	Chlorophyll a (ug/L)	Samples from zone of maximum dissolved oxygen		Cells per ml	Chlorophyll a (ug/L)	Composites from euphotic zone		Cells per ml	Chlorophyll a (ug/L)	Samples from zone of maximum dissolved oxygen	
	spring	summer	spring	summer																
C.J. Brown Reservoir above dam -----	84-52	<2	20	<2	9,600	26	Chrysophyta Fragilaria	55% 35%	8,100	26	Euglenophyta Cryptomonas	55% 30%	130,000	--	Cyanophyta Aphanizomenon	100% 87%	290,000	32	Cyanophyta Aphanizomenon	100% 97%
Deer Creek Reservoir above dam -----	2	<2	<2	<2	8,200	20	Chrysophyta Cyclotella	47% 31%	15,000	30	Chrysophyta Cyclotella	34% 22%	460,000	22	Cyanophyta Anacystis	97% 43%	420,000	25	Cyanophyta Anacystis	98% 50%
Dillon Lake above dam ----------	10-54	<4-16	10-136	<4-120	1,900	2.7	Cyanophyta Oscillatoria	54% 42%	4,100	3.7	Cyanophyta Oscillatoria	50% 50%	160,000	41	Cyanophyta Oscillatoria	94% 83%	860,000	78	Cyanophyta Oscillatoria	99% 79%
East Branch Reservoir above dam ----	80-90	24-200	60-44	10-430	9,400	13	Chlorophyta Melosira (& Chrysophyte)	36% 19%	8,600	13	Chrysophyta Melosira	63% 27%	3,000,000	23	Cyanophyta Lyngbya	94% 48%	3,400,000	29	Cyanophyta Lyngbya	96% 70%
Indian Lake near Shawnee Island ----	<4	<3-3	2-<4	126-430	610,000	43	Cyanophyta Oscillatoria	92% 88%	730,000	72	Cyanophyta Oscillatoria	91% 87%	2,500,000	90	Cyanophyta Oscillatoria	97% 89%	1,600,000	83	Cyanophyta Oscillatoria	98% 60%
Killdeer Reservoir at SW corner ----	<2	<2-4	2	<2-6	180	3	Euglenophyta Cryptomonas	58% 48%	910	3	Chrysophyta Fragilaria	66% 44%	13,000	5.8	Cyanophyta Anacystis	78% 78%	12,000	8.4	Cyanophyta Anacystis	58% 58%
Kiser Lake above dam ----------	<2	<2	2-<2	8	660,000	85	Cyanophyta Oscillatoria	90% 90%	560,000	39	Cyanophyta Oscillatoria	87% 73%	3,400,000	145	Cyanophyta Oscillatoria	97% 60%	4,200,000	149	Cyanophyta Oscillatoria	98% 84%
Knox Lake above dam ----------	3-<9	<3-56	<3-3	<2-8	46,000	30	Chrysophyta Melosira	34% 44%	49,000	23	Cyanophyta Oscillatoria	37% 31%	320,000	46	Cyanophyta Oscillatoria	90% 31%	450,000	38	Cyanophyta Oscillatoria	91% 45%
Long Lake at midpoint ----------	2-<2	34-12	<2	26-12	270,000	87	Cyanophyta Oscillatoria	85% 84%	280,000	77	Cyanophyta Oscillatoria	83% 83%	860,000	46	Cyanophyta Cylindrospermum	98% 55%	470,000	38	Cyanophyta Oscillatoria	96% 64%
M.J. Kirwan Reservoir above dam ----	<2	2	<2-4	<2-2	3,200	8.6	Cyanophyta Oscillatoria	56% 56%	4,600	4.6	Cyanophyta Oscillatoria	93% 93%	1,800	4.3	Cyanophyta Anacystis	46% 40%	1,600	8.4	Cyanophyta Oscillatoria	58% 36%
Nimisila Reservoir above dam -------	2	72-12	2-<2	102-20	780,000	41	Cyanophyta Oscillatoria	100% 99%	390,000	31	Cyanophyta Oscillatoria	99% 97%	1,700,000	41	Cyanophyta Aphanizomenon	100% 69%	1,600,000	44	Cyanophyta Lyngbya	99% 69%
Piedmont Lake above dam ----------	<2-2	<2	2-<2	2-6	180,000	20	Cyanophyta Oscillatoria	90% 88%	210,000	16	Cyanophyta Oscillatoria	92% 91%	480,000	31	Cyanophyta Cylindrospermum	100% 82%	710,000	33	Cyanophyta Cylindrospermum	100% 57%
Stonelick Lake above dam ----------	3-24	4-8	8-9	12-14	6,000	36	Euglenophyta Cryptomonas	81% 52%	11,000	54	Euglenophyta Cryptomonas	77% 55%	89,000	24	Chlorophyta Sphaerocystis	83% 74%	91,000	21	Chlorophyta Sphaerocystis	83% 58%
Turkeyfoot Lake at midpoint --------	2-<2	12-<2	2	46-10	150,000	59	Cyanophyta Oscillatoria	64% 64%	590,000	62	Cyanophyta Oscillatoria	93% 93%	8,100,000	28	Cyanophyta Lyngbya	100% 71%	1,000,000	34	Cyanophyta Lyngbya	97% 55%

[1] Water column data - near surface values shown first; single value used when near-surface and near-bottom values were equal.

[a] Modified from Tobin and Youger, 1979.

3) Nutrients and Trophic Levels

Nutrient enrichment is widely recognized as a major contributor to problems in lakes. Research has demonstrated that phosphorus is the nutrient most frequently controlling primary production in north temperate lakes (Schindler, 1978). Lakes enriched with phosphorus typically develop high populations of algae or thick growths of aquatic weeds. Increased lake productivity can lead to ecological changes, such as dissolved oxygen depletion, and changes in the composition of the fish, algae, and invertebrate communities present in the lake. These changes, particularly abundant algae, can lower the aesthetic and recreational value of a lake.

An extreme example of the higher aquatic plant problem in Ohio was noted in Clark Lake (Clark Co.), during 1979, where *Ceratophyllum* sp. covered 80% of the lake's surface, severely impairing recreational use.

A method described by Carlson (1977) was used to determine the trophic status of Ohio's lakes and reservoirs. Any one of three parameters, chlorophyll *a*, secchi disc, or total phosphorus, can be used in a parameter specific equation to generate a trophic index from 0 to 100. The following equations (Carlson 1977) were used to calculate the Trophic State Index (TSI):

a. Chlorophyll *a* (mg/m^3)

$$TSI\ (Chl\ a) = 10\ (6 - (2.04 - 0.68 \ln Chl\ a)/\ln 2)$$

b. Secchi Disc (meters)

$$TSI\ (SD) = 10\ (6 - \ln SD/\ln 2)$$

c. Total phosphorus (mg/m^3)

$$TSI\ (TP) = 10\ (6 - (\ln 48/TP/\ln 2))$$

Carlson's method for trophic evaluation is more sensitive and less subjective than the traditional oligo-meso-eutrophic method in which lakes having substantially different nutrient concentrations may be classified in the same trophic category.

Summer chlorophyll *a*, summer secchi disc transparency values, and spring total phosphorus were used to determine TSI values. TSI values were then used to classify lakes according to the traditional classification scheme listed in Table VII-7. All three TSI values were evaluated in classifying a lake when substantial differences in TSI values occurred. First priority was given to summer chlorophyll *a*, followed by summer secchi disc transparency values, and then spring total phosphorus.

Conditions existing in the lake at the time of sampling were also taken into consideration. The effect of color interference with secchi disc measurements was tested with a technique described by Brezonik and Chesney, (1976), and was found to be insignificant.

Table VII-7: A Comparison of Carlson's Trophic State Index (TSI) to Standard Trophic Terminology[a]

TSI Value	Trophic Classification
below 40	Oligotrophic
40 to 50	Mesotrophic
50 to 70	Eutrophic
greater than 70	Hypereutropic

a Carlson (1977, and personal communication, 1980); Trophic Classification Modifications from Garn and Parrott, (1977) using USEPA data (1978).

Eighty-three or 40% of the 210 lakes listed in the lake inventory have been classified according to trophic status. Seventy-eight percent of the 83 lakes were classified eutrophic, 13% mesotrophic and 9% hypereutrophic. The trophic classification and the Trophic State Index values, where available, are listed in Table VII-1B.

The following observations were made from a review of trophic level determinations:

- A lake's trophic level generally reflected the nature of the surrounding bedrock. In general, lakes and reservoirs in the glaciated and limestone bedrock regions of the state had higher TSI's than those lakes in the sandstone bedrock areas of the state.

- Upground, pumped storage reservoirs with regulated inflows had lower TSI values than nearby impoundments.

- The six canal feeder lakes as a group had the highest TSI's of all lakes surveyed. The four largest lakes, Buckeye Lake, Indian Lake, Lake Loramine and Grand Lake St. Marys, were classified as hypereutrophic. The two smaller lakes, Summit Lake and Turkey Foot Lake, were classified as eutrophic. The four larger lakes are shallow, easily mixed by the wind, did not undergo stratification and did not become anaerobic during the summer. The two smaller lakes, although less productive, were deeper, became stratified and developed anaerobic conditions during the summer.

B. Problem Areas

1. Resource Extraction

Several lakes have problems related to coal mining or oil drilling in their drainage basins. Piedmont Reservoir (Harrison County), the two New Lexington Reservoirs (Perry County) and Lake Hope (Vinton County) have been adversely affected by coal mining operations; Corning Reservoir (Perry County) has been affected adversely by drainage from oil wells.

Piedmont Reservoir has a high sulfate concentration (410 mg/l) (Tobin and Youger, 1979), attributed to active strip mining operations, which has prevented its use as a water supply reservoir. The "New" and "Old" New Lexington Reservoirs have high manganese concentrations also attributed to strip mining operations. The manganese must be removed from the reservoir water prior to its use for drinking water; this requires expensive supplemental treatment of the raw reservoir water (Heitz and Myers, 1980; Ohio EPA, 1979). Seepage from abandoned deep mines and runoff from refuse piles has lowered the pH of Lake Hope to less than pH 5.5 (Tobin and Youger, 1977; Tobin and Youger, 1979). This has lowered the productivity and adversely affected fish populations in the lake. The city of Corning is no longer using Corning Reservoir as a water supply due to high chloride concentrations that enter the reservoir from leaking oil wells in the basin (Heitz and Myers, 1980).

Coal mining and oil drilling are occurring in the drainage basins of other lakes and reservoirs in Ohio, the reader is referred to the mining section of this document (Volume V) for further information and references to further reading.

2) Urbanization

Two lakes, Summit Lake (Summit Co.) and Winton Lake (Hamilton Co.) had problems attributed to their proximity to urban development (Tobin and Youger, 1979).

Summit Lake water had high chloride levels apparently resulting from its use in industrial processes and from seepage of nearby salt wells. Refuse dumped into the lake along the shoreline was also evident. Winton Lake had high BOD, lead, and chloride levels and objectional odors emanating from the bottom waters. A layer of water immediately above the lake bottom had a high conductivity (3000 mhos) indicating the presence of pollution. Refuse was observed floating on the surface and drifting along the lake shoreline. Deteriorated and overloaded sanitary/storm sewer systems are the probable causes of the degraded water quality. Improvements are being made to the sewer systems which should alleviate some of the water quality problems in the near future.

IV. Restoration

Interest in lake restoration projects is increasing as a result of Section 314 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). The goal of the program is to protect at least one lake with water quality suitable for contact recreation, or to restore a degraded lake to that condition, within 25 miles of every major population center (Standard Metropolitan Statistical Area). The city of Akron has received a grant under Section 314 for restorative measures for Summit Lake. The cities of Aurora, Springfield, Stow and Youngstown have expressed interest in applying for lake restoration grants.

A USEPA funded program has been initiated in the Lake Hope Drainage Basin (Vinton Co.). The objective of this project is to prevent abandoned coal mine drainage with low pH from entering Lake Hope. This will be accomplished by sealing exposed coal seams and disposing of mine refuse.

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This information deals with lakes in Ohio (public) potentially affected by mine drainage. It was taken from the data that Ohio EPA, ICOG, assembled to write the 1980 305(b) report (Volume II). Surveillance has a complete volume of the data.

This information was not included in the lakes volume of the 1980 305-(b).

Introduction

The objective of this report is to identify streams and reservoirs in Ohio which are affected by coal mine drainage resulting in ambient stream water quality which exceeds Ohio Water Quality Standards.

The following analysis of streams affected by coal mine drainage is based on several criteria. Streams or reservoirs considered coal mine drainage affected must have 1) abandoned coal mines in the watershed, 2) water quality data which demonstrates a violation(s) of Warmwater Habitat (WWH) standards for pH, total dissolved solids (or equivalent specific conductance at 25°C), total iron and total zinc; or 3) a stream or reservoir used as a public water supply in which water quality exceeds Public Water Supply (PWS) standards of soluble iron, total manganese, sulfates and/or total zinc. A violation of any one parameter, coupled with the presence of past mining activity in the watershed constitutes sufficient evidence in this analysis for inclusion as a mine drainage affected stream or reservoir.

In a few instances, streams or reservoirs which do not contain coal mining in their watersheds but have water quality concentrations in excess of WWH or PWS standards were included. These segments are asterisked (*) and described as having natural background conditions which exceed or violate WWH or PWS standards.

Streams potentially affected by mine drainage were also included in this analysis. Streams or reservoirs with mining in the watershed, for which insufficient data is available to determine if any violations of PWS or WWH occur, were considered potentially affected. Further information is needed to characterize their degree of affectation.

The physical-chemical information presented originates from different sources. However, the most common method of collection is the grab sample. Data gathered by Skelly and Loy and some data in the Corps of Engineers, 1977 study was obtained at or near the pollution source. In general, data from these sources will exhibit more violations of Water Quality Standars than data obtained farther away from the pollution source.

The analyses of mine drainage stream segments and affected reservoirs as presented, cannot evaluate historical trends of water quality. This is due to incomplete or unavailable information or the manner in which the data was reported as means and ranges over the period of record. What can be gained from the analysis is a fairly complete list of areas and degree of degradation from past mining activities in Ohio at least for major streams. Data on small feeder streams is quite sparse or totally lacking in many cases. In several cases, historical biological or chemical-physical data was included (when no current data was reported) in the hope that this could serve as a groundwork for further investigations.

In most cases the streams and reservoirs in this analysis are predominantly affected by drainage from abandoned or orphaned mines. The ranges of observed mine drainage parameter concentrations are the result of many environmental processes and conditions including the extent of natural secondary succession and/or reclamation, topography, runoff and climate, to name a few. It is conservative to say, in most cases, stream quality with respect to mine drainage conditions, will not improve substantially in the near future unless reclamation of the abandoned mines is accomplished.

This report consists of two, distinct portions; the text and the appendices. The text briefly describes geological, geographical, physical, chemical and occasionally biological aspects of the affected stream or

reservoir, its watershed and the coal seam mined. The streams are listed alphabetically by basin in the text except for the tributaries which are described as a group following the main stream description. The county in parentheses after the segment description is the county in which the lowest downstream portion of the segment is located.

Chemical, physical and biological water quality data are presented in summary table form in the text. (These summary tables within the text are not numbered). Chemical-physical water quality summary tables represent ranges of water quality observed in the main stream segment and in its affected tributaries over variable time intervals. The summary table does not indicate precise, stream specific ambient concentrations for the listed mine drainage parameters. Biological water quality summary tables in the text are representative of specific stream sampling sites.

Available physical, chemical and biological water quality data for all streams or reservoirs mentioned is tabularized in Appendix I. This means reported are arithmetic means. Other statistical parameters such as median and mode may be more representative of actual conditions. In all tables, a - means there was no data available for that parameter and/or sampling site, while N/A designates not applicable. The sampling sites are described wherever possible. In some cases, the STORET station numbers give the latitude and longitude of the sample in degrees, minutes, and seconds. The Skelly and Loy sampling sites are located on a map which is available from Ohio DNR, Division of Reclamation.

Appendix II lists the taxa or species of organisms and the classifications of pollution tolerance used in the analysis of biological water quality. The biological information presented originates from several sources, was collected using different methods in different years, and represents a wide range of taxonomic distinctions (species level to ordinal level).

FOOTNOTES

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4. Surber sample.

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Quantitative comparisons of biological communities between streams are probably not valid due to the diffuse nature of the data. Gross qualitative comparisons may be made when combined with chemical-physical information.

Appendix III is a list of fish kills attributable to mine drainage reported by Ohio DNR, Division of Wildlife.

Appendix IV is a table of current water quality standards for the Warmwater Habitat (WWH), Exceptional Warmwater Habitat (EWH), Coldwater Habitat (CWH), and Public Water Supply (PWS) stream classifications.

Attached to this report is a glossary of common terms used in the field of mining and reclamation. Bibliographies of cited and uncited literature appear at the end of this report.

GLOSSARY

Abatement - Elimination of pollutional effects upon the aquatic environment caused by mine drainage.

Alkaline - Having the qualities of a base; i.e., a pH above 7.0.

Aquatic - Of or relating to water.

Aquifer - A water-bearing stratum of permeable rock, sand, or gravel.

Auger - Any drilling device in which the cuttings are mechanically and continuously removed from a borehole without the use of fluids.

Benthos - Organisms that inhabit the bottom substrate of lakes, ponds and streams. These organisms may be artifically divided into two major groups - macrobenthos and microbenthos. Macrobenthos consist of organisms retained by a No. 30 U.S. Series sieve.

CWH - Coldwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Deep Mine - An underground mine.

DNR - Department of Natural Resources - A State of Ohio agency.

Drainage - The area drained by a particular stream.

Drift - A deep mine entry driven directly into a horizontal or near horizontal mineral seam or vein when it outcrops or is exposed at the ground surface.

Effluent - Any water flowing out of the ground or from an enclosure to the surface flow network.

EPA - Abbreviation for Environmental Protection Agency.

Erosion - Process whereby solids are removed from their original location on the land surface by hydraulic or wind action.

EWH - Exceptional Warmwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Gob - Rock that has a high carbon content - usually referring to dark colored mining waste material.

Haul Road - A road built to carry heavily loaded trucks. The grade is limited on this type of road and usually kept to less than 17 percent of climb in the direction of load movement.

Head (of water) - Water pressure expressed as the feet of elevation difference between the top of the water and the point at which the pressure is exerted.

Highwall - The exposed vertical or near vertical wall associated with strip or area surface mines.

Hydrology - The science that relates to the water systems of the earth.

Impoundment - A body of water formed by collecting and confining water, as in a reservoir.

Infiltration - Water entering the gound water system through the land surface.

Leaching - Extraction of a mineral from an ore by selectively dissolving it in a suitable solvent.

Meiofauna - Microbenthos of the interstitial sediments of lakes and streams.

Mining - The process of obtaining useful minerals from the earth's crust which includes both underground excavations and surface workings.

Neutralization - The process of adding an acid or alkaline material to wastewater to adjust its pH to a neutral position.

Outcrop - The surface exposure of bedrock or strata.

Outslope - The face of a strip mine bench or spoil pile opposite the highwall.

Overburden - The nonsalable rock material that overlies a mineable mineral.

Parameter - Any of a set of physical properties whose values determine the characteristics or behavior of something.

pH - The negative logarithm to the base ten of the hydrogen ion activity. pH 7 is considered neutral. Above 7 is basic - below 7 is acidic.

PWS - An abbreviation for Public Water Supply, an office of Ohio EPA.

Pyrites - Any of various metallic-looking sulfides of which Ferrous Sulfide (Pyrite) is the most common.

Reclamation - The procedures by which a disturbed area can be reworked to make it productive, useful, non-polluting or aesthetically pleasing. Reclamation does not necessarily imply return of the land to its original physical state or condition.

Refuse - Rock that has a high carbon content - usually refers to the dark colored mining waste extracted from underground mines.

Reserve - That portion of the actual identified resource material which can be economically and legally extracted at the time of determination.

Resource - Material known to exist in the earth's crust or judged by geologic inference and extrapolation as likely to exist.

Runoff - That part of precipitation that flows over the land surface from the area upon which it falls.

Sediment - Solid material settled from suspension in a liquid medium.

SEDO - Southeast District Office, an office of Ohio EPA.

Settling Pond - A holding or retention pond which provides sufficient residence time to allow the precipitation of suspended solids.

Silt (Sediment) - Solid material settled from suspension of a liquid medium.

Slope Stability - The resistance of any inclined surface, as the wall of an open pit or cut, to failure by sliding or collapsing.

Slugging - The sudden increase in concentration of stream pollutants, such as silt, acid, iron, or sulfate, resulting from heavy rainfall rapidly washing the leached pollutants from the land surface and underground mines.

Spoil Material - The waste material removed from the strip cut that is not considered a useful product.

Spoil Pile - The area where mine waste or spoil materials are disposed or piled.

STORET - U.S. EPA's data storage and retrieval system.

Strip Mine - A surface mine where the overburden is removed to expose the mineable material.

Stripping - The removal of earth or non-ore rock material as required to gain access to the ore or mineral materials wanted; the process of removing overburden or waste material in a surface mining operation.

Subsidence - The surface depression over an underground mine that has been created by subsurface caving.

Surface Mine - A mine facility that is generally conducted from the land surface. It does not have a mineral roof.

TDS - An abbreviation for total dissolved solids.

Watershed - Surface region or area contributing to the supply of a stream or lake; drainage area, drainage basin, catchment area.

WWH - Warmwater Habitat - An Ohio EPA water use designation (See Appendix IV).

Yellowboy - The unsightly, orange-red or yellow precipitate of ferric sulfate and hydroxide observed in many streams polluted by mine drainage.

APPENDIX II

Mine Drainage

Pollution Tolerant

Ephemeroptera - (most are sensitive except)

Epeorus sp.

Trichoptera - (most are facultative or sensitive except)

Hydropsyche betteni

Cheumatopsyche sp.

Diplectrona sp.

Polycentropus sp.

Brachycentrus americanus

Ptilostomis sp.

Plecoptera - (most are facultative or sensistive except)

Isoperla clio

Nemoura nigritta

Peltoperla sp.

Chloroperla terna

Megaloptera

Sialis sp.

Coleoptera -

dystiscidae - diving beetles

Chironomidae -

Chironomus plumosus

Ceratopogonidae - biting midges

Diptera

Tipula sp.

Eriocera sp.

Tendipedidae -

Tendipes sp

Procladius sp

Oligochaeta

Hirundinae

Mine Drainage Pollution

Facultative

Ephemeroptera - Mayflies

Stenonema rubrum

Epeorus sp.

Plecoptera - Stoneflies

Taenioptergx maura

Acroneuria lycorias

Tricoptera -

Coleoptera -

Elmidae

Odonata - Dragon and Damsel Flies

Boyeria uniosa

dragonfly nymphs

fingernail clams

midge larvae

cranefly larvae

blackfly larvae

scuds - gammarus

snails

sow bugs - isopoda

Mine Drainage

Pollution Sensitive

Immature or larval - most are sensitive including:

Ephemeroptera

Ephemerella subvaria

Heptagenia sp.

Stenonema pulchellum

Stenonema interpunctatum

Stenonema maculipennis

Paraleptophlebia sp.

Ephemerella walkeri

Ephemerella invaria

Tricoptera - (most are sensitive including:)

glossosoma nigrior

Rhyacophila nigritta

Neophylax sp

Plecoptera

Pteronarcys dorsata

Isogenus fontalis

Acroneuria sp.

Phasganophora capitata

Leuctra sibleyi

Leuctra carolinensis

Coleoptera -

Psephenus sp.

Megaloptera - dobsonflies, alderflies, fishflies

Coryalidae - dobsonflies, fishflies, hellgrammites (dobsonfly larvae)

Mine Drainage

Pollution Sensitive

Odonata -

Ophiogomphus rupinsulensis

Boyeria vinosa

Gomphidae

Phesphenidae -

Isopoda

Lirceus frontinalis

Asellus militaris

APPENDIX III - Fish Kills Attributable to Mine Drainage (selected years 1968-78)

Date d m y	County	Stream	No. Killed
07/12/78	Coshocton	Dickinson Run	10,184
08/29/78	Washington	Duck Creek	10
06/01/77	Meigs	Kingsberry Creek	121
06/03/76	Coshocton	Little Mill Creek	516
06/28/76	Jackson	Symmes Creek	596
10/03/76	Pike	Big Run	450
07/23/74	Washington	Duck Creek	13,580
08/08/72	Meigs	Leading Creek	482
09/08/72	Jackson	Symmes Creek	794
07/17/71	Columbiana	Leslie Run	208
07/23/71	Muskingum	Thompson Run	15,741
07/28/61	Athens	Hocking River	17
08/23/71	Noble	W. Fork Duck Creek	224
08/30/71	Washington	Duck Creek	47,250
09/28/71	Noble	E. Fork Duck Creek	32,678
04/30/70	Mahoning	Meander Creek	2,006
06/21/70	Mahoning	Meander Creek	120

APPENDIX III - Fish Kills Attributable to Mine Drainage (selected years 1968-78)

Continued

Date d m y	County	Stream	No. Killed
07/29/70	Harrison	Middle Fork Short Creek	18,315
08/25/70	Jefferson	Yellow Creek	765
08/26/70	Meigs	Leading Creek	8
09/11/70	Jackson	Little Raccoon Creek	23
10/26/70	Tuscarawas	Tuscarawas River	54
09/11/68	Jefferson	Cross Creek	3135
05/03/68	Mahoning	Meander Creek	57
08/16/68	Tuscarawas	Tuscarawas River	23
08/11/66	Belmont	Captina Creek	15,591
09/13/66	Carroll	Riley's Creek	84
08/21/66	Coshocton	Mill Creek	3,061
09/22/66	Muskingum	Muskingum River	20,860
08/31/66	Tuscarawas	Sugar Creek	50,680

APPENDIX IV:

Summary of Standards for Mine Drainage Parameters

	Warmwater Habitat	Exceptional Warmwater Habitat	Coldwater Habitat	Public Water Supply
Conductivity	2400 micromhos/cm at 25°C	2400 micromhos/cm at 25°C	2400 micromhos/cm at 25°C	800 micromhos/cm at 25°C monthly average 1200 micromhos/cm at 25°C maximum
Total Dissolved Solids (TDS)	1500 mg/l	1500 mg/l	1500mg/l	500 mg/l monthly average 750 mg/l maximum
pH	within 6.5-9.0 S.U.	within 6.5-9.0 S.U.	within 6.5-9.0 S.U.	No standards
Sulfates	No standards	No standards	No standards	250 mg/l
Iron	1.0 mg/l total	1.0 mg/l total	1.0 mg/l total	0.3 mg/l dissolved
Total Manganese	No standards	No standards	No standards	0.050 mg/l
Total Zinc	See Table 3 Chapter 3745.1 Ohio Administrative Code	0.030 mg/l	0.030 mg/l	5.0 mg/l
Total Aluminum	No standards	No standards	No standards	No standards

Definitions of Water Use Designations and Standards of Mine Drainage Parameters for State of Ohio

3745-1-07 WATER USE DESIGNATIONS

(A) WARMWATER HABITAT

These are waters capable of supporting reproducing populations of fish, normally referred to as warmwater species, and associated vertebrate and invertebrate organisms and plants on an annual basis. These standards will apply outside the mixing zone.

Dissolved Solids - may exceed one but not both of the following:

1500 mg/l (Equivalent 25°C specific conductance values is 2400 micromhos/cm) or

150 mg/l attributable to human activities (Equivalent 25°C specific conductance value is 240 micromhos/cm).

Iron - 1.000 mg/l.

pH - 6.5 to 9.0.

Zinc - not to exceed the concentrations in Table 3 based on total hardness. These values are based on 0.01 x 96 hour LC_{50}.

(B) EXCEPTIONAL WARMWATER HABITAT

These are waters capable of supporting exceptional or unusual populations of fish, normally referred to as warmwater species, and associated vertebrate and invertebrate organisms and plants on an annual basis. These would include waters of exceptional chemical quality that are capable of supporting sensitive species of fish and other aquatic organisms. Waters supporting Salmonid migration and waters having a high diversity of aquatic organisms should be included. These standards will apply outside the mixing zone.

Dissolved Solids - may exceed one but not both of the following:

1500 mg/l (Equivalent 25°C specific conductance values is 2400 micromhos/cm).

150 mg/l attributable to human activities (Equivalent 25°C specific conductance value is 240 micromhos/cm).

Iron - 1.000 mg/l.

pH - 6.5 - 9.0, with no change within that range attributable to man-induced conditions.

Zinc - 0.030 mg/l.

(C) COLDWATER HABITAT

These are waters capable of supporting populations of fish, normally referred to as coldwater species and associated vertebrate and invertebrate organisms and plants on an annual basis. These waters are not necessarily capable of supporting successful reproduction of Salmonids and may be stocked periodically. These standards will apply outside the mixing zone.

Dissolved Solids - may exceed one but not both of the following:

1500 mg/l (Equivalent 25°C specific conductance values is 2400 micromhos/cm) or

150 mg/l attributable to human activities (Equivalent 25°C specific conductance value is 240 micromhos/cm).

Iron - 1.000 mg/l.

pH - 6.5 to 9.0 with no change within that range attributable to man-induced conditions.

Zinc - 0.030 mg/l.

(F) PUBLIC WATER SUPPLY

These are waters that with conventional treatment will be suitable for human intake and meet federal regulations for drinking water.

Dissolved Solids - may exceed one but not both of the following:

500 mg/l as a monthly average nor exceed 750 mg/l at any time (Equivalent 25°C specific conductance values are 800 and 1200 micromhos/cm), or

150 mg/l attributable to human activities (Equivalent 25°C specific conductance value is 240 micromhos/cm).

Iron - 0.3 mg/l (soluble).

Manganese - 0.050 mg/l.

Sulfates - 250.0 mg/l.

Zinc - 5.0 mg/l.

TABLE 3, CHAPTER 3745.1 OF ADMINISTRATIVE CODE

Concentration of Total Copper and Zinc based on Total Hardness

Hardness mg/l as $CaCO_3$	Copper (mg/l)	Zinc (mg/l)
0 - 80	0.005	0.040
81 - 120	0.010	0.055
121 - 160	0.015	0.070
161 - 180	0.020	0.095
181 - 200	0.025	0.115
201 - 220	0.030	0.130
221 - 240	0.040	0.150
241 - 260	0.050	0.175
261 - 280	0.060	0.205
281 - 300	0.075	0.235
301 - 320	0.085	0.275
321 - 340	0.115	0.320
341 and above	0.145	0.365

APPENDIX III - Fish Kills Attributable to Mine Drainage (selected years 1968-78)

Date d m y	County	Stream	No. Killed
07/12/78	Coshocton	Dickinson Run	10,184
08/29/78	Washington	Duck Creek	10
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06/28/76	Jackson	Symmes Creek	596
10/03/76	Pike	Big Run	450
07/23/74	Washington	Duck Creek	13,580
08/08/72	Meigs	Leading Creek	482
09/08/72	Jackson	Symmes Creek	794
07/17/71	Columbiana	Leslie Run	208
07/23/71	Muskingum	Thompson Run	15,741
07/28/61	Athens	Hocking River	17
08/23/71	Noble	W. Fork Duck Creek	224
08/30/71	Washington	Duck Creek	47,250
09/28/71	Noble	E. Fork Duck Creek	32,678
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06/21/70	Mahoning	Meander Creek	120

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APPENDIX III - Fish Kills Attributable to Mine Drainage (selected years 1968-78)

Continued

Date d m y	County	Stream	No. Killed
07/29/70	Harrison	Middle Fork Short Creek	18,315
08/25/70	Jefferson	Yellow Creek	765
08/26/70	Meigs	Leading Creek	8
09/11/70	Jackson	Little Raccoon Creek	23
10/26/70	Tuscarawas	Tuscarawas River	54
09/11/68	Jefferson	Cross Creek	3135
05/03/68	Mahoning	Meander Creek	57
08/16/68	Tuscarawas	Tuscarawas River	23
08/11/66	Belmont	Captina Creek	15,591
09/13/66	Carroll	Riley's Creek	84
08/21/66	Coshocton	Mill Creek	3,061
09/22/66	Muskingum	Muskingum River	20,860
08/31/66	Tuscarawas	Sugar Creek	50,680

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Reservoirs Affected by Mine Drainage in the Hocking River Basin

1) Burr Oak Reservoir - An impoundment of the East Branch of Sunday Creek (Morgan and Athens Counties.

Burr Oak Reservoir, a public water supply, intermittently violates WWH Standards for total iron, PWS Standards for sulfate, dissolved iron and manganese and Exceptional WWH Standards for total zinc. It is not known if these violations are a direct result of the few abandoned mines in the watershed or natural background conditions or other land disturbances such as highway construction. (See Appendix I, Tables H-102 - H-104 and H-110 - H-111)

2) Dotson Run Reservoir - An impoundment of Dotson Run.

The Corning public water supply on Dotson Run violates PWS Standards for total manganese and intermittently violates WWH Standards for pH, total iron and total zinc. These violations may be related to the abandoned mines although other undefined sources may contribute.

3) New Lexington Reservoirs - Impoundments of an unnamed tributary of Rush Creek, north of New Lexington.

The two public water supplies are Old Reservoir and New Reservoir. New reservoir is an auxiliary water supply to Old Reservoir, used at a dilution factor of 4:1. Four (Ohio EPA, 1979) samples taken in New Reservoir exhibit PWS Standards violations for manganese and sulfate and WWH violations for pH. Old Reservoir data indicates PWS Standards are violated for manganese. (See Appendix I, Table H-67).

Table H-66: Rush Creek

Parameter/Unit	Date 23/07/74	First county road below New Lexington STP	Second county road below New Lexington STP
pH (S.U.)		2.9	3.0
Alkalinity ($CaCO_3$)(mg/l)		-	-
Acidity ($CaCO_3$)(mg/l)		475	575
Hardness ($CaCO_3$)		-	-
Residue, Tot. Filt.(mg.l)		2377	2784
Total Sulfate (mg/l)		1150	1490
Total Aluminum (mg/l)		-	-
Total Iron (mg/l)		55.0	70.0
Total Manganese (mg/l)		-	-
Total Zinc (mg/l)		-	-

Source, Ohio EPA, SEDO

Table H-67: New Lexington Public Water Supply

Parameter/Unit	Date 3/79	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)		4	5.6	6.0	4.9
Alkalinity ($CaCO_3$)(mg/l)		4	6.5	9.0	5.0
Acidity ($CaCO_3$)(mg/l)		-	-	-	-
Hardness ($CaCO_3$)		4	351	384	317
Residue, Tot. Filt.(mg.l)		-	-	-	-
Total Sulfate (mg/l)		4	343	380	289
Total Aluminum (mg/l)		4	1.2	2.2	0.3
Total Iron (mg/l)		4	0.17	0.29	0.08
Total Manganese (mg/l)		4	7.4	7.5	0.3
Total Zinc (mg/l)		4	0.2	0.3	0.07

Table H-68: Rush Creek

Watershed Station No.	Stream	pH S.U.	Acidity ppm	Alkalinity ppm	Total Iron ppm	Sulfate ppm
32	Rush Creek	2.7	354	0.0	60.0	210

Source: Stately and Loy, 1973

Table H-101: Little Green's Run 9.9 Miles North of Athens

STORET (1977-78) 110654

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	2	375	400	350
pH (S.U.)	2	6.85	6.9	6.8
Total Alkalinity ($CaCO_3$)(mg/l)	1	90	N/A	N/A
Total Acidity ($CaCO_3$)(mg/l)	2	18	34	3
Total Hardness ($CaCO_3$)	-	-	-	-
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	70	70	70

Table H-102: Burr Oak Lake

STORET (1975) 1TJEW0009

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	2	430	655	205
pH (S.U.)	12	7.1	7.2	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	2	36	47	24
Total Acidity ($CaCO_3$)(mg/l)	-	-	-	-
Total Hardness ($CaCO_3$)	2	159	232	86
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	158	280	35
Total Iron (mg/l)	2	1.25	1.33	1.18
Total Manganese (mg/l)	2	1.4	1.7	1.1
Total Zinc (mg/l)	2	0.1	0.1	0.1
Total Aluminum (mg/l)	-	-	-	-
Total Residue (mg/l)	2	313	495	131
Dissolved Iron (mg/l)	2	0.34	0.58	0.1

Table H-103: Burr Oak Reservoir above Dam near Gouster

STORET (1976) 393226082031900

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	21	185	198	160
pH (S.U.)	21	7.6	8.7	6.5
Total Alkalinity ($CaCO_3$)(mg/l)	4	56	90	41
Total Acidity ($CaCO_3$)(mg/l)	-	-	-	-
Total Hardness ($CaCO_3$)	1	79	N/A	N/A
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	1	42	N/A	N/A
Total Iron (mg/l)	1	0.18	N/A	N/A
Total Manganese (mg/l)	1	0.15	N/A	N/A
Total Zinc (mg/l)	1	0	N/A	N/A
Total Aluminum (mg/l)	-	-	-	-
Total Residue (mg/l)	1	127	N/A	N/A
Filterable Residue 180°C (mg/l)	1	107	N/A	N/A

Table H-104: Burr Oak Lake

STORET (19[illegible]) 1TJEW0004

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	44	230	328	178
pH (S.U.)	44	7.57	8.9	6.9

Table H-105: Cedar Run 3.2 Miles East of Corning

STORET (19[illegible]-78) 110642

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	2	275	310	240
pH (S.U.)	2	7.05	7.1	7.0
Total Alkalinity ($CaCO_3$)(mg/l)	1	51	N/A	N/A
Total Acidity ($CaCO_3$)(mg/l)	1	28	N/A	N/A
Total Hardness ($CaCO_3$)	-	-	-	-
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	47	50	44

Table H-109: East Branch Sunday Creek 4 Miles Southeast of Corning

STORET (1977-78) 110640

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	2	273	320	225
pH (S.U.)	2	7.1	7.2	6.9
Total Alkalinity ($CaCO_3$)(mg/l)	1	62	N/A	N/A
Total Acidity ($CaCO_3$)(mg/l)	1	30	N/A	N/A
Total Hardness ($CaCO_3$)	-	-	-	-
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	46	52	41

Table H-110: Dotson Run 0.7 Miles East of Corning

STORET (1977-78) 110643

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	2	235	250	220
pH (S.U.)	2	6.8	7.0	6.6
Total Alkalinity ($CaCO_3$)(mg/l)	1	10	N/A	N/A
Total Acidity ($CaCO_3$)(mg/l)	2	17	30	4
Total Hardness ($CaCO_3$)	-	-	-	-
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	54	55	53

Table H-111: Corning Public Water Supply

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity (micromhos/cm)	3	165	180	150
pH (S.U.)	3	6.8	7.3	6.4
Total Alkalinity ($CaCO_3$)(mg/l)	3	51	53	40
Total Acidity ($CaCO_3$)(mg/l)	-	-	-	-
Total Hardness ($CaCO_3$)	3	83	106	62
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	3	34	78	29
Total Iron (mg/l)	3	0.8	1.4	0.28
Total Manganese (mg/l)	3	0.49	0.64	0.22
Total Zinc (mg/l)	3	0.07	-	-
Total Aluminum (mg/l)	3	0	0	0
Total Dissolved Solids (mg/l)	3	146	204	100

Source: Ohio EPA, Public Water Supply, 1974-77.

Central Tributaries List of Potential Mine Drainage or
Mine Drainage Lakes and Reservoirs

Jefferson Lake (an impoundment of Town Fork, a tributary of Yellow Creek, Jefferson County).

There is no available water quality data for Jefferson Lake or Town Fork from either STORET, Ohio EPA or Skelly and Loy. There are abandoned surface coal mines along the drainage divide which range from poor to fair in degree of reclamation. In the East Springfield area there are several large abandoned underground mines, one of which is mostly in the Town Creek drainage and about 1/2 square mile in area. The lake may be affected by abandoned coal mine drainage but to what extent is unknown.

Austin Lake (an impoundment of Town Fork, a tributary of Yellow Creek, Jefferson County).

About three miles downstream from Jefferson Lake on Town Fork lies Austin Lake. There is no water quality data available from STORET, Ohio EPA or Skelly and Loy. There are several abandoned surface coal mines located along the drainage divide of Austin Lake and Jefferson Lake. The lake may be affected by abandoned coal mine drainage but to what extent is unknown.

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LAKES AND RESERVOIRS AFFECTED BY MINE DRAINAGE
IN THE SOUTHEAST OHIO RIVER TRIBUTARIES BASIN

1. Lake Alma - An impoundment of Little Raccoon Creek, Vinton County

   This reservoir may be affected by acid mine drainage because Little Raccoon Creek below the Lake Alma Spillway violates WWH standards for pH (see Appendix I, Table S-9). However, no water quality data was available for the reservoir.

2. Lake Hope - An impoundment of Sandy Run, a tributary to Raccoon Creek, Vinton County.

   Water quality in Lake Hope violates WWH standards for pH and total iron (See Appendix I, Table S-58). Manganese concentrations in the reservoir exceed PWS standards. See the narrative description of Raccoon Creek Tributaries.

3. Jackson Lake - An impoundment of the Black Fork of Symmes Creek, Jackson County.

   Black Fork, the major source of water for Jackson Lake only slightly exceeds WWH standards for pH and total iron. The reservoir does not appear to be seriously affected (See Appendix I, Table S-114), however, this reservoir has very low alkalinities such that continued contributions of acid water from mining or atmospheric sources will detrimentally affect the water quality and usage of the reservoir.

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Table S-8: Little Raccoon Creek Near Vinton, Ohio

STORET (1972-74) 03201990

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	3	655.3	770	430
pH (S.U.)	3	3.76	3.8	3.7
Total Alkalinity ($CaCO_3$)(mg/l)	3	0	0	0
Total Acidity ($CaCO_3$)(mg/l)	3	58	84	30
Total Hardness ($CaCO_3$)(mg/l)	2	220	300	140
Non-carbonate Hardness ($CaCO_3$)(mg/l)	2	220	300	140
Total Sulfate (mg/l)	3	300	370	170
Total Iron (mg/l)	1	0.38	0.38	0.38
Total Manganese (mg/l)	1	3.8	3.8	3.8
Total Zinc (mg/l)	-	-	-	-
Total Aluminum (mg/l)	-	-	-	-
Total Residue (mg/l)	1	571	N/A	N/A
Dissolved Residue 180°C (mg/l)	1	468	N/A	N/A

N/A - Not applicable

Table S-9: Little Raccoon Creek near Wellston

STORET (1975) 390038082270900

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	700
pH (S.U.)	1	3.7
Total Alkalinity ($CaCO_3$)(mg/l)	1	0
Total Acidity ($CaCO_3$)(mg/l)	1	94
Total Hardness ($CaCO_3$)(mg/l)	1	290
Non-carbonate Hardness ($CaCO_3$)(mg/l)	1	290
Total Sulfate (mg/l)	1	290
Total Iron (mg/l)	1	1.0
Total Manganese (mg/l)	1	6.0
Total Zinc (mg/l)	1	0.2
Total Aluminum (mg/l)	1	8.8

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Table S-55: Lake Hope above Dam near Zaleski

STORET (1975, 1978) 391914082211800

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	25	153	180	137
pH (S.U.)	25	5.3	7.5	4.2
Total Alkalinity ($CaCO_3$)(mg/l)	-	-	-	-
Total Acidity ($CaCO_3$)(mg/l)	-	-	-	
Total Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	2	52.5	54	51
Total Iron (mg/l)	3	7.9	23	0.21
Total Manganese (mg/l)	3	1.1	2.4	0.41
Total Zinc (mg/l)	3	0.023	0.03	0.01
Total Aluminum (mg/l)	-	-	-	-

Table S-56: Hewett Fork at Mouth

Station 381623

Surface Water Quality
Physical and Chemical Data

Parameter	Number of Samples	Maximum Value	Minimum Value	Arithmetic Mean
Temperature (C)	12	20.0	6.0	12.7
pH (S.U.)	10	4.7	2.8	3.5
Conductivity*	12	1620	290	1025
Flow (cfs)	12	76.0	0.3	23.7

Chemical Observations

	Number of Samples	Maximum Value (mg/l)	Minimum Value (mg/l)	Mean Value (mg/l)	Maximum Value (lb/day)	Minimum Value (lb/day)	Mean Value (lb/day)
Acidity	12	300	35	151	14600	485	7220
Alkalinity	12	0	0	0	0	0	0
Hardness	12	396	112	249	45900	608	19900
Sulfate	12	1200	78	439	64200	1070	28400
Total Iron	12	10.7	4.1	7.2	4390	10	1060
Manganese	12	6.4	1.2	3.8	492	10	215

Source: FWPCA, 1967
*-micromhos/centimeter

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Table S-114: Jackson Lake above Dam at Site L-1

STORET (1978) 385331082360500

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	8	178	310	143
pH (S.U.)	8	7.05	7.7	6.2
Total Alkalinity ($CaCO_3$)(mg/l)	2	15.5	18	13
Total Acidity ($CaCO_3$)(mg/l)	-	-	-	-
Total Hardness ($CaCO_3$)	1	53	N/A	N/A
Non-carbonate Hardness ($CaCO_3$)(mg/l)	-	-	-	-
Total Sulfate (mg/l)	1	47	N/A	N/A
Dissolved Iron (mg/l)	1	0.52	N/A	N/A
Dissolved Manganese (mg/l)	1	0.95	N/A	N/A
Total Zinc (mg/l)	1	0.01	N/A	N/A
Total Aluminum (mg/l)				

N/A - Not applicable

draft

Potential Mine Drainage and Proposed Mine Drainage Lakes and Reservoirs
Muskingum Basin

1. Atwood Reservoir (Indian Fork, Conotton Creek, Tuscarawas County).

There are abandoned mines and small underground mines in the tributaries. Insufficent water quality data exists at this time to ascertain to what degree the Reservoir is affected by abandoned coal mine drainage (See Appendix I, Tables M-100 - M-105). In the one sample from the Reservoir which was analyzed for more than zinc, only manganese concentrations exceeded PWS Standards. A sample from a site on Indian Fork above Atwood Dam, however, had concentrations which violated pH, total iron and total zinc WWH Standards part of the time and PWS Standards for total manganese all of the time, indicating mine drainage problems.

2. Beach City Reservoir (Sugar Creek, Tuscarawas River, Tuscarawas County).

There are abandoned strip mines and small underground mines in the tributaries. Insufficent water quality data exists at this time to ascertain to what degree the reservoir is affected by abandoned coal mine drainage. Data consists of one sample in which zinc was the only mine drainage parameter measured. Zinc concentrations did not exceed PWS Standards but because it was only known to be less that 0.1 mg/l it is not known whether it violates EWH Standards.

3. Cambridge Reservoir (Unnamed tributary to Wills Creek, Guernsey County).

There are large abandoned underground mines in this small watershed which underlie most of its drainage area. There is no water quality data available for the reservoir in STORET.

4. Clendening Reservoir (Brushy Fork of Stillwater Creek, Harrison County).

There are many extensive abandoned strip mines and a few small underground mines in the headwaters of Brush Fork. In the Reservoir, pH, total iron, and total zinc concentrations violate EWH Standards part of time. However, the pH violations are unusual in that they are above 9.0 S.U. PWS Standards are alos exceeded by concentrations of total sulfate, dissolved iron, and total manganese. Brushy Fork above Clendenin Lake violates PWS Standards for levels of conductivity and total sulfate (See Appendix I, Tables M-106 - M-109). More data is needed to ascertain to what extent this reservoir is affected and the sources of mine drainage in its tributaries.

5. Dillon Reservoir (Licking River, Muskingum County).

There are very few abandoned surface or underground coal mines in this watershed. Concentrations of total iron, and pH values (below 6.5 S.U.) violate EWH Standards in the reservoir and total manganese concentrations exceed PWS Standards (See Appendix I, Tables M-105 and M-106. Water quality problems, however, may not be related to abandoned coal mines, as Clear Fork*, a tributary with no abandoned mines in its watershed, has concentrations of total iron which violate WWH Standards and manganese concentrations which exceed PWS Standards. Too little data is available from other tributaries to reach any definite conclusions (See Appendix I, Tables M-110 - M-113). It would appear that Dillon Reservoir is not or is only minimally affected by abandoned coal mine drainage, but it may be affected by other sources.

6. Leesville Reservoir (McGuire Creek of Stillwater Creek, Carroll County).

There is a concentration of small abandoned surface and underground coal mines in the northwest tributaries of the Reservoir. The concentrations of total iron in the reservoir violate EWH Standards part of the time and total manganese concentrations exceed PWS Standards all of the time. To what extent this is due to abandoned mine drainage is unknown. The North Fork of McGuire Creek also has violations of WWH Standards part of the time and total manganese concentrations exceed PWS Standards all of the time (See Appendix I, Tables M-114 - M-118). The sources of possible mine drainage in this basin should be investigated.

7. Ohio Power Recreational Area (Dyes Fork, Meigs Creek, Morgan County).

This area has been extensively strip mined and some reclamation work has been done by planting trees. The lakes and ponds are strip pit ponds and dammed reservoirs. Both have been stocked with a variety of fish and fishing is reported to be good in many of the ponds. No water quality data is available in STORET. The water quality data on Dyes Fork indicates high sulfate, hardness and TDS values would be expected in the ponds, but whether TDS would violate EWH Standards is questionable.

8. Piedmont Reservoir (Stillwater Creek, Harrison County).

The headwaters and tributary watersheds of Piedmont Reservoir have been extensively stip mined and a large percentage of the watershed contains abandoned strip mines. Mine drainage constituent concentrations in Piedmont Lake (See Appendix I, Table M-82 and M-119) do not violate any EWH Standards for the site located in the dam.

Piedmont Reservoir, however, has been exempted from the classification of Public Water Supply because of abandoned coal mine drainage and the concentrations of total conductivity, sulfates, total manganese and TDS would exceed PWS Standards. Water quality data for Piedmont Reservoir tributaries show violations of WWH Standards for total iron concentrations and occasionally pH values and total manganese, total sulfates, and conductivity concentrations would exceed PWS Standards (see Appendix I, Tables M-69 - M-77).

Benthic collections were made at two stations in Piedmont Reservoir in 1973-74; near the spillway, and at the inflow of Stillwater Creek. The method of collection was not reported.

Large differences occurred in the density and variety of the benthic community in 1974 between the two stations. The benthic community near the spillway was comprised of predominantly pollution facultative forms except on one date (Appendix, I Table M-119b), while the station at the source was comprised of fewer taxa and number of predominantly pollution tolerant groups.

The gradient of quality of the benthic community may be inversely related to the gradient of mining activities in the Piedmont Reservoir watershed.

Biological Parameters

Station		Benthic invertebrates/ Pollution Tolerant	% Facultative	% Pollution Sensitive	No. of Taxa	Water Quality Class	Total No. Organisms
[8,14]Piedmont Reservoir Reservoir near spillway	01/08/73	lt 0.1	96	3.99	14	-	632
	23/08/73		99.6	0.4	11	-	273
	26/09/73	2.4	95.4	2.2	15	-	503
	31/10/73	0.6	98.5	0.9	13	-	347
	18/12/73	8.3	91.1	0.6	17		1181
	31/01/74	0	97.3	2.7	8	-	112
	27/03/74	72.5	27.5	0	5	-	40
	01/05/74	1.2	66.2	33.6	21	-	414
[8,14]Piedmont Reservoir near inflow source at C.R. 100	30/07/73		100		3		17
	30/07/73	96.7	3.2	0	2	-	31
	28/08/73	91.7	0	8.3	2	-	12
	24/09/73	81.8	9.7	9.1	4		11
	31/10/73	72.1	27.9	0	3	-	43
	28/11/73	97.8	2.2	0	7	-	89
	31/01/74	100.0	0	0	7	-	126
	27/03/74	98.4	1.6	0	4	-	184
	01/05/74	100	0	0	1	-	34

14 Method of sampling not reported.
8 Corps of Engineers, National Eutrophication Study, 1974. (Sampled in 1973).
lt - less than

9. Salt Fork Reservoir (Salt Fork is a tributary of Wills Creek, Muskingum County).

pH values in Salt Fork Reservoir slightly exceed EWH Standards part of the time. PWS Standards are exceeded by total manganese concentrations probably all of the time and EWH Standards are exceeded by total zinc concentrations all of the time (See Appendix I, Tables M-120 - M-122). Whether these conditions are a result of abandoned mines is questionable. Some Salt Fork tributaries (See Appendix I, Tables M-140*, M-141*, M-151*) have no abandoned coal mines and also have total manganese concentrations exceeding PWS Standards. Salt Fork headwater tributaries (See Appendix I, Tables M-123 - M-151) have concentrations violating total iron and pH WWH Standards part of the time and the region has many surface mines in the Pittsburgh coal. Salt Fork below Salt Fork Reservoir does not appear to be severely affected by abandoned coal mine drainage, but fluctuations in total sulfate concentrations suggest slugging (See Appendix I, Tables M-152 and M-153).

10. Senecaville Reservoir (Seneca Fork of Wills Creek, Guernsey County).

There are many abandoned surface mines in the watershed, particularly on Beaver Creek. pH values in Seneca Fork violate EWH Standards part of the time and in the South Fork of Seneca Fork total iron EWH Standards are violated, however, there are no abandoned coal mines on South Fork (Tables M-154 - M-157). Manganese concentrations exeeded PWS standards in 16 out of 17 samples in the Seneca Fork and South Fork data. More data is needed to determine if Senecaville Reservoir is affected by abandoned mine drainage.

11. Tappan Reservoir (Little Stillwater Creek, Harrison County).

The Tappan Reservoir tributaries watersheds contain many large surface mines in the Pittsburgh No. 8 coal. pH, total iron and total zinc concentrations in Tappan Reservoir violate EWH Standards part of the time and total manganese, total sulfate and dissolved iron concentrations violate PWS Standards. (see Appendix I, Tables M-158 - M-168). Samples from Tappan Lake tributaries showed no violations of WWH Standards (See Appendix I, Tables M-169 - M-171). More water quality data is necessary to assess the effects of abandoned coal mine drainage on Tappan Reservoir.

12. Wills Creek Reservoir (Wills Creek, Coshocton County).

Wills Creek Reservoir is on the mainstem of Wills Creek, a proposed Mine Drainage stream. It also has numerous tributaries which are either proposed as Mine Drainage or are potential mine drainage streams. Despite this, water quality is relatively quite good. Total iron is the only mine drainage parameter which violates EWH Standards and only total manganese concentrations exceed PWS Standards (see Appendix I, Tables M-172 and M-173); however, this data may not reflect the slugging which possibly takes place.

13. Zanesville Honor Camp Pond (Unnamed tributary of Blount Creek, Muskingum County).

This camp's pond drains a large strip mined area with rather poor reclamation. No water quality data is available. The pond has unknown uses and it is not known if water quality in any way inhibits its usage.

14. Zoar Wildlife Area (Lime Kilm Lake, Unnamed Tributary of Tuscarawas River, Tuscarawas County).

The lake drains an area of strip mines with rather poor reclamation. No water quality data is available. The Lake has unknown uses and it is not known if water quality in any way inhibits its usage.

Table M-69: Big Run Creek and Tributary

Parameter/Unit	P11/03C Big Run Creek	P11/04C Tributary to Big Run Creek
pH (S.U.)	3.4	6.5
Alkalinity ($CaCO_3$)(mg/l)	0	23
Acidity ($CaCO_3$)(mg/l)	20	8
Hardness ($CaCO_3$)(mg/l)	-	-
Residue, Total Filterable (mg/l) (Dissolved)	-	-
Total Sulfate (mg/l)	580	432
Total Aluminum (mg/l)	-	-
Total Iron (mg/l)	-	2.02
Total Manganese (mg/l)	5	4.06
Total Zinc (mg/l)	-	0.08
Conductivity at 25°C (umhos/cm)	900	700

Source: Ohio EPA, Title X Study, 1976.

Table M-70: Stillwater Creek above Piedmont Lake

STORET (1977) 400543081075600

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	1135	1100	1090
pH (S.U.)	2	7.7	7.8	7.6

Table M-71: Spencer Creek at Hendrysburg, Ohio

STORET (1975-1977) 400321081091300

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	3	7.8	8.0	7.7
Total Alkalinity ($CaCO_3$)(mg/l)	3	160	203	136
Total Hardness ($CaCO_3$)(mg/l)	2	545	650	440
Total Sulfate (mg/l)	2	365	410	320
Total Iron (mg/l)	2	7.7	15	0.3
Total Manganese (mg/l)	2	0.76	1.2	0.31
Total Zinc (mg/l)	2	0.11	0.17	0.05
Total Aluminum (mg/l)	2	0.89	1.6	0.18

Table M-72: Six Mile Run above Piedmont

STORET (1977) 400744081083100

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	1368	1410	1325
pH (S.U.)	2	8.1	8.2	8.0

Table M-73: South Fork near Flushing, Ohio

STORET

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	2	7.9	8.0	7.8
Total Alkalinity ($CaCO_3$)(mg/l)	2	227	233	220
Total Hardness ($CaCO_3$)(mg/l)	2	1950	2100	1800
Total Sulfate (mg/l)	2	1225	1250	1200
Total Iron (mg/l)	2	0.25	0.28	0.21
Total Manganese (mg/l)	2	0.46	0.50	0.42
Total Zinc (mg/l)	2	0.02	0.03	0.01
Total Aluminum (mg/l)	2	0.14	0.18	0.10

Table M-74: Spencer Creek station 1 near Hendrysburg

STORET (1976-1977) 400223081093300

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	2	7.9	7.9	7.8
Total Alkalinity ($CaCO_3$)(mg/l)	2	128	141	115
Total Hardness ($CaCO_3$)(mg/l)	1	240	N/A	N/A
Non-carbonate Hardness ($CaCO_3$)(mg/l)				
Total Sulfate (mg/l)	2	180	230	130
Total Iron (mg/l)	2	8.12	16.0	0.23
Total Manganese (mg/l)	1	0.82	N/A	N/A
Total Zinc (mg/l)	1	0.08	N/A	N/A
Total Aluminum (mg/l)	1	1.7	N/A	N/A

Table M-75: Spencer Creek Station 3 near Hendrysburg

STORET (1976) 400502081080800

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos/cm)	1	7.6
Total Alkalinity ($CaCO_3$)(mg/l)	1	135

Table M-76: Sixteen Valley Creek near Hendrysburg

STORET (1975) 400544081094200

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos/cm)		
pH (S.U.)	1	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	1	108
Total Hardness ($CaCO_3$)(mg/l)	1	1300
Total Sulfate (mg/l)	1	1100
Total Iron (mg/l)	1	0.24
Total Manganese (mg/l)	1	0.37
Total Zinc (mg/l)	1	0.02
Total Aluminum (mg/l)	1	0.22

Table M-77: Summary of Water Quality of Selected Piedmont Lake Tributaries 1967-1973

Station / Parameter (Units)	BTH-1				BTH-2				BTH-3				BTH-4				BTH-9				BT-2			
	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N
pH (S.U.)	8.9	6.8	7.5	81	8.0	6.8	7.2	79	8.1	7.0	7.5	80	8.1	7.0	7.6	80	8.3	7.0	7.6	82	8.0	7.0	7.6	58
Suspended Solids (mg/l)	500	5	46	70	4250	2	85	69	1300	1	70	74	342	4	67	73	652	2	63	71	1494	0	34	49
Total Iron (mg/l)	19.4	0.1	1.4	81	74.1	0.0	2.0	69	30.0	.0	1.8	80	10.2	0.0	1.5	80	17.2	0.0	1.2	82	33.6	0.0	0.8	58
Sulfate (mg/l)	930	100	359	80	1550	31	552	80	950	100	356	80	950	38	241	80	1010	86	383	82	1555	448	910	58
Total Alkalinity (mg/l)	220	70	157	81	245	54	143	80	230	115	163	80	300	63	196	82	300	63	196	82	240	77	167	58
Specific Conductance (µmhos)	1500	860	1287	11	2350	1500	1828	112	1550	620	1136	14	1600	690	1028	12	1700	1120	1422	12	1900	1160	1508	5

Source: Ohio EPA files, 1967-1973

BTH-1 Head End Piedmont Lake at Belmont C.R. 100; Stillwater Creek
BTH-2 Sixteen Valley Creek at Belmont C.R. 100
BTH-3 Stillwater Creek at Belmont C.R. 100
BTH-4 Stillwater Creek at Kirkwood T.R. 343
BT-2 Sixmile Run at Mouth, Flushing T.R. 366

Table M-77: Summary of Water Quality of Selected Piedmont Lake Tributaries 1967-1973 (Continued)

Station / Parameter (Units)	BT-3				BTH-5				BTH-6				BTH-7				BTH-8			
	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N	Max	Min	Avg	N
pH (S.U.)	8.3	6.9	7.6	74	8.1	7.0	7.6	80	8.2	6.8	76	81	8.0	3.8	7.2	81	8.1	6.7	7.6	82
Suspended Solids (mg/l)	796	0	53	60	342	4	67	73	392	0	43	73	1025	0	89	71	576	0	45	82
Total Iron (mg/l)	15.1	0.0	1.2	74	10.2	0.0	1.5	80	14.5	0	1.3	82	140	0.0	10.6	80	27.5	0.0	1.1	82
Sulfate (mg/l)	1160	31	196	74	950	38	241	80	840	40	200	82	1339	174	494	81	409	8	150	82
Total Alkalinity (mg/l)	295	77	207	74	220	81	166	80	1740	100	188	82	200	4	121	81	708	101	162	82
Specific Conductance (micromhos/cm)	2050	460	1508	12	1600	640	1028	12	1400	670	830	12	1800	840	1306	12	900	550	700	12

Source: Ohio EPA files, 1967-1973

BT-3 Unnamed tributary at Mouth, Belmont C.R. 100
BTH-5 Spencer Creek at Mouth T.R. 343
BTH-6 Spencer Creek just below I-70
BTH-7 Stillwater Creek at U.S. Route 40
BTH-8 Spencer Creek off S.R. 800 just above I-70

Table M-78: Piedmont Lake Tributaries

Watershed 49	Stream	pH S.U.	Acidity ppm	Alkalinity ppm	Total Iron ppm	Sulfate ppm
Station No.						
15	Stillwater Creek	6.5	0	156	2.0	530
16	Unnamed Tributary	6.9	0	156	2.0	530

Source: Skelly and Loy, 1973.

Table M-79: Skull Fork near Londonderry

STORET (1975) 400527081163600

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	2	7.4	7.6	7.2
Total Alkalinity ($CaCO_3$)(mg/l)	2	84	95	72
Total Hardness ($CaCO_3$)(mg/l)	2	1250	1400	1100
Total Sulfate (mg/l)	2	1010	1020	1000
Total Iron (mg/l)	2	2.1	3.9	0.29
Total Manganese (mg/l)	2	9.7	10	9.3
Total Zinc (mg/l)	2	0.19	0.23	0.15
Total Aluminum (mg/l)	2	5.0	9.2	0.76

Table M-M82b: Biological Data for Selected Stations on Stillwater Creek

	Stillwater Creek at Bethesda			Stillwater Creek at Freeport	Stillwater Creek South of Dennison	Stillwater above mouth
	NA	MA	SA			
Tricoptera						
Hydropsydiidae	186	767	1	2		
Hydroptilidae		2				
Psychomyiidae	19	1				
Plectoptera						
Nemouridae	3					
Ephemeroptera						
Baetidae		10				
Ephemeridae					12	4
Odonata						
Giomphidae						
Megaloptera						
Coryalidae						
Ephemeroptera						
Baetidae						
Diptera						
Ceratopogonidae	14	15				
Anthomyiidae	5					
Rhagionidae	4		7			
Simulidae	3	161	1			
Tabanidae	1					
Tenidpedidae	42	16	4	16	8	12
Tipulidae	22					

Table M-M82b: Biological Data for Selected Stations on Stillwater Creek (Continued)

	Stillwater Creek at Bethesda			Stillwater Creek at Freeport	Stillwater Creek South of Dennison	Stillwater above mouth
	NA	MA	SA			
Coleoptera						
Baetidae				4		
Elmidae						4
Pulmonata				1		
Oligochaeta				10		316
Total Number	299	972	13	33	20	336
No./Sq.Ft.	33.2	108	3.2	17	20	336
No. Taxa	10	7	4	5	2	4
% Pollution Tolerant	21.4	1.6	30.8	30	0	94
% Pollution Facultative	9.0	18.1	61.5	64	40	5
% Pollution Sensitive	69.6	80.3	7.7	6	60	1

Table M-83: Stillwater Creek in Pool below Piedmont Reservoir

STORET (1973-77) 1PESW002

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	168	6.8	8.9	-
Total Alkalinity ($CaCO_3$)(mg/l)	85	40	148	-
Total Acidity ($CaCO_3$)(mg/l)	18	6	8	2
Total Hardness ($CaCO_3$)(mg/l)	67	527	620	52
Total Sulfate (mg/l)	37	481	700	89
Total Iron (mg/l)	69	0.307	3.61	0.09
Total Manganese (mg/l)	68	539	8.15	0.02
Total Zinc (mg/l)	28	0.108	0.31	0.10
Total Aluminum (mg/l)	20	0.595	2.4	0.50
Total Residue (mg/l)	68	841	1817	433
Total Volatile Residue (mg/l)	34	150	288	73
Non-filterable Residue (mg/l)	51	25	975	0
Filterable Residue (mg/l) at 180°C	17	799	826	756
Dissolved Iron (mg/l)	60	0.109	0.50	0.05
Dissolved Zinc (mg/l)	23	0.1	0.1	0.1
Dissolved Aluminum (mg/l)	19	0.50	0.50	0.50

Table M-84: Stillwater Creek at Selected Stations

Watershed 49 Stream		pH S.U.	Acidity ppm	Alkalinity ppm	Total Iron ppm	Sulfate ppm
Station No.						
1	Stillwater Creek	6.2	0	119	0.6	670
1	Stillwater Creek	6.9	0	115	0.9	560
9	Stillwater Creek	7.0	0	126	0.3	480

Source: Skelly and Loy, 1973

Table M-85: Sugar Creek

Watershed 63 Stream		pH S.U.	Acidity ppm	Alkalinity ppm	Total Iron ppm	Sulfate ppm
Station No.						
3	Sugar Creek	7.0	0	86	3.0	350
4	Sugar Creek	7.0	0	99	3.0	500

Source: Skelly and Loy, 1973

Table M-99: Wills Creek

Watershed 42	Stream	pH S.U.	Acidity ppm	Alkalinity ppm	Total Iron ppm	Sulfate ppm
Station No.						
1	Wills Creek	7.0	0	99	1.2	172
4	Wills Creek	7.0	0	97	0.6	250
5	Wills Creek	6.8	0	104	1.6	360
12	Wills Creek	6.8	0	120	1.8	460

Table M-100: Atwood Lake above Dam near New Cumberland

STORET (1976) 403141081165900

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	19	243	285	220
pH (S.U.)	19	7.3	8.0	6.7
Total Alkalinity ($CaCO_3$)(mg/l)	4	46	72	30
Total Hardness ($CaCO_3$)(mg/l)	1	74	N/A	N/A
Total Sulfate (mg/l)	1	34	N/A	N/A
Total Iron (mg/l)	1	0.27	N/A	N/A
Total Manganese (mg/l)	1	0.2	N/A	N/A
Total Zinc (mg/l)	1	0.02	N/A	N/A
Total Residue (mg/l)	1	161	N/A	N/A
Filterable Residue (mg/l) at 180°C	1	139	N/A	N/A

Table M-101: Atwood Reservoir

STORET (1976) 1ATIW006

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Total Zinc (mg/l)	7	0.1	0.1	0.1

Table M-102: Atwood Reservoir on Indian Fork

STORET (1974-1976) 1ATIW0002

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Total Zinc (mg/l)	21	0.1	0.1	0.1

Table M-103: Willow Run above Atwood Lake at Dellroy

STORET (1976) 403414081114400

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	3	338	475	270
pH (S.U.)	3	7.07	7.1	7.0

Table M-104: Indian Fork above Atwood Dam

STORET (1974-1977) 1AT1W003

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	19	330	483	178
pH (S.U.)	18	7.1	7.6	6.4
Total Alkalinity ($CaCO_3$)(mg/l)	12	72	113	31
Total Hardness ($CaCO_3$)(mg/l)	19	103	130	60
Total Sulfate (mg/l)	19	41	52	32
Total Iron (mg/l)	20	1.87	4.8	0.64
Total Manganese (mg/l)	20	0.37	0.68	0.11
Total Zinc (mg/l)	12	0.135	0.5	0.1
Total Aluminum (mg/l)	6	0.93	2.5	0.5
Total Residue (mg/l)	19	249	401	132
Dissolved Iron (mg/l)	14	0.11	0.17	0.1

Table M-105: Indian Fork above Atwood Lake at Dellroy

STORET (1976) 403304081102800

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	407	510	305
pH (S.U.)	2	7.15	7.3	7.0

Table M-106: Clendening Reservoir

STORET (1974-1978) 1CLBW0002

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	181	677	900	494
pH (S.U.)	181	7.8	9.2	6.6
Total Alkalinity ($CaCO_3$)(mg/l)	19	76	128	7
Total Hardness ($CaCO_3$)(mg/l)	54	357	478	247
Total Sulfate (mg/l)	51	283	431	52
Total Iron (mg/l)	55	0.26	1.06	0.1
Total Manganese (mg/l)	55	0.74	3.6	0.02
Total Zinc (mg/l)	30	0.11	0.35	0.1
Total Aluminum (mg/l)	24	0.5	0.5	0.5
Total Residue (mg/l)	50	551	736	198
Dissolved Iron (mg/l)	50	0.129	0.555	0.1

Table M-107: Clendening Lake above Dam at Tippecanoe

STORET (1976) 401612081164000

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	20	684	810	605
pH (S.U.)	20	7.9	8.6	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	4	100	180	67
Total Hardness ($CaCO_3$)(mg/l)	1	310	N/A	N/A
Total Sulfate (mg/l)	1	240	N/A	N/A
Total Iron (mg/l)	1	0.11	N/A	N/A
Total Manganese (mg/l)	1	0.67	N/A	N/A
Total Zinc (mg/l)	1	0.01	N/A	N/A
Total Residue (mg/l)	1	480	N/A	N/A
Filterable Residue (mg/l) at 180°C	1	452	N/A	N/A

Table M-108: Brushy Fork above Clendening Lake

STORET (1976) 401457081085800

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	1950	2100	1800
pH (S.U.)	2	7.9	8.0	7.8

Table M-109: Brushy Fork near Cadiz

STORET (1979) 401505081061800

Parameter/Unit	No. of Samples	Value
Conductivity at 25oC (umhos/cm)	1	2150
pH (S.U.)	1	8.1
Total Alkalinity ($CaCO_3$)(mg/l)	1	202
Total Sulfate (mg/l)	1	1200
Total Iron (mg/l)	1	0.15
Total Manganese (mg/l)	1	0.12
Dissolved Iron (mg/l)	1	0.01

Table M-110: Dillon Lake above Dam near Zanesville

STORET (1977) 395939082050500

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	21	372	475	290
pH (S.U.)	21	7.5	8.2	6.9
Total Alkalinity ($CaCO_3$)(mg/l)	4	101	123	82
Total Hardness ($CaCO_3$)(mg/l)	1	130	N/A	N/A
Total Sulfate (mg/l)	1	33	N/A	N/A
Total Iron (mg/l)	1	1.3	N/A	N/A
Total Manganese (mg/l)	1	0.04	N/A	N/A
Total Zinc (mg/l)	1	0.01	N/A	N/A
Total Residue (mg/l)	1	260	N/A	N/A
Filterable Residue (mg/l) at 180oC	1	199	N/A	N/A

Table M-111: Licking River in Pool above Dam

STORET (1973-1976) 1DIL002

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	100	429	600	240
pH (S.U.)	94	7.7	9.4	4.0
Total Alkalinity ($CaCO_3$)(mg/l)	41	119	159	0
Total Acidity ($CaCO_3$)(mg/l)	19	5.4	8	3
Total Hardness ($CaCO_3$)(mg/l)	54	186	265	116
Total Sulfate (mg/l)	26	51	74	22
Total Iron (mg/l)	55	2.4	18	0.1
Total Manganese (mg/l)	55	0.18	1.2	0.02
Total Zinc (mg/l)	19	0.1	0.11	0.1
Total Aluminum (mg/l)	16	1.21	6.5	0.5
Total Residue (mg/l)	54	311	550	197
Filterable Residue (mg/l) at 180oC	6	314	379	209
Dissolved Iron (mg/l)	52	0.098	0.2	0.05

Table M-112: Big Run above Dillon Lake near Zanesvilles

STORET (1977) 400222082050800

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	322	325	320
pH (S.U.)	2	7.1	7.4	6.8

Table M-113: Clear Fork near Birmingham

STORET (1975) 400932081265200

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	2	500	740	260
pH (S.U.)	2	7.2	7.4	7.0
Total Alkalinity ($CaCO_3$)(mg/l)	2	93	113	73
Total Hardness ($CaCO_3$)(mg/l)	2	170	200	140
Non-carbonate Hardness ($CaCO_3$)(mg/l)	2	77	87	67
Total Sulfate (mg/l)	2	34	41	28
Total Iron (mg/l)	2	0.82	1.1	0.53
Total Manganese (mg/l)	2	0.235	0.340	0.130
Total Zinc (mg/l)	2	0.01	0.01	0.01
Total Aluminum (mg/l)	2	0.16	0.29	0.02

Table M-114: Leesville Lake above dame near Leesville

STORET (1976) 402814081113500

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	21	167	202	155
pH (S.U.)	21	7.4	8.1	6.5
Total Alkalinity ($CaCO_3$)(mg/l)	4	48	89	31
Total Hardness ($CaCO_3$)(mg/l)	1	63	N/A	N/A
Total Sulfate (mg/l)	1	29	N/A	N/A
Total Iron (mg/l)	1	0.4	N/A	N/A
Total Manganese (mg/l)	1	0.39	N/A	N/A
Total Zinc (mg/l)	1	0.02	N/A	N/A
Total Residue (mg/l)	1	116	N/A	N/A
Dissolved Residue 180°C (mg/l)	1	96	N/A	N/A

Table M-115: McGuire creek above Dam

STORET (1974-1976) 1LEMW0004021

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	11	219	311	165
pH (S.U.)	11	7.05	7.6	6.5
Total Alkalinity ($CaCO_3$)(mg/l)	6	65	84	37
Total Hardness ($CaCO_3$)(mg/l)	10	90	111	54
Total Sulfate (mg/l)	10	26	33	18
Total Iron (mg/l)	10	1.16	3.3	0.39
Total Manganese (mg/l)	10	0.297	0.62	0.07
Total Zinc (mg/l)	4	0.1	0.1	0.1
Total Aluminum (mg/l)	5	0.5	0.5	0.5
Total Residue (mg/l)	10	142	202	58
Dissolved Iron (mg/l)	4	0.125	0.2	0.1

Table M-116: McGuire Creek above Leesville Lake

STORET (1976) 402828081063400

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	2	280	325	235
pH (S.U.)	2	7.4	7.4	7.4

Table M-117: North fork McGuire Creek above Leesville Lake

STORET (1976) 403044081073400

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	2	307	365	250
pH (S.U.)	2	7.5	7.5	7.5

Table M-118: North Fork of McGuire Creek

STORET (1974-1976) 1LEMW0003

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	9	243	300	170
pH (S.U.)	9	7.3	7.8	6.5
Total Alkalinity ($CaCO_3$)(mg/l)	6	72	87	52
Total Hardness ($CaCO_3$)(mg/l)	10	96	115	60
Total Sulfate (mg/l)	10	29	36	23
Total Iron (mg/l)	10	0.76	1.8	0.5
Total Manganese (mg/l)	10	0.17	0.35	0.065
Total Zinc (mg/l)	4	0.1	0.1	0.1
Total Aluminum (mg/l)	4	0.5	0.5	0.5
Total Residue (mg/l)	10	146	187	101
Dissolved Iron (mg/l)	4	0.145	0.28	0.1

Table M-119: Piedmont Lake above Dam at Piedmont, Ohio

STORET (1977) 401116081125500

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
pH (S.U.)	20	8.2	8.6	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	4	110	161	69
Total Hardness ($CaCO_3$)(mg/l)	1	520	N/A	N/A
Total Sulfate (mg/l)	1	410	N/A	N/A
Total Iron (mg/l)	1	0.09	N/A	N/A
Total Manganese (mg/l)	1	0.19	N/A	N/A
Total Zinc (mg/l)	1	0	N/A	N/A
Total Residue (mg/l)	1	811	N/A	N/A
Filterable Residue (mg/l) at 180°C	1	777	N/A	N/A

Table M-120: Salt Fork Lake above Dame near Cambridge

STORET (1975) 400617081331600

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos/cm)	20	253	287	235
pH (S.U.)	20	7.1	6.2	8.4
Total Alkalinity ($CaCO_3$)(mg/l)	4	54	89	36
Total Hardness ($CaCO_3$)(mg/l)	1	95	N/A	N/A
Total Sulfate (mg/l)	1	66	N/A	N/A
Total Iron (mg/l)	1	0.15	N/A	N/A
Total Manganese (mg/l)	1	0.48	N/A	N/A
Total Zinc (mg/l)	1	0.01	N/A	N/A
Total Residue (mg/l)	1	189	N/A	N/A
Filterable Residue (mg/l) at 180°C	1	168	N/A	N/A

Table M-121: Salt Fork Lake in North Inlet near Cambridge

STORET (1975) 400749081312900

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	16	234	300	200
pH (S.U.)	16	7.6	6.4	8.4

Table M-122: Salt Fork Reservoir

STORET (1975) 400522081304800

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	15	294	324	270
pH (S.U.)	-	7.4	8.3	6.5

Table M-123: Salt Fork Creek near Summerfield

STORET (1975) 394745081162800

Parameter/Unit	No. of Samples	Value
Conductivity at 25oC (umhos/cm)	1	425
pH (S.U.)	1	7.6
Total Alkalinity ($CaCO_3$)(mg/l)	1	177
Total Hardness ($CaCO_3$)(mg/l)	1	230
Non-carbonate Hardness ($CaCO_3$)(mg/l)	1	53
Total Sulfate (mg/l)	1	39
Total Iron (mg/l)	1	0.05
Total Manganese (mg/l)	1	0
Total Zinc (mg/l)	1	0.03
Total Aluminum (mg/l)	1	0.12

Table M-124: Sugartree Fork near Winterset

STORET (1975) 400832081252600

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	2	318	390	245
pH (S.U.)	2	7.45	7.5	7.4
Total Alkalinity ($CaCO_3$)(mg/l)	2	106	125	86
Total Hardness ($CaCO_3$)(mg/l)	2	150	170	130
Non-carbonate Hardness ($CaCO_3$)(mg/l)	2	44.5	45	44
Total Sulfate (mg/l)	2	25	28	22
Total Iron (mg/l)	2	0.595	0.8	0.39
Total Manganese (mg/l)	2	0.125	0.18	0.07
Total Zinc (mg/l)	2	0.01	0.01	0.01
Total Aluminum (mg/l)	2	0.15	0.25	0.05

Table M-125: Upper Part of Salt Fork Creek

Station SF/03

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25oC (umhos/cm)	12	626	880	200
pH (S.U.)	12	7.6	8.1	7.2
Total Alkalinity ($CaCO_3$)(mg/l)	12	114	145	79
Total Acidity ($CaCO_3$)(mg/l)	11	7.4	25	0
Total Hardness ($CaCO_3$)(mg/l)	9	235	294	190
Total Sulfate (mg/l)	12	127	190	107
Total Manganese (mg/l)	12	0.167	0.5	0.05
Total Zinc (mg/l)	12	0.69	3.9	0.12
Total Aluminum (mg/l)	12	0.41	1.8	0.2
Dissolved Iron (mg/l)	4	0.048	0.09	0.03

Source: Ohio EPA, Salt Fork Study, 1977.

Table M-126: Upper Part of Salt Fork Creek

Station: SF/04

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	7	782	1040	621
pH (S.U.)	7	7.4	7.7	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	7	125	242	69
Total Acidity ($CaCO_3$)(mg/l)	6	11.8	37	0
Total Hardness ($CaCO_3$)	4	349	426	304
Total Sulfate (mg/l)	7	243	350	197
Total Iron (mg/l)	7	1.48	5.5	0.22
Total Manganese (mg/l)	7	0.46	1.1	0.32
Total Aluminum (mg/l)	7	0.76	2.7	0.2
Dissolved Iron (mg/l)	2	0.035	0.04	0.3
Filterable Residue (mg/l)	7	514	672	420

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-127: Upper Part of Salt Fork Creek

Station: SF/01 - Southeast of Middlebourne

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	11	792	1072	630
pH (S.U.)	11	7.3	8.0	6.6
Total Alkalinity ($CaCO_3$)(mg/l)	11	126	273	73
Total Acidity ($CaCO_3$)(mg/l)	11	6.1	20	0
Total Hardness ($CaCO_3$)	8	280	382	2
Total Sulfate (mg/l)	11	204	275	166
Total Iron (mg/l)	11	0.42	1.13	0.1
Total Manganese (mg/l)	11	0.48	1.08	0.05
Total Aluminum (mg/l)	11	0.69	2.4	0.2
Dissolved Iron (mg/l)	3	0.05	0.07	0.03
Filterable Residue (mg/l)	11	470	593	411

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-128: Upper Part of Salt Fork Creek

Station: SF/02

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	12	855	1219	610
pH (S.U.)	12	7.4	7.7	6.8
Total Alkalinity ($CaCO_3$)(mg/l)	12	88	128	1
Total Acidity ($CaCO_3$)(mg/l)	12	5.3	17	0
Total Hardness ($CaCO_3$)	9	370.6	647	104
Total Sulfate (mg/l)	12	283	670	186
Total Iron (mg/l)	12	0.78	2.19	0.16
Total Manganese (mg/l)	12	0.83	3.03	0.34
Total Aluminum (mg/l)	12	0.67	2.0	0.2
Dissolved Iron (mg/l)	4	0.037	0.05	0.03
Filterable Residue (mg/l)	11	581	1074	444

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-129: Upper Part of Salt Fork Creek

Station: SF/05

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	13	1259	1498	959
pH (S.U.)	13	6.83	7.5	6.15
Total Alkalinity ($CaCO_3$)(mg/l)	13	64	84	22
Total Acidity ($CaCO_3$)(mg/l)	12	4	13	0
Total Hardness ($CaCO_3$)	9	342	685	2
Total Sulfate (mg/l)	13	551	730	380
Total Iron (mg/l)	13	1.85	3.23	0.31
Total Manganese (mg/l)	13	3.35	6.0	2.7
Total Aluminum (mg/l)	13	2.3	4.0	0.3
Dissolved Iron (mg/l)	3	.09	0.15	0.03
Filterable Residue (mg/l)	13	868	1060	713

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-130: Upper Part of Salt Fork Creek

Station: SF/06

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	11	1306	1579	891
pH (S.U.)	11	71.4	7.7	6.4
Total Alkalinity ($CaCO_3$)(mg/l)	11	74	91	30
Total Acidity ($CaCO_3$)(mg/l)	9	3	13	0
Total Hardness ($CaCO_3$)	8	475	725	2
Total Sulfate (mg/l)	10	631	800	430
Total Iron (mg/l)	11	0.85	2.56	0.21
Total Manganese (mg/l)	11	2.3	5.4	0.21
Total Aluminum (mg/l)	11	0.79	2.0	0.3
Dissolved Iron (mg/l)	4	0.04	0.06	0.04
Filterable Residue (mg/l)	11	898	1110	652

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-131: Upper Part of Salt Fork Creek

Station: SF/07

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	9	648	749	480
pH (S.U.)	9	7.15	7.7	6.8
Total Alkalinity ($CaCO_3$)(mg/l)	9	111	209	71
Total Acidity ($CaCO_3$)(mg/l)	8	5	13	1
Total Hardness ($CaCO_3$)	7	247	270	208
Total Sulfate (mg/l)	9	160	188	138
Total Iron (mg/l)	9	0.88	1.45	0.38
Total Manganese (mg/l)	9	0.40	0.76	0.25
Total Aluminum (mg/l)	9	0.67	1.2	0.3
Dissolved Iron (mg/l)	4	0.043	0.05	0.03
Filterable Residue (mg/l)	9	319	450	180

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-132: Upper Part of Salt Fork Creek

Station: SF/08

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	10	592	693	415
pH (S.U.)	9	7.58	8.0	7.25
Total Alkalinity ($CaCO_3$)(mg/l)	10	136	269	91
Total Acidity ($CaCO_3$)(mg/l)	9	3.6	10	0
Total Hardness ($CaCO_3$)	7	243	270	206
Total Sulfate (mg/l)	10	134	176	109
Total Iron (mg/l)	10	0.49	0.88	0.19
Total Aluminum (mg/l)	10	0.36	0.6	0.2
Dissolved Iron (mg/l)	4	0.038	0.05	0.03
Filterable Residue (mg/l)	10	349	406	295

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-133: Upper Part of Salt Fork Creek

Station: SF/09

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	9	964	1189	714
pH (S.U.)	9	7.28	7.6	6.95
Total Alkalinity ($CaCO_3$)(mg/l)	10	93	126	62
Total Acidity ($CaCO_3$)(mg/l)	10	4.5	10	0
Total Hardness ($CaCO_3$)	7	448	550	322
Total Sulfate (mg/l)	10	374	460	242
Total Iron (mg/l)	10	2.15	3.9	1.24
Total Manganese (mg/l)	10	1.05	2.17	0.63
Total Aluminum (mg/l)	10	1.59	4.0	0.7
Dissolved Iron (mg/l)	4	0.032	0.04	0.03
Filterable Residue (mg/l)	10	634	851	451

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-134: Upper Part of Salt Fork Creek

Station: SF/10

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	10	855	1030	654
pH (S.U.)	9	7.34	8	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	9	109	131	81
Total Acidity ($CaCO_3$)(mg/l)	10	4.6	10	0
Total Hardness ($CaCO_3$)	6	395	430	338
Total Sulfate (mg/l)	9	352	880	214
Total Iron (mg/l)	10	2.38	3.8	1.4
Total Manganese (mg/l)	10	0.839	1.18	0.6
Total Aluminum (mg/l)	10	1.36	2.1	0.8
Dissolved Iron (mg/l)	3	0.043	0.07	0.03
Filterable Residue (mg/l)	10	564	713	448

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-135: Upper Part of Salt Fork Creek

Station: SF/11

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	490
pH (S.U.)	1	8.1
Total Alkalinity ($CaCO_3$)(mg/l)	1	156
Total Acidity ($CaCO_3$)(mg/l)	1	2
Total Hardness ($CaCO_3$)	1	184
Total Sulfate (mg/l)	1	45
Total Iron (mg/l)	1	0.55
Total Manganese (mg/l)	1	0.11
Total Aluminum (mg/l)	1	0.4
Dissolved Iron (mg/l)	1	0.05
Filterable Residue (mg/l)	1	225

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-136: Upper Part of Salt Fork Creek

Station: SF/21

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	6	1147	1300	975
pH (S.U.)	6	6.73	7.0	5.7
Total Alkalinity ($CaCO_3$)(mg/l)	6	50	60	34
Total Acidity ($CaCO_3$)(mg/l)	6	7	21	1
Total Hardness ($CaCO_3$)	2	736	755	718
Total Sulfate (mg/l)	6	731	810	620
Total Iron (mg/l)	6	4.1	6.9	2.12
Total Manganese (mg/l)	6	4.4	6.1	3.11
Total Aluminum (mg/l)	6	3.12	4.5	1.6
Filterable Residue (mg/l)	6	1064	1150	919

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-137: Upper Part of Salt Fork Creek

Station: SF/22

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	630	780	530
pH (S.U.)	5	7.4	8.0	7.0
Total Alkalinity ($CaCO_3$)(mg/l)	5	210	348	159
Total Acidity ($CaCO_3$)(mg/l)	5	7	17	0
Total Hardness ($CaCO_3$)	3	287	328	256
Total Sulfate (mg/l)	5	170	267	113
Total Iron (mg/l)	5	1.18	2.0	0.36
Total Manganese (mg/l)	5	0.13	1.17	0.10
Total Aluminum (mg/l)	5	0.73	1.2	0.3
Filterable Residue (mg/l)	5	431	584	341

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-138: Upper Part of Salt Fork Creek

Station: SF/23

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	6	1238	1662	989
pH (S.U.)	5	7.3	7.9	6.7
Total Alkalinity ($CaCO_3$)(mg/l)	6	113	216	60
Total Acidity ($CaCO_3$)(mg/l)	6	11	30	3
Total Hardness ($CaCO_3$)	3	549	696	476
Total Sulfate (mg/l)	6	498	600	420
Total Iron (mg/l)	6	0.73	1.46	0.31
Total Manganese (mg/l)	6	1.66	2.5	0.58
Total Aluminum (mg/l)	6	0.7	1.0	0.2
Filterable Residue (mg/l)	6	932	1171	755

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-139: Upper Part of Salt Fork Creek

Station: SF/25

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	446	530	392
pH (S.U.)	5	7.4	7.9	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	5	156	183	137
Total Acidity ($CaCO_3$)(mg/l)	5	3	7	0
Total Hardness ($CaCO_3$)	3	199	202	196
Total Sulfate (mg/l)	5	67	83	51
Total Iron (mg/l)	5	0.6	1.53	0.18
Total Manganese (mg/l)	5	0.18	0.32	0.09
Total Aluminum (mg/l)	5	0.48	1.0	0.2
Filterable Residue (mg/l)	5	275	287	267

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-140: Rocky Fork

Station: RF/01

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	215	230	200
pH (S.U.)	1	6.9	N/A	N/A
Total Alkalinity ($CaCO_3$)(mg/l)	2	41	53	29
Total Acidity ($CaCO_3$)(mg/l)	2	2	4	0
Total Hardness ($CaCO_3$)	2	76	90	62
Total Sulfate (mg/l)	2	30.5	33	28
Total Iron (mg/l)	2	1.09	1.4	0.71
Total Manganese (mg/l)	2	0.32	0.15	0.7
Total Aluminum (mg/l)	2	0.5	0.6	0.4
Dissolved Iron (mg/l)	2	0.65	1.2	0.1
Filterable Residue (mg/l)	2	112.5	113	112

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-141: Rocky Fork

Station: RF/02

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	270
pH (S.U.)	1	6.8
Total Alkalinity ($CaCO_3$)(mg/l)	1	44
Total Acidity ($CaCO_3$)(mg/l)	1	0
Total Hardness ($CaCO_3$)	1	84
Total Sulfate (mg/l)	1	37
Total Iron (mg/l)	1	0.5
Total Manganese (mg/l)	1	0.11
Total Aluminum (mg/l)	1	0.2
Dissolved Iron (mg/l)	1	0.11
Filterable Residue (mg/l)	1	107

Note: No abandoned mines in watershed
Source: Ohio EPA Salt Fork Study, 1977

Table M-142: Rocky Fork

Station: RF/03

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	374	469	288
pH (S.U.)	5	7.05	7.75	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	5	99	194	45
Total Acidity ($CaCO_3$)(mg/l)	5	2.4	10	0
Total Hardness ($CaCO_3$)	3	100	121	82
Total Sulfate (mg/l)	5	34	42	26
Total Iron (mg/l)	4	1.33	1.54	1.06
Total Manganese (mg/l)	5	0.29	0.48	0.15
Total Aluminum (mg/l)	5	0.42	0.6	0.2
Dissolved Iron (mg/l)	1	0.12	N/A	N/A
Filterable Residue (mg/l)	5	202	297	104

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-143: Clear Fork

Station: CF/01

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	240	260	220
pH (S.U.)	2	7.1	7.4	6.8
Total Alkalinity ($CaCO_3$)(mg/l)	2	49	56	42
Total Acidity ($CaCO_3$)(mg/l)	2	1.5	3	0
Total Hardness ($CaCO_3$)	2	85	90	80
Total Sulfate (mg/l)	2	32	32	32
Total Iron (mg/l)	2	0.86	1.33	0.39
Total Manganese (mg/l)	2	0.065	0.07	0.06
Total Aluminum (mg/l)	2	0.45	0.7	0.2
Dissolved Iron (mg/l)	2	0.085	0.11	0.06
Filterable Residue (mg/l)	2	136	139	133

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-144: Clear Fork

Station: CF/02

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	250	300	200
pH (S.U.)	2	6.7	6.8	6.6
Total Alkalinity ($CaCO_3$)(mg/l)	2	40.5	53	28
Total Acidity ($CaCO_3$)(mg/l)	2	1	2	0
Total Hardness ($CaCO_3$)	2	73	90	56
Total Sulfate (mg/l)	2	29.5	33	26
Total Iron (mg/l)	2	1.28	2.07	0.49
Total Manganese (mg/l)	2	0.135	0.17	0.1
Total Aluminum (mg/l)	2	0.55	0.8	0.3
Dissolved Iron (mg/l)	2	0.075	0.09	0.06
Filterable Residue (mg/l)	2	121	140	102

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-145: Clear Fork

Station: CF/03

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	337	413	276
pH (S.U.)	5	7.17	7.35	6.9
Total Alkalinity ($CaCO_3$)(mg/l)	5	116	216	52
Total Acidity ($CaCO_3$)(mg/l)	5	3.6	15	0
Total Hardness ($CaCO_3$)	3	127	166	94
Total Sulfate (mg/l)	5	41	53	33
Total Iron (mg/l)	5	1.27	1.82	0.76
Total Manganese (mg/l)	5	0.28	0.56	0.09
Total Aluminum (mg/l)	5	0.44	0.6	0.3
Dissolved Iron (mg/l)	1	0.1	N/A	N/A

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-146: Sugartree Fork

Station: STF/01

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	300
pH (S.U.)	1	7.25
Total Alkalinity ($CaCO_3$)(mg/l)	1	73
Total Acidity ($CaCO_3$)(mg/l)	1	0
Total Hardness ($CaCO_3$)	1	102
Total Sulfate (mg/l)	1	31
Total Iron (mg/l)	1	0.37
Total Manganese (mg/l)	1	0.04
Total Aluminum (mg/l)	1	0.2
Dissolved Iron (mg/l)	1	0.08
Filterable Residue (mg/l)	1	145

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-147: Sugartree Fork

Station: STF/02

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	280
pH (S.U.)	1	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	1	80
Total Acidity ($CaCO_3$)(mg/l)	1	3
Total Hardness ($CaCO_3$)	1	126
Total Sulfate (mg/l)	1	31
Total Iron (mg/l)	1	0.3
Total Manganese (mg/l)	1	0.04
Total Aluminum (mg/l)	1	0.2
Dissolved Iron (mg/l)	1	0.05
Filterable Residue (mg/l)	1	143

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-148: Sugartree Fork

Station: STF/03

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	343	402	311
pH (S.U.)	5	6.94	7.2	6.4
Total Alkalinity ($CaCO_3$)(mg/l)	5	136	248	72
Total Acidity ($CaCO_3$)(mg/l)	5	4.6	15	1
Total Hardness ($CaCO_3$)	3	131	142	112
Total Sulfate (mg/l)	4	35	46	28
Total Iron (mg/l)	5	1.95	3.24	0.47
Total Manganese (mg/l)	5	0.62	0.92	0.08
Total Aluminum (mg/l)	5	0.62	1.2	0.24
Dissolved Iron (mg/l)	1	0.07	N/A	N/A
Filterable Residue (mg/l)	5	192	225	137

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-149: Brushy Fork

Station: BF/01

Parameter/Unit	No. of Samples	Value
pH (S.U.)	1	7.5
Total Alkalinity ($CaCO_3$)(mg/l)	1	85
Total Acidity ($CaCO_3$)(mg/l)	1	1
Total Hardness ($CaCO_3$)	1	148
Total Sulfate (mg/l)	1	43
Total Iron (mg/l)	1	0.2
Total Manganese (mg/l)	1	0.03
Total Aluminum (mg/l)	1	0.2
Dissolved Iron (mg/l)	1	0.04
Filterable Residue (mg/l)	1	180

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-150: Brushy Fork

Station: BF/03

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	432	525	391
pH (S.U.)	5	7.08	7.4	6.7
Total Alkalinity ($CaCO_3$)(mg/l)	5	154	284	78
Total Acidity ($CaCO_3$)(mg/l)	5	5	21	1
Total Hardness ($CaCO_3$)	3	149	174	130
Total Sulfate (mg/l)	5	48	62	40
Total Iron (mg/l)	5	1.57	2.58	0.32
Total Manganese (mg/l)	5	0.77	1.14	0.05
Total Aluminum (mg/l)	5	0.6	1.0	0.3
Dissolved Iron (mg/l)	1	0.08	N/A	N/A
Filterable Residue (mg/l)	5	247	281	167

Souce: Ohio EPA, Salt Fork Study, 1977

Table M-151: Brushy Fork

Station: BF/01

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	400
pH (S.U.)	1	7.2
Total Alkalinity ($CaCO_3$)(mg/l)	1	72
Total Acidity ($CaCO_3$)(mg/l)	1	10
Total Hardness ($CaCO_3$)	1	118
Total Sulfate (mg/l)	1	42
Total Iron (mg/l)	1	1.49
Total Manganese (mg/l)	1	0.19
Total Aluminum (mg/l)	1	0.6
Dissolved Iron (mg/l)	1	0.05
Filterable Residue (mg/l)	1	158

Note: No abandoned mines in watershed
Souce: Ohio EPA, Salt Fork Study, 1977

Table M-152: Salt Fork near Cambridge

STORET (1965-71) 03142200

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	9	503	902	219
pH (S.U.)	7	7.4	7.7	7.0
Total Alkalinity ($CaCO_3$)(mg/l)	3	102	126	79
Total Hardness ($CaCO_3$)	7	233	442	82
Non-carbonate Hardness ($CaCO_3$)(mg/l)	5	191	353	50
Total Sulfate (mg/l)	7	131	346	29
Filterable Residue 180°C (mg/l)	5	454	646	222

Table M-153: Salt Fork below Dam near Cambridge

STORET (1970-77) 03142295

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	31	268	349	219
.U.)	21	7.6	8.5	7.0
Total Alkalinity ($CaCO_3$)(mg/l)	12	57	125	33
Total Hardness ($CaCO_3$)	19	112	150	82
Non-carbonate Hardness ($CaCO_3$)(mg/l)	10	60	64	53
Total Sulfate (mg/l)	21	62	110	48
Total Zinc (mg/l)	5	0.03	0.05	0.01
Total Residue (mg/l)	2	240	264	216
Filterable Residue 180°C (mg/l)	2	168	172	164
Dissolved Iron (mg/l)	7	0.04	0.09	0.01

Table M-154: Seneca Fork of Wills Creek

STORET (1974-75) 1SESW003 078

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	6	403	500	300
pH (S.U.)	6	7.4	7.9	6.1
Total Alkalinity ($CaCO_3$)(mg/l)	5	185	285	134
Total Hardness ($CaCO_3$)	5	197	212	163
Total Sulfate (mg/l)	5	34	46	3.8
Total Iron (mg/l)	5	0.49	0.77	0.31
Total Manganese (mg/l)	5	0.072	0.18	0.04
Total Zinc (mg/l)	1	0.1	N/A	N/A
Total Residue (mg/l)	5	268	322	221

Table M-155: Seneca Fork of Wills Creek

STORET (1974-75) 1SESW0001 076

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	7	364	415	320
pH (S.U.)	8	7.5	8.2	6.3
Total Alkalinity ($CaCO_3$)(mg/l)	7	120	247	23
Total Hardness ($CaCO_3$)	7	184	244	134
Total Sulfate (mg/l)	7	50	69	9
Total Iron (mg/l)	7	0.385	0.693	0.17
Total Manganese (mg/l)	7	0.610	2.645	0.055
Total Zinc (mg/l)	3	0.1	0.1	0.1
Total Residue (mg/l)	7	256	312	237
Dissolved Iron (mg/l)	2	0.1	0.1	0.1

Table M-156: Seneca Fork of Wills Creek above Senecaville

STORET (1976) 395200081195300

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	477	479	474

Table M-157: South Fork of Seneca Fork of Wills Creek

STORET (1974-75) 1SESW0004 077

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	6	437	520	340
pH (S.U.)	6	7.4	7.8	6.5
Total Alkalinity ($CaCO_3$)(mg/l)	5	199	329	123
Total Hardness ($CaCO_3$)	5	208	250	156
Total Sulfate (mg/l)	5	36	46	5
Total Iron (mg/l)	5	1.29	2.65	0.36
Total Manganese (mg/l)	5	0.115	0.24	0.025
Total Zinc (mg/l)	1	0.1	N/A	N/A
Total Residue (mg/l)	5	293	352	213

Note: No abandoned mines in watershed

Table M-158: Tappan Lake

STORET (1973) 393402

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	5	576	580	570
pH (S.U.)	8	8.1	8.9	7.3
Total Alkalinity ($CaCO_3$)(mg/l)	8	76	85	70

Table M-159: Tappan Lake

STORET (1973) 393403

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	763	775	750
pH (S.U.)	6	8.4	9.1	8.2
Total Alkalinity ($CaCO_3$)(mg/l)	6	77	100	62

Table M-160: Tappan Lake above Dam near Dennison

STORET (1976) 402129081133200

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	18	634	668	620
pH (S.U.)	18	7.7	8.3	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	4	79	108	66
Total Hardness ($CaCO_3$)	1	310	N/A	N/A
Total Sulfate (mg/l)	1	230	N/A	N/A
Total Iron (mg/l)	2	1.02	1.3	0.74
Total Manganese (mg/l)	2	1.45	2.2	0.7
Total Zinc (mg/l)	1	0.02	N/A	N/A
Total Residue (mg/l)	1	483	N/A	N/A
Dissolved Residue 180°C (mg/l)	1	472	N/A	N/A

Table M-161: Tappan Reservoir

STORET (1975) 1TALW0005

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	31	720	760	620
pH (S.U.)	31	8.1	9.0	7.3

Table M-162: Tappan Reservoir

STORET (1976) 1TALW0006

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	27	723	740	640
pH (S.U.)	27	8.1	9.1	7.3

Table M-163: Tappan Reservoir

STORET (1976) 1TALW0007

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	55	709	770	643
pH (S.U.)	55	8.2	9.3	7.2
Total Hardness ($CaCO_3$)	7	345	365	330
Total Sulfate (mg/l)	7	271	380	260
Total Iron (mg/l)	7	0.29	0.47	0.13
Total Manganese (mg/l)	7	0.12	0.29	0.045
Total Zinc (mg/l)	7	0.1	0.1	0.1
Total Aluminum (mg/l)	7	0.5	0.5	0.5
Total Residue (mg/l)	7	503	527	487
Dissolved Residue 180°C (mg/l)	7	0.1	0.1	0.1

Table M-164: Tappan Reservoir

STORET (1975) 1TALW0008

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	21	765	805	720
pH (S.U.)	17	8.3	9.5	7.3

Table M-165: Tappan Reservoir

STORET (1975) 1TALW0009

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	17	794	830	740
pH (S.U.)	12	8.4	8.9	7.6

Table M-166: Tappan Reservoir

STO . (1975-76) 1TALW0010

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	25	809	1100	570
pH (S.U.)	21	8.31	9	7.6
Total Hardness ($CaCO_3$)	5	456	612	260
Total Sulfate (mg/l)	5	346	440	230
Total Iron (mg/l)	5	0.68	1.3	0.34
Total Manganese (mg/l)	5	0.14	0.17	0.11
Total Zinc (mg/l)	5	0.1	0.1	0.1
Total Aluminum (mg/l)	3	0.63	0.9	0.5
Total Residue (mg/l)	3	531	623	425
Dissolved Iron (mg/l)	3	0.1	0.1	0.1

Table M-167: Tappan Reservoir

STORET (1974-76) 1TALW002

rameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	112	701	870	500
pH (S.U.)	112	7.8	9.0	6.7
Total Alkalinity ($CaCO_3$)(mg/l)	22	73	116	61
Total Hardness ($CaCO_3$)	40	351	1122	156
Total Sulfate (mg/l)	40	276	340	230
Total Iron (mg/l)	39	0.27	1.5	0.1
Total Manganese (mg/l)	39	0.46	4.3	0.03
Total Zinc (mg/l)	35	0.1	0.1	0.1
Total Aluminum (mg/l)	12	0.5	0.5	0.5
Total Residue (mg/l)	30	510	556	471
Dissolved Iron (mg/l)	29	0.12	0.58	0.1

Table M-168: Tappan Lake

STORET (1973) 393401

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
onductivity at 25°C (umhos)	4	535	540	520
l Alkalinity ($CaCO_3$)(mg/l)	11	80	120	72

Table M-169: Clear Fork above Tappan Lake near Cadiz

STORET (1976) 402021081063100

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	1295	1320	1270
pH (S.U.)	2	7.8	7.9	7.7

Table M-170: Standingstone Fork above Tappan Lake

STORET (1976) 401816081054000

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	2	2235	2400	2070
pH (S.U.)	2	8.1	8.2	8.0

Table M-171: Clear Fork near Jewett

STORET (1979) 402012081051200

Parameter/Unit	No. of Samples	Value
Conductivity at 25°C (umhos)	1	1200
pH (S.U.)	1	8.0
Total Alkalinity ($CaCO_3$)(mg/l)	1	133
Total Sulfate (mg/l)	1	610
Total Iron (mg/l)	1	0.31
Total Manganese (mg/l)	1	0.13

Table M-172: Wills Creek Lake above Dam near Conesville

STO. . (1976) 400918081510200

Parameter/Unit	No. of Samples	Mean	Maximum	Minimum
Conductivity at 25°C (umhos)	13	562	620	522
pH (S.U.)	13	8.07	8.6	7.1
Total Alkalinity ($CaCO_3$)(mg/l)	4	92	103	85
Total Hardness ($CaCO_3$)	1	250	N/A	N/A
Total Sulfate (mg/l)	1	190	N/A	N/A
Total Iron (mg/l)	1	1.4	N/A	N/A
Total Manganese (mg/l)	1	0.01	N/A	N/A
Total Zinc (mg/l)	1	0.01	N/A	N/A
Total Residue (mg/l)	1	449	N/A	N/A
Dissolved Residue 180°C (mg/l)	1	392	N/A	N/A

Table M-173: Wills Creek

Parameter/Unit	Station Date	Wills Creek near mouth 8-16-77
Hardness ($CaCO_3$)		189
Total Sulfate (mg/l)		104
Total Iron (mg/l)	1.62	2.03
Total Manganese (mg/l)	3.8	0.42
Total Zinc (mg/l)	0.11	0.03
Total Nofilterable Residue		55

Source: Ohio EPA, SEDO

OHIO WETLANDS

GROUND WATER

WATER DEPLETION

BEACHES

TOXICS

NON-POINT SOURCE ASSESSMENT

POINT SOURCE BASIN LOADING ESTIMATES

ECONOMICS

ADMINISTRATIVE PROGRESS AND DIFFICULTIES

1980 305(b) Report
Volume VIII

Editor
J.F. Estenik

Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards
Columbus, Ohio 43216
April, 1980

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OHIO WETLANDS

1980 305(b) Report
Volume VIII

Prepared by
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Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Summary

Ohio Wetlands

A general definition of wetlands, a description of the general wetland types found in Ohio and a general description of the wetland functions are presented in this 5 page section. A wetland inventory, reported by wetland type, acreage and percent, and a comparison of the percentage of wetland types in a 1954 and a 1974 inventory is presented in Tables VIII-2 and VIII-3. The reasons for wetland losses in Ohio are listed along with wetland protective programs currently in effect.

Recommendations

The well being of Ohio's wetlands is dependent upon action taken to conserve them. In order to achieve this objective, the following recommendations are made:

- Enact legislation recognizing wetlands as a unique resource and to provide for the preservation, protection, and management of these areas;

- Develop and maintain coordination among State resource agencies concerned with the protection of wetlands;

- Undertake a multidisciplinary interagency wetland inventory, utilizing the results as a data base for determining wetland values.

Wetlands have long been considered wastelands. Only recently has it been realized that they are a valuable natural resource. While some data does exist on Ohio's wetlands, much of it is incomplete. The following pages offer a brief overview of the State's wetlands, and several recommendations for enhancing our understanding of these areas.

"Wetlands are an area of land where the water table is at, near, or above the land surface long enough each year to result in the formation of characteristic wet soil types, and to support the growth of water dependent vegetation." Ohio wetlands include marshes, swamps, and bogs; descriptions are found in Table VIII-1.

Wetlands are a unique resource which serve several important purposes, including:

- the provision of habitat and food production for various types of wildlife (e.g., waterfowl, furbearers, fish spawning and nursery areas).

- the ability they possess to control flooding by slowing the water velocities and reducing the flood peak. Niering (1966) has shown that 1.5 million gallons of water can be stored with only a 6-inch increase in water level in a 10 acre wetland.

- maintaining and improving water quality. As water flows through a wetland, plants incorporate nitrogen and phosphorus as nutrients, resulting in a reduction in the concentration of these potential pollutants. Wetlands also slow water velocities such that sediment can settle, nourishing the wetland and improving downstream water quality.

- the provision of areas for ground water recharge.

Table VIII-1: Wetland Classification (Modified from Martin, 1953)

Type No.	Type Name	Description	Characteristic Vegetation
3	Shallow Fresh Marsh	Soil normally waterlogged during the growing season, often covered with as much as 6" water.	Reed, whitetop, rice cutgrass, carex, giant burreed
4	Deep Fresh Marsh	Soil covered with 3"-6" of water during the growing season.	Cattails, reed, round-stemmed bulrush, spikerush, wild rice. In open areas pondweed, naiads, coontail, watermilfoil, water-weed, duckweed, water lilies, and spatterdock.
5	Open Fresh Water	Water of variable depth	Pondweed, naiads, wild celery, coontail, watermilfoils, musk-grass, water lilies, spatterdock
6	Shrub Swamp	Soil normally waterlogged during growing season, often covered with as much as 6" water	Alders, willows, buttonbush, dogwoods, swamp-privet
7	Wooded Swamps	Soil waterlogged at least to within a few inches of surface during growing season, often covered with as much as one foot of water	Tamarack, aborvitae, black spruce, balsam, red maple, black ash. Usually thick ground covering of mosses; deciduous swamps frequently support beds of duckweed, swampweed
8	Bogs	Soil usually waterlogged	Heath shrubs, sphagnum moss, sedge, leather-leaf, labrador tea, cranberries, carex, cottongrass

Wetlands are implicitly included as "waters of the State" which Ohio EPA is mandated to protect. The Agency also has statutory responsibility to protect public water supplies, many of which are dependent on wetlands via ground water recharge. The legislative authority to protect the water quality of wetlands is the Ohio water quality standards. In addition, a policy exists which addresses the Agency's position regarding projects that may affect wetlands (Attachment VIII-1).

In order to determine the number and size of wetlands in Ohio, several inventories have been undertaken. The United States Fish and Wildlife Service inventory conducted in 1954 showed approximately 60,000 acres of wetlands, types 3 through 8, existing in Ohio (Rounds, 1955). However, this inventory was not complete. The Ohio Department of Natural Resources wetland inventory in 1974 showed approximately 77,600 acres of wetlands, types 3 through 8 (Weeks, 1974). The acreage is listed by type in Table VIII-2. Weeks (1974) noted that differences in sampling methodology and availability of data made direct comparison of the 1954 and 1974 inventories impossible. However, by using percentages, the general trends in acreage can be determined (Table VIII-2)

Table VIII-2: Comparison of 1954 and 1974 Ohio wetland inventories by percent wetland type[a] [b]

Wetland Type	1954	1974( )[c]	% Change
3	9	2 (1,749)	-7
4	62	27 (21,421)	-35
5	20	59 (45,847)	+39
6	2	5 (3,835)	+3
7	2	6 (4,697)	+4
8	3	1 (31)	-3

a. See Table VIII-1 for definitions of types.
b. Acreage by type for 1954 not available.
c. Acreage

The coastal wetlands of Lake Erie are the most extensive in Ohio, and the most studied. It was estimated that 30,000 acres of wetlands existed adjacent to Lake Erie in 1954. By 1974, 15,000 acres of wetlands existed, a reduction of approximately 50 percent. These wetlands are primarily type 4, or deep fresh marsh (Table VIII-3).

Destruction of Ohio's wetlands is largely attributable to development. Wetlands have been, and continue to be, drained for agricultural, industrial and residential expansion. Those that do survive developmental pressures are often quite degraded. Lake Erie wetlands in particular are subject to these pressures, due mainly to the demand for lakefront development and to current high lake levels. It is estimated that better than one-half of the coastal wetlands have been lost since 1954 (Anonymous, 1979).

Currently, 10,000 acres of wetlands are protected and maintained by Federal and State governments and by private hunting clubs. The Ohio Department of Natural Resources has several programs allowing them to purchase wetlands for preservation and management, including the Coastal Zone Management program and the State Nature Preserve program. Physical protection of wetlands is also necessary due to the current high lake levels, in the form of dikes. As the lake level rises, inland advancement of wetlands is not possible due to encroaching development. Water levels can be maintained within the dike, allowing the wetland to retain its natural character.

Currently, numbers placed on wetland acreages are approximate, and loss figures are estimates. It is not possible to determine how much, if any, wetland area is expendable. Effort should be directed toward resolving these deficiencies.

Table VIII-3: Lake Erie Marshes, Diked, Undiked, and Total Acreage (Modified after Weeks, 1974)

Location	Diked	Undiked	Total
Sandusky Bay	5,054	221	5,275
Toussaint River	191	-	191
Portage River	273	-	273
Lake Front Marshes	8,854	28	8,882
Huron River	-	85	85

References

Anonymous, 1979. Public Review Draft. Ohio Department of Natural Resources, Division of Water, Coastal Zone Management Program.

Martin, A.C. et al., 1953. Classification of the Wetlands of the United States. Special Scientific Report: Wildlife No. 20, U.S. Department of Interior, Fish and Wildlife Service.

Niering, William A., 1966. The Life of the Marsh: The North American Wetlands.

Rounds, Burton W., 1955. Wetlands Inventory of Ohio. Office of River Basin Studies, U.S. Department of Interior, Fish and Wildlife Service.

Weeks, John L., 1974. Ohio Wetlands Inventory. Ohio Department of Natural Resources, Division of Wildlife.

Attachment VIII-1

Ohio EPA Wetlands Policy

It shall be this Agency's policy to:

1. Give particular cognizance and consideration to any proposal that has the potential to damage wetlands;

2. Recognize the irreplaceable value and man's dependence on wetlands to maintain a environment acceptable to society;

3. Minimize alterations in the quantity or quality of the natural flow of water that nourishes wetlands;

4. Preserve and protect wetlands from damaging misuses, including but not limited to adverse dredging or filling practices, solid waste management practices, siltation or the addition of pesticides, salts, or toxic materials arising from non-point source waters and through construction activities.

5. Prevent violation of applicable water quality standards due to such environmental insults.

Ohio EPA will apply this policy to the extent of its authorities in conducting all program activities, research, development and demonstration, technical assistance, and review of the Environmental Impact Statements.

GROUND WATER

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Prepared by
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Ohio Environmental Protection Agency
Division of Ground Water

Ground Water

Introduction

Ground water serves as the primary source of domestic water supply for 4-1/2 million Ohio residents representing nearly 40% of the State's population. Included in this figure are 2 million rural users who rely on individual wells and approximately 700 municipal ground-water supplies. Ground water also contributes greatly toward meeting industrial, agricultural, and commercial demands through several thousand private wells.

The Division of Ground Water in the Office of Public Water Supply has the responsibility of conducting a statewide program for the protection and surveillance of Ohio's ground-water resources under the authority of Chapters 3745 and 6111 of the Ohio Revised Code. Since most ground water in Ohio is uncontaminated, the major emphasis of the Agency's program has been the prevention of ground water contamination through proper land use practices, adequate well construction and siting, and defining ambient water quality as well as existing and potential problem areas.

As in previous years, staff activities for 1978 and 1979 have continued in the areas of geologic evaluation of public ground water supplies and land disposal sites, technical assistance to well owners regarding ground-water quality and contamination, and the conduct of a comprehensive ground-water quality monitoring network. The Ground Water Staff works closely with District Engineers, consultants, and the general public in compiling hydrogeologic and water quality data for a wide range of informational requests.

Geologic Site Evaluations

Geologic site evaluations for public ground water supplies and various land disposal activities are conducted routinely by the Division of Groun Water Staff as a technical assistance function for all program offices of the Ohio EPA. For the reporting period, a total of 325 geologic field investigations and follow-up summary reports were completed. Land disposal site evaluations were performed for proposed sanitary landfills, industrial lagoons, sludge disposal sites, spray irrigation fields, ash ponds and coal refuse piles. Evaluation reports include descriptions of local geologic and ground water conditions, comments on site suitability, and specific recommendations for the protection and monitoring of local ground-water resources. Nearly 60% of the total site investigations were for new sanitary landfills or landfill expansion areas and were requested by the OEPA Office of Land Pollution Control. Most of the remaining sites were for the disposal or storage of industrial wastes or sewage and were requested by the Office of Wastewater Pollution Control.

A total of 68 new public well sites were evaluated by the Ground Water Staff in 1978 and 1979 to assure that public wells were properly constructed and were in compliance with isolation requirements from potential sources of contamination.

Water Quality Requests and Compliants

A total of 406 individual request for information on local ground-water quality were handled by the Division of Gound Water during the reporting period. Approximatey half of the total requests involved private individual wells where contamination was either observed or suspected. Each contamination complaint was investigated and water samples collected for analyses to identify specific pollutants or pollutant sources. Follow-up reports were submitted to well owners describing cause and effect relationships and recommendations were made for corrective action when applicable.

Nearly 75 percent of the documented contamination cases were related to on-lot sources. The most prevalent water quality problems were turbidity and bacterial contamination, on-lot sewage disposal effects or spillage and/or leakage of petroleum products. The vast majority of these problems were directly attributed to improper well siting or deficiencies in well construction and maintenance. A few problems were related to on-lot application of pesticides.

Contamination of individual wells from oil and gas drilling activity was the second most prevalent problems and comprised 48 individual requests during the two-year reporting period. Well contamination from brine, crude oil, or natural gas were equally common and were largely concentrated in southeastern areas of the State. Faulty annular injection systems for brine, inadequate casing or cementing, and leakage from brine storage pits were the most common sources of local contamination.

A total of six contamination complaints were related to road salt application or open salt storage and were all in the northeastern area of the State. Less than 5% of the documented contamination problems were attributed to land disposal facilities.

Ground Water Monitoring

The Division's ground-water monitoring activities for 1978 and 1979 included the collection and analyses of 834 ground water samples. An average of 14 chemical parameters were determined for each sample. A detailed description of the Ageny's ambient and pollution source monitoring networks is included in Volume II, Monitoring Programs.

Special Projects

208 Planning: During the latter part of 1977 and early 1978, ground water-related subtasks were completed for all non-designated drainage basins throughout the State and included inventories of all documented cases of ground water contamination, locations and chemical data for all public ground-water supplies, and areal maps showing significant recharge areas.

Surface Impoundment Assessment: The Division of Ground Water received Federal grant funding under the Safe Drinking Water Act to conduct an inventory of all earthen ponds, pits, and lagoons in the State which are used for the storage and/or disposal of waste waters. During the latter part of 1978 and throughout

1979, a total of over 12,000 impoundments were located and described on inventory forms. Approximately 85% of the impoundments were assessed for ground water pollution potential using a standard rating system. Impoundment categories included: industrial, municipal, agricultural, mining and oil and gas-related.

Underground Injection Control: During 1978, the State of Ohio was one of 22 states designated by the U.S. EPA as needing an Underground Injection Control Program as mandated by the Safe Drinking Water Act. In early 1979, program work plans and grant applications were jointly submitted by the Ohio EPA, Division of Ground water and the Ohio Department of Natural Resources, Division of Oil and Gas to address specific injection well inventory and aquifer mapping activities as described in the Federal guidance documents. The Ohio EPA, Division of Ground Water will complete inventories of Class I, IV and V injection wells and will begin to map and designate aquifers as drinking water sources beginning in late 1979.

Future Program Needs

Expand Monitoring Program: The current ground water monitoring program, consisting of approximately 225 wells sampled semi-annually, does not aprovide comprehensive areal coverage of Ohio's major aquifer systems or adequate surveillance of existing land disposal facilities. The program scope of both the ambient and the pollution source monitoring networks is being expanded with the addition of approximately 300 new wells over the next two years.

Data Processing: The existing manual filing system of ground water quality data is not easily accessible to the general public or for use in water quality management studies. The current data base includes from 3,000 to 4,000 well analyses with the addition of up to 500 new analyses each year. Plans are underway to develop an automated system in order that regional and local water quality information can be quickly retrieved.

Ground Water Public Awareness: In recent years there has been a tremendous increase in public concern regarding ground water quality and protection due largely to national publicity over hazardous waste disposal and promulgation of RCRA and the Safe Drinking Water Act. The Division of Ground Water is a relatively small Division under the Public Water Supply Supervision Program and lacks identity or sufficient staff to attain its goals.

The efficient conduct of a comprehensive ground water protection program is best accomplished through a single multi-functional unit. Effective ground water protection strategy involves a wide range of activities and a close working relationship with the offices of Public Water Supply, Land Pollution, Wastewater, Planning and Emergency Response. A high, future priority should be to explore various options for changing the current organizational structure and develop better channels of coordination between the Division of Ground Water and other program offices.

Future program activities should include a public awareness campaign directed toward the multi-function approach to effective ground water protection. In-house training seminars, brochures, guidance documents and policy and procedures statements should be developed to assure that all program offices are incorporating measures for ground water protection in their routine activities.

WATER DEPLETION

BEACHES

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Prepared by
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Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Water Quality at Lake Erie Bathing Beaches

Summary

The majority of Lake Erie beaches had good to excellent bathing water quality in 1978-1979. The only reported beach closing was at Port Clinton for a portion of the 1979 recreational season. Five of seven beaches sampled between Vermilion and Cleveland-Edgewater had poor bathing water quality, reflecting the impact of nearby urban centers. There was a significant increase in the frequency of moderate fecal contamination (sample values exceeding 1000/100ml) in 1979 compared to 1978, probably as a result of weather conditions.

Data Base and Evaluation

Bacteriological data for this evaluation was obtained from the Ohio Department of Health (ODH), Bureau of Environmental Health (ODH 1978, 1979). Information concerning beach closings was obtained through a survey of local county and city Boards of Health having authority over the Lake Erie beaches. The Ohio Department of Natural Resources, Division of Parks and Recreation was contacted concerning the status of State Park beaches. It should be noted that some of the beaches included in the ODH survey have experienced severe shore erosion problems and are no longer popular bathing areas.

Bathing Waters are defined as "...all water segments directly related to existing swimming areas where bathhouses and/or lifeguards are provided...". Bathing Waters receive a special use designation in the Ohio Water Quality Standards. Lake Erie, outside of specifically excepted areas listed in Rule 3745-1-11(c) of the Ohio Administrative Code, is designated Bathing Waters. The fecal coliform standard for Bathing Waters is as follows:

> Geometric mean fecal coliform content (either MPN or 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 ten percent of the samples taken during any 30 day period. (Rule 3745-1-07 of the Ohio Administrative Code)

The ODH sampling schedule for Lake Erie beaches meets the requirement of 5 samples per month. The fecal coliform standard for primary contact recreation is worded as above with limits of 1000/100 ml and 2000/100 ml replacing the limits of 200/100 ml and 400/100 ml, respectively. Bacteriological data from Lake Erie beaches were compared to both standards.

Results

Closings.

Only one pollution related beach closing was reported at the Lake Erie beaches included in this survey. The Port Clinton Beach was closed during part of the 1979 recreational season. The criteria employed by local county and city Boards of Health in the closing of beaches is not standardized. Thus, the fact that the Port Clinton Beach was the only beach closed does not necessarily indicate that the worst bathing water quality existed at the Port Clinton Beach. An examination of the violations information shows this not to be the case.

Violations.

Twenty-five Lake Erie beaches were surveyed by the ODH in 1978 and 1979 (See Figure 1). The majority had good to excellent bathing water quality (Tables VIII-4 to VIII-6). Table VIII-4 summarizes the bathing water quality at the 25 beaches sampled in 1978-1979 and compares the current evaluation to a previous study (Ohio DNR, 1953). In 1978-1979, four Lake Erie beaches had excellent quality (i.e., no violations of the Bathing Water standards over two recreational seasons), while six beaches had poor quality (i.e., three or more violations of the 200/100 ml standard and four or more violations of the 400/100 ml standard). Five of the six poor bathing water locations were between Vermilion and Cleveland-Edgewater, reflecting the impact of this highly urbanized area. The remaining beaches were of good quality over the two year period and had excellent quality during major portions of the recreational season.

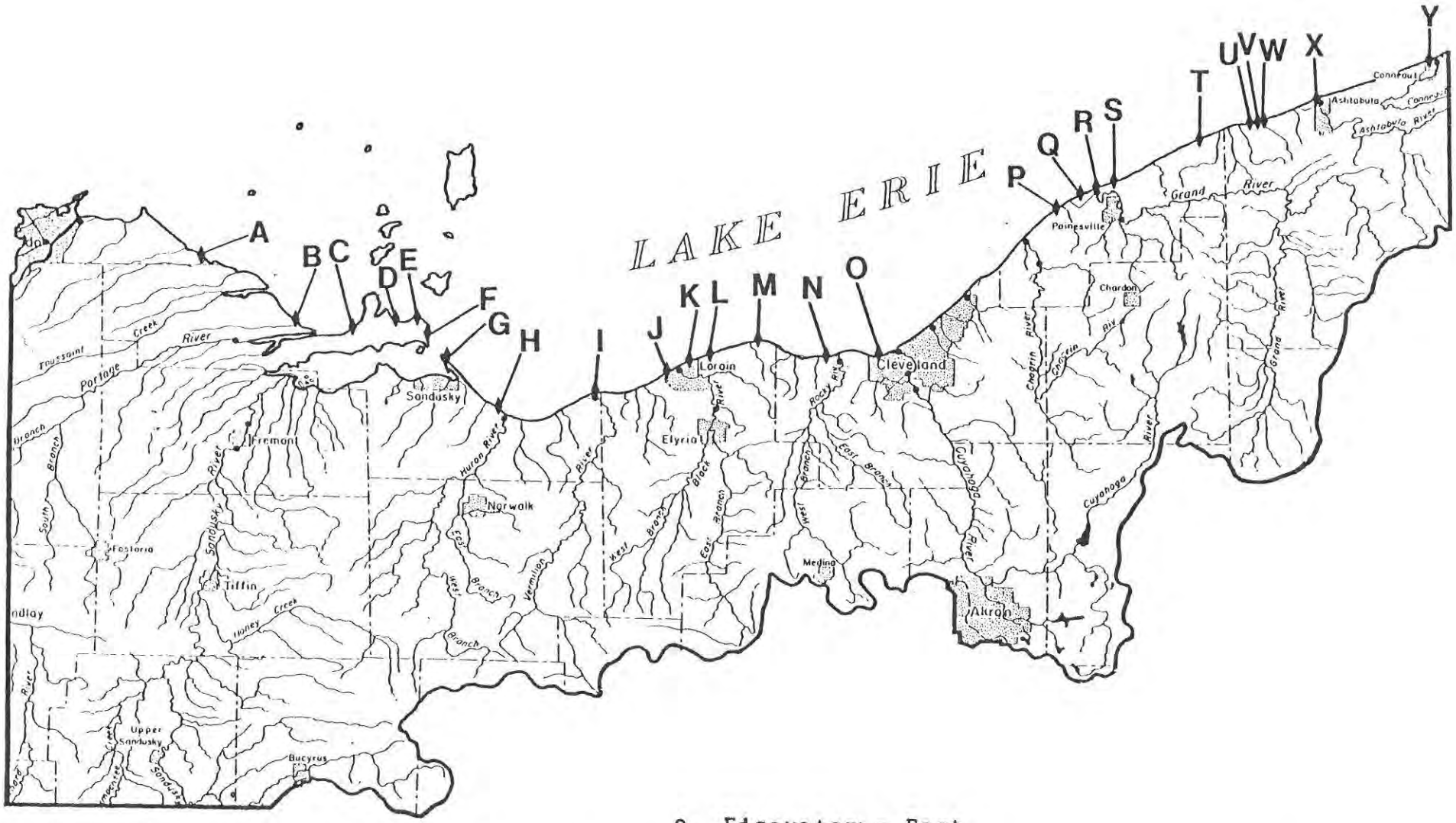
Table VIII-4 reveals no dramatic changes in current bathing water quality at the beaches studied when compared to 1950-1951 conditions. Pollution problems and associated fecal contamination persists at Edgewater Beach in Cleveland. Conditions may have improved at Huntington Beach, although the data from 1950-1951 is very spotty; bathing water quality at Vermilion appears to have declined since the 1950's. Otherwise, the beaches judged acceptable for swimming in 1951 remain in excellent or good condition.

The ODH survey revealed more frequent occurrences of moderate fecal contamination (individual sample values exceeding 1000/100 ml) at Lake Erie beaches in 1979 compared to 1978 (Table VIII-6). The number of beaches with one or more sample values exceeding 1000/100 ml increased from 13 to 20. A paired analysis (1978 vs. 1979) of the number of sample values exceeding 1000 fecal coliforms/100 ml at the 25 beaches showed this increased to be significant ($P < .05$) (Table VIII-6). Thus, moderate fecal contamination at Lake Erie beaches was more geographically widespread and occurred more frequently in 1979. This result was probably due to weather conditions and not any major change in point source pollution. Heavy rains contribute to fecal pollution by causing runoff that carries poorly treated sewage and non-point source contamination. High wave action can also stir contaminated bottom sediments, thus elevating fecal coliform levels. However, Saybrook Beach showed noticeable improvement in bathing water quality between 1978 and 1979 because of point source pollution control measures (Tables VIII-5 and VIII-6).

REFERENCES

Ohio Department of Health. 1978-1979 (unpublished). Data available from the Bureau of Environmental Health, Ohio Department of Health, Columbus, Ohio.

Ohio Department of Natural Resources. 1953. Lake Erie pollution survey, final report. Ohio DNR, Division of Water, Columbus, Ohio 201 pp.



A	Crane Creek	H	Nickle Plate	O	Edgewater - East Edgewater - West	U	Geneva - East Geneva - West
B	Camp Perry	I	Vermilion	P	Mentor-on-the-Lake	V	Geneva Township
C	Port Clinton	J	Lakeview Park	Q	Mentor Headlands - East Mentor Headlands - West	W	Saybrock
D	East Harbor	K	Century Park	R	Fairport Harbor	X	Walnut
E	Lakeside	L	Sheffield	S	Tuttle	Z	Conneaut Beach
F	Bay Point	M	Avon Lake	T	Madison Township		
G	Cedar Point Causeway	N	Huntington				

Figure VIII-1. Lake Erie Beaches surveyed by the Ohio Department of Health, 1978-1979.

Table VIII-4: Bathing water quality at selected Lake Erie beaches in 1950-1951 and 1978-1979

Key to Map	Beach	1950-1951[a]	1978-1979[b]
A	Crane Creek	-	G
B	Camp Perry	-	G
C	Port Clinton	-	P
D	East Harbor	A	E
E	Lakeside	A	G
F	Bay Point	-	E
G	Cedar Point Causeway	A	G
H	Nickle Plate	-	G
I	Vermilion	D	P
J	Lakeview Park	D	G
K	Century Park	U	P
L	Sheffield	-	P
M	Avon Lake	-	P
N	Huntington	U	G
O	Edgewater - East	U	P
	Edgewater - West	U	P
P	Mentor-on-the-Lake	D	G
Q	Mentor Headlands - East	A	G
	Mentor Headlands - West	A	G
R	Fairport Harbor	A	E
S	Tuttle	A	G
T	Madison Township	A	G
U	Geneva - East	D	G
	Geneva - West	D	G
V	Geneva Township	-	E
W	Saybrook	A	G
X	Walnut	D	G
Z	Conneaut Beach	A	G

a Based on survey and evaluation by Ohio DNR (1953)
Criteria: A, Acceptable, monthly average total coliforms less than 1000/100 ml
D, Doubtful, seasonal average total coliforms less than 1000/100 ml
U, Unacceptable, seasonal average total coliforms greater than 1000/100 ml

b Based on ODH survey and evaluation by Ohio EPA
Criteria: E, excellent, no violations of the 200/100 ml standard or 400/100 ml standard over two years.
G, Good, no more than two violations of the 200/100 ml standards, and no more than three violations of the 400/100 ml standard over two years.
P, Poor, three or more violations of 200/100 ml standards and four or more violations of the 400/100 ml standard over two years.

Table VIII-5: The number of State bathing water standard violations at Lake Erie beaches, 1978 and 1979, based upon fecal coliform geometric means exceeding 200/100 ml.

Key to Map	Beach	1978[a]	1979[b]
A	Crane Creek	0	0
B	Camp Perry	0	0
C	Port Clinton	6	6
D	East Harbor	0	0
E	Lakeside	0	0
F	Bay Point	0	0
G	Cedar Point Causeway	0	0
H	Nickle Plate	0	2
I	Vermilion	4	4
J	Lakeview Park	0	1
K	Century Park	4	2
L	Sheffield	8	1
M	Avon Lake	6	7
N	Huntington	0	2
O	Edgewater - East	12	3
	Edgewater - West	-	6
P	Mentor-on-the-Lake	0	0
Q	Mentor Headlands - East	0	0
	Mentor Headlands - West	-	0
R	Fairport Harbor	0	0
S	Tuttle	0	0
T	Madison Township	0	0
U	Geneva - East	0	0
	Geneva - West	-	0
V	Geneva Township	0	0
W	Saybrook	2	0
X	Walnut	0	0
Z	Conneaut Beach	0	0

a 13 possible violations for beaches A through L;
15 possible violations for beaches M through Y

b 8 possible violations for beaches A through Y

Table VIII-6: The number of fecal coliform concentrations exceeding 400/100 ml (bathing water standard violation), and 2000/100 ml (primary contact recreation standard violation) at Lake Erie beaches, 1978 and 1979.

Key to Map	Beach	Number of values exceeding 400		1000		2000		5000	
		1978	1979	1978	1979	1978	1979	1978	1979
A	Crane Creek	0	2	0	1	0	1	0	1
B	Camp Perry	0	2	0	1	0	0	0	0
C	Port Clinton	5	4	2	3	2	3	2	3
D	East Harbor	0	0	0	0	0	0	0	0
E	Lakeside	2	3	2	2	2	2	2	2
F	Bay Point	0	0	0	0	0	0	0	0
G	Cedar Point Causeway	2	0	0	0	0	0	0	0
H	Nickle Plate	1	3	1	1	1	0	1	0
I	Vermilion	3	5	1	4	1	4	1	4
J	Lakeview Park	0	3	0	1	0	0	0	0
K	Century Park	4	2	2	1	1	1	0	1
L	Sheffield	5	3	2	2	2	1	0	0
M	Avon Lake	5	8	2	5	1	5	1	2
N	Huntington	2	3	0	3	0	2	0	1
O	Edgewater - East	4	5	4	5	3	5	3	3
	Edgewater - West	8	11	3	7	2	6	2	3
P	Mentor-on-the-Lake	1	2	0	1	0	0	0	0
Q	Mentor Headlands - East	2	1	1	0	0	0	0	0
	Mentor Headlands - West	1	1	1	1	0	0	0	0
R	Fairport Harbor	0	0	0	0	0	0	0	0
S	Tuttle	1	2	0	1	0	0	0	0
T	Madison Township	2	0	0	0	0	0	0	0
U	Geneva - East	1	2	1	0	0	0	0	0
	Geneva - West	-	1	-	0	-	0	-	0
V	Geneva Township	0	0	0	0	0	0	0	0
W	Saybrook	7	3	4	1	2	0	0	0
X	Walnut	1	3	0	1	0	0	0	0
Z	Conneaut Beach	0	3	0	2	0	0	0	0

Areas of Water Depletion

Water quality problems arising from the depletion of a water resource are not a widespread concern in Ohio. However, segments of at least three rivers experience aggravated, water quality problems because of water withdrawals for public water supplies. The diversion of substantial volumes of water from rivers during the dry summer months can leave inadequate dilution water for the assimilation of municipal and/or industrial wastewater effluents. The Cuyahoga River in the Akron-Kent area, the East Branch of the Rocky River at Berea and the Scioto River at Columbus are three river segments where water quality degradation is particularly severe due to upstream water withdrawals. The reader is referred to the specific subbasin reports (Volume IV) for additional details concerning these three segments.

Consumptive uses of water in Ohio are minimal. Approximately 5 percent of the water withdrawn for all uses in the Ohio River Basin is consumed (i.e., water removed from and not returned to the ground water/surface water environment) (Murray and Reeves, 1977). Irrigation is the major consumptive use of water nationwide, but only 54,000 acres of Ohio cropland are irrigated (SCS, 1979).

REFERENCES

Murray, C.R., and E.B. Reeves. 1977. Estimated use of water in the United States in 1975. Geological Survey Circular 765. U.S. Geological Survey, Dept. of Interior, Washington, D.C., 39 pp.

Soil Conservation Survey. 1979. Ohio resources inventory: natural resources and erosion inventory - 1977. U.S. Dept. of Agriculture, Soil Conservation Service, Columbus, Ohio.

TOXICS

1980 305(b) Report
Volume VIII

Prepared by
J.F. Estenik

Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Toxics

The approximate number of water pollution incidents that were investigated by the Ohio EPA Emergency Response during 7/77 to 7/78 and 7/78 to 7/79 were 1314 and 1896, respectively. The numbers of incidents by category, i.e., hydrocarbons, chemical, sewage and other, are found in Tables VIII-7A and VIII-7B. The highest numbers of toxic incidents for each reporting year occurred in the hydrocarbon category (gasoline, oil, fuel oil, etc.) followed by toxic chemical incidents.

The Adjutant General Disaster Service Agency (DSA) has primary responsibility for responding to radiation incidents in Ohio. Ohio EPA Emergency Response generally responds to 3 to 5 radiation incidents per year. New programs are being developed by Emergency Respnse and DSA to coordinate radiation response activities throughout the State.

An estimate of the river miles affected by toxic spills is given for each month beginning with August 1978. An estimated 1215 river miles were affected by toxic spills from August 1978 to July 1979.

Sewage Byasses and Public Drinking Water

There were no known incidents where public drinking water was affected by sewage bypasses during the reporting period. The Ohio EPA Emergency Response notifies public drinking water personnel downstream of a reported sewage bypass. There were 69 and 50 reported sewage bypass incidents during 7/77 to 7/78 and 7/78 to 7/79, respectively (Table VIII-8). In most cases, the amount of sewage bypassed (71% and 82%) was unknown; the duration of the bypass was unknown for 17% and 18% of the bypass incidents.

Table VIII-8: Sewage bypasses and public drinking water personnel notifications[a]

Year	Reported Incidents (Number of Dischargers)	Unknown Amount ( )[b]	Unknown Time ( )[c]
7/77 to 7/78	69 (40)	49 (71)	12 (17)
7/78 to 7/79	50 (40)	41 (82)	9 (18)

[a] Bypasses occurring in Lake Erie and the Ohio River are not included.

[b] Percent of incidents when the total amount of sewage bypassed was unknown.

[c] Percent of incidents when the duration of the sewage bypasses, independent of unknown amount incidents, was unknown.

Emergency Reponse includes sections titled "Hydrocarbon Case Histories" and "Highlights of Chemical Spills" which are brief descriptions of pertinent information about major hydrocarbon and chemical spills as part of a monthly report. Emergency Response keeps data about toxic spills and sewage bypasses in a computer file; data includes the spill number, the date the incident occurred, the date the incident was reported, the entity involved, who reported the incident, the time lapse for the incident, the Ohio EPA district, the location (county and town), the waterway affected, the incident size, the type the amount, and the type of material involved.

Table VIII- 7A: Water Pollution Incidents (7/77 to 7/78)

Date	6/28/77 7/27/77	7/28/77 8/28/77	8/29/77 9/27/77	9/28/77 10/27/77	10/28/77 11/27/77	11/28/77 12/27/77	12/28/77 1/27/78	1/28/78 2/26/78	2/27/78 3/24/78	3/25/78 4/30/78	5/1/78 5/30/78	6/1/78 6/30/78	Total[b] 6/28/77-6/30/78
Incidents by Type													
Hydrocarbons	71	58	66	61	59	a	58	55	a	134	94	57	713
Chemical	16	25	16	17	16	a	19	17	a	30	29	35	220
Sewage	22	17	14	11	16	a	18	24	a	30	30	13	185
Other[c]	20	22	17	17	16	a	13	14	a	12	38	27	196
River Miles Affected	-	-	-	-	-	-	-	-	-	-	-	-	-

Table VIII- 7B: Water Pollution Incidents (7/78 to 7/79)

Date	7/1/78 7/31/78	8/1/78 8/31/78	9/1/78 9/30/78	10/1/78 10/31/78	11/1/78 11/30/78	12/1/78 12/31/78	1/1/79 1/31/79	2/1/79 2/28/79	3/1/79 3/31/79	4/1/79 4/30/79	5/1/79 5/31/79	6/1/79 6/30/79	Total[b] 7/1/78-6/30/79
Incidents by Type													
Hydrocarbons	47	68	50	64	70	a	76	106	116	87	86	98	868
Chemical	44	23	30	29	22	a	29	31	51	57	64	34	414
Sewage	21	18	16	21	12	a	10	16	25	19	21	24	203
Other[c]	42	27	20	34	24	a	33	32	55	45	53	46	411
River Miles Affected[d]	-	70.4	84.7	127.25	92.75	-	82.1	155.75	153.25	173.5	165.5	109.75	1215

a. Data unavailable.
b. Excludes months when data were not available.
c. Other includes radioactive, miscellaneous and unknown incidents.
d. Approximate mileage.

POINT SOURCE BASIN LOADING ESTIMATES

1980 305(b) Report
Volume VIII

Prepared by
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Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Point Source Basin Loading Estimates

Summary

A description of LEAPS, an Ohio EPA National Pollutant Discharge Elimination System (NPDES) Self Monitoring Program data storage and processing system, is presented in this section. Two Tables (Table VII-8 and Table VII-10) list sources of basin loading data by entity for the State, i.e., for both designated and non-designated areas. A brief description of the kind of basin loading data found in each designated area document (Table VIII-9) and in each non-designated document (Pages 28-30) are also given.

Data Base

The Ohio EPA NPDES Self Monitoring Program data are processed by LEAPS, a comprehensive data storage and processing system designed and used by the Ohio EPA. NPDES permit holders submit data which is stored, processed and screened by LEAPS to determine exceptions to entities' permit requirements.

There are two distinctly different types of descriptive records contained in the computer based NPDES Permit file. The first type of record describes the facility covered by the permit. Information in this category includes:

1. The name of the owner of the facility or the parent company name.

2. The name of the division of the parent company (if any). The specific name of the plant covered by the permit (if any).

3. The mailing address for information sent to the facility that pertains to specific permit reporting requirements.

4. Alternate names or previous names used for the facility covered by the permit.

5. Alternate mailing address (previous mailing address) for the facility covered by the permit.

6. The name of an individual to whom correspondence is sent regarding reporting requirements in the permit.

7. The telephone number of the individual or office to contact regarding reports submitted to OEPA.

8. The name and title of the individual at the owner's address that is to be contacted regarding administrative matters regarding the contents of the NPDES permit.

9. The mailing address of the owning or controlling company for the permitted facility.

10. Three digit numbers used to identify reporting stations(s) for water quality for the following;

    a. in the receiving stream upstream the facility,

    b. at sampling stations that are internal to the facility and prior to a point of discharge,

    c. at the discharge(s) from the facility to the waters of the state,

    d. in the receiving stream downstream of the facility,

    e. that is taken or discharged below the general surface of the land, and

    f. of discharges that are applied to the land surface and do not directly enter the waters of the state.

11. Four digit SIC numbers are used to describe the facility and the process used in manufacture of the product(s). The type of manufacturers that contribute to the sewage load in sufficient quantity to significantly alter the character of the facility's discharge from what would be expected from a facility of this type are identified for municipalities covered by an NPDES permit.

12. A description of the product(s) of the manufacturing facility.

13. An indication of the months that are considered as winter, spring, summer and fall by the officials at the facility and the average number of hours per week in each season when the facility is in operation or staffed.

14. The name of the stream that transports the discharge from the facility out of the state (either Lake Erie or Ohio River).

15. The name of the stream that transports the facility's discharge to the Major Basin.

16. Coded information that discloses the complete network of receiving streams from the point of discharge from the facility through the major receiving basin.

17. The station numbers that are used to determine the general ambient conditions of the receiving stream i.e., nearest OEPA supported STORET ambient water quality monitoring station upstream of the facility's discharge, nearest OEPA supported

STORET ambient water quality monitoring station downstream of the facility's discharge and the USGS gauging station (if any) nearest to the facility's discharge and on the same stream.

18. The four (or fewer) letters used to disclose the Ohio EPA district in which the facility is located.

19. The name of the county where the majority of the liquid wastes from the facility are discharged.

20. A number used to designate the county name, i.e., a number from one to 88 when the counties are alphabetized.

21. The estimated population served by the municipal facility covered by an NPDES permit. This information is reported in millions of people or equivalent, the actual number of people, the BOD_5 population equivalent and the suspended solids population equivalent that the facility was designed to serve.

22. The flow information regarding the wastes from the facility including the maximum design capacity and maximum designed hydraulic capacity of the facility.

23. The flow information regarding the current wastes from the facility at the time the permit was written including; the dry weather average flow, the maximum reported monthly average and the maximum reported daily flow.

24. Additional comments supplied by a variety of offices and the person that originally supplied the information to compile the record.

25. The name of the individual that last supplied update information for the record.

26. Location information regarding the author or last person to update the record.

27. Telephone information for the most current author of the record.

28. Computer generated information regarding the year and month of record creation and the year and month that the record was last updated.

29. The date the record was coded by the author.

The second type of record describes the limitations set in the permit for a particular period of time. Information in this category includes:

30. The code number for the station covered by the record and the period of time it is to be in effect. The following data are listed.

    a. the station code,

    b. the year/month the information in the record becomes effective and through which it is effective,

    c. the latitude and longitude of the sampling station,

    d. the length of the receiving stream from the point of facility discharge until the receiving stream either changes its name or exits the state.

       This information is only used on the sampling stations external to the facility.

31. Information regarding the NPDES permit that details the requirements that are coded in the record (Self monitoring data supplied by the permittee). This data includes;

    a. the U.S. EPA permit number equivalent to the NPDES permit number assigned to the facility by OEPA,

    b. the OEPA NPDES permit number,

    c. the year/month/day that the permit became effective, and

    d. the year/month/day that the permit expires.

    e. a description of the sampling station. Three digit numbers are used to identify reporting station(s) that are in a stream line from one point to another within the facility.

    f. a detailed coding that discloses permit requirements for a single constituent in the sampled water.

    g. the net field (used when it is necessary to determine the difference between reported values for this station and another station for the same period of time,)

h. the reporting code number (generally equivalent to the code assigned by U.S. EPA in the STORET program),

i. the maximum concentration limitation established in the permit.

j. the minimum concentration limitation established in the permit,

k. a daily reporting frequency requirement indicator.

l. a monthly frequency reporting requirement, i.e. the number of days to be reported per month,

m. a quarterly frequency reporting requirement in terms of the number of samples in a quarter.

n. an annual frequency reporting requirement in terms of the number of samples in a year,

o. an indicator that the permit was not specific as to how frequently a report would have to be prepared, and

p. a code to indicate the type of screening that the permit requires.

32. The name of the individual that last supplied update information for the record.

33. The location information regarding the author or last person to update the record.

34. Telephone information for the most current author of the record.

35. Computer generated information regarding the year and month of record creation and the year and month that the record was last updated.

36. The date that the record was coded by the author. (OEPA, no date)

The Ohio EPA has not developed a computer software program for LEAPS. Therefore, basin and subbasin loadings cannot be mathematically manipulated by individual parameter or by category, i.e., industrial or municipal. Basin loadings, reported by entity, are listed in various continuing planning agency documents for designated areas (Tables VIII-9 and VIII-10) and in Ohio EPA Water Quality Management Planning documents for non-designated areas (Table VIII-11). The kind of basin loading data found in each designated area document are listed in Table VIII-10).

Table VIII-9: Continuing planning agency (areawide)
Load and flow data references
for designated areas in Ohio

Agency	Document	Date	Planning Area	Data	
				Type	Page(s)
Ohio Kentucky Indiana Regional Council of Governments (OKI)	OKI Regional Water Quality Management Plan	06/01/77	Great Miami River Basin	Municipal flows & loads	VI-24 to 33
				Industrial flows & loads	VI-33 to 38
			Little Miami River Basin	Municipal flows & loads	VII-21 to 31
				Industrial flows & loads	VII-31 to 33
			Mill Creek Basin	Municipal flows & loads	VIII-14 to 18
Miami Valley Regional Planning Commission (MVRPC)	MVRPC 208 Water Quality Management Plan (undergoing revision) Potential Alternative Reports (7)	01/11/77	WQMA 4	Municipal flows & loads	Chapter IV (each doc.)
		05/20/77	WQMA 18,19,20,21		
		07/78	WQMA 17,22,23 25,26,27,29	Industrial flows & loads	Chapter VII (each doc.)
		03/25/77	WQMA 1,2,28		
		03/14/77	WQMA 3		
		08/78	WQMA 6,7,8,9		
		08/78	WQMA 5,10,11,12, 13,14,16		
MVRPC - Continued (prepared by the Miami Conservancy District (MCD)	Interim 208 Technical Report Point Sources of Pollution, Step 1-6	09/01/75	MVRPC Region	General reference document that lists where data can be found	85 pages
	208 Technical Program Inventory & Evaluation of Point Source Structural and Non-Structural Controls	04/76	MVRPC Region	Industrial flows & loads	8
				Institutional flows & loads	10

Table VIII-9 (con't): Continuing planning agency (areawide) Load and flow data references for designated areas in Ohio

Agency	Document	Date	Planning Area	Data	
				Type	Page(s)
Toledo Metropolitan Council of Governments (TMACOG)	TMACOG Areawide Water Quality Managment Plan 208 Baseline Report (Appendix A)	07/76	Minor Basins	Municipal flows & loads Industrial flows & loads	A-2-31
Eastgate Development and Transportation Agency (EDATA)	EDATA Areawide Water Quality Management Plan	07/77			
	208 Planning Base Report	04/76	F.P.A.'s	Municipal flows & loads	
	Volume five	07/77	Several Industries	Industrial flows & loads	
Northeast Ohio Areawide Coordinating Agency (NOACA)	Northeast Ohio Lake Erie Basin Plan		By basin and service area		
	Interim Report on 208 Water Quality	05/27/77 (revised 03/21/80)	Cuyahoga Co.	Municipal flows & loads	4-4 to 27
			Geauga Co.	Municipal flows & loads	4-4 to 27
			Lake Co.	Municipal flows & loads	4-39 to 48
			Lorain Co.	Municipal flows & loads	4-48 to 54
			Medina Co.	Municipal flows & loads	4-54 to 66
			Portage Co.[a]	Municipal flows & loads	4-66 to 77
			Summit Co.[a]	Municipal flows & loads	4-78 to 82

Table VIII-9 (con't): Continuing planning agency (areawide) Load and flow data references for designated areas in Ohio

Agency	Document	Date	Planning Area	Data	
				Type	Page(s)
Northeast Ohio Four County Regional Planning and Development Organization (NEFCO)	NEFCO Clean Water Plan (Volume II, Appendix D)	08/78	By discharger	Municipal & industrial flows & loads (permit requirements)	D-4-42
	Clean Water Plan Revisions	08/08/79 11/01/79	Dischargers identified as municipal industrial private 11/1/79 revision in basin summaries.		85-393
	Muskingum Watershed Water Quality Assessment and Low Flow Analysis[b]	1975	Existing load & flow data for certain dis-chargers in the Upper Muskingum	Municipal and Industrial	

[a] To be integrated into the NEFCO Clean Water Plan.
[b] Prepared by Havens and Emerson for the State of Ohio.

Table: VIII-10: The kind of loading data found in the continuing planning agency reports (designated areas)

Agency Contact Person Telephone Numbers	NPDES Permit Numbers	Entity Name	County	Basin (Minor Basin)	Receiving Stream	Mile Point (River Mile Index)	Existing Loading (Estimated Loadings)	Final NPDES Permit Concentrations
OKI Dory Montazemi (513)621-7060	X	X	X	X	X	X (X)	X	X
MVRPC Richard Robertson (513) 223-6323	Interim 208, 1975	X	X	Water Quality Management Areas	X	X	X	X
TMACOG Edward Hammett (419) 241-9155	X	X		X (X)	X	(X)	(X)	
EDATA John Getchy (216)793-3282		X					X (X)	
NOACA James Cubis (216)241-2414		X		X			X (X)	
NEFCO Charles Larlham (216) 253-4196	X	X	X		X		X	X

Table VIII-11: Ohio EPA Water Quality Management Planning Documents (non-designated areas)

Ashtabula/Grand River Basins

Central Ohio River Tributaries

Great Miami River Basin

Hocking River Basin

Huron/Vermilion River Basins

Little Beaver Creek Basin

Little Miami River Basin
Southwest Ohio River Tributaries

Maumee/Portage River Basins

Muskingum River Basin

Sandusky River Basin

Scioto River Basin

Southeast Ohio River Tributaries

Wabash River Basin

The following basin loading data are found in each non-designated area document.

PUBLIC AND SEMI-PUBLIC FACILITY DATA

Public and Semi-Public Wastewater Treatment Facility Data provides information on Public and Semi-Public Facilities with design flow of not less than 0.025 mgd. The information is taken from STORET 245 data. Municipal Needs Survey, NPDES Reports and OEPA District Office Correspondence. Each column within the table and its important features are noted below:

Columns 1 and 2 - The map codes, facility names (same as plant names) and numbers are identical to those given in the Public and Semi-Public Wasteater Discharges Effluent Data Table. The second column also gives the owner's name as well as the county in which the facility is located.

Columns 3 and 4 - The Design Population Equivalent is the calculated population that would be served by the facility when the volume and strength of the waste reach the design limits. A population equivalent is computed to be approximately 0.17 pounds (0.08 kg) of BOD, 0.20 pounds (0.09 kg) of TSS and/or 100 gallons (378.5 l) of flow. Column 3 also contains an estimate of the actual population now being served by the facility. Column 4 lists the design flow capacity in mgd of the treatment facility.

Column 5 - The type of tretment has been classified as either primary, secondary or tertiary with some details given, when available, as to materials and treatment units used.

Column 6 - The characteristics of the wastewater has been classified as either domestic or domestic and industrial. When industrial flow is involved the type of individual waste is mentioned and the volume of industrial flow in mgd appears below the line.

Column 7 - The method used to treat sludge collected during the wastewater treatment process is shown above the line. The method of ultimate sludge disposal appears below the line.

Column 8 - The availability of land to expand or upgrade the existing facility, is indicated in this column. Very little information has been presented concerning the availability of land.

Column 9 - The last column contains remarks concerning any known condition, problems or information that may affect the operation of the facility.

INDUSTRIAL FACILITY DATA

Industrial Wastewater Treatment Facility Data, provides information on those industrial facilities which are judged to have significance as sources of point-source pollution. The table is composed of facilities which discharge to a stream, either directly or via a storm sewer, and have applied for or received an NPDES Permit. All information was gleaned from correspondence in the files of the Central and District Offices of the OEPA and discussion with various members of the OEPA Engineering staff. Major sources of information were Compliance Monitoring Reports and other documents describing on-site plant inspections by OEPA personnel. Each column within the table and its important features are noted below.

Column 1 and 2 - The map codes, facility names and numbers in the first and second columns are the same as in the Industrial Wastewater Dischargers Effluent Data Table. Both tables refer to the same map. The second column also gives the owner's (corporate) name, as well as the location of the facility. The location is the actual plant address, where available, or else the mailing address for NPDES permit correspondence.

Column 3 - This column shows the principal products or activities at the facility and the corresponding Standard Industrial Code.

Columns 4 through 7 - These four columns consitute the outfall, flow waste and treatment descriptions. Column 4 is the outfall station designator. Numbers beginning with a 6, however, such as 601, are internal stations that exist to allow monitoring and evaluation of performance of individual components of the waste treatment system. These stations discharge to another station such as 001 before entering a stream. A number beginning with 5, such as 503, represents disposal to either a surface lagoon or an underground stratum. These 3 digit numbers, when atached to the right end of the facility number, are the numbers listed in the second column of the Industrial Wastewater Discharges Effluent Data Table. Column 5 is the volume of flow during the period of record which is the same flow as shown in the Industrial Wastewater Dischargers Effluent Data Table, unless indicated to be estimated from sources other than the self-monitoring data. Column 6 is the origin of the waste; whether sanitary, process, cooling, etc. and column 7 is the treatment processes employed.

Columns 8 and 9 - The final two columns of the table concern availability of land for expansion or upgrading of treatment facilities and remarks. Column 8 is usually blank due to the lack of information and will need to be completed in a later revision. The remarks column, whenever possible, is used to point out the particular aspects of the facility's operation which render them troublesome as a polluter, and the steps being taken to remedy the problems." (OEPA, 1980)

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Ohio Environmental Protection Agency. 1980. Initial Water Quality Management Plan Wabash River Basin. Ohio EPA, Columbus, Ohio, p. 13.

NON-POINT SOURCE ASSESSMENT

1980 305(b) Report
Volume VIII

Prepared by
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Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Non-point Source Assessment

Summary

The following excerpts from two Ohio EPA documents (OEPA, 1979; OEPA, 1980) briefly summarize the Agency's strategy for non-point source pollution assessment. The methodologies developed to date have been used to rank the sediment producing potential of the 133 hydrologic subbasins in the State; pollutants associated with sediment (nitrogen, phosphorus and BOD_5) can also be addressed. Information concerning the levels of sediment and other non-point source pollutants in Ohio streams and their relationship to the clean water goals has not been adequately addressed.

Data Base and Evaluation

The Ohio Environmental Protection Agency contracted with W.E. Gates & Associates, Inc., to develop a computer-based system that would "...include the capability to store an extensive data base and also the ability to manage the complex data manipulations and computations required in the environmental planning and management process. Beyond these features, it was desired to have essentially no restrictions on the type and number of alternatives that might be proposed and to be able to accept information, in whatever form it existed, from participants in the environmental planning process" (OEPA, 1979).

"W.E. Gates & Associates, Inc., used the Areal Design and Planning Tool (ADAPT) as the foundation for the Planning and Engineering Data Management System for Ohio (PEMSO). ADAPT was originally developed by W.E. Gates & Associates, Inc., to meet the needs of environmental management planning. The full PEMSO system includes ADAPT and a system developed by the Ohio EPA to link land based information (ADAPT) to hydrologic and water quality information. This is done through the River Mile Index (RMI). Together, the land based system, the River Mile Index, and the associated water quality information comprise the PEMSO System" (OEPA, 1979).

"The Ohio EPA uses the Planning and Engineering Data Management System for Ohio, as a computerized data base which links land based, hydrologic and water quality information. PEMSO is suited for environmental problem solving processes in which topography (the surface features of an area), hydrology and the spatial distribution of activities are likely to affect one another. The PEMSO system focuses on topography and the spatial distribution of activities because of the major role that they play in determining the character and magnitude of environmental problems and in determining the acceptable solutions to such problems.

PEMSO is a computer-based spatial information system in which:

Large amounts of land based data can be stored and manipulated.

The data base can be easily updated or modified.

The level of detail can vary within the data base.

Computer programs can be used to do the bulk of data manipulation necessary to characterize alternative types of environmental management programs" (OEPA, 1979).

Ohio EPA uses PEMSO in conjunction with a non-point source screening model to assess non-point pollution problems. The non-point source screening model utilized "...is designed to provide an estimation of the relative level of non-point source sediment pollution from drainage basin land areas. It estimates both rural and urban sediment yields, and the associated pollutants; specifically nitrogen, phosphorus and 5-day biochemical oxygen demand (BOD_5). The results can be expressed as the annual pollutant load for a basin, for a specific subbasin, or for an individual triangle in the PEMSO data base. Yields from rural land areas are calculated by a soil loss equation, while urban area yields are calculated by a curb mile index. For rural land use, the calculation utilizes the Universal Soil Loss Equation (USLE) and an area based sediment deliver ratio (SDR). Results are calculated for both gross rural sediment and for delivered sediment. For urban land use, the results are derived from urban land use pollution loading rates, storm event data and the curb mile index. Results are for total urban sediment, and assume 100 percent delivery of pollutants to the stream. Associated pollutant calculations for nitrogen, phosphorus, and 5-day biochemical oxygen demand are also calculated differently for rural and urban land use. For rural land use, the model estimates that these pollutants are a specified percentage of sediment. For urban areas, the pollutant loads are dependent on both land use and total sediment load. The results also include a listing of the data used for each model run, and the rural sediment delivery ratio calculated from the terrain representation in the data base. The results can be expressed on a triangle-by-triangle basis for a subarea or an entire basin. However, because of potential variation in the results and general level of information used to calculate results, the best use of the data is in ranking the larger areas, rather than to specifically predict loads. In this analysis, the sediment predictions were used to rank the State's 133 hydrologic subbasins" (OEPA, 1980). The rankings are discussed in detail in the results section of the report, and detailed model results and specific rankings are provided in Table I (OEPA, 1980).

REFERENCES

Ohio Environmental Protection Agency, 1979. The PEMSO System Orientation Manual, Report No. 1, OEPA, Office of the Planning Coordinator, Columbus, Ohio.

Ohio Environmental Protection Agency, 1980. The PEMSO System Nonpoint Source Screening, Report No. 2, OEPA, Office of the Planning Coordinator, Columbus, Ohio.

ECONOMICS

1980 305(b) Report
Volume VIII

Prepared by

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Economic Evaluation Section

Economics

Summary

This section discusses the economic impacts of achieving or not achieving the goals of the Clean Water Act. A quantitative assessment of these costs is presented for municipal and industrial compliance where available. The remaining sections deal with benefit estimation techniques and a discussion of a time frame for compliance with the goals of the Clean Water Act.I.

Introduction

The following discussion will present the available, quantitative facts concerning the economic impacts of the Clean Water Act (PL 92-500) on the State of Ohio. An assessment of the economic impacts must consider not only the costs of attaining the goals of the Act, but also the costs associated with not achieving those goals.

Information concerning the economic costs associated with achieving or not achieving the goals of the Clean Water Act is not available in a complete form. Given the nature of the assessment and the uncertainty involved, exact cost estimates in many cases are difficult - if not impossible.

The following narrative will present those costs which have been documented and discuss those areas in which the quantification of economic impacts is currently unavailable.

II. Economic Impacts of Achieving the Goals of the Clean Water Act

The economic impact of achieving the goals of the Clean Water Act must take into account both the direct and indirect costs of compliance. The direct costs of compliance, the dollar outlay to finance or maintain pollution abatement facilities, are the most easily identifiable. The assessment of the indirect costs present a more difficult task.

Indirect costs of compliance include those costs not directly expended to purchase or maintain pollution abatement practices. For example, the costs associated with the closure of an industrial plant due to required environmental expenditures and the resultant disruption in the area's economy represent indirect costs of compliance. In the municipal sector, a decline in public services provided by municipalities to finance wastewater treatment facilities would represent indirect costs of compliance. Current economic impact data do not assess these costs on a statewide basis, however, there is limited information concerning the results of closure or declining economy for selected basins in the State. In fact, due to the many factors which influence the results, a long range assessment of these economic costs becomes extremely difficult.

The economic impact of direct costs can be determined with a greater degree of accuracy. An estimate of direct cost impacts is determined according to the expenditures required for municipal wastewater treatment and those required for industrial wastewater treatment.

Municipal Costs

The direct economic impact of achieving the 1983 goals of the Act for Ohio municipalities has been largely assessed in the 1978 NEEDS Survey, "EPA Assessments for Construction of Publicly Owned Wastewater Treatment Facilities" (U.S. EPA, 1979). The survey, conducted for U.S. EPA by Dames & Moore Researchers, Inc., presents a cost estimate of achieving the 1983 goals of the Clean Water Act. The results were published on a state by state basis. A 1978 estimate of the additional expenditures required of Ohio's public entities to comply with the 1983 goal is as follows (U.S. EPA, 1979):

Category	Definition	Cost (millions of 1978 $)
I	Secondary Treatment	$ 86
II	Higher than Secondary Treatment	$ 1,656
III	Correction of Infiltration & Inflow	$ 256
IV	Major Rehabilitation of Sewers	$ 8
V	New Collector Sewers	$ 683
VI	New Interceptor Sewers	$ 825
VII	Control of Combined Sewer Overflow	$ 3,261
TOTAL		$ 6,777

It should be noted that the above figures do not include all costs which municipalities will be required to expend to comply with the 1983 goal of the Clean Water Act.

It does not include the cost of facilities planning, which must assess innovative and alternative treatment, on-site disposal systems or the possibility of instituting a regional system.

Additionally, it includes only the required, capital cost expenditure. It does not assess the cost of amortizing the capital expenditure (i.e., bond sales and resultant interest costs). In some cases, the NEEDS survey details the estimated costs of the treatment works alone and does not address the cost of the collection system.

A major expenditure category not included in the NEEDS Survey is operations and maintenance costs. These costs represent a substantial portion of a municipality's annual outlay for wastewater treatment. For many Ohio municipalities, operation and maintenance expenditures will be greatly increased due to treatment requirements more stringent than secondary.

These and many additional expenditures are required of a municipality and an estimate of these expenditures should be added to the total NEEDS Survey cost figures.

Industrial Costs

For many reasons, data assessing the compliance cost for industrial dischargers in Ohio is limited. First, equipment and plant processes necessary to treat industrial wastes vary widely for each industry. Accurate compliance cost estimates would probably have to be made on a plant by plant basis. Second, since BAT guidelines for industry have not yet been promulgated for most standard industrial code categories, economic impacts cannot be accurately assessed. Finally, assessment of the economic impacts of achieving the the goals of the Act require evaluations of future conditions. In the case of industrial compliance, this would require an estimate of the future viability of Ohio's industries.

Assuming compliance with the 1983 goal, it would be difficult to discern what actions a firm would take given the economic conditions of that period. Due to Ohio's early development as an industrial state, many manufacturing facilities are older and would require substantial expenditure to retrofit pollution abatement equipment to meet the 1983/1984 goals. In the case of these older facilities, many of which could be considered marginal operations, the possibility of closing the operation instead of installing pollution abatement equipment becomes a foreseeable option.

Given the above difficulties, an accurate assessment of the cost of compliance for Ohio's industries has not been developed. In order to provide some estimate as to the magnitude of the required expenditures, the following was developed. The costs presented in the 1976, "Staff Report to the National Commission on Water Quality" were updated to 1979 dollars by the Economics Evaluation Section of the Ohio EPA . It was then estimated that Ohio's portion of the total dollar outlay to meet BAT may require an expenditure of several billon dollars. This is presented only as an estimate and will undoubtedly be revised as BATEA limitations are developed.

III. Benefits of Achieving the Goals of the Clean Water Act

The measurement or assessment of the benefits resulting from the attainment of the goals of the Clean Water Act involves both tangible and intangible costs.

In most areas, the benefits to be gained by the abatement of pollution are not directly traded in the marketplace, therefore, they have no evident dollar worth as a measurement of their allocative value to society. In the absence of market forces, the most desirable method is to determine the dollar amount that recipients would be willing to pay for the desired good (i.e., benefit).

The best measurement of the benefits received from improved water quality is the total value of those dollars expended on water related activities. It is important that only the incremental benefits, those which can be directly attributed to a specific improvement in water quality, are measured. For example, if a secondary treatment facility is upgraded to a tertiary treatment facility, the incremental benefits are those benefits which result directly from the improvement in the water quality due to the upgrade. This allows the incremental costs of the project (the cost of the upgrade from secondary to tertiary) to be compared on an equal basis with the incremental benefits received.

The benefits which result from the attainment of the goals of the Clean Water Act will be both tangible and intangible. The measurement of these two types of benefits is different. A tangible benefit can be estimated quantitatively, while an intangible benefit lends itself to abstract (qualitative) measurement. Where possible, a dollar amount should be assigned to the tangible benefit categories. The sum of the dollar benefits represents the benefits attributable to the attainment of the 1983 goals. In addition, a qualitative discussion of the intangible benefit categories should be presented. The tangible plus the intangible benefits result in an estimate of total benefits.

The following is a preliminary list of those activities which can be related to water quality and use. Once again it is not exhaustive, since in many specific cases additional activities may be applicable.

A. Tangible
   1. Boating
   2. Camping
   3. Canoeing
   4. Commercial activities
      a. Fishing
      b. Boat rentals
         1) Canoe liveries
         2) Fishing trips and other rentals
   5. Fishing (for sport)
   6. Hiking
   7. Hunting & Trapping
   8. Picnicking
   9. Sailing
   10. Swimming
   11. Water skiing
   12. Other recreational uses
   13. Water supply
      a. Agricultural
         1) Livestock
         2) Irrigation
      b. Industrial
      c. Public
   14. Property value changes
   15. Health benefits

B. Intangible
   1. Aesthetics
      a. Sight, smell, knowledge of good water quality
   2. Human interest
      a. Scenic views
      b. Parks and reserves

In the absence of federal guidance on benefits estimation procedures, the Ohio EPA has drafted a methodology for the purpose of estimating benefits to the people of the State. There is currently an effort being made to gather the data necessary to determine coefficients for use in the benefits estimation process. When this work is completed, the Ohio EPA will be able to provide benefit estimations.

IV. Economic Impact of Not Achieving the Goals of the Clean Water Act

Assessment of the economic impact of not achieving the goals of the Clean Water Act represents a very complex and involved problem. The economic impact must be assessed in two ways. First, as the value of the forgone benefits of clean water; and second, as the value of the benefits accrued to an entity by delaying or forgoing the installation of pollution abatement equipment.

While it is possible to identify some of the areas in which lost benefits will result from the non-achievement of the goals of the Act, it is very difficult to assign a dollar value to them. In many cases, it is beyond the ability of current estimation techniques to derive a reasonable cost estimate in dollar terms.

For this reason, the following discussion will be limited to outlining those areas in which benefits would be forgone as a result of non-achievement of the goals of the Clean Water Act.

In economic theory, the cost of not doing an action is equal to the value of the forgone benefits of that action. In the case of pollution control, the cost of not cleaning up the environment is equal to the value of the benefits that would have been received due to the cleaner environment. For example, given that pollution in a waterway is in no way reduced, the cost of not cleaning the waterway can be denoted by the following:

(1) The dollar value of the forgone benefits of using the waterway for recreational activities (i.e., boating, swimming, fishing, etc.).

Plus:

(2) The dollar value of the forgone asthetic benefits (i.e., the value of knowing or enjoying the idea of having clean water).

Plus:

(3) The dollar value of the cost expenditures to avoid pollutants (i.e., a municipal water supplier, which intakes from the river, is required to expend additional monies to combat the taste, smell or toxicity of the water's pollutants before use).

Plus:

(4) The dollar value of the increased cost required for health expenditures, assuming that the pollution could be related to health problems.

The above costs are only an example of a few of the benefits of clean water that are lost by non-achievement of the goals of the Clean Water Act. The dollar values of these costs are difficult to ascertain, in most cases, and nearly impossible in others.

In many cases, the dollar value of the economic benefits of delaying or avoiding pollution abatement expenditures can be determined. This is particularly true in the case of industrial or commercial entities. Any delay of pollution abatement expenditures will result in savings equal to the cost of operating the pollution abatement facilities over the period of the delay. Additionally, given that the capital reserved for pollution control expenditures was utilized in other investments during this delay, the economic benefit to the company is equal to the rate of return on that interim investment.

Should an entity be able to avoid pollution abatement expenditures permanently, the economic benefit would equal the present worth of the capital expenditure and the future operations and maintenance charges on the required facilities.

In the case of a municipality, the question of economic gain from non-compliance is more complex. Since a municipality is not a profit oriented concern, forgone pollution abatement expenditures are not always used in other capital investments. Increased sewer fees or additional taxes that would have been used to finance the required facilities are not collected. The resultant economic benefit is accrued to the residents of the municipality in the form of lower taxes or fees, thus allowing them more discretionary income.

When a municipality does divert capital for other public services (i.e., police or fire services) instead of pollution abatement facilities, the question of public service priorities arises. As a result of these questions, the determination of economic benefits from noncompliance in the public sector is difficult.

Development of benefit estimation techniques is continuing and is currently making progress. In the future, it will be feasible to better assess the costs of noncompliance.

V. Estimate of the Date of Achievement of the Goals of the Clean Water Act

Any estimate of the date for achieving the goals of the Clean Water Act is tenuous, at best. The attainment of the 1985 goal, i.e., the elimination of the discharge of pollutants, is an unreasonable expectation and any estimate as to its attainment date would therefore be academic (U.S. Congress, 1977).

The attainment of the 1983 goal of fishable-swimmable waters will be influenced by several factors. Initially, it is somewhat uncertain at this time what limitations will be enforced as compliance with the 1983 goal.

This being due to incomplete and late promulgation of BAT guidelines for industry and the recent institution of AWT reviews for municipal wastewater treatment facilities requiring advanced wastewater treatment. In Ohio, the above mentioned factors are compounded by possible changes in the water

quality standards for Ohio waters. Should the water quality standards be made more stringent, changes will surely result in the schedules affecting the NEEDS survey, 208 planning, NPDES permits and compliance. These changes could substantially delay achievement of the goals of the Act.

Additionally, the date of achievement of compliance for municipalities will be very much dependent upon the federal policy concerning the availability of construction grant monies. Some question remains as to whether enforcement of the goals for municipalities will be precluded by the inavailability of federal construction grant monies.

In fact, the continued availability of construction grant funds cannot be assured and is dependent upon the actions and appropriations of Congress.

Given the current atmosphere, which calls for reductions in federal spending and a shift in emphasis of national goals to energy concerns, the amount of monies available for construction grants may be in question.

All of the above factors represent obstacles to the assessment of a date for compliance with the goals of the Clean Water Act. In order to arrive at a reasonable estimate, these factors must be resolved.

VI. Conclusion

At this date, a reasonably, accurate assessment of the economic impact of the goals of the Clean Water Act on the State of Ohio is unavailable. Given the scope of the assessment, any realistic estimate of economic impact would require substantial funding and manpower. Current Ohio EPA levels of staff and funding are insufficient to undertake an assessment of this magnitude. It is recognized that economic cost estimations are an extremely important tool; and they must be developed to assure that the benefits received from compliance with the goals of the Clean Water Act justify the costs expended.

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COSTS FOR CURRENT NONPOINT SOURCE CONTROL PROGRAMS

Prepared by

Ohio Environmental Protection Agency
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April 1, 1980

COSTS FOR CURRENT NONPOINT SOURCE CONTROL PROGRAMS

SUMMARY

This section outlines those programs currently in use in Ohio to control nonpoint source pollution. A listing of current funding levels is presented to summarize the dollar amounts expended for nonpoint source control measures within the State.

I. INTRODUCTION

Although water pollution control from point sources is gradually being reduced, it is apparent that present water quality standards will not be met in many areas of the State, even if all point sources are eliminated. Increasingly, nonpoint sources of pollution have been identified as a major factor affecting water quality. Due to the nature of nonpoint pollution, sources are difficult to identify and control. Generally, water quality problems associated with these sources are rainfall dependent, i.e., water quality degradation is coincident with periods of heavy rainfall and runoff. They are also diffuse, in that pollution can enter streams over their entire length. These characteristics combine to make nonpoint source monitoring and control difficult and expensive.

Nonpoint source control needs have not been addressed to any great extent throughout the State. Some regional planning agencies have inventoried nonpoint source pollution problems and developed general listings of the type of control practices in use. Ohio EPA has confined itself to only a few nonpoint source categories within non-designated areas.

With the publication of the Initial Water Quality Management Plans (Ohio EPA, 1980), the inventory of nonpoint source pollution problems has been partially completed for the non-designated portion of the State. Information is spotty, at best, being associated with only a few major nonpoint source problems (agricultural runoff, mine drainage and on-lot sewage disposal), and restricted to small areas of individual basins and/or watersheds. Further study is needed to determine what additional regulatory programs and management agencies may be necessary to meet present and future problems.

II. CURRENT NEEDS

In order to significantly reduce nonpoint source pollution, one must treat the land from which it emanates. For example, Ohio's cropland is an area requiring control of sediment loss; pastureland and forest, while having lower annual soil losses, also contribute significant amounts of sediment to streams and lakes.

Providing a complete and precise description of the costs required to deal with nonpoint source needs statewide is difficult because of their diffuse nature and the lack of detailed water quality data available to identify sources and loads. Therefore, the following discussion is general and based on land treatment needs which, if satisfied, will significantly reduce nonpoint source pollution. The discussion is also focused primarily on the cost of reducing nonpoint source pollution from agricultural lands.

Projecting overall treatment costs would have very little reliability because conditions vary widely and nonpoint sources are ill-defined. To provide some insight into the likelihood of achieving nonpoint source control goals, Table VII-12 lists actual governmental expenditures to control nonpoint source pollution rather than projecting overall costs.

Table VIII-12: Funding levels in Ohio for existing programs

1. U. S. DEPARTMENT OF AGRICULTURE (FY 1980)

Soil Conservation Service (SCS)

Conservation Operations	$ 5,560,000
Watersheds	2,416,000
Resource Conservation & Development	447,000
Rural Abandoned Mines Program	728,000
Total SCS	$ 9,151,000

Agricultural Stabilization & Conservation Service (ASCS)

Annual Conservation Practice Program	$ 3,460,500
Special Projects	287,178
Technical Service (to SCS)	197,246
Long Term Agreements (LTA)	460,750
LTA Technical Service (to SCS)	24,250
Special projects from ASCS state reserve (includes several projects around the state)	400,000
Honey Breek Watershed Project	65,000
Brush Creek Project (Proposed)	57,000
Rural Clean Water Program (Ohio)	-0-
Total ASCS	$ 4,951,924

2. U.S. ARMY CORP OF ENGINEERS

Lake Erie Wastewater Management Study total (3 year study)	$ 1,000,000
Honey Creek Watershed (average/year)	100,000
Cuyahoga Restoration Study (3 year study)	150,000
Corp of Engineers Total	$ 1,250,000

3. U.S. EPA REGION V

Agricultural Non-Point Source Planning	$ 275,000
General Non-Point Source Planning	100,000
Total Region V	$ 375,000

ADMINISTRATIVE PROGRESS AND DIFFICULTIES

1980 305(b) Report
Volume ~~VIII~~

Prepared by
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Ohio Environmental Protection Agency
Office of Wastewater Pollution Control
Division of Surveillance and Water Quality Standards

Progress and Difficulties in the Administration of Programs

Progress

With the exception of 14 cities on the Ohio and Mahoning Rivers and one on Lake Erie, secondary treatment facilities have been provided for all communities of over 5000 population in Ohio.

With minor exceptions, Ohio industries which discharge directly to surface waters, meet or exceed the requirements for Best Practical Treatment.

Substantial reduction of phosphorus inputs from Ohio point sources into Lake Erie have been accomplished.

Pollution from new strip mines has been controlled since 1973 by enforcement of the mining and reclamation law of the State.

A greatly expanded stream surveillance effort, which has been in effect since the passage of P.L. 92-500, has provided information needed to determine problem areas and analyze causes and alternatives for correction.

Initial water quality management planning has been completed for the entire state and implementation of some aspects of the planning recommendation is underway.

As documented in this report, there has been significent improvement in water quality due to point source pollution controls at many locations in Ohio.

Difficulties

The most serious difficulty has been the lack of coordination of the interelated program elements of the Clean Water Act (i.e., water quality standards, and wasteload allocations, effluent guidelines, toxic substances, permit issuance and the justification requirements with regard to Advanced Secondary Treatment/Advanced Wastewater Treatment (AST/AWT) projects). This absence of coordination, as well as the lack of a long term strategy, results in crisis management and less than effective use of already inadequate resources. An overall strategy, which takes these issues into account, will result in the maximum use of limited agency resources.

Industrial Program

Further progress in providing industrial wastewater pollution control facilities is dependent upon the establishment by USEPA of Best Available Technology Economically Achieveable (BATEA) Guidelines for toxic pollutants. Unitl this is done, issuance of National Pollutant Discharge Elimination System (NPDES) permits outlining further pollution abatement requirements for industry is being held in abeyance.

Municipal Program

Because of the 75% federal funding for municipal pollution control projects, progress on the construction of needed facilities is totally dependent upon the funding and administration of the 201 construction grants program. The

proliferation of laws, regulations and requirements which apply to the grants program have resulted in a great deal of confusion and delay. Implementation of PRM 79-7, which requires development of elaborate justification for treatment better than secondary, has resulted in further confusion and delay and has caused a loss of creditability for the program.

Proposed funding cuts at the federal level will adversely affect the municipal program in Ohio, since much of the administrative work required is the responsibility of Region V. Joint administration of the program at both the State and federal level is inefficient and efforts thus far to have the program delegated to Ohio have been unsuccessful.

Non-Point and Combined Sewer Problems

As indicated in Ohio's Water Quality Standards, there are numerous stream segments in Ohio which are limited due to combined sewer overflows and many which are limited due to acid drainage from abandoned mines. The cost and feasibility of correcting these problems will preclude the possibility of substantial, overall improvement for these conditions in the near future.

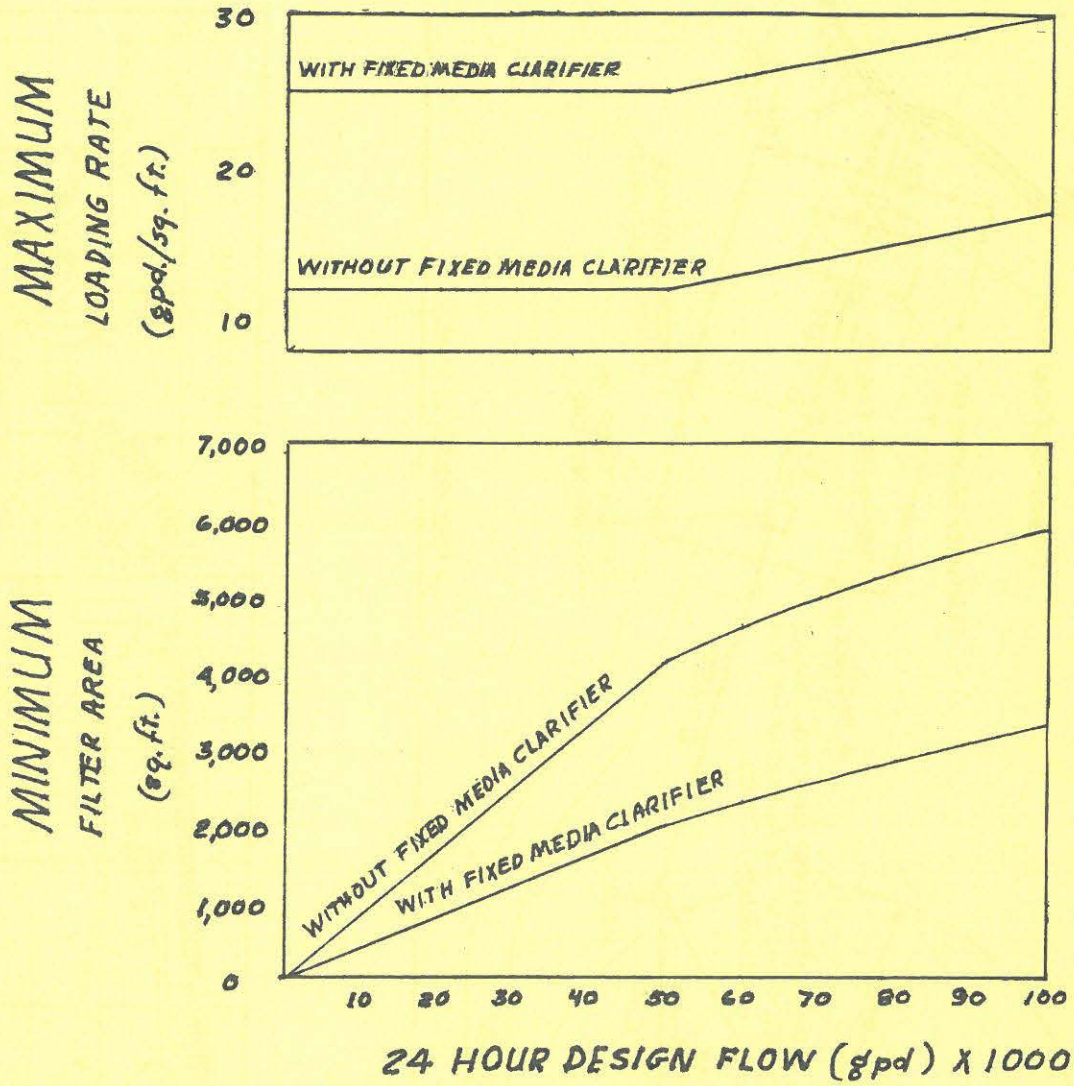
Water quality management planning efforts to date have helped to emphasize the problems associated with the flushing of sediment, nutrients, pesticides, oil and various toxic materials from both urban and rural areas classed as non-point sources. It is doubtful that sufficient funding and/or control programs will be provided in the immediate future to produce a measurable improvement. Bans on the use of certain products have proven to be effective, but there is a practical limit in terms of acceptable tradeoffs between productivity and environmental concerns.

Water Quality Standards and Related Issues

Ohio EPA proposed revisions to the water quality standards (Ohio Administrative Code 3745-1) for the State of Ohio and held public hearings in 1977. Following the public comment period, revised water quality standards were adopted on February 14, 1978. The standards were disapproved by USEPA, Region V on May 17, 1978, but were later (August 9, 1978) approved except for certain provisions. These exceptions generally fall into three categories; 1) downgraded stream segments, 2) instream concentrations for certain parameters - notably dissolved oxygen and cyanide, and 3) certain provisions of the state's anti-degradation policy (i.e., the low flow stream criterion, conditions for exceptions, and mixing zone standards). Between August 1978 and June 1979, Ohio EPA and USEPA, Region V were involved in a series of negotiations with a view toward resolving the outstanding differences between the agencies regarding the disapproved parts of the standards. An early product of these negotiations was the idea of formulating a Memorandum of Understanding (MOU) which would codify the approach agreed upon to resolve differences between the two agencies. No fewer than eleven draft versions of the MOU were exchanged. The provisions of these drafts have varied substantially, and have yet to achieve any general acceptance by the two agencies. A joint hearing on the Ohio water quality standards was proposed by USEPA, Region V in early 1979. This effort failed and on July 6, 1979, USEPA published proposed water quality standards for Ohio surface waters (44FR). Ohio EPA put forth a substantial effort to comment on the USEPA proposal that included an extensive technical justification of its dissolved oxygen,

cyanide, and mixing zone standards, and limited use segment designations. On September 7, 1979, Ohio EPA filed suit against the original USEPA disapproval (August 9, 1978) of Ohio's water quality standards. At this time, there has been no action by USEPA to publish a final rule for Ohio surface waters, nor has there been a final decision on the September 7, 1979 lawsuit. One of the most critical issues at stake in the Ohio EPA-USEPA dispute over water quality standards is the general USEPA policy with regard to Quality Criteria for Water (USEPA 1978) which is commonly referred to as the "Red Book". Current USEPA policy is that all Red Book criteria have presumptive applicability nationwide, unless a state can show evidence that a less stringent criteria is justified. Ohio EPA firmly believes that it has presented adequate justification for those standards that deviate from Red Book criteria.

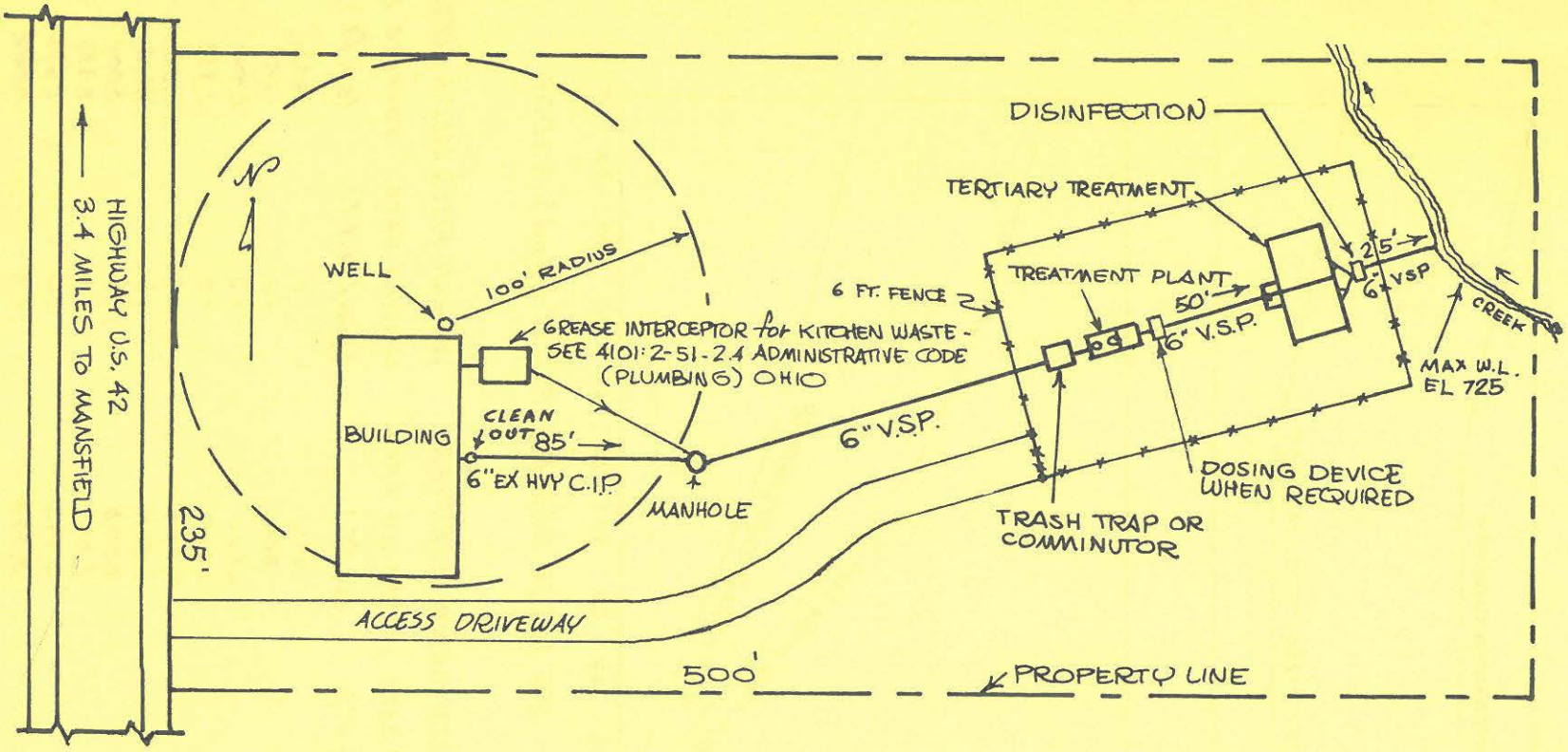
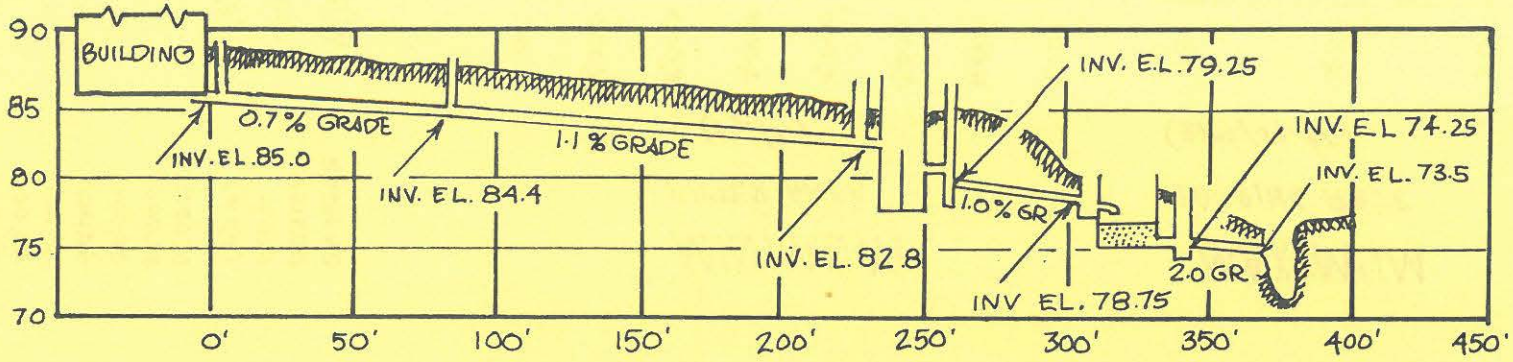
APPENDIX



24 HOUR DESIGN FLOW (gpd)	WITH FIXED MEDIA CLARIFIER		WITHOUT FIXED MEDIA CLARIFIER	
	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)	LOADING RATE (gpd/sq. ft.)	SURFACE AREA. (sq. ft.)
10,000	25	400	12	833
20,000	25	800	12	1,667
30,000	25	1,200	12	2,500
40,000	25	1,600	12	3,333
50,000	25	2,000	12	4,167
60,000	26	2,308	13	4,615
70,000	27	2,593	14	5,000
80,000	28	2,857	15	5,333
90,000	29	3,103	16	5,625
100,000	30	3,333	17	5,882

SLOW SAND FILTERS - LOADING RATE AND AREA

(SEE PAGE 16)

TYPICAL SITE PLAN AND PROFILE

(SEE PAGES 3 & 9)
DRAWING No. 1